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Article *in* Progress in Orthodontics · May 2011

DOI: 10.1016/j.pio.2010.09.010 · Source: PubMed

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Review

Dental occlusion and posture: an overview

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ARTICLE INFO

Article history:
Received 21 December 2009
Accepted 28 September 2010

Keywords:
body sway
Crossbite
head posture
malocclusion
scoliosis
spine curvatures

ABSTRACT

Objectives: In recent decades, it has been suggested that disorders of the masticatory system such as malocclusions, can influence whole body posture. A growing number of patients are seeking concomitant treatment for dental malocclusions and postural disorders. The aim of this overview is to critically analyze the relationship between dental occlusion and posture.

Materials and methods: A literature overview was carried out to analyze the association between "malocclusion" versus "head posture", "spine curvature", and "body sway".

Results: The studies showed that even if some associations have been found between occlusal factors and postural alterations, there is not enough scientific evidence to support a cause-effect relations. Most studies suffer from major flaws such as lack of control groups, failure to take into account for the possible confounders, inappropriate study design, and lack of sufficient reliability and validity of used diagnostic tests.

Conclusions: On the basis of this overview, it is not advisable to perform occlusal and/or orthodontic treatment, especially if irreversible and expensive, to treat or prevent postural imbalances or alteration of spine curvatures.

1. Link between malocclusion and posture: background and rationale

The human posture is the result of positioning and orientation of the body and limbs in equilibrium with motion and gravitation. It has been demonstrated that respiration, head and neck position, mood states, especially anxiety, can modify posture[1]. Postural adjustments, consisting in slight sways, include visual, vestibular and somatosensory inputs integrated in a complex regulatory system[2]. The erect position of the head is maintained by a balanced tension between craniocervical bones, myofascial structures and dental occlusion. Finally, the upper cervical spine is the mediator between head and trunk and forms an anatomically and functionally interrelated system[3]. Neuroanatomical connections between the oral and cervical area have been well documented. Afferents from the periodontal apparatus, jaw muscles and TMJ converge on trigeminal nuclei together with sensory information from the cervical spine, while projection of the trigeminal neurons descend further down to C5, C6, C7, and to the vestibular nuclei[4]. At the neurophysiological level, the stimulation of C1 dorsal root can evoke headache and orofacial pain as a consequence of referred pain related to convergence

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1723-7785/$ – see front matter
doi:10.1016/j.pio.2010.09.010

of nociceptive stimuli originating from the glossopharyngeal and vagal nerve and/or from neck and dural vessels within the trigeminal subnucleus caudalis[5,6].

Hence, the functional and anatomical relationships between the masticatory system and posture control system give the rationale for a possible association between postural disorders and malocclusions. In this respect, the craniomandibular relationship, i.e. the way in which the teeth fit together, might play a key role. These correlations have also been reported in a recent review, indicating that the combination of occlusal and trigeminal afferents may play a role in mantaining body postural control.[7]

The possibility that an occlusal correction could be used to treat postural dysfunctions is very appealing for dentists, as they might considerably extend their spectrum of interventions. Therefore, the aim of this study was to analyze the correlations between occlusal and postural disorders by means of a critical overview of the literature.

Recent studies emphasize the potential role of mandibular position[8,9] in maintaining postural control. Since mandibular posture and function are strongly influenced from the position of teeth, different dental occlusions have been considered as potentially influencing the body posture. Bracco et al.[8] found that in subjects free from malocclusions, different jaw relations influence body posture. In particular, the so-called myocentric jaw position caused a reduction in body sway and an improvement in weight distribution on the foot area. Gangloff et al.[9] evaluated postural control while keeping the mandible in four different positions imposed by interocclusal splints. Postural control and gaze stabilization decreased, from the best to the worst, with splints in centric relation, intercuspal position, and lateral occlusion, respectively. Even though the results reported in these studies are statistically significant, they cannot be considered clinically relevant[10]

Trigeminal afferents have been shown to influence posture in a study where the anesthesia of its mandibular branch modified postural control in human subjects[11]. There are also studies suggesting that dental occlusion may influence head posture[12], spine curvatures (e.g., scoliosis and lordosis)[13], and even leg length[14].

Also in experimental animal study is suggested that alterations in the occlusion and in jaw position could evoke changes in the position of the vertebrae and reactions of the motor system and the autonomous nervous system[15]. After unilateral teeth grinding or augmentation of the teeth, postural abnormalities in terms of inability of head maintenance, T-wave inversion on electrocardiogram, hair loss, change in tongue mobility, and eating disorders as well as ocular pathologies have been observed[3]. The observed changes normalized after restoration of the original occlusal plane or grinding of the contra lateral side. Although extrapolation of animal findings to humans can be strongly misleading, the authors concluded that in rats occlusion seems to have an impact on head position, cervical spine posture, spinal column alignment, and masticatory muscles.

These functional and anatomical relationships between the masticatory system and posture control system suggest a correlation between postural disorders and malocclusions. According to this hypothesis, a malocclusion could modify the body posture both on the frontal and sagittal plane and may eventually alter foot support. These alterations can in turn cause postural imbalances, pain and dysfunction. Since dentists can change the occlusion, it has become appealing the suggestion of an occlusal treatment in order to solve so-called postural imbalances.

2. Malocclusion and head posture

A number of studies used lateral cephalometric radiographs to analyze the relation between posture of the head and neck region, the position of the cervical vertebrae in the sagittal plane, and malocclusion by means of orthopedic reference lines and planes[3,12,16,17].

Albeit using different methods and analyses, most of the studies reported a significant correlation between distal jaw position, sagittal mandibular length, and increased cervical lordosis[3,16,17]. Indeed, children with skeletal class II showed a significantly higher extension of the head upon the spinal column compared to children with skeletal class I and skeletal class III. Recently a correlation was also found between cervical lordosis and mandibular divergency (i.e. vertical craniofacial morphology)[13]. Gadotti et al.[18], analyzed head posture and electromyographic (EMG) activity of the anterior portion of temporal and masseter muscles bilaterally among subjects with different dental occlusion classified according to Angle. The results indicated that the EMG responses of temporal and masseter muscles tend to be modified in Angle Class II subjects who present more frequently the occurrence of forward head posture. Also, Nobili et al.[19] studied this correlation by means of posturography on a group of 50 patients belonging to every Angle's malocclusion. In this, which was designed as a case series and lacked a matched control group, the subjects were asked to stand on the balance platform and to perform five different tests. The authors concluded that subjects with Class II malocclusion exhibited a forward body position, whereas body position in subjects with Class III malocclusion was posteriorly displaced. A possible causal explanation for this association was given by Solow & Sandham[20] who used the term "soft-tissue stretching": differences in craniofacial morphology could be explained by the stretching of the soft tissue layer of the skin when the head is bent backward. The increased force level would restrict the forward growth of the maxilla and the mandible.

Some points must be discussed that raise doubts on the importance of head posture in patient with different malocclusion or in patients affected by TMDs. Firstly, according to scientific evidence the degree of lordosis of the cervical spine declines with increasing age, and most studies investigating these arguments did not adjust the analyses for the possible confounding effect of age. Therefore, taking into account this effect, poor posture and jaw relation are only hardly related and should be considered independent developmental disorders [3,21-23]. Secondly, the cause-effect relationships between craniofacial form and head posture have not been clearly established. According to the "soft-tissue stretching" theory[18] variations in head posture can be the cause rather than the consequences of a malocclusion. Indeed, when the head is bent backward, the soft tissue layer of the skin is stretched and the resulting forces would restrict the forward growth

of the maxilla and the mandible. Therefore, the suggestion to treat malocclusions, especially in adults, in order to correct the head posture does not make sense. Interestingly, one study analyzed changes in resting head and neck posture in patients affected with severe skeletal malocclusions before and after orthognathic surgery with a one-year follow-up. The findings of this study indicated that over long-term the head and neck posture did not change significantly in any malocclusion groups[24].

3. Malocclusion and spine curvatures

The relationship between malocclusion, spinal curvatures as well as thoracic, lumbar, and pelvic tilts, has also been assessed, with a number of studies supporting significant associations [13,16,17,25]. The underlying hypothesis to explain this association is that an altered position and contact of the maxillary and mandibular teeth influence the distal musculature[26].

A series of human studies analyzed the correlations between the kyphotic inclination, the lordotic angle, and the pelvic inclination[25], and between parameters of body posture in the frontal profile[27], and the craniofacial morphology in healthy adult patients with different occlusal parameters. Six angular skeletal measurements (facial axis, mandibular plane angle, inner gonial angle, lower facial height, facial depth, and maxilla position) were determined based on the analysis of lateral head cephalographs. Rasterstereography was used for precise reconstruction of the back sagittal profile. Correlations were found between craniofacial parameters and thoracic, lordotic, and pelvic inclination, suggesting that there is some clinical evidence for a relationship between the vertical and sagittal position of the lower jaw and body posture. Nevertheless, in another study and with the same sample, but on the basis of different measurements, a relationship was found between jaw position and body posture in the upper part of the spine but any connection with the lower part of the spine was ruled out[13].

Scoliosis is the orthopedic pathology most frequently investigated on an interdisciplinary basis. It is characterized by left-right asymmetries on the transversal plane that might indirectly be linked to some mild forms of facial asymmetry or dental deviations in the transversal dimension[28]. Idiopathic scoliosis is an orthopedic condition characterized by faulty posture; it is a progressive, lateral deviation of the spine, often revealed in childhood and worsening during growth. The etiology is unknown, but genetic factors are mentioned, and hormonal, neurological, biochemical, and possibly biomechanical factors interact[29].

The malocclusion that has the strongest potential to influence scoliosis and leg length is the unilateral posterior crossbite. This is one of the most frequent malocclusions in deciduous and early mixed dentition, with a reported prevalence of 7% to 23%. An unilateral posterior crossbite has a strong impact on correct functioning of the masticatory system[30]. In the early stages, crossbites are associated with a lateral functional shift of the mandible in approximately 80% of the cases and may induce asymmetrical mandibular growth[31]. It was suggested that the functional displacement of the mandible for a long period suppresses or activates mandibular growth, especially in the condylar region. Accordingly, an asymmetrically positioned mandible in a unilateral crossbite patient might lead to asymmetrical condylar heights. Kilic et al.[32] investigated condylar and ramal asymmetries in unilateral crossbite patients as compared with normocclusive subjects. The patients with unilateral posterior crossbite had more asymmetric condyles than did the controls. In addition, condylar, ramal, and condylar-plus-ramal heights on the crossbite side were smaller than those on the noncrossbite side. Results from experimental animal studies also suggest that alterations in the occlusion evoke changes in condylar growth as well as in many other regions of the body. Sato et al.[33] studied the effects of a lateral functional shift of the rat mandible on the condylar cartilage during the growth period. Rats were initially divided into three groups: shift, recovery, and control. For the recovery group, the appliance was removed after 2 weeks. For the shift group, the appliance was used for 4 weeks. Results showed that in the shift group the cartilage thickness increased in the central region on the contralateral side, whereas it decreased in the lateral region on the ipsilateral side. However, in the recovery group, 1 to 2 weeks after appliance removal, the cartilage thickness became similar to that of the control groups.

A statistically significantly elevated prevalence of unilateral crossbite was observed by orthodontists in patients suffering from scoliosis. Huggare et al.[28] found an increased craniocervical angle, particularly in frontal view, and a midline shift of the lower dental arch in subjects treated for scoliosis. Ben-Bassat et al.[34] clinically examined the occlusions of 96 patients with idiopathic scoliosis and the occlusal features of a random group of 705 children as control. A greater prevalence of asymmetrical malocclusion (in upper and lower midline deviations, anterior and posterior crossbites) was found in children affected with scoliosis. No association was found between dental site, side, or severity of scoliosis and the appearance or site of the malocclusion features examined.

It has been hypothesized that the crossbite is a compensatory curvature in the visceral cranium for the transmission of the asymmetry of the body to the skull. According to the hypothesis that dental occlusion may influence whole body posture, disorders of the functioning, such as chewing and swallowing, of masticatory muscles can be transmitted to distal musculature along the so-called “muscle chains”[35] It has also been suggested that this etiological chain of events may be reversed. Hence, a difference in length of the legs may be considered either a consequence of a disorder affecting the masticatory apparatus or a risk factor for a masticatory disorder[36]

Michelotti et al. [37] investigated the potential association between leg length inequality (LLI) and posterior crossbite in a large sample of young adolescents recruited from secondary schools by means of two-stage cluster sampling. All subjects underwent an orthodontic examination. In all, 1159 subjects were selected and underwent an orthodontic and orthopedic examination. LLI was assessed using a specially designed device. A difference equal to or greater than 10 mm between leg length was considered as the clinically relevant threshold for diagnosis of LLI. In all, 120 subjects (10.3%) were diagnosed as having LLI. A unilateral posterior crossbite was found in 142

of the 1159 subjects (12.2%). Multiple logistic regression analysis failed to demonstrate a significant association between this factor and LLI, showing an odds ratio (OR) very close to 1. Therefore the findings suggest that in young adolescents, a unilateral posterior crossbite is not a risk factor for LLI.

In conclusion, transversal malocclusion, e.g. unilateral posterior crossbite, induces asymmetrical growth of the mandible and asymmetrical muscle activity, whereas early intervention can correct the skeletal deformity, achieving symmetrical growth of jaw bones. Therefore, independent of the different explanations offered of the high prevalence of crossbite in patients with alteration of the spine curvature on the frontal plane, an interdisciplinary treatment approach to create appropriate conditions for normal occlusal development, alleviate facial asymmetry and stabilize head posture, initiated as early as possible, has been recommended. It has also been shown, according to the literature, that patients with Class II, Division 1 malocclusion with increased overjet and a long face syndrome are more prone to orthopedic findings. Nevertheless, despite unanimous descriptions of an interdependence of the upper cervical spine and jaw position, there is little evidence for such correlations in more caudally located spine sections[21]. It is well known that malocclusion has a multifactorial etiology and that several factors, such as breathing mode, muscle tonicity, genetics, and oral habits play an important role in the pathogenesis. Therefore, a causal treatment approach should take all factors into account in treatment planning.

4. Malocclusion and body sway

The potential association between malocclusion and postural alterations in terms of body sway has also been a matter of debate.

Recent studies emphasize the potential role of mandibular position[8,9] in maintaining postural control. Since mandibular posture and function are strongly influenced from the position of teeth, different dental occlusions have been considered as potentially influencing the body posture. Bracco et al.[8] found that in subjects free from malocclusions, different jaw relations influence body posture. In particular, the so-called myocentric jaw position caused a reduction in body sway and an improvement in weight distribution on the foot area. Gangloff et al [9] evaluated postural control while keeping the mandible in four different positions imposed by interocclusal splints. Postural control and gaze stabilization decreased, from the best to the worst, with splints in centric relation, intercuspal position, and lateral occlusion, respectively. Also, trigeminal afferents have been shown to influence posture in a study where the anesthesia of its mandibular branch modified postural control in human subjects[11]. However statistically significant correlations were reported only in some of the analysis performed in these studies, The association between posterior crossbite and body sway has been investigated in one epidemiologic study published by Michelotti et al.[38]

Among 1291 students, twenty-six subjects (14 males and 12 females) affected with unilateral posterior crossbite with and without mandibular lateral slide were selected and compared with 52 controls with an “ideal occlusion” matched by age and gender randomly selected from a population-based sample. Postural stability was assessed by means of a stabilometric platform. Weight distribution on the foot area and the speed of body sway were not significantly influenced by crossbite (with and without lateral mandibular slide), occlusal conditions (ICP, cotton rolls), and gender. Therefore, the results do not support the hypothesis that posterior crossbite (with and without lateral slide) has any effect on weight distribution on the foot area, and on the speed of body sway. Hence, our findings are not consistent with the so-called muscle chain theory, according to which abnormal occlusal contacts can cause “imbalances” in the locomotor apparatus resulting in postural asymmetries.

The evidence arising from this study conflicts with the common belief of many dental and medical practitioners, who recommend dental or orthodontic treatment for correction of a unilateral posterior crossbite to prevent or treat so-called ‘postural imbalances’. In these cases, the treatment decision is mainly based on anecdotal or case reports rather than on scientific evidence.

The cited studies used posturography to detect correlation between body posture and stomatognathic system. A recent review has provided information on the relevance of posturography as a diagnostic aid in dentistry. The authors concluded that posturography has little relevance in the monitoring of body responses to changes in the stomatognathic system, with a large failure rate because of the large variability of the recordings[10]

Well designed studies therefore appear necessary to support clinical decision making. It must be stressed that the potential relationship between occlusion and posture has low biological plausibility since in healthy subjects (i.e., free of parafunctional activities) the teeth get in contact for a very limited amount of time (i.e., chewing and swallowing activities), which does not usually exceed 20–30 min per day. Based upon these observations, clinicians should be cautious in recommending early orthodontic or dental treatment in patients with unilateral posterior crossbite aiming only to prevent or treat postural disorders.

5. Conclusion

From the analysis of these studies it can be concluded that even if some associations have been found between occlusal factors and postural alterations, there is not enough scientific evidence to support a cause-effect relations It is reasonable that stomatognatic system can affect cervical region function, but the clinical effects and relevance on body posture are not yet well known at moment.

According to Hill[39] there are several factors that have to be taken into account when searching for a cause-effect relationship: 1) temporality (i.e. exposure to cause is followed by occurrence of disease), 2) strength of the association (i.e. relative risk), 3) dose - response (i.e. as the suspected cause increases there should be an increasing risk of the effect); 4) consistency (i.e. causation is supported when all studies designs lead to the same results); 5) reversibility (i.e. eliminating the cause should eliminate the effect);

6) biological plausibility (i.e. it should make epidemiological sense).

Literature reviews[7,10,21,23] published on this topic concluded that, despite growing interest in possible correlations between orthopedic and dental findings, there is still a lack of methodologically sound clinical studies whose results might shed light on a field dominated by hypotheses and theories. Indeed, most studies suffer from major flaws such as lack of control groups, failure to take into account for the possible confounders, inappropriate study design, and lack of sufficient reliability and validity of used diagnostic tests.

According to Perinetti et al[10], of 21 selected papers, on 1.576 studies examined: only one was a controlled clinical trial (CCT), six papers showed a full sample description and three studies respected blinding in measurements.

Finally 20 of the 21 studies analyzed had a low quality score. If the quality of the best available evidence is low, the results are apt to be misinterpreted, and there is a latent danger of over-diagnosis and over-treatment. In spite of scant current scientific evidence for these causal relationships, many dental and medical practitioners recommend dental or orthodontic treatment for correction of a dental occlusion to prevent or to treat 'postural imbalances' and temporomandibular disorders. In such cases, the treatment decision is mainly based on anecdotal or case reports rather than on scientific evidence. Well designed studies therefore appear necessary to support clinical decision making. On the basis of this review, it is not advisable to perform occlusal and/or orthodontic treatment, especially if irreversible and expensive, to treat or prevent postural imbalances or alteration of spine curvatures.

Conflict of interest

The authors have reported no conflict of interest.

Riassunto

Obiettivi: *Recentemente è stato ipotizzato che alterazioni del sistema masticatorio, come le malocclusioni, possano influenzare la postura corporea. Un numero crescente di pazienti richiede il trattamento per le malocclusioni dentarie e per i disordini posturali in contemporanea. Lo scopo di questa revisione è di analizzare criticamente la relazione tra l'occlusione dentaria e la postura.*

Materiali e metodi: *È stata effettuata una revisione della letteratura per analizzare l'associazione tra "maloccusione" e "postura della testa", "alterazioni della colonna vertebrale" e "oscillazioni corporee".*

Risultati: *Gli studi hanno mostrato che, anche se è stata trovata qualche associazione tra i fattori occlusali e le alterazioni posturali, non c'è una sufficiente evidenza scientifica che supporti un rapporto causa-effetto. La maggior parte degli studi presenta delle importanti carenze metodologiche, come la mancanza di gruppo controllo, la possibile presenza di fattori confondenti, un inappropriato disegno sperimentale e la carenza di adeguata riproducibilità e validità relativamente ai test diagnostici utilizzati.*

Conclusioni: *Sulla base di questa revisione, non è raccomandabile eseguire trattamenti occlusali e/o trattamenti ortodontici, in particolare se irreversibili e dispendiosi per trattare o prevenire alterazioni posturali o modifiche anatomo-funzionali della colonna vertebrale.*

Résumé

Objectif: *Lors des récentes décennies, on a envisagé que les troubles de la mastication, tels que les malocclusions, pouvaient influencer la posture totale du corps. Un nombre croissant de patients se soumettent à un traitement concomitant pour traiter les malocclusions dentaires et les troubles posturaux. Le but de cette vue d'ensemble est d'analyser critiquement la relation entre l'occlusion dentaire et la posture.*

Matériels et méthodes: *On a mené une étude de la littérature dans le but d'analyser l'association entre « malocclusion » par rapport à « posture de la tête », « courbure de l'épine » et « inclinaison du corps » (body sway).*

Résultats: *Les études ont montré que bien que des associations aient été identifiées entre des facteurs d'occlusion et des altérations posturales, il n'y a pas d'évidence scientifique suffisante pour établir une relation de cause à effet. La majorité des études sont biaisées par un manque de groupes de contrôles, une non-considération de possibles facteurs de confusion, une conception inadéquate de l'étude, et finalement un manque de fiabilité et de validité suffisantes des tests diagnostiques utilisés.*

Conclusions: *Sur la base de notre état des lieux, il n'est pas à conseiller de réaliser un traitement occlusal et/ou orthodontique, notamment si irréversible et couteux, pour traiter ou prévenir des déséquilibres posturaux ou bien des altérations de la courbure de l'épine.*

Resumen

Objetivos: *En las útimas décadas, se ha hipotizado que los trastornos de masticación como las malas oclusiones pueden influir en la postura total del cuerpo. Un número creciente de pacientes buscan un tratamiento concomitante para las malas oclusiones dentarias y los trastornos posturales. El propósito de esta visión de conjunto es analizar críticamente la relación entre la oclusión dentaria y la postura.*

Materiales y método: *Se llevó a cabo un análisis de la literatura con vistas a analizar una relación entre "mala oclusión" versus "postura de la cabeza" "curvatura de la espina" e"inclinación del cuerpo" (body sway).*

Resultados: *Los estudios destacaron que aunque unas asociaciones sí que se encontraron entre factores de oclusión y alteraciones posturales, no hay evidencia científica suficiente como para fraguar una relación causa-efecto. La gran parte de los estudios están marcados por sesgos, como la falta de grupos de control, el no tener en cuenta posibles factores de confusión, lo inadecuado del diseño del estudio, la falta de fiabilidad y validez suficientes de los ensayos diagnósticos utilizados.*

Conclusiones: *Con arreglo a esta visión de conjunto, no es aconsejable realizar un tratamiento de oclusión y/o ortodóncico, sobre todo si es irreversible y caro, para tratar o prevenir desequilibrios posturales o alteraciones de las curvaturas de la espina.*

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