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Review Article
Dental occlusion, body posture and temporomandibular disorders: where we are now and where we are heading for

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SUMMARY The aim of this investigation was to perform a review of the literature dealing with the issue of relationships between dental occlusion, body posture and temporomandibular disorders (TMD). A search of the available literature was performed to determine what the current evidence is regarding: (i) The physiology of the dental occlusion–body posture relationship, (ii) The relationship of these two topics with TMD and (iii) The validity of the available clinical and instrumental devices (surface electromyography, kinesiography and postural platforms) to measure the dental occlusion–body posture–TMD relationship. The available posturographic techniques and devices have not consistently found any association between body posture and dental occlusion. This outcome is most likely due to the many compensation mechanisms occurring within the neuromuscular system regulating body balance. Furthermore, the literature shows that TMD are not often related to specific occlusal conditions, and they also do not have any detectable relationships with head and body posture. The use of clinical and instrumental approaches for assessing body posture is not supported by the wide majority of the literature, mainly because of wide variations in the measurable variables of posture. In conclusion, there is no evidence for the existence of a predictable relationship between occlusal and postural features, and it is clear that the presence of TMD pain is not related with the existence of measurable occluso-postural abnormalities. Therefore, the use instruments and techniques aiming to measure purported occlusal, electromyographic, kinesiographic or posturographic abnormalities cannot be justified in the evidence-based TMD practice.

KEYWORDS: occlusion, body posture, temporomandibular disorders, diagnosis, treatment

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Introduction

The issue of relationships between dental occlusion, body posture and temporomandibular disorders (TMD) is a controversial topic in dentistry, and it is often a source of speculations. A description of the available knowledge about the physiology of the body posture–dental occlusion relationship is fundamental to discuss the possible diagnostic and therapeutic implications of the assessment of body posture in subjects with occlusal abnormalities or patients with TMD. In particular, claims for treating TMD according to pathophysiological concepts to correct purported occluso-postural abnormalities seem to be based on doubtful theories. The invasive nature of such treatments requires that these concepts have to be proven with evidence-based data which account properly for the physiology of such relationships.

According to the proponents of these concepts, appropriate diagnostic procedures and instrument have

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to be adopted to measure stomatognathic function and to assess its possible relation with the whole body posture. To this purpose, several mechanical or electronic devices have been utilised as measurement tools in the research setting; among others, they include surface electromyography (sEMG), kinesiography (KG), postural platforms and posturographic devices. However, their use in the clinical setting as stand-alone diagnostic tools has raised strong negative criticism within the scientific community (1–3). Indeed, the most common application for some of the above devices is in the diagnosis of TMD, where they are frequently used to diagnose occlusal abnormalities and to plan their irreversible correction to manage and even prevent TMD symptoms (4). Space does not permit a full discussion of this matter here, but suffice it to say that this approach to TMD problems has been widely challenged and generally rejected by the scientific TMD community.

Owing to the lack of knowledge regarding several aspects of the occlusion–body posture–TMD relationship, it seems that caution is needed before refuting the diagnostic usefulness of functional instrumental assessment in the clinical setting. Therefore, the authors decided to review the available literature on these matters to analyse current scientific thinking about the following three topics: (i) The physiology of the dental occlusion–body posture relationship, (ii) The relationship of these two factors with TMD and (iii) The validity of the available instrumental devices to measure the dental occlusion–body posture–TMD relationship.

Physiology of the dental occlusion–body posture relationship

The biomechanical and neurological relationships of the stomatognathic system with other body districts have been addressed by a growing number of researches in recent years (5, 6). The available literature reviews suggested that there is a twofold need to improve the methodological quality of the investigations as well as to address more specific clinical questions (7–10). In particular, the occlusion–posture relationships must be assessed in terms of a possible two-way effect, viz., occlusion affects posture and viceversa. At present, literature data were mostly based on the effects of dental occlusion on head and body posture, while very scarce information is available on the inverse effects of posture on dental occlusion. Some occlusal features related with gross skeletal malocclusions are likely to require postural adaptation at near as well as remote musculoskeletal districts; so, it should be interesting to gain a better insight into the relationship of, among the others, severe retrognathism, pronounced prognathism, skeletal hyper/hypodivergence, facial asymmetry, with postural adaptation at the cervical spine level, as well as postural balance and foot leaning area.

As concerns the relationship between malocclusions and head posture, a correlation was described between features of skeletal class II malocclusions, viz., retruded mandibular position and reduced mandibular length on the sagittal plane and increased cervical lordosis (11). Also, the degree of cervical lordosis was shown to be associated with vertical craniofacial morphology and anterior overjet, with skeletal class II having an anteriorised and class III a posteriorised head and body posture (12). Actually, no investigation so far controlled for the effect of age as a possible confounder. Such shortcoming assumes importance in the light of findings that age is the main factor influencing the degree of cervical lordosis, with the two variables having a direct proportional relationship, viz., lordosis increases with age (13).

As regards the influence of dental occlusion abnormalities on remote musculoskeletal districts, it was hypothesised that jaw posture may influence distal muscles and cause postural adaptations at the spine cord level. Among the occlusal factors potentially influencing spine curve and morphology, the role of monolateral cross-bite has been investigated in the literature as a risk factor for asymmetric jaw growth and muscle activity (14, 15). Actually, despite the well-known orthodontic indications to correct monolateral cross-bite in the paediatric age (16), evidence is lacking that untreated cross-bite may lead to the onset and/or worsening of pathological transverse asymmetry at the dorsal or lumbar spine level. Orthodontic treatment of monolateral cross-bite cannot influence, neither positively nor negatively, scoliosis, which is the spine pathology more frequently investigated in dentistry (9). Indeed, scoliosis has an unknown idiopathic aetiology in about 90% of cases (17, 18).

More in general, the available studies focused on the association between a single occlusal feature and a single postural parameter in non-representative populations, in the absence of control groups, without blind examiners, and with the adoption of measurement tools the validity of which was not assessed. Also, a cause-and-effect relationship was never assessed as this would require longitudinal studies that are currently lacking.

The literature is not conclusive also as for the influence of jaw posture and occlusal features on the foot leaning area. The available posturographic techniques and devices failed to detect an association between body posture and dental occlusion (19, 20) or, when detected, these were notably small and with poor clinical relevance. Clinically, this means that trigeminal priopriception influencing posture is likely mediated by compensation mechanisms through afferent pathways to the neuromuscular system regulating body balance and posture. As a consequence, it can be suggested that posturographic techniques may be employed for the study of posture physiology in the research setting, but their clinical usefulness in dentistry is poor. Moreover, it seems that the execution of controlled jaw motor tasks has a positive effect on posture control by reducing body sway area, thus suggesting that occlusal priopriocepive feedback affects posture control independently by the morphology of dental occlusion (21).

Occlusion, body posture and TMD symptoms

There are several concerns that prevent from drawing conclusions on the physiopathology of the relationship between occlusion and posture and its clinical impact; among these, the need to find appropriate measurement devices and the lack of major associations between any occlusal and/or postural features and TMD symptoms.

As regards the measurement of occlusal and postural features, several techniques (e.g. sEMG, KG, different clinical and instrumental posturographic approaches) were proposed over the years to assess various neuromuscular variables which were claimed by proponents to be related with dental occlusion and body posture. Despite the efforts made in the research setting to assess and improve the reliability of those instrumental devices for the study of the stomatognathic system and the relationship with posture (22–26), they have well-known strong limits to their clinical application because of the absence of normative values controlled for age, sex, weight, height and facial morphology. Moreover, data interpretation is often misleading owing to the high intra- and inter-examiners variability for single, as well as repeated measures (27).

The majority of instrumental data on the stomatognathic system were achieved with sEMG recordings, which may help to assess the kinesiology of movement disorders, to discriminate between different tremors, myoclonus and dystonia, to evaluate gait and pace disorders, to measure psychophysical reaction time. Their usefulness in the diagnostic and treatment pathways of pain disorders is not supported in the neurological literature (28).

Despite their quick diffusion in the years immediately following their introduction on the dental market (29–32), few researchers focused on the reliability and accuracy of the various technological devices, and even early literature reviews suggested that most authors failed to understand their limits of application in dentistry (33). The adoption of controlled experimental protocols can markedly reduce the effects of non-physiological factors on sEMG recordings and make such technique a useful tool to unravel some aspects of jaw elevator muscles functioning (34). Thus, the main, and probably unique, field of application for sEMG is the research setting, while too many shortcomings prevent from suggesting its clinical application for diagnostic purposes, especially as concerns resting sEMG values (35).

As regards the relationship between occluso-postural features and clinical symptoms, the literature has repeatedly shown the poor predictive value of occlusal features for TMD symptoms in multiple variable models (36, 37). Such a weak association with clinical symptoms was also shown for cervical spine curve (38), and foot leaning features (21). Indeed, for example, even if statistically significant differences have been recently described as for the craniocervical posture between patients with myogenous TMD and healthy subjects, such differences were too small, viz., 3·3 degrees, to be judged significant from a clinical viewpoint (39). Also, it should be considered that myogenous TMD pain might even be the responsible for muscle tone and postural adaptation in near districts, so that the clinical usefulness of such information is very poor. Moreover, the most recent systematic literature reviews did not support the use of irreversible occlusal therapies for TMD treatment and/or prevention (40–43).

Despite the overwhelming amount of papers suggesting that studying dental occlusion is not a key factor in the TMD practice, two main lines of research have been advancing for years, viz., the study of the statistical association between certain occlusal variables and the presence of signs and symptoms of TMD, and the attempts to simulate experimentally situations of occlusal stress to verify their potential to damage the TMJ and masticatory muscles.

Occlusal features were neither found to be associated with TMJ problems (36) nor with muscle disorders (44), but they should be viewed as the means through which muscle forces are transmitted to the different structures of the stomatognathic system (45). Also, the presence of occlusal abnormalities in patients with TMD may be actually due to joint degeneration and/or remodelling resulting in an occlusal shift (46).

Experiments on human and animal models investigating the potential of occlusal interferences to provoke TMD signs and symptoms showed that possible iatrogenic abnormalities (e.g. high occlusal restorations) can, at worst, cause local trauma. Those interferences demand postural and functional adaptation of masticatory patterns which rarely lead to dental and/or masticatory muscle pain. Also, when those symptoms occur, they seem to be mainly transient and can be easily reversed through removal of the iatrogenic interference. Data from randomised controlled studies suggest that in healthy subjects the application of an occlusal interference leads to a reduction in the usual EMG activity of the masseter muscles (47) and does not significantly affect pressure pain thresholds (48).

Interestingly, subjects with a TMD history seem to respond differently to iatrogenic occlusal interferences compared with subjects who reported no history of previous TMD (49). The former were reported to have an increased risk of reporting pain with muscle palpation in response to occlusion abnormalities provoked by dental procedures. These observations should be borne in mind when carrying out occlusal treatments such as prosthetic or orthodontic rehabilitations, which may involve periods of occlusal instability (e.g. temporary restorations, increases in vertical dimension and teeth shifting). From a TMD practitioner's perspective, it is clearly important to avoid overestimating the importance of these results, because responses to the introduction of an artificial interference cannot be equated with the presence of TMD. Besides, an acute experimental occlusal alteration cannot be compared with a clinical situation characterised by the presence of a 'non-ideal' dentition to which the patient has gradually adapted over a period of years (50, 51).

In view of the above considerations, attempts to achieve standardised measurements for research purposes as well as a more sensible approach to the use of technology for clinical purposes must be encouraged. Notwithstanding that, it should be borne in mind that TMD have a multifactorial aetiology and that a single causal factor can be seldom identified, thus suggesting caution before hypothesising any cause-and-effect links based on some occasional weak associations between occluso-postural factors and TMD described in a few studies (52–54). On the other hand, it should also be remembered that diminishing the role of occlusion in the aetiology of TMD is not equal than neglecting well-established occlusal concepts in orthodontics and prosthetic dentistry, because wrong occlusion on restored/treated dentition has the potential to cause iatrogenic trauma if acute changes of the interarch relationship are provided (55, 56).

In summary, a mechanical approach to TMD management by means of irreversible occlusal treatments (e.g. orthodontics, prosthodontics and occlusal adjustment), which are often recommended on the basis of instrumental assessments of patients with TMD, must be strongly discouraged from a scientific viewpoint and firmly condemned from an ethical viewpoint (3). Owing to the poor knowledge on TMD aetiology at the individual level, and also because of the high success rates of several conservative approaches (57–60), the standard of care for TMD treatment is now based on symptoms management by reversible and non-invasive treatments (61). Indeed, most patients with TMD seem to be good responders to unspecific treatment regimens, because of symptoms' fluctuation and self-limitation, regression to the mean phenomena and placebo effect (62, 63). The pathological relevance of purported abnormalities, such as joint click sounds, was strongly diminished (64), and there is growing evidence that chronic TMD pain is related to central sensitisation phenomena that require a complex multidisciplinary approach (65). Thus, TMD are neither occlusal nor postural pathologies; they are musculoskeletal disorders needing for a clinical management in line with that adopted for similar disorders in other fields of medicine (e.g. orthopedics, rheumatology and rehabilitation medicine) and, in those most severe cases, needing for a multidisciplinary effort to manage chronic pain in cooperation with other professionals (e.g. neurologists, psychiatrists and psychologists).

Diagnostic accuracy of technological devices

In theory, using instruments to measure objectively an otherwise subjective clinical parameter is a fascinating idea that requires an upmost attention in life-threatening pathologies, where any potential source of diagnostic bias may lead to disruptive consequences and that also attracts researchers from any medical fields dealing with musculoskeletal disorders, where the learning curve to achieve standardised clinical diagnoses is usually long and frustrating.

In practice, to be useful in a clinical setting, an instrument should have both internal and external validity. The former validity derives from those factors that determine the repeatability and technical efficacy, while the latter validity depends on the instrument's accuracy to measure the main pathological marker (i.e. the power to recognise disease versus absence of disease).

In the field of TMD, the main pathological marker is pain. The need to find an objective relationship between clinical symptoms (e.g. pain evoked with palpation) and instrumental signs led to diminish the role and to the identify better the indications for otherwise technically efficacious devices, such as magnetic resonance imaging (76-68), on the basis of their influence on decision-making and treatment-planning (69, 70).

The same reasoning should be done to define the clinical usefulness of sEMG, KG and postural platforms, which are even characterised by a doubtful internal validity. Besides, several works in the literature showed that such techniques have a low accuracy to discriminate between patients with TMD and asymptomatic subjects (27, 33, 71–73). Their adoption as diagnostic or even treatment-planning tools in patients with TMD cannot be justified due to a too high percentage of false positives, which is up to 80% for several parameters (e.g. sEMG values at rest, all kinesiographic parameters and all postural platform variables) (73, 74).

Despite such shortcomings, the literature also showed that sEMG may find promising application in the clinical setting by considering only some selected parameters, and in particular the maximum clenching levels. Indeed, according to the pain adaptation model and its integration (75, 76), pain affects negatively motor units recruitment and causes a reduction in maximum muscle force with respect to normal physiological functioning. Standardised approaches under controlled experimental conditions allow recording reliable and repeatable measurements (24), with acceptable values of sensitivity and specificity for sEMG values during maximum clenching (74). Standardised sEMG in laboratory settings showed a sensitivity of 86% and a specificity of 92% to discriminate between patients with TMD and those with neck pain (77). Also, some sEMG-based indexes of muscle functioning (e.g. muscle torque index) may have acceptable accuracy to recognise patients with different RDC/TMD diagnoses (78), but they cannot identify asymptomatic subjects (79). In view of the above, it can be suggested that even EMG devices adopted in controlled laboratory settings, which are able to provide ancillary findings to the clinical assessment, cannot be used as stand-alone diagnostic tools.

As for clinical techniques for postural assessment and as for posturographic instruments, such as postural and baropodometric platforms, the literature provided no data on their specificity and sensitivity in dentistry. The most comprehensive review published so far concluded that the usefulness of such instruments/techniques in dentistry is very poor (73). The examined papers were of low quality on average, with a poor methodological design, and posturography failed to be reliable and accurate to intercept TMD patients, with only two of 21 papers finding a higher between-group (patients with TMD versus controls) difference in the main outcome parameter than the within-group variance of the same parameter (73). Those two studies assessed respectively an asymmetry index of the body sway area on postural platforms to be used in controlled laboratory settings (80), and some clinical parameters for the trunk postural analysis on the sagittal plane (81). The clinical significance of such findings is yet to be defined. Thus, in general, the wide majority of the studies, even if some authors claimed positive conclusions on the use of postural platforms that were not supported even by their own study's findings (82, 83), did not support the use of clinical postural assessment and posturographic devices in dentistry (19, 84–86).

An important point to remark is there it seems to be a strong difference between the concepts underlying the use of electromyography, KG and posturography in the research setting and the commercial abuse characterising their adoption in the clinical setting. Indeed, the latter is too often based on presumptive pathophysiological theories aiming to justify the need for irreversible and expensive occlusal treatments. The scientific community's scepticism towards the potential usefulness of technological devices in the TMD field concerns their adoption as stand-alone diagnostic tools to intercept purported occlusal and postural abnormalities that, in the users' intentions, need to be corrected. Such a typical chain of events, which characterises some so-called philosophies to approach the dental profession (e.g. neuromuscular dentistry, dental kinesiology and osteopathy) is not scientifically sound and is a source of unjustified overtreatments, with subsequent huge biological and financial costs. The biological, psychosocial and social consequences as well as the clinical implications of such behaviours must be considered for debate as a growing medical legal problem (3). On the other hand, it must be borne in mind that an ad-hoc use of technological devices for research purposes still remains fundamental to get deeper into the knowledge of the stomatognathic system's physiology. Also, a major shortcoming of some clinical hypotheses is that, while strong emphasis has been put on proposing occlusal approaches to correct body posture, only a few information has been gathered on the potential usefulness of treating body posture to optimise jaw function and manage TMD symptoms and on the relative usefulness of correcting occlusion for postural disorders with respect to other systemic approaches proper of the evidence-based rehabilitation medicine. This means that, according to some dental professionals, dentists seem to have almost the whole task of discovering and treating postural disorders, which is likely to be a biological non-sense.

Conclusions

In conclusion, there is no evidence for the existence of a predictable relationship between occlusal and postural features, and it is clear that the presence of TMD pain is not related with the existence of measurable occluso-postural abnormalities. Therefore, the use instruments and techniques aiming to measure purported occlusal, electromyographic, kinesiographic or posturographic abnormalities cannot be justified in the evidence-based TMD practice.

All theories apparently supporting the clinical implications of assessing dental occlusion–body posture–TMD relationship did not stand up to serious scrutiny, and they appear to be a clinical non-sense. The adoption of instrumental devices to assess dental occlusion and body posture has to be reserved to strictly controlled research settings, with the aim to clarify the main doubts concerning the high interindividual variability of the occlusion–body posture–TMD relationship. Only then, hypothesis-tested clinical suggestions could be drawn.

The available evidence suggests that the consequences of occlusal overtreatments aiming to solve TMD pain and their related biological, financial and psychosocial costs have to be more clearly defined from a medical legal viewpoint, viz., professional liability profiles. From an ethical viewpoint, all practitioners involved in the management of patients with TMD have to recognise their role of care-providers pursuing the patients' interests within the boundaries of evidence-based medicine.

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