

Bibliography and Online TMD-Headache References

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Education, Knowledge and Awareness

1. **Predoxal teaching of temporomandibular disorders - A survey of U.S. and Canadian dental schools.** [Background. In the United States and Canada, there are no specific curriculum guidelines for predoxal dental education in the field of temporomandibular disorders (TMDs). This situation has the potential to cause confusion for new graduates. Methods. The authors sent an 11-question survey regarding predoxal teaching of TMDs to the appropriate faculty members in all U.S. and Canadian dental schools either electronically or via the postal service between June and December 2005. Results. Predoxal teaching of TMD—both didactic and clinical aspects—has progressed. Some schools, however, do not address these topics adequately, while others teach outdated concepts. Conclusions. Both qualitative and quantitative standards are needed to ensure that all predoxal dental students learn about the diagnosis and treatment of nondental orofacial pain problems. Practice Implications. Owing to the lack of standardized predoxal teaching of TMD, U.S. or Canadian patients with TMD or facial pain are at risk when seeking appropriate primary care for their problems.] Klasser GD, Green CS. *J Am Dent Assoc*, Vol 138, No 2, 231-237. <http://jada.ada.org/cgi/content/abstract/138/2/231>

Anatomy, Physiology, Occlusion

2. **An appraisal of the literature on centric relation. Part III.** [The literature directly and indirectly related to centric relation (CR) has been reviewed chronologically. More than 300 papers and quoted sections of books have been divided into three sections. The first two parts are related to CR. Studies in this group mainly compared, either the position of the mandibular condyle or the mandible itself in different CR recordings. Various tools were discussed for this purpose. The third part of the paper is about CR-centric occlusion (CO) discrepancy. CR still remains one of the controversial issues in prosthodontics and orthodontics. Debates such as mounting casts on the articulator by reproducible records for orthodontic treatment planning and end results, and whether or not orthodontic treatment based on CO causes TMJ dysfunction, remain unsolved. The references are listed at the end of Part III.] Keshvad A, Winstanley RB. Department of Restorative Dentistry, School of Clinical Dentistry, University of Sheffield, Claremont Crescent, Sheffield, UK. *Journal of Oral Rehabilitation*, Volume 28 Issue 1 Page 55 - January 2001. <http://www.blackwell-synergy.com/links/doi/10.1046/j.1365-2842.2001.00654.x>
3. **Association Between Mandibular Retrognathia and TMJ Disorders in Adult Females.** [This study assesses the association between temporomandibular joint (TMJ) disorders and mandibular retrognathia. ... Conclusions: We found a strong association between TMJ disorders and severe mandibular retrognathia in adult females. In some women this likely resulted from TMJ disorders influencing mandibular development over time. However, among a subset of women, our data support the reverse hypothesis—that severe mandibular retrognathia may influence the development of TMJ disorders. Despite this strong association, abnormal mandibular position contributed only a small portion to the overall rate at which women sought treatment for TMJ disorders.] Miller JR, Burgess JA, et al. *Journal of Public Health Dentistry*, Vol.64, Issue 3, p.157-163, Sept 2004. <http://www.blackwell-synergy.com/doi/abs/10.1111/j.1752-7325.2004.tb02746.x>

4. **Central distribution of cervical primary afferents in the rat, with emphasis on proprioceptive projections to vestibular.** [The projections of primary afferents from rostral cervical segments to the brainstem and the spinal cord of the rat were investigated by using anterograde and transganglionic transport techniques. Projections from whole spinal ganglia were compared with those from single nerves carrying only exteroceptive or proprioceptive fibers. Injections of horseradish peroxidase (HRP) or wheat germ agglutinin-horseradish peroxidase conjugate (WGA-HRP) were performed into dorsal root ganglia C2, C3, and C4. Free HRP was applied to the cut dorsal rami C2 and C3, greater occipital nerve, sternomastoid nerve, and to the C1/2 anastomosis, which contains afferents from suboccipital muscles and the atlanto-occipital joint. WGA-HRP injections into ganglia C7 and L5 were performed for comparative purposes. Injections of WGA-HRP or free HRP into rostral cervical dorsal root ganglia and HRP application to C2 and C3 dorsal rami produced labeling in dorsal and ventral horns at the level of entrance, the central cervical nucleus, and in external and main cuneate nuclei. From axons ascending to pontine and descending to upper thoracic spinal levels, medial collaterals were distributed to medial and descending vestibular, perihypoglossal and solitary nuclei, and the intermediate zone and Clarke's nucleus dorsalis in the spinal cord. Lateral collaterals projected mainly to the trigeminal subnucleus interpolaris and to lateral spinal laminae IV and V. Results from HRP application to single peripheral nerves indicated that medial collaterals were almost exclusively proprioceptive, whereas lateral collaterals were largely exteroceptive with a contribution from suboccipital proprioceptive fibers. WGA-HRP injections into dorsal root ganglia C7 and L5 failed to produce significant labeling within vestibular and perihypoglossal nuclei, although they demonstrated classical projection sites within the brainstem and spinal cord. The consistent collateralisation pattern of rostral cervical afferents along their whole rostrocaudal course enables them to contact a variety of precerebellar, vestibulospinal, and preoculomotor neurons. These connections reflect the well-known significance of proprioceptive neck afferents for the control of posture, head position, and eye movements.] Neuhuber WL, Zenker W. *J Comp Neurol.* 1989 Feb 8;280(2):231-53.
http://www.ncbi.nlm.nih.gov/sites/entrez?cmd=Retrieve&db=PubMed&list_uids=2466876&dopt=Citation
5. **Central projections of the mesencephalic nucleus of the fifth nerve: An autoradiographic study.** [Mesencephalic nucleus V afferents have collateral connections with the vestibular nucleus (labyrinth/organ of balance) as well as the cerebellum. This clearly means that the posture of patients are paramount in explaining jaw position, forward head position and artifacts encountered in diagnosis. Artifacts and discrepancies seen in posture and electronic diagnostic records must be explained as well as why these must be corrected when correcting the occlusion whether for removable fixed or orthodontic correction. Abstract: Projections of cells of the mesencephalic nucleus of the fifth nerve (Mes V) to brainstem structures in the cat were studied by labelling Mes V cells with tritiated leucine. Before the leucine injections were made, however, large kainic acid lesions were produced in the vicinity of Mes V cells because these neurons are resistant to being killed or injured by this neurotoxin. Thus Mes V cells were selectively labelled by the leucine even though they are scattered among many other neurons. Leucine injections near Mes V cells located in the mesencephalon, which are primarily the somata of jaw muscle spindle afferent fibers, produced essentially the same

pattern of terminal labelling as injections near a caudally located group of Mes V cells that includes the somata of many tooth mechanoreceptive afferents. Labelling was dense above the trigeminal motor nucleus in the nucleus supratrigeminalis and in the most medial portion of the principal trigeminal sensory nucleus. A scattering of labelled axons and diffuse label was seen along the length of the tract of Probst, which follows the medial border of the descending trigeminal sensory nucleus as far caudally as the dorsal motor nucleus of the vagus. Labelling within most of the trigeminal motor nucleus, which is known to receive direct synaptic input from Mes V cells, was very light. The only reasonably dense region of label was confined to a small dorsolateral portion of the motor nucleus. Although Mes V has generally been supposed to be involved with jaw control in a direct, reflexive manner, the extensive projections to nucleus supratrigeminalis and parts of the trigeminal sensory system draw attention to the potential proprioceptive sensory contribution of Mes V.] Luschei ES. *The Journal of Comparative Neurology*, vol 263, Issue 1, Pages 137-145. <http://www3.interscience.wiley.com/cgi-bin/abstract/109689553/ABSTRACT?CRETRY=1&SRETRY=0>

6. **Centric relation, A historical and contemporary orthodontic perspective .** [Background. Centric relation (CR) has been a controversial subject in dentistry for more than a century. For at least the past four decades, issues involving CR have been of interest to orthodontists. The definition of CR has changed over the past half-century from a retruded, posterior and, for the most part, superior condyle position to an anterior-superior condyle position. Type of Studies Reviewed. The authors addressed the historical and contemporary orthodontic perspective of CR. The source material for this review came mainly from literature and searches the lead author accumulated over the last 30 years. As there is no evidence-based (EB) model level 3 (systemic) review on the topic of CR, the best evidence on this subject was gleaned only from a thorough examination and evaluation at EB model level 2 (experience plus best available sample studies). There was, however, enough high-quality EB model level 2 information on the topic of CR for the authors to draw conclusions on the basis of a scientific appraisal of relevant research. Results. Although the reliability of CR records has been substantiated, the records' validity has little to no evidentiary support. In addition, population-based sample studies and consensus statements from national conferences support the view that the positions of the temporomandibular joint (TMJ) condyles in relation to the glenoid fossa or CR position are not diagnostic of temporomandibular disorders. There appears to be little to no benefit of using gnathologic records and articulator-mounted dental casts to discern discrepancies in maximum intercuspation of the teeth coincident with TMJ condyles in an anterior-superior CR position in orthodontic patients. Clinical Implications. The benefit of using gnathologic CR records and articulators in orthodontics has not been substantiated by scientific evidence.] Rinchuse DJ, Kandasamy S. *J Am Dent Assoc*, Vol 137, No 4, 494-501. <http://jada.ada.org/cgi/content/abstract/137/4/494>
7. **Centric relation. Its effect on occluso-muscle harmony.** [The most common cause of pain in the region of the temporomandibular joint is occluso-muscle imbalance. This results most often from disharmony between the articulation of the teeth and the centric relation of the condyles. Muscle tenderness of palpation indicates that muscle is involved. An examination must then be done to determine the cause of the muscle tenderness. Before the condyle-occlusion relationship can be evaluated, an accurate centric relation must be determined and verified. The condyles are in centric relation when they are in the

most superior position possible in the fossae. From that apex of force position, the condyle can travel neither forward nor backward without moving downward. This position can be located with careful bilateral manipulation and then verified if it can resist firm pressure with no tension or tenderness. Until this correct centric relation is located and verified, it is not possible to properly evaluate the occlusal relationship to the temporomandibular joints. If the occlusion is harmonized to a centric related condyle that can resist firm pressure with pressure with no discomfort, there will be no reason for the muscles to protect either the teeth or the joints. If an occlusion is adjusted to a malrelated condylar position, the occluso-muscle imbalance will be perpetuated and often intensified. Centric relation is the starting point of occlusal contact. Incline interferences in excursive movements must also be eliminated and the occlusion must be harmonized to the envelope of function for each patient. If centric relation is not properly located, occlusal interferences will remain regardless of what procedures are used to record or adjust excursive movements.] Dawson PE. [Dent Clin North Am](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=285896&dopt=Abstract). 1979 Apr;23(2):169-80. http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=285896&dopt=Abstract

8. **Changes in Head Position Due to Occlusal Supporting Zone Loss During Clenching.** [To establish the relationship between the condition of the stomatognathic system and body posture, changes in the head position during clenching were observed and investigated when the occlusal supporting zone was lost unilaterally and bilaterally. The results were as follows: 1. Regardless of the occlusal conditions, the head position was changed by clenching; 2. The occlusal conditions did not affect the changed distance of the head position; 3. The head position was changed forward and down by clenching regardless of the condition of the occlusal supporting zone. The head position changed more laterally to the opposite side of the lost occlusal supporting zone by clenching with the occlusal supporting zone lost unilaterally rather than bilaterally. Based on this study, it is suggested that unilateral loss of the occlusal supporting zone may cause the neck muscles to become inharmonious and thus affect body posture.] Yoshino G, Higashi K, Nakamura T. *Cranio*. 2003 Apr;21(2):89-98. http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=12723854&dopt=Abstract
9. **Correlation of Occlusal Factors and Condyle Position Asymmetry with Signs and Symptoms of Temporomandibular Disorders in Young Adults.** [The role of the occlusion in the etiology and prevalence of temporomandibular disorders (TMD) has not been conclusively demonstrated. Occlusal factors and condyle position asymmetry as deduced from computed tomography (CT) axial scans were correlated with signs and symptoms of TMD in 49 young adults (mean age 24 years, range 15-33 years) with complete or almost complete dentition. A statistically significant correlation was noted between these signs and symptoms and occlusal variables describing asymmetry (the amount and lateral deviation of the slide from the retruded contact position (RCP) to the intercuspal position (IP), deviation of protrusion and asymmetry in bilateral cuspid occlusion). It seems that occlusal discrepancy can be a predisposing factor to TMD, especially when it is asymmetrically expressed.] Raustia AM, Pirttiniemi PM, et al. *J of Craniomandibular Practice*. July 1995; 13(3): 152-155. <http://www.cranio.com/search/search.asp>.

10. **HPA axis activity on occlusal interference in rat.** [This study aimed to investigate whether exposing rats to experimental occlusal interference would affect the stress response of the hypothalamo-pituitary-adrenal axis (HPA axis), a representative response system in the endocrine system. ... Conclusion: Activation of the HPA axis to stressful stimulation suggested that the endocrine system responds to stimulation produced by exposure to experimental occlusal interference as stress.] Kobayashi T, Yamazaki K, et al. IADR General Session, June 28, 2006) Brisbane AU.
http://iadr.confex.com/iadr/2006Brisb/techprogram/abstract_81804.htm
11. **Incidents of Symptomatic Temporomandibular (TM) Joint Disorders in Female Population with Missing Permanent First Molar(s).** [ABSTRACT: In the literatures, the relationship between missing teeth or malocclusion and the symptoms of temporomandibular joint disorder such as frequent headaches, earaches, sinus pain, and jaw pain, has been documented. However, there were no specific details as to which teeth were missing to cause these symptoms. In this project the relationship between missing first molars in adult female subjects to the previously mentioned symptoms was studied using one group of 65 subjects with missing one, two, three, or four first molars and a control group of 67 subjects with no missing first molars. The study revealed a significant relationship of missing first molar(s) and the occurrence of headaches, earaches, sinus pain, and jaw pain.] Abdel-Fattah RA. Cranio. 1996 Jan;14(1):55-62
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=9086877&dopt=Abstract
12. **Is occlusion becoming more confusing? A plea for simplicity.** [It is not difficult to observe and record patient occlusal characteristics before starting simple or complex occlusal rehabilitations. If this is done, and if the subsequently placed crowns and fixed prostheses are constructed in observation of similar characteristics, clinical success usually is the result. Deviations from the suggestion to duplicate the "normal" occlusion should be made when the original natural occlusion had caused overt pathosis, or when all teeth or one arch of the teeth is being restored at one time. If this is the case, centric relation occlusion is more reproducible and easier to develop than occlusion with a shift from centric relation to centric occlusion. Peculiar requests of patients relative to occlusal positioning, or routine dependence on various devices to predetermine occlusal characteristics for rehabilitation (as is currently popular in some groups), should be considered, but they should be tempered with careful observation of preoperative occlusal characteristics.] Christensen GJ, J Am Dent Assoc, Vol 135, No 6, 767-770.
<http://jada.ada.org/cgi/content/full/135/6/767>
13. **Occlusal characteristics in subjects with facial pain compared to a pain-free control group.** [Facial pain has been considered a common symptom of temporomandibular disorders (TMD) with a multifactorial etiology. There is controversy regarding the role of occlusion in the background of facial pain and TMD. The aim of the study was to compare the occlusal relationships with two definite measurements in subjects with and without facial pain, in a population-based sample of young adults. The study is part of the Northern Finland 1966 Birth Cohort Project. A subsample of the cohort was formed based on a questionnaire and consisted of 104 subjects, including 52 subjects with facial pain and 52 non-pain controls. Analyses of the dental occlusion of the subjects were performed in gypsum casts by following two methods: 1. the Peer assessment rating (PAR), according to Richmond, et al. (Method 1), and 2. the bilateral canine relationship

and the dental midline measurement by the method presented by Pirttiniemi, et al. (Method 2). Method 2 showed higher sensitivity in detecting sagittal occlusal discrepancies than Method 1. Assessment of the intermaxillary relationships in terms of the canine relation showed the lower canine to be more mesially located in the facial pain group, compared to the controls, measured by Method 2. It can be concluded that differences in occlusal sagittal relationships, especially mesial canine relation, seem to correlate with facial pain symptoms at population level.] Sipila K, Ensio K, et al. *Cranio*. 2006 Oct;24(4):245-51.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=pubmed&list_uids=17086853&cmd=Retrieve&indexed=google

14. **Occlusion Confusion.** [The term "centric relation" is highly controversial. Rehabilitated **occlusions** restored to retruded centric relation (posterior-superior centric relation) will most likely shift some 1 to 2 millimeters anterior into a physiologic centric **occlusion** position.. It is wise to consider restoring the "broken" **occlusion** back to the "fundamental occlusal characteristics that existed before the rehabilitation" (*if the pre-existing occlusion was functional and healthy*). Many young patients with "canine rise" will be found later in life to possess "group function" (*and/or "balanced occlusion," free of any pathology*).*Letters. J Am Dent Assoc, Vol 135, No 9, 1223-1225.*

<http://jada.ada.org/cgi/content/full/135/9/1223-a>

15. **Orientation of craniofacial planes and temporomandibular disorder in young adults with normal occlusion.** [The aim of this study was to investigate the relationship between orientation of craniofacial planes relative to the true horizontal and temporomandibular disorder (TMD), in normal occlusion. Fourteen university dental students, with full natural dentition and bilateral Angle Class I occlusion, who exhibited signs and symptoms of TMD, were compared with 14 age- and sex-matched healthy controls. Frontal and lateral photographs were taken in natural head position with the subject standing up, clenching a Fox plane and having a facial arch positioned. Photographs were examined by a standardized image analysis. Inter-pupillary axis, Frankfurt, occlusal and Camper planes were evaluated. In frontal view, the Frankfurt plane was right rotated relative to the true horizontal both in TMD subjects ($P < 0.01$) and controls ($P < 0.05$), but rotation was larger in TMD subjects (mean difference between groups, 1.1 degrees, 95% confidence interval, 95% CI, 0.2-2.0 degrees). No significant deviation from the horizontal or difference between groups was observed for the interpupillary axis and occlusal plane. In lateral view, the Frankfurt plane was upward-orientated relative to the true horizontal in TMD group (mean angular deviation 2.8 degrees, 95% CI, 1.0-4.6 degrees). The occlusal and Camper planes were downward-orientated in both groups ($P < 0.0001$), but inclination of occlusal plane tended to be smaller in TMD subjects (mean difference between groups, -3.8 degrees, 95% CI, -7.6-0.1 degrees). Angles between any craniofacial planes did not significantly differ between groups. The findings show that in young adults with normal occlusion, a weak association exists between the orientation of craniofacial planes in natural head position and signs and symptoms of TMD. Furthermore, they suggest that, within this population, TMD might be mainly associated with head posture rather than with craniofacial morphology.] Ciancaglini R, Colombo-Bolla G, et.al. *J Oral Rehabil*. 2003 Sep;30(9):878-86

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=12950968&dopt=Abstract

16. **Primary- and Secondary-Like Jaw-Muscle Spindle Afferents Have Characteristic Topographic Distributions.** [Proprioceptors from the PDL and motor/sensory evoked activity in the trigeminal motor nucleus causes jaw elevation. Single jaw-muscle spindle afferent axons were characterized physiologically and intracellularly stained to determine whether particular physiological types of spindle afferent show distinctive morphologies. Microelectrodes filled with either horseradish peroxidase (HRP) or biotinamide (Neurobiotin) were advanced into the mesencephalic trigeminal nucleus (Vme) in anesthetized rats. Intracellular recordings then were characterized by their response: to palpation of the jaw muscles; when pressure was applied to the teeth and during passive ramp and hold and sinusoidal jaw movement. Seventy-one afferents were characterized physiologically and injected with HRP; an additional 61 afferents were typed and injected with biotinamide. The response of 43 stained neurons was recorded in the presence of suxamethonium. The major projection areas of these afferents were the: trigeminal motor nucleus (Vmo); region dorsal to Vmo; reticular formation, spinal trigeminal nucleus, superior cerebellar peduncle and Vme. One afferent type was modulated strongly during stretching of the jaw-elevator muscles. Based on their high sensitivity during stretching of the jaw muscles and/or their silencing during the release phase of muscle stretch, these afferents were classified as primary-like spindle afferents. These afferents projected most strongly to Vmo. A second type of afferent was modulated only modestly during stretching of the jaw-elevator muscles. These tonic afferents were classified as secondary-like spindle afferents because of their low dynamic sensitivity during ramp muscle stretch and their continued discharge during the release phase of muscle stretch. Secondary-like afferents projected most strongly to the region dorsal to Vmo. Boutons ($n = 3,834$) from 11 afferents were studied in detail. Secondary-like afferents had statistically larger boutons within Vmo. In both secondary- and primary-like spindle afferents, only a small number of boutons were associated closely with the somata and proximal dendrites of trigeminal motoneurons. In these cases, however, two to five boutons appeared to contact individual motoneurons, implying multiple monosynaptic inputs to a selective subset of jaw-elevator motoneurons. Some "giant" boutons were present dorsal to Vmo and in Vme. These results demonstrate that dynamically sensitive and nondynamically sensitive jaw-elevator muscle spindle afferents project preferentially to different regions. Primary-like spindle afferents are capable of providing feedback related to the dynamic phases of muscle stretch and project most heavily to Vmo. Secondary-like spindle afferents can transmit a feedback signal associated with muscle length and project most strongly to the supratrigeminal region. Both types of afferent have projections caudal to Vmo that may serve longer latency jaw-muscle stretch reflexes and/or the projection of proprioceptive information to the thalamus and cerebellum.] Dessem D. Revers D. et.al, *Neurophysiol.* 77: 2925-2944, 1997. <http://intl-jn.physiology.org/cgi/content/abstract/77/6/2925>
17. **Prospective assessment of parafunctional activity in temporomandibular disorder patients.** [Previous studies have shown that parafunctional tooth contact can increase pain and may produce the symptoms of temporomandibular disorders (TMD) in otherwise normal, pain-free individuals. Objective: This study tested the hypothesis that patients diagnosed with TMD engaged in higher levels of parafunctional tooth contact than normal controls. Methods: 45 individuals were diagnosed according to the Research

Diagnostic Criteria for TMD by two independent examiners. Individuals accepted into the study were those diagnosed with myofascial pain, myofascial pain and arthralgia, disc displacement, or no facial pain. Participants carried a pager for one week. Approximately every two hours during the participant's non-sleep times, the pager signaled the participant to complete an eight-item questionnaire printed on a 3" by 5" card. From these data, the proportion of time that the participant reported tooth contact was computed. The mean number of data points upon which percent time values was over 45 per participant. Results: Groups differed significantly in the percent time that tooth contact was reported, $F(3,41)=2.75, p < .05$. Participants in the normal control group reported the lowest mean proportion of tooth contact, with increasing values reported for the myofascial pain, disc displacement, and myofascial pain and arthralgia groups, respectively. Conclusions: Higher levels of parafunctional tooth contact were associated with a greater likelihood of receiving a diagnosis of TMD. Parafunctional tooth contact and other parafunctional oral habits may be etiological factors in TMD.] Glaros A, Lausten L, Univ of MI – Kansas City. The IADR/AADR/CADR 80th General Session (March 6-9, 2002).

http://iadr.confex.com/iadr/2002SanDiego/techprogram/abstract_18957.htm

18. **Relation between vertical facial morphology and jaw muscle activity in healthy young men.** [The aim of the current investigation was to quantitatively analyze the relation between the activity of masticatory muscles and the inclination of the mandibular plane in a group of 73 healthy white men aged 20–36 years. The three-dimensional coordinates of soft-tissue landmarks gnathion and left and right gonion were digitized using an electromagnetic computerized instrument, the orientation of mandibular plane relative to the true vertical was computed and projected on the anatomical sagittal plane. The electromyographic (EMG) potentials of left and right masseter and temporalis anterior during maximum voluntary teeth clenching were recorded, and the mean EMG amplitude calculated. Two groups of men with opposite facial morphology were then selected: all men with a steep mandibular plane (higher than the mean plus one standard deviation) entered a first group (10 'long face' subjects), while all men with a relatively more horizontal mandibular plane (lower than the mean minus one standard deviation) entered a second group (13 'short face' subjects). Mean EMG potentials computed in the two groups were compared by using Student's *t*-test for independent samples. All the EMG potentials recorded during maximum voluntary clench in the 'long face' men were lower than that recorded in the 'short face' men, with statistically significant differences for all four analyzed muscles ($p < 0.05$). In conclusion, a non-invasive three-dimensional method confirmed that facial morphology and muscular function are significantly related, at least in men with a sound stomatognathic apparatus.] Serrao G, Sforza C, et al. *Prog Orthod* 4, 2003/45-51. <http://www.blackwell-synergy.com/doi/pdf/10.1034/j.1600-9975.2002.02031.x>
19. **Relationship Between Dental Occlusion and Physical Fitness in an Elderly Population.** [*Background.* The relationship between physical fitness and dental health status in elderly adults is still unknown. The purpose of the present study is to examine the relationship between physical fitness and occlusal condition of natural teeth in the elderly population. The sample consisted of 591 individuals aged 70 years and 158 aged 80 years selected from the registry of residents in Niigata city. *Conclusions.* Leg extensor power, stepping rate, and one-leg standing time with eyes open are useful indicators in evaluating lower extremity dynamic strength, agility, and balance function, respectively.

These findings suggest that dental occlusal condition is associated with lower extremity dynamic strength, agility, and balance function in elderly adults.] Yamaga Takayuki, Yoshihara A, et al. *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences* 57:M616-M620 (2002).

<http://biomed.gerontologyjournals.org/cgi/content/abstract/57/9/M616>

20. **Reproducibility of the centric relation bite registration technique.** [Many orthodontists today are using diagnostic casts mounted in centric relation (CR) because they can reveal a completely different malocclusion than what is seen in maximum intercuspation (MI). The CR to MI slide can be measured at the condyles using a semi-adjustable articulator and a condylar position indicator device (CPI). However, before planning treatment from casts mounted in CR, the reliability of the method must be established. Therefore, the purposes of this investigation were: i) to determine the reproducibility, measured with the CPI, of the two-piece wax CR bite registration technique as described by Roth; ii) to determine the direction of the centric slide; iii) to determine differences in overjet measured from CR and MI and; iv) to evaluate the location of the initial tooth contacts in CR. The condylar displacements for 39 subjects were measured in vertical and horizontal components from mounted models. A CR bite registration was taken five times (approximately every five days) and used to remount the lower cast and record the data five times. Since there was not a significant difference between the five CPI readings ($p > .05$), the Roth CR bite registration is highly reproducible. The condyle moved inferiorly with a small distal component from CR to MI. A statistically significant difference ($p < .001$) was found in the overjet measurements between CR and MI. Thirty six out of 39 subjects had an initial tooth contact in CR on the most posterior tooth.] Wood DP, Elliott RW. *Angle Orthod.* 1994;64(3):211-20.
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=PubMed&cmd=Display&dopt=pubmed_pubmed&from_uid=8060017
21. **Tensor tympani muscle: strange chewing muscle.** [This work seeks to alert medical and odontological staff to understanding and using interdisciplinary handling for detecting different pathologies common otic symptoms. It offers better tools for this shared symptomatology during therapy s conservative phase. Tensor tympani muscle physiology and function in the middle ear have been veiled, even when their dysfunction and anatomical relationships may explain a group of confused otic symptoms during conventional clinical evaluation. Middle ear muscles share a common embryological and functional origin with chewing and facial muscles. This article emphasizes that these muscles share a functional neurological and anatomical dimension with the stomatognathic system; these muscles increased tonicity ceases to be a phenomenon having no logical connections. It offers functionality and importance in understanding referred otic symptoms in common with other extra-otical symptom pathologies. Tinnitus, vertigo, otic fullness sensation, hyperacusia, hypoacusia and otalgia are not only primary hearing organ symptoms. They should be redefined and related to the neighboring pathologies which can produce them. There is a need to understand temporomandibular disorders and craniofacial referred symptomatology from neurophysiologic and muscle-skeletal angles contained in the stomatognathic system. Common symptomatology is frequently observed in otic symptoms and temporomandibular disorders during daily practice; this should be understood by each

discipline from a broad, anatomical and clinical perspective.] Ramirez LM, Balesteros LE, et.al. *Med Oral Patol Oral Cir Bucal*. 2007 Mar 1;12(2):E96-100.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=17322813

22. **The central neural connections of the area postrema of the rat.** [We applied the neuroanatomical tracers cholera toxin-horseradish peroxidase and wheat germ agglutinin-horseradish peroxidase to investigate the neural connections of the area postrema (AP) in the rat. We find that the AP projects to the nucleus of the solitary tract (NTS) and dorsal motor nucleus of the vagus bilaterally both rostral and caudal to obex; the nucleus ambiguus; the dorsal aspect of the spinal trigeminal tract and nucleus and the paratrigeminal nucleus; the region of the ventrolateral medullary catecholaminergic column; the cerebellar vermis; and a cluster of structures in the dorsolateral pons which prominently include a discrete set of subnuclei in the lateral parabrachial nucleus. The major central afferent input to the area postrema is provided by a group of neurons in the paraventricular and dorsomedial hypothalamic nuclei whose collective dendrites describe a horizontally oriented plexus which encircles the parvocellular nucleus of the hypothalamus bilaterally. In addition, the caudal NTS may project lightly to the AP. The lateral parabrachial nucleus provides a very light input as well. These connections, when considered in the context of the known vagal afferent input and reduced blood-brain barrier of AP, place this structure in a unique position to receive and modulate ascending interoceptive information and to influence autonomic outflow as well.] Shapiro RE, Miselis RR. *J Comp Neurol*. 1985 Apr 15;234(3):344-64.
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=3988989&dopt=Abstract
23. **The central projections of the great auricular nerve primary afferent fibers--an HRP transganglionic tracing method.** [A study of the central distribution of the primary afferent fibers of the great auricular nerve (GAN) was made in 18 rabbits by means of transganglionic transport of horseradish peroxidase (HRP). HRP applied to the cut central end of the GAN was detected ipsilaterally in the dorsal root ganglion cells (segments C2-C3) and the superior cervical ganglion cells. The transganglionically labeled fibers were seen in the dorsal column of the upper 4 cervical segments and in the cranial nerve nuclei of the medulla oblongata. The afferent projections were rather strong in the regions of laminae I-V of C2, the caudal subnucleus of the nucleus of the spinal tract of the trigeminal nerve (NVSp), the solitary nucleus (SN), the medial and lateral cuneate nuclei, etc. The results showed that the primary afferent impulses of the GAN and the peripheral nerves which supply the head, face, trunk and viscera might converge on the upper cervical cord, the NVSp and the SN, and play a certain role of modulation on the transmission of somaticovisceral sensations, especially pain.] Liu D, Hu Y. *Brain Res*. 1988 Apr 5;445(2):205-10.
http://www.ncbi.nlm.nih.gov/sites/entrez?cmd=Retrieve&db=PubMed&list_uids=2453252&dopt=Citation
24. **The Effects of a Single Intercuspal Interference on Electromyographic Characteristics of Human Masticatory Muscles During Maximal Voluntary Teeth Clenching.** [In 13 healthy subjects (eight men and five women, mean age, 22 years), an aluminum intercuspal interference (height, 0.25 mm) was placed on the maxillary right first premolar to study its effect on the contractile symmetry of the right and left masseter

and anterior temporalis muscles when measured through a Percentage Overlapping Coefficient (POC), derived from surface electromyographic recordings of maximum voluntary teeth clenching. Additionally, and to estimate the potential of the experimental intercusp interference to induce lateral displacement of the mandible, a Torque Coefficient (TC) was derived from surface electromyographic recordings. The conclusion was that the experimental occlusal interference gave rise to asymmetric contractile activity in the studied mandibular elevator muscles as well as a potential to displace the mandible in a lateral direction.] *Cranio*. 1999 Jul;17(3):184-8.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=10650405&dopt=Abstract

25. **The hinge-axis: a review of the literature.** [Study of hinge-axis opening of the mandible has occupied many distinguished workers over a large number of years. This paper is an attempt to bring all their ideas together into one publication so that readers may reach their own conclusions. In the healthy patient CR is a strained (close packed) position based on an imaginary axis that does NOT define jaw motion in such subjects. This study considered varied opinions as to the existence of the hinge axis including the study of Posselt who stated "the terminal hinge movement is a type of movement that could not even in its initial phases coincide with simple relaxed natural opening or closure 'In brief the axis is not a physiological or anatomical entity. Kinematic axis apparatus engenders by its very construction a stretch reflex making such tracings unphysiological.] Winstanley RB. *J Oral Rehabil*. 1985 Mar;12(2):135-59.
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=3886864&dopt=Abstract
26. **The human lateral pterygoid muscle: A review of some experimental aspects and possible clinical relevance.** [The clinical notion that some disturbance to the activity of the lateral pterygoid muscle plays a role in the aetiology of TMD is still widely accepted and influences management strategies. However, there is no rigorous scientific evidence to support this clinical notion and the role of the lateral pterygoid muscle in normal function is still controversial. The classically defined functions of each head of the muscle are that the superior head is active on closing, retrusion, and ipsilateral jaw movements, while the inferior head is active on opening, protrusion and contralateral jaw movements. However, recent data indicate that these concepts are too simplistic. For example, recent evidence suggests that parts of the superior head may also be active on opening, protrusion and contralateral jaw movements, and that the superior head may consist of three mediolaterally arranged functional zones. Given these complexities, the proposal that clicking and/or locking conditions arise in the temporomandibular joint through some form of lack of co-ordination between the two heads of the muscle needs re-evaluation. Despite earlier reports to the contrary, both heads of the lateral pterygoid muscle appear to be electrically silent at the postural or resting jaw position, and therefore appear to play no role in the anteroposterior positioning of the jaw at the postural position. An important role has also been demonstrated electromyographically for progressive changes in activity in the inferior head as the direction of horizontal jaw force shifts from one side to the other. This suggests an important role for the lateral pterygoid muscle in the generation of side-to-side and protrusive jaw forces. The lateral pterygoid muscle is likely therefore to play an important role in parafunctional excursive jaw movements and also possibly a role in influencing jaw position in patients where the

maxillomandibular relationship records change from session to session. The above data provide new insights into normal function of the lateral pterygoid muscle.] Murray GM, Phanachet I, et.al. *Australian dental Journal* 2004;49(1):2-8.

http://www.ada.org.au/media/documents/Products_Publications/Journal%20Archives/2004%20Archive/March/0403Mur.pdf

27. **The Influence of Craniofacial Form on Bite Force and EMG Activity of Masticatory Muscle. IX-2. Association between the Asymmetry Index of EMG Activity, and Frontal Dentoskeletal Form and Lateralized Mastication Index in Denture Wearers.** [Complete denture wearers in the normal face group were divided into left and right deviation groups for the frontal dentoskeletal form. The mechanisms of their jaw functions were analyzed in terms of the lateralized mastication index and asymmetry index of masticatory muscle EMG activity. Their relationship was examined, and the magnitude of bite force was divided into two levels (50% and 100% MC). The results revealed that the asymmetry index of masticatory muscle EMG activity was strongly related to deviation and frequency of the lateralized mastication index, as well as the mandible in the frontal dentoskeletal form when chewing, during masticatory movement with relatively weaker bite force. (author abst.)] Masanori M. *Journal of the Japan Prosthodontic Society*, Vol(43(3)481-488(1999). <http://sciencelinks.jp/j-east/article/199920/000019992099A0650022.php>
28. **The involvement of the styloid process in head and neck pain--a preliminary study.** [The styloid process and associated structures have been implicated in a variety of craniomandibular dysfunctions and pain complaints. There have been anecdotal reports that treatment directed at this area can result in a dramatic reduction in referred symptoms, somatic pain and autonomic signs as well as an increase in mandibular range of motion. In the past, an elongation of the styloid process was considered necessary for pain and dysfunction symptoms to arise from this area. The patients in this study did not have elongated styloid processes, yet had orofacial pain and dysfunction symptoms seemingly referred from this area. An injection of local anaesthetic and corticosteroid in the area of the styloid process significantly reduced lateral head pain and improved mandibular function in spite of an absence of any demonstrable pathology at the styloid process.] Palesy P, Murray GM, et.al. *J Oral Rehabil.* 2000 Apr;27(4):275-87. http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=10792587&dopt=Abstract
29. **The relationship between the severity of periodontitis and occlusal conditions monitored by the K6 Diagnostic System.** [The occlusal conditions of periodontitis patients were investigated by using a computerized monitoring device. Thirty-three mild to severe periodontitis patients were enrolled in the study and they were categorized into three groups by their periodontitis severity. Each subject answered a preliminary questionnaire, received routine dental examinations, and underwent MKG/EMG tests using the K6 Diagnostic System. Clinical manifestations of periodontitis were confirmed by the questionnaire and the routine clinical examinations. According to the MKG tests, the traces of maximum opening distance and vertical freeway space showed no significant statistical difference among the groups. However, the velocity of terminal tooth contact was significantly delayed in the severe periodontitis group. According to the EMG tests, there was no significant difference in the rest mode EMG activities, but the function mode EMG activities significantly weakened in the severe periodontitis

group. These results showed that severe periodontitis patients had poor occlusal conditions that might have been triggered by the instability of centric occlusion due to attachment loss.] Sakagami R, Kato H. *Journal of Oral Rehabilitation Volume 23 Issue 9 Page 615 - September 1996.* <http://www.blackwell-synergy.com/doi/abs/10.1046/j.1365-2842.1996.d01-207.x>

30. **The role of occlusion in the etiology and treatment of periodontal disease.** [If occlusion and the condition of the periodontium are interrelated in periodontal health and in tissue destruction that occurs in periodontal disease, they should also be interrelated in periodontal treatment and in the preservation of post-treatment health. The etiologic significance of trauma from occlusion in periodontal disease and the therapeutic effectiveness of occlusal adjustment were considered, and critical questions regarding them were raised.] Glickman I. *J Dent Res Supplement, Vol 50 1971, p. 199-204.* <http://jdr.iadrjournals.org/cgi/reprint/50/2/199.pdf>
31. **The Trigeminal Nerve. Part I: An Over-View.** [The trigeminal nerve is the largest and most complex of twelve cranial nerves. Its vast size and influence are greatly appreciated when one attempts to diagnose and treat patients suffering from orofacial pain and temporomandibular joint disorders. Without a thorough knowledge of the trigeminal nerve, the efficacy of diagnostic and therapeutic procedures will be very disappointing. This is the first of a four-part series of articles about the trigeminal nerve, a basic overview of both the gross and neuroanatomical structures is presented.] Shankland WE. *Cranio. 2000 Oct;18(4):238-48.* http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=11202843&dopt=Abstract
32. **The Trigeminal Nerve. Part II: The Ophthalmic Division.** [The ophthalmic, or first division (V1) of the trigeminal nerve, is the smallest of the three divisions and is purely sensory or afferent in function. It supplies sensory branches to the ciliary body, the cornea, and the iris; to the lacrimal gland and conjunctiva; to portions of the mucous membrane of the nasal cavity, sphenoidal sinus, and frontal sinus; to the skin of the eyebrow, eyelids, forehead, and nose; and to the tentorium cerebelli, dura mater, and the posterior area of the falx cerebri. At first glance, one might not expect one interested in the diagnosis and treatment of orofacial pain and temporomandibular joint disorders to have a need to be concerned with the ophthalmic division. Although much of this division's influence is dedicated to structures within the orbit, nose, and cranium, still, the ophthalmic division may be afflicted with a lesion or structural disorder which can cause all sorts of orofacial pain. Ignorance of this or any portion of the trigeminal nerve will lead to diagnostic and therapeutic failures. In this, the second of four (4) articles concerning the trigeminal nerve, the first division of this vast cranial nerve will be described in detail.] Shankland WE. *Cranio. 2001 Jan;19(1):8-12.* http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=11842844&dopt=Abstract
33. **The Trigeminal Nerve. Part III: The Maxillary Division.** [The maxillary nerve gives sensory innervation to all structures in and around the maxillary bone and the midfacial region including the skin of the midfacial regions, the lower eyelid, side of nose, and upper lip; the mucous membrane of the nasopharynx, maxillary sinus, soft palate, palatine tonsil, roof of the mouth, the maxillary gingivae, and maxillary teeth. This vast and complex division of the trigeminal nerve is intimately associated with many sources

of orofacial pain, often mimicking maxillary sinus and/or temporomandibular joint involvement. For those who choose to treat patients suffering with orofacial pain and temporomandibular disorders, knowledge of this nerve must be second nature. Just providing the difficult services of a general dental practice should be stimulus enough to understand this trigeminal division, but if one hopes to correctly diagnose and treat orofacial pain disorders, dedication to understanding this nerve cannot be overstated. In this, the third of a four part series of articles concerning the trigeminal nerve, the second or maxillary division will be described and discussed in detail.] Shankland WE. *Cranio*. 2001 Apr;19(2):78-83.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=11842868&dopt=Abstract

34. **The Trigeminal Nerve. Part IV: The Mandibular Division.** [The mandibular or third division of the trigeminal nerve is the largest of the three divisions. It is considered a mixed nerve. That is, like the ophthalmic and maxillary divisions, the mandibular conveys afferent fibers. But unlike the former two divisions, the mandibular also contains motor or efferent fibers to the muscles of mastication, the mylohyoid and anterior digastric muscles, and the tensor veli palatini and tensor tympani muscles. So intimately associated with dentistry, the mandibular nerve has also been termed the dental nerve by anatomists in the past. This extensive and complicated division of the trigeminal nerve can cause confusion to both patient and doctor. Pain is often referred within its branches and even into other trigeminal divisions, chiefly the maxillary. This fourth and last article about the trigeminal nerve will present in detail the mandibular division.] Shankland WE. *Cranio* 2001 Jul;19(3). <http://www.cranio.com/search/search.asp>
35. **Tooth Contact in Patients with Temporomandibular Disorders.** [Both experimental and retrospective studies suggest a link between parafunctions and pain in temporomandibular disorder (TMD) patients. To investigate the role of parafunctions in TMD, experience sampling methodology was used as a prospective test of the hypothesis that patients with TMD have higher levels of tooth contact and tension than non-TMD controls. Three groups of TMD patients and a group of normal controls carried pagers for one week, were contacted approximately every two hours by an automated calling system, and completed questionnaires assessing tooth contact, tension, and pain at each contact. Results showed that tooth contact was much more frequent among normal controls than is commonly presumed. Patients with myofascial pain with/without arthralgia reported more frequent contact, higher intensity contact, and more tension than patients with disk displacement or normal controls. Increased masticatory muscle activity responsible for tooth contact and tension may be an important mechanism in the etiology and maintenance of the myofascial pain and arthralgia of TMD.] Glaros AG, Williams K, et al. *Cranio*. 2005 Jul;23(3):188-93.
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=pubmed&list_uids=16128353&cmd=Retrieve&indexed=google
36. **Topography of spinal, dorsal column nuclear, and spinal trigeminal projections to the pontine gray in rats.** [Several studies using a variety of animals have reported conflicting evidence concerning the distribution, laterality, and indeed the presence of ascending projections to the pontine nuclei. In an attempt to clarify this issue, projections to the pontine nuclei from the spinal cord, dorsal column nuclei, and spinal trigeminal nucleus were investigated with anterograde methods, i.e., the Fink-Heimer technique

and/or autoradiography, in Long-Evans black-hooded rats. Results revealed that dorsal column nuclear projections to the contralateral pontine gray terminate predominantly in two regions - one in the caudal aspect of the medial pontine subdivision and another overlapping the ventral and lateral subdivisions. Within the medial and ventrolateral nuclear regions, fibers from nucleus cuneatus primarily terminated more rostrally to afferents from the nucleus gracilis. Spinal trigeminal projections terminated most heavily within the contralateral pontine gray at midpontine levels. Similar to the dorsal column nuclear projections, trigeminal afferents were observed in the medial and ventrolateral subdivisions, although these terminations were rostral and dorsal to areas receiving cuneatus input. Additional projections from the spinal trigeminal nuclei to the contralateral ventral peduncular nucleus were also observed. In comparison to the above-mentioned pontine afferents, both high cervical and midthoracic spinal cord lesions produced a similar pattern of axonal degeneration in the ipsilateral pontine gray which overlapped substantially with gracilis inputs. The observed topographic distribution pattern of ascending afferents to pontine gray confirm and extend previous findings which in general have only briefly described these pathways.] Swenson RS, Kosinski RJ, et al. *The Journal of Comparative Neurology* Volume 222, Issue 2, Pages 301 – 311.

<http://www3.interscience.wiley.com/cgi-bin/abstract/109687645/ABSTRACT?CRETRY=1&SRETRY=0>

37. **Trigeminal primary afferent projections to "non-trigeminal" areas of the rat**

central nervous system. [This study has demonstrated that somatosensory information from the head and face may be transmitted directly to widespread and functionally heterogeneous areas of the rat central nervous system, including the spinal cord dorsal horn, numerous brainstem nuclei, and the cerebellum.] Marfurt CG, Rajchert DM. *J Comp Neurol.* 1991 Jan 15;303(3):489-511.

http://www.ncbi.nlm.nih.gov/sites/entrez?cmd=Retrieve&db=PubMed&list_uids=1706735&dopt=Citation

38. **Vertical Dimension. Part 2: The Changes in Electrical Activity of the Cervical**

Muscles Upon Varying the Vertical Dimension. [This study was conducted in order to determine the effect of vertical dimension variation on the electromyographic (EMG) activity of the sternocleidomastoid and trapezius muscles. The study was performed on 15 healthy subjects. Basal tonic electromyographic (BT-EMG) recordings were performed by placing surface electrodes on the left sternocleidomastoid and trapezius muscles. BT EMG activity was recorded upon varying the vertical dimension every five millimeters from vertical dimension of occlusion to 45 millimeters of jaw opening (series 1), following the habitual opening path. Afterward, BT-EMG activity was recorded every millimeter from vertical dimension of occlusion to 4 mm, and then every two millimeters from four to ten millimeters (series 2). In series 1, a significant increase of BT-EMG activity was observed in both muscles (simple logarithmic regression analysis). In series 2, a significant increase was observed in the sternocleidomastoid muscle whereas trapezius muscle did not present a significant change. BT-EMG behavior of the sternocleidomastoid muscle in series 2 could be relevant when dentists increase vertical dimension by means of intermaxillary appliances during a short-term period. Moreover, these results add further information to the concept of the interrelatedness between the different components of the cranio cervical-mandibular system.] Miralles R, Dodds C, et al. *Cranio.* 2002 Jan;20(1):39-47.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=1831343&dopt=Abstract

Pathophysiology, Inflammation

39. **Bradykinin Expression in Synovial Tissues and Synovial Fluids Obtained from Patients with Internal Derangement of the Temporomandibular Joint.** [Bradykinin has been implicated in the pathogenesis of inflammatory arthritis by virtue of the potent pro-inflammatory properties. The purpose of this study is to investigate the expression of bradykinin in patients with internal derangement of the temporomandibular joint (TMJ). We examined 33 TMJ synovial biopsy specimens from 31 patients with internal derangement of the TMJ by an immunohistochemical technique using specific antibodies. We also determined the concentration of bradykinin in 20 synovial fluids from 18 patients with TMJ internal derangement by enzyme-linked immunosorbent assay. These data were compared with those of the control subjects. Bradykinin was predominantly localized in the synovial lining cell layer of TMJ samples obtained from patients with TMJ internal derangement. Bradykinin was also detected in 19 patients' TMJ synovial fluids and the average of bradykinin concentration in the synovial fluids of patients was higher than that of the healthy controls. Although a statistically significant correlation was not observed, these findings support the hypothesis that bradykinin may also be involved in the pathogenesis of TMJ pain and synovitis.] Suzuki T, Segami N, et al. *Cranio*. 2003 Oct;21(4):265-70.
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=14620699&dopt=Abstract
40. **Clinical Significance of Cytokine Determination in Synovial Fluid.** [Cytokines are a complex family of small regulatory proteins able to mediate intercellular communication and play a crucial role in immunologic and inflammatory reactions. Many reports have demonstrated that some cytokines, in particular tumor necrosis factor α (TNF α) and interleukin (IL)-1 β , IL-6, and IL-8, so-called proinflammatory, may have a major role in the pathogenesis of joint diseases. Thus, high levels of these substances have been found in inflammatory arthropathies, in particular in those characterized by a more aggressive and destructive outcome, such as rheumatoid arthritis, gout, and infectious arthritis. In keeping with their role, the determination of cytokines in synovial fluid may be proposed for clinical purposes, including diagnostic and prognostic assessments. Furthermore, as some of these cytokines may reflect disease activity, their determination may also be useful in the evaluation of therapy.] Punzi L, Calo L, et al. *Critical Reviews in Clinical Laboratory Sciences* Volume 39, Number 1/January-February 2002. P 63-88.
<http://taylorandfrancis.metapress.com/content/xl7eupq0p2j9k8cq/>
41. **Clinical, radiographic, and electromyographic study of patients with internal derangement of the temporomandibular joint.** [Fifteen patients with internal derangement of the temporomandibular joint (TMJ) were examined clinically, radiographically, and electromyographically. Electromyographic recordings were also obtained from 11 subjects without signs or symptoms associated with their TMJs or masticatory musculature. All the patients with internal derangement demonstrated interferences on the ipsilateral side. This was interpreted as the result of disc displacement producing a reduced joint space and, consequently, a decreased vertical dimension on the symptomatic side. Slow opening and closing mandibular movements

without clenching could be performed by healthy persons without noticeable EMG activity in the temporalis and masseter muscles. In association with disc displacement, electromyographic activity of the temporalis and masseter muscles occurred when the condyle slid over the posterior band of the disc and could be interpreted as an arthrokinetic reflex caused by distraction. Continuous muscle activity could be provoked by TMJ disc displacement and ceased when the disc position was normalized on mouth opening, only to occur again every time the disc became displaced on mouth closure. Anterior disc displacement without reduction (closed lock) could cause spastic activity in the temporalis muscle on the affected side. Spastic activity of the masseter and temporalis muscles occurring on the same side as a joint with anterior disc displacement hinders or inhibits the condylar movement necessary to achieve reduction.] Isberg A, Widmalm SE, et.al. *Am J Orthod.* 1985 Dec;88(6):453-60.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=3865535&dopt=Abstract

42. **Cytokine profile in synovial fluid from patients with internal derangement of the temporomandibular joint: a preliminary study.** [Temporomandibular joint disorders (TMD) comprise a group of chronic painful conditions of mastication in the temporomandibular joint (TMJ). Although the association between TMD and internal derangement of the TMJ is well documented, the functional relevance is still unclear. Increased concentrations of inflammatory mediators have been identified in the synovial fluid of affected patients with TMD, suggesting an underlying degenerative or inflammatory process. The aim of this study was to generate a comprehensive cytokine expression profile in TMD. ... Conclusions: This study confirmed previous reports of elevated cytokine levels in TMD. Additionally, we identified previously undescribed cytokines that were upregulated and correlated significantly with the presence of JE. We were able to identify novel cytokines that have hitherto not been described in TMD. Strategies targeting the identified cytokines may represent a novel therapy option in TMD.] Matsumoto K, Honda K, et.al. *Dentomaxillofacial Radiology* (2006) 35, 432-441. <http://dmfr.birjournals.org/cgi/content/abstract/35/6/432>
43. **Cytokine profile in temporomandibular joint synovial fluid: Correlation with the degree of joint effusion.** [We firstly detected angiogenin, FGF-9 and MIP-1 β whose expression levels were strongly correlated with the degree of joint effusion, which may reflect the status of TMJ inflammation. Angiogenin, FGF-9 and MIP-1 β may be novel markers for the diagnosis of TMJ disorders.] Matsumoto K, Ohshima M, et al. *Internatinoal Congress Series Vol 1284, Sept. 2005, Pages 225-226.* http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B7581-4H880XN-26&_user=10&_coverDate=09%2F30%2F2005&_rdoc=1&_fmt=&_orig=search&_sort=d&_view=c&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=427809650e4391bc423c0634b9585be6
44. **Dentition Status and Temporomandibular Joint Disorders in Patients with Rheumatoid Arthritis.** [We compared dentition status and temporomandibular joint (TMJ) disorders in 142 women with rheumatoid arthritis (RA, ages, 40 to 69 years) and 143 women of similar age without RA. The RA group had significantly fewer remaining teeth than the non-RA group. Number of decayed, missing, and filled (DMF) teeth, number of edentulous subjects, and number of subjects with complete and removable partial dentures were significantly higher in the RA group. Among RA subjects, 1.4%

had unprovoked TMJ pain, 4.9% had pain on mouth opening, and 14.8% noted difficulty with opening. In the RA group, TMJ tenderness was elicited in 9.2%, clicking in 12.7%, and crepitus in 35.9%, representing a significant excess occurrence of crepitus. The prevalence of TMJ disorders was 67.6% in the RA group and 32.9% in the non-RA group; degenerative joint disorders were particularly frequent. TMJ disorders correlated with Steinbrocker stage and the duration of RA.] Yamakawa M, Ansai T, et al. *Cranio*. 2002 Jul;20(3):165-71.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=12150262&dopt=Abstract

45. **Estrogen increases nociception-evoked brain-derived neurotrophic factor gene expression in the female rat.** [Chronic pain induces plastic changes in nociceptive sensory pathways, and is often accompanied and exacerbated by depression. Estrogen can influence nociceptive sensory processing, but the molecular mechanisms underlying sex differences in pain remain unclear. Brain-derived neurotrophic factor (BDNF) may orchestrate changes occurring during persistent pain or depression by increasing spinal nociceptive signaling and altering neuronal growth in higher brain structures. This study addressed whether estrogen regulates BDNF gene expression in central systems associated with nociceptive processing and/or affective state, which may in turn influence sex differences in pain sensitivity... Results demonstrate that BDNF gene expression in certain brain structures is inhibited by inflammatory pain, yet estrogen may enhance central nervous system sensitization associated with sensory processing. Since alterations in BDNF gene expression in higher brain centers may be relevant to cognitive changes that occur in recurrent depression, these results may provide insights into the coincidence of chronic pain and depression.] Allen AL, McCarson KE. *Neuroendocrinology*. 2005;81(3):193-9. Epub 2005 Jul 11.
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=16020928&dopt=Abstract
46. **Genistein reduces the production of proinflammatory molecules in human chondrocytes.** [Previously, we reported that cartilage is an estrogen receptor (ER) positive tissue and that mRNA levels of ERbeta increase in postmenopausal women with osteoarthritis. Based on our findings and those of other investigators, we hypothesized that local rather than circulating estrogen levels negatively affect chondrocyte metabolism and that selective ER modulators (SERM) augment cartilage health. ...Our data indicate that the LPS-stimulated increases in COX-2 protein level and NO in supernatant are reduced by pretreatment of genistein, whereas COX-1 protein level is not affected by genistein. The ability of genistein to suppress COX-2 but not COX-1 is advantageous because suppressing COX-2 can lead to suppression of proinflammatory molecules. Although genistein suppresses COX-2 production, it does not affect the production of COX-1 enzyme, which is responsible for releasing prostaglandins involved in cellular house-keeping functions such as the maintenance of gastrointestinal integrity and vascular homeostasis.] Hooshmand S, Soung DY, et al. *J Nutr Biochem*. 2007 Mar 16
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=17368882
47. **Ghrelin is expressed in trigeminal neurons of female mice in phase with the estrous cycle.** [Several disorders mediated by the trigeminal nerve including migraine and

temporomandibular disorder (TMD) are more common in women than in men, and painful attacks are often linked to the menstrual cycle. Estrogen receptors in trigeminal neurons may be involved in regulating neuronal function, causing changes in sensitivity that contribute to these attacks. In a previous study, we demonstrated that expression of specific neuropeptides including galanin and neuropeptide Y in trigeminal ganglia of female rodents varies with the estrous cycle. In this study, we examined expression of the orexigenic peptide ghrelin in trigeminal ganglia of cycling female mice. RT-PCR studies demonstrated that ghrelin mRNA is upregulated by over 5-fold at the high estrogen stages of the cycle, proestrus and early estrus over the levels expressed at the low estrogen stage of the cycle, diestrus. Double-labeling immunohistochemical studies and cell size measurements were conducted to identify the phenotype of neurons in trigeminal ganglia containing ghrelin. Ghrelin was present in trigeminal neurons containing peripherin, a marker of neurons with unmyelinated axons, in trigeminal neurons binding IB4, a marker of nonpeptidergic nociceptors, in trigeminal neurons containing neurofilament H, a marker of neurons with myelinated axons, and in trigeminal neurons containing the neuropeptide calcitonin gene-related peptide (CGRP). Ghrelin-positive neurons averaged 25.6 microm in diameter, but included neurons in all the size ranges except the smallest peripherin-positive neurons. Thus, nearly all of the major populations of trigeminal neurons including peptidergic and nonpeptidergic nociceptors contain ghrelin. These studies suggest that ghrelin, a multifunctional peptide, may contribute to the mechanism linking orofacial pain syndromes in females, including temporomandibular disorder and migraine, to cyclical hormonal changes.] Puri V, Chandrala S, Puri S, Daniel CG, Klein RM, Berman NE. *Neuropeptides*. 2006 Feb;40(1):35-46. Epub 2006 Jan 10.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Abstract&list_uids=16376425

48. **How the Blood Talks to the Brain Parenchyma and the Paraventricular Nucleus of the Hypothalamus During Systemic Inflammatory and Infectious Stimuli.** [There are exciting new developments regarding the molecular mechanisms involved in the influence of circulating proinflammatory molecules within cells of the blood-brain barrier (BBB) during systemic immune challenges. These molecules, when present in the circulation, have the ability to trigger a series of events in cascade, leading to either the mitogen-activated protein (MAP) kinases/nuclear factor kappa B (NF- κ B) or the janus kinase (JAK)/signal transducer and activator of transcription (STAT) transduction pathways in vascular-associated cells of the central nervous system (CNS). The brain blood vessels exhibit both constitutive and induced expression of receptors for different proinflammatory ligands that have the ability to stimulate these signaling molecules. Depending on the challenges and the cytokines involved, the transduction signal(s) solicited in cells of the BBB may orient the neuronal activity in a very specific manner in activating the transcription and production of soluble factors, such as prostaglandins (PGs). It is interesting to note that cytokines as well as systemic localized inflammation stimulate the cells of the BBB in a nonselective manner (i.e., within both large blood vessels and small capillaries across the brain). This nonselectivity raises several questions with regard to the localized neuronal activation induced by different experimental models of inflammation and cytokines. It is possible that the selectivity of the neuronal response is a consequence of the fine interaction between nonparenchymal synthesis of soluble

- mediators and expression of specific receptors for these ligands within parenchymal elements of different brain nuclei. This review will present the recent developments on this concept and the mechanisms that take place in cells of the BBB, which lead to the neuronal circuits involved in restoring the body's homeostasis during systemic immunogenic challenges. The induction of fever, the hypothalamic-pituitary adrenal (HPA) axis, and other autonomic functions are among the physiological outcomes necessary for the protection of the mammalian organism in the presence of foreign material.] Rivest S, Lacroix S, et.al. *Proceedings of the Society for Experimental Biology and Medicine* 223:22-38 (2000). <http://www.ebmonline.org/cgi/content/abstract/223/1/22>
49. **Increased BDNF serum concentration in fibromyalgia with or without depression or antidepressants.** [Fibromyalgia (FM) is still often viewed as a psychosomatic disorder. However, the increased pain sensitivity to stimuli in FM patients is not an "imagined" histrionic phenomena. Pain, which is consistently felt in the musculature, is related to specific abnormalities in the CNS pain matrix. Brain-derived neurotrophic factor (BDNF) is an endogenous protein involved in neuronal survival and synaptic plasticity of the central and peripheral nervous system (CNS and PNS). Several lines of evidence converged to indicate that BDNF also participates in structural and functional plasticity of nociceptive pathways in the CNS and within the dorsal root ganglia and spinal cord. In the latter, release of BDNF appears to modulate or even mediate nociceptive sensory inputs and pain hypersensitivity. We were interested, if BDNF serum concentration may be altered in FM. ... the results from our study indicate that BDNF may be involved in the pathophysiology of pain in FM. Nevertheless, how BDNF increases susceptibility to pain is still not known.] Laske C, Stransky E. et.al. *J Psychiatr Res.* 2006 Apr 3. http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=16600301&dopt=Citation
50. **Inflammatory cytokines activity in temporomandibular joint disorders: a review of literature.** [Cytokines are important polypeptides mediators of acute and chronic inflammation. These molecules act as a complex immunological network, in which there are pro-inflammatory cytokines, such as interleukin-1 (IL-1), IL-6 and tumor necrosis factor- α (TNF- α), and anti-inflammatory mediators like IL-10 and transforming growth factor- β . In spite of some controversial findings, in general high levels of pro-inflammatory cytokines have been correlated with signs and symptoms of temporomandibular disorders (TMD) such as internal derangement and osteoarthritis. These mediators promote degradation of cartilage and bone joint by inducing release of proteinases and other inflammatory molecules. Indeed, pro-inflammatory cytokines have been associated with temporomandibular joint (TMJ) tissue destruction. However, its mechanisms and pathophysiology have not been clearly delineated. In attempt to summarize the role of cytokines in TMD pathophysiology and its potential for medical intervention, the purpose of the current study was to review the literature concerning the analysis]. Campos MIG, Campos PSF, et.al. *Braz J Oral Sci.* July-September 2006 - Vol. 5 - Number 18 http://www.fop.unicamp.br/brjorals/temp2/c18_Art1_inflammatory.pdf
51. **Levels of soluble cytokine factors in temporomandibular joint effusions seen on magnetic resonance images.** [OBJECTIVE: To elucidate the correlations between joint effusion (JE) on T2-weighted magnetic resonance images (MRI) of the temporomandibular joint (TMJ) and the levels of various cytokine receptors, cytokine antagonists, and protein in the synovial fluid of patients with temporomandibular joint

disorders (TMD). STUDY DESIGN: Fifty-five TMJs of 55 patients with TMD were scanned by MRI, and synovial fluid samples were obtained on the same day. The grade of JE was evaluated on a scale of 0 to 3: Grades 0 and 1 indicated absence, and grades 2 and 3 indicated the presence of JE. Correlations were evaluated between JE and the concentrations of soluble tumor necrosis factor receptors I and II (sTNFR-I and sTNFR-II, respectively), IL-6 soluble receptor (IL-6sR), IL-1 soluble receptor type II, and IL-1 receptor antagonist and protein in the synovial fluid of patients with TMD. RESULTS: The concentrations of sTNFR-I and protein in the group with JE (18 joints) were significantly higher than in the group without JE (37 joints). In addition, there were significant positive correlations between the grade of JE and the levels of sTNFR-I, sTNFR-II, and protein. CONCLUSIONS: sTNFRs and protein may play important roles in the pathogenesis of TMD. These mediators seem to influence the expression of JE, which may reflect synovial inflammation of the TMJ.] Kaneyama K, Segami N, et al. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 2005 Apr;99(4):411-8.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=15772591&dopt=Citation

52. **Musculoskeletal etiology and therapy of craniomandibular pain and dysfunction.** [A number of diverse symptoms, conventionally diagnosed and treated as individual problems, exist in combination in the craniomandibular pain and dysfunction patient. This chapter explores musculoskeletal dysfunction of the area as a common etiologic factor for head and neck pain. The electronically derived data, reported in 68 case histories, indicate that a common measurable etiology is responsible for the many ostensibly diverse manifestations of craniomandibular pain and dysfunction. Both quantitative and subjective data support the etiologic validity of the diagnosis. The basis for the effectiveness of the reported therapy rests on diagnosis of a skeletal malrelation of the mandible to the cranium that poses sustained accommodative demand on the neuromusculature.] Coy RE, Flocken JE, Adib F. *Cranio Clin Int.* 1991;1(2):163-73. http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=1811804&dopt=Abstract
53. **Neurophysiologic evidence for a central sensitization in patients with fibromyalgia.** [To determine whether abnormalities of peripheral and central nociceptive sensory input processing exist outside areas of spontaneous pain in patients with fibromyalgia (FM) as compared with controls, by using quantitative sensory testing (QST) and a neurophysiologic paradigm independent from subjective reports. Our results strongly, although indirectly, point to a state of central hyperexcitability of the nociceptive system in patients with FM. The NFR can be used to assess central allodynia in FM. It may also help discriminate patients who may benefit from use of centrally acting analgesics.] Desmeules JA, Cedraschi C, et al. *Arthritis & Rheumatism, Vol 48, Issue 5, P 1420-1429.* <http://www3.interscience.wiley.com/cgi-bin/abstract/104530625/ABSTRACT?CRETRY=1&SRETRY=0>
54. **New insights into migraine pathophysiology.** [This review emphasizes several neurobiological aspects of migraine that reveal paroxysmal disturbances in neuronal and vascular function, that in turn reflect disturbances in the maintenance of ionic gradients.] Sanchez-Del-Rio M, Reuter U, et al. *Curr Opin Neurol.* 2006 Jun;19(3):294-8. http://www.ncbi.nlm.nih.gov/sites/entrez?cmd=Retrieve&db=PubMed&list_uids=16702838&dopt=Abstract

55. **Pathogenesis of Degenerative Joint Disease in the Human Temporomandibular Joint.** [The wide range of disease prevalences reported in epidemiological studies of temporomandibular degenerative joint disease reflects the fact that diagnoses are frequently guided by the presence or absence of non-specific signs and symptoms. Treatment is aimed at alleviating the disease symptoms rather than being guided by an understanding of the underlying disease processes. Much of our current understanding of disease processes in the temporomandibular joint is based on the study of other articular joints. Although it is likely that the molecular basis of pathogenesis is similar to that of other joints, additional study of the temporomandibular joint is required due to its unique structure and function. This review summarizes the unique structural and molecular features of the temporomandibular joint and the epidemiology of degenerative temporomandibular joint disease. As is discussed in this review, recent research has provided a better understanding of the molecular basis of degenerative joint disease processes, including insights into: the regulation of cytokine expression and activation, arachidonic acid metabolism, neural contributions to inflammation, mechanisms of extracellular matrix degradation, modulation of cell adhesion in inflammatory states, and the roles of free radicals and heat shock proteins in degenerative joint disease. Finally, the multiple cellular and molecular mechanisms involved in disease initiation and progression, along with factors that may modify.] Haskin CL, Milam SB, Cameron IL. *Crit Rev Oral boil Med* 6(3):248-277 (1995).
<http://crobm.iadrjournals.org/cgi/reprint/6/3/248.pdf>
56. **Proinflammatory cytokines detectable in synovial fluids from patients with temporomandibular disorders.** [OBJECTIVE: To measure the levels of the proinflammatory cytokines, interleukin (IL)-1 beta, IL-6, tumor necrosis factor- (TNF) alpha, IL-8, and interferon- (IFN) gamma in synovial fluid samples taken from patients with temporomandibular disorders (TMD). STUDY DESIGN: We studied 6 asymptomatic volunteers and 51 patients with TMD. The IL-1 beta, IL-6, TNF-alpha, IL-8, and IFN-gamma levels in temporomandibular joint synovial fluid were measured using enzyme-linked immunosorbent assay. RESULTS: Measurable level of at least one cytokine in the synovial fluid was found in 40 (64.5%) of 62 joints in the patients: IL-1 beta and IFN-gamma were each detected in 18 (29.0%) of 62 joints; IL-6 in 13 (21.0%) of 62 joints; IL-8 in 11 (19.3%) of 57 joints; and TNF-alpha in only 5 (8.1%) of 62 joints. None of these cytokines was detectable in the synovial fluid in the control group. Furthermore, there was a strong correlation between the detection of IL-1 beta and pain in the joint area. CONCLUSIONS: These data clearly demonstrate increased levels of several proinflammatory cytokines in certain patients with TMD and suggest that these cytokines may play a role in the pathogenesis of synovitis and degenerative changes of the cartilaginous tissue and bone of the temporomandibular joint.] Takahashi T, Kondoh T, et.al. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 1998 Feb;85(2):135-41.
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=9503445&dopt=Citation
57. **Radiographic signs of bone destruction in the arthritic temporomandibular joint with special reference to markers of disease activity. A longitudinal study.** [*Objective.* To investigate the progression of radiographic changes of the temporomandibular joint (TMJ) with reference to plasma levels of interleukin-1 β (IL-1 β), C-reactive protein (CRP) and disease duration. *Methods.* Twenty-one patients with

chronic inflammatory joint disease and TMJ involvement were included. Individualized tomography of the TMJ was performed twice with an interval of at least 12 months. Blood samples were analysed for IL-1 β and CRP. *Results.* Significant progression of the overall grade of radiographic changes occurred during the observation period, whereas erosions showed great interindividual variability. Progression of TMJ bone loss was correlated to raised levels of CRP and, in patients with a diagnosis of rheumatoid arthritis, or with shorter duration, also to plasma IL-1 β . *Conclusion.* Progression of overall grade of radiographic changes in the TMJ occurs in patients with chronic inflammatory joint disease. Raised levels of serum CRP are associated with progression of TMJ bone loss.] Nordahl S, Alstergren P, et.al. *Rheumatology* 2001; 40: 691-694.
<http://rheumatology.oxfordjournals.org/cgi/content/abstract/40/6/691>.

58. **Relationship between disorder in the stomatognathic system and general joint involvement in individuals with rheumatoid arthritis.** [Seventy-one individuals with rheumatoid arthritis (RA) were examined and compared with 52 individuals without history or symptoms of joint disease (C group) with regard to disorders of the stomatognathic system. Laboratory findings and articular and functional rheumatologic indices were compared. The clinical dysfunction index of Helkimo for the stomatognathic system was positively correlated to both the articular Ritchie index and the functional Lee index. The concentration of C-reactive protein (CRP) and the Ritchie index were positively correlated to temporomandibular joint (TMJ) pain. Vertical overbite was negatively correlated to the Ritchie index. In addition, there were positive correlations among TMJ crepitus, anterior open bite, sagittal distance between retruded position and intercuspal position, and erythrocyte sedimentation rate (ESR). The concentration of CRP, the ESR, and the Ritchie and Lee indices were highest in the individuals with bilateral current TMJ symptoms and lowest in those with previous but not current TMJ symptoms. It was concluded that the severity of TMJ involvement in RA is correlated to concentration of serum acute-phase reactants and to rheumatologic indices.] Tegelberg A, Kopp S, et.al. *Acta Odontol Scand.* 1987 Dec;45(6):391-8.
<http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?CMD=search&DB=pubmed>
59. **Soluble tumour necrosis factor receptors in synovial fluids from temporomandibular joints with painful anterior disc displacement without reduction and osteoarthritis.** [The objective of this study was to detect soluble-form tumour necrosis factor receptors (sTNFRs) in temporomandibular joint (TMJ) synovial fluid aspirates, and to compare the sTNFR concentrations between painful anterior disc displacement without reduction and osteoarthritis (ADDwoR/OA) and asymptomatic TMJs. Synovial fluid was sampled from the superior TMJ cavity of 11 painful ADDwoR/OA cases (mean age: 36.9 years) and 10 asymptomatic females (mean age: 24.7 years) by diluted aspiration. The concentrations of sTNFR-I and -II in the synovial fluid were measured using human sTNFR-I and -II enzyme-linked immunosorbent assays. The total protein concentrations in synovial fluids were measured using a bicinchoninic acid protein assay kit. All data were normalised to the total protein concentration of each sample. Two-way factorial analysis of variance and post hoc multiple comparison revealed that: (1) mean normalised sTNFR-I and -II concentrations were higher in TMJ synovial aspirates from ADDwoR/OA patients than from healthy controls; (2) in the ADDwoR/OA patients and the healthy controls, the sTNFR-I concentration in TMJ synovial aspirates was higher than the sTNFR-II concentration; and

(3) high TMJ synovial aspirate sTNFR-II seemed to be associated with less TMJ pain and a less restricted range of mouth opening in the ADDwoR/OA patients. The concentrations of sTNFRs in TMJ synovial fluid are higher in the presence of painful ADDwoR/OA, which could modulate intracapsular inflammation.] Uehara J, Kuboki T, et.al. *Arch of Oral biology vol 49, Issue 2, P 133-142.*

<http://www.aobjournal.com/article/PIIS0003996903002036/abstract>

60. **Temporomandibular Joint Involvement in Rheumatoid Arthritis: A Radiological and Clinical Study.** [Temporomandibular joint (TMJ) involvement in rheumatoid arthritis (RA) is not uncommon. In this study a questionnaire, clinical assessment, and high resolution computerized tomography (HRCT) were used in 15 patients with rheumatoid arthritis to evaluate the diagnostic criteria of TMJ involvement. Symptoms due to TMJ involvement were present in 33.3% of the patients. Frequency of involvement was 40.0% on clinical assessment but 86.6% with HRCT assessment. The most common HRCT findings were decreases in the joint space (33.3%), mandibular subchondral cysts (23.3%), temporal subchondral cysts (23.3%), degeneration (23.3%), shape (13.3%) and height (13.3%) anomalies of the mandibular condyle, condylar head resorption (13.3%), erosion of the mandibular condyle (13.3%), and demineralization (13.3%). All patients with positive clinical findings also had positive HRCT findings. In seven (46.7%) of the patients, there were no symptoms or clinical findings implying TMJ involvement; however, they had positive results on HRCT evaluation. The HRCT findings may be the initial sign of TMJ involvement in patients with rheumatoid arthritis. In conclusion, it is suggested that RA patients with the suspicion of TMJ involvement should undergo HRCT evaluation, because HRCT findings may precede the clinical findings.] Bayar N, Kara SA, et al. *Cranio. 2002 Apr;20(2):105-10.*
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=12002825&dopt=Abstract
61. **Testosterone and estrogen have opposing actions on inflammation-induced plasma extravasation in the rat temporomandibular joint.** [The present study was designed to test the hypothesis that estrogen exacerbates inflammation of the temporomandibular joint (TMJ). Evans blue dye was used to quantify plasma extravasation (PE) around the rat TMJ. In an initial set of experiments, TMJ PE was compared in naive intact male and female rats, as well as in both groups after complete Freund's adjuvant (CFA)-induced inflammation of the TMJ. In contrast to our hypothesis, TMJ PE was significantly greater in both naive and CFA-inflamed male rats than in females. To determine whether these differences were due to gonadal hormones, four additional groups of rats were studied: gonadectomized (Gx) males and females, Gx males with chronic testosterone (T) replacement, and Gx females with chronic estrogen (E) replacement. The sex difference in baseline TMJ PE appeared to reflect the actions of T. However, in the presence of TMJ inflammation, T augmented TMJ PE in males, while E attenuated TMJ PE in females. Changes in PE were also assessed in the contralateral TMJ. Results from this analysis indicated that there is a transient contralateral increase in TMJ PE in females but not males. Given that there is an inverse relationship between PE and joint damage, our results suggest that testosterone may mitigate, but estrogen may exacerbate, TMJ damage, particularly in the presence of overt inflammation. Importantly, our results may help explain both the higher prevalence and severity of temporomandibular disorder pain in females than males.] Flake NM, Hermanstyn TO, Gold MS. *Am J Physiol Regul*

Integr Comp Physiol. 2006 Aug;291(2):R343-8. Epub 2006.

<http://ajpregu.physiology.org/cgi/content/abstract/291/2/R343>

62. **Testosterone and estrogen have opposing actions on inflammation-induced plasma extravasation in the rat temporomandibular joint.** [The present study was designed to test the hypothesis that estrogen exacerbates inflammation of the temporomandibular joint (TMJ). Evans blue dye was used to quantify plasma extravasation (PE) around the rat TMJ. In an initial set of experiments, TMJ PE was compared in naïve intact male and female rats, as well as in both groups after complete Freund's adjuvant (CFA)-induced inflammation of the TMJ. In contrast to our hypothesis, TMJ PE was significantly greater in both naïve and CFA-inflamed male rats than in females. To determine whether these differences were due to gonadal hormones, four additional groups of rats were studied: gonadectomized (Gx) males and females, Gx males with chronic testosterone (T) replacement, and Gx females with chronic estrogen (E) replacement. The sex difference in baseline TMJ PE appeared to reflect the actions of T. However, in the presence of TMJ inflammation, T augmented TMJ PE in males, while E attenuated TMJ PE in females. Changes in PE were also assessed in the contralateral TMJ. Results from this analysis indicated that there is a transient contralateral increase in TMJ PE in females but not males. Given that there is an inverse relationship between PE and joint damage, our results suggest that testosterone may mitigate, but estrogen may exacerbate, TMJ damage, particularly in the presence of overt inflammation. Importantly, our results may help explain both the higher prevalence and severity of temporomandibular disorder pain in females than males.] Flake NM, Hermanstynne TO, et.al. *Am J Physiol Regul Integr Comp Physiol* 291: R343-R348, 2006.

<http://ajpregu.physiology.org/cgi/content/abstract/291/2/R343>

63. **The Cholinergic Anti-inflammatory Pathway: A Missing Link in Neuroimmunomodulation.** [This review outlines the mechanisms underlying the interaction between the nervous and immune systems of the host in response to an immune challenge. The main focus is the cholinergic anti-inflammatory pathway, which we recently described as a novel function of the efferent vagus nerve. This pathway plays a critical role in controlling the inflammatory response through interaction with peripheral $\alpha 7$ subunit-containing nicotinic acetylcholine receptors expressed on macrophages. We describe the modulation of systemic and local inflammation by the cholinergic anti-inflammatory pathway and its function as an interface between the brain and the immune system. The clinical implications of this novel mechanism also are discussed. . . Introduction: Inflammation is a normal response to disturbed homeostasis caused by infection, injury, and trauma. The host responds with a complex series of immune reactions to neutralize invading pathogens, repair injured tissues, and promote wound healing. The onset of inflammation is characterized by release of pro-inflammatory mediators including tumor necrosis factor (TNF), interleukin (IL)-1, adhesion molecules, vasoactive mediators, and reactive oxygen species. The early release of pro-inflammatory cytokines by activated macrophages has a pivotal role in triggering the local inflammatory response. Excessive production of cytokines, such as TNF, IL-1 β , and high mobility group B1 (HMGB1), however, can be more injurious than the inciting event, initiating diffuse coagulation, tissue injury, hypotension, and death. The inflammatory response is balanced by anti-inflammatory factors including the cytokines IL-10 and IL-4, soluble TNF receptors, IL-1 receptor antagonists, and transforming

growth factor (TGF) β . Although simplistic, the pro-/anti- terminology is widely used in the discussion of the complex cytokine network. Apart from their involvement in local inflammation, TNF and IL-1 β are signal molecules for activation of brain-derived neuroendocrine immunomodulatory responses. Neuroendocrine pathways, such as the hypothalamo-pituitary-adrenal (HPA) axis and the sympathetic division of the autonomic nervous system (SNS), control inflammation as an anti-inflammatory balancing mechanism. The host thereby mobilizes the immunomodulatory resources of the nervous and endocrine systems to regulate inflammation. Restoration of homeostasis as a logical resolution of inflammation does not always occur. Insufficient inflammatory responses may result in increased susceptibility to infections and cancer. On the other hand, excessive responses are associated with autoimmune diseases, diabetes, sepsis, and other debilitating conditions. When control of local inflammatory responses is lost, pro-inflammatory mediators can spill into the circulation, resulting in systemic inflammation that may progress to shock, multiple organ failure, and death. Effective therapies for diseases of excessive inflammation are needed.] Pavlov VA, Wang H, et.al. *Mol Med.* 2003 May-Aug; 9(5-8): 125-134.

<http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1430829>

64. **The Effects of Glucosamine and Chondroitin Sulfate On Osteoarthritis of the TMJ: A Preliminary Report of 50 Patients.** [The signs and symptoms of osteoarthritis are common complaints seen in patients suffering with chronic temporomandibular disorders (TMD), specifically, internal derangements with a diagnosis of osteoarthritis. With or without the complaints of pain and swelling, joint noises are bothersome and annoying to both the patient and at times, to those seated close to the patient during mealtime. In fact, many patients are driven to seek care by family members because of his or her TMJ noises. For years in veterinarian medicine, glucosamine and chondroitin sulfates have been used to treat symptoms of osteoarthritis. Recently, the use of these two supplements has been recommended for human beings as well. Reports of decreased joint noises, pain and swelling after the administration of therapeutic doses of these supplements have sparked an interest in their possible use in the treatment of osteoarthritis.] shankland WE. *Cranio.* 1998 Oct;16(4):230-5.
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=10029750&dopt=Abstract
65. **The influence of hot pack therapy on the blood flow in masseter muscles.** [The purpose of this study was to clarify whether hot pack therapy can change the blood flow of human masseter muscles. The results suggest that hot pack therapy can increase regional blood flow of human masseter muscles and creates an advantageous condition for aerobic energy metabolism in the muscles.] Okada K, Yamaguchi T, et al. *Journal of Oral Rehabilitation, Volume 32 Issue 7 Page 480 - July 2005.* <http://www.blackwell-synergy.com/doi/abs/10.1111/j.1365-2842.2005.01448.x?journalCode=jor>
66. **The Influence of Tissue Blood Flow Volume on Energy Metabolism in Masseter Muscles.** [This study investigated the energy metabolism of masseter muscles by ³¹P-Magnetic Resonance Spectroscopy (MRS) during increased blood flow induced by hot pack application to clarify the influence of changes in blood flow on muscle fatigue. Twelve healthy subjects with no history of muscle pain in the masticatory system participated in this study. The ³¹P-MRS measurements were performed before and after hot pack application and the ratio of phosphocreatine (PCr) acting as the energy source to

reproduce ATP to beta-ATP, the PCr/beta-ATP ratio, was analyzed. Results showed that PCr/beta-ATP ratios increased significantly by an average of 22.4% after the hot pack application. The results suggest that changes in blood flow volume influence the energy metabolism in masseter muscles and that blood flow increases due to the hot pack cause higher energy levels in masseter muscles and offer an advantageous condition for preventing and relieving muscle fatigue.] Okada K, Yamaguchi T, et al. *Cranio*. 2005 Jul;23(3):166-73.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=16128350&dopt=Abstract

67. The role of brain insulin in the neurophysiology of serious mental disorders: review.

[The purpose of this review is to indicate the role insulin plays in normal brain neurophysiology, together with the role insulin may play in the regulation of regional cerebral blood flow (rCBF). The relationship between sustained elevation of the inflammatory cytokines and brain insulin dysregulation, with respect to the serious mental disorders, is also discussed. It has been observed that, as the inflammatory cytokines increase, they exert a synergistic influence on insulin and somatostatin, by initially increasing and then decreasing insulin secretion. In the brain, increased levels of insulin result in increased glucose utilization and over-stimulation of the autonomic nervous system (ANS), while the inhibition of insulin secretion results in decreased glucose utilization and dysregulation of the hypothalamo-pituitary-adrenal (HPA) axis. It will further be argued that these alterations in brain insulin influence rCBF in the serious mental disorders such as schizophrenia and the affective disorders. It is hypothesized that insulin regulates rCBF either directly, or indirectly via GLUT4 in the hypothalamus now considered the glucose-sensing, insulin-sensing mechanism of the brain and the body. Thus, we shall propose that insulin plays an important role in normal neurophysiology and that sustained elevation of the inflammatory cytokines dysregulates insulin secretion, rCBF, ANS and the HPA-axis in serious mental disorders.] Holden RJ. *Med Hypotheses*. 1999 Mar;52(3):193-200.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=10362277&dopt=Citation

68. The stress system in the human brain in depression and neurodegeneration.

[Corticotropin-releasing hormone (CRH) plays a central role in the regulation of the hypothalamic-pituitary-adrenal (HPA)-axis, i.e., the final common pathway in the stress response. The action of CRH on ACTH release is strongly potentiated by vasopressin, that is co-produced in increasing amounts when the hypothalamic paraventricular neurons are chronically activated. Whereas vasopressin stimulates ACTH release in humans, oxytocin inhibits it. ACTH release results in the release of corticosteroids from the adrenal that, subsequently, through mineralocorticoid and glucocorticoid receptors, exert negative feedback on, among other things, the hippocampus, the pituitary and the hypothalamus. The most important glucocorticoid in humans is cortisol, present in higher levels in women than in men. During aging, the activation of the CRH neurons is modest compared to the extra activation observed in Alzheimer's disease (AD) and the even stronger increase in major depression. The HPA-axis is hyperactive in depression, due to genetic factors or due to aversive stimuli that may occur during early development or adult life. At least five interacting hypothalamic peptidergic systems are involved in the symptoms of major depression. Increased production of vasopressin in depression does

not only occur in neurons that colocalize CRH, but also in neurons of the supraoptic nucleus (SON), which may lead to increased plasma levels of vasopressin, that have been related to an enhanced suicide risk. The increased activity of oxytocin neurons in the paraventricular nucleus (PVN) may be related to the eating disorders in depression. The suprachiasmatic nucleus (SCN), i.e., the biological clock of the brain, shows lower vasopressin production and a smaller circadian amplitude in depression, which may explain the sleeping problems in this disorder and may contribute to the strong CRH activation. The hypothalamo-pituitary thyroid (HPT)-axis is inhibited in depression. These hypothalamic peptidergic systems, i.e., the HPA-axis, the SCN, the SON and the HPT-axis, have many interactions with aminergic systems that are also implicated in depression. CRH neurons are strongly activated in depressed patients, and so is their HPA-axis, at all levels, but the individual variability is large. It is hypothesized that particularly a subgroup of CRH neurons that projects into the brain is activated in depression and induces the symptoms of this disorder. On the other hand, there is also a lot of evidence for a direct involvement of glucocorticoids in the etiology and symptoms of depression. Although there is a close association between cerebrospinal fluid (CSF) levels of CRH and alterations in the HPA-axis in depression, much of the CRH in CSF is likely to be derived from sources other than the PVN. Furthermore, a close interaction between the HPA-axis and the hypothalamic-pituitary-gonadal (HPG)-axis exists. Organizing effects during fetal life as well as activating effects of sex hormones on the HPA-axis have been reported. Such mechanisms may be a basis for the higher prevalence of mood disorders in women as compared to men. In addition, the stress system is affected by changing levels of sex hormones, as found, e.g., in the premenstrual period, ante- and postpartum, during the transition phase to the menopause and during the use of oral contraceptives. In depressed women, plasma levels of estrogen are usually lower and plasma levels of androgens are increased, while testosterone levels are decreased in depressed men. This is explained by the fact that both in depressed males and females the HPA-axis is increased in activity, parallel to a diminished HPG-axis, while the major source of androgens in women is the adrenal, whereas in men it is the testes. It is speculated, however, that in the etiology of depression the relative levels of sex hormones play a more important role than their absolute levels. Sex hormone replacement therapy indeed seems to improve mood in elderly people and AD patients. Studies of rats have shown that high levels of cumulative corticosteroid exposure and rather extreme chronic stress induce neuronal damage that selectively affects hippocampal structure. Studies performed under less extreme circumstances have so far provided conflicting data. The corticosteroid neurotoxicity hypothesis that evolved as a result of these initial observations is, however, not supported by clinical and experimental observations. In a few recent postmortem studies in patients treated with corticosteroids and patients who had been seriously and chronically depressed no indications for AD neuropathology, massive cell loss, or loss of plasticity could be found, while the incidence of apoptosis was extremely rare and only seen outside regions expected to be at risk for steroid overexposure. In addition, various recent experimental studies using good stereological methods failed to find massive cell loss in the hippocampus following exposure to stress or steroids, but rather showed adaptive and reversible changes in structural parameters after stress. Thus, the HPA-axis in AD is only moderately activated, possibly due to the initial (primary) hippocampal degeneration in this condition. There are no convincing

arguments to presume a causal, primary role for cortisol in the pathogenesis of AD. Although cortisol and CRH may well be causally involved in the signs and symptoms of depression, there is so far no evidence for any major irreversible damage in the human hippocampus in this disorder.] Swaab DF, Bao AM, et.al. *Ageing Res Rev.* 2005 May;4(2):141-94.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=15996533&dopt=Citation

69. **Three major haplotypes of the beta2 adrenergic receptor define psychological profile, blood pressure, and the risk for development of a common musculoskeletal pain disorder.** [Adrenergic receptor beta(2) (ADRB2) is a primary target for epinephrine. It plays a critical role in mediating physiological and psychological responses to environmental stressors. Thus, functional genetic variants of ADRB2 will be associated with a complex array of psychological and physiological phenotypes. These genetic variants should also interact with environmental factors such as physical or emotional stress to produce a phenotype vulnerable to pathological states. In this study, we determined whether common genetic variants of ADRB2 contribute to the development of a common chronic pain condition that is associated with increased levels of psychological distress and low blood pressure, factors which are strongly influenced by the adrenergic system. We genotyped 202 female subjects and examined the relationships between three major ADRB2 haplotypes and psychological factors, resting blood pressure, and the risk of developing a chronic musculoskeletal pain condition-Temporomandibular Joint Disorder (TMD). We propose that the first haplotype codes for lower levels of ADRB2 expression, the second haplotype codes for higher ADRB2 expression, and the third haplotype codes for higher receptor expression and rapid agonist-induced internalization. Individuals who carried one haplotype coding for high and one coding for low ADRB2 expression displayed the highest positive psychological traits, had higher levels of resting arterial pressure, and were about 10 times less likely to develop TMD. Thus, our data suggest that either positive or negative imbalances in ADRB2 function increase the vulnerability to chronic pain conditions such as TMD through different etiological pathways that imply the need for tailored treatment options.] Diatchenko L, Anderson AD, et.al. *Am J Med Genet B Neuropsychiatr Genet.* 2006 Jul 5;141(5):449-62. <http://www3.interscience.wiley.com/cgi-bin/abstract/112641311/ABSTRACT>

Migraines, Headaches and Facial Pain

70. **A Retrospective Evaluation of the Impact of Temporomandibular Joint Arthroscopy on the Symptoms of Headache, Neck Pain, Shoulder Pain, Dizziness, and Tinnitus.** [ABSTRACT: Forty-three patients who underwent arthroscopic surgery for arthrogenous TMD were polled concerning the effect of surgery on the symptoms of headache, neck pain, shoulder pain, dizziness and tinnitus. Statistically significant levels of symptom reduction were recorded for all symptoms polled. This indicates that a substantial number of significant symptoms are produced by the influence of temporomandibular joint pathology on central neural processes. A model for the affect of temporomandibular joint pathology on cervical and masticatory musculature is proposed. This data implies that we cannot use muscle tenderness, hypertonicity and/or pain to differentiate arthrogenous from myogenous temporomandibular disorders. The

characteristics of a population of whiplash onset TMD patients were compared to other TMD populations. The results indicate that whiplash induced TMD may differ from insidious onset TMD and even other trauma onset TMDs by prevalence of neck pain, intensity of neck pain and probability of concurrence of neck pain, shoulder pain, headache and jaw pain. These symptoms resolved within 24 hours of arthroscopic temporomandibular joint surgery indicating that the temporomandibular joint pathology was the perpetuating force behind, if not the cause of, these symptoms.] Steigerwald DP, Verne SV, et al. *Cranio*. 1996 Jan;14(1):46-54.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=9086876&dopt=Abstract

71. **A Comparison of Headache Symptoms Between Two Groups: A TMD Group and a General Dental Practice Group.** [Several studies have shown that headaches are associated with patients who have temporomandibular disorders (TMD) compared with non-TMD patients. None of these studies separated the patients by gender or controlled for TMD in the two groups of patients. This study compared a TMD group of patients and a non-TMD group for recent headache symptoms, TMD symptoms and for gender differences. Each patient was asked to rate headache, temporomandibular joint and facial pain symptoms over the past week. The data was collected, tabulated and controlled for TMD symptoms. The data was scored using the Fischer's p-test and a multivariate logistic regression analysis was performed. The headaches were significantly greater in the TMD group ($p < 001$) than in the private practice group with the genders combined. Dividing the two groups into genders, both males and females in the TMD group were shown to have a greater number of headache symptoms, and the number of headaches was statistically different than the non-TMD group (males $p = .037$, females $p < .001$). The TMD group had greater severity of headaches than the non-TMD group. Dividing the two groups into genders, females also had a greater severity of headaches than male counterparts in the TMD and non-TMD groups. From the multivariate logistic regression analysis, these results indicate that headache symptoms are common in patients with TMD symptoms and that the headaches were more severe in the TMD patients than in the non-TMD patients.] Pettengill C. *Cranio*. 1999 Jan;17(1):64-9.
- http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=10425932&dopt=Abstract
72. **An epidemiologic study of headache among adolescents and young adults.** [Despite extensive description of headache among patients in specialty clinics and general practices in the United States, there have been few community-wide investigations. In a population-based telephone interview study of 10,169 Washington County, Maryland, residents who were 12 through 29 years old, 57.1% of males and 76.5% of females reported that their most recent headache occurred within the previous 4 weeks. Four or more headaches in the preceding month were reported by 6.1% of males and 14.0% of females. The average duration of the subjects' most recent headache was 5.9 hours for males and 8.2 hours for females; 7.9% and 13.9%, respectively, missed part of a day or more of school or work because of that headache. Within the month before interview, 3.0% of males and 7.4% of females had suffered from a migraine headache. Consultations with a physician, by specialty, for headache-related problems are described by sex and age of subjects, as is the use of specific prescription and nonprescription

- medications.] Linet MS, Steward WF. et al. *JAMA Vol.261 No. 15, April 21 1989.*
<http://jama.ama-assn.org/cgi/content/abstract/261/15/2211>
73. **Burden of tension-type headache.** [Epidemiology of headache has been the subject of increased attention recently. It appears that the overall human and financial cost of headache is considerable. Moreover, when the comorbidity and indirect implications of headache are taken into account, the result can be staggering. Most of the literature has concentrated on migraine rather than other headache types such as tension-type headache. This article gathers emerging data that give an estimate of some of the aspects of the burden imparted by tension-type headache on society. It also briefly considers some of the factors that could positively influence this challenge of modern medicine.] Lenaerts ME. *Current Pain and Headache Reports, Vol 10, No.6, p. 459-462.*
<http://www.springerlink.com/content/wg156001x1586435/>
74. **Cervical headache: an investigation of natural head posture and upper cervical flexor muscle performance.** [In this study, 60 female subjects, aged between 25 and 40 years, were divided into two equal groups on the basis of absence or presence of headache. A passive accessory intervertebral mobility (PAIVM) examination was performed to confirm an upper cervical articular cause of the subjects' headache and a questionnaire was used to establish a profile of the headache population. Measurements of cranio-cervical posture and isometric strength and endurance of the upper cervical flexor muscles were compared between the two groups of subjects. The headache group was found to be significantly different from the non-headache group in respect to forward head posture (FHP) ($t = -5.98, p < 0.00005$), less isometric strength ($t = 3.43, p < 0.001$) and less endurance ($t = 8.71, p < 0.0005$) of the upper cervical flexors. A statistically significant relationship was also established between natural head posture and isometric endurance of the upper cervical flexor musculature which demonstrated that FHP corresponded with a low endurance capacity ($\chi^2 = 13.2; p < 0.01$). The outcome of this study highlights the need to screen for cervical etiology in patients who are suspected of suffering from common migraine.] Watson DH, Trott Ph. *Cephalalgia. 1993 Aug;13(4):272-84; discussion 232.*
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=8374943&query_hl=2
75. **Cervical pain in individuals with and without temporomandibular disorders.** [The objective of this study was to evaluate the association of the Temporomandibular Disorder (TMD) with the presence of pain in the cervical region, as well as to evaluate the involvement of Sternocleidomastoid (SCM) muscle during the activity of the temporal and masseter muscles during dental clenching. 40 female volunteers aged between 18 and 41 years, distributed into a control group and TMD group were enrolled in this study. Clinical examinations of the craniomandibular system and of the neck were performed. Myoelectric activity of the temporalis, masseter and SCM muscle was registered during the mandibular rest position and during the contraction in maximal intercuspal position. The results show to the existence of association between the groups and the presence of cervical pain. It was registered bigger myoelectric activity in SCM muscle during the contraction in maximal intercuspal position than mandibular rest position. The results of this study indicate that individuals with TMD present more pain in the cervical region. The presence of compensatory strategies represents a mechanism necessary to find stability for the mandibular and cervical region during the mandibular

movements.] Ries, LGK, Berzin F. *Braz J Oral Sci.* 5(19)1301-1307.

http://www.fop.unicamp.br/brjorals/temp2/c20_Art_11_Cervical.pdf

76. **Cluster-like Signs and Symptoms Respond to Myofascial/Craniomandibular Treatment: A Report of Two Cases.** [Two cases with pain profiles characteristic of cluster-like headache, both within and outside the trigeminal system, are reported. One male patient would typically awaken from sleep with severe unilateral temporal head pain and autonomic signs of ipsilateral lacrimation and nasal congestion. A female patient exhibited severe unilateral boring temporal and suboccipital head pain with associated ipsilateral lacrimation and rhinorrhea. In addition, both patients presented with signs and symptoms of masticatory and/or cervical disorders. These two cases illustrate possible treatment alternatives, as well as possible influences from cervical and masticatory structures in the development of cluster or cluster-like headache.] Vargo CP, Hickman DM. *Cranio.* 1997 Jan;15(1):89-93.
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=9586493&dopt=Abstract
77. **Concurrent cervical and craniofacial pain. A review of empiric and basic science evidence.** [Because many patients present themselves for treatment with both craniofacial and craniocervical pain, 2 questions arise: (1) What are the sensory and motor consequences of dysfunction in either of these areas on the other? (2) Do craniofacial and craniocervical pain have a similar cause? These questions formed the impetus for this review article. The phenomenon of concurrent pain in craniofacial and cervical structures is considered, and clinical reports and opinions are presented regarding theories of cervical-to-craniofacial and craniofacial-to-cervical pain referral. Because pain referral between these 2 areas requires anatomic and functional connectivity between trigeminally and cervically innervated structures, basic neurophysiologic and neuroanatomic literature is reviewed. The published data clearly demonstrate neurophysiologic and structural convergence of cervical sensory and muscle afferent inputs onto trigeminal subnucleus caudalis nociceptive and non-nociceptive neurons. Moreover, changes in metabolic activity and blood flow in the brainstem and cervical dorsal horn of the spinal cord in both monkeys and cats have been demonstrated after electric stimulation of the V1-innervated superior sagittal sinus. In conclusion, the animal experimental data support the findings of human empiric and experimental studies, which suggest that strong connectivity exists between trigeminal and cervical motor and sensory responses.] Browne PA, Clark GT, et al. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 1998 Dec;86(6):633-40.
http://www.ncbi.nlm.nih.gov/sites/entrez?cmd=Retrieve&db=PubMed&list_uids=9868716&dopt=Citation
78. **Diagnosis and Treatment of Craniocervical Pain and Headache based on Neuromuscular Parameters.** [There is increasing evidence supporting the premise that hypertonicity within facial muscles is an etiologic factor for some chronic headache patients. This muscular hypertonicity is the result of neuromuscular imbalances within the head and neck. Through the analysis of electromyograph (EMG) data, it is possible to construct an intraoral orthosis which creates neuromuscular balance and subsequently relieves the pain. This study attempted to identify (i) the relationship of EMG-measured dysfunction to reported craniocervical pain and (ii) the effectiveness of EMG-based orthoses on reversing myospastic conditions. Results of the study (N=203) indicate a

significant ($p < .0001$) decrease in muscular myospasm at rest and a significant ($p < .0001$) increase in muscular activity during function following treatment with EMG-based orthoses. Reported craniocervical pain was significantly reduced. Results of this study support the hypothesis that creation of a physiologic neurovasomuscular envelope of craniocervical motion allows reduction of muscular hypertonicity resulting in reduction of pain. Furthermore, utilization of electromyography is a valuable tool during assessment and treatment of chronic facial pain patients.] Lynn JM, Mazzocco MW, et al. *Am Journal of Pain Management*, 2:3, --143-151. <http://www.myotronics.com/learning.cfm?id=2>

79. **Epidemiology and Economic Impact of Migraine.** [Migraine is a very common disorder, affecting about 11% of adult populations in Western countries. Prevalence is highest during the peak productive years - between the ages of 25 and 55. The prevalence is higher in females than males at all post-pubertal ages, but the sex ratio varies with age. In the United States, migraine prevalence is higher in those with low income or education, perhaps because migraine interferes with work and school. Most migraineurs manage their headaches without conventional medical advice and generally treat their attacks with over-the-counter medication. The indirect costs of migraine greatly outweigh the cost of treatment, creating opportunities for cost-effective intervention. The public health burden of migraine is substantial due to its high prevalence and prominent temporary disability. The widespread disability produced by migraine is an important target for treatment.] Lipton R, Stewart WF, et al. *Current Med Res and Opinion*, 17(1s):24-s12,2001. <http://www.medscape.com/viewarticle/429665>
80. **Evaluation of Acute Headaches in Adults.** [Classifying headaches as primary (migraine, tension-type or cluster) or secondary can facilitate evaluation and management. A detailed headache history helps to distinguish among the primary headache disorders. "Red flags" for secondary disorders include sudden onset of headache, onset of headache after 50 years of age, increased frequency or severity of headache, new onset of headache with an underlying medical condition, headache with concomitant systemic illness, focal neurologic signs or symptoms, papilledema and headache subsequent to head trauma. A thorough neurologic examination should be performed, with abnormal findings warranting neuroimaging to rule out intracranial pathology. The preferred imaging modality to rule out hemorrhage is noncontrast computed tomographic (CT) scanning followed by lumbar puncture if the CT scan is normal. Magnetic resonance imaging (MRI) is more expensive than CT scanning and less widely available; however, MRI reveals more detail and is necessary for imaging the posterior fossa. Cerebrospinal fluid (CSF) analysis can help to confirm or rule out hemorrhage, infection, tumor and disorders related to CSF hypertension or hypotension. Referral is appropriate for patients with headaches that are difficult to diagnose, or that worsen or fail to respond to management.] Clinch CR. *Am Family Physician*, 2001;63:685-92. <http://www.aafp.org/afp/20010215/685.html>
81. **Functional connectivity between trigeminal and occipital nerves revealed by occipital nerve blockade and nociceptive blink reflexes.** [Headache syndromes often suggest occipital and neck involvement, although it is still unknown to what extent branches of segment C1-C3 contribute actively to primary headache. Pain within the occipital area may be referred to the trigeminal territory. However, a modulation of trigeminal transmission by affecting cervical input in humans has not been elucidated so

far. A convergence of cervical and trigeminal input at the level of the caudal part of the trigeminal nucleus in the brainstem has been suggested due to anatomical and neurophysiological studies in animals. We examined the R2 components of the nociceptive blink reflex responses in 15 healthy subjects before and after unilateral nerve blockade of the greater occipital nerve with 5 ml prilocain (1%). R2 response areas (AUC) decreased and the R2 latencies increased significantly after the nerve blockade only on the side of injection. AUC and latencies on the non-injection side remained stable. Thresholds for sensory or pain perception did not differ significantly between the repeated measurements on both sides. Our findings extend previous results related to anatomical and functional convergence of trigeminal and cervical afferent pathways in animals and suggest that the modulation of this pathway is of potential benefit in primary headache disorders.] Busch V, Jakob W, et al. *Cephalgia*, vol 26, Issue 1, p.50-55, Jan 2006, <http://www.blackwell-synergy.com/doi/abs/10.1111/j.1468-2982.2005.00992.x?cookieSet=1&journalCode=cha>

82. **Greater occipital nerve block is ineffective in chronic tension type headache.**

[Patients with primary headache syndromes often describe a pain distribution, that does not respect the trigeminal innervation of the head. In addition to pain in frontal areas, innervated by the first (ophthalmic) division of the trigeminal nerve, the pain often occurs in occipital parts of the head, innervated by the greater occipital nerve, a branch of the C₂ spinal nerve root. Anatomical and neurophysiological studies in animals suggest a convergence of cervical and trigeminal input in the trigeminal nucleus caudalis. Modulation of this pathway has been discussed to be of potential benefit in headache disorders. We investigated in an open pilot study the effect of bilateral block of the greater occipital nerve with 50 mg prilocaine and 4 mg dexamethasone in patients with chronic tension type headache. From 15 patients, only one patient described a headache relief after initial exacerbation of headache for 2 days. Headache intensity was unchanged in 11 patients. In further three patients, the headache worsened in the first hours or days after injection. No serious adverse events were observed. One patient showed a bradycardia (36/min) after the first injection during palpation of the muscles of the neck. Three patients suffered pain on the injection site for a few days. Our results indicate that block of the greater occipital nerve is not effective in the treatment of chronic tension type headache. If at all, rather a 'pro-nociceptive' effect was observed.] Leinisch-Dahlke E, Jurgens T, et al. *Cephalgia*, Vol.25, Issue 9, p.704-798, Sept 2005. <http://www.blackwell-synergy.com/doi/abs/10.1111/j.1468-2982.2004.00941.x?journalCode=cha>

83. **Headache improvement through TMD stabilization appliance and self-management therapies.**

[The purpose of this study was to assess headache response of unselected neurology clinic chronic headache patients to TMD stabilization appliance and self-management therapies, and to identify features of patients whose headaches are more likely to improve from these therapies. Twenty chronic headache patients in a nontreatment control period were provided appliance and self-management therapies, evaluated five weeks after therapy, and those who chose to continue using their appliances were evaluated three months later. The mean pretreatment Headache Disability Inventory (HDI) score of 64.5 suggested the headaches were severe. After five weeks, the mean HDI score decreased by 17 percent (p<0.003), headache medication consumption dropped by 18 percent (p<0.0001), and headache symptoms decreased by

19 percent ($p < 0.002$). Comparing the three months with pretreatment follow-up, the fourteen participants who chose to continue using their appliances had a mean HDI score decrease of 23 percent ($p < 0.003$), headache medication consumption drop of 46 percent ($p < 0.001$), and headache symptom decrease of 39 percent ($p < 0.001$). There was no correlation between response and headache type ($p = 0.722$). These results suggest appliance and self-management therapies can be beneficial for many severe headache patients, irrespective of the headache type (tension-type, migraine without aura, and migraine with aura).] Wright EF, Clark EG, et al. *Cranio*. 2006 Apr;24(2):104-11. http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=pubmed&list_uids=16711272&cmd=Retrieve&indexed=google

84. **Headache and temporomandibular disorders: evidence for diagnostic and behavioural overlap.** [To assess the diagnostic and behavioural overlap of headache patients with temporomandibular disorders (TMD), individuals recruited from the general population with self-described headaches were compared with non-headache controls. The examination and diagnostic procedures in the Research Diagnostic Criteria (RDC) for TMD were applied to both sets of subjects by a blinded examiner. Following their examination, subjects used experience sampling methods to obtain data on pain, tooth contact, masticatory muscle tension, emotional states and stress. Results showed that a significantly higher proportion of the headache patients received an RDC/TMD diagnosis of myofascial pain than non-headache controls. Headache patients also reported significantly more frequent and intense tooth contact, more masticatory muscle tension, more stress and more pain in the face/head and other parts of the body than non-headache controls. These results are similar to those reported for TMD patients and they suggest that headache patients and TMD patients overlap considerably in diagnosis and oral parafunctional behaviours.] Glaros AG, Urban D, Locke J. *Cephalalgia(OnlineEarly Articles)*. <http://www.blackwell-synergy.com/doi/abs/10.1111/j.1468-2982.2007.01325.x>
85. **Headaches and their relationship to sleep.** [Despite the complex influences of normal sleep physiology and sleep disorders on the development or presentation of headache, it is important to recognize and understand these relationships. Successful outcomes depend on the provision of treatment interventions specifically directed toward each condition. Nocturnal or early morning headaches that are associated with OSA are often eradicated after the sleep disorder is successfully managed with CPAP, oral appliances, or surgery. Substantial improvement in headache can also result from the successful management of other sleep disorders that may incite headaches such as heavy snoring, PLMS, or the various forms of insomnia. To improve headache patterns associated with bruxism and TMD, it is often necessary to formulate a multidisciplinary treatment approach that combines oral appliance therapy, stress management, biofeedback, oromandibular physical therapy, and, at times, pharmacologic treatment (i.e., tricyclic antidepressant, intramuscular botulinum toxin injections). There are still many gaps in the understanding of the interrelationships of sleep physiology and headache pathophysiology. More well-designed clinical trials are needed so that enough data can be amassed for the formulation of evidence-based guidelines or consensus statements that can better delineate the identification, diagnostic evaluation, and treatment of sleep-related headache disorders and headaches that develop as a consequence of disordered sleep.] Biondi DM. *Dent Clin North Am*. 2001 Oct;45(4):685-700.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=11699236&dopt=Citation

86. **Headache disorders.** [Various forms of headache, properly called headache disorders, are among the most common disorders of the nervous system. They are pandemic and, in many cases, life-long conditions. Headache itself is a painful and often disabling feature of a relatively small number of primary headache disorders. It also occurs secondarily to a considerable number of other conditions. A wide range of headache types have been classified in detail by the International Headache Society (table I). The most common among them – tension-type headache (TTH), migraine, cluster headache and the so-called chronic daily headache syndromes – cause substantial levels of disability. Headache has been and continues to be underestimated in scope and scale, and headache disorders remain under-recognized and under-treated throughout the world.] World Health Organization. <http://www.who.int/mediacentre/factsheets/fs277/en/>
87. **Mandibular Repositioning Can Be Effective in Treatment of Reducing TMJ Disk Displacement. A Long-term Clinical and MR Imaging Follow-up.** [In order to evaluate the long term clinical and morphologic results of recapture of a displaced TMJ disk, we recalled for follow-up MR imaging 75 patients who had been treated by attempted disk recapture based on pre-treatment MR imaging 1-6 years earlier. The treatment included a day appliance with inclines to guide the mandible into the therapeutic position and a telescopic night appliance which prevented retrusion of the mandible during sleep. Appliance treatment was followed by rebuilding or resurfacing the posterior teeth of one arch to permanently support the mandible in the therapeutic position. After treatment of 115 joints with displaced disks, 52% of the disks were normally positioned, 23% were improved in position, and 25% showed persistent disk displacement. Symptom relief was 92% in patients with normalized (recaptured) disks, 84% in patients with improved disk position, and 49% in patients with persistent disk displacement. Failure to improve disk position occurred in 7% of the joints with anterior disk displacement and in 44% of the joints with a transverse (sideways) component to the displacement. Forty-five percent of the recaptured-disks improved in contour. We concluded that anterior mandibular repositioning was effective in the treatment of patients with reducing displaced disks primarily when the disks were displaced only in an anterior direction. This treatment can be recommended in anterior disk displacements if the patient has failed more conservative treatment measures, permanent occlusal reconstruction can be justified, and the patient understands that long-term use of a night appliance may be necessary. Anterior mandibular repositioning appears much less effective in cases with a transverse component to the disk displacement.] Summer JD, Westesson PI. *Cranio*. 1997 Apr;15(2):107-20. http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=9586512&dopt=Abstract
88. **Migraine and Tension-Type Headache Reduction Through Pericranial Muscular Suppression: A Preliminary Report.** [Migraine and tension-type headaches have always plagued mankind. In spite of all the research dollars spent trying to determine the etiologies of these headaches, the neurology community still has not established a known cause of migraine and tension type headaches. This paper describes a study that was conducted for the U.S. Food and Drug Administration in which the efficacy of the Nociceptive Trigeminal Inhibition Tension Suppression System was evaluated and

proved safe and efficacious in the reduction of medically diagnosed migraine and tension-type headache.] Shankland WE. *Cranio*. 2001 Oct;19(4):269-78.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=11725851&dopt=Abstract

89. **Myofascial pain syndrome misdiagnosed as odontogenic pain: a case report.** [The aim of this report is to illustrate the case of a patient whose myofascial pain syndrome was misdiagnosed as odontogenic pain, and who was treated using irreversible dental procedures. Even if dental pain commonly has an odontogenic etiology, it is also possible that pain arising from different orofacial sites such as jaw muscles, maxillary sinus, or nervous structures can be referred to the teeth. When the etiology of a dental pain condition cannot be clearly identified, it is necessary to consider all possible causes of dental pain, which may also be nonodontogenic. The need for comprehensive examination and careful diagnosis before irreversible dental treatment is emphasized.] Farella M, Michelotti A, et al. *Cranio*. 2002 Oct;20(4):307-11.
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=12403190&dopt=Abstract
90. **Myofascial trigger points and their relationship to headache clinical parameters in chronic tension-type headache** [OBJECTIVE: To assess the presence of trigger points (TrPs) in several head and neck muscles in subjects with chronic tension-type headache (CTTH) and in healthy subjects; and to evaluate the relationship of these TrPs with forward head posture (FHP), headache intensity, duration, and frequency. BACKGROUND: Tension-type headache (TTH) is a headache in which myofascial TrPs in head and neck muscles might play an important etiologic role. ... CONCLUSIONS: Active TrPs in upper trapezius, sternocleidomastoid, and temporalis muscles were associated with CTTH. CTTH subjects with active TrPs usually reported a greater headache intensity and longer headache duration than those with latent TrPs. CTTH subjects with active TrPs tended to have a greater FHP than CTTH subjects with latent TrPs.] Fernandez-de-Las-Penas C, Alonso-Blanco C, et al. *Headache*. 2006 Sep;46(8):1264-72.
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=pubmed&cmd=Retrieve&dopt=AbstractPlus&list_uids=16942471&query_hl=3&itool=pubmed_docsum
91. **Myofascial trigger points, neck mobility, and forward head posture in episodic tension-type headache.** [Objective.-To assess the differences in the presence of trigger points (TrPs) in head and neck muscles, forward head posture (FHP) and neck mobility between episodic tension-type headache (ETTH) subjects and healthy controls. In addition, we assess the relationship between these muscle TrPs, FHP, neck mobility, and several clinical variables concerning the intensity and the temporal profile of headache. Background.-TTH is a headache in which musculoskeletal disorders of the craniocervical region might play an important role in its pathogenesis. ...Conclusions.-Active TrPs in the upper trapezius, sternocleidomastoid, and temporalis muscles were more common in ETTH subjects than in healthy controls, although TrP activity was not related to any clinical variable concerning the intensity and the temporal profile of headache. ETTH patients showed greater FHP and lesser neck mobility than healthy controls, although both disorders were not correlated with headache parameters.] Fernandez-de-Las-Penas C, Cuadrado ML, et al. *Headache*. 2007 May;47(5):662-72.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=17501847

92. **New Data Estimate Migraine Headaches Cost U.S. Employers more than \$24 Billion Annually.** [According to new data presented at the 48th Annual Scientific Meeting of the American Headache Society, migraine headaches cost American employers more than \$24 billion a year in direct and indirect healthcare costs.] Thompson Healthcare News Bulletin, June 27, 2007. <http://www.medstat.com/News/view/?id=545>
93. **Role of Temporomandibular Disorders (TMD) in Facial Pain: Occlusion, Muscle and TMJ Pain.** [Temporomandibular disorders (TMD) which comprise myogenic and arthralgic components have been reported to predispose subjects to headache and facial pain. The aim of this study was to evaluate the role of these components in patients with facial pain and to investigate the influence of treatment of TMD on pain of these patients. The subject group consisted of 25 patients suffering from facial pain. The clinical stomatognathic examination was performed before conservative treatment of TMD, and one-two weeks, three months and one year after treatment. The severity of TMD was assessed using the anamnestic (AI) and clinical dysfunction (DI) indices of Helkimo. The intensity of pain was evaluated on a numerical rating scale (NRS). According to clinical findings the patients were classified to following diagnostic subgroups: TMD myo (mainly myogenic), TMD arthro (mainly arthrogenous) and TMD comb (both myogenic and arthrogenous components involved). Fifteen patients were classified in the TMD myo group, nine in the TMD comb group and one in the TMD arthro group. The DI index decreased significantly one-two weeks after treatment and remained at this level at three month and one year follow-up examinations. At the first examination the TMD myo group had the highest level of NRS index, which decreased significantly during the time of follow-up, while no significant changes were found in other groups. Bruxism reported by the patient had a positive correlation with the amount of painful muscles on the right side at first examination. The results show that facial pain combined with TMD may be mostly of myogenic origin, and myogenic pain seems to have most favorable response to conservative treatment of TMD.] Rauhala K, Oikarinen KS, et al. *Cranio*. 1999 Oct;17(4):254-61.
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=10650397&dopt=Abstract
94. **Temporomandibular Disorders And Migraine Headache: Comorbid Conditions?** [Migraine headache and temporomandibular disorders represent two conditions that affect a significant portion of the population. The relationship between tension-type headache, formerly called musculo-skeletal headache, and myalgia of the masticatory muscles has been known and demonstrated in many patients. However, few studies show a significant association between vascular headache or migraine and temporomandibular disorders. Increasing evidence suggests a potential link in the etiology and course of these seemingly distinct pain disorders. This paper reviews these two conditions and discusses the possible connection between migraine headache and temporomandibular disorders.] DeRossi SS, Stoopler ET, Sollecito TP. *The Internet Journal of Dental Science*. 2005. Volume 2 Number 1.
<http://www.ispub.com/ostia/index.php?xmlFilePath=journals/ijds/vol2n1/migraine.xml>
95. **Temporomandibular Disorders, Occlusion, and Neck Pain in Subjects with Facial Pain: A Case-Control Study.** [The etiology of facial pain is multifactorial. Based on the

results of a questionnaire included in the study of the 1966 Northern Finland Birth Cohort, performed in 1997-98, we found an association of facial pain with subjective symptoms of temporomandibular disorders (TMD), neck pain and with occlusal factors reported by 5,696 subjects. The aim of the present study was to examine these associations clinically. ...Anamnestic data were collected, and clinical stomatognathic and musculoskeletal examinations were performed, both the clinicians and the subjects being unaware of the case-control status. Anamnesticly, stress was the most often reported provoking factor for facial pain. Facial pain associated significantly with reported TMD symptoms and allergies. Based on clinical findings, most of the cases were classified in the myogenous subgroup of TMD. The risk for facial pain was six-fold in subjects with clinically assessed TMD, defined as moderate (DiII) or severe (DiIII) by Helkimo's clinical dysfunction index, almost six-fold in subjects with protrusion interferences and approximately three-fold in subjects with clinically assessed tenderness of distinct fibromyalgia (FM) points in the neck. According to the adjusted logistic regression analyses, TMD had the strongest influence on facial pain, followed by protrusion interferences, anamnesticly reported allergies and "other headaches". The present study shows that as well as being connected with TMD, facial pain is associated with pain and muscle tenderness in the neck area.] Sipila K, Zitting P. et al. *Cranio*. 2002 Jul;20(3):158-64.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=12150261&dopt=Abstract

96. **The Cost and Prevalence of Migraine Headaches.** [The medical care costs of conditions under-ascertained by claims data, such as migraine headaches, are difficult to estimate accurately. Using a validated telephone screen to ascertain migraine cases and non-migraine controls, and comprehensive claims data to estimate costs, we describe the prevalence of migraine headache and estimate the medical care costs associated with migraine. ... The prevalence of migraine in the managed care population was 19.2% among women and 6.5% among men. Only 13% of the interview ascertained migraine cases were identifiable using migraine diagnostic codes available in claims data. Claims diagnosed cases incurred significantly higher costs compared to cases that had not been diagnosed (\$4,483 vs. \$2,513, $p < 0.01$). Interview ascertained cases incurred significantly higher unadjusted medical care costs (\$2,761 vs. \$2,064, $p < 0.01$) compared to non-migraine controls. After adjusting for patient socio-demographic characteristics, interview ascertained cases incurred costs 1.23 times higher (95% CI of 1.03, 1.46) than controls. ... CONCLUSIONS: Using claims data alone the prevalence of migraine headache is substantially underestimated. Furthermore, the sole reliance on claims data would incorrectly estimate the medical care costs attributable to migraine due to the overestimate of cost per case. We have shown, by combining information from a validated telephone survey to identify migraine cases and controls linked with comprehensive claims data, that although migraine cases incur slightly higher annual medical care costs compared to controls, the presence of psychiatric symptoms and other co-morbidities is associated with these increased costs. IMPLICATIONS FOR POLICY, DELIVERY OR PRACTICE: Results support the available clinical evidence suggesting that among patients with migraine and depression, treating both is key to improving outcomes. Furthermore, results illustrate the importance of combining interview data with claims data for accurate medical care cost estimation when claims data under-ascertain an

illness. Similar cost estimation methods may be useful for other common symptom-based conditions under-ascertained by claims data, such as depression, asthma, gastro-esophageal reflux disease or dementia.] Lafata JE, Moon C, et al. *Abstr AcademyHealth Meet.* 2003; 20: abstract no. 797.

<http://gateway.nlm.nih.gov/MeetingAbstracts/102275765.html>

97. **The Cost of Migraine and Its Treatment.** [Migraine headache incurs estimated annual costs totaling as much as \$17 billion in the United States. Most of the direct costs are for outpatient services: medications, office or clinic visits, emergency department visits, laboratory and diagnostic services, and management of treatment side effects. Indirect costs from lost productivity in the workplace add substantially to the total. The triptan class of drugs, used for abortive treatment, account for the greatest portion of medication costs. Because these agents are expensive, optimal use is critical. Research suggests that a stratified care strategy, with initial therapy based on the patient's score on the Migraine Disability Assessment Scale, is both clinically advantageous and more cost-effective than stepped-care strategies. Also, the triptans are not interchangeable, and costs as well as clinical outcomes may vary with different agents in this class. Migraine prophylaxis is aimed at preventing frequent attacks and the development of a long-term condition that often incurs heavy costs for abortive treatment, diagnostic services, and medical care. Agents approved for migraine prophylaxis include the antiepileptics divalproex and topiramate and the beta blockers propranolol and timolol. As with abortive therapy, costs vary widely among these prophylactic agents. A novel approach to migraine prophylaxis is injection of botulinum toxin. A costanalysis model is presented to show the impact of utilizing botulinum toxin in a large managed care system.] Goldberg LD. *Am J Management Care*, 2005;11:s62-67.

http://www.ajmc.com/files/articlefiles/A115_05junGoldbergS62toS67.pdf

98. **Trigger Points in the Suboccipital Muscles and Forward Head Posture in Tension-Type Headache.** [Objective.—To assess the presence of trigger points (TrPs) in the suboccipital muscles and forward head posture (FHP) in subjects with chronic tension-type headache (CTTH) and in healthy subjects, and to evaluate the relationship of TrPs and FHP with headache intensity, duration, and frequency. Background.—Tension-type headache (TTH) is a prototypical headache in which myofascial TrPs in the cervical and pericranial musculature can play an important role. ...Conclusions.—Suboccipital active TrPs and FHP were associated with CTTH. CCTH subjects with active TrPs reported a greater headache intensity and frequency than those with latent TrPs. The degree of FHP correlated positively with headache duration, headache frequency, and the presence of suboccipital active TrPs.] Fernández-de-las-Peñas,C, Alonso-Blanco C. *Headache: The Journal of Head and Face Pain*, Volume 46 Issue 3 Page 454 - March 2006.

<http://www.blackwell-synergy.com/doi/abs/10.1111/j.1526-4610.2006.00288.x>

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99. **Brain hyperexcitability: the basis for antiepileptic drugs in migraine prevention.** [Abnormal brain excitability may provide the susceptibility for triggering migraine attacks. Antiepileptic drugs may diminish neuronal excitability and consequently reduce the frequency of migraine. Because migraine aura is predominantly visual, hyperexcitability of the occipital cortex has been the focus of investigations. Functional magnetic resonance imaging of the brain and magnetoencephalography provide the most

consistent evidence for the role of brain hyperexcitability in migraine and confirm that triggering an abnormal electric and metabolic event consistent with the cortical spreading depression (CSD) of Leao is anatomically and functionally linked with migraine aura symptoms. Future drug discovery should focus on the interface between the excitable cell and the earliest events of CSD.] Welch KM. *Headache*. 2005 Apr;45 Suppl 1:S25-32. http://www.ncbi.nlm.nih.gov/sites/entrez?cmd=Retrieve&db=PubMed&dopt=Abstract&list_uids=15833087

100. **Concepts of migraine headache pathogenesis: insights into mechanisms of chronicity and new drug targets.** [The pathophysiology of migraine is incompletely understood. Neurobiological and gene regulation studies and advanced brain imaging are providing new insights into migraine pathogenesis. Recent discoveries have shed light on the neuronal events mediating both the aura and the headache phases of migraine, identifying a cerebral cortical origin of migraine aura, susceptibility to attacks based on cortical hyperexcitability, and the trigeminovascular system and its central projections as the origin of headache. This review focuses on abnormal modulation of brain nociceptive systems leading to central sensitization that may explain prolonged headache of the migraine attack and shift of the migraine phenotype from episodic to chronic headache.] Welch KMA. *Neurological Sciences*, Vol24, Supp2, May 2003, p.s149-2153. <http://www.springerlink.com/content/26hmtc1kwyc0x19m/>
101. **From spreading depression to the trigeminovascular system.** [Migraine headaches have a complex pathophysiology; both vascular and neuronal mechanisms have been proposed. One possible scenario begins with brain-initiated events evolving to cortical spreading depression (CSD), which in turn activates the trigeminal nerve to cause headaches. Experimental evidence supports a relationship between CSD as a cause of migraine aura as well as CSD as a cause of trigeminal activation. Susceptibility to CSD and to migraine appears to be genetically determined. In some migraine subtypes, genes controlling translocation of calcium, sodium and potassium have been implicated, perhaps altering the susceptibility to CSD.] Dalkara T, Zervas NT, et al. *Neurol Sci*. 2006 May;27 Suppl 2:S86-90. http://www.ncbi.nlm.nih.gov/sites/entrez?cmd=Retrieve&db=PubMed&dopt=Abstract&list_uids=16688636
102. **Functional Imaging of the Trigeminal System: Applications to Migraine Pathophysiology.** [Based largely on data from animal models, migraine is hypothesized to involve changes in neural function in brain areas that mediate nociception—specifically, the trigeminal nerve, spinal trigeminal nucleus, and thalamus. These hypotheses about migraine pathophysiology can be tested directly in humans for the first time, with recent advances in functional neuroimaging techniques, which allow assessment of functional activity of specific brain areas. This article discusses the hypothesized role of the trigeminovascular pain system in migraine, reviews recent findings involving functional imaging of the human trigeminal system, and considers applications of functional imaging in the study of migraine pathophysiology. Functional neuroimaging is the only noninvasive approach for the objective measurement of changes in neural activity in humans. Functional magnetic resonance imaging has been applied to the measurement of neural activation of the trigeminal nociceptive system in healthy volunteers, and in patients with pain syndromes such as trigeminal pain. Conclusions.—The demonstrated utility of functional magnetic resonance imaging at elucidating, in a

regionally specific manner, the functional and temporal changes in neural activity in the trigeminal nociceptive system, promises to make it a useful tool for the study of migraine pathophysiology and the evaluation of therapeutic interventions.] Borsook David, Burstein Rami, et al. *Headache: The Journal of Head and Face Pain, Vol46, Issue s1, p.S32-S38, June 2006.* <http://www.blackwell-synergy.com/doi/abs/10.1111/j.1526-4610.2006.00488.x?journalCode=hed>

103. **Inflammation and excitotoxicity: role in migraine pathogenesis.** [The pathogenesis of migraine is still unclear, but much evidence suggests a role of inflammation in pain generation. Calcitonin gene related peptide, nitric oxide and cytokines are all molecules shown to be involved both in animal and human studies. The glutamatergic system is also described as a possible mechanism leading to neuronal hyperexcitability and cortical spreading depression (CSD). Excitotoxic neural death, due to excessive release of the amino acid in the extracellular space, may represent a consequence of protracted CSD and oligemia and may be involved in migrainous infarction and aspecific lesions seen on T2-weighted NMR imaging.] Longoni M, Ferrarese C. *Neurol Sci. 2006 May;27 Suppl 2:S107-10.* http://www.ncbi.nlm.nih.gov/sites/entrez?cmd=Retrieve&db=PubMed&dopt=Abstract&list_uids=16688611
104. **Insights from experimental studies into allodynia and its treatment.** [Migraine is a common disorder that often is accompanied by cutaneous allodynia. Cutaneous allodynia on the head has been linked to sensitization of neurons in the trigeminal nucleus caudalis in animal models of migraine. In addition, migraine with allodynia is refractory to acute treatment with triptans. Understanding the mechanisms of allodynia, preventing its development, and finding effective treatments have become a priority in headache research. This paper reviews recent research on the pathogenesis of headache and the generation of allodynia. We discuss the regions of the nervous system that are involved in generating and maintaining headache pain and allodynia. We also discuss recent advances in the treatment of migraine based on translation research.] Oshinsky ML. *Current Pain and Headache Reports, Vol 10, No.3, p.225-230.* <http://www.springerlink.com/content/9133428431112331/>
105. **Intrinsic brain activity triggers trigeminal meningeal afferents in a migraine model.** [Although the trigeminal nerve innervates the meninges and participates in the genesis of migraine headaches, triggering mechanisms remain controversial and poorly understood. Here we establish a link between migraine aura and headache by demonstrating that cortical spreading depression, implicated in migraine visual aura, activates trigeminovascular afferents and evokes a series of cortical meningeal and brainstem events consistent with the development of headache. Cortical spreading depression caused long-lasting blood-flow enhancement selectively within the middle meningeal artery dependent upon trigeminal and parasympathetic activation, and plasma protein leakage within the dura mater in part by a neurokinin-1-receptor mechanism. Our findings provide a neural mechanism by which extracerebral cephalic blood flow couples to brain events; this mechanism explains vasodilation during headache and links intense neurometabolic brain activity with the transmission of headache pain by the trigeminal nerve.] Bolay H, Reuter U, et al, *Nature Medicine, 8, 136-142(2002).* <http://www.nature.com/nm/journal/v8/n2/full/nm0202-136.html>

106. **Mechanisms and genetics of migraine.** [Migraine is the most frequent primary headache disorder. It is a neurovascular disorder in which the primary abnormality is thought to be a neuronal excitability underlined by a complex genetic susceptibility. Epidemiogenetic studies have shown that migraine without aura and migraine with aura are polygenic conditions. The three known migraine genes have been identified by the study of the unique monogenic variety of migraine, i.e. familial hemiplegic migraine. These genes all encode ion transporters: the P/Q type calcium channel, a calcium/potassium ATPase and a sodium channel. According to the latter hypothesis about the mechanisms of migraine attacks, poorly known triggers initiate a cortical wave of depolarisation that is responsible for the transient aura symptoms. This cortical spreading depression induces several biochemical changes which, by diffusion through the extracellular space, stimulate the trigeminovascular fibres. These fibres release vasoactive neuropeptides that initiate the neurogenic inflammation. Trigemino-vascular fibres transmit nociceptive information centrally via the brainstem. The trigeminovascular fibres also activate the parasympathetic system that is responsible for the persistence of vasodilation in meningeal vessels.] Ducros A. *CNS Drugs*. 2006;20 Spec no.1:1-11.
http://www.ncbi.nlm.nih.gov/sites/entrez?cmd=Retrieve&db=PubMed&dopt=Abstract&list_uids=16841522
107. **Migraine, Allodynia, Sensitisation and All of That ...** [Migraine is the most common form of disabling primary headache. One common and often troublesome feature of the disorder is an abnormal sensory state where normally innocuous stimuli are felt as painful: allodynia. This occurs in about two-thirds of patients and manifests as common complaints, such as pain when touching the hair. The neurophysiological correlate of allodynia is sensitisation, an increased afferent barrage for an unchanged peripheral stimulus. Sensitisation may be peripheral, central or disinhibitory. The potential mechanisms of each of these and their possible manipulation by treatments of the acute attack are considered.] Goadsby PJ. *European Neurology* 2005;53 (Suppl.1):10-16.
<http://content.karger.com/produktedb/produkte.asp?typ=fulltext&file=ENE2005053S01010>
108. **Migraine diagnosis and treatment.** [The underlying mechanism is sensitization of the central trigeminovascular neurons. In migraine, nociceptor stimulation on the dura activates the second sensory neurons in the trigeminal nucleus caudalis (TNC). Migraine associated with allodynia is mediated by sensitization of the TNC neurons.] Silberstein SD, Lipton RG, et al. *Headache in Clinical Practice*, Martin Duntz Ltd; 2002.
<http://www.medscape.com/viewarticle/506099>
109. **Migraine and the neck: New insights from basic data.** [The clinical presentation of pain in patients with migraine showing spread and referral of pain throughout the trigeminal and cervical innervation territories accompanied by hyperalgesia and allodynia indicates a dynamic trigeminocervical interaction. The physiologic mechanisms may be convergence of trigemino-cervical afferents and central sensitization of trigemino-cervical neurons leading to dynamic neuroplastic changes during migraine. This review highlights the clinical phenotype and mechanisms of how nociceptive input from neck structures of the upper cervical spine are integrated into the trigemino-cervical system. The nociceptive input into the spinal cord also is subject to a

- modulation by segmental mechanisms in the spinal cord and by inhibitory projections from brain stem structures such as the periaqueductal gray. The functional relevance of these basic mechanisms is discussed with reference to recent studies using neurostimulation of afferent nerves aiming at pain modulation in patients with migraine.] Bartsch Thorsten. *Current Pain and Headache Reports, Vol9, No3, June, 2005, p.191-196.* <http://www.springerlink.com/content/t3275445qw058277/>
110. **Migraine-update--current concepts of migraine pathogenesis.** [Abundant evidence in support of the view that migraine as an illness of the central nervous system has been accumulated. First, the hyperexcitability in the brain is recognized even in the stage between attacks in migraineurs according to findings of transcranial magnetic stimulation techniques, MRI-BOLD studies or 31P SPECT examinations. Second, cortical spreading depression originating in the occipital cortex is more likely to be related to the aura. Third, sensitization of the trigeminal nerve system is substantially involved in process of headache pain in migraine. Fourth, clonic dysfunction of the periaqueductal gray matter in the brain stem may underlie the migraine pathogenesis. Thus, current concept of susceptibility of migraine is attributed to certain dysfunction of the deep brain structures such as the brain stem rather than the blood vessels in the brain or dura mater.] Suzuki N. *Rinsho Shinkeigaku.* 2005 Nov;45(11):834-6. http://www.ncbi.nlm.nih.gov/sites/entrez?cmd=Retrieve&db=PubMed&dopt=Abstract&list_uids=16447739
111. **Neocortical spreading depression provokes the expression of c-fos protein-like immunoreactivity within trigeminal nucleus caudalis via trigeminovascular mechanisms.** [The effects of neocortical spreading depression (SD) on the expression of immunoreactive c-fos protein were examined within the superficial laminae of trigeminal nucleus caudalis (TNC), a brainstem region processing nociceptive information.... This is the first report demonstrating that neurophysiological events within cerebral cortex can activate brainstem regions involved in the processing of nociceptive information via trigeminovascular mechanisms.] Moskowitz MA, Nozaki K, et al. *J of Neuroscience, Vol 12, 1167-1177.* <http://www.jneurosci.org/cgi/content/abstract/13/3/1167>
112. **Neurobiology in primary headaches.** [Both migraine and cluster headache involve activation of the trigeminovascular system. In support, there is a clear association between the head pain and the release of the neuropeptide calcitonin gene-related peptide (CGRP) from the trigeminovascular system. In cluster headache there is, in addition, release of the parasympathetic neuropeptide vasoactive intestinal peptide (VIP) that is coupled to facial vasomotor symptoms. Triptan administration, activating the 5-HT(1B/1D) receptors, causes the headache to subside and the levels of neuropeptides to normalise, in part through presynaptic inhibition of the cranial sensory nerves. These data suggest a central role for sensory and parasympathetic mechanisms in the pathophysiology of primary headaches.] Edvinsson L, Uddman R. *Brain Res Brain Res Rev.* 2005 Jun;48(3):438-56 http://www.ncbi.nlm.nih.gov/sites/entrez?cmd=Retrieve&db=PubMed&dopt=Abstract&list_uids=15914251
113. **New insights into migraine pathophysiology.** [This review emphasizes several neurobiological aspects of migraine that reveal paroxysmal disturbances in neuronal and vascular function, that in turn reflect disturbances in the maintenance of ionic gradients.] Sanchez-Del-Rio M, Reuter U, et al. *Curr Opin Neurol.* 2006 Jun;19(3):294-8.

http://www.ncbi.nlm.nih.gov/sites/entrez?cmd=Retrieve&db=PubMed&list_uids=16702838&dopt=Abstract

114. **Pathogenesis of the migraine attack.** [There is clinical experimental evidence that extracranial arterial vasodilation, extracranial neurogenic inflammation, and decreased inhibition of central pain transmission are involved in the pathogenesis of the migraine headache. The migraine aura is likely caused by a neurophysiologic phenomenon akin to Leão's cortical spreading depression, a wave of short-lasting neuronal excitation that travels over the cerebral cortex, followed by prolonged depression of cortical neuronal activity. METHOD: A concept of the pathogenesis of the migraine attack is presented, in which the relation of the mechanism of the migraine aura and that of the migraine headache is considered parallel rather than sequential in nature. CONCLUSIONS: The process driving the pathogenesis of the migraine attack and susceptible to the migraine trigger factors may be located in the brain stem.] Spierings EL. *Clin J Pain.* 2003 Jul-Aug;19(4):255-62.
http://www.ncbi.nlm.nih.gov/sites/entrez?cmd=Retrieve&db=PubMed&list_uids=12840620&dopt=Abstract
115. **Pathophysiology of Migraine.** [Alteration in neurochemical balance of the central nervous system could lead to trigeminovascular activation with the release of vasoactive peptides and neurogenic inflammation. This in turn lowered the sensory threshold for trigeminal input entering the brainstem at the Nucleus Claudalis of the Trigeminal Nerve. Sensory input from the C1 and C2 dermatomes would be integrated with the trigeminal input, and eventually synapse in the somatosensory and limbic cortex, where it is interpreted into conscious awareness as headache. The pathophysiology of migraine has advanced considerably over the last 20 years. Attacks of migraine are considered to originate in the brain, thus making migraine a neurological rather than vascular disease. In addition, frequent episodes of migraine can lead to chronic migraine, which is a complex disorder that is characterized by the near daily occurrence of low-grade headache, frequent attacks of IHS migraine, and prolonged neurological disruption, such as depression, anxiety, and myofascial pain occurring concomitantly with chronic headache. This has led to migraine being considered a chronic, genetically determined disease with episodic manifestations.] Cady R. *The Pain Practitioner, Spring 2001, p. 6-10.* <http://www.aapainmanage.org/currents/images/cady.pdf>
116. **Pathophysiology of migraine--new insights.** [Current theories propose that the primary dysfunction in migraine occurs within the CNS and that this evokes changes in blood vessels within pain-producing intracranial meningeal structures that give rise to headache pain. Migraine is now thought of as a neurovascular disorder. It has been proposed that genetic abnormalities may be responsible for altering the response threshold to migraine specific trigger factors in the brain of a migraineur compared to a normal individual. The exact nature of the central dysfunction that is produced in migraineurs is still not clear and may involve spreading depression-like phenomena and activation of brain stem monoaminergic nuclei that are part of the central autonomic, vascular and pain control centers. It is generally thought that local vasodilatation of intracranial extracerebral blood vessels and a consequent stimulation of surrounding trigeminal sensory nervous pain pathways is a key mechanism underlying the generation of headache pain associated with migraine. This activation of the 'trigeminovascular system' is thought to cause the release of vasoactive sensory neuropeptides, especially

CGRP, that increase the pain response. The activated trigeminal nerves convey nociceptive information to central neurons in the brain stem trigeminal sensory nuclei that in turn relay the pain signals to higher centers where headache pain is perceived. It has been hypothesized that these central neurons may become sensitized as a migraine attack progresses. The 'triptan' anti-migraine agents (e.g. sumatriptan, rizatriptan, zolmitriptan naratriptan) are serotonergic agonists that have been shown to act selectively by causing vasoconstriction through 5-HT_{1B} receptors that are expressed in human intracranial arteries and by inhibiting nociceptive transmission through an action at 5-HT_{1D} receptors on peripheral trigeminal sensory nerve terminals in the meninges and central terminals in brain stem sensory nuclei. These three complementary sites of action underlie the clinical effectiveness of the 5-HT_{1B/1D} agonists against migraine headache pain and its associated symptoms.] Hargreaves RJ, Shephard SL. *Can j Neurol Sci.* 1999 Nov;26 Suppl 3:S12-9.

http://www.ncbi.nlm.nih.gov/sites/entrez?cmd=Retrieve&db=PubMed&list_uids=10563228&dopt=Abstract

117. **Possible mechanism of c-fos expression in trigeminal nucleus caudalis following cortical spreading depression.** [Cortical spreading depression (CSD) is characterized by a transient, reversible depression of EEG activity which advances across the cortical surface at a velocity of 2-5 mm/min. CSD was originally linked to the aura phase of migraine, but recently also to migraine headache. The theory is that CSD activates meningeal trigeminal C-fibers causing neurogenic inflammation and pain ... We suggest that the C-fiber activation observed is caused by hyperosmolar KCl/NaCl and not CSD. Hence, our results do not support the hypothesis of Moskowitz et al. which links CSD with migraine headache.] Ingvarlsen BK, Laursen H, et al. *Pain.* 1997 Sep;72(3):407-15.
http://www.ncbi.nlm.nih.gov/sites/entrez?cmd=Retrieve&db=PubMed&list_uids=9313281&dopt=Abstract
118. **Recent advances in understanding migraine mechanisms, molecules and therapeutics.** [Migraine is a complex, disabling disorder of the brain that manifests itself as attacks of often severe, throbbing head pain with sensory sensitivity to light, sound and head movement. ... Therapeutic developments in migraine have come by targeting the trigeminovascular system, with the most-recent being the proof-of-principle study of calcitonin gene-related peptide (CGRP) receptor antagonists in acute migraine. To understand the basic pathophysiology of migraine, brain imaging studies have firmly established reproducible changes in the brainstem in regions that include areas that are involved in sensory modulation. These data lead to the view that migraine is a form of sensory dysmodulation--a system failure of normal sensory processing.] Goadsby PJ. *Trends Mol Med.* 2007 Jan;13(1):39-44.
http://www.ncbi.nlm.nih.gov/sites/entrez?cmd=Retrieve&db=PubMed&dopt=Abstract&list_uids=17141570
119. **Serotonin depletion, cortical spreading depression, and trigeminal nociception.** [Our findings indicate that 5-HT depletion enhances CSD-induced trigeminal nociception by increasing the cortical excitability and sensitivity of trigeminal nociceptive system. These findings may provide a better understanding regarding the relationship between low 5-HT and clinical headaches.] Supornsilpchai W, Sanguanrangsirikul S, et al. [Headache](#). 2006 Jan;46(1):34-9.

http://www.ncbi.nlm.nih.gov/sites/entrez?cmd=Retrieve&db=PubMed&dopt=Abstract&list_uids=16412149

120. **The emerging importance of cortical spreading depression in migraine headache.** [Migraine is a disabling neurovascular disorder with a complex pathophysiology. Functional imaging and magnetoencephalographic studies strongly suggest that Cortical Spreading Depression (CSD) constitutes the biological basis for the neurologic aura that precedes headache in one fourth of migrainers. It is likely that the aura is the generator of the headache since experimentally, CSD triggers the activation of the trigeminovascular system, possibly through matrix metalloproteases activation which is associated with an increase in vascular permeability. These data may have therapeutic implications: strategies to block trigeminal activation or its downstream consequences are central to treat the acute headache whereas strategies to block events lying upstream of trigeminal activation would be crucial in prophylaxis.] Bolay H, Moskowitz MA. *Rev Neurol (Paris)*. 2005 Jul;161(6-7):655-7.
http://www.ncbi.nlm.nih.gov/sites/entrez?cmd=Retrieve&db=PubMed&dopt=Abstract&list_uids=16141950
121. **The pathophysiology of migraine.** [Migraine results from episodic changes in central nervous system physiologic function in hyperexcitable brain manifested by abnormal energy metabolism, lowered threshold for phosphene generation, and increased contingent negative variation. Human functional magnetic resonance imaging and magnetoencephalography data strongly suggest that aura is caused by cortical spreading depression. REVIEW SUMMARY: Brain hyperexcitability may be caused by low magnesium levels, mitochondrial abnormalities with abnormal phosphorylation of adenosine 5'-diphosphate, a dysfunction related to nitric oxide, or calcium channelopathy. Low magnesium can result in opening of calcium channels, increased intracellular calcium, glutamate release, and increased extracellular potassium, which may in turn trigger cortical spreading depression. Mitochondrial dysfunction has been suggested by a low phosphocreatine:Pi ratio and a possible response by migraine patients to riboflavin prophylaxis. Nitroglycerine administration results in a delayed migraine-like headache in migraine patients but not in control patients, and a nonspecific nitric oxide synthase inhibitor aborted migraine at 2 hours in the majority of tested migraine patients compared to controls. Many patients with familial hemiplegic migraine have a missense mutation in the P/Q calcium channel, so that this form of migraine, at least, is associated with a demonstrable calcium channelopathy. CONCLUSIONS: The generation of migraine occurs centrally in the brain stem, sometimes preceded by cortical spreading depression and aura. Activation of the trigeminovascular system stimulates perivascular trigeminal sensory afferent nerves with release of vasoactive neuropeptides, resulting in vasodilation and transduction of central nociceptive information. There is then a relay of pain impulses to central second- and third-order neurons and activation of brain stem autonomic nuclei to induce associated symptoms.] Tepper SJ, Rapoport A, et al. *Neurologist*. 2001 Sep;7(5):279-86.
http://www.ncbi.nlm.nih.gov/sites/entrez?cmd=Retrieve&db=PubMed&list_uids=12803669&dopt=Abstract
122. **The pathophysiology of migraine: year 2005.** [Migraine is a complex pathophysiology in which both central and peripheral components of the trigeminal pain pathway probably play a significant role, both in the symptoms and signs of the attack

and in the mechanisms of action of antimigraine compounds, such as triptans, which constitute the most important therapy for aborting migraine pain and possess several mechanisms on 5-HT receptor-mediated actions. The experimental neurogenic inflammation model represents a simple procedure to obtain preliminary information on well characterized receptortargeted drugs. ... A link between central and peripheral components of the trigeminal pain pathway is provided by the observation that cortical spreading depression in the rat activates trigeminovascular afferents and induces a series of cortical meningeal and brainstem events consistent with the development of headache. Studies in humans support the hypothesis that cortical spreading depression underlies migraine aura. Therefore, it is possible that visual, motor or sensory aura might be responsible for the generation of the pain through the above mechanisms.] Buzzi MG, Moskowitz MA. *J Headache Pain*. 2005 Jun;6(3):105-11.
http://www.ncbi.nlm.nih.gov/sites/entrez?cmd=Retrieve&db=PubMed&dopt=Abstract&list_uids=16355290

Posture

123. **A study on the prevalence of and risk factors for neck pain among university academic staff in Hong Kong.** [The 1-year prevalence of neck pain and possible risk factors among university academic staff were investigated. ...The percentage of female academic staff with neck pain (62%) was higher than that in male staff (38%). This matched the results of other studies, which demonstrated that neck pain was more prevalent in women. There was a significant association between head posture during computer processing and neck pain ($p = 0.02$). Among those with neck pain during computer processing, 60.5% had a forward head posture. However, a low correlation between psychosocial factors and neck pain was demonstrated ($r = 0.343$). Academic staff in tertiary institutions could be considered as a high-risk group of job-related neck pain.] Chiu TT, Ku WY, et al. *J Occup Rehabil*. 2002 Jun;12(2):77-91.
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=12014228&dopt=Abstract
124. **A study on the relationships between imbalance of stomatognathic function and asymmetry of craniofacial morphology, and the center of gravity of the upright posture.** [] Ishii H. *Osaka Daigaku Shigaku Zasshi*. 1990 Dec;35(2):517-56.
http://www.ncbi.nlm.nih.gov/sites/entrez?cmd=Retrieve&db=PubMed&list_uids=2134879&dopt=Abstract
125. **Association among postural and skull-cervico-mandibular disorders in childhood and adolescence. Analysis of 428 subjects.** [The aim of the study is to appraise the prevalence of the mild defects of the spine or paramorphysm in a normal paediatric population, without orthopaedic pathology, and to verify the possible association with the dysfunctions of the dental apparatus. The recovery of a real association among these pathologies could furnish a sprout for a correct therapeutic approach. ... A statistically significant relationship among that disorders of posture and malocclusion and ogival palate has been found. Despite these correlations, it is very difficult to explain this association from the point of view of etiopathogenesis. For this we hold to have to continue the study, to give a meaning to such correlations and to find an appropriate therapy.] Pedrotti L, Bertani MR, et al. *Pediatr Med Chir*. 2007 Mar-Apr;29(2):94-8.

http://www.ncbi.nlm.nih.gov/sites/entrez?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=17461096

126. **Balance in Migraineurs.** [The purpose of this study is to investigate the occurrence of balance disorders in migraineurs during interictal period by posturography (*Smart balance master* Although the link between migraine balance disorders has long been known, postural balance in migraineurs without manifest vestibulopathy is not often studied. ...RESULTS: (1) There was significant difference when comprehensive sway velocity in retroflexion (mean of on platform and foam EO and EC) in migraineurs compared with the controls (p<0.05). (2) There was significant difference when comprehensive sway velocity in left head turn in migraineurs compared with the controls (p<0.05). (3) There was significant difference in LOS (maximal excursion and reaction time) in migraineurs when compared with the controls (p<0.05). 4- There was significant difference in tandem walking in migraineurs when compared with the controls (p<0.05). CONCLUSIONS/RELEVANCE: Our findings show a balance disorder in migraineurs which suggests an underlying dysfunction in the vestibulospinal system.] Akdal G, Donmez B, et al. *American Academy of Neurology 59th Annual Meeting April/May 2007*. http://www.abstracts2view.com/aan2007boston/view.php?nu=AA07L_S05.004
127. **Body position effects on EMG activity of sternocleidomastoid and masseter muscles in patients with myogenic cranio-cervical-mandibular dysfunction.** [This study was conducted in order to determine the effects of body position on integrated electromyographic (IEMG) activity of sternocleidomastoid and masseter muscles in 17 patients with myogenic cranio-cervical-mandibular dysfunction. EMG recordings at rest and during swallowing of saliva and maximal voluntary clenching were performed by placing surface electrodes on the sternocleidomastoid and masseter muscles (contralateral to the habitual side of sleeping of each patient), in the following body positions: standing, seated, supine, and lateral decubitus position. Significant higher EMG activities were recorded in the sternocleidomastoid muscle in the lateral decubitus position and in the supine position (except during swallowing), whereas a significant higher EMG activity was recorded in the masseter muscle during maximal voluntary clenching in standing and seated positions. The EMG pattern observed suggests that the presence of parafunctional habits and body position could be closely correlated with the clinical symptomatology in the sternocleidomastoid and masseter muscles at wakening and during waking hours, respectively, in patients with myogenic cranio-cervical-mandibular dysfunction.] Palazzi C, Miralles R, et al. *Cranio. 1996 Jul;14(3):200-9*. http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=9110611&dopt=Abstract
128. **Body position effects on EMG activity of the temporal and suprahyoid muscles in healthy subjects and in patients with myogenic cranio-cervical-mandibular dysfunction.** [This study was conducted in order to determine the effects of body position on integrated electromyographic (IEMG) activity of anterior temporal and suprahyoid muscles. The study was performed on 15 patients with myogenic cranio-cervical-mandibular dysfunction (CMD) and 15 healthy subjects. IEMG recordings at rest and during swallowing of saliva and maximal voluntary clenching were performed by placing surface electrodes on the anterior temporal and suprahyoid muscles in the following body positions: standing, seated, supine, and lateral decubitus position. Insignificant changes in IEMG activity of both muscles were observed upon variations in

the body position. Insignificant differences in IEMG activity were observed between patients with myogenic CMD and healthy subjects. A pattern of higher IEMG at rest and during swallowing of saliva was observed in the suprahyoid muscles than in the anterior temporal muscles, whereas during maximal clenching activity, an opposite pattern was observed. Results of the present study seem to suggest that for the anterior temporal and suprahyoid muscles there is no specific body position that could be relevant to initiate and/or to perpetuate a craniomandibular dysfunction.] Ormeno G, Miralles R, et al.

Cranio. 1999 Apr;17(2):132-42.

http://www.ncbi.nlm.nih.gov/sites/entrez?cmd=Retrieve&db=PubMed&list_uids=10425940&dopt=Abstractv

129. **Body Position Effects on Sternocleidomastoid and Masseter EMG Pattern Activity in Patients Undergoing Occlusal Splint Therapy.** [ABSTRACT: This study was conducted in order to determine the effects of body position on electromyographic (EMG) activity of sternocleidomastoid and masseter muscles, in 15 patients with myogenic craniocervical-mandibular dysfunction undergoing occlusal splint therapy. EMG activity was recorded by placing surface electrodes on the sternocleidomastoid and masseter muscles (contralateral to the habitual sleeping side of each patient). EMG activity at rest and during swallowing of saliva and maximal voluntary clenching was recorded in the following body positions: standing, supine and lateral decubitus. In the sternocleidomastoid muscle significant higher EMG activities at rest and during swallowing were recorded in the lateral decubitus position, whereas during maximal voluntary clenching EMG activity did not change. In the masseter muscle significant higher EMG activity during maximal voluntary clenching in a standing position was observed, whereas EMG activity at rest and during swallowing did not change. The opposite pattern of EMG activity supports the idea that there may exist a differential modulation of the motor neuron pools of the sternocleidomastoid and masseter muscles, of peripheral and/or central origin. This suggests that the presence of parafunctional habits and body position could be closely correlated with the clinical symptomatology in these muscles in patients with myogenic craniomandibular dysfunction.] Ormerio G, Miralles R, et al. *Cranio*. 1997 Oct;15(4):300-9.
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=9481992&dopt=Abstract
130. **Body Posture Photographs as a Diagnostic Aid for Musculoskeletal Disorders Related to Temporomandibular Disorders (TMD).** [The purpose of this study was to test the hypothesis that body posture could be an etiologic factor in patients with temporomandibular disorders. "Faculty" body posture has been considered to be an initiating and perpetuating etiologic factor in some temporomandibular disorders (TMD). ... Within the experimental group, a significant correlation existed between the shoulder line and the pelvis line, on the frontal as well as on the dorsal photograph. The results suggest a somatic basis for the observed postural imbalances in patients with temporomandibular disorders. The results, however, must be interpreted with reservation.] Zonnenberg AJ, Van Maanen CJ, et al. *Cranio*. 1996 Jul;14(3):225-32.
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=9110614&dopt=Abstract
131. **Breathing type and body position effects on sternocleidomastoid and suprahyoid EMG activity.** [The objective of this study was to determine the effects of

breathing type and body position on sternocleidomastoid and suprahyoid electromyographic (EMG) activity. The sample included 18 subjects with upper costal breathing type (study group) and 15 subjects with costo-diaphragmatic breathing type (control group). All individuals had natural dentition and bilateral molar support. EMG recordings at rest and while swallowing saliva were carried out by placing surface electrodes on the left sternocleidomastoid and left suprahyoid muscles. EMG activity was recorded while standing, seated upright, and in the lateral decubitus position. Upper costal breathing type subjects showed a significantly higher suprahyoid EMG activity at rest than costo-diaphragmatic subjects in all body positions studied (mixed model with unstructured covariance matrix). In the lateral decubitus position, both breathing types showed a significantly higher sternocleidomastoid EMG activity at rest and while swallowing saliva. The suprahyoid muscles demonstrated a significantly higher EMG activity at rest as well as in the lateral decubitus position (mixed model with unstructured covariance matrix). These results are relevant because sternocleidomastoid and suprahyoid muscles play an important role in controlling the head posture and mandible dynamics. The neurophysiological mechanisms involved are discussed.] de Mayo T, Miralles R, et al. *J Oral Rehabil.* 2005 Jul;32(7):487-94.
http://www.ncbi.nlm.nih.gov/sites/entrez?cmd=Retrieve&db=PubMed&list_uids=15975128&dopt=Abstract

132. **Changes in Weight Distribution at the Feet Due to Occlusal Supporting Zone Loss During Clenching.** [To establish the relationship between the condition of the stomatognathic system and body posture, changes in the weight distribution at the feet using the four-quadrant weight scale were investigated when the occlusal supporting zone was lost unilaterally and bilaterally. The results were as follows: 1. Regardless of occlusal conditions, the weight distribution was changed during clenching; 2. The weight distribution was shifted anteriorly during clenching regardless of the condition of the occlusal supporting zone. Additionally, weight distribution shifted more laterally to the opposite side of the lost occlusal supporting zone during clenching with the occlusal supporting zone lost more unilaterally than bilaterally. From the present findings, it is suggested that the body posture may be affected and changed to an unusual position causing neck or shoulder pain, especially when the occlusal supporting zone is lost both unilaterally and bilaterally.] Yoshino G, Higashi K, Nakamura T. *Cranio.* 2003 Oct;21(4):271-8.
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=14620700&dopt=Abstract
133. **Combined effect of vestibular and craniomandibular disorders on postural behavior.** [A correlation has been reported in the dental literature between temporomandibular disorders and musculoskeletal abnormalities, however, the question whether they modify body postural sway remains controversial. In the present investigation, the Craniomandibular Index was used to evaluate the clinical extension of temporomandibular joint dysfunction and related problems in 40 patients with normal vestibular function and in 42 patients with peripheral vestibular disorders. Balance function was assessed by static posturography and body sway area was measured in two conditions: i) eye open, and g) eye closed. Data were compared to those of 40 healthy subjects. Postural control showed a significantly different behaviour between groups with an increase in average body sway in patients with craniomandibular disorders as opposed

to controls ($p < 0.005$). Although the involvement of the stomatognathic apparatus was not quantitatively different in the two groups of patients, those also presenting a peripheral vestibular disorder exhibited greater average body sway than patients with only craniomandibular disorders ($p < 0.005$). The latter showed a greater average body sway than controls only in the trial with eyes closed ($p < 0.05$). The results demonstrated that craniomandibular alterations could produce moderate postural instability in patients with a normal vestibular function. Conversely, their association with peripheral vestibular disorders becomes a real challenge to the upright quiet stance probably due to a negative effect of somatosensory origin on the vestibulo-spinal reflex impairment.] Monzani D, Guidetti G, et al. *Acta Otorhinolaryngol Ital.* 2003 Feb;23(1):4-9.

http://www.ncbi.nlm.nih.gov/sites/entrez?cmd=Retrieve&db=PubMed&list_uids=12812128&dopt=Abstract

134. **Correlation between interdental occlusal plane and plantar arches. An EMG study.** [The Authors carried out an experimental study on a homogeneous group of young people to provide evidence of functional correlation among masticatory muscles and, indirectly, between changes to the interdental occlusal plane and modifications of the plantar arches due to talipes valgus and flat foot. In the two analysed conditions, the masticatory muscles undergo different functional alterations. This is due to the fact that the mechanoreceptors in the tendons of the muscles governing the plantar arch configuration are stimulated in different ways during the activation of long osteoarthromuscular chains. Dental specialists will have to take these correlation into account when diagnosing TMJ disorders.] Valentino B, Melito F, et.al. *Bull Group Int Rech Sci Stomatol Odontol.* 2002 Jan-Apr;44(1):10-3
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=12201007&dopt=Abstract
135. **Correlation of Temporomandibular Joint Pathologies, Neck Pain and Postural Differences.** [Background and purpose. The purpose of this study was to investigate the relationship between temporomandibular joint (TMJ) pathologies, neck pain and postural differences. Subjects and Methods. Eighteen patients referred to us with TMJ and neck pain complaints were included in the study. The control group consisted of individuals who had no TMJ and neck pain complaints. Both groups were subjected to cervical X-Ray and Magnetic Resonance Imaging (MRI) of TMJ. Patients were evaluated by mandibular ROM (active-passive), and head-shoulder angles parameters. Mandibular ROM as active and passive was measured with a ruler in millimeters between the upper and lower first incisor teeth. For measurement of head and shoulder angles, tragus, processus spinosus of C7 cervical vertebra and acromial head on shoulder were marked and angular measurements were taken from these three points on the patients' photographs. Results. There was a statistical difference in head-shoulder angles and TMJ active-passive ROM values when both groups were compared with each other ($p < 0.001$). Conclusion. This study supports the hypothesis that cervical postural changes affect the muscles of the stomatognathic system and cause TMJ dysfunction pathologies.] Evcik D, Aksoy O. *Journal of Physical Therapy Science*, Vol. 12 (2000) , No. 2 97-100.
http://www.jstage.jst.go.jp/article/jpts/12/2/12_97/article/-char/en
136. **Effect of C1-C2 rotation on canal size.** [An anthropometric study of the atlas and axis was undertaken to determine spinal canal diameters, the degree of narrowing with rotation, and odontoid tilt. The mean sagittal diameter of the atlas was 30.1 mm and

the mean coronal diameter was 28.8 mm. The mean sagittal diameter of the axis was 19.0 mm and the mean coronal diameter was 22.8 mm. Approximately 64 degrees of rotation occurred at the atlantoaxial complex before sufficient narrowing caused spinal cord compression in the average specimen. An average of 63 degrees of rotation was required to cause facet dislocation. Most specimens examined had a posterior odontoid tilt up to 45 degrees and a facet angle between 1 degree and 29 degrees. Bilateral facet dislocation occurred at 63 degrees. Spinal canal narrowing to 1 cm occurred at 64 degrees. This narrowing would probably not damage the cord, which averages 1 cm in diameter; however, if the rotary motion of C1 and C2 progressed, cord damage could occur. Facet angles and posterior odontoid tilts that are not within the normal range indicate pathological changes.] Mazzara JT, Fielding JW, et al. *Wheeless' Textbook of Orthopaedics*, Clin Orthop Relat Res. 1988 Dec;(237):115-9.

137. **Evaluation of Body Posture in Individuals With Internal Temporomandibular Joint Derangement.** [Temporomandibular dysfunctions (TMD) comprise a great number of disruptions that may affect the temporomandibular joint (TMJ), the masticatory muscles, or both. TMJ internal derangement is a specific type of TMD, of which the etiology and physiopathology are broadly unknown, but have been suggested to be linked to head, neck, and body posture factors. This study aimed at verifying possible relationships between body posture and TMJ internal derangements (TMJ-id), by comparing 30 subjects presenting typical TMJ-id signs to 20 healthy subjects. Subjects' clinical evaluations included anamnesis, stomatognathic system evaluation, and plotting analysis on body posture photographs. No statistically significant differences were found between the groups. Results do not support the assertion that body posture plays a role in causing or enhancing TMD; however, these results should be cautiously considered because of the small number of subjects evaluated and the many posture variables submitted to statistical procedures that lead to high standard deviations.] Munhoz WC, Marques AP, de Siqueira JT. *Cranio*. 2005 Oct;23(4):269-77 .
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=16353467&dopt=Abstract
138. **Evaluation of Cervical Posture of Children in Skeletal Class I, II, and III.** [Previous studies on the relationship between morphological structure of the face and cervical posture have predominantly focused on vertical dimensions of the face. The aim of this study was to investigate whether there are significant differences in cervical posture in subjects with a different sagittal morphology of the face, i.e., a different skeletal class. One hundred twenty (120) children (60 males and 60 females, average age 9.5 yrs., SD+/-0.5) were admitted for orthodontic treatment. Selection criteria was: European ethnic origin, date of birth, considerable skeletal growth potential remaining and an absence of temporomandibular joint dysfunction (TMD). Lateral skull radiographs were taken in mirror position. Subjects were divided into three groups based on their skeletal class. The cephalometric tracings included postural variables. The most interesting findings were: 1. children in skeletal class III showed a significantly lower cervical lordosis angle ($p < 0.001$) than the children in skeletal class I and skeletal class II; 2. children in skeletal class II showed a significantly higher extension of the head upon the spinal column compared to children in skeletal class I and skeletal class III ($p < 0.001$ and $p < 0.01$, respectively). This is probably because the lower part of their spinal column was straighter than those of subjects in skeletal class I and II ($p < 0.01$ and $p < 0.001$,

respectively). Significant differences among the three groups were also observed in the inclination of maxillary and mandibular bases to the spinal column. The posture of the neck seems to be strongly associated with the sagittal as well as the vertical structure of the face.] D'Attilio M, Caputi S, et al. *Cranio*. 2005 Jul;23(3):219-28.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=16128357&dopt=Abstract

139. **Forward Head Posture is the Cause of 'Straight Spine Syndrome' in Many Professionals.** [Background: Objective of the study was to assess the relationship of posture and Occupation developing into Straight Spine Syndrome (SSS) of neck. Subject: Total 369 subjects (210 males & 159 females aged between 28-49 years) belonging to different occupations (computer operators, car drivers, bank- executives, dentists, microbiologists, scooter drivers, and housewives of stature >170 cm) reported with symptoms (inclusion criteria) were followed every quarter for one year. Methods: The subjects and their workplaces were surveyed to assess their posture during work. They were investigated for routine biochemistry, radiological study of cervical spine both AP and lateral views, MRI when needed and reviewed after six months. Subjects were explained about ergonomic implications and posture correction. Subjects were treated for pain-relief, followed by exercise therapy and conditioning of affected musculature. Results: All the subjects had radiological loss of normal lordosis of cervical spine (straight spine) but reported as normal radiographs. On clinical examination, all of them had tender trigger points over trapezius, and other muscles of the neck. The common postural defect in all the subjects observed was the forward-head posture. Seventy eight percent of them got relieved of symptoms , but 67 percent of them attained their normal lordotic curvature of the cervical spine within 6 months. Eleven percent continues to have straight spine without symptoms. Eight percent of them did not improve and needed surgical intervention. Fourteen percent were dropouts. Conclusion: Our results show that forward head posture is the commonest defect found in variety of professionals. This leads to SSS, an early functional stage, and can lead to serious compression of cervical nerve roots. Education programs on right posture, ergonomics, regular corrective exercises may prevent SSS.] Choudhary Bakhtiar S, Suneetha S, et al. *Indian J Occupat and Environmental Med* 2000 (Jul); 4 (3): 122—124.
- <http://medind.nic.in/imvw/imvw4014.html>

140. **Forward Head Posture: Its Structural and Functional Influence on the Stomatognathic System, a Conceptual Study.** [An extensive conceptual analysis to establish the primary role a forward head posture plays in the appearance of some craniomandibular dysfunctions and internal derangements of the temporomandibular joints, associated to craniocervical postural disturbances. The analysis is based on findings contributed by scientific investigations in the field of dentofacial orthopedics and dysfunction. Special emphasis has been put on the influence of forward head posture on the craniofacial growth as it can determine a morphoskeletal and neuromuscular pattern leading to a dysfunctional condition. A correlation is established between Class II Occlusion, forward head posture, and craniomandibular dysfunction. The concept of craniocervical postural position is defined, as well as its close relation to the mandibular postural position.] Gonzalez HE, Manns A. *Cranio*. 1996 Jan;14(1):71-80.
- http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=9086879&dopt=Abstract

141. **Hyperkyphotic posture and risk of future osteoporotic fractures: the Rancho Bernardo study.** [It is unknown whether kyphosis of the thoracic spine is an independent risk factor for future osteoporotic fractures. In 596 community-dwelling women, we found that with increasing kyphosis, there was a significant trend of increasing fracture risk that was independent of previous history of fractures or BMD. INTRODUCTION: It is unknown whether kyphosis of the thoracic spine is an independent risk factor for future osteoporotic fractures. ...CONCLUSIONS: Whereas hyperkyphosis may often result from vertebral fractures, our study findings suggest that hyperkyphotic posture itself may be an important risk factor for future fractures, independent of low BMD or fracture history.] Huang MH, Barrett-Conner E, et al. *J Bone Miner Res.* 2006 Mar;21(3):419-23. Epub 2005 Dec 5.
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=pubmed&cmd=Retrieve&dopt=AbstractPlus&list_uids=16491290&query_hl=2&itool=pubmed_docsum
142. **Hyperkyphotic posture predicts mortality in older community-dwelling men and women: a prospective study.** [To determine the association between hyperkyphotic posture and rate of mortality and cause-specific mortality in older persons. Hyperkyphotic posture, defined as requiring one or more blocks under the occiput to achieve a neutral head position while lying supine, was more common in men than women (44% in men, 22% of women, $P < .0001$). In age- and sex-adjusted analyses, persons with hyperkyphotic posture had a 1.44 greater rate of mortality (95% confidence interval (CI)=1.12-1.86, $P = .005$). In multiply adjusted models, the increased rate of death associated with hyperkyphotic posture remained significant (relative hazard=1.40, 95% CI=1.08-1.81, $P = .012$). In cause-specific mortality analyses, hyperkyphotic posture was specifically associated with an increased rate of death due to atherosclerosis. CONCLUSION: Older men and women with hyperkyphotic posture have higher mortality rates.] Kado DM, Huang MH, et al. *J Am Geriatr Soc.* 2004 Oct;52(10):1662-7.
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=pubmed&cmd=Retrieve&dopt=AbstractPlus&list_uids=15450042&query_hl=2&itool=pubmed_docsum
143. **Immediate effects of plantar inputs on the upper half muscles and upright posture: a preliminary study.** [This purpose of this study was to investigate the immediate effects of plantar inputs on both the upper half muscle activity (anterior temporal, masseter, digastric, sternocleidomastoid, upper and lower trapezius, cervical) and the body posture, by means of electromyography (EMG) and vertical force platform, respectively. Twenty four (24) healthy adults, between the ages of 24 and 31 years (25.3 +/- 1.9), with no history of craniomandibular disorder or systemic musculoskeletal dysfunction, were randomly divided into two groups: test group (fourteen subjects) and control group (ten subjects). A first recording session (TO) measured the baseline EMG and postural patterns of both groups. After this session, the test group wore test shoes with insoles that stimulated the plantar surfaces, while the control group wore placebo shoes. After one hour, a second set of measurements (T1) were performed. Significant differences between the groups at baseline were observed in the left anterior temporal, left cervical, and left upper trapezius, as well as at T1 in the left anterior temporal and right upper trapezius ($p < 0.05$). Within-test group analysis showed a significant increase of the right upper trapezius activity ($p < 0.05$), whereas no changes were found by within-control group analysis. Lower risk of asymmetric muscle patterns and postural blindness in the test group compared to the control group was observed. Further studies are

warranted to investigate the short and long-term effects of this type of insole, in patients with both craniomandibular-cervical and lower extremity disorders.] Ciuffolo F, Ferritto AL, et.al. *Cranio*. 2006 Jan;24(1):50-9.

144. **Incidence of Common Postural Abnormalities in the Cervical, Shoulder, and Thoracic Regions and their Association with Pain in Two Age Groups of Healthy Subjects.** [The purposes of this study were to identify the incidence of postural abnormalities of the thoracic, cervical, and shoulder regions in two age groups of healthy subjects and to explore whether these abnormalities were associated with pain. Eighty-eight healthy subjects, aged 20 to 50 years, were asked to answer a pain questionnaire and to stand by a plumb line for postural assessment of forward head, rounded shoulders, and kyphosis. Subjects were divided into two age groups: a 20- to 35-year-old group (mean = 25, SD = 63) and a 36- to 50-year-old group (mean = 47, SD = 2.6). Interrater and intrarater reliability (Cohen's Kappa coefficients) for postural assessment were established at .611 and .825, respectively. Frequency counts revealed postural abnormalities were prevalent (forward head = 66%, kyphosis = 38%, right rounded shoulder = 73%, left rounded shoulder = 66%). No relationship was found between the severity of postural abnormality and the severity and frequency of pain. Subjects with more severe postural abnormalities, however, had a significantly increased incidence of pain, as determined by chi-square analysis (critical $\chi^2 = 6$, $df = 2$, P less than .05). Subjects with kyphosis and rounded shoulders had an increased incidence of interscapular pain, and those with a forward-head posture had an increased incidence of cervical, interscapular, and headache pain.] Griegel-Morris P, Larson K, et al. *Phys Ther*. 1992 Jun;72(6):425-31.
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=1589462&dopt=Abstract
145. **Modulation of H reflex of pretibial and soleus muscles during mastication in humans.** [A previous study in our laboratory demonstrated that the soleus H reflex was facilitated during mastication in humans. In the present study, we investigated whether there was any modulation of the magnitude of the pretibial H reflex during mastication in five healthy adult volunteers. The pretibial H reflex was significantly facilitated during mastication, and there was no significant difference in the facilitation between jaw-closing and jaw-opening phases; that is, the gain of the H reflex was modulated tonically but not in a phase-dependent manner during mastication. Furthermore, in the same subjects, we confirmed that the soleus H reflex was facilitated during mastication. Based on our findings, we conclude that the H reflexes in both the pretibial and soleus muscles undergo a nonreciprocal facilitation during mastication. It is suggested that mastication contributes to stabilization of postural stance in humans.] Takahashi T, Ueno T, et al. *Muscle Nerve*. 2001 Sep;24(9):1142-8.
http://www.ncbi.nlm.nih.gov/sites/entrez?cmd=Retrieve&db=PubMed&list_uids=11494266&dopt=Citation
146. **Occlusal support and head posture.** [In order to examine the relationship between occlusal support and head posture, the electromyographic (EMG) activities of the jaw closing muscles and the sternocleidomastoid muscle during voluntary maximal clenching (VMC) under several conditions of occlusal support in eight healthy dentates were recorded and analysed. The head posture was also recorded simultaneously by the electromagnetic, 6-degree-of-freedom tracking instrument (POLHMUS Co. 3 SPACE-

WIN*). In the VMC with lateral imbalance of occlusal support, EMG activity of the jaw closing muscles and the sternocleidomastoid muscle on the occlusal support side was greater than those on the non-occlusal support side, and the neck was bent in the direction of the occlusal support side. Moreover, a positive correlation was found between the asymmetry of muscle activity (asymmetry index) of the sternocleidomastoid muscle and the angle of lateral bending of the neck. From these results, it can be said that lateral imbalance of the occlusal support could promote imbalance in sternocleidomastoid muscle activity, causing lateral bending of the neck. From this study, it is suggested that there is a close relationship between occlusal support and head posture.] Kibana Y, Ishijima T, et al. *J Oral Rehabil.* 2002 Jan;29(1):58-63.

http://www.ncbi.nlm.nih.gov/sites/entrez?cmd=Retrieve&db=PubMed&list_uids=11844033&dopt=Citation

147. **Postural hypotension in a patient with cervical myelopathy due to cranio-vertebral anomaly.** [We report a patient with craniovertebral anomaly leading to cervical cord compression who presented with disabling postural hypotension. A 60-year-old electrician presented with progressive weakness of the upper and lower limbs, which had started 7 years previously. He had had difficulty in holding urine for the previous year and had blacked out on standing for the past 3 months. He had upper limb wasting and lower limb spasticity, with impaired joint position sense. Autonomic dysfunctions included postural hypotension, absence of sinus arrhythmia, impaired Valsalva ratio, and lack of increase in blood pressure on cold immersion and isometric contraction. Cervical spine radiograph and magnetic resonance imaging revealed atlantoaxial dislocation, Klippel-Feil syndrome and osteophytes, resulting in cord compression at C₂-C₄. Partial and selective damage to the descending autonomic fibres may be responsible for postural hypotension in this patients.] Misra UK, Kalita J, et al. *Clinical Autonomic Research*, Vol.7, No.5, Oct 1977, p.223-226.

<http://www.springerlink.com/content/3714v1235g03t5w3/>

148. **Preliminary report on head posture and muscle activity in subjects with class I and II.** [Forward head posture may cause alterations in the stomatognathic system, including changes in the muscle activity of the masticatory muscles and dental occlusion alterations. Considering the need for further understanding of the relationship between the stomatognathic system and the cervical region, the purpose of this study was to analyse the head posture and the electromyographic (EMG) activity of the anterior portion of temporal and masseter muscles bilaterally among bruxist's subjects with different dental occlusion classifications using the Angle method. The study consisted of 20 female volunteers, between the ages of 17 and 27 years. They were separated into two groups (class I and class II occlusions) according to a dentist-performed evaluation. An assessment of forward head posture was conducted using a photographic technique (angular calculus) combined with a clinical analysis. In the EMG analyses, active differential surface electrodes (Ag) were utilized and were placed bilaterally on the belly of masseter and temporal muscles, perpendicular to the muscles fibres. The EMG signal recorded during bilateral isotonic mastication, was presented using the Root Mean Square and was processed by Matlab software. The results indicated that the EMG responses of temporal and masseter muscles tend to be modified by occlusion alteration class II. Subjects with class II occlusion tended to present more occurrence of forward head posture with alterations in the muscle activity pattern between masseter and temporal

muscles.] Gadotti IC, Berzin F, et al. *Journal of Oral Rehabilitation*, Volume 32 Issue 11 Page 794 - November 2005. <http://www.blackwell-synergy.com/doi/abs/10.1111/j.1365-2842.2005.01508.x?journalCode=jor>

149. **Relationship Between Craniomandibular Disorders and Poor Posture.** [The purpose of this research was to show that a relationship between craniomandibular disorders (CMD) and postural abnormalities has been repeatedly postulated, but still remains unproven. This study was intended to test this hypothesis. Twenty-five CMD patients (mean age 28.2 years) were compared with 25 gender and age matched controls (mean age 28.3 years) in a controlled, investigator-blinded trial. Twelve postural and ten muscle function parameters were examined. Measurements were separated into three subgroups, consisting of those variables associated with the cervical region, the trunk in the frontal plane, and the trunk in the sagittal plane. Within these subgroups, there was significantly more dysfunction in the patients, compared to control subjects (Mann-Whitney U test $p < 0.001$, $p < 0.05$, $p < 0.01$). Postural and muscle function abnormalities appeared to be more common in the CMD group. Since there is evidence of the mutual influence of posture and the craniomandibular system, control of body posture in CMD patients is recommended, especially if they do not respond to splint therapy. Whether poor posture is the reason or the result of CMD cannot be distinguished by the data presented here.] Nicolakis P, Nicolakis M, et al. *Cranio*. 2000 Apr;18(2):106-12. http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=11202820&dopt=Abstract
150. **Relationship Between Dental Occlusion and Posture.** [The purpose of this study is to show the effects of dental occlusion on postural position. Thirty subjects were divided into two groups: an experimental group who wore mandibular orthopedic repositioning appliances (MORA) and a control group who wore no oral device. All of the subjects underwent the same Fukuda-Unterberger experimental stepping test to check their postural attitude. Any deviation of the subject during the test from his initial position was analyzed. The results seemed to confirm that altering dental occlusion by wearing an oral appliance could induce some fluctuations in dynamic postural attitude. The phenomenon occurs after prolonged wearing of a MORA. Feedback effects are gradual after removing the mandibular splint.] Milani RS, DePeriere DD, et al. *Cranio*. 2000 Apr;18(2):127-34. http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=11202823&dopt=Abstract
151. **Relationship between head position and the muscle hardness of the masseter and trapezius muscles: a pilot study.** [The purpose of this study was to examine the hardness of the masseter and trapezius muscles at various head positions and to explore the relationship of these two muscles to each other in terms of their respective levels of muscle hardness at different head positions. Twenty-two asymptomatic male subjects participated in this study. Using a hand-held hardness meter, muscle hardness was first measured in a relaxed position as a baseline. The subjects were then asked to assume five deviated head positions, and the muscle hardness was measured again. The data obtained at each deviated head position were compared to those at baseline. In addition, the subjects were asked to maintain a five minute sustained anterior flexion of the head, and muscle hardness was also measured and compared to the baseline. As a result, there was a significant increase in muscle hardness at the point of the whole trapezius with 30-

degree anterior flexion, while there was a significant decrease at the point of the right masseter. A significant increase in hardness was seen in the upper trapezius muscle in conjunction with right side bending and in the right upper trapezius muscle on left side bending. Also, a significant decrease in hardness was observed in the right masseter with right side bending. With reference to the axial rotation, there was a significant increase in hardness in the upper right trapezius muscle upon right axial rotation. Moreover, there was a significant increase in the muscle hardness in the whole trapezius after the five minute anteriorly sustained head task. This study provides evidence that deviated head positions lead to an increase in hardness of the trapezius muscle. The data also revealed the simultaneous occurrence of the elevation of muscle hardness in the upper trapezius muscle and the decrease in muscle hardness in the masseter muscle associated with right side bending and anterior flexion.] Kashima K, Maeda S, et.al. *Cranio*. 2006 Jan;24(1):38-42.

152. **Relationship Between Head Posture and Temporomandibular Dysfunction Syndrome.** [To investigate the relationship between temporomandibular joint dysfunction and head posture. Methods: Thirty patients with temporomandibular joint pain and thirty healthy adults were included the study. After physical examination, patients were subjected by cervical X-ray and magnetic resonance imaging of temporomandibular joint. The cervical and mandibular range of motion [active-passive], the vertical dimension of the mandibular rest position, head and shoulder angles parameters of the patients were evaluated. Cervical range of motion was measured by a goniometer. Mandibular range of motion was measured with ruler, between upper and lower first incisor teeth. The rest position of the mandible was calculated between the most anterior point on nose and chin from the photographic approach. For measurement of head and shoulder angles; tragus, spinal process tip of C7 cervical vertebra and acromial head on shoulder were marked. Then calculations were performed from these three points of the patients' photographs. Results: There was a statistical difference in head and shoulder angles, temporomandibular joint active-passive range of motion values and rest position of the mandible between comparison groups [P < 0.001]. There was no statistical significant difference in cervical range of motion results [P > 0.05]. Conclusion: This study supports that poor posture causes muscle imbalance and pain which are highly correlated with developing temporomandibular dysfunction syndrome.] Evcik D, Aksoy O. *Journal of Musculoskeletal Pain Vol.12(2)p.19-24,(2004)*.
<https://www.haworthpress.com/store/ArticleAbstract.asp?sid=4QBGV8RQVD489PCDUVSQ6PKM6VK61SDC&ID=45898>
153. **Relationship Between Posture and Occlusion: A Clinical and Experimental Investigation.** [Recently many postural diseases have been classified among occlusal-functional alterations, mostly on a clinical basis. However some anatomic and physiologic aspects are still unknown. The purpose of this study was to review the literature and to support the correlations by means of a balance platform on a group of 50 patients (30 males and 20 females, mean age 25.8 years) belonging to every Angle classification of malocclusion. The subjects were asked to stand on the balance platform and perform five different tests. The results showed that subjects with a Class II malocclusion exhibit an anteriorly displaced posture, whereas subjects with a Class III malocclusion exhibit a posteriorly displaced posture.] Nobili A, Adversi R. *Cranio*. 1996 Oct;14(4):274-85.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=PubMed&cmd=Retrieve&list_uids=9110621&Dopt=Citation

154. **Sagittal Spinal Posture in Relation to Craniofacial Morphology.** [Objective: The aim of this study is to determine correlations between the parameters of body posture in the sagittal profile and sagittal jaw position by obtaining objective and valid three-dimensional measurements of the dorsal profile by means of rasterstereography. ...Conclusions: It can be concluded that the mandible seems to have a greater effect on body posture than other craniofacial parameters. As a clinical result of this study, patients with severe malocclusions should be examined interdisciplinarily before orthognathic surgery is performed to minimize postural influence on the altered jaw relationship after surgery.] Lippold C, Danesh G, et al. *The Angle Orthodontist: Vol. 76, No. 4, pp. 625–631.* <http://www.angle.org/anglonline/?request=get-document&issn=0003-3219&volume=076&issue=04&page=0625>
155. **Spinal canal capacity in simulated displacements of the atlantoaxial segment – a skeletal study.** [In normal, physiological circumstances there is ample room in the spinal canal to accommodate the spinal cord. Our study aimed to identify the degree of compromise of the spinal canal which could be anticipated in various atlantoaxial pathological states. We examined paired atlas and axis vertebrae using high-definition radiography and simultaneous photography in both normal and simulated pathological orientations in order to measure the resultant dimension of the spinal canal and its percentage occlusion. At the extreme of physiological axial rotation (47°) the spinal canal is reduced to 61% of its cross-sectional area in neutral rotation. The spinal cord is thus safe from compromise. Atlantoaxial subluxation of up to 9 mm reduces the area of the spinal canal, in neutral rotation, to 60% with no cord compromise. Any rotation is, however, likely to cause cord compression. The mechanism of fixation in atlantoaxial rotatory subluxation could be explained by bony interlocking of the facet joint, reproducible in dry bones.] Tucker SK, Taylor BA. *The Journal of bone and Joint Surgery, Vol.80-B, No.6, Nov 1998, p.1073-1078.* <http://www.jbjs.org.uk/cgi/reprint/80-B/6/1073>
156. **The effect of condyle fossa relationships on head posture.** [Although it is commonly accepted that there is an interrelationship between the temporomandibular joint (TMJ) and head posture, few, if any, previous studies have quantified this effect. The purpose of this study is to quantify the effect of a change in the condyle fossa relationship of symptomatic temporomandibular joints on head posture. Charts of 51 patients (N=10 men and N=41 women) with symptomatic TMJ pathology were reviewed. The condyle fossa relationships were measured pre- and posttreatment using sagittal corrected hypocycloidal tomography. The amount of slant between the shoulder and external auditory meatus (EAM) was measured in pre- and posttreatment photographs as an indicator of forward head posture; less slant indicates better posture. Subjects ranged in age from 13-74 years (mean=43.1) and had been treated for an average of 5 months. Comparisons with pre-treatment measures showed that after treatment, the amount of retrodiskal space was significantly increased by an average of 1.67 mm on the left side (t=-10.11, p<0.0001) and 1.92 mm on the right (t=-9.62, p<0.0001). Comparisons also showed that after treatment, the amount of slant between the shoulder and EAM decreased by 4.43 inches on average which was also significant (t=13.08, p<0.0001). Improvement in the condyle fossa relationship was related to decreased forward head

posture. This suggests that optimizing mandibular condyle position should be considered in the management of forward head posture (adaptive posture).] Olmos SR, Kritz-Silverstein D, et.al. *Cranio*. 2005 Jan;23(1):48-52.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=15727321&dopt=Abstract

157. **The effect of translation of the C1-C2 on the spinal canal.** [The stability of the atlantoaxial articulation depends fundamentally on the integrity of the odontoid process and the ligaments. Ligament stability mostly is maintained by two ligaments: the transverse ligament and the alar, apical ligaments. Failure of the transverse ligament can result in anterior translation of the atlas on the axis. The anteroposterior diameter of the ring of the atlas is approximately 3 cm. The spinal cord and the odontoid process are each approximately 1 cm in diameter, approximately 1/3 the diameter of the ring. According to Steel's rule of thirds, the remaining centimeter of free space allows for some degree of pathologic displacement. The current anatomic study showed that the space available for the spinal cord was limited. The sagittal diameter C1-C2 canal is 18.71 +/- 2.88 mm (excluding 10 mm thickness of the dens and 2.91 +/- 0.69 mm thickness of transverse ligament), with the spinal cord occupying 7.73 +/- 0.87 mm of the available space. Space available for spinal cord at the level of the atlas is 3.44 +/- 1.19 mm plus 1.01 +/- 0.20 mm space anterior to the cord (anterior epidural space) and 5.64 +/- 2.22 mm space posterior to the cord (posterior epidural space), which is approximately in agreement with the normal diameter by Steel's rule of thirds.] Ebraheim NA, Lu J, et al. *Clin Orthop Relat Res*. 1998 Jun;(351):222-9.

http://www.ncbi.nlm.nih.gov/sites/entrez?cmd=Retrieve&db=PubMed&list_uids=9646766&dopt=Abstract

158. **The functional relationship between the occlusal plane and the plantar arches. An EMG study.** [We studied many postural tests with an electromyographical methodology on a group of young men who had a right molar precontact. We compared the results of these tests before and after changing the right plantar arch by placing some plastic on the medial right margin of the homolateral plantar arch (talipes valgus) or on the whole plantar arch (flat foot). We demonstrated the dependence of the occlusal plane on the morphological variations of the plantar arch.] Valentino B, Fabozzo A, et.al. *Surg Radiol Anat*. 1991;13(3):171-4.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=1754950&dopt=Abstract

159. **The Influence of Clenching on Head Posture and Body Sway.** [Objectives: The purpose of this study was to elucidate the relationship between stomatognathic function and body equilibrium. Methods: In 6 healthy, fully dentate males aged 27 to 33 years, the body sway was recorded by the stabilometer (NEC medical systems, EB1101) and the head movement was also recorded simultaneously by the electromagnetic, six-degree-of-freedom tracking instrument (POLHMUS Co. Fastrak) outputting three-dimensional coordinates and orientation angles to each axis of coordinates. The impact lord (8.82J) disturbing the body balance by a sand bag was applied to each subject standing upright on the stabilometer under the eyes closed condition. The head movement and body sway were recorded at both the intercuspal position with the voluntary maximal clenching (VMC) and the mandibular rest position (RP) during the dynamic event and analyzed. Statistical analysis was performed by one-way analysis of variance (ANOVA)

and the regression analysis (SPSS for Windows 9.0, SPSS Inc.). Results: Cooperative movement between the head and body was observed during the dynamic event in VMC and RP. From the analysis of body sway, area of sway (root mean square value) and lateral body sway (maximum value) in RP was statistically greater than those in VMC ($p < 0.05$). From the analysis of head posture, total locus length in RP was statistically greater than that in VMC ($p < 0.05$). It is speculated from the results that the teeth clenching suppresses the head movement and body sway during the dynamic event. This speculation is supported by previous studies that activities of sternocleidomastoid muscles are synchronized to activities of jaw closing muscles during VMC. Conclusions: It is concluded that stomatognathic function and body equilibrium have an interdependent relationship.] Kibana Y, Ishijima T, et al. Health Sciences University of Hokkaido, School of Dentistry, Ishikari-Tobetsu, Japan .

http://iadr.confex.com/iadr/2002SanDiego/techprogram/abstract_15118.htm

160. **The influence of an experimentally-induced malocclusion on vertebral alignment in rats: a controlled pilot study.** [There is a growing interest in the relationship between occlusion and posture because of a greater incidence of neck and trunk pain in patients with occlusal dysfunction. The study was designed to verify whether an alteration of the spinal column alignment may be experimentally induced in rats as a consequence of altering dental occlusion and also to investigate whether the spinal column underwent any further changes when normal occlusion was then restored. ... A scoliotic curve developed in all the test rats at T1. There were no alterations of spinal position observed in any of the control rats. Additionally, the spinal column returned to normal condition in 83% of the test rats when the balance in occlusal function was restored. The alignment of the spinal column seemed to be influenced by the dental occlusion.] D'Attilio M, Filippi MR< et al. *Cranio*. 2005 Apr;23(2):119-29.
http://www.ncbi.nlm.nih.gov/sites/entrez?cmd=Retrieve&db=PubMed&list_uids=15898568&dopt=Abstract
161. **The Influence of Forward Head Posture on Dental Occlusion.** [A well established premise in the field of craniomandibular and cervical spine orthopedics is that forward head posture (FHP) adversely affects mandibular position and therefore dental occlusion. The purpose of this study was to investigate the influence of FHP on the initial occlusal contact pattern (IOCP) in order to provide further clarification on this important topic. Thirty-nine healthy subjects, 10-74 years old, underwent a series of tests in which the IOCP was recorded in four different head positions using the T-Scan Occlusal Diagnostic System. Three tests each were performed in military posture (MP), natural sitting posture (NP), FHP, and maximal forward head posture (MFHP) for a total of twelve trials. A repeated measures analysis of variance failed to demonstrate a correlation between FHP and IOCP; however, a multiple linear regression analysis revealed a relationship between age and the IOCP. This study raises questions about the relationship between FHP and occlusion.] Makofsky HW. *Cranio*. 2000 Jan;18(1):30-9.
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=11202813&dopt=Abstract
162. **The relationship between forward head posture and temporomandibular disorders.** [This study investigated the relationship between forward head posture and temporomandibular disorder symptoms. Thirty-three temporomandibular disorder patients with predominant complaints of masticatory muscle pain were compared with an

age- and gender-matched control group. Head position was measured from photographs taken with a plumb line drawn from the ceiling to the lateral malleolus of the ankle and with a horizontal plane that was perpendicular to the plumb line and that passed through the spinous process of the seventh cervical vertebra. The distances from the plumb line to the ear, to the seventh vertebra, and to the shoulder were measured. Two angles were also measured: (1) ear-seventh cervical vertebra-horizontal plane and (2) eye-ear-seventh cervical vertebra. The only measurement that revealed a statistically significant difference was angle ear-seventh cervical vertebra-horizontal plane. This angle was smaller in the patients with temporomandibular disorders than in the control subjects. In other words, when evaluating the ear position with respect to the seventh cervical vertebra, the head was positioned more forward in the group with temporomandibular disorders than in the control group.] Lee WY, Okeson JP, et al. *J Orofac Pain*. 1995 Spring;9(2):161-7.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=7488986&query_hl=2

Abfraction

163. **A Critical Review of Non-carious Cervical (Wear) Lesions and the Role of Abfraction, Erosion, and Abrasion.** [The terms ‘abfraction’ and ‘abrasion’ describe the cause of lesions found along the cervical margins of teeth. Erosion, abrasion, and attrition have all been associated with their formation. Early research suggested that the cause of the V-shaped lesion was excessive horizontal toothbrushing. Abfraction is another possible etiology and involves occlusal stress, producing cervical cracks that predispose the surface to erosion and abrasion. This article critically reviews the literature on abrasion, erosion, and abrasion, and abfraction. The references were obtained by a MEDLINE search in March, 2005, and from this, hand searches were undertaken. From the literature, there is little evidence, apart from laboratory studies, to indicate that abfraction exists other than as a hypothetical component of cervical wear.] Bartlett DW, Shah P. *J Dent Res* 85(4):306-312, 2006.
<http://jdr.iadrjournals.org/cgi/content/full/85/4/306>
164. **A review of noncarious dental cervical lesions.** [Noncarious dental cervical lesions are categorized as abrasions, attritions, erosions, or abfractions. From these destructive processes, hypersensitive dentin is a common sequela experienced by the dental patient. Cold air and tactile probing are among the stimuli that precipitate this reaction. A complete patient history and clinical evaluation are essential for an accurate diagnosis. Treatment measures for hypersensitive dentin include restoring the lesion with composite resin or glass-ionomer material, the application of dentin bonding agents and/or fluoride, and iontophoresis therapy.] Gallien GS, Kaplan I, Owens BM. *Compendium*. 1994 Nov;15(11):1366, 1368-72, 1374.
http://www.ncbi.nlm.nih.gov/sites/entrez?cmd=Retrieve&db=PubMed&list_uids=7758024&dopt=Citation
165. **Association of occlusal, periodontal, and dietary factors with the presence of non-carious cervical dental lesions.** [PURPOSE: To investigate in vivo the relationship of occlusal stress factors, periodontal health status, and acidic dietary patterns to the

presence of non-carious cervical lesions (NCCL) in a convenience sample of undergraduate clinic, adult dental patients. MATERIALS & METHODS: Forty three subjects who met the entry criteria were admitted into the study; 178 teeth exhibiting NCCL were evaluated. A dietary assessment focusing on acidic food/beverage intake was used to evaluate nutritional intake over the most recent 24-hour period. Periodontal evaluation included intraoral measurement of gingival attachment loss, assessment of tooth mobility, and radiographic interpretation of percent bone loss using the Schei ruler method. Among the occlusal factors evaluated were shape and orientation of NCCL, presence and location of wear facets, and symptoms and characteristics of centric and eccentric occlusal function. RESULTS: 95% of teeth examined exhibited functional wear facets, indicating a systematic relationship with presence of NCCL (Chi Square = 16.9, $P < 0.0001$); 48% displayed buccal or incisal facets; 64% were accompanied by balancing interferences in lateral excursion; 98.3% had mobility scores ≤ 1 ; there was no significant association between mobility and facets present (Chi Square = 3.04, $P = 0.21$); and, no relationship with dietary patterns was found. Group function, that may evolve with age, and/or traumatic occlusion factors may be related to etiology of NCCL. Longitudinal controlled clinical trials are needed to confirm suspected etiologies and establish treatment guidelines for non-carious cervical lesions.] Mayhew RB, Jessee SA, Martin RE. *Am J Dent* 1998 Feb;11(1):29-32.

http://www.ncbi.nlm.nih.gov/sites/entrez?cmd=Retrieve&db=PubMed&list_uids=9823083&dopt=Citation

166. **Biomechanics of cervical tooth structure lesions and their restoration.** [The purpose of this study was to evaluate photoelastically the effects of a cervical tooth structure lesion and its restoration on stress distribution within a tooth. Method and materials: Three-dimensional composite models of a maxillary first premolar with a buccal cervical lesion were fabricated. Two types of cervical lesion were tested: one was wedge shaped and had a sharp line angle at the apex of the lesion, and the other was more rounded and saucer shaped. Vertical loads of 10 lb were applied to the unrestored and restored models at the tip of the buccal cusp, the tip of the lingual cusp, and the center of the occlusal surface. The resulting stresses within the tooth model were monitored and recorded photographically in the field of a circular polariscope arrangement. RESULTS: In the unrestored situation, stress concentrated at the apex of the lesion, regardless of the lesion configuration. However, the sharper, wedge-shaped lesion demonstrated a more severe stress concentration. In the restored situation, stress around the lesion apex and the lingual cervical lesion decreased, while stresses at the gingival and occlusal margins of the lesion increased, compared with the unrestored situation. These tendencies were most obvious when the buccal cusp was loaded. CONCLUSION: The presence of a cervical lesion changed occlusal load-induced stress distribution and concentrated stress at the apex of the lesion. The shape and dimension of the lesion governed the severity of stress concentration. Restoration of the cervical lesion relieved concentrated stress at the apex of the lesion.] Kuroe T, Itoh H, et al.,

Quintessence International 2000;31:267– 274,

http://www.ncbi.nlm.nih.gov/sites/entrez?cmd=Retrieve&db=PubMed&list_uids=11203935&dopt=Abstract

167. **Case-control study of non-carious cervical lesions.** [An exploratory case-control study of non-carious cervical lesions was undertaken to examine the effects of a

variety of risk factors. Candidate exposure variables were related to erosion, abrasion, and tooth flexure, the three principal putative causal mechanisms for cervical lesions. Because previous studies have tended to focus on specific causal mechanisms, evidence for a multifactorial etiology is inconclusive. Data describing exposure factors were obtained through clinical examination, dietary and behavioral questionnaires, and analysis of study casts from 264 subjects (137 cases, 127 control). Salivary data were also obtained for a subset of these subjects. Patient and tooth-level logistic regression models were constructed for the full subject group, and the subset with salivary data. For the two patient-level models, only exposures related to brushing entered. For tooth-level models, multiple exposures representing all three causal mechanisms were included in both models. The results suggest that non-carious cervical lesions do have a multifactorial etiology, and that multiple causal mechanisms may operate in the initiation and progression of individual lesions.] Bader JD, McClure F, et al. *Community Dent Oral Epidemiol.* 1996 Aug;24(4):286-91.

http://www.ncbi.nlm.nih.gov/sites/entrez?cmd=Retrieve&db=pubmed&list_uids=8871039&dopt=Citation

168. **Dental erosion. Definition, classification and links.** [An overview of tooth wear, i.e. of non-carious destructive processes affecting the teeth including abrasion, demastication, attrition, abfraction, resorption and erosion is presented. The nomenclature and classification of dental erosion commonly used in the dental literature are summarized. They are based on etiology (extrinsic, intrinsic, idiopathic), on clinical severity (Classes I to III), on pathogenetic activity (manifest, latent) or on localization (perimolysis). Interactions between erosion and abrasion, demastication, attrition, and abfraction as well as caries and low salivary flow rate are highlighted.] Imfeld T. *Eur J Oral Sci.* 1996 Apr;104(2 (Pt 2)):151-5.

http://www.ncbi.nlm.nih.gov/sites/entrez?cmd=Retrieve&db=PubMed&list_uids=8804882&dopt=Citation

169. **Dentin Erosion Simulation by Cantilever Beam Fatigue and pH Change.** [Exposed root surfaces frequently exhibit non-carious notches representing material loss by abrasion, erosion, and/or abfraction. Although a contribution from mechanical stress is often mentioned, no definitive proof exists of a cause-effect relationship. To address this, we examined dimensional changes in dentin subjected to cyclic fatigue in two different pH environments. Human dentin cantilever-beams were fatigued under load control in pH = 6 (n = 13) or pH = 7 (n = 13) buffer, with a load ratio (R = minimum load/maximum load) of 0.1 and frequency of 2 Hz, and stresses between 5.5 and 55 MPa. Material loss was measured at high- and low-stress locations before and after cycling. Of the 23 beams, 7 withstood 1,000,000 cycles; others cracked earlier. Mean material loss in high-stress areas was greater than in low-stress areas, and losses were greater at pH = 6 than at pH = 7, suggesting that mechanical stress and lower pH both accelerate erosion of dentin surfaces.] Marshall GW, Marshall SJ. *J Dent Res* 84(4):371-375, 2005.

<http://jdr.iadrjournals.org/cgi/content/full/84/4/371>

170. **Development of noncarious cervical notch lesions in vitro.** [PURPOSE: The initiation and progression of noncarious cervical notch lesions (NCCL) continues to perplex clinicians worldwide and poses a considerable restorative challenge. The purpose of this brief communication is to report what is believed to be the first in vitro production of notch-shaped lesions in the cervical third of premolar teeth. MATERIALS &

METHODS: The lesions, were produced by axial loading of selected permanent premolar teeth in a 10% aqueous solution of sulfuric acid over a period of 5 days, followed by immersion in water for 7 days. **RESULTS:** Results revealed macroscopic and microscopic features similar to those observed in noncarious cervical lesions in vivo. The lesions were incidental findings while the authors were studying stress corrosion of enamel at low pH. Although much remains to be investigated regarding the etiology and pathogenesis of NCCL, axial loading and a corrosive environment may be implicated in these processes. The artificial lesions arose in clinically sound teeth, suggesting that there is no simple clinical examination to identify teeth at risk from NCCL. **CLINICAL SIGNIFICANCE:** The relationship between the development of NCCL and applied stress indicates that occlusal factors may play the most significant role in the initiation and progression of NCCL. Whitehead SA, Wilson NH, Watts DC. *J Esthet Dent* 1999;11(6):332-7.

http://www.ncbi.nlm.nih.gov/sites/entrez?cmd=Retrieve&db=PubMed&list_uids=10825868&dopt=Citation

171. **Noncarious cervical lesions and abfractions.** A re-evaluation. [Background. The concept of abfraction is controversial. The authors present the fundamental basis of abfraction and review studies that describe the condition. Types of Studies Reviewed. The authors used data on masticatory forces, enamel and dentin properties, as well as stress studies related to abfraction, for background information. They also analyzed the genesis of the abfraction theory, experimental evidence, case presentations, clinical investigations and restorative studies. Results. The theory of abfraction is based primarily on engineering analyses that demonstrate theoretical stress concentration at the cervical areas of teeth. While some recent stress studies support earlier findings, others have provided significant deviating information. Few controlled studies exist that demonstrate the relationship between occlusal loading and abfraction lesions. The role of occlusal loading in noncarious cervical lesions (as shown by clinical data) appears to be part of a multifactorial event that may not necessarily follow the proposed classic abfraction mechanism, and other mechanisms or factors may explain cervical restoration failure just as well. Clinical Implications. There is little direct evidence supporting the theory of abfraction as the primary factor in the formation of noncarious cervical lesions. Controlled clinical trials are necessary to elucidate more fully the etiology of those lesions.] Litonjua LA, Sebastiano A, et al. *J Am Dent Assoc.* Vol 134, July 2003, p.845-850. <http://jada.ada.org/cgi/reprint/134/7/845.pdf>
172. **Noncarious dental "abfraction" lesions in an aging population.** [A new classification for noncarious dental lesions has evolved from the dental literature. The name given to these lesions, [dental "abfractions,"](#) is a theory propounding tooth fatigue, flexure, and deformation through [biomechanical loading](#) of tooth structure, primarily at the cervical regions of the dentition. These lesions are typically wedge shaped with sharp line angles, but occlusal abfractions have been observed as circular invaginations. Dental abfractions can occur alone and are sometimes associated with toothbrush abrasion and erosion from endogenous or exogenous acids. Treatment consists of the application of composite resin or glass-ionomer cement restorations and/or the discontinuance of the etiology of these lesions. If esthetics are not a primary concern of the patient and the tooth is not

structurally compromised, many of these lesions can be observed, provided that the patient is informed that bruxism or malocclusion problems exist.] Owens BM, Gallien GS. *Compend Contin Educ Dent*. 1995 Jun;16(6):552, 554, 557-8,

http://www.ncbi.nlm.nih.gov/sites/entrez?cmd=Retrieve&db=PubMed&list_uids=8620386&dopt=Citation

173. **Possible role of tensile stress in the etiology of cervical erosive lesions of teeth.**

[A tensile stress hypothesis for the etiology of idiopathic cervical erosions of human teeth is presented. It is proposed that when occlusion is not ideal, lateral forces cause the teeth to bend. The tensile stresses created during bending disrupt the chemical bonds of the crystalline structures of enamel and dentin. Small molecules may enter between the crystals and prevent the reestablishment of the chemical bonds. As a result, the disrupted tooth structure is more susceptible to loss through dissolution and abrasion and results in the development of the typically wedge-shaped lesions. Patients with lesions typical of hundreds examined by the authors were presented to illustrate the concept. The possible consequences of the proposed hypothesis were discussed. The hypothetical conclusions made in this article will be tested by experimentation.] Lee WC, Eakle WS. *J Prosthet Dent*. 1984 Sep;52(3):374-80.

http://www.ncbi.nlm.nih.gov/sites/entrez?cmd=Retrieve&db=PubMed&list_uids=6592336&dopt=Citation

174. **Potential for load-induced cervical stress concentration as a function of periodontal support.**

[PURPOSE: The purpose was to determine, photoelastically, the locations of occlusal load-induced stress concentrations within a maxillary premolar as a function of degree of periodontal support. MATERIALS & METHODS: Composite three-dimensional models of a maxillary first premolar were fabricated for quasi-three-dimensional photoelastic stress analysis. Individual materials were used to model enamel, dentin, periodontal ligament, and alveolar bone. Three levels of periodontal support reduction (0%, 20%, 25%) were simulated by varying the socket depth. Vertical loads of 10 lb were applied to: (1) tip of buccal cusp, (2) tip of lingual cusp, and (3) center of occlusal surface. The resulting stresses were monitored and recorded photographically in the field of a circular polariscope arrangement. RESULTS: Cuspal loading concentrated stress around the cervical region below the loaded cusp, being highest under buccal cusp loading. The location of the stress concentration shifted apically as periodontal support diminished. CLINICAL SIGNIFICANCE: Observed cervical stress concentration corresponded well to the common location of abfractions seen in clinical situations. Since the location of cervical stress concentration varied with occlusal conditions, occurrence of abfractions must be highly dependent upon each patient's occlusion. Periodontal support reduction shifted the location of highest stress away from the cemento-enamel junction. Therefore, abfractions are less likely to occur on periodontally compromised teeth compared to stable teeth.] Kuroe T, Itoh H, Caputo AA, Nakahara H. *Esthet Dent* 1999;11(4):215-22.

http://www.ncbi.nlm.nih.gov/sites/entrez?cmd=Retrieve&db=PubMed&list_uids=10825878&dopt=Citation

175. **Stresses at the cervical lesion of maxillary premolar—a finite element investigation .**

[Objectives. The objective of this study was to use a three-dimensional (3-D) finite element model to investigate normal stress distribution to substantiate the tooth

flexure mechanism. The study also compared the changes in the stresses by different occlusal loading sites and directions. *Methods*. The 3-D finite element analysis was used. A maxillary premolar was selected to construct the simulation model. The model was constructed step-by-step for convergence and validity. Seven load conditions for various load sites and different directions were simulated to the model. *Results*. The maximal principal stress and minimal principal stress distributions developed within the structures of seven load conditions were output and their stress distributions on z-plane at the vertical midline were shown. The peak tensile stress of the cervical area for various load conditions were compared and listed. *Conclusions*. This study has shown that the presence of tensile stresses in the cervical region of a maxillary premolar by various loading sites and different directions. The results coincided with the stress-induced theory, hence sustaining it. The relationship of the affected factors of leverage to the development of cervical abfraction lesions, was explored.] Lee HE, Lin CL, et al. *J of Dentistry Volume 30, Issues 7-8, 2002, Pages 283-290.*

http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6T86-47G3SH6-1&user=10&coverDate=11%2F30%2F2002&rdoc=1&fmt=&orig=search&sort=d&view=c&acct=C000050221&version=1&urlVersion=0&userid=10&md5=20a312e9afb8375cffff3cc8be344bbb

176. **Stress-induced cervical lesions: review of advances in the past 10 years.** [The accumulation of experimental and clinical evidence during the past decade has significantly contributed to the understanding of the role of occlusally generated tensile stress in the etiology of certain noncarious cervical lesions of teeth. More important, this knowledge has led to the understanding of the reasons why traditional restorative treatments of these stress-induced cervical lesions fail. The case of failure can be attributed to the occlusally generated stresses that are concentrated at the cervical region and result in debonding, leakage, retention failure, and, ultimately, restorative failure. With the new understanding, restorative approaches that combine chemical adhesion and restorative materials of appropriate elastic properties show promise of long-term success. Lee WC, Eakle WS. *J Prosthet Dent* 1996 May;75(5):487-94.

177. **Studies in vitro of abrasion by different manual toothbrush heads and a standard toothpaste.** [Loss of dentine at the buccal cervical region of teeth has a multifactorial aetiology. However, a considerable amount of circumstantial evidence, supported by laboratory experiments, implicates toothbrushing with toothpaste as a consistent factor. Most interest has centred around the abrasivity of toothpastes, particularly since a toothbrush alone has negligible effects on dentine. The influence of filament stiffness on toothpaste abrasion was the subject of some studies, mostly at least 2 decades ago, and produced conflicting conclusions. Numerous changes to toothbrush design and construction have taken place in recent years. AIMS: The aim of this study was to measure the abrasion of a standard substrate, acrylic, by a standard toothpaste carried on modern brands of toothbrushes classified by manufacturers as hard (3 brands), medium (3 brands) and soft (6 brands). METHOD: The substrate was brushed for 20,000 strokes with at least 6 heads from each brand. Measurements of substrate loss were made at 5000 stroke increments by profilometry. RESULTS: Substrate loss for all brushes showed a pattern of abrasion which was to a first approximation linear. Overall, hard brushes caused least abrasion and soft brushes the most, with differences between groups being significant. Within-group differences between brands reached significance for soft

and medium brushes but not hard brushes. CONCLUSIONS: The results could be explained by increased retention of toothpaste by smaller diameter filaments and denser tufts on soft brushes and the greater flexion of filaments increasing the area of contact with the surface. Calculations on the clinical outcome of these data in vitro indicate that toothbrushing with toothpaste alone would produce minimal damage to dentine even over many years. Differences between brushes therefore are probably of little clinical significance. Certainly, the data do not support the use of hard brushes, particularly in view of the potential detrimental effects to gingival tissues.]

Dyer D, Addy M, Newcombe RG. *J Clin Periodontol*. 2000 Feb;27(2):99-103.

http://www.ncbi.nlm.nih.gov/sites/entrez?cmd=Retrieve&db=PubMed&list_uids=10703654&dopt=Abstract

178. **The aetiology of the non-carious cervical lesion.** [Erosion and abrasion have been widely reported as causes of non-carious cervical lesions (NCCL). However, more recently, tooth flexure has been implicated in the formation of these lesions generating renewed interest in the pathogenesis of the non-carious loss of cervical tooth substance. This paper considers the causes of erosion and abrasion, related to modern lifestyles, and reviews the literature concerning tooth flexure as a cause of NCCL. A description of different types of NCCL is given, as an aid to determining the aetiology, yet at the same time accepting that the causation and pathogenesis of NCCL is probably multi-factorial resulting in many different clinical presentations. Consideration is given to the indications for treatment of NCCL and to the selection of materials for restoring such defects.] Osborne-Smith KL, Burke FJ, et al. *Int Dent J* 1999 Jun;49(3):139-43.

http://www.ncbi.nlm.nih.gov/sites/entrez?cmd=Retrieve&db=PubMed&list_uids=10858746&dopt=Abstract

179. **The role of cuspal flexure in the development of abfraction lesions: a finite element study.** [A tooth flexure mechanism has been proposed over the past 15 yr to explain non-carious cervical tooth loss. It is well established that cavity preparation weakens a tooth, resulting in more cuspal movement under occlusal load. The aim of this study was to investigate the effect that an occlusal restoration would have on the stress profile in the cervical region of a lower second premolar using two-dimensional finite element stress analysis. Under an eccentric 100 N occlusal load, a premolar with an occlusal amalgam restoration showed peak tensile and shear stresses in the buccal cervical region that were in excess of the known failure stress for enamel. Increases in the cavity depth of the occlusal amalgam restoration were found to increase cervical stress more than increases in cavity width. It was concluded that the weakening effect of cavity preparation may contribute to the development of non-carious cervical tooth loss.] Rees JS. *Eur J Oral Sci* 1998 Dec;106(6):1028-32.

http://www.ncbi.nlm.nih.gov/sites/entrez?cmd=Retrieve&db=PubMed&list_uids=9879915&dopt=Citation

- 180.

Cervical Spine, Chiropractic

181. **Asymptomatic Cervical Spine Dysfunction (CSD) in Patients with Internal Derangement of the Temporomandibular Joint.** [Patients with temporomandibular disorders (TMDs) frequently show symptoms related to the cervical spine. It is however unknown whether patients with TMD who have no symptoms in the neck region often have signs of cervical spine dysfunction (CSD) and whether there is a predominant localization of these asymptomatic CSDs. In a prospective and controlled examiner-blinded clinical trial, the prevalence and localization of asymptomatic CSD in patients with TMD was examined. Thirty patients with internal derangement of the temporomandibular joint but without any neck problems were compared with 30 age and gender matched healthy controls. Significantly more asymptomatic dysfunctions of the vertebral joints and increased muscle tenderness were found in the patient group. The difference between patients and nonpatients for vertebral joint dysfunction and muscle tenderness was greatest in the upper cervical spine. These findings support the thesis that a complementary examination of this area should be performed, even when TMD patients do not report any neck problems.] Fink M, Tschernitschek H, et al. *Cranio*. 2002 Jul;20(3):192-7.
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=12150265&dopt=Abstract
182. **Comorbidity of internal derangement of the temporomandibular joint and silent dysfunction of the cervical spine.** [The aim of this evaluation was to examine correlations between internal derangement of the temporomandibular joint (TMJ) and cervical spine disorder (CSD). A prospective controlled clinical study was carried out. Thirty patients with signs and symptoms of internal derangement but without any subjective neck problems and 30 age- and gender-matched control subjects without signs and symptoms of internal derangement were examined. The investigation of the temporomandibular system was carried out using a 'Craniomandibular Index'. Afterwards an examiner-blinded manual medical investigation of the craniocervical system was performed. This included muscle palpation of the cervical spine and shoulder girdle as well as passive movement tests of the cervical spine, to detect restrictions in the range of movement as well as segmental intervertebral dysfunction. The internal derangement of the TMJ was significantly associated with 'silent' CSD (t -test, $P < 0.05$). Patients with raised muscle tenderness of the temporomandibular system exhibited significantly more often pain on pressure of the neck muscles than patients without muscle tenderness of the temporomandibular system (t -test, $P < 0.05$). As a result of the present study, for patients with internal derangement of the TMJ an additional examination of the craniocervical system should be recommended.] Stiesch-Scholz M, Fink M, et.al. *Journal of Oral Rehabilitation*, Volume 30 Issue 4 Page 386 - April 2003 . <http://www.blackwell-synergy.com/links/doi/10.1046/j.1365-2842.2003.01034.x>
183. **Correlation between cervical spine and temporomandibular disorders.** [Neuroanatomical interconnections and neurophysiological relationships between the orofacial area and the cervical spine have been documented earlier. The present single-blind study was aimed at screening possible correlations between clinical signs of temporomandibular disorders (TMD) and cervical spine disorders. Thirty-one consecutive patients with symptoms of TMD and 30 controls underwent a standardised clinical examination of the masticatory system, evaluating range of motion of the

mandible, temporomandibular joint (TMJ) function and pain of the TMJ and masticatory muscles. Afterwards subjects were referred for clinical examination of the cervical spine, evaluating segmental limitations, tender points upon palpation of the muscles, hyperalgesia and hypermobility. The results indicated that segmental limitations (especially at the C0-C3 levels) and tender points (especially in the m. sternocleidomastoideus and m. trapezius) are significantly more present in patients than in controls. Hyperalgesia was present only in the patient group (12-16%).] De Laat A, Meuleman H, et.al. *Clinical Oral Investigations Volume 2, Number 2 / August, 1998* <http://www.springerlink.com/content/3gel4uu1xj2xgwm3/>.

184. **Correlation between signs of temporomandibular (TMD) and cervical spine (CSD) disorders in asthmatic children.** [Neck accessory respiratory muscles and mouth breathing suggest a direct relationship among asthma, Temporomandibular (TMD) and Cervical Spine (CSD) Disorders. This study was performed to evaluate and correlate TMD, CSD in asthmatic and non-asthmatic. ... Results showed a positive correlation between the severity of TMD and CSD signs in asthmatic children ($r = 0.48$). No child was considered normal to CSD and cervical mobility. The possible shortening of neck accessory muscles of respiration and mouth breathing could explain the relationship observed between TMD, CSD signs in asthmatic children and emphasize the importance of the assessment of temporomandibular and cervical spine regions in asthmatic children.] Chaves TC, Frossi DB, et.al. *J Clin Pediatr Dent. 2005 Summer;29(4):287-92* http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=16161392&dopt=Abstract
185. **Cranio-cervical posture: a factor in the development and function of the dentofacial structures.** [Many practitioners will recognize that subjects with a large mandibular plane inclination are characterized by an extended head posture and a forward inclined cervical column, i.e. an extended cranio-cervical posture. It is also typical that subjects with a short-face morphology often carry their heads somewhat lowered, and have a markedly backward-curved upper cervical spine, i.e. cervical lordosis. The aim of the paper is to link together the findings of a series of studies that attempt to clarify this relationship, and bring into focus cranio-cervical posture, which is a functional factor that seems to be involved in many clinical orthodontic problems. To provide a background for the article, the concept of standardized posture of the head and the cervical column is developed, and procedures for recording this posture, as well as categories of cephalometric variables that express the different postural relationships, are described. Findings that relate cranio-cervical posture to upper airway obstruction, to craniofacial morphology, and to malocclusion are surveyed, and a post-natal developmental mechanism that explains the findings and leads to further questions is discussed. Recent findings of a relationship between extended cranio-cervical posture and signs and symptoms of temporomandibular disorders further emphasize the biological importance of this functional parameter.] Solow B, Sandham A. *The European Journal of Orthodontics 2002 24(5):447-456; doi:10.1093/ejo/24.5.447.* <http://ejo.oxfordjournals.org/cgi/content/abstract/24/5/447>
186. **Eighty-One Patients with Multiple Sclerosis and Parkinson's Disease Undergoing Upper Cervical Chiropractic Care to Correct Vertebral Subluxation: A Retrospective Analysis.** [The objective of this article is threefold: to examine the role of head and neck trauma as a contributing factor to the onset of Multiple Sclerosis (MS) and

Parkinson's disease (PD); to explore the diagnosis and treatment of trauma-induced injury to the upper cervical spine through the use of protocol developed by the International Upper Cervical Chiropractic Association (IUCCA); and to investigate the potential for improving and arresting MS and PD through the correction of traumainduced upper cervical injury. Data from 81 MS and PD patients who recalled prior trauma, presented with upper cervical injuries, and received care according to the above protocol are reviewed.... A causal link between trauma-induced upper cervical injury and disease onset for both MS and PD appears to exist. Correcting the injury to the upper cervical spine through the use of IUCCA protocol may arrest and reverse the progression of both MS and PD. Further study in a controlled, experimental environment with a larger sample size is recommended.] Elster EL. Journal of Vertebral Subluxation Research, JVSr.com. Aug 2, 2004, p1-9.

<http://www.jvsr.com/abstracts/index.asp?id=205>

187. **Symptoms of the stomatognathic system in temporomandibular and cervical spine disorders.** [This study was performed to assess the prevalence of signs and symptoms of temporomandibular disorders (TMD) in patients with cervical spine disorders (CSD) and to compare patients with CSD and subgroups of patients with TMD with regard to the results of orthopaedic tests of the stomatognathic system. A group of 103 consecutive patients with signs and symptoms of CSD and a group of 111 consecutive patients with TMD were examined. All subgroups of TMD patients showed a significantly smaller range of motion than the CSD patients. Patients with TMD had limited mouth opening (< 40 mm) on active and passive mouth opening more often than CSD patients. TMD patients with myogenous problems reported oral habits more often than CSD patients, although no objective differences between CSD and TMD patients were found. Subgroups of TMD patients reported joint sounds, and pain on palpation and joint play tests of the temporomandibular joint (TMJ) more frequently than CSD patients. Joint sounds on active movements, pain on palpation of the TMJ, and pain on joint play tests correctly classified 82% of the patients with TMD and 72% of the patients with CSD. In spite of the biomechanical and anatomical relationship between the neck and the stomatognathic system, the results of the study show that CSD patients have signs and symptoms of TMD comparable with those of the adult Dutch population. It was concluded that the function of the masticatory system should be evaluated in patients with neck complaints in order to rule out a possible involvement of the masticatory system.] de Wijer A, Steenks MH, etl.al *J Oral Rehabil.* 1996 Nov;23(11):733-41.
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=8953477&dopt=Abstract

188. **The effect of occlusal alteration and masticatory imbalance on the cervical spine.** [The characteristics of mandibular lateral displacement include lateral inclination of the occlusal plane and the differences between the right and left masticatory muscles. The aims of this investigation were to compare the mandibular stress distribution and displacement of the cervical spine using three-dimensional finite element models (3D FEM) to simulate masticatory movements and to clarify the association between morphological and functional characteristics and head posture. A symmetrical standard model was produced (model-A). Model-B had higher masticatory muscle strength on the left side, model-C had symmetrical masticatory muscle strength but the occlusal plane was inclined upwards towards the right and model-D had the occlusal plane inclined

upwards towards the right with higher masticatory muscle strength on the left side. Model-A showed a completely symmetrical stress distribution pattern, while in model-B there was an uneven distribution in the mandible with higher stress on the left side. In addition, the stress distribution in the cervical spine was asymmetrical, showing displacement to the right. Model-C showed a similar mandibular tendency to model-B but the opposite tendency in the cervical spine. In model-D, the mandibular stress distribution was markedly asymmetrical, but almost symmetrical in the cervical spine with markedly decreased lateral displacement. These results suggest that lateral inclination of the occlusal plane and imbalance between the right and left masticatory muscles antagonistically act on displacement of the cervical spine, i.e. the morphological and functional characteristics in patients with mandibular lateral displacement may play a compensatory role in posture control.] Shimazaki T Motoyoshi M. et al. European Journal of Orthodontics 25(2003)457-463.
<http://ejo.oxfordjournals.org/cgi/reprint/25/5/457.pdf>

Strength, Sports

189. Affecting Upper Extremity Strength by Changing Maxillo-Mandibular Vertical Dimension in Deep Bite Subjects. [The effect of vertical dimension of occlusion (VDO) on maximizing isometric deltoid strength (IDS) was measured in subjects with deep overbite. Sixteen female dental students with deep dental overbite and no history of temporomandibular joint disorder (TMD) were used as their own control and tested for isometric strength of the deltoid muscles, using a hand held strain gauge. Measurements were taken under four mandibular conditions: 1. habitual occlusion; 2. mandibular rest position; 3. biting on a bite elevating appliance set to the functional criterion of peak IDS; and 4. biting on a placebo appliance. Results showed that in deep bite subjects, isometric deltoid strength in habitual occlusion was significantly less than in the mandibular rest position. Isometric deltoid strength with the bite elevating appliance was significantly greater than isometric deltoid strength in habitual occlusion, as well as in the mandibular rest position. Isometric deltoid strength achieved in habitual occlusion and placebo did not differ. Results of this study support previous findings indicating that a change in the VDO will affect isometric strength of the upper extremities.] Abdallah EF, Mehta NR, et al. *Cranio*. 2004 Oct;22(4):268-75.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=15532310&dopt=Abstract

190. **Effect of Increased Maxillo-mandibular Relationship on Isometric Strength in TMD Patients with Loss of Vertical Dimension of Occlusion.** [ABSTRACT: The effect on isometric strength of the shoulders and limbs while biting in habitual occlusion, on a bite-elevating appliance and on a placebo appliance was analyzed. Twenty female volunteer patients, presenting with temporomandibular pain dysfunction syndrome and obvious loss of vertical dimension, served as subjects. All were weaker to the manual application of the Isometric Deltoid Press (IDP) when biting, as opposed to maintaining the mandible in an unsupported rest position. Two intra-oral appliances were fabricated for each subject: a bite-elevating appliance (BEA) set by a functional criterion of peak strength to the IDP and a placebo appliance which did not interfere with occlusion but was "set" with a mock IDP procedure. Testing was carried out by the Neuromuscular Research Testing Laboratory of the Neurology Department of Tufts New England

Medical Center. Testing was independent of the dentist who fabricated and set the appliances. A standard neuromuscular test with the Maximal Voluntary Isometric Contraction apparatus was used to assess strength of right and left shoulder, elbow and knee flexion and extension as is routinely performed with all neuromuscular disease patients. Twelve strength tests were carried out for each of three conditions: 1. Baseline—biting in habitual occlusion; 2. Elevated—biting on the BEA; and 3. Placebo—biting with the placebo appliance inserted. The order of conditions 2 and 3 was counterbalanced without knowledge of the subjects. Twelve repeated measures ANOVAs (each subject as their own control) were conducted for each of the 12 strength measures. All F-tests indicated a significant main effect for treatment differences ($p < 0.0001$). Mean strength biting on the BEA was consistently greater ($p < 0.001$) than Baseline or Placebo strength. Baseline and Placebo condition were equivalent. These findings confirmed previous observations at this TMD Center: individuals with loss of vertical dimension of occlusion respond to a bite raising appliance by increased isometric-strength.] Abduljabbar T, Mehta NR, et al. *Cranio*. 1997 Jan;15(1):57-67, http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=9586489&dopt=Abstract

191. **The Effect of Stepwise Increases in Vertical Dimension of Occlusion on Isometric Strength of Cervical Flexors and Deltoid Muscles in Nonsymptomatic Females.** [This mixed, single-double blind study examined the effect of a stepwise increase in vertical dimension of occlusion (VDO) on the isometric strength of cervical flexor and deltoid muscles in 20 asymptomatic females with deep bite (age range 20-40 years). Vertical dimension of occlusion was increased by mandibular acrylic bite plates, 2, 4, 6 and 12 mm. Subjects were instructed to bite while resisting: 1. an increasing horizontal force was applied to the forehead; and 2. an increasing vertical downward force to the wrist of each extended arm. Forces were applied by a hand-held strain gauge until resistance yielded. The force applied at the point of yielding was recorded as isometric peak strength of that trial. The peak strength for each muscle group was measured twice and averaged to produce a mean peak strength measure. This procedure was repeated in the subject's habitual occlusion and for the four increased VDOs. Mean strength of cervical flexors with increased VDO (12.0 kg) was significantly greater than that for existing vertical dimension occlusion (9.6 kg). With the exception of pre-experimental existing VD of occlusion, strength for right and left deltoids did not differ, but mean deltoid strength in the increased condition (8.6 kg) was significantly greater than biting in without a bite plate (6.6 kg). In the peak condition, cervical flexor strength increased 24% and deltoid strength increased an average of 29% from that of biting without an increase. As VDO increased further, strength in all sites was found to diminish. Repeating the strength test without a bite plate, after all trials were administered, did not show differences from pre-experimental levels, indicating that fatigue was not an important factor. The findings demonstrate that isometric strength of the cervical flexors and deltoids increases significantly from habitual occlusion as the VDO is increased, then diminishes as VDO is increased further. The strength of both cervical flexors and deltoids varied in concert with changes of VDO.] Chakfa AM, Mehta NR, et al. *Cranio*. 2002 Oct;20(4):264-73. http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=12403184&dopt=Abstract

192. **The Effect of Vertical Dimension and Mandibular Position on Isometric Strength of the Cervical Flexors.** [This study compared the peak isometric strength of the cervical flexors in deep bite temporomandibular dysfunction (TMD) patients while biting in four bite positions: habitual occlusion, edge-to-edge, lateral shift and retruded. These values were then compared to those of the same subjects' bite positions elevated to a functional criterion (maximum isometric strength of the deltoid muscles). The mean height increase was 2.4 mm with a range of 1.5-3.8 mm. Fifteen of eighteen deep bite subjects met an inclusionary criterion, at least 13.3 Newtons (N) stronger cervical muscle strength with mandible relaxed open than habitual bite. Peak strength biting edge-to-edge was significantly greater than biting in habitual occlusion. Strength was found to increase significantly when biting in each of four mandibular positions when the bite was elevated to the functional criterion. The greatest strength was obtained from elevated habitual and edge-to-edge positions. The findings are of clinical significance, suggesting that cervical muscle isometric strength is affected by bite position and vertical dimension of occlusion. The results suggest that when biting, individuals with deep bite may be functioning at about 60% of their potential cervical flexor, isometric strength. The interaction between occlusal position, vertical dimension and cervical muscle function suggests a craniomandibular-cervical masticatory system.] al-Abbasi H, Mehta NR, et al. *Cranio*. 1999 Apr;17(2):85-92.
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=10425935&dopt=Citation
193. **The Relationship Between Jaw Posture and Muscular Strength in Sports Dentistry: A Reappraisal.** [ABSTRACT: From the late 1970s until the early 1990s, there have been several reports of improved appendage muscle strength and athletic performance. Much of the criticism of using a mouthguard alone or in conjunction with a splint, such as a mandibular orthopedic repositioning appliance (MORA), to enhance athletic performance has been aimed at study designs, controls, periods of time, double blindness, and the placebo effect. Although it would appear that designing a study which pleases both clinician and researcher would be a difficult task, studies have been performed that do meet the “gold standard.” The results favor the premise that jaw repositioning can enhance appendage muscular strength and athletic performance. Studies performed during the mid-1980s, and to which the scientific community refers to continually, on closer examination are flawed.] Gelb H, Mehta NR, et al. *Cranio*. 1996 Oct;14(4):320-5
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=9110627&dopt=Abstract

Function

194. **A method for standardizing jaw displacements in the horizontal plane while recording single motor unit activity in the human lateral pterygoid muscle.** [The normal function of the lateral pterygoid muscle is not well understood although this muscle is thought to play an important role in the control of jaw and jaw-joint function and is implicated in temporomandibular disorders (TMD). The lack of a validated method for standardization of jaw movement in studies of lateral pterygoid function has contributed to the lack of understanding of the normal function of this muscle. An improved understanding of normal function will allow valid comparisons to be made with

TMD patients in order to identify whether purported differences in activity actually exist. This paper describes a methodology for standardizing command jaw movements in the horizontal plane, together with reliable recordings of single-motor-unit (SMU) activity. In six human participants, jaw movements were standardized by having participants track a linear bank of light-emitting diodes (LEDs) aligned on a monitor displaying the mid-incisor point (MIPT). In all participants, the MIPT target (i.e. an illuminated LED) could be tracked, according to a pre-determined criterion, during single- and multiple-step displacements at different rates (1.3--6.5 mm/s at MIPT) and magnitudes (0.65--12 mm) of movement. SMU activity from the superior (SHLP) or inferior (IHLP) head of the lateral pterygoid muscle could be reliably discriminated during repeated trials of these defined tasks. This methodology establishes a reliable technique for characterizing the firing properties of SMUs within the lateral pterygoid, and has implications for analogous studies in other jaw muscles.] Phanachet I, Wanigaratne K, et.al. *J Neurosci Methods*. 2001 Feb 15;105(2):201-10.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=11275277&dopt=Citation

195. **Activation of masseter muscles with inspiratory resistance loading.** [Closure of the jaw exerts traction on muscles that insert on the hyoid bone and that may stabilize or expand the pharyngeal airway. We postulated that the masseter muscles, which close the jaw, would be activated when the patency of the pharyngeal airway is threatened. We therefore measured electromyographic activation of the masseters during inspiratory resistance loading and compared it with activation of chin muscles and alae nasi in 10 normal subjects. We observed no masseter activation during quiet unloaded breathing, but as pharyngeal pressure became lower there was a significant increase in masseter activation in all subjects. The change in masseter activation relative to pharyngeal pressure was similar to that of chin muscles and alae nasi. Activation of the masseter preceded the fall in pharyngeal pressure as also occurred in the chin muscles and alae nasi. We conclude that the masseters are activated by inspiratory resistance loading and have respiratory activity similar to pharyngeal airway muscles.] Hollowell DE, Suratt PM. *J Appl Physiol*. 1989 Jul;67(1):270-5.
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=2759953&dopt=Abstract

196. **Bilateral TMJ Disk Displacement Induces Mandibular Retrognathia.** [Unilateral non-reducing TMJ disk displacement has been shown to retard mandibular growth on the ipsilateral side, with facial asymmetry a sequela. We hypothesized that bilateral affliction would impair mandibular growth bilaterally, generating mandibular retrognathia. Non-reducing TMJ disk displacement was surgically created in 10 growing New Zealand White rabbits. Ten additional rabbits served as a sham-operated control group. Facial growth was followed in serial cephalograms, with tantalum implants, during a period corresponding to childhood and adolescence in man. The results verified that bilateral non-reducing TMJ disk displacement retarded mandibular growth bilaterally, the extent corresponding to mandibular retrognathia in man. Maxillary growth was also retarded, but to a lesser degree. Growth impairment fluctuated over time, the most striking retardation occurring during periods of general growth acceleration. This should be taken into consideration when orthodontic treatment, aimed at stimulating mandibular growth, is initiated in adolescent individuals with non-reducing TMJ disk displacement.]

- Bryndahl F, Eriksson L, et.al. *J Dent Res* 85(12):1118-1123, 2006.
<http://jdr.iadrjournals.org/cgi/content/abstract/85/12/1118>
197. **Effect of a surgically created disk displacement on mandibular symmetry in the growing rabbit.** [PURPOSE: The purpose of this study was to evaluate the contribution of unilateral disk displacement to growth changes in the young New Zealand White rabbit. METHODS: Ten female rabbits aged 10 weeks were included in this study. The five experimental rabbits had unilateral anterior disk displacement surgery. The five controls had no surgery. The rabbits were killed at 22 weeks of age, and the mandibles hemisected and radiographed. Cephalograms were digitized and analyzed by conventional methods. RESULTS: The gross appearance showed shortening and flattening of the articulating surface in the experimental group ($P < 0.05$). No significant shortening and flattening was found in the control group. CONCLUSION: These observations suggest that surgically created internal derangement can produce altered growth in the mandible.] Hatala MP, Macher DJ, et.al. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 1996 Dec;82(6):625-33.
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=PubMed&cmd=Retrieve&list_uids=8974134&Dopt=Citation
198. **Efficacy of a mandibular manipulation technique in reducing the permanently displaced temporomandibular joint disc.** [PURPOSE: The purpose of this study was to determine whether disc reduction occurred in patients with closed lock after mandibular manipulation (MM) and to analyze the factors that influenced the result. PATIENTS AND METHODS: Two hundred fifteen patients with closed lock received MM. Of these, 74 patients (79 joints) were assessed by means of magnetic resonance imaging (MRI) for disc reduction. The results of the MRI were compared with the findings from the clinical and radiographic examinations. RESULTS: According to the MRI assessment, only 18% (14 of 79) of the joints had successful disc reduction. The unsuccessfully treated joints had severe joint pain, disc displacement, condylar bone change, and disc deformity. CONCLUSIONS: The results of this study suggest that successful reduction of the disc by MM is rare. They also suggest that MM is least effective in the advanced stages of internal derangement, when the disc becomes deformed.] Kurita H, Kurashina K, et.al. *J Oral Maxillofac Surg.* 1999 Jul;57(7):784-7; discussion 788.
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=10416624&dopt=Abstract
199. **Electromyographic power spectral analysis of sternocleidomastoid muscle during sustained voluntary clenching.** [The purpose of this study was to investigate the changes of the activity of the sternocleidomastoid (SCM) muscles during sustained voluntary clenching. Ten healthy male subjects without any occlusal functional problems were asked to clench as long as possible in the intercuspal position while keeping the electromyographic activity of the masseter muscle at the 50% maximum voluntary contraction. Frequency analysis was carried out by computer using a fast Fourier transform algorithm to obtain the power spectrum of the SCM muscle during the fatiguing process and the recovery process. The results were as follows: 1. Sustained activities of the SCM muscles were observed during sustained voluntary clenching. 2. The power spectra of the SCM muscles significantly shifted to a lower frequency as time elapsed. 3. The power spectra of the SCM muscles obtained three minutes after relaxation

recovered to those of the beginning of clenching. These findings indicated that muscle fatigue may be induced in the SCM muscle during sustained voluntary clenching and that electromyographic power spectral analysis can be used as a noninvasive, objective, and quantitative index of SCM muscle fatigue.] Yamasawa H. *Kokubyo Gakkai Zasshi*. 1998 Mar;65(1):84-92. (Article in Japanese)

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=9584424&dopt=Abstract

200. **Electromyography activities of the head, neck and upper trunk muscles with mandibular movement in normal adults.** [OBJECTIVE: To investigate the activities of head, neck and upper trunk muscles with mandibular movement in normal adults. METHODS: The integral data of surface electromyography (EMG) had been recorded to analyze the activities of anterior temporal (Ta), posterior temporal (Tp), sternocleidomastoid (SCM) and trapezius (TRAP) muscles with mandibular movement in ten normal adults. RESULTS: The former mentioned muscles acted constantly when the mandible was in the rest position. The activities of Ta, Tp and SCM muscles increased with protrusion of mandible, mouth opening, tapping, maximum clenching, and chewing movements. The amplitudes of the increased activity of these muscles were correlated significantly with each other. When the activities of Ta and Tp muscles increased to 56 times and 25 times respectively, the activity of SCM muscle increased to 5 - 6 times. The activity of trapezius muscle increased with protrusion of mandible and opening movement, but tended to stop with the maximum clenching and chewing movement. The correlations of left and right sides of the same muscles had been found. CONCLUSIONS: The muscles of head, neck and upper trunk can act as contributors to keep the mandibular positions and take part in the mandibular movements.] Jiang T, Yang Z, et.al. *Zhonghua Kou Qiang Yi Xue Za Zhi*. 2002 Nov;37(6):431-4.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=12641956&dopt=Abstract

201. **Freeway space measurement using mandibular kinesiograph and EMG before and after TENS.** [This investigation expands on a previous pilot study of the effects of TENS on the resting position of the mandible. The tendency is for an increase in freeway space, but the variability of results makes individual evaluation essential.] Konchak PA, Thomas NR, et.al. *The Angle Orthodontist Oct 1988, p.343-350*

<http://www.angle.org/pdfserv/i0003-3219-058-04-0343.pdf>

202. **Functional Activity of Superior Head of Human Lateral Pterygoid Muscle during Isometric Force.** [There is controversy as to the jaw tasks for which the superior head of the human lateral pterygoid muscle (SHLP) becomes active. The aim was to describe the functional activities of SHLP single motor units (SMUs) during horizontal isometric force tasks. In 11 subjects, 48 SMUs were recorded from computer-tomography-verified SHLP sites during generation of horizontal isometric force in the contralateral (CL), protrusive (P), and ipsilateral (IL) directions and intermediate directions (CL-P, IL-P). In eight subjects, SHLP SMUs were active in CL, CL-P, and P. Qualitatively, SHLP EMG activity increased with increased isometric force. Forty-two SMUs were active in directions other than IL; 6 exhibited activity at IL and other directions. The similarity of these data to previous human lateral pterygoid (IHLP) data supports the notion that SHLP and IHLP should be regarded as a single muscle, with activities shaded according to the biomechanical demands of the task.] Ruangsri S,

Whittle T, et.al. *J Dent Res* 84(6):548-553, 2005.

<http://jdr.iadrjournals.org/cgi/content/full/84/6/548>

203. **Functional Heterogeneity in the Superior Head of the Human Lateral Pterygoid.** [The activity of the superior head of the human lateral pterygoid muscle (SHLP) is controversial. Given the non-parallel alignment of some SHLP fibers, the SHLP may be capable of differential activation. The aims were to clarify SHLP activity patterns in relation to location within SHLP. In 18 subjects, SHLP single motor units were intramuscularly recorded at computer-tomography-verified sites during horizontal (*e.g.*, protrusion) and vertical (*e.g.*, opening) jaw tasks (recorded by a jaw-tracking device) and at resting postural jaw position. None of 92 units was active at the resting postural position. Medially located units (21) showed activity during contralateral movement, protrusion, and opening; 5 were also active on jaw closing. There was a significant association between unit location and the number of units active during vertical tasks (*i.e.*, jaw closing and clenching). Analysis of the data suggests differential activation within SHLP and raises the possibility of functional heterogeneity within SHLP.] Phanachet I, Whittle T, et.al. *J Dent Res* 82(2): 106-111, 2003
<http://jdr.iadrjournals.org/cgi/content/full/82/2/106>
204. **Functional Properties of Single Motor Units in Inferior Head of Human Lateral Pterygoid Muscle: Task Relations and Thresholds.** [The aim of this study was to clarify the normal function of the inferior head of the human lateral pterygoid muscle (IHLP). The hypothesis was that an important function of the IHLP is in the fine control of horizontal jaw movements... Taken together, the data suggest that specific regions of the IHLP are capable of selective activation in a finely controlled manner to allow the application of the appropriate force vector (magnitude and direction) to effect the required condylar movement needed for the generation and control of horizontal jaw movements.] Phanachet I, Whittle T, et.al. *J Neurophysiol* 86: 2204-2218, 2001.
<http://jn.physiology.org/cgi/content/abstract/86/5/2204>
205. **Functional relationships between the masseter and sternocleidomastoid muscle activities during gum chewing.** [The purpose of this study was to investigate the functional relationship between masseter muscle (MM) and sternocleidomastoid muscle (SCM) activities and between mandibular and head movements during mastication, under experimental muscle fatigue. The sample consisted of 12 adults with individually normal occlusion. The subjects were asked to chew gum at three different times: before maximum clenching, immediately after maximum clenching, and 3 minutes after maximum clenching. At these times, we examined the activity of the MM and SCM as well as the movement of the mandible and head. The activity and movement were simultaneously measured using both electromyography and the motion capture system. The MM activity time after clenching was significantly shorter than that before clenching, whereas the SCM activity time was significantly longer after clenching. There was no significant difference in the changes of three-dimensional distance of the mandibular movement between the respective times. On the other hand, the changes in the three-dimensional distance of head movement after clenching increased when compared with before clenching. Furthermore, the difference in the time of MM and SCM activity onset and of mandibular and head movement onset after clenching was shorter than that before clenching. A functional relationship exists between the MM and SCM activities and between mandibular and head movements during mastication.]

Shimazaki K, Matsubara N, et.al. *The Angle Orthodontist*: Vol. 76, No. 3, pp. 452–458.
<http://www.angle.org/anglonline/?request=get-abstract&issn=0003-3219&volume=076&issue=03&page=0452>

206. **Human lateral pterygoid muscle activity on the return phase of contralateral and protrusive jaw movements.** [Normal function of the lateral pterygoid muscle is not well understood. The principal aim of this study was to determine whether there is a progressive decrease in lateral pterygoid activity as the condyle moves posteriorly and superiorly during the return phase of a contralateral or protrusive jaw movement, as would be expected if the muscle is involved in controlling or stabilizing the condyle during the return phase of these movements. In seven humans, electromyographic activity was recorded in the superior (SHLP) and inferior (IHLP) heads of the lateral pterygoid, the masseter, anterior temporal, posterior temporal and submandibular group of muscles, together with condylar movement, during contralateral and protrusive jaw movement. In most individuals, there was a progressive decrease in rectified and smoothed IHLP activity in relation to condylar movement during the return phase of contralateral and protrusive jaw movement. However, this pattern usually was not seen when SHLP activity was studied in relation to condylar movement. Further, there was a high correlation coefficient between condylar displacement and the rectified and smoothed IHLP and anterior temporal muscle activities during the return phase of contralateral or protrusive jaw movement, while SHLP presented a much lower correlation. Findings suggest an important role for the IHLP and anterior temporal in controlling the movement of the condyle to the glenoid fossa on the return phase of contralateral and protrusive jaw movements. Further studies are needed to clarify the function of the lateral pterygoid muscle during these and other jaw movements.] Phanachet I, Murray GM. *Arch Oral Biol.* 2000 Jun;45(6):517-29.
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=10775680&dopt=Abstract
207. **Maximal Bite Force and Its Association with Signs and Symptoms of TMD, Occlusion, and Body Mass Index in a Cohort of Young Adults.** [The purpose of this population-based cohort was to measure maximal bite force (MBF) in the molar and incisal regions and to examine whether MBF was associated with TMD, gender, occlusion (in terms of overjet, overbite, and total number of occluding contacts), and body mass index (BMI). ... According to multiple linear regression, TMJ discomfort was significantly negatively associated with MBF in the molar region ($p < 0.05$) and overjet was significantly negatively associated with maximal incisal bite force ($p < 0.05$). No significant associations between MBFs and body mass were found. The results demonstrate that in a population-based cohort of young adults signs, and symptoms of TMD and studied occlusal factors, unlike body mass, associate independently with MBF.] Ahlberg JP, Kovero OA, et al. *Cranio.* 2003 Oct;21(4):248-52.
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=14620696&dopt=Abstract&holding=f1000,f1000m,isrcn
208. **MRI Findings Concerning the Lateral Pterygoid Muscle in Patients with Symptomatic TMJ Hypermobility.** [Clinical studies have shown a close association between temporomandibular joint hypermobility (TMJH) and temporomandibular disorders (TMD). While pathological change of the lateral pterygoid muscle (LPM) is one of the most emphasized in studies of TMD, there have been no detailed clinical

reports of the LPM studies using magnetic resonance imaging (MRI) in TMJH. This study investigates structural and pathological alterations involving the LPM in patients with TMJH using MRI. A retrospective analysis was made of high-field MRI images from 98 patients with TMJH. LPMs of 143 joints were analyzed. In 110 joints (77%), hypertrophy, atrophy, and contracture were found in the superior belly and/or the inferior belly of the LPM. Pathological changes were more frequently found in the superior rather than the inferior belly of the LPM. In the cases with abnormalities in both bellies of the LPM, hypertrophy of the inferior belly was usually found combined with other changes of the SBLPM. The results of this study indicated that the pathological changes of the LPM or MRI are not infrequent in patients with symptomatic TMJH.] Yang X, Pemu H, et al. *Cranio*. 2001 Oct;19(4):260-8.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=11725850&dopt=Citation

209. **Objective evaluation of masticatory function in temporomandibular disorders patients. (Article in Japanese)** [PURPOSE: The purpose of this experiment was to objectively evaluate the masticatory function in TMD (Temporomandibular disorders) patients. ... CONCLUSION: It was suggested that the masticatory function in TMD patients is much inferior to that in healthy subjects.] Mizuuchi K, Shiga H, et al. *Nihon Hotetsu Shika Gakkai Zasshi*. 2006 Jul;50(3):405-13.
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=pubmed&list_uids=17159287&cmd=Retrieve&indexed=google
210. **Occlusal contact area, occlusal pressure, bite force and masticatory efficiency in patients with anterior disc displacement of the temporomandibular joint.** [The occlusal contact area, occlusal pressure, bite force, and masticatory efficiency were measured in 48 patients with anterior disc displacement (ADD) of the temporomandibular joint (TMJ). The results were compared with those of 30 normal controls without TMJ dysfunction. The values of occlusal contact area, bite force, and masticatory efficiency measured in patients with ADD were significantly smaller than those measured in the controls, although there was no difference in occlusal pressure between the two groups. The results of the measurements of 22 patients with ADD with reduction were also compared with those of 26 patients with ADD without reduction. There was no difference in any measurement between these patients subgroups. The analysis of occlusal contact area, bite force, and masticatory efficiency appeared to be useful methods in documenting the fact that masticatory function was impaired in patients with ADD of the TMJ.] Sato S, Ohta M, et al. *Journal of Oral Rehabilitation*, Volume 26 Issue 11 Page 906 - November 1999. <http://www.blackwell-synergy.com/links/doi/10.1046/j.1365-2842.1999.00481.x/abs/>
211. **Occlusal patterns in patients with idiopathic scoliosis.** [Idiopathic scoliosis is an orthopedic condition characterized by faulty posture. It might also be associated with some mild forms of facial asymmetry or dental deviations. The aim of the study was to clinically examine the occlusions of patients with idiopathic scoliosis. ... Conclusions: Patients with idiopathic scoliosis have asymmetric features of malocclusion compared with a random population.] Ben-Bassat y, Yitschaky M, et al. *Am J of Orthodontics and Dentofacial Orthopedics*, Vol.130, Issue 5. Nov 2006, p.629-633.
http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6W9R-4MBJHXH-S&_user=10&_coverDate=11%2F30%2F2006&_rdoc=1&_fmt=&_orig=search&_sort

[=d&view=c&_acct=C000050221&version=1&urlVersion=0&userid=10&md5=a3477a344184d850e6bca19196ff6b1a](#)

212. **Occlusion, sternocleidomastoid muscle activity, and body sway: a pilot study in male astronauts.** [The modifications induced by microgravity on the coordinated patterns of movement of the head, trunk, and limbs are reported on extensively. However, apparently there is little data on the masticatory muscles. In normal gravitational conditions, information from the neck and stomatognathic apparatus play a role in maintaining the body's balance and equilibrium. The current pilot study used normal gravity conditions to investigate the hypothesis of a functional coupling between occlusion and neck muscles and body postural oscillations. The immediate effect of modified occlusal surfaces on the contraction pattern of the sternocleidomastoid muscles during maximum voluntary clenching and on the oscillation of the center of foot pressure was analyzed in 11 male astronauts (aged 31-54 yrs). All subjects were healthy and free from pathologies of the neck and stomatognathic apparatus. Occlusal splints were prepared using impressions of their dental arches. The splints were modeled on the mandibular arch, had only posterior contacts, and were modified to obtain a more symmetric, standardized contraction of the masseter and temporalis muscles during teeth clenching. Surface EMG activity of the sternocleidomastoid muscles was recorded during a maximal voluntary clench with and without the splint. Sternocleidomastoid potentials were standardized as percent of the mean potentials recorded during a maximum contralateral rotation of the head, and the symmetry of the EMG waves of left- and right-side muscles was measured. Body sway was assessed with and without the splint, either with eyes open or closed. The variations of the center of foot pressure were analyzed through bivariate analysis, and the area of the 90% standard ellipse was computed. Within each visual condition (eyes open or closed), the difference between the areas of oscillation measured with and without the splint was computed. Muscular activity was more symmetric with the splint. The area of oscillation of the center of foot pressure was larger without the splint than with the splint, both with eyes open and eyes closed. The modifications, induced by the occlusal splint in the sternocleidomastoid muscles' symmetry, and center of foot pressure differential area with closed eyes, were significantly related ($p < 0.05$): the larger the increment in muscular symmetry, the smaller the area of oscillation with the splint as compared to without the splint. A functionally more symmetric maxillo-mandibular position resulted in a more symmetric sternocleidomastoid muscle contraction pattern and less body sway. Modifications in the contraction of the masticatory muscles may therefore affect the whole body.] Sgorza C, Tartaglia GM, et.al. *Cranio*. 2006 Jan;24(1):43-9.
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=16541845&dopt=Citation
213. **Open-close movements in the human temporomandibular joint: does a pure rotation around the intercondylar hinge axis exist?** [Mandibular movements near the maximum intercuspal position were analysed for the location of the mean instantaneous centre of curvature of the interincisal point path. Measurements were performed using a kinesiograph in 28 healthy young adults with sound dentitions and free from temporomandibular joint disorders. The subjects performed habitual open-close cycles at different speeds; opening movements starting from the centric relation occlusion were also analysed. In none of the 28 subjects was the interincisal point path derived from pure

rotation movements performed around the intercondylar axis, not even in the first millimetres of motion. Translation and rotation were always combined, and the position of the centre of curvature changed during the motion, showing different characteristics in the open and close movements; these patterns were also dependent upon motion speed. The results show that the hinge axis theory cannot explain the mandibular movements because a pure rotation did not occur around the intercondylar axis.] Ferrario VF, Sforza C, et.al. *J Oral Rehabil.* 1996 Jun;23(6):401-8.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=8809695&dopt=Abstract

214. **Reflex control of the human jaw muscles.** [The aim of this review is to discuss what is known about the reflex control of the human masticatory system and to propose a method for standardized investigation. Literature regarding the current knowledge of activation of jaw muscles, receptors involved in the feedback control, and reflex pathways is discussed. The reflexes are discussed under the headings of the stimulation conditions. This was deliberately done to remind the reader that under each stimulation condition, several receptor systems are activated, and that it is not yet possible to stimulate only one afferent system in isolation in human mastication experiments. To achieve a method for uniform investigation, we need to set a method for stimulation of the afferent pathway under study with minimal simultaneous activation of other receptor systems. This stimulation should also be done in an efficient and reproducible way. To substantiate our conviction to standardize the stimulus type and parameters, we discuss the advantages and disadvantages of mechanical and electrical stimuli. For mechanical stimulus to be delivered in a reproducible way, the following precautions are suggested: The stimulus delivery system (often a probe attached to a vibrator) should be brought into secure contact with the area of stimulation. To minimize the slack between the probe, the area to be stimulated should be taken up by the application of pre-load, and the delivered force should be recorded in series. Electrical stimulus has advantages in that it can be delivered in a reproducible way, though its physiological relevance can be questioned. It is also necessary to standardize the method for recording and analyzing the responses of the motoneurons to the stimulation. For that, a new technique is introduced, and its advantages over the currently used methods are discussed. The new method can illustrate the synaptic potential that is induced in the motoneurons without the errors that are unavoidable in the current techniques. We believe that once stimulation, recording, and analysis methods are standardized, it will be possible to bring out the real "wiring diagram" that operates in conscious human subjects.] Turker KS. *Crit Rev Oral Biol Med.* 13(1):85-104 (2002). <http://crobm.iadrjournals.org/cgi/content/abstract/13/1/85>.
215. Simultaneous recording of mandibular condylar movement and single motor-unit activity at verified sites in the human lateral pterygoid muscle. [In recent years, understanding of normal jaw-muscle function has been enhanced by detailed descriptions of their complex internal architecture and of the functional activity of single motor units (SMUs). The lateral pterygoid muscle, however, has been poorly studied, although it is thought to play an important part in the control of jaw and jaw-joint movement. The present study is the first of a series of SMU studies to clarify the normal function of this muscle. The aims were to demonstrate (a) the unequivocal isolation of SMU activity from one or two verified recording sites within the lateral pterygoid, and (b) that these SMUs can be recorded reliably together with condylar movement during simple command jaw

movements. Recordings of SMU activity were made with fine-wire electrodes from sites within the superior and inferior heads of the right lateral pterygoid during biting or command lateral jaw movements and combined with recordings of condylar and mid-incisor point movement. Recording sites were verified by computed tomography. In four young adults, the activities of 17 SMUs were reliably discriminated at seven recording sites within the lateral pterygoid. The units could be recorded during repeated trials of the same movement throughout a recording session with no appreciable change in amplitude or waveform. Units could also be discriminated simultaneously at separate recording sites--one in the superior head and the other in the inferior head. These data demonstrate that SMU activity can be recorded from verified sites within the lateral pterygoid simultaneously with condylar movement during command jaw movements.] Murray GM, Phanachet I, et.al. [Arch Oral Biol.](#) 1999 Aug;44(8):671-82.
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=10459779&dopt=Citation

216. **Spatiotemporal consistency of human mandibular and head-neck movement trajectories during jaw opening-closing tasks.** [Previous studies of spatial and temporal coordination between human mandibular and head-neck movements during single as well as rhythmic jaw opening-closing tasks suggest that these movements are regulated by central nervous commands common for jaw and neck muscles. The present study evaluated the spatiotemporal consistency of concomitant mandibular and head-neck movements during repeated single jaw opening-closing tasks, in short- as well as long-term perspectives and at different speeds. ... In conclusion, the present results suggest a high degree of spatiotemporal consistency of the kinematic patterns of mandibular and head-neck movements during jaw opening-closing, in short- as well as long-term perspectives. They also indicate that underlying neural processes are invariant in nature. The results give further support to the notion of a tight functional coupling between the human jaw and the neck motor systems during natural jaw function.] Zafar, H, NOrdh E, et.al. *Experimental Brain Research Volume 146, Number 1 / September, 2002.*
<http://www.springerlink.com/content/3v7a6vvrqkphr194/>
217. **Temporal coordination between mandibular and head-neck movements during jaw opening-closing tasks in man.** [Previous finding of concomitant mandibular and head movements during jaw function suggest a functional relation between the human jaw and neck regions. This study examined the temporal coordination between mandibular and head-neck movements during maximal jaw opening-closing tasks, at fast and slow speed. Twenty-four healthy individuals, median age 25 years, participated in the study. They were seated with firm back support but without head-neck support. Mandibular and head movements were simultaneously monitored by a wireless optoelectronic system for three-dimensional movement recording. The timing of head movement in relation to mandibular movement was estimated at defined time-points (start, peak, end and maximum velocity of movement), and during the entire course of the jaw-opening and jaw-closing phases. The results showed that the head in general started to move simultaneously with or before the mandible, reached the peak position simultaneously with, before or after the mandible, and reached the end position after the mandible. A higher degree of temporal coordination was found for fast speed at the start and the peak positions. The head most often attained maximum velocity after the mandible, and mostly lagged behind the mandible during the entire jaw-opening and -

closing phases. These findings support the notion of a functional linkage between the human temporomandibular and craniocervical regions. They suggest that "functional jaw movements" comprise concomitant mandibular and head-neck movements which involve the temporomandibular, the atlanto-occipital and the cervical spine joints, and are caused by jointly activated jaw and neck muscles. It is proposed that these jaw and neck muscle actions, particularly at fast speed, are elicited and synchronized by preprogrammed neural command(s) common to both the jaw and the neck motor systems. From the present results and previous observations of concurrent jaw and head movement during fetal yawning, we suggest that these motor programmes are innate.] Zafar H, Nordh E, et.al. *Arch Oral Biol.* 2000 Aug;45(8):675-82.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=10869479&dopt=Abstract

218. **Temporomandibular Joint Range of Motion: A Ratio of Interincisal Opening**

to Excursive Movement in a Healthy Population. [Range of motion is used in the examination and diagnosis of many joints. A simple method to measure and record temporomandibular joint range of motion is presented. Correlation of mandibular movement to excursive or lateral movements for a healthy population is described. The maximum incisal opening and lateral movements of 75 subjects, aged 20-50 years, were recorded. The average of maximum opening to lateral movements was found to be 4.4 to 1. A significant correlation or ratio of mandibular movement for use in diagnoses and treatment planning is discussed.] Hochstedler JL, Allen JD, Follmar MA. *Cranio.* 1996 Oct;14(4):296-300.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=9110623&dopt=Abstract

219. The accuracy with which the human condyle can be expressed in the coordinate system of JAWS3D using a unilateral fiducial marker. [Previous studies have indicated that the selection of condylar referencing points can significantly influence condylar point trajectories, and the use of radiographically determined condylar points is essential for accurate representation of condylar movement. The aim of this investigation was to determine the accuracy with which the three-dimensional locations of condylar points could be determined in the coordinate system of the JAWS3D tracking device when an ipsilateral fiducial marker is used. A perspex mandible containing condylar radiographic markers was constructed. A JAWS3D target frame and a fiducial marker, supporting radiographic markers, were secured to the perspex mandible. The image data from computer tomography scans of the condyles and fiducial marker, together with photographs of the fiducial marker and the JAWS3D target frame were used to calculate condylar point coordinates in the JAWS3D coordinate system. These data were then compared with the data obtained by direct measurement of the condylar radiographic markers in the JAWS3D coordinates. The results suggest that a unilateral fiducial marker is sufficient to allow the registration of ipsilateral condylar point coordinates to an accuracy of ~1.0 mm.] Swintara W, Johnson CWL, et.al. *Journal of Oral Rehabilitation* Volume 28 Issue 1 Page 33 - January 2001. <http://www.blackwell-synergy.com/links/doi/10.1046/j.1365-2842.2001.00637.x>

220. **The Functional Relationship Between the Craniomandibular System,**

Cervical Spine, and the Sacroiliac Joint: A Preliminary Investigation. [The hypothesis of a functional coupling between the muscles of the craniomandibular system

and the muscles of other body areas is still controversial. The purpose of this pilot study was to examine whether there is a relationship between the craniomandibular system, the craniocervical system and the sacropelvic region. To test this hypothesis, the prevalence and localization of dysfunction of the cervical spine and the sacroiliac joint were examined in a prospective, experimental trial. Twenty healthy students underwent an artificial occlusal interference, which caused an occlusal interference. The upper cervical spine (CO-C3) and the sacroiliac joint were examined before, during and after this experimental test. The primary outcome with these experimental conditions was the occurrence of hypomobile functional abnormalities. In the presence of occlusal interference, functional abnormalities were detected in both regions examined and these changes were statistically significant. The clinical implications of these findings may be that a complementary examination of these areas in CMD patients could be useful.] Fink M, Wahling K, et al. *Cranio*. 2003 Jul;21(3):202-8.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=12889677&dopt=Abstract

221. **The role of condylar cartilage in the development of the temporomandibular joint.** [A review of studies on the development and functional adaptation of the mandibular condylar cartilage, presenting a comprehensive concept of condyle development and its adaptive response that may help elucidate the etiology of some temporomandibular disorders.] Copray JCVM, Dibbets JMH, et.al. *the Angle Orthodontist Oct 1988, p.369-380*. <http://www.angle.org/pdfserv/i0003-3219-058-04-0369.pdf>

222. **The role of the human lateral pterygoid muscle in the control of horizontal jaw movements.** [There is a limited understanding of the normal function of the lateral pterygoid muscle (LP) and the role that this muscle plays in temporomandibular disorders. This article addresses the hypothesis that a major function of the LP is in the control of horizontal jaw movements. The range of fiber alignments suited to generating a major horizontal force vector (magnitude and direction), together with the likelihood of independent activation of subcompartments (that is, functionally heterogeneous zones) within each head, provide the possibility of a finely graded range of force vectors on the condyle to effect the fine control of horizontal jaw movements. This level of control does not appear to extend to the control of resting jaw posture, as recent single motor unit (SMU) data indicate that the LP is inactive with the jaw in the postural jaw position. Available electromyographic data demonstrate graded changes in multiunit and SMU activity with small horizontal jaw displacements at low force levels, a single preferred direction of the SMU firing rate during horizontal isometric jaw tasks, and graded changes in the SMU firing rate with horizontal force magnitude and direction. The evidence suggests that a major function of the LP is in the generation and fine control of the horizontal component of jaw movement by the graded activation of a subset of SMUs within the LP. The data also suggest that the LP is involved in the generation of horizontal force vectors, as required in parafunctional activities and heavy mastication.] Murray GM, Phanachet I, et.al. *J Orofac Pain*. 2001 Fall;15(4):279-92; discussion 292-305.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=12400398&dopt=Abstract

223. The role of the inferior head of the human lateral pterygoid muscle in the generation and control of horizontal mandibular force. [The aim was to test the hypothesis that the inferior head (IH) of the human lateral pterygoid muscle (LP) is involved in the generation and fine control of horizontal isometric mandibular force. Although previous studies provided some evidence for this, they had limitations that necessitate a re-examination. In eight participants, electromyographic (EMG) activity was recorded from the IHLP unilaterally, as well as bilateral surface recordings from the masseter (M) and anterior temporalis (AT), and the submandibular group of muscles (SUBM), during the generation of horizontal isometric mandibular force in a direction contralateral to the side of the IHLP recording. Isometric force at 5–8 mm open from the intercuspal position was exerted on a transducer (attached by a bar to the upper teeth) by a rod attached to the lower teeth. Participants tracked a target on a video screen that required 5-s holding periods at each 100 gwt (0.98 N) between 400 gwt (3.92 N) and 800 gwt (7.84 N). The mean of multi-unit EMG activity from all muscles during the most stable 2-s force-holding periods increased significantly with each force increment (GLM repeated measures: $P < 0.0001$). When normalized, the multi-unit data from the IHLP exhibited the steepest rate of increase. The mean firing rates of 21 IHLP single motor units (SMUs) significantly increased with force (GLM repeated measures: $P < 0.0001$). Two SMUs fired in advance of force onset, which suggests a role in force initiation. There were close associations between fluctuations in force and in IHLP SMU firing rates and multi-unit activity, but a similar correspondence was not as clear for the other recorded jaw muscles. These findings suggest that the IHLP is important in the generation and fine control of contralaterally directed, horizontal jaw forces.] Uchida S, Whitle T, et.al. *Archives of Oral Biology Volume 46, Issue 12, December 2001, Pages 1127-1140.* http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6T4J-448BDNS-6&_user=10&_coverDate=12%2F31%2F2001&_rdoc=1&_fmt=&_orig=search&_sort=d&_view=c&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=c94e7b36dcce67e8a0a2e5b858b67ffe
224. **The trajectories of arbitrary and anatomical condylar points during non-working side excursive and protrusive movements of the mandible.** (Abstract not available). Peck C, Murray GM, et.al. *Journal of Prosthetic Dentistry*, 82; 322-331, 1999b
225. **Three dimensional radiographic evaluation of condyle poles in closed-lock syndrome.**] A radiographic study of 39 cases of closed lock syndrome using three radiographic projections, finding approximately equal involvements of medial and lateral poles in long-standing cases.] Nadler GL. *The Angle Orthodontist Oct 1988, p.35-7368.* <http://www.angle.org/pdfserv/i0003-3219-058-04-0357.pdf>
226. **Velocity-dependent functional properties of superior head human lateral pterygoid muscle.** [Objective: The role of the superior head of the human lateral pterygoid muscle (SHLP) in the control of jaw function is unclear. An association between SHLP single motor unit (SMU) activity and isometric force suggests an important role for the SHLP in the fine control of horizontal force delivery to the jaw. Here we aimed to determine whether the jaw displacement where SHLP SMUs commenced firing (threshold) was associated with jaw velocity as would be expected for a role in the fine control of jaw movements. The hypothesis was that the threshold for

firing of SHLP SMUs increases with decrease in jaw velocity. Conclusion: SHLP SMUs showed velocity-dependent functional properties that suggests an important role for SHLP in the fine control of horizontal jaw movements.] Peck C, Whittle T, et.al.

http://iadr.confex.com/iadr/anz05/techprogram/abstract_71985.htm

227. **Vertical dimension and freeway space. A kinesiographic study.** [A statistical correlation is found between the S-N/mandibular plane angle and clinical freeway space, but there was no correlation after TENS stimulation. The S-N/MP angle did not prove to be a reliable predictor of freeway space.] Konchak PA, Thomas NR, et.al. *Angle Orthod.* 1987 Apr;57(2):145-54.
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=PubMed&cmd=Display&dopt=pubmed_pubmed&from_uid=3264667

Bioelectronic Instrumentation, EMG, TENS

228. **A comparison of electromyographic activity between anterior repositioning splint therapy and a centric relation splint.** [The purpose of this study was to compare the electromyographic activity of masticatory muscles (temporal and masseter) with the use of an anterior repositioning splint and a centric relation superior repositioning splint. Twenty-six consecutive patients, who referred with the chief complaint of temporomandibular pain and/or headache were selected from one of the author's practices. All these subjects were diagnosed as having internal derangement of the temporomandibular joint. Ten normal subjects were used as controls. Surface electromyographic recordings were taken of each subject prior to the beginning of clinical therapy for the patients. The results show significantly less masseter and temporal muscle activity with anterior repositioning splint therapy compared to the centric relation superior repositioning splint therapy.] Williamson EH, Navarro EZ, et.al. *Cranio.* 1993 Jul;11(3):178-83.
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=8242779&dopt=Abstract
229. **An electromyographic investigation of masticatory muscles symmetry in normo-occlusion subjects.** [The influence of occlusal conditions on stomatognathic function can be assessed by electromyography. Electromyographic activity of left and right temporal and masseter muscles was recorded in 30 young healthy adults with a normal occlusion during: (1) a 3-s maximum voluntary clench on cotton rolls positioned on the posterior teeth (standardization recording); (2) a 3-s maximum voluntary clench in intercuspal position; and (3) a 3-s alternate 'maximum' voluntary contraction and relaxation with a 1 Hz frequency. All potentials were standardized as a percentage of the maximum potential of test 1. Waveforms of paired muscles were compared by computing a percentage overlapping coefficient (ratio between each 50-ms overlapped areas and the total areas, up to 100% for symmetric muscles). Waveforms were also analysed for a laterodeviating effect on the mandible given by unbalanced muscular couples, and a torque coefficient (up to 100% for a significant laterodeviating couple on the mandible) was computed. In all subjects, both tests were performed with symmetric muscular patterns (more than 88%) and with negligible laterodeviating couples on the mandible (lower than 10%). The two coefficients allow an assessment of muscular asymmetry during static and dynamic clenching tests, and, together with the standardization of the potentials, could be a useful tool to detect functionally altered occlusal conditions, i.e.

conditions where an apparent good morphological situation is not related to a correct neuromuscular status.] Ferrario VF, Sforza C, et al. *Journal of Oral Rehabilitation*, Volume 27 Issue 1 Page 33 - January 2000. <http://www.blackwell-synergy.com/links/doi/10.1046/j.1365-2842.2000.00490.x>

230. **An EMG study on TMJ disorders.** [The Authors have described a clinical case involving a patient with a classical TMJ syndrome and a full range of typical symptoms, both dental and non-dental. The patient underwent a set of EMG tests before his occlusal plane was restored using a special material, immediately following reconstruction and, lastly, three months following the application of a prosthesis. The findings of these EMG tests have shown that the complex symptoms reported by the patient could be traced back to his occlusal plane. Once it was reconstructed, all the typical dental and non-dental symptoms of TMJ disorders subsided.] Balentino B, Aldi B, et.al. *Bull Group Int Rech Sci Stomatol Odontol.* 2002 Jan-Apr;44(1):14-8b. http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=12201008&dopt=Abstract
231. **Analysis of kinesiograph recordings and masticatory efficiency after treatment of non-reducing disk displacement of the temporomandibular joint.** [SUMMARY The purpose of this study was to clarify the kinesiographs of chewing movement and masticatory efficiency before and after treatment in patients with non-reducing disk displacement of the temporomandibular joint (TMJ). Twenty patients who were diagnosed with unilateral non-reducing disk displacement of the TMJ were treated with pumping of the joint with injection of sodium hyaluronate. Chewing movement patterns in these patients were evaluated, using mandibular kinesiography (MKG) at their initial visit and at mean 19-month follow-up and the results were compared. Masticatory efficiency was also measured. As controls, 23 volunteers without TMJ dysfunction were employed. Far from the results of normal volunteers, chewing movement patterns of the patients on MKG did not show deviation to the chewing side in the TMJ-unaaffected-side chewing in the horizontal plane. However, such patterns of the patients became similar to those of normal volunteers after treatment. Masticatory efficiency of the patients improved after treatment, though it was impaired at initial visit. The MKG and masticatory efficiency test appeared to be a useful method of comparing masticatory function before and after treatment in patients with non-reducing disk displacement of the TMJ.] Sato S, Nasu F, et.al. *Journal of Oral Rehabilitation*, Volume 30 Issue 7 Page 708 - July 2003. <http://www.blackwell-synergy.com/links/doi/10.1046/j.1365-2842.2003.01122.x>
232. **Analysis of maximal electromyographic activity of the masseter and anterior temporalis muscles in Myocentric and Habitual Centric in Temporomandibular Joint and Musculoskeletal Dysfunction.** [A computer review of maximal bite integrated EMG values for 46 consecutive patients referred to a clinical practice for treatment of TMJ/MSD was analyzed for data correlation. The 46 patients included 37 females and 9 males. The average ages of the patients were 42 and 46 years, respectively, for females and males. The patients all displayed 3 or more of the standardized symptoms in the Kinnie-Funt TMJ profile [23]. Only those patients with EMG/CMS profiles indicating a positive rationale for orthosis therapy were selected. This meant that the patients had either an excess of 2.0 mm of freeway space, or had an anterior/posterior discrepancy between neuromuscular and habitual trajectory of closure that precluded selective

grinding of the teeth. (1) Analysis of 46 temporomandibular joint/musculoskeletal dysfunction patients showed masseter EMG activity significantly lower than anterior temporalis EMG activity during maximal bite to habitual occlusion. Since the masseter muscle is the primary force muscle, while the anterior temporalis is the primary posturing muscle, this appears to be a consistent finding in temporomandibular joint/musculoskeletal dysfunction patients with nonoptimal occlusion. (2) The combined integrated EMG in the symptomatic temporomandibular joint/musculoskeletal dysfunction patient is significantly diminished when the patient maximally occludes in the habitual occlusion as opposed to the myocentric position. Restoration of the occlusion to a neuromuscular myocentric resulted in a 72.2% improvement in motor unit recruitment. The marked increase in motor unit recruitment and the significant reduction in the number of symptoms as reported by the patients in this study, suggests that the myocentric position is a more efficacious functional position for motor muscle recruitment than the existing habitual occlusion in the musculoskeletal dysfunction patient. (3) The study supports previous studies showing reduced EMG activity during maximal bite in temporomandibular joint and musculoskeletal dysfunction patients. Therefore, integrated EMG of maximal function appears to be a reliable, quantitative modality to identify functional disorders of the masticatory system. (4) Integrated EMG of maximal bite effort can be used as a quantitative means to monitor patient progress. There appears to be a significant correlation by the increase in maximal EMG activity of the masseter and anterior temporalis, and the reduction in the number of patient-reported symptoms. (5) Providing a neuromuscular myocentric occlusal position for the temporomandibular joint/musculoskeletal dysfunction patients allowed markedly increased motor unit recruitment during maximal bite. The increase in function correspondingly resulted in concomitant reduction in the patient symptom index. (6) Treatment to the myocentric position resulted in significantly more symmetrical recruitment of masseter and anterior temporalis motor units. The temporomandibular joint/musculoskeletal dysfunction patient appears to have a greater asymmetry of muscle function during maximal bite to the habitual occlusal position. Restoration of the temporomandibular joint/musculoskeletal patient to a neuromuscular myocentric position resulted in significant improvement of muscle recruitment and symmetry. To conclude, this study of 46 consecutive clinical dysfunction patients confirmed the findings of Moller, Eriksson, Sheikholeslam, Ruse, Molin, Pruim, Jarabak, Kydd, Bigland, Lous, Prayer-Galletti, and Pantaleo and others in support of maximal bite EMG analysis for diagnosis and temporomandibular joint/musculoskeletal dysfunction. The restoration of the dysfunctional patient to a neuromuscular myocentric occlusion results in significantly increased function and synergy of the anterior temporalis and masseter muscles.] Jankelson R. *Front. Oral Physiol., Karger, Basal, Vol 7, pp 83-97.*

<http://www.myotronics.com/learning.cfm?id=2>

233. **Analysis of post-treatment electromyographs in patients with non-reducing disc displacement of the temporomandibular joint.** [SUMMARY The purpose of this study was to clarify the electromyographic property of chewing movement before and after treatment in patients with non-reducing disc displacement of the temporomandibular joint (TMJ). Twenty patients who were diagnosed with unilateral non-reducing disc displacement of the TMJ were treated by pumping and injection of sodium hyaluronate into the joint. Chewing movement in these patients was evaluated by electromyography

(EMG) at the initial visit and at mean 19-month follow-up and the results were compared. Chewing movement in 23 normal controls were also examined. Duration of contraction, cycle time and integrated value at the initial visit which were different from those in the controls without TMJ dysfunction tended to be at the control level mean 19 months after treatment of pumping and injection of sodium hyaluronate into the joint in patients with non-reducing disc displacement of the TMJ. Electromyography appeared to be a method of documenting the chewing movement which was impaired at initial visit improved after treatment in patients with non-reducing disc displacement of the TMJ.] Sato S, Nasu F, et.al. *Journal of Oral Rehabilitation*, Volume 29 Issue 11 Page 1126 - November 2002. <http://www.blackwell-synergy.com/links/doi/10.1046/j.1365-2842.2002.00996.x>

234. **Applying the Neuromuscular Principles in TMD and Orthodontics.** [Neuromuscular dentistry goes beyond traditional dentistry in that it includes consideration of the “physiologic posture” of the mandible. Determining habitual posture vs. physiologic posture requires evaluation of the muscles, joints and nerves involved in mandibular posture and function in addition to the teeth. Today’s computerized measuring and recording instrumentation, together with an understanding of neuromuscular principles, give dentists the ability to be true “physicians of the mouth.” Muscles cannot be evaluated by radiographic analysis alone. With bioinstrumentation it is possible to determine a proper resting jaw position that positively affects the facial, head, and neck muscles and the teeth as well as the joints. A case study is presented in great detail describing how a severe TMD case had failed to respond to long and frustrating traditional dental therapy, but was then resolved through the application of neuromuscular principles and evaluation. Following provisional treatment that proved a symptom-free mandibular position, the case was permanently finished to that position with orthodontic treatment.] Chan CA. *J. Am. Orthodontic Soc.*, pp20-29, Spring 2005. <http://www.myotronics.com/learning.cfm?id=2>
235. **Bilateral experimental muscle pain changes electromyographic activity of human jaw-closing muscles during mastication.** [The effects of bilateral experimental muscle pain on human masticatory patterns were studied. Jaw movements and electromyographic (EMG) recordings of the jaw-closing muscles were divided into multiple single masticatory cycles and analyzed on a cycle-by-cycle basis. In ten men simultaneous bilateral injections of hypertonic saline (5%) into the masseter muscles caused strong pain (mean-SE: 7.5-0.4 on a 0-10 scale), significantly reduced EMG activity of jaw-closing muscles in the agonist phase, and significantly increased EMG activity in the antagonist phase. Nine of the subjects reported a sensation of less intense mastication during pain. Injections of isotonic saline (0.9%) did not cause pain or significant changes in masticatory patterns. The influence of higher brain centers on conscious human mastication can not be discarded but the observed phase-dependent modulation could be controlled by local neural circuits and/or a central pattern generator in the brain stem which are capable of integrating bilateral nociceptive afferent activity.] Svensson P, Houe L, et.al. *Experimental Brain Research Volume 116, Number 1 / August, 1997.* <http://www.springerlink.com/content/duewevmq298f2a8h/>
236. **Effect of conventional TENS on pain and electromyographic activity of masticatory muscles in TMD patients.** [Temporomandibular disorders (TMD) are characterized by several signs and symptoms, such as pain and changes in the electrical activity of masticatory muscles. Considering that transcutaneous electrical nerve

stimulation (TENS) is a resource indicated to promote analgesia, the objective of this study was to evaluate the effect of TENS on pain and electromyographic (EMG) activity of the jaw elevator muscles in TMD patients. This study evaluated 35 female volunteers: 19 TMD patients (mean age = 23.04 ± 3.5) and 16 normal subjects (mean age = 23.3 ± 3.0). Transcutaneous electrical nerve stimulation (conventional mode, 150 Hz) was applied once to each group for 45 minutes. Surface electromyography (gain of 100 times and 1 kHz sampling frequency) and the visual analogue scale (VAS) were applied before and immediately after TENS application. Both VAS data and root mean square (RMS) values were analyzed using Student's *t*-test. The TMD group, compared to the control group, showed higher EMG activity of the jaw elevator muscles at rest. No difference was observed between the groups regarding maximum voluntary clenching (MVC). In TMD patients, TENS reduced both pain and EMG activity of the anterior portion of the temporal muscle, increasing the activity of the masseter muscles during MVC. It is possible to conclude that a single TENS application is effective in pain reduction. However, it does not act homogeneously on the features of the electric activity of the muscles evaluated.] Rodrigues D, Siriani AO. et.al. *Braz. oral res. vol.18 no.4 São Paulo Oct./Dec. 2004.* http://www.scielo.br/scielo.php?pid=S1806-83242004000400003&script=sci_arttext

237. **Electromyographic activity of the human lateral pterygoid muscle during contralateral and protrusive jaw movements.** [Understanding of the normal function of the lateral pterygoid muscle is limited. The principal aim here was to determine whether there is a progressive increase in lateral pterygoid activity as the mandibular condyle moves downwards and forwards as would be expected if the muscle is concerned with the precise horizontal positioning of the mandible. In eight humans, recordings were made of the activity of the superior (SHLP) and inferior (IHLP) heads of the lateral pterygoid and the masseter, anterior temporal, posterior temporal and digastric muscles, together with the movement of the palpated lateral condylar pole (JAWS-3D tracking system) during trials of a contralateral and a protrusive jaw movement. Recording sites in SHLP and, in one participant, IHLP were verified by computed tomography. In each participant there was a progressive increase in the rectified and smoothed SHLP and IHLP activity in association with condylar movement during the contralateral and protrusive jaw movement. Further, irregularities in condylar movement, which reflected variations in the rate at which the jaw was moved, were correlated in time with prominent bursts of SHLP and IHLP activity. In all participants there was a consistently high correlation coefficient between the rectified and smoothed SHLP and IHLP activity and condylar displacement during the contralateral or protrusive jaw movements. ... These observations support the notion that the lateral pterygoid provides the principal driving force for moving the jaw forwards or laterally in protrusive or lateral excursive condylar movements. Further, the data suggest that the muscle plays a part in the fine control of jaw movements.] Murray GM, Organos T, et.al. *Arch Oral Biol. 1999 Mar;44(3):269-85.* http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=10217518&dopt=Abstract

238. **Electromyographic activity of the masticatory and cervical muscles during resisted jaw opening movement.** [One of the relaxation techniques that have been used by physical therapists when treating patients with temporomandibular disorders, is the agonist contract-antagonist relax technique (AC). When the AC technique is applied, a

submaximal resistance to the jaw opening movement is necessary to cause relaxation of the masticatory muscles. No information about the effect of this technique on masticatory or cervical muscles has been found in the literature. Thus, the aim of this study was to evaluate the electromyographic activity of the masseter and anterior temporalis and the upper trapezius and splenius capitis during resisted jaw opening movement. A convenience sample of 30 students was used. Electromyography activity of the superficial masseter, anterior temporalis, upper trapezius and splenius capitis was registered before, during and after the application of this resistive movement to jaw opening. A two-way anova with repeated measures analysis was used to analyse data. The level of significance was at $\alpha = 0.05$. The EMG activity of both the masticatory muscles and the cervical muscles increased during and after the application of resisted jaw opening ($P < 0.05$). Based on the results obtained from this study, the behaviour of all muscles analysed (masseter, anterior temporalis, splenius capitis and upper trapezius) was similar. All muscles increased their activity when the resistance to the jaw opening movement was applied. Complex muscular interactions of the supra- and infrahyoid muscles (jaw openers), masticatory muscles, and cervical muscles may exist to stabilize the craniomandibular system during resisted jaw opening.] Armijo-Olivo S, Magee DJ. *J Oral Rehabil.* 2007 Mar;34(3):184-94.

http://www.ncbi.nlm.nih.gov/sites/entrez?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=17302946

239. **Electromyographic and kinesiographic study in patients with nonreducing disk displacement of the temporomandibular joint.** [OBJECTIVE. The purpose of this study was to clarify electromyographic and mandibular kinesiographic properties of the chewing movements in patients with unilaterally painful nonreducing disk displacement of the temporomandibular joint. STUDY DESIGN. Chewing movement in 50 female patients was evaluated by electromyograph and mandibular kinesiograph, and the results were compared with those in 31 normal controls. RESULTS. In the analysis by electromyograph, some differences between patients and controls were found. In the analysis by mandibular kinesiograph, chewing movement showed deviation to the chewing side in the TMJ-affected-side chewing but did not show deviation in the TMJ- unaffected-side chewing in the horizontal plane. The maximal anteroposterior width between opening and closing paths in the sagittal plane was smaller in the experimental subjects. CONCLUSION. These differences between patients and controls may be helpful to diagnosis for painful nonreducing disk displacement of the temporomandibular joint.] Sato S, Goto S, et. Al. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 1996 May;81(5):516-21.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=8734695&dopt=Abstract

240. **Electromyographic evaluation of masseter and anterior temporalis muscles in patients with temporomandibular disorders following interocclusal appliance treatment.** [The purpose of this study is to evaluate the interocclusal appliance efficiency in patients with temporomandibular disorder (TMD), by using computerized electromyographic (EMG) evaluation in the rest position of the mandible. Twenty-two patients (male and female) with TMD symptoms, between 18 and 53 years of age, were examined. EMG evaluations were performed before the treatment and during the 90th, 120th and 150th day of using the interocclusal appliance therapy. In the 90th and 120th

day, inserting canine guidance and group function disclusion, respectively, changed interocclusal appliance. The results showed that group function disclusion caused shorter EMG activity in the mandible rest position for the anterior temporalis muscle.]

Landulpho AB, eSilva WAB, et.al. *Journal of Oral Rehabilitation Volume 31 Issue 2 Page 95 - February 2004* <http://www.blackwell-synergy.com/doi/abs/10.1046/j.0305-182X.2003.01204.x?journalCode=jor>

241. **Electromyographic Evidence of Reduced Muscle Activity When ULF-TENS Is Applied to the Vth and VIIth Cranial Nerves.** [The object of this study was to determine if the resting muscle activity of TMD patients with measured hyperactivity could be reduced by the application of ULF-TENS. Twenty-nine patients with resting muscle hyperactivity and ten without resting muscle hyperactivity were selected from a series of 124 consecutively diagnosed TMD patients. Electromyographic records were taken bilaterally (with the mandible at rest) from the superficial masseter, anterior temporalis, anterior digastric, and posterior temporalis muscles before and after the application of ULF-TENS. The EMG data were averaged. For the 85 muscles that were found initially to exceed the usual cutoff of 2.0 microvolts, means and standard deviations were calculated. ... We conclude that ULF-TENS has an activity-reducing effect on the resting EMG levels of both hyperactive and relaxed muscles. It also appears that while the > 2.0 microvolt cutoff is useful for identifying patients that are hyperactive at rest, it does not identify complete relaxation of masticatory muscles.] Kamyszek G, Ketcham R, et al. *Cranio. 2001 Jul;19(3):162-8.*
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=11482827&dopt=Abstract
242. **Electromyography during chewing movement in patients with anterior disc displacement of the temporomandibular joint.** [The purpose of this study was to investigate the value of electromyography in patients with anterior disc displacement (ADD) of the temporomandibular joint (TMJ). Electromyography (EMG) during chewing movement was evaluated in 48 women with unilateral ADD of the TMJ (21 patients with ADD with reduction and 27 with ADD without reduction). As a control group, 31 women without TMJ dysfunction were evaluated. The duration of contraction, latency, cycle time, and integrated value on the EMG were measured in the patients and controls. There were significant differences between the patients and controls in the duration of contraction, cycle time, and integrated value. However, there were no differences in any measurements between the two subgroup patients. EMG appeared to be a method of documenting that masticatory function was impaired in patients with ADD.] Sato S, Ohta M, et.al. *Int J Oral Maxillofac Surg. 1998 Aug;27(4):274-7.*
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=9698173&dopt=Abstract
243. **Electromyography tension and frequency spectrum analysis at rest of some masticatory muscles, before and after TENS.** [On a population of 52 subjects surface electromyographic recordings were performed of 13.5 sec. of duration before and after ULF (Ultra Low Frequency)-TENS relaxing procedure, while they were holding their mandible at rest. For each recording the average of tension (IEMG) and the median of frequency was calculated. To compute the median of frequencies a Fast Fourier Transformer (FFT) was applied. In order to compare modifications induced by the 45' ULF-TENS relaxing procedure, so that the influence of ULF-TENS could be well

isolated from any influence due simply to the time passing between one recording and another, three recordings were performed at different times: the first at time 0', the second at time 0' + 20', and only the third after TENS, time 0' + 20' + 45'. The results of the study permit us to draw the following conclusions: 1. it is confirmed that ULF-TENS can decrease muscle IEMG; 2. the study of the IEMG and frequency of the electromyographic signal at rest can be carried out starting from a window whose size and position in the 13.5 sec. of recording is arbitrary; 3. there is no connection between IEMG and frequency: in other words, at rest, there is no necessary correspondence between high or low IEMG and a high or low frequency values; 4. on application of the neurodiagnostic test of ULF-TENS, the IEMG of the electromyographic signal decreases, while the frequency of the signal remains unchanged. These last two observations permit us to hypothesize that the IEMG and the frequency of the electromyographic signal reflect some different and independent characteristics of the electrical activity of the muscle at rest.] Bazzotti L. *Electromyogr Clin Neurophysiol.* 1997 Sep;37(6):365-78. http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=9313998&dopt=Abstract

244. **Electromyography tension and frequency spectrum analysis at rest of some masticatory muscles, before and after TENS.** [On a population of 52 subjects surface electromyographic recordings were performed of 13.5 sec. of duration before and after ULF (Ultra Low Frequency)-TENS relaxing procedure, while they were holding their mandible at rest. For each recording the average of tension (IEMG) and the median of frequency was calculated. To compute the median of frequencies a Fast Fourier Transformer (FFT) was applied. In order to compare modifications induced by the 45' ULF-TENS relaxing procedure, so that the influence of ULF-TENS could be well isolated from any influence due simply to the time passing between one recording and another, three recordings were performed at different times: the first at time 0', the second at time 0' + 20', and only the third after TENS, time 0' + 20' + 45'. The results of the study permit us to draw the following conclusions: 1. it is confirmed that ULF-TENS can decrease muscle IEMG; 2. the study of the IEMG and frequency of the electromyographic signal at rest can be carried out starting from a window whose size and position in the 13.5 sec. of recording is arbitrary; 3. there is no connection between IEMG and frequency: in other words, at rest, there is no necessary correspondence between high or low IEMG and a high or low frequency values; 4. on application of the neurodiagnostic test of ULF-TENS, the IEMG of the electromyographic signal decreases, while the frequency of the signal remains unchanged. These last two observations permit us to hypothesize that the IEMG and the frequency of the electromyographic signal reflect some different and independent characteristics of the electrical activity of the muscle at rest.] Bazzotti L. *Electromyogr Clin Neurophysiol.* 1997 Sep;37(6):365-78. http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=9313998&dopt=Abstract
245. **Electrosonographic characteristics of sounds from temporomandibular joint disc replacement.** [The purpose of this study was to investigate the waveform and electrosonographic characteristics of sounds emanating from internal derangement of the temporomandibular joint (TMJ). TMJ sounds were recorded from 10 joints of normal people (NP), 10 joints from patients with anterior disc displacement with reduction (DDR) and 20 joints from patients with anterior disc displacement without reduction

(DDNR). The sounds were analyzed through fast Fourier transfer methods to observe their waveforms and electrosonographic characteristics. The observations were then used in differentially diagnosing internal derangement. Wave pattern and electrosonography (ESG) differed among the NP, DDR and DDNR groups. There was very little difference in frequency between the sounds from DDR and DDNR, but the amplitude of the DDR sounds was higher than those of DDNR and NP.] Deng M, Long X, et.al. *Int J Oral Maxillofac Surg*. 2006 May;35(5):456-60.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=16427252&dopt=Abstract

246. **Fatigue and pain in human jaw muscles during a sustained, low-intensity clenching task.** [Fatigue, pain and changes in the electromyographic (EMG) activity of the jaw-closing muscles are well documented during short, high-intensity tooth-clenching tasks but less so during sustained, low-intensity tasks. In this study, 11 healthy men clenched on a bite-force meter for 60 min at 10% of the maximal voluntary contraction (MVC) and scored the intensity of fatigue and pain on separate 10 cm visual analogue scales (VAS). Surface EMG activity from the masseter and anterior temporalis muscles was recorded in 10 s epochs every 5 min throughout the task. Pressure-pain thresholds (PPTs) in the jaw-closing muscles, unassisted maximum jaw opening and MVC were determined before and after the task. All participants reported an increasing sensation of fatigue in the jaw-closing muscles during the task... The changes in EMG activity were more strongly correlated with the sensation of fatigue than pain. These findings demonstrate that a sustained, low-intensity clenching task can induce subjective and electrophysiological indications of fatigue.] Svensson P, Burgaard A, et.al. *Arch of Oral biology*, Vol 46, Issue 8, P 773-777.

<http://www.aobjournal.com/article/PIIS0003996901000280/abstract>

247. **Laterotrusive occlusal schemes and jaw posture tasks effects on supra- and infrahyoid EMG activity in the lateral decubitus position.** [The purpose of this study was to determine the effect of canine guidance and group function on supra- and infrahyoid EMG activity in the lateral decubitus position at different jaw posture tasks. The sample included 40 healthy subjects with natural dentition and bilateral molar support, 20 with bilateral canine guidance and 20 with bilateral group function. An inclusion criterion was that subjects had to be free of signs and symptoms of any dysfunction of the masticatory system. Bipolar surface electrodes were located on the left supra- and infrahyoid muscles for EMG recordings. In the lateral decubitus position, EMG activity was recorded in subjects with canine guidance or group function, during the following jaw posture tasks: A. maximal clenching in the edge-to edge lateral contact position; B. grinding from intercuspal position to edge-to-edge lateral contact position, and C. grinding from edge-to-edge lateral contact position to intercuspal position. Supra- and infrahyoid EMG activity was not significantly different with canine guidance or group function (mixed model with unstructured covariance matrix). Overall comparison of suprahyoid or infrahyoid EMG activity among the three jaw posture tasks studied showed a significantly higher activity during jaw posture task A (clenching) than jaw posture tasks B and C (grinding). Suprahyoid EMG activity was significantly higher during jaw posture task C than B, whereas infrahyoid EMG activity did not present a significant difference between jaw posture tasks C and B. These EMG patterns observed could be of clinical importance in the presence of parafunctional habits, i.e., clenching

and/or grinding. The neurophysiological mechanisms involved are discussed.] Miralles R, Gallardo F et al. *Cranio*. 2007 Apr;25(2):106-13.

<http://www.cranio.com/subscribe/index.asp>

248. **Muscle relaxation by transcutaneous electric nerve stimulation (TENS) in bruxism. An electromyographic study.** Article in German. [In recent years transcutaneous electrical neuromuscular stimulation (TENS) has become increasingly more common in the treatment of functional diseases of the masticatory muscles and currently the practitioner can choose among a variety of stimulators. In an electromyographic study of 17 adults suffering from nocturnal bruxism and of a control group consisting of 18 adults without any functional disturbances of the masticatory muscles, the effect of this kind of neuromuscular stimulation on the temporal and masseter muscle was examined. The myoelectric signals were registered before and after TENS treatment in 3 different positions of the mandible. Each person was treated 3 times with both the Myo-Monitor (Myo-Tronics, Seattle) and the TNS SM2 MF stimulator (schwa-medico, Giessen). The different effects of continuous low frequency and intermittent high frequency muscular stimulation were studied simultaneously. Muscular activity was determined by computer aided integration of the electromyographically measured raw signals. A fourier analysis of the power spectrum yielded information on the frequency behavior of the studied muscles resulting from the TENS treatment. A statistical analysis of the results led to the following significant conclusions: 1. TENS treatment decreased the values of the registered integrated signals on all test persons, however, the treatment increased the median frequency and the mean power frequency (MPF). Since this effect is contrary to muscle fatigue, these electromyographic results can be interpreted as providing objective proof of a relaxation in the treated muscles. 2. The electromyographic changes after TENS treatment were similar when using either the Myo-Monitor or the TNS SM2 MF stimulator. In addition, the 2 different types of stimulation (high or low frequency) showed the same effects. 3. Compared to the persons in the control group, there was no significant increased muscular activity in patients with nocturnal bruxism. Following TENS treatment both groups showed the same alterations in the electromyograms. The results of the study provide further evidence that TENS treatment is an adequate supportive procedure in the treatment of nocturnal bruxism.] Frucht S, Jonas I, et.al. *Fortschr Kieferorthop*. 1995 Sep;56(5):245-53.
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=7557797&dopt=Abstract

249. **Natural course of non-reducing disc displacement of the temporomandibular joint: changes in electromyographic activity during chewing movement.** [SUMMARY The purpose of this study is to examine whether electromyographic activity (EMG) during chewing movement changes towards the control level spontaneously in the subsequent course after diagnosis in patients with non-reducing disc displacement of the temporomandibular joint (TMJ) who do not receive any treatment. In 15 such patients, EMG data were examined at initial visit and at a mean follow-up of 21.7 months. As a control, 23 persons who had no TMJ dysfunction were studied. The results of EMG were compared among patients at initial visit, those at follow-up, and controls. The patients' clinical signs and symptoms were alleviated during the follow-up period. Duration of muscle contraction, cycle time and integrated EMG value (IEMG) at initial visit in patients were significantly different from those in the controls. In patients, IEMG for

chewing-side masseter during chewing in the TMJ-affected side was greater at follow-up ($14.2 \pm 8.01 \mu\text{V s}$) than that at initial visit ($10.5 \pm 3.69 \mu\text{V s}$) ($P < 0.05$). In patients, duration of muscle contraction or cycle time at follow-up was not different from that at initial visit. Patients with non-reducing disc displacement of the TMJ showed spontaneous increasing of IEMG without any treatment in the subsequent course after diagnosis, coupled with improvement of clinical signs and symptoms. Duration of muscle contraction or cycle time did not change towards the control level. The results presented are useful as control data to understand the true effect of a particular treatment for patients with non-reducing disc displacement of the TMJ.] Sato S, Kawamura H. *Journal of Oral Rehabilitation* Volume 32 Issue 3 Page 159 - March 2005. <http://www.blackwell-synergy.com/links/doi/10.1111/j.1365-2842.2004.01431.x/abs/>

250. **Ocular correction effects on EMG activity of stomatognathic muscles in children with functional mandibular lateral- deviation: a case control study.** [This study was conducted in order to determine the ocular correction effects on electromyography activity of anterior temporal, masseter, sternocleidomastoid and anterior digastric muscles in children with functional mandibular lateral-deviation. CONCLUSION: The significant worsening in EMG activity, mainly observed with conventional corrective lenses, could have an important consequence in clinical diagnostic and therapeutic behaviour because anterior temporal muscles are important in postural position of the mandible. Instead EMG corrective lenses could improve tonus and balance of stomatognathic muscles and, therefore, support the functionality of orthodontic treatment. Moreover, the data suggest an interesting new tool in order to reach an interdisciplinary approach to complex growth disorders represented by functional lateral deviation of mandible and ocular-extrinsic muscular tone disorders.] Monaco A, Cattaneo R, et.al. *Eur J Paediatr Dent.* 2006 Jun;7(2):81-8. http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=pubmed&list_uids=16842029&cmd=Retrieve&indexed=google
251. **Parameters of an Optimal Physiological State of the Masticatory System: The Results of a Survey of Practitioners Using Computerized Measurement Devices.** [While bioelectronic instruments have been available for nearly 30 years to assist dentists in day-to-day evaluations of patients' masticatory systems, little guidance has been published to support physiological norms or ideals. An electronic questionnaire was developed and administered to an international group of dentists familiar with the use of bioelectronic instrumentation. Respondents were asked to provide feedback on the norms or ideal parameters of jaw movement, masticatory muscle function with electromyography, and joint sounds through electrosonography that they use in guiding evaluation and treatment of patients with temporomandibular disorders, neuromuscular occlusion, and orthodontics. Surveys were collated to determine areas of consensus. Out of 150 surveys, 55 responses were received from dentists representing nine different countries. Sixty percent of the respondents reported treating more than 150 cases in the past five years using bioelectronic testing. While experience ranged from 2-30 years with different types of devices, average experience was longer with mandibular/jaw tracking (mean 15.3 years) and electromyography (mean 14.1 years) than with electrosonography (mean 7.0 years). Parameters proposed as norms or ideals for electromyographic rest and clench values, and mandibular tracking (velocity, freeway space, and trajectory to closure) were very consistent. Although a smaller number of respondents reported

utilization of electrosonography, their criteria for data significance and tissue-type genesis of joint sounds were consistent. While the intra-patient variability may limit the diagnostic use of bioelectronic instruments, the current study demonstrates that through decades of experience, dentists have independently arrived at very consistent definitions of an ideal physiology that can be used to guide treatment.] Cooper BC. *Cranio*. 2004 Jul;22(3):220-33.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=15293778&dopt=Abstract

252. **Sound analysis of temporomandibular joint internal derangements with phonographic recordings.** [Temporomandibular joint (TMJ) sound recordings could be analyzed to assess the state of TMJ internal derangements. PURPOSE: The aim of the study was to assess the value of sound analysis in the diagnosis of the type of the TMJ internal derangements. ... CONCLUSION: Within the limitations of this study, the results suggest that TMJ sound analysis on mandibular excursions was indicative for diagnosis and establishment of severity of TMJ internal derangements. Clicking and crepitation may be looked on as signs of abnormal joint disorder, clicking indicating anterior disc displacement with reduction, and crepitation, indicating progression from anterior disc displacement without reduction to osteodegenerative arthritis.] Oqutcent-Toller M. *J Prosthet Dent*. 2003 Mar;89(3):311-8.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=12644809&dopt=Abstract

253. **Surface electromyographic response of the neck muscles to maximal voluntary clenching of the teeth.** [The purpose of this study was to evaluate the activity of digastric, sternocleidomastoid, upper trapezius, lower trapezius and cervical muscles in response to maximum voluntary clenching (MVC) of the teeth. Twenty healthy subjects aged 24-31 years were divided into two groups of 10: a resting group and a clenching group. The resting group simply maintained the mandible at rest with teeth apart for two 1-min periods, whereas the clenching group underwent an initial resting period followed after 1-min by a clenching period during which they were required to perform MVC. The electromyography (EMG) responses of each muscle were recorded during all periods, and means and standard deviations of the root mean square EMG were calculated. Within-group and between-group comparisons of EMG activity were made using, respectively, the Sign two-tailed test for two related samples and the Kolmogorov-Smirnov two-tailed test for two independent samples (significance level 0.05). Data indicated a significant increase of EMG activity of the anterior neck muscles (digastric and sternocleidomastoid) during MVC as compared with EMG recorded during resting periods. If confirmed by further research, our findings suggesting an involvement of anterior neck muscles during isometric contraction of the jaw elevator muscles may have clinical implications.]

Ciuffolo F, Manzoli L, et.al. *J Oral Rehabil*. 2005 Feb;32(2):79-84

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=15641971&dopt=Abstract

254. **TENS: its short-term and long-term effects on the masticatory muscles.** [In an electromyographic study on subjects with no functional disturbances of the masticatory muscles, the duration of the post-therapeutic effects of transcutaneous electrical nerve stimulation (= TENS) on the superficial masseter and anterior temporal muscle was analyzed. The myoelectric signals were registered from 20 healthy volunteers in 3

different mandibular positions. The recordings were performed before a 20-minute TENS application with the J-4 Myomonitor and continued with a sequence of follow-up registrations with increasing interval to the initial stimulation. The EMG signals underwent computer-aided analysis and were evaluated by determining the integrated values as a parameter of muscle activity, and after Fourier transformation by 7 describing parameters of the power spectrum (e.g. mean power frequency = MPF). A detailed analysis of variance of all data was used to investigate significant changes of the parameters during the observation period. Muscular response to TENS includes a decrease in muscular activity (= reduction in integrated EMG signals) and a shift in the power spectrum to higher frequencies (increase in MPF). These changes were statistically highly significant for both analyzed muscles and for all different mandibular exercises. As these reactions to TENS are contrary to muscle fatigue, the results can be interpreted as indicating that this type of therapy stimulates a change in the biochemical and physiological muscular conditions, which leads to muscle relaxation. Electromyographically, the post-therapeutic effect lasted for 2 hours in case of normal masticatory muscle activity but for more than 7 hours in case of low muscular loading. The alterations of the integrated EMG values were more persistent than those of the parameters of the power spectrum.] Eble OS, Jonas IE, Kappert HF. *Orofac Orthop.* 2000;61(2):100-11.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=10783562&dopt=Abstract

255. **The effect of four jaw relations on electromyographic activity in human masticatory muscles.** [Significant differences were found in the electromyographic (EMG) activation between the masseter and temporalis muscles for the leaf gauge (LG), manually manipulated (CR) and neuromuscular (NM) bite positions during maximal static clench. The LG position consistently demonstrated the lowest EMG activity, while the NM position displayed the highest degree of muscle activity. Similarly, the ratio of the masseter/temporalis EMG activity during maximal clench was lower for the LG and CR positions and highest for the NM position. These data indicate that the NM position produced the greatest total muscle recruitment, with more masseter involvement during maximal clench, and enabled the subjects to generate greater clenching forces in the NM position as compared to the LG and CR positions.] Hickman DM, Cramer R, Stauber WT. *Arch Oral Biol.* 1993 Mar;38(3):261-4.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=8489420&dopt=Citation

256. **The Immediate Effect of Changing Mandibular Position on the EMG Activity of the Masseter, Temporalis, Sternocleidomastoid, and Trapezius Muscle.** [This study investigated the immediate effect of changing mandibular position on the electromyographic (EMG) activity of the masseter (MS), temporalis (TM), sternocleidomastoid (SCM) and trapezius (TR) muscles. Thirty-three (33) asymptomatic subjects (16 males and 17 females), ages 23 to 52 were selected. Surface EMG recordings were obtained for all muscles bilaterally with the mandible in a relaxed open position (relaxed) and during maximal voluntary clenching (fullbite) for the following: a non-repositioning appliance (NONREPOS) and repositioning appliance (REPOS). REPOS significantly reduced EMG activity of all muscles bilaterally during fullbite. During relaxation, reduction in EMG activity was only found for TR bilaterally. NONREPOS

decreased the EMG activity bilaterally for TM and TR and unilaterally (left) for MS and SCM during fullbite. During relaxation, NONREPOS decreased muscle activity bilaterally for TR and SCM. A unilateral reduction was found for TM (right). These findings suggest that immediate alterations in mandibular position affect the cranio-cervical system. Both mandibular positions tested lowered the EMG activity of masticatory and cervical muscles in the relaxed and fullbite positions. The trapezius muscle was the most responsive to alterations in mandibular position.] Ceneviz C, Mehta NR, et al. *Cranio*. 2006 Oct;24(4):237-44.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=17086852

257. **The Myo-monitor: Its use and abuse (I).** [The Myo-monitor transcutaneously stimulates the motor branches of the Vth and VIth cranial nerves, relaxes the associated musculature, and then records an occlusal position that is compatible with a continued state of relaxation. Additional techniques have been developed for taking denture impressions (or relining old dentures) functional occlusal diagnosis, occlusal adjustment, and treatment of TMJ and MPD syndrome.] Jankelson, B. Quintessence International No.2:Report 1601, pp47-51. <http://www.myotronics.com/learning.cfm?id=2>
258. **The role of bioelectronic instrumentation in the documentation and management of temporomandibular disorders.** [Temporomandibular disorders (TMDs) can affect the form and function of the temporomandibular joint, masticatory muscles, and dental apparatus. Electronic measurement of mandibular movement and masticatory muscle function provides objective data that are defined by commonly accepted parameters in patients with TMDs; these data can then be used to design and monitor therapy and enhance treatment therapy. In this study, data on 3681 patients with TMD are presented, including electronic test data on 1182 treated patients with TMDs. Electronic jaw tracking was used to record mandibular movement and to compare the presenting and therapeutic dental occlusal positions. Electromyography was used to analyze the resting status of masticatory muscles and occlusal function at presentation and after therapeutic intervention. Transcutaneous electrical nerve stimulation therapy relaxed masticatory muscles and aided in the determination of a therapeutic occlusal position. The data show a positive correlation between the clinical symptoms of TMD and the presenting occlusion, accompanied by muscle activity. A strong positive correlation also appears to exist between a therapeutic change in the dental occlusion to a neuromuscularly healthy position with use of a precision orthotic appliance and the significant relief of symptoms within 1 month and at 3 months.] Cooper BC. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 1997 Jan;83(1):91-100. http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=9007931&dopt=Abstract ; <http://www.tmjtm.com/research/article02/#101>
259. **Transcutaneous electrical nerve stimulation (TENS): its short-term and long-term effects on the masticatory muscles.** [In an electromyographic study on subjects with no functional disturbances of the masticatory muscles, the duration of the post-therapeutic effects of transcutaneous electrical nerve stimulation (= TENS) on the superficial masseter and anterior temporal muscle was analyzed. The myoelectric signals were registered from 20 healthy volunteers in 3 different mandibular positions. The recordings were performed before a 20-minute TENS application with the J-4 Myomonitor and continued with a sequence of follow-up registrations with increasing

interval to the initial stimulation. The EMG signals underwent computer-aided analysis and were evaluated by determining the integrated values as a parameter of muscle activity, and after Fourier transformation by 7 describing parameters of the power spectrum (e.g. mean power frequency = MPF). A detailed analysis of variance of all data was used to investigate significant changes of the parameters during the observation period. Muscular response to TENS includes a decrease in muscular activity (= reduction in integrated EMG signals) and a shift in the power spectrum to higher frequencies (increase in MPF). These changes were statistically highly significant for both analyzed muscles and for all different mandibular exercises. As these reactions to TENS are contrary to muscle fatigue, the results can be interpreted as indicating that this type of therapy stimulates a change in the biochemical and physiological muscular conditions, which leads to muscle relaxation. Electromyographically, the post-therapeutic effect lasted for 2 hours in case of normal masticatory muscle activity but for more than 7 hours in case of low muscular loading. The alterations of the integrated EMG values were more persistent than those of the parameters of the power spectrum.] Eble OS, Jonas IE, et.al. *J Orofac Orthop.* 2000;61(2):100-11.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=10783562&dopt=Abstract

260. **Transcutaneous electrical stimulation as an adjunct in the management of myofascial pain-dysfunction syndrome.** [Twenty-one patients, 14 women and seven men, presenting with symptoms of the MPD syndrome, were treated with a regimen based on a neuromuscular theory of occlusion involving TES. Evaluation of treatment results shows 95% success immediately after therapy and an 86% success 1 year after therapy. No effort was made to establish a personality profile on the patients nor to incorporate active psychotherapy in treatment.] Wessberg GA, Carroll WL, et al. *J Prosthet Dent.* 1981 Mar;45(3):307-14.
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=6971327&dopt=Abstract

261. **Visual input effect on EMG activity of masticatory and postural muscles in healthy and in myopic children.** [AIM: The purpose of this study was to evaluate the activity of Anterior Temporal, Masseter, Sternocleidomastoid and Anterior Digastric muscles in response to changes in visual input in subjects with defective vision by means surface electromyography. METHODS: A total of 20 children, aged between 7 and 13 years, were evaluated. In the study group 10 children with myopic defects were enlisted, selected among patients afferent to the paediatric dentistry clinic. Ten subjects with normal vision, the control group, were chosen through the Pair Matching procedures, so that each myopic child had a matching age case control. Both study group and control group patients maintained mandible at rest with teeth apart and were submitted to a 15-sec electromyography (EMG) recording with closed eyes followed by a 15-sec EMG recording with open eyes. RESULTS/STATISTICS: The Root Mean Square (RMS) values were elaborated to obtain means and standard deviation. Statistical analysis was undertaken using the Student's T-test for independent samples. Analysis of the results demonstrated a marked difference in tonic activity of temporal anterior muscles at open eyes between the myopic and the normal groups. CONCLUSION: The findings suggest that in the evaluation of masticatory muscles tenderness, such as episodic tension type headaches, attention should be paid to vision defects.] Monaco A, Cattaneo R, et.al. *Eur J*

Paediatr Dent. 2006 Mar;7(1):18-22.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=16646640&dopt=Citation

Bruxism, Clenching

262. **A Clinical Study of Specific Signs and Symptoms of CMD in Bruxers Classified by the Degree of Severity.** [Two hundred and seventy-six CMD patients referred consecutively for diagnosis and treatment over a period of four years were assessed. Two hundred and eleven were classified as bruxers according to the use of a questionnaire and clinical examination. One hundred (47.39%) presented clinical characteristics of mild bruxers, 66 (31.27%) presented moderate bruxism and 45 (21.32%) demonstrated severe bruxism. Severe bruxers presented the lowest degree of jaw opening (39.21 mm) and highest prevalence of capsulitis (97.77%), retrodiskal pain (84.44%) and disk-attachment pain (48.88%). As compared to the mild and moderate groups, severe bruxers also demonstrated significantly higher prevalence of protective splinting and transient locking or recent history of intermittent locking, masticatory pain, reciprocal clicking and signs and symptoms of Myofascial Pain Dysfunction Syndrome (MPDS). Because higher prevalence of specific muscle and joint disorders were observed in bruxers and such prevalence was progressive from the mild to the moderate and severe group, it may be concluded that bruxing behavior is a significant factor in the etiology and progression of muscle and joint disorders. Based on the review of the literature, the analysis of our data in comparison to other studies allowed us to conclude that severe bruxers are more impaired by muscular and joint disorders as compared to mild and moderate bruxers.] Molina OF, dos Santos Jr, et al. *Cranio.* 1999 Oct;17(4):268-79. http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=10650399&dopt=Abstract
263. **Bruxism and Cranial-cervical Dystonia: Is There a Relationship?** [To characterize the relationship between bruxism and dystonia, 79 patients (28 men and 51 women) with cranial-cervical dystonia were studied. Sixty-two patients (78.5%), 22 men and 40 women, had bruxism. The mean age at onset of dystonia in patients with bruxism was 52.4 +/- 12.6 years (range 14-80), similar to patients with cranial-cervical dystonia without bruxism. Involuntary oromandibular movements (46 patients) and blepharospasm (34 patients) were the most common initial symptoms among patients with dystonia. About one-fourth of bruxism patients had associated dental problems including TMD (21%) and tooth wear (5%). A majority (58%) of the bruxism patients had diurnal bruxism and 12% had nocturnal bruxism. The bruxism patients were compared to 100 patients with Parkinson's disease (PD), cervical dystonia, cranial dystonia, and normal controls, respectively. The prevalence of bruxism was much higher in the cranial-cervical dystonia patients when compared to normal controls ($P < 0.001$); however, this difference was not significant between other diseased groups and controls. Medications and botulinum toxin injections, used in the treatment of focal dystonia also provided effective relief of bruxism.] Watts MW, Tan EK, Jankovic J. *Cranio.* 1999 Jul;17(3):196-201. http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=pubmed&list_uids=10650407&cmd=Retrieve&indexed=google
264. **Bruxism. Associations with sleep and gut disturbances: a pilot study.** [Sleep bruxism has major implications in dentistry. It can result in tooth fractures, masticatory

muscle disorders and loss of tooth structure. However there is no agreement on its pathophysiology, and it remains a poorly understood and a poorly managed entity. A medical aetiology for bruxism needs to be considered. Objectives: This study was to (1) determine specific clinical features of bruxism, (2) identify test and control groups based on clinical features, (3) investigate levels of sleep disturbance, jaw muscle EMG, and gastrointestinal symptoms in test and control subjects. ... Results: Data suggests that bruxing subjects display higher levels of sleep disturbances, EMG activity, bowel symptoms and gut microbacterial imbalances. Conclusions: This pilot study suggests associations between signs and symptoms of sleep bruxism, sleep disturbance, and gut disturbances.] Hong S. Whittle T, et al. *IADR General Session June 28, 2006, Brisbane AU*. http://iadr.confex.com/iadr/2006Brisb/techprogram/abstract_80593.htm

265. **Bruxism: Something to chew on?!** [Bruxism is a very common condition consisting of involuntary rhythmic or spasmodic non-functional gnashing, grinding or clenching of teeth. Although the exact etiology of bruxism is not known, current literature suggests that it is regulated centrally and not peripherally. There are many cited consequences of bruxism. These include temporomandibular disorders, tension headaches, tooth wear/sensitivity/fracture, implant and other restoration failure. Diagnosis of sleep bruxism by dentists is traditionally based on subjective reports and findings from clinical examinations due to practical limitations. This has been superseded by BiteStrip (SLP Ltd), a single-use, battery operated, home EMG device. With the introduction of this new technology, the existence and frequency of bruxism can now be accurately determined. Management of bruxism is usually directed towards tooth/restoration protection, reduction of bruxism activity and pain relief. A patient-centric approach using a combination of pharmacological, psychological and dental strategies should be considered for individual patients with bruxism. Anterior splints, which are used primarily during sleep, have gained much popularity in recent years. They are based on the ability of anterior bite stops to reduce masticatory muscle activity during clenching and grinding. When occlusal splints are used, a good recall system must be established.] Yap AUJ. *Dental Asia*, May/June 2005.
http://www.pabloasia.com/en/DA_archive/MayJune05/Bruxism.pdf

266. **Cardiovascular autonomic control is disturbed in nocturnal teethgrinders.** [To examine the hypothesis of disturbed autonomic function, non-invasive cardiovascular reflex tests were performed on 11 sleep bruxists in the waking state. The tests included the Valsalva manoeuvre, a deep-breathing test, and an orthostatic test (standing up). The R-R intervals were monitored continuously, and blood pressure was measured non-invasively and continuously using the Finapres method. In total, 64% of bruxists showed abnormalities in at least two variables reflecting the cardiovascular autonomic function. Abnormalities were found in blood pressure regulation during the Valsalva strain, and in the immediate biphasic heart rate response during standing up, but not in the vagally mediated deep-breathing difference. These findings suggest that bruxism is accompanied by abnormalities in autonomic function, particularly in sympathetic vasoconstrictor function.] Sjolholm TT, Piha SJ, et al. *Clin Physiol* 1995;15(4):349-54.
<http://www.websciences.org/cfemplate/NAPS/archives/indiv.cfm?ID=19961170>

267. **Clenching Suppresses Motor Unit Recruitment during Isometric Muscle Contractions.** [It is reported that the 90 degrees arm abduction force counteracting external adduction moments was significantly smaller under clenching than under non-

clenching control condition. We attempted to elucidate the physiological mechanism underlying the inhibitory effect of clenching on the arm abduction. ... Conclusion: These results suggest that clenching suppresses motor unit recruitment during isometric contraction of muscles involved in the abduction. It may be possible that impulses in central axons of mesencephalic trigeminal sensory neurons innervating jaw muscle spindle or periodontal ligament would cause inhibition of primary sensory neuron or gamma motor neuron involved in abduction of upper limb in the cervical spinal cord.] Sato H, Maeda Y, et al. IADR General Session, June 28, 2006. Brisbane AU.

http://iadr.confex.com/iadr/2006Brisb/techprogram/abstract_83707.htm

268. **Effect of Parafunctional Clenching on Temporomandibular Disorder Pain and Proprioceptive Awareness.** [This study tested the hypothesis that parafunctional clenching increases pain, can lead to a diagnosis of temporomandibular disorder (TMD) pain, and can produce reductions in proprioceptive awareness. Twenty individuals participated in EMG biofeedback training sessions on the left and right temporalis and masseter muscles. No subjects had TMD prior to training. Subjects were randomly assigned to either a Decrease group, who were instructed to maintain EMG activity below 2 microV during training, or an increase group, who were instructed to maintain EMG activity above 10 microV. To test the impact of parafunctional clenching on proprioceptive awareness, all subjects were instructed to barely touch their teeth together while EMG activity was recorded pre- and post-training. Three subjects assigned to the Increase group and no subjects assigned to the Decrease group were diagnosed with TMD pain following training. Self-reported pain post-training was significantly higher for the Increase group. Parafunctional clenching did not affect performance in the proprioceptive test.] Glaros AB, Forbes M, et al. *Cranio*. 2000 Jul;18(3):198-204. http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=11202838&dopt=Citation
269. **Enhanced sympathetic cardiac modulation in bruxism patients.** [Sleep bruxism, an oral parafunction including teeth clenching and grinding, might be related to increased stress. To evaluate sympathetic cardiac activity in bruxism patients, we monitored cardiac autonomic modulation using spectral analysis of heart rate variability and compared results to those of age-matched healthy volunteers. In bruxism patients, sympathetic cardiac activity was higher than in volunteers. The increased sympathetic tone suggests increased stress and might be related to occlusal disharmonies.] Marthol H, Reich S, et al. *Clin Auton Res*. 2006 Aug;16(4):276-80. Epub 2006 Jun 12. http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=pubmed&list_uids=16770525&cmd=Retrieve&indexed=google
270. **Prevalence of Bruxism Awareness in a Sardinian Population.** [1014 subjects on the island of Sardinia (Italy) were interviewed regarding the habit of clenching and grinding their teeth. They had to specify if this activity occurred during the day, during the night, or both. Other information recorded was their age, gender, marital status, and occupation. Overall prevalence of bruxism was 27.2% (276 subjects). No association was found between bruxism and age, gender and job. Even differentiating diurnal, nocturnal, diurnal and nocturnal bruxism, associations were non-significant. Marital status seems to make some difference: divorced people reported higher parafunctional activity compared to widows and widowers who reported the least. Although awareness of bruxism is not a precise measure of parafunction, based on the results we cannot support the role of stress

on bruxism etiology.] Melis M, Abou-Atme YS. *Cranio*. 2003 Apr;21(2):144-51.
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=12723861&dopt=Abstract

271. **Prevalence of Modalities of Headaches and Bruxism Among Patients with Craniomandibular Disorder.** [ABSTRACT: This study compared the presence of headache and bruxing behavior among 133 craniomandibular disorder patients (CMD) referred to the The Center For the Study Of Craniomandibular Disorders and to the presence of headache and bruxing behavior occurring in 133 controls seeking routine dental care. Both patients and controls were consecutive referrals to the clinic occurring over a three year period. The mean age of the CMD group was 38 years (range 28-42), and the mean age of the controls was 37 years (range 25-44). The information gathered included questionnaire and clinical examination. Different types of headaches, signs and symptoms of CMD, and bruxing behavior were assessed both in the CMD group and in the corresponding control group. Results of this study showed that bruxing behavior and headache pain were significantly more prevalent in the CMD group (57%, 76%) than in the corresponding control group (37%, 49%). Of the three types of headache observed, tension and combination headaches were more prevalent in the CMD group (n=48=36% and n=37=28%). Migraine headache was more prevalent in the CMD group (n=16=12%) than in the control group (n=3=2%). It was concluded that headache and bruxing behavior predominated in CMD patients. This data reinforces the need to assess headache pain and signs and symptoms of bruxing behavior in CMD patients, particularly in those suffering chronic facial pain and headache.] Molina OF, Santos J, et al. *Cranio*. 1997 Oct;15(4):314-25
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=9481994&dopt=Abstract
272. **Profile of TMD and Bruxer Compared to TMD and Nonbruxer Patients Regarding Chief Complaint, Previous Consultations, Modes of Therapy, and Chronicity.** [This comparative study by groups assesses the profiles of TMD (temporomandibular dysfunction) and bruxism patients and TMD-nonbruxing patients regarding chief complaint, previous medical and dental consultations, duration of the chief complaint, previous medication, and use of splints. ... It was observed that the need for medical and dental consultations increased with the severity of bruxism. It was also apparent in this study that the need for medication (analgesics, muscle relaxants, and antidepressants), increased with the severity of bruxism. Moderate and severe subgroups of bruxers used significantly more splints compared to mild bruxers and to TMD-nonbruxer patients. Both groups of TMD + bruxism and TMD - nonbruxism sought medical and dental consultations with dentists (clinicians and specialists) neurologists, and otolaryngologists more frequently compared to other medical professionals. Since the need for health services increased with the severity of bruxism, this study urges the need to include a protocol or questionnaire to assess the severity of bruxing behavior in TMD patients in order to use a customized method of treatment/management. This study also reinforces the point of view that different subgroups of TMD and bruxism do exist and suggests a differentiated therapeutic approach. They show previously confirmed findings that pain is the major complaint of TMD and bruxer patients.] Molina OF, dos Snatos Jr. J, et al. *Cranio*. 2000 Jul;18(3):205-19.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=11202839&dopt=Abstract

273. **The Prevalence of Some Joint Disorders in Craniomandibular Disorder (CMD) and Bruxers as Compared to CMD Nonbruxer Patients and Controls.** [The objective of this study was to assess and compare the frequency of some joint disorders in 130 CMD + bruxing behavior patients, 66 CMD/nonbruxing behaviors patients referred for diagnosis and treatment to the Center for the Study of Craniomandibular Disorders and 130 control subjects seeking routine dental care. Both patients and controls were consecutive referrals to the clinic occurring over a five year period...The study concluded that capsulitis/synovitis, retrodiskal pain and disk-attachment pain predominated in CMD + bruxing behavior patients. The data reinforces the need to assess CMD + bruxing behavior patients to evaluate signs and symptoms of such disorders in order to obtain additional information about the true source of pain and the need for proper management.] Molina OF, dos Santos Jr J. *Cranio*. 1999 Jan;17(1):17-29.
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=10425926&dopt=Abstract

Collateral Diseases

274. **Atlas vertebra realignment and achievement of arterial pressure goal in hypertensive patients: a pilot study.** [Anatomical abnormalities of the cervical spine at the level of the Atlas vertebra are associated with relative ischaemia of the brainstem circulation and increased blood pressure (BP). Manual correction of this mal-alignment has been associated with reduced arterial pressure. This pilot study tests the hypothesis that correcting mal-alignment of the Atlas vertebra reduces and maintains a lower BP. Using a double blind, placebo-controlled design at a single center, 50 drug naïve ($n=26$) or washed out ($n=24$) patients with Stage 1 hypertension were randomized to receive a National Upper Cervical Chiropractic (NUCCA) procedure or a sham procedure. Patients received no antihypertensive meds during the 8-week study duration. The primary end point was changed in systolic and diastolic BP comparing baseline and week 8, with a 90% power to detect an 8/5 mm Hg difference at week 8 over the placebo group. The study cohort had a mean age 52.7 ± 9.6 years, consisted of 70% males. At week 8, there were differences in systolic BP (-17 ± 9 mm Hg, NUCCA versus -3 ± 11 mm Hg, placebo; $P < 0.0001$) and diastolic BP (-10 ± 11 mm Hg, NUCCA versus -2 ± 7 mm Hg; $P = 0.002$). Lateral displacement of Atlas vertebra (1.0 , baseline versus 0.04° week 8, NUCCA versus 0.6 , baseline versus 0.5° , placebo; $P = 0.002$). Heart rate was not reduced in the NUCCA group (-0.3 beats per minute, NUCCA, versus 0.5 beats per minute, placebo). No adverse effects were recorded. We conclude that restoration of Atlas alignment is associated with marked and sustained reductions in BP similar to the use of two-drug combination therapy.] Bakris G, Dickholtz M, et al. *Journal of Human Hypertension advance online publication 2 March 2007*; doi: 10.1038/sj.jhh.1002133.
<http://www.nature.com/jhh/journal/vaop/ncurrent/abs/1002133a.html>
275. **Basal Circadian Cortisol Secretion in Women with Temporomandibular Disorders.** [Muscular temporomandibular disorder (TMD) is a common stress-related condition showing marked comorbidity with depression and fibromyalgia (FM), both of which are associated with dysregulation of cortisol secretion. We measured cortisol levels in 15 women with well-defined TMD and 15 matched controls by sampling blood at 10-

- minute intervals over 24 hours in a controlled environment. TMD patients showed markedly increased daytime cortisol levels 30% to 50% higher than those of controls ($p = 0.0032$) and a one-hour phase delay in the timing of maximum cortisol levels ($p = 0.048$). Increased activation of the stress hormone axis by conscious pain perception is a likely explanation, but the magnitude of the increase could indicate that pain in the facial region acts as a greater stimulus than pain elsewhere in the body.] Korszun A, Young EA, et al. *J Dent Res* 81(4): 279-283, 2002. <http://jdr.iadrjournals.org/cgi/content/full/81/4/279>
276. **Cardiac stress related to occlusal instability and temporomandibular joint dysfunction: report of a case.** (No Abstract Available.) Smith SD. *J Am Osteopath Assoc.* 1981 Jun;80(10):690-7. http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=7239960&dopt=Abstract
277. **Chronic illness profiles in temporomandibular joint dysfunction patients and case report on cardiac stress.** (No abstract available.) Smith SD. *Basal Facts.* 1978 Oct;3(2):78-87. http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=159695&dopt=Abstract
278. **ENT manifestations of gastroesophageal reflux disease (GERD).** [Gastroesophageal reflux disease (GERD) has been associated increasingly with ear, nose, and throat (ENT) signs and symptoms. However, the cause and effect relationship between these two clinical entities are far from established. Many patients diagnosed initially with GERD as the cause of laryngeal signs do not symptomatically or laryngoscopically respond to aggressive acid suppression and do not have abnormal esophageal acid exposure by pH monitoring. The hypothesis that GER causes laryngeal symptoms and conditions remains to be definitively proved. In many patients, the cause of laryngeal symptoms may well be multifactorial, and to identify definitively those patients in which GER may be playing a role remains a challenge. This has resulted in frustration on the part of both gastroenterologists and ENT physicians and confusion on the part of patients. In this article we discuss the recent data.] Watanabe Y. *Nippon Rinsho.* 2004 Aug;62(8):1533-6. http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=15344546&dopt=Abstract
279. **Gastroesophageal reflux diagnosed by occlusal splint tintion.** [The gastroesophageal reflux (GER) disease is a very frequent digestive disorder, mainly characterised by the reflux of the gastric acidic content to the esophagus in abnormal quantities. There are different situations that favour this situation but almost in all of them rely on an incompetence of the esophageal sphincter. The clinical consequences are many, including oral manifestations. Among all of them the most frequent is the esophagitis followed by symptoms at the pharynx or larynx and finally, the oral cavity. At this level fundamentally we will find enamel and oral mucosa erosions. We report the case of a patient who was indirectly diagnosed of her esophageal disease by the observation of the alterations in the occlusal splint induced by the gastric reflux. We review the literature concerning the above topic and its possible association with the myofascial syndrome.] Cebrian-Carretero JL, Lopez-Arcas-Calleja JM. *Med Oral Patol Oral Cir Bucal.* 2006 Jan 1;11(1):E26-8.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=16388289&dopt=Abstract

280. **Health Care Utilization by Patients with Temporomandibular Joint Disorders.** [The claims data base of a large New England managed care organization was used to compare the health care utilization patterns of patients with TMJ disorders to non-TMJ subjects. Inpatient, outpatient and psychiatric claims data were examined over a wide range of diagnostic categories. Age and sex adjusted results showed that, overall, patients with TMJ disorders were greater utilizers of health care services and had higher associated costs than non-TMJ subjects. For some of the major diagnostic categories, such as nervous, respiratory, circulatory, and digestive, the inpatient and outpatient claims differences in utilization and costs were as large as 3 to 1. For only one diagnostic category, pregnancy and childbirth, were utilization and costs greater for non-TMJ subjects than TMJ patients. The psychiatric claims for TMJ patients exhibited differences that were at least twice as large as those for the non-TMJ subjects.] Shimshak DG, DeFuria MC. *Cranio*. 1998 Jul;16(3):185-93.
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=9852811&dopt=Abstract
281. **Sleep Apnea and Bruxism in TMD Patients during Nocturnal Sleep** [Objectives: In order to clarify the appearance phase of sleep apnea in TMD patients the sleep apnea and bruxism of healthy subjects and TMD patients during sleep at night were analyzed. Methods: Twenty healthy subjects and 20 TMD patients, all females in their twenties were selected. Using a wireless telemeter system, the EEG, EOG, ECG, masseter EMG, mental EMG and respirogram were recorded simultaneously throughout the night. First the frequency of sleep apnea and the frequency of bruxism were compared between the healthy group and the patient group. Next the relationship between the frequency of sleep apnea and the frequency of bruxism was investigated. Sleep apnea was defined as cessation of respiration for over 10 seconds and bruxism was defined as those bursts that lasted more than 5 seconds or the burst between two bursts that was less than 5 seconds apart and the muscular activities were larger than the swallowing activities recorded prior to sleep. Results: Both the frequency of sleep apnea and the frequency of bruxism were larger for the patient group (bruxism : 8.2n/h, apnea : 1.6n/h) than for the healthy group (bruxism : 5.5n/h, apnea : 0.3n/h) and a significant difference was found between the two. There was no correlation between the frequency of sleep apnea and the frequency of bruxism in the healthy group, but for the patient group, when the frequency of bruxism increased the frequency of sleep apnea also increased and there was a positive correlation between the two ($y=0.00187x^{3.12}$, $R=0.809$, $p<0.01$, s.). Conclusions: From these results it was concluded that sleep apnea was intimately connected to bruxism and in TMD patient with high frequency of bruxism attention should be paid to the possibility of sleep apnea.] Y. KOBAYASHI, H. SHIGA, and M. YOKOYAMA, The Nippon Dental University, Tokyo, Japan .
http://iadr.confex.com/iadr/2002SanDiego/techprogram/abstract_13927.htm
282. **Sleep Disturbance in Orofacial Pain Patients: Pain-Related or Emotional Distress?** [Associations between pain, depression, and sleep disturbance have been documented in several chronic pain patient samples. The current study assessed the prevalence and magnitude of sleep disturbance in a sample of 128 orofacial pain patients referred for clinical evaluation and tested linkages between sleep, depression, anxiety,

and pain using cross-sectional and longitudinal data. Seventy-seven percent of the patients reported reduced sleep quantity since pain onset. In cross-sectional analyses, reduced sleep quantity was associated with depression and pain. Reduced sleep quality was associated with negative affect. Longitudinally, initial depression and pain predicted sleep at time two and initial pain predicted negative affect. Sleep did not predict pain. Results support the hypothesis that pain, rather than sleep disturbance, increases negative affect across time, whereas negative affect is more a cause of concurrent reduced sleep quality than is pain. The results highlight the importance of assessing for sleep disturbance in orofacial pain patients.] Riley JL, Benson MB, et al. *Cranio*. 2001 Apr;19(2):106-13.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=11842861&dopt=Abstract

Psychosocial and Psychological

283. **Analysis of background variables in 350 patients with TMJ disorders as reported in self administered questionnaire.** [All 350 patients referred to the Department of Stomatognathic Physiology during a 4-month period were given a self-administered questionnaire intended to give a review of the patients' history. The questions concerning general somatic and psychic health, education and social conditions are dealt with in this article. Twenty-five percent of the patients, more women than men, considered their general state of health to be impaired or poor. Seventy-two percent of the patients denied having had nervous or psychic disorders while 9% were currently being treated for such symptoms. Patients who had answered with alternatives indicating a "poor social situation" had, for instance, more pain in the face and jaws, poorer general health, more nervous or psychic disorders and more symptoms of TMJ disorders than the other patients. When the influence of education was considered, the patients with low education reported more severe symptoms of TMJ disorders than those with higher education. The general level of somatic and psychic health of the patients in this study did not differ markedly from that of the general population, but a negative influence on the health of the masticatory system of poor social conditions and low educational level could be demonstrated.] Carlsson GE, Kopp S, et al. *Community Dent Oral Epidemiol*. 1982 Feb;10(1):47-51.

http://www.ncbi.nlm.nih.gov/sites/entrez?cmd=Retrieve&db=PubMed&list_uids=6949666&dopt=Abstract

284. **Association Between Symptoms of Temporomandibular Disorders and Depression: An Epidemiological Study of the Northern Finland 1966 Birth Cohort.** [Facial pain and other symptoms of temporomandibular disorders (TMD) are rather common in the adult population. According to clinical studies, psychological factors play an important role in the etiology and maintenance of these symptoms. On the other hand, chronic pain can cause depression. The aim of this study was to evaluate the association between symptoms of TMD and depression in a large population sample of young adults. .. Almost all the associations remained significant after adjusting for marital status, education, and self-rated general health. In conclusion, the results show that depression has an association with TMD symptoms, especially those related to pain. When treating patients with facial pain, dentists should consider the possible presence of psychopathology and, if necessary, consult appropriate mental health professionals.]

Sipila K, Veijola J, et al. *Cranio*. 2001 Jul;19(3):183-7.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=1482830&dopt=Abstract

285. **Cognitive Factors Associated with Facial Pain.** [Most well-accepted etiological models of facial pain (e.g., temporomandibular disorders and headache) implicate emotional distress as an important factor in the development and maintenance of pain. Data exists to support the notion that some facial pain sufferers are more emotionally distressed than no pain controls. However, many of these dependent measures of emotional distress are either lengthy assessment batteries, lack clear cut psychotherapeutic treatment implications, or focus exclusively on pain related sequela. As cognitive-behavioral interventions become more integrated into the treatment of chronic pain conditions, including various facial pain conditions, it becomes more imperative that the tools used to assess psychological functioning provide the clinician with specific cognitive/behavioral targets for change. The purpose of this study was to assess the degree to which symptomatic treatment seeking facial pain sufferers (N = 25), symptomatic non-treatment seeking facial pain sufferers (N = 48), and healthy pain-free controls (N = 70) differed on the Rational Beliefs Inventory (RBI). ... [the] findings indicated that facial pain sufferers generally hold maladaptive beliefs that may be of clinical significance for cognitive/behavioral treatment approaches.] Schwartz SM, Gramling SE. *Cranio*. 1997 Jul;15(3):261-6.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=9586505&dopt=Citation

286. **Effects of Somatization on Pain and Blood Pressure Responses.** [Somatization is the presence of multiple nonspecific physical symptoms and distress in excess of what would be expected from clinical signs. We have previously shown that Temporomandibular Disorders (TMD) patients high in somatization report more pain on palpations in a clinical exam, use health care excessively and are less likely to improve with cognitive behavioral treatment. Objectives: The current study examined pain, behavioral and blood pressure responses to experimental pain stimuli in women with TMD (concurrent myofascial pain and arthralgia). Methods: Fifty-seven subjects underwent an experimental protocol that included algometer palpations of 28 sites routinely assessed in TMD and fibromyalgia examinations and blood pressure measurement prior to, during and after a painful ischemic stimulus. Participants were classified based on levels (low, moderate, high) of somatization according to Research Diagnostic Criteria for TMD. Significant differences from Analysis of Variance (ANOVA) were followed by post hoc comparisons using Tukey's HSD. Results: High somatizers reported higher depression and anxiety ($p < .05$) than those with low or moderate levels. High somatizers reported more palpations as painful (18 v 14.5; $p < .05$) than low somatizers. Their mean ratings of pain at extra-oral palpation sites were also higher ($p < .05$). Furthermore, despite no differences in pain threshold, tolerance or pain sensitivity to the tourniquet task, high somatizers had higher resting systolic blood pressures and heart rates before the tourniquet task (SBP=114.5 v 109.8 mmHg; HR=66.0 v 75.2 BPM ; $p < .05$) and higher systolic blood pressure reactivity to the tourniquet task (9.4 v 6.1 mm Hg; $p < .05$) when compared to those with moderate somatization. Conclusion: Differences in pain perception in high somatizers are more apparent for clinically relevant pain stressors (palpations rather than ischemic pain). Furthermore,

physiological activation and impaired stress reactivity may influence symptom reporting among those high in somatization.] Sherman JJ, Leresche L, et al. IADR General Session, June 2003. http://iadr.confex.com/iadr/2003Goteborg/techprogram/abstract_37563.htm

287. **Feeling Bad in More Ways than One: Comorbidity Patterns of Medically Unexplained and Psychiatric Conditions.** [Considerable overlap in symptoms and disease comorbidity has been noted among medically unexplained and psychiatric conditions seen in the primary care setting, such as chronic fatigue syndrome, low back pain, irritable bowel syndrome, chronic tension headache, fibromyalgia, temporomandibular joint disorder, major depression, panic attacks, and posttraumatic stress disorder. *Objective* To examine interrelationships among these 9 conditions. *Results* Comorbidity among these 9 conditions far exceeded chance expectations; 31 of 36 associations were significant. Latent class analysis yielded a 4-class solution. *Class I* (2% prevalence) had high frequencies of each of the 9 conditions. *Class II* (8% prevalence) had high proportions of multiple psychiatric diagnoses. *Class III* (17% prevalence) participants reported high proportions of depression, low back pain, and headache. Participants in *class IV* (73% prevalence) were generally healthy. *Class I* participants had the poorest markers of health status. *Conclusions* These results support theories suggesting that medically unexplained conditions share a common etiology. Understanding patterns of comorbidity can help clinicians care for challenging patients.] Schur EA, Afari N, et al. *Journal of General Internal Medicine, Vol.22, No.6, June, 2007 p.818-821.* <http://www.springerlink.com/content/j602073621w413x6/>
288. **Personality Characteristics of Temporomandibular Disorder Patients Using M.M.P.I.** [It is generally recognized that psychological factors play an important role in chronic orofacial pain patients. This study analysed psychological profiles of chronic pain patients affected with temporomandibular disorders (TMD), by means of the Minnesota Multiphasic Personality Inventory (MMPI) test. Fifty consecutive TMD patients were examined and were then divided into two subgroups: 1. myofascial pain and 2. temporomandibular joint articular disorders. Sixty-two percent of the whole sample presented pathological MMPI scores. Both subgroups presented similar profiles with alteration of the neurotic triad (hypochondriasis, depression, hysteria), and pathological values of hypochondriasis and hysteria ("V" configuration). Since the personality profile did not differ between the two subgroups investigated, it was not dependent on the dysfunctional origin of the pathology (myalgia or primary TMJ pathology). Chronic TMD patients presented personality characteristics similar to those of other chronic pain patients according to the MMPI.] Michelotti A, martina R, et al. *Cranio. 1998 Apr;16(2):119-25.* http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=9709566&dopt=Abstract
289. **Psychological Factors and Temporomandibular Outcomes.** [This study examines the effect of psychological dysfunction as an etiological factor in temporomandibular disorder (TMD). It employs a thoroughly validated psychometric measurement system, the TMJ Scale (Pain Resource Center, Inc., Durham, North Carolina), to determine the effects of pretreatment stress and psychological dysfunction upon presenting symptom levels. The study also addresses these parameters for the eventual treatment outcome. During the course of this study, 2,074 patients were evaluated. Seven hundred and fifty-four by Dr. Steed and 1,320 by Dr. Wexler. Both

practices address essentially identical patient populations and focus special interest in craniofacial pain and the diagnosis and Phase I treatment of temporomandibular dysfunction. Of the patients in the study who were found to have clinically treatable temporomandibular disorders, 561 consecutive patients completed treatment and were deemed to have reached Maximum Medical Improvement (MMI). The TMJ Scale was re-administered to this post-treatment population. This study summarized findings pertinent to the four primary issues: 1. pre-treatment psychological factors and stress, which seem to be moderately related to presenting pain levels and overall TMD levels (excepting joint function); 2. treatment outcomes which appeared to be unrelated to the initial psychosocial symptom severity; 3. physical symptoms outcomes and psychosocial outcomes which appeared to be significantly related and; 4. intracapsular symptom improvement which appeared to be unrelated to psychological functioning changes but mildly related to stress.] Wexler GB, Steed PA. *Cranio*. 1998 Apr;16(2):72-7.
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=9709560&dopt=Abstract

290. **Relationship between pain sensitivity and resting arterial blood pressure in patients with painful temporomandibular disorders.** [Patients experiencing temporomandibular disorders (TMD) show greater sensitivity to painful stimuli than age- and gender-matched control subjects. This enhanced pain sensitivity may result, at least in part, from an alteration in pain regulatory systems that are influenced by resting arterial blood pressure. In this study, we examined the relationship between resting systolic blood pressure and pain perception in 64 female TMD and 23 age-matched pain-free female subjects. ... CONCLUSIONS: These findings confirm our previous findings that TMD patients are more sensitive to noxious stimuli and suggest that painful TMD may result, at least in part, from an impairment in central pain regulatory systems that are influenced by resting arterial blood pressure.] Maixner W, Fillingim R, et al. *Psychosomatic Medicine*, Vol 59, Issue 5 503-511.
<http://www.psychosomaticmedicine.org/cgi/content/abstract/59/5/503>
291. **Screening for psychosocial risk factors in patients with chronic orofacial pain.** [The authors compiled information about recent advances in screening for psychosocial risk factors considered to be yellow flags for potentially poor outcomes among patients with chronic orofacial pain (most commonly temporomandibular disorders). ... Dentists can improve the quality of care for patients with chronic orofacial pain by screening for psychosocial risk factors and by referring patients with risk factors for psychological or psychiatric assessment and treatment.] Turner JA, Dworkin SF. *J Am Dent Assoc*, Vol 135, No 8, 1119-1135.
<http://jada.ada.org/cgi/content/abstract/135/8/1119>
292. **TMD Treatment Outcomes: A Statistical Assessment of the Effects of Psychological Variables.** [This study analyzes the degree to which pretreatment psychosocial factors (psychological dysfunctions and stress) effect outcome in 269 consecutive temporomandibular disorder (TMD) patients at the completion of treatment. Employing the TMJ Scale, a validated measure of TMD symptoms, it is found that pretreatment TMD pain and overall symptom levels (excluding internal derangement symptoms) are weakly but nevertheless, significantly related to pretreatment psychological dysfunction and stress. However, the latter appeared totally unrelated to four treatment outcome measures. Additionally, the data supports the hypothesis that both

initial and post-treatment intrascapular symptoms (TMJ Scale, Joint Dysfunction subscale) are unrelated to psychosocial factors. Data from this study call into question the value of categorizing the TMD patients by means of psychosocial "profiling" and "dual-axis" classification methods proposed by some researchers.] Steed PA. *Cranio*. 1998 Jul;16(3):138-42.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=9852806&dopt=Abstract

Growth and Development

293. **Developmental effects of impaired breathing in the face of the growing child.** [Craniofacial morphology and occlusal pattern are evaluated in 71 subjects having impaired breathing as diagnosed by an otolaryngologist, and in an equal number of controls. The impaired group demonstrate characteristic combinations of craniofacial deformities and malocclusions, with the younger individuals demonstrating a lesser expression of malocclusion progression and morphologic deformities. This suggests that early recognition of such facial patterns may be utilized to identify those breathing compromised individuals who have a likely tendency to develop certain types of malocclusion.] Cheng MC, Enlow DH, et al. *The Angle Orthodontist* Oct 1988, p.309-312. <http://www.angle.org/pdfserv/i0003-3219-058-04-0309.pdf>
294. **Diagnostic Image Analyses of Activator Treated Temporomandibular Joint in Growth and Maturing Stages.** [This study evaluates the condylar response to activator in growth and in maturing patients using radiographs and magnetic resonance images (MRI). Seven patients (four in growth and three in maturing stages) treated for mandibular distal occlusion were studied. In all seven patients, lateral roentgen cephalograms, panoramic radiograms, and MRIs were made before and following functional treatment. All patients' mandibles advanced during treatment. Downward and forward mandibular growth was observed by superimposition of lateral cephalograms. On the condylar posterosuperior regions for both groups, double contours were sometimes observed on the panoramic radiograms following therapy. These double contours coincided with an area of high intensity in the MRIs for both groups. In the mature adult group, the double contours were more clearly observed when compared with those in the growth group. There were differences in the condylar adaptation types between the growth and mature development stages. Condylar adaptation to the newly created mandibular position was nevertheless found even in adult patients.] Uematsu H, Ichida T, et al. *Cranio*. 2002 Oct;20(4):254-63. http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=12403183&dopt=Abstract

TM Joint, Internal Derangements

295. **A possible etiology of the internal derangement of the temporomandibular joint based on the MRI observations of the lateral pterygoid muscle.** [The purpose of this study was to evaluate the relationship of the temporomandibular joint (TMJ) internal derangement and lateral pterygoid muscle (LPM) by magnetic resonance imaging (MRI). In this study, 115 subjects with TMJ internal derangement (total 230 TMJs) and 21 subjects without clinical symptoms (total 42 TMJs) were included. TMJ disc position and LPM were evaluated using MRI. LPM attachments were categorized into two

different types: type 1, where fibers of the superior head of the LPM (SLPM) were attached to the disc and fibers of the inferior head of the LPM (ILPM) were attached to condyle, and type 2, where fibers of the SLPM were attached to the disc and condyle, and fibers of the ILPM were attached to condyle. The presence of muscle atrophy and degeneration were also evaluated. LPM attachments were observed in two different parts. Disc displacements were common in the muscle attachments of both types. Type 1 muscle attachments were seen in 85.9% of all the anterior disc displacement without reduction (ADD) TMJs (total 64 TMJs). Atrophy was seen in a higher proportion (43.7%) in TMJs with ADD (28/64) than in TMJs with normal and anterior disc displacement with reduction (ADDR). Out of 74 TMJs with atrophy, 68 had type 1 muscle attachment. Four TMJs had atrophy in both superior and inferior heads of the lateral pterygoid. However, atrophy was not present only in the ILPM. It has been concluded that since the SLPM only attached to the disc in type 1, the disc may displace anteriorly very easily. Therefore, this situation will reduce the function of the SLPM. Reduced muscle function may cause muscle atrophy. The activity of the SLPM may be more reduced since the disc permanently dislocated in TMJs with ADD. Finally, spasm of the LPM causes disc displacement and atrophy and then the degeneration of the LPM may follow disc displacement.] Taskaya-Yalmaz N, Ceylan G, et al. *Surgical and Radiologic Anatomy, Volume 27, Number 1 / March, 2005.*

<http://www.springerlink.com/content/vncl6fyqlf45x0bf/>

296. **Degenerative disease of the temporomandibular joint.** [Progression of degenerative joint disease is dependent on the underlying pathologic and/or reactive processes involved that, in general, compromise tissue adaptability. A review of clinical and experimental literature relating to degenerative joint disease is presented. Epidemiology, pathogenesis, diagnosis, treatment, and prognosis are described with particular emphasis given to the temporomandibular joint. This article describes factors affecting the temporomandibular joint remodeling/degeneration parity and presents rationale for approaches to diagnosis and treatment.] Kamelchuk LS, Major PW. *J Orofac Pain.* 1995 Spring;9(2):168-80.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=7488987&dopt=Abstract

297. **Diagnosis and Treatment of Temporomandibular Disorders in Primary Care.** [A patient who has temporomandibular pain may seek help from a primary care health care provider before seeking dental evaluation. TMD should be treated like any other musculoskeletal complaint. Conservative therapy is best for a first-line approach to treating the patient. Temporomandibular disorders (TMDs) affect the temporomandibular joint (TMJ) or the muscles involved with chewing. The most common symptom for which patients with TMDs seek treatment is pain, localized predominantly in the preauricular area. To a lesser extent, the ear, temple, and muscles of the neck are involved. A subset of patients who have TMD do not experience pain, but complain of popping, clicking, and other noises that emanate from the TMJ while the joint is in motion. Symptoms can range from barely noticeable to seriously debilitating. On rare occasions, the TMJ may lock, which allows little or no motion of the mandible.] Knight J. *Hospital Physician June 1999, p 55-58.* http://www.turner-white.com/pdf/hp_jun99_temporo.pdf

298. **Initial TMJ Disk Recapture with Anterior Repositioning Appliances and Relation to Dental History.** [ABSTRACT: Fifty-eight consecutive patients in a referral based practice seeking treatment for complex chronic painful temporomandibular joint (TMJ) disease were enrolled in a prospective study to assess the recapture of displaced disks by anterior repositioning appliances (ARA) and the improvement in disk position in those disks that did not fully recapture. After standard clinical workup, including assessment of pain, maxillary and mandibular ARAs were constructed which repositioned condyles to the Gelb 4/7 position as determined by cephalometrically-corrected linear tomograms. Multi-planar magnetic resonance imaging (MRI) was performed immediately before and after insertion of the mandibular ARA, showing three-dimensional recapture of disks in 85% and improved disk position in 6% of reducing displacements. Disk position was improved in 28% of nonreducing joints, but none were totally recaptured. Recapture or improvement was achieved in 91% of reducing, 28% of nonreducing, and 63% of all joints with internal derangements. Initial disk position, reduction on opening and recapture by ARA were statistically independent of patient age, number of teeth missing, number of third molars missing, malocclusion (Angle's class), overjet, overbite, prosthetic appliances, and previous orthodontic treatment. It was concluded that ARA therapy provided effective recapture of displaced TMJ disks that reduce upon mouth opening. In this population of patients with chronic TMJ pain, previous dental treatment had no statistically significant effect on the incidence of internal derangement or on disk recapture by ARA therapy. There was no evidence of adverse effect from orthodontics, prosthetics, or any other dental care.] Simmons HC, Gibbs J. *Cranio*. 1997 Oct;15(4):281-95.
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=9481990&dopt=Abstract
299. **MRI study of a physiotherapeutic protocol in anterior disk displacement without reduction.** [Disk displacement of the temporomandibular joint (TMJ) without reduction has been considered a fundamental pathophysiologic abnormality of the joint. In this paper there are supportive clinical and MRI evidence of a successful repetitive manipulative technique for the treatment of acute and chronic locking. In 1500 treated cases, documented on videotape, only five cases required surgical intervention. The success of the therapy was confirmed by 13 MRI images of the TMJ of patients with acute and chronic locking before and after therapy. In all cases the anteriorly dislocated disk in closing and opening position was recaptured and repositioned in a normal position in the temporomandibular fossa. Three complete cases are reported with complete clinical and MRI documentation.] Martini G, Martini M, Carano A. *Cranio*. 1996 Jul;14(3):216-24.
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=9110613&dopt=Abstract
300. **Prevalence of different temporomandibular joint sounds, with emphasis on disc-displacement, in patients with temporomandibular disorders and controls.** [Temporomandibular joint (TMJ) sounds are very common among patients with temporomandibular disorders (TMD), but also in non-patient populations. A variety of different causes to TMJ-sounds have been suggested e.g. arthrotic changes in the TMJs, anatomical variations, muscular incoordination and disc displacement. In the present investigation, the prevalence and type of different joint sounds were registered in 125

consecutive patients with suspected TMD and in 125 matched controls. Some kind of joint sound was recorded in 56% of the TMD patients and in 36% of the controls. The awareness of joint sounds was higher among TMD patients as compared to controls (88% and 60% respectively). The most common sound recorded in both groups was reciprocal clickings indicative of a disc displacement, while not one single case fulfilling the criteria for clicking due to a muscular incoordination was found. In the TMD group women with disc displacement reported sleeping on the stomach significantly more often than women without disc displacement did. An increased general joint laxity was found in 39% of the TMD patients with disc displacement, while this was found in only 9% of the patients with disc displacement in the control group. To conclude, disc displacement is probably the most common cause to TMJ sounds, while the existence of TMJ sounds due to a muscular incoordination can be questioned. Furthermore, sleeping on the stomach might be associated with disc displacement, while general joint laxity is probably not a causative factor, but a seeking care factor in patients with disc displacement.] Elfving L, Helkimo M, et.al. *Swed Dent J.* 2002;26(1):9-19.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=12090160&dopt=Citation

301. **Temporomandibular disorders in the medical practice.** [Patients suffering with various orofacial pain conditions are likely to seek advice and treatment from a family physician. Temporomandibular disorders (TMD) are common in the general population, and the clinician should be aware of the common associated signs and symptoms so that proper therapy can be provided. The family physician can often provide initial therapies that are effective in reducing TMD symptoms. In some instances, it is appropriate for the family physician to refer the patient to a dentist for a more comprehensive evaluation of the masticatory system. This article describes the common patient complaints associated with TM disorders. A few simple therapies are discussed along with suggestions regarding the appropriate time for referral to a dentist for a thorough dental evaluation.] Okeson JP, de Kanter RJ. *J Fam Pract.* 1996 Oct;43(4):347-56.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=8874369&dopt=Abstract

302. **Temporomandibular disorders: referred cranio-cervico-facial clinic.** [The bond between temporomandibular disorders and referred craniofacial symptomatology is more and more evident. In it subsists the prevailing necessity of understanding the temporomandibular disorders and the cranio-cervico-facial referred symptomatology from a neurophysiologic and muscle-skeletal perspective contained in the stomatognathic system. Diagnosis in head and neck areas is difficult because of its complex anatomy. Some painful craniofacial syndromes exhibit the same symptoms although they don't seem objectively possible and that is what confuses the specialist and the patient. Pain in the head and the neck is one of the most complex to diagnose because of its varied origins that can be neurological, vascular, muscular, ligamental and bony. This article seeks to show some reasonable anatomical and pathophysiological connections of this muscle-skeletal disorder expressed with symptoms like tinnitus, otic fullness, otalgia and migraine among others. Disciplines in health such as neurology, the otolaryngology and dentistry share common anatomical and pathophysiological roads constructed in an increased muscular activity that generates muscle-skeletal disorders and

is difficult to locate referred craniofacial symptomatology. This revision aspires to sensitize the medical specialist and the odontologist in the understanding of the important interdisciplinary handling in the detection of this disorder. This offers better tools in the conservative therapy phase of this craniofacial referred symptomatology.] Ramirez LM, Sandoval GP, et al. *Med Oral Patol Oral Cir Bucal*. 2005 Apr 1;10 Suppl 1:E18-26. http://www.ncbi.nlm.nih.gov/sites/entrez?cmd=Retrieve&db=PubMed&list_uids=15800464&dopt=Abstract

303. **Temporomandibular joint internal derangement: relationship between joint pain and MR grading of effusion and total protein concentration in the joint fluid.** [The objective of this study was to determine whether there is any association between the protein concentration in the synovial fluid and (i) the amount of articular hydrops, as graded in magnetic resonance (MR) images, and (ii) joint pain in temporomandibular joints (TMJs) with and without displacement of the disc. Conclusion: Pain in the TMJ was not related to MR findings of effusion in internal derangement and synovial fluid aspirate findings of total protein concentration. However, total protein concentration was related to the amount of JE in DDwoR joints and painful joints were more likely to demonstrate the JE.] Güler N, Uçkan S, et al. *Dentomaxillofacial Radiology* (2005) 34, 175-181. <http://dmfr.birjournals.org/cgi/content/abstract/34/3/175?hits=25&RESULTFORMAT=&FIRSTINDEX=525&maxtoshow=&HITS=25&searchid=1&resourcetype=HWFIG>
304. **The relationship between cervical whiplash and temporomandibular joint injuries: an MRI study.** [Temporomandibular joint (TMJ) symptoms are a common finding in motor vehicle accident (MVA) patients with hyperextension/hyperflexion injuries of the cervical spine (cervical whiplash). The relationship between cervical whiplash and TMJ injuries was documented with magnetic resonance imaging (MRI) in 87 consecutive MVA cervical whiplash patients who presented with TMJ symptoms and had sustained no direct trauma to the face, head or mandible and had no TMJ complaints prior to the MVA. One hundred sixty-four TMJ patients were evaluated for internal derangement, effusion and inflammation, utilizing T1 and T2 weighted images. A high percentage of the TMJ patients demonstrated abnormal findings: disk displacement with reduction (DDR), 118/164 (72%); disk displacement without reduction (DDNR), 25/164 (15%); effusion, 113/164 (69%); inflammation or edema, 84/164 (51%); total TMJ abnormalities, 156/164 (95%). The high percentage of TMJ abnormalities in this study significantly illustrates the proximate relationship between cervical whiplash and TMJ injuries.] Garcia R, Arrington JA. *Cranio*. 1996 Jul;14(3):233-9. http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=9110615&dopt=Abstract
305. **TMJ Clicking: A Comparison of Clinical Examination, Sonography, and Axiography.** [ABSTRACT: A sample of 30 subjects, 15 with and 15 without subjective temporomandibular joint (TMJ) complaints (noises, sounds), underwent a clinical examination, a sonography and an axiography, to detect TMJ clicking. The clinical examination found 22 noisy joints in a total of 60 TMJs considered. Axiography found 19 noisy joints and sonography 32. While 90% of the examined joints showed agreement between axiography and clinical examination (with a little higher sensitivity demonstrated by clinical examination with respect to axiography), 20% of the joints were positive for clicking in sonography only. Sonography showed a high sensitivity in

detection of joint noises which suggests its utility as a screening test for early detection of craniomandibular disorders.] Bracco P, Deregibus A, et al. *Cranio*. 1997 Apr;15(2):121-6.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=9586513&dopt=Abstract

Ear Complaints - Tinnitus, Vertigo, Minniere's Syndrome

306. **A model of peripherally developing hearing loss and tinnitus based on the role of hypoxia and ischemia.** [The incidence of sensorineural hearing loss often caused by direct damage to the cochlear hair cells is by far more frequent and more serious than disorders affecting the external ear or the middle ear. Mechanisms that are discussed to be relevant for the genesis of tinnitus and acquired hearing impairment are hair cell loss, signal transduction disturbances in the region of the outer and inner hair cells and the spiral ganglion, impairment of cochlear blood flow, mechanical disturbance, and hypoxia and ischemia. The present model surveys the possible cellular and molecular biological causes of peripherally developing hearing loss and tinnitus. In particular, the paper discusses the roles of hypoxia and ischemia in the cochlea and in the etiology of the neurosensory types of tinnitus. Peripheral origins of hearing disturbances and tinnitus may be: (a) damage to the stereocilia and the tip links, (b) dysfunction of potassium channels or (c) modification of the glutamate release. Moreover, the hypoxia inducible factor-1 may have an important role to play as a key transcription factor in the cells' adaptation to hypoxia and ischemia. An impairment of the cochlear blood flow may be induced by the expression of target genes like nitrogen monoxide synthase and endothelin-1 resulting in tinnitus. The paper discusses consequences resulting from the present model for the medical treatment of peripherally developing tinnitus and hearing loss.] Mazurek B, Haupt H, et al. *Med Hypotheses* (2006) 67: 892-9.

<http://www.ionchannels.org/showabstract.php?pmid=16757123>

307. **All that rings is not from the ear: somatic tinnitus in non-clinical Subjects and the profoundly deaf.** [Evidence has been accumulating linking clinical tinnitus to the somatosensory system. Most clinical tinnitus patients can change the acoustic properties of their tinnitus with forceful head and neck contractions. The significance of such somatic modulation of tinnitus was assessed by testing non-clinical subjects. Like clinical tinnitus patients, about 80% of non-clinical subjects, who had ongoing tinnitus at the time of testing (whether or not they had been previously aware of it), could modulate their tinnitus with head and neck contractions. Half of those with no tinnitus at the time of testing could elicit a tinnitus-like auditory percept with head and neck contractions. Because similar results were found in the profoundly deaf, we conclude that neural somatosensory-auditory interactions within the central nervous system are accounting for most, if not all, somatic modulation of tinnitus as well as the development of auditory percepts with somatic testing. Somatic influences upon auditory perception are not limited to tinnitus subjects but are a fundamental property of the auditory system.] Levine RA, Abel M and Cheng H. *Massachusetts Eye and Ear Infirmary; Massachusetts General Hospital; Harvard Medical School; Harvard Dental School; Massachusetts Institute of Technology, Boston.*

<http://72.14.253.104/search?q=cache:xPMZUtOUJzMJ:epl.meei.harvard.edu/~ral/LevineFremantle.pdf+&hl=en&ct=clnk&cd=1&gl=us>

308. **Cervical Signs and Symptoms in Patients with Meniere's Disease: A Controlled Study.** [This study compares the frequency of signs and symptoms from the cervical spine in 24 patients diagnosed with Meniere's disease and 24 control subjects from a population sample. From a previous controlled comparative study concerning signs and symptoms of craniomandibular disorders, 24 patients diagnosed with Meniere's disease (10 males and 14 females) and their 24 matched control subjects participated in this investigation on the state of the cervical spine. Symptoms of cervical spine disorders, such as head and neck/shoulder pain, were all significantly more frequent in the patient group than in the control group. Most of the patients (75%) reported a strong association between head neck movements in the atlanto-occipital and atlanto-axial joints and triggered attacks of vertigo. Also, 29% of the patients could influence their tinnitus by mandibular movements. Signs of cervical spine disorders, such as limitations in side-bending and rotation movements, were significantly more frequent in the patient group than in the control group. Tenderness to palpation of the transverse processes of the atlas and the axis, the upper and middle trapezius, and the levator scapulae muscle were also significantly more frequent in the patient group. The study shows a much higher prevalence of signs and symptoms of cervical spine disorders in patients diagnosed with Meniere's disease compared with control subjects from the general population.] Bjorne A, Berven A, Agerberg G. *Cranio*. 1998 Jul;16(3):194-202.
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=9852812&dopt=Abstract
309. **Long-term effect on tinnitus by treatment of temporomandibular disorders: A two-year follow-up by questionnaire.** [Objective. The aim of the study was to investigate the presence of symptoms and signs of temporomandibular disorders (TMD) in patients with tinnitus and to evaluate the effect of TMD treatment on tinnitus in a long-term perspective in comparison with a control group of patients on a waiting list. ... Conclusion. The results of this study showed that TMD symptoms and signs are frequent in patients with tinnitus and that TMD treatment has a good effect on tinnitus in a long-term perspective, especially in patients with fluctuating tinnitus.] Tullberg M, Ernberg M. *Acta Odontologica Scandinavica*, Volume 64, Issue 2 April 2006, pages 89 – 96.
<http://www.informaworld.com/smpp/content~content=a743916494~db=all>
310. **Muscle Contractions and Auditory Perception in Tinnitus Patients and Nonclinical Subjects.** [Evidence has been accumulating linking subjective tinnitus to the somatosensory system. Most subjective tinnitus patients can change the psychoacoustic attributes of their tinnitus with forceful head and neck contractions. This study assessed the significance of such somatic modulation of tinnitus by testing nonclinical subjects. Like tinnitus patients, about 80% of nonclinical subjects, who had ongoing tinnitus at the time of testing (whether or not they were previously aware of it), could modulate their tinnitus with head and neck contractions. Over half of those with no tinnitus at the time of testing could elicit a tinnitus-like auditory perception with head and neck contractions. The finding that forceful head and neck contractions, as well as loud sound exposure, were significantly more likely to modulate ongoing auditory perception in people with tinnitus than in those without tinnitus supports the concept of a neural threshold for tinnitus. Somatic influences upon auditory perception are not limited to tinnitus sufferers but appear to be a fundamental property of the auditory system.] Abel MD, Levine RA. *Cranio*. 2004 Jul;22(3):181-91.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=15293775&dopt=Abstract

311. **Objective Tinnitus and the Tensor Tympani Muscle.** [Objective tinnitus (OT) may be caused by contraction of the tensor tympani muscle (TTM). The more forcefully the TTM contracts, the greater the intensity of the OT heard. Forceful closure of both eyelids can reflexively cause OT by contracting the TTM. The Forceful Eyelid Closure Syndrome (FECS) was reported at the Proceedings of the Second International Tinnitus Seminar in 1983.(1) FECS consists of several factors: (1) Objective tinnitus (2) An associated waning of hearing primarily of the lower frequencies, as much as 45 dB at 125 Hz, 30 to 40 dB at 250 Hz ascending to the patient's norm at 2000 Hz and approximately a 5 to 10 dB at 4000 Hz and 5 to 20 dB at 8000 Hz (3) Retraction of the manubrium and posterior mid-third of the tympanic membrane (TM) at the malleus-umbo area as seen under the otomicroscope (OM) in 25% (108) of 432 ears examined (4) These same ears were 75% (324) positive for increased impedance at maximum compliance with FEC. Of the patients studied, 25% had no response under the otomicroscope or by impedance audiometry.] Rock EH. *Int Tinnitus J.* 1995;1(1):30-37.
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=10753317&dopt=Abstract
312. **The Relationship of Tinnitus to Craniocervical Mandibular Disorders.** [Patients with craniocervical mandibular (TMD) disorders can present with tinnitus as a primary or secondary complaint. The embryology and functional anatomy of the middle ear, temporomandibular joint, muscles of mastication and associated tendons, ligaments, blood vessels, nerves and lymphatics was found to be helpful in establishing etiologic concepts which relate tinnitus to these temporomandibular disorders. In addition to etiologic concepts, treatment modalities are described. The authors relate their experiences as well as those of others with different patient populations.] Gelb H, Gelb ML, Wagner ML. *Cranio.* 1997 Apr;15(2):136-43.
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=9586516&dopt=Abstract
313. **Tonic contractions of the tensor tympani muscle: a key to some non-specific middle ear symptoms? Hypothesis and data from temporal bone experiments.** [The results of this study show that in clinical practice it will not be easy to diagnose tonic contractions of the tensor tympani muscle and only a combination of findings will be helpful. Based on these experimental results a clinical study will be started which should clarify the diagnostic relevance of indicators of tonic tensor muscle contractions. OBJECTIVES: There are indications from the literature and from personal experience that tonic contractions of the tensor tympani muscle may play a role in some ear symptoms, such as fullness, certain cases of tinnitus, slight hearing loss or Meniere's disease-like findings. In order to prove this theory we looked for indicators, either visual or functional, to help clinically diagnose the functional state of the muscle, particularly its tonic contraction. MATERIAL AND METHODS: Experiments simulating tensor contractions were carried out on temporal bone specimens. Traction was applied either to the isolated muscle, to its tendon or to the malleus neck. Effects were observed either visually via an endoscope or by impedance audiometry using multiple-frequency tympanometry. RESULTS: During simulated tensor traction the aspect of the tympanic membrane changed slightly, i.e. there was some inward movement of the umbo.]

However, such effects were only identifiable during the pulling action or by directly comparing the "contracted" and "relaxed" states. Tympanometry revealed a decrease in the peak amplitudes and a shift in the middle ear resonance towards higher frequencies during contractions.] Pau HW, Punke C, et al. *Acta Otolaryngol.* 2005

Nov;125(11):1168-75.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=16243741&dopt=Abstract

314. **Trigeminal Input Modulates Acoustic Stapedius Reflex and Inner Ear Function.** [Ear symptoms, such as stuffy ear sensation, tinnitus and vertigo, are frequently reported by patients with temporomandibular muscle and joint disorders (TMJDs), however, the arising mechanism of these symptoms still remained to be clarified. The aim of this study was to demonstrate the neural connection between trigeminal system and auditory system by means of neurotology devices. ... Conclusions: This study provides the evidence that electrical stimulation of bilateral masseter muscles can modulate acoustic stapedius reflex and inner ear function. Neurotology devices may become diagnostic tool to evaluate ear symptoms in patients with TMJDs. Further study is needed to clarify the arising mechanism of ear symptoms in patients with TMJDs.] Ito M, Okubo M, et al. *IADR General Session June 28, Brisbane AU.*
http://iadr.confex.com/iadr/2006Brisb/techprogram/abstract_81667.htm

Tonsils, Adenoids, & Surgery

315. **Improvement of bruxism after T & A surgery.** [Bruxism or tooth grinding is an oral habit that frequently occurs during sleep. Some authors suggest it is associated to sleep apnea. **Objective:** The main goal of this study is compare the incidence of bruxism before and after adenotonsillectomy (T & A surgery) in children with sleep-disordered breathing. **Methods:** This is a prospective study in which we evaluated 69 consecutive children from the Otolaryngology Department of the University of São Paulo Medical School in pre- and post-surgical periods of adenotonsillectomy. Before and after surgery parents answered a questionnaire about sleep-disturbed breathing and bruxism. Children were submitted to E.N.T. examination and speech pathologist evaluation. The orthodontist inspected malocclusion. Before surgery all the 69 children presented sleep apnea and 45.6% presented bruxism. Malocclusion could be found in 60.71%. Three months after surgery none of the children presented breathing problems and only 11.8% presented bruxism. There was no difference in malocclusion. **Conclusion:** This study suggests that there is a positive correlation between sleep-disordered breathing and bruxism. There was an important improvement of bruxism after T & A surgery. Otolaryngologists must be aware that this pernicious sleep disorder is associated to airway obstruction and so, it must be considered when evaluating T & A hyperplasia.] DiFrancesco RC, Junqueira PAS, et al. *International Journal of Pediatric Otorhinolaryngology*, Vol. 68, Issue 4, p.441-445. April 2004.
http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6T7V-4BK2JJ6-2&_user=10&_coverDate=04%2F30%2F2004&_rdoc=1&_fmt=&_orig=search&_sort=d&_view=c&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=936226b75e238f2f5ceb2d3671194299
316. **Muscular, functional and orthodontic changes in pre school children with enlarged adenoids and tonsils.** [Introduction: Hypertrophy of the adenoids and palatine

tonsils is the second most frequent cause of upper respiratory obstruction and, consequently, mouth breathing in children. Prolonged mouth breathing leads to muscular and postural alterations which, in turn, cause dentoskeletal changes. *Objective:* The aim of this study was to determine muscular, functional and dentoskeletal alterations in children aged 3–6 years. *Materials and methods:* Seventy-three children, including 44 with tonsil hypertrophy and 29 controls, were submitted to otorhinolaryngologic, speech pathologic and orthodontic assessment. *Results:* Otorhinolaryngologic evaluation revealed a higher incidence of nasal obstruction, snoring, mouth breathing, apneas, nocturnal hypersalivation, itchy nose, repeated tonsillitis and bruxism in children with tonsils hypertrophy. Speech pathologic assessment showed a higher incidence of open lip and lower tongue position, and of hypotonia of the upper and lower lips, tongue and buccinator muscle in these children, accompanied by important impairment in mastication and deglutition. Orthodontic evaluation demonstrated a higher incidence of lower mandible position in relation to the cranial base, a reduction in lower posterior facial height, transverse atresia of the palate, and a dolicofacial pattern. *Conclusion:* Postural and functional alterations anticipate dentoskeletal changes, except for the facial pattern. Postural alterations and the skeletal pattern seem to play an important role in infant dentofacial growth.] Valera FCP, Travitzki LVV, et al. *International Journal of Pediatric Otorhinolaryngology*, Vol. 67, Issue 7 p.761-770. July 2003.
http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6T7V-48JSR10-4&_user=10&_coverDate=07%2F31%2F2003&_rdoc=1&_fmt=&_orig=search&_sort=d&_view=c&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=552ff0266271b14e08b6160d4d48377d

Injury – Whiplash, Cervical Injury, etc.

317. **Head and Neck Injury (HANI) as a Risk Factor for Development of Chronic Daily Headache (CDH): A Population Based Study.** [HANI is a significant risk factor for occurrence of CDH, whether or not occurring proximate to CDH onset There was a dose-response relationship between HANI and CDH. In this population sample, the estimated proportion of CDH cases theoretically due to HANI was 15% for all HANI and 5% for HANI within two years of CDH onset. HANI and cumulative burden of HANI are significant contributors to risk of CDH.] Couch JR, Lipton RB, et al. *Am Academy of Neurology*, 59th annual meeting, April/May 2007.
http://www.abstracts2view.com/aan2007boston/view.php?nu=AAN07L_S05.002
318. **The Craniocervical Connection: A Retrospective Analysis of 300 Whiplash Patients with Cervical and Temporomandibular Disorders.** [Because the concept of whiplash as a causative factor for temporomandibular disorders (TMD) is highly controversial, we decided to do a retrospective analysis of patients treated in our office who had sustained whiplash injuries and were treated for cervical and temporomandibular disorders. The records of 300 patients with TMD preceded by a motor vehicle accident were examined retrospectively. The most common presenting symptoms, in order, were: jaw pain, neck pain, post-traumatic headache, jaw fatigue, and severe temporomandibular joint (TMJ) clicking. The most common TMD diagnoses were: masseter trigger points, closing jaw muscle hyperactivity, TMJ synovitis, opening jaw muscle hyperactivity, and advanced TMJ disk derangement. Based primarily on the physical examination, we concluded that the TMJ and surrounding musculature should be

examined similarly to other joints, with no preconceived notion that TMD pathology after whiplash is unlikely.] Friedman MH, Weisberg J. *Cranio*. 2000 Jul;18(3):163-7.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&list_uids=11202833&dopt=citation

319. **The Relationship Between Cervical Whiplash and Temporomandibular Joint Injuries: An MRI Study.** [Temporomandibular joint (TMJ) symptoms are a common finding in motor vehicle accident (MVA) patients with hyperextension/hyperflexion injuries of the cervical spine (cervical whiplash). The relationship between cervical whiplash and TMJ injuries was documented with magnetic resonance imaging (MRI) in 87 consecutive MVA cervical whiplash patients who presented with TMJ symptoms and had sustained no direct trauma to the face, head or mandible and had no TMJ complaints prior to the MVA. One hundred sixty-four TMJ patients were evaluated for internal derangement, effusion and inflammation, utilizing T1 and T2 weighted images. A high percentage of the TMJ patients demonstrated abnormal findings: disk displacement with reduction (DDR), 118/164 (72%); disk displacement without reduction (DDNR), 25/164 (15%); effusion, 113/164 (69%); inflammation or edema, 84/164 (51%); total TMJ abnormalities, 156/164 (95%). The high percentage of TMJ abnormalities in this study significantly illustrates the proximate relationship between cervical whiplash and TMJ injuries.] Garcia R, Arrington JA. *Cranio*. 1996 Jul;14(3):233-9.
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=9110615&dopt=Abstract

Trigeminal Neuralgia

320. **A Trigeminal Neuralgia-like Paroxysmal Pain Condition Presumably Due to Buccal Nerve Compression in the Temporalis Muscle.** [We encountered three patients with trigeminal neuralgia-like paroxysmal pain in the buccal nerve region. In all cases, paroxysmal pain was felt spreading to the receptive field of the ipsilateral buccal nerve, and clear tenderness was observed during intraoral palpation at the inner side of the mandibular ramus where the temporalis muscle runs and attaches. It was assumed that the paroxysmal pain might be caused by nerve compression related to temporalis muscle hyperactivity. To lend support to this hypothesis, we also studied the anatomical relationship between the buccal nerve and the masticatory muscles. In this autopsy study, the buccal nerve pierced the temporalis muscle in six (12%) of 52 specimens from 26 cadavers. These findings support the hypothesis that peripheral buccal nerve compression could be an etiology of paroxysmal neuropathic pain in the unilateral orofacial region.] Maeda S, Miyawaki T, et al. *Cranio*. 2001 Jan;19(1):56-60.
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=11842842&dopt=Abstract
321. **The "Missing Link" in the Origin of Trigeminal Neuralgia: A New Theory and Case Report.** [Tic Douloureux (Trigeminal Neuralgia) has afflicted mankind for centuries, perhaps for all time. This sharp stabbing paroxysm of pain along the branches of the trigeminal nerve is described as "...one of the most painful problems that plagues mankind." Many theories about the cause of trigeminal neuralgia have been previously presented. Often these theories build on the previous foundations when new research presents itself. The complete picture still eludes researchers today. Much of the mechanism has been proposed, but researchers lacked one essential component. There

has never been an answer to why these pains only occur in cranial segments and why, thankfully, TN is rare. What sets the stage for the development of TN? The unique neurophysiology of the trigeminal nerve and the accompanying ability of the Temporomandibular joints to create a sensitized neural system are the last piece of the puzzle. This central sensitization of the Trigeminal Nerve allows the development of a small cluster of neurons that act as a central trigger for the paroxysmal pain. The role of the TMJ in trigeminal neuralgia is illustrated by this case report.] Miller D. *The Functional Orthodontist January-March 1999*. <http://www.tmjfacialpain.com/pub6.htm>

322. **The Prevalence of Trigeminal Neuritis with TMD.** [Subjects with temporomandibular joint disorder (TMD) occasionally present with additional orofacial pain complaints. These can arise from dysfunction in teeth, bones, ligaments, tendons, nerves, and other structures. In this retrospective study, a group of 501 consecutive subjects with TMD complaints were evaluated for the presence of trigeminal neuritis. Very little information on the prevalence of this condition concomitant with TMDs exists in the literature. The existence of trigeminal neuritis was determined by the presence of pain when palpating trigeminal peripheral nerve branches exiting the supraorbital, infraorbital, and mental foramina in addition to the supratrochlear nerve. Each subject in this study had the involved nerves blocked with local anesthesia injections or lidocaine iontophoresis to assist in confirming the source of pain. Sixty subjects with TMD were found to have trigeminal neuritis. Early recognition of this disorder is important because treatment is usually more successful in the acute peripheral state.] Dupont JS. *Cranio*. 2003 Jul;21(3):180-4. http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=12889673&dopt=Abstract

Treatments

323. **Anterior Repositioning Appliance Therapy for TMJ Disorders: Specific Symptoms Relieved and Relationship to Disk Status on MRI.** [Forty-eight (48) consecutive patients seeking treatment in a referral based practice for complex chronic painful temporomandibular joint (TMJ) disease were enrolled in a prospective study to assess specific symptom relief from anterior repositioning appliance (ARA) therapy and the relationship between specific symptom relief and the status of the TMJ disk. Each patient was assessed on 86 symptoms based upon whether each symptom was present before treatment and absent, better, unchanged or worse after Maximum Medical Improvement (MMI). The most common symptom was occipital cephalalgia (94%). The least common symptom was pain and burning of tongue (8%). A profile of a temporomandibular disorder (TMD) patient was developed. The typical TMD patient has cephalalgia, mainly in the occipital, temporal and frontal region, pain upon chewing food, pain upon opening and closing the mouth, TMJ pain, pain in the back of the neck and difficulty chewing food. Before treatment, patients with bilateral displaced disks had more symptoms than those with unilateral displaced disks and the opposite side normal. After MMI, the maximum benefit (percent of pretreatment symptoms relieved) was found in patients with normal or recaptured disks. The minimum occurred in patients whose disks did not recapture with therapy. ARA therapy improved or eliminated symptoms in all patients in the study.] Simmons HC, Gibbs SJ. *Cranio*. 2005 Apr;23(2):89-99.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=15898565&dopt=Abstract

324. **Comparison of Moist and Dry Heat Penetration Through Orofacial Tissues.** [Application of superficial moist heat has been shown to have a beneficial effect on Temporomandibular Disorder (TMD) symptoms and is often recommended for patients with this disorder. A review of the literature shows that few studies have compared the effects of moist to dry heat. Throughout this study, moist and dry heat were applied through a commercial heating pad alternately for 20 minute intervals. The application sequence was randomized and all individuals received both moist and dry modalities. Intraoral and extraoral thermocouples were positioned on the mid-cheek area of 46 volunteers to record temperature readings. Dry and moist heat applications were equally effective in both maximum tissue temperature rise and the rate of thermal transfer ($p > 0.05$). However, in a small number of subjects moist heat was preferred. As there seems to be little difference between using moist rather than dry heat, patients may be counseled to employ the superficial heating option that: 1. is an individual's personal preference or 2. improves convenience and optimizes compliance.] Poindexter RH, Wright EF, Murchison DF. *Cranio*. 2002 Jan;20(1):28-33.
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=11831341&dopt=Abstract
325. **Effect of Anterior Repositioning Splints on the Electromyographic Activities of Masseter and Anterior Temporalis Muscles.** [The effect of anterior repositioning (AR) splint therapy on masticatory muscle activity was investigated in seventeen patients with internal derangement; disk displacement with reduction in particular. Integrated electromyography (EMG) recordings from the masseter and anterior temporalis muscles were analyzed quantitatively during maximal biting in intercuspal position before and after eight week treatment period, EMG recordings were taken for each subject prior to the beginning of clinical therapy and final EMG recordings were made without AR splint to provide a standard for comparison. The results of the investigation revealed the following: 1. AR splint therapy did not cause any significant modification of the EMG activity in the recorded muscles during maximal biting in intercuspal position; 2. Before and after treatment the EMG activity from the masseter muscle was less than from the temporal muscle; 3. AR splint therapy resulted in reduction of the pain (88.2%) and jaw joint sounds (64.7%) and mean vertical opening which was 42.17 mm before treatment increased to 45.06 mm.] Hersek N, Uzun G, et al. *Cranio*. 1998 Jan;16(1):11-6.
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=9481981&dopt=Abstract
326. **Effect of Short-Term Use of a Centric Occlusion Stabilization Oral Appliance On Sensory and Pain Perception Thresholds in the Cervically Innervated Area.** [This preliminary study was done to determine the effect of short-term use of a centric occlusion stabilization oral appliance with regard to noxious and sensory perception in the upper extremities. The subjects consisted of 22 asymptomatic females, and the experiments were performed on two separate days within the same week, with the days randomly assigned as either appliance-wearing or nonappliance-wearing days. For each experimental day, cool sensation, warm sensation, cold-induced pain and heat-induced pain were measured using a computer-based quantitative testing device, and these thresholds were compared between the experimental days with or without the oral

appliance. We found that during the experimental day wearing an oral appliance, subjects had significantly higher thresholds for warm sensation and heat-induced pain. There was no statistical difference between the testing days in cool sensation or cold-induced pain thresholds. These findings indicate that short-term wearing of a centric occlusion stabilization oral appliance may inhibit some noxious and sensory inputs from cervically innervated structures, which are primarily served by unmyelinated C fibers, and that oral appliances may be appropriate for the treatment of painful cervical disorders.] Kashima K, Ogihara M, et al. *Cranio*. 2005 Oct;23(4):278-82.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=16353468&dopt=Abstract

327. **Long-Term Outcome After Treatment of Temporomandibular Joint Osteoarthritis with Exercise and Manual Therapy.** [In a previous study, exercise and manual therapy demonstrated a 90% success rate in patients with osteoarthritis of the temporomandibular joints in the short-term. The aim of this follow-up study was to assess the long-term effect of these treatment modalities. Seventeen patients were evaluated. All patients suffered from osteoarthritis of the temporomandibular joints with pain in the temporomandibular joint at baseline and were treated successfully in a prior short-term study. The parameters were pain at rest and at chewing, impairment in daily life, and mouth opening. At follow-up, 11 patients (65%) experienced no pain and 13 patients (76%) had no pain at rest (Fisher's Exact Test: $p < 0.02$). Thirteen patients (76%) had a normal incisal edge clearance, and ten patients (59%) felt no impairment due to the disease (Fisher's Exact Test: $p = 0.01$). Thirteen patients (76%), who had been treated once successfully, have not needed treatment within the three years after cessation of their therapy. Exercise therapy is an effective tool to treat osteoarthritis of the temporomandibular joints.] Nicolakis P, Erdogmus CB, et al. *Cranio*. 2002 Jan;20(1):23-7.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=11831340&dopt=Abstract

328. **Manual physical therapy interventions and exercise for patients with temporomandibular disorders.** [The purpose of this study was to investigate the outcome of a series of consecutive patients with temporomandibular disorder (TMD) who were treated with manual physical therapy interventions and exercise. Consecutive patients with the clinical presentation of TMD completed several self-report measures and underwent a standardized historical and physical examination. Following the examination, patients received a multimodal treatment approach incorporating manual physical therapy and exercise. All self-report questionnaires were completed at a 2-week follow-up. Paired t-tests were performed between the baseline and 2-week follow-up scores. The mean TMD Disability Index scores were 32.1% (15.4%) at baseline and 18.3% (12.5%) at the 2-week follow-up, representing an improvement of 13.9% (CI: 8.2%, 19.5%) ($p < 0.05$). Patient Specific Functional Scale (PSFS) scores improved 3.1 points (CI: 2.3, 3.9) ($p < 0.05$). These results suggest that patients with TMD who are treated with a rehabilitation program including manual physical therapy interventions plus exercise, with or without iontophoresis with dexamethasone, can demonstrate clinically meaningful improvements in disability and overall perceived change in a relatively short period of time.] Furto ES, Cleland JA, et al. *Cranio*. 2006 Oct;24(4):283-91.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=pubmed&list_uids=17086858&cmd=Retrieve&indexed=google

329. **Occlusal stabilization appliance. Evaluation of its efficacy in the treatment of temporomandibular disorders.** [Occlusal stabilization appliances or splints are the most widely employed method for treatment of temporomandibular disorders (TMD). Magnetic Resonance Imaging (MRI) is the most indicated imaging modality to evaluate the components of the temporomandibular joint (TMJ). Forty patients with signs and symptoms of temporomandibular disorders were treated with splints for a mean period of 12 months, comprising regular semimonthly follow-ups. After stabilization of the clinical status, occlusal adjustments and MRI evaluation were performed. It was concluded that the success of this kind of treatment are related to the total (70%) or partial improvement (22.5%) of painful symptomatology and to the functional reestablishment of the craniomandibular complex. The MRI allowed evaluation and also the conclusion that the splints provide conditions for the organism to develop means to resist to the temporomandibular disorders by means of elimination of several etiologic factors. Moreover, after treatment the patients are able to cope with disc displacements with larger or smaller tolerance.] Tanaka EE, Arita ES, et al. *J. Appl. Oral Sci.* vol.12 no.3 http://www.scielo.br/scielo.php?pid=S1678-77572004000300015&script=sci_arttext
330. **Randomized Effectiveness Study of Four Therapeutic Strategies for TMJ Closed Lock.** [For individuals with temporomandibular joint (TMJ) disc displacement without reduction with limited mouth opening (closed lock), interventions vary from minimal treatment to surgery. ... The findings of this study suggest that primary treatment for individuals with TMJ closed lock should consist of medical management or rehabilitation. The use of this approach will avoid unnecessary surgical procedures.] Schiffman EL, Look JO, et al. *Dent Res* 86(1):58-63, 2007. <http://jdr.iadrjournals.org/cgi/content/abstract/86/1/58>
331. **Response of temporomandibular joint intermittent closed lock to different treatment modalities: A multicenter survey.** [This study investigated the clinical picture and different treatment methods and results at a number of institutions with the aim of establishing an effective method of treatment for intermittent closed lock (intermittent lock) of the temporomandibular joint (TMJ). The subjects were 104 patients (29 males, 65 females) diagnosed with intermittent lock among 1787 temporomandibular disorder patients. The cases were classified into two types based on the time and occasion when the intermittent lock occurred. The sudden onset type developed in 69.2%, and the habitually occurring type in 29.8%. The most common treatment was disk repositioning exercises alone (in 41 cases) followed by stabilization splints during sleeping. The highest efficacy rate (60.0%) was obtained with the combination of disk repositioning exercise and a repositioning splint followed by a rate of 52.6% with stabilization splints and 41.7% with disk repositioning exercise alone.] Yoda T, Sakamoto I, et al. *Cranio*. 2006 Apr;24(2):130-6. http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=16711275
332. **Temporomandibular Disorder Treatment Outcomes: First Report of a Large-Scale Prospective Clinical Study.** [The diagnosis and treatment of temporomandibular disorders (TMD) has been surrounded by considerable controversy. Clinical research in the field to date has been inconsistent and methodologically limited

and has not firmly established the role of treatment interventions. This large scale, multisite study attempts to answer some of the questions regarding TMD diagnosis and treatment. More than 6,500 patients are currently being analyzed and 1,212 have completed TMD therapy, providing the basis for comparison with 198 untreated patients. A wide variety of treatments have been administered from 60 practice sites, whose practitioners were carefully calibrated to maximize inter-rater reliability. A validated symptom measurement system, the TMJ Scale, was employed to assure uniform assessment of treatment outcomes. Treated patients reported statistically and clinically significant symptom improvement, while untreated patients reported unchanged symptom levels. **Data presented here do not support the hypothesis that TMD patients improve spontaneously without treatment.** Gaudet El, B rown DT. *Cranio*. 2000

Jan;18(1):9-22.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=11202819&dopt=Abstract

333. **The treatment of painful temporomandibular joint clicking with oral splints.** [The authors compared the efficacy of bilateral balanced and canine guidance (occlusal) splints in the treatment of temporomandibular joint (TMJ) pain in subjects who experienced joint clicking with a nonoccluding splint in a double-blind, controlled randomized clinical trial. The type of guidance used did not influence the pain reduction, yet both occlusal splints were superior to the nonoccluding splint, on the basis of the VAS. Despite similar outcomes in relation to opening, left lateral and protrusive movements, TMJ and muscle pain on palpation, subjects who used the occlusal splints had improved clinical outcomes. The frequency of joint noises decreased over time, with no significant differences among groups. Subjects in the groups using the occlusal splints reported more comfort. The type of lateral guidance did not influence the subjects' improvement. All of the subjects had a general improvement on the VAS, though subjects in the occlusal splint groups had better results than did subjects in the nonoccluding splint group.] Conti PCR, dos Santos CN, et al. *J Am Dent Assoc*, Vol 137, no 8, 1108-1114. <http://jada.ada.org/cgi/content/abstract/137/8/1108>
334. **The Treatment of Temporomandibular Disorders Through Repositioning Splint Therapy: A Follow-up Study.** [The purpose of this study was to investigate the effectiveness of repositioning splint therapy as a conservative treatment modality for TMD patients. The treatment sequence of 160 randomly sampled TMD patients was monitored in order to assess different aspects of the patients' response to splint therapy. Included among these aspects were the pretreatment symptoms; the treatment duration required for initial and final alleviation of symptoms; the number of patients requiring surgery; and the particular appliance and its wear pattern utilized to maintain the treatment results. The treatment success was based on the remission of symptoms including but not limited to pain to palpation, headaches, earaches, jaw locking, and joint noises. Eighty-nine and four tenths percent (89.4%) of the patients experienced a complete remission of symptoms and did not require any surgical intervention. The average time for initial improvement was 22.3 days, while the average time for complete remission of symptoms was 4.3 months. The results of the study indicate that repositioning splint therapy is an effective treatment modality for the conservative treatment of temporomandibular disorders.] Williamson EH, Rosenzweig BJ. *Cranio*. 1998 Oct;16(4):222-5.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=10029748&dopt=Abstract

335. **The treatment of temporomandibular disorders with stabilizing splints in general dental practice.** [The authors evaluated temporomandibular disorder (TMD) outcomes in general dental practice one year after treatment with stabilizing splints (SS) or nonoccluding control splints (CS). . . .Improvements after initial treatment were maintained at one year for all outcomes, except for TMJ clicking, which returned to pretreatment levels. Eighty-one percent of the subjects rated their treatment as either good or excellent in reducing jaw pain. The authors found that subjects were aware of more of their TMJ clicks than dentists observed at the one-year clinical examination, but most subjects thought their clicking or the associated pain had been reduced. Fifty-five percent subjects had used their splints in the previous six months, but only 31 percent of these had done so daily. There were no significant differences between splint groups. At one year, a good response to TMD treatment in general practice had been maintained, but many subjects still had clicking TMJs.] Wassell RW, Adams N, et al. *J Am Dent Assoc*, Vol 137, No 8, 1089-1098. <http://jada.ada.org/cgi/content/abstract/137/8/1089>