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The relationship between occlusion and posture

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***Abstract*---**The stomatognathic system includes the relationship between teeth, masticatory muscles and temporomandibular joints with its relation with body and head posture. Aim of the study: This Systematic review is to research the relationship between occlusion and body posture. Materials and methods-Study design: This is a literature systematic review which is done after collecting more than 10 previous papers. Inclusion criteria: Papers explaining dental occlusion in details and its correlation with body and head posture. Exclusion criteria: Papers about occlusion focusing on occlusal splints and lab work. Conclusion: There is a strong relation between dental occlusion class, head, and body posture through PDL and the trigeminal nerve in the brain. Accordingly, the occlusion affects the posture and, more importantly, the position of the condyle in the temporal fossa. It was always believed that condyle position comes first then the occlusion, but it is the other way around.

***Keywords*---**Occlusion, Posture, Head posture, Neuromuscular, Orthodontics.

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Introduction

The Glossary of Prosthodontic Terms (1) defined 'Occlusion' as the static relationship between the incising or masticating surfaces of the maxillary or mandibular teeth. 'Occluding' relates to the function of the jaw. This is one of the contributors to the masticatory system, which consists not only of teeth but also of the temporomandibular joint and masticatory muscles. Any disequilibrium with a harmonious interrelationship between the temporomandibular joints (TMJs), the masticatory musculature, and the occluding surfaces of the teeth will lead to malocclusion.

Occlusion is considered an extremely fine and detailed process, and there is growing consensus that dentists should give it more attention and focus, not only as a relation between upper and lower teeth but also as a full harmony between teeth, muscles, and mandibular movement. Ideal occlusion is the position in which the head and body posture will be in harmony and optimally adjusted.

According to the first molar position, the head and body posture will follow because of an integrated relationship between occlusion and posture through periodontal ligament mechanoreceptors and trigeminal nerve nuclei. One of the most significant issues malocclusion entails is the fact that the functional body posture will be immediately affected. It can have biomechanical, aesthetic and functional consequences. The goal of this master's thesis is to research a correlation between occlusion and posture.

A). Occlusion in details

1. Requirements and benefits of correct occlusion

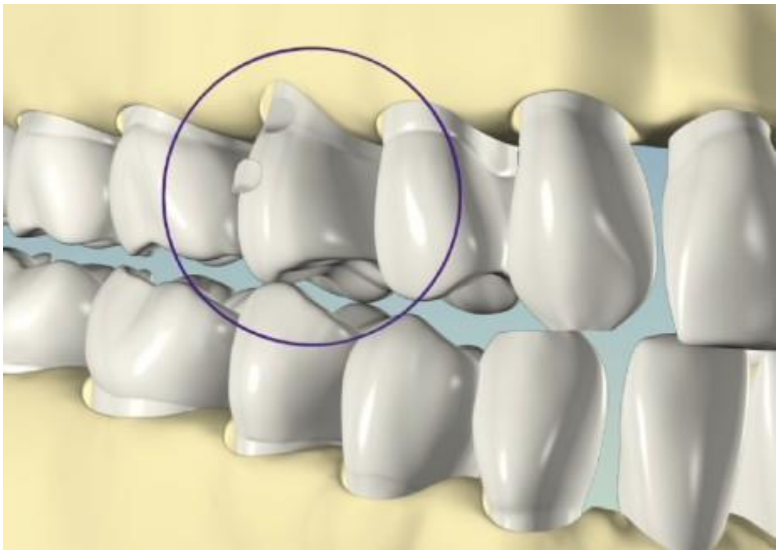
Occlusion is important as it affects teeth, muscles, the function of the condyle within the TMJ, and body posture; as all these factors are in harmony when occlusion is in the correct position. To get the correct position of occlusion, TMJ should be comfortable and stable, anterior teeth should be in harmony with the envelope of function and have a proper relationship with the lips, the tongue, and the occlusal plane, and posterior teeth should be non-interfering. This position is more comfortable because occlusal disharmony may cause tooth sensitivity, any restorations will have a longer life, and if the dentist wanted to improve the patient's esthetics, it would be easily achievable.

The best occlusion by which full harmony will be achieved is the canine-guided occlusion, which is a mutually protected occlusion and is also known as organic occlusion. The basic concept of canine-protected function is that on lateral excursive movements of the mandible, only the canine contacts and therefore protects the remaining dentition from adverse occlusal torsional forces because the posterior teeth will be disengaged in the lateral mandibular movements.

On lateral mandibular movement, on one side teeth will touch (the working side) and on the other side - teeth will not touch (the non-working side). Canine-guided occlusion means that on lateral mandibular movement, neither the working side nor the non-working side teeth will touch, also known as disocclusion.

D'Amico, Stallard and Stuart, Lucia and the members of the Gnathological Society (2) observed that in many mouths with a healthy periodontium and minimal wear, the teeth were arranged in a way so that the overlap of the anterior teeth prevented the posterior teeth from making any contact. This can be explained as canine protection, which favors the vertical chewing pattern and prevents the wear of posterior teeth. Jemt, Lundquist, and Hedegard (3) found that lateral displacement and total displacement of the mandible were greater with group function than with canine-protected occlusion

In addition, Goldstein GR(4) defined mutually protected occlusion as when all posterior teeth are in contact with the forces being directed along their long axis during maximum intercuspation. The anterior teeth either contact lightly or are very slightly out of contact, relieving them of the obliquely directed forces. During excursive movement, the posterior teeth are not occluding, and only the anterior teeth stay in contact. As a result, the anterior teeth protect the posterior teeth in all mandibular excursions, and the posterior teeth protect the anterior teeth at the intercuspal position, hence the name mutually protected occlusion.
(figure 1)



Khurshid and Garg (5) claimed that unfavorable anterior guidance may cause bone loss, and tooth mobility and will limit the movement of the mandible at the front. In cases, where the maxillary and the mandibular canines are worn out at the incisal surface, the mandible when protruded or moves in a lateral excursion, the palatal slopes of the canine direct the mandible in a downward direction rather than moving forward.

Therefore, restoration of the maxillary or mandibular canine with single crowns may be done with steeper inclines so that the mandible can assume its normal position when protruded or taken into a lateral excursion. Goldstein GR(4) claimed that shock contact of the upper cuspids by the opposing mandibular teeth during eccentric excursions causes the transmission of periodontal proprioceptive impulses to the mesencephalic root of the fifth cranial nerve, which in turn alters the motor impulses transmitted to the musculature. This involuntary action lessens the tension of the musculature, thus reducing the magnitude of the forces being applied. TMJ is protected in canine guidance occlusion by redirecting the occlusal forces as the anterior teeth are located far away from TMJ and thereby have better leverage to offset. Syed Zoheb Ali, Jasmina Tabeen Bhat (6) said that the horizontal force is further lessened by reducing the mediolateral cusp angle. Furthermore, the masticatory muscles also are rested, which decreases clenching due to the fact that the elimination of posterior contacts decreases the activity of the elevator muscles, which are the masseter and the temporalis.

2. How does occlusion affect muscle activity?

Williamson and Lundquist (7) investigated the effect of anterior guidance on the electromyographic activity of temporal and masseter muscles and concluded that appropriate anterior guidance that produces posterior separation can reduce the elevating activity of the temporal and masseter muscles. They observed that when this canine protection is taken away, muscles stay active, leading to clenching, grinding of teeth, abfraction, and gum recession. Kawamura (8) demonstrated that the teeth most sensitive to pressure were incisors, canines, and premolars, followed by molars.

3. Why canines are the best orientation to guide the occlusion:

Kruger and Michel (9) discovered that canines had higher concentrations of neurons than any other teeth. That's why a canine is the best to be used in mutually protected occlusion.

4. Group function occlusion:

On the other hand, group function occlusion is another type of occlusion, which means that all teeth on the working side are touching the lateral excursive mandibular movement**. Lee (10)** pointed out that from a biological point of view, based on proprioceptive cuspid guidance, group function is not ideal. Group function results in too flat and broad occlusal surfaces to function efficiently.

McAdam (11) claimed that in group function the first contact is not between the supporting cusp and opposing fossa but instead at a lateral location followed by a slide to centric occlusion. This will result in some horizontal forces, but these can be minimized by striking simultaneously as many working contacts as possible, reducing the angle of incline, reducing the friction by removing irregularities and roughness, and slightly rounding off the facio-occlusal line angle. The correct occlusion will result in harmony between teeth, muscles, TMJ, and body posture.

B). Body posture connection with occlusion through pdl and brain

1. What is body posture?

In general, body posture is defined as the position or bearing of the body, which is influenced by the alignment of bones, joints, muscles, and nerves. It can be characteristic or assumed for a special purpose or attitude. (49) Body and head posture are affected by occlusion in a way that if, for example, the occlusion is class II malocclusion, the head position will be forward, which is an excessively forward neck position, clinically recognized as a form of repetitive strain injury and always associated with forward head extension. Vice versa, if the occlusion is class III, the head posture will be backward.

2. The PDL connection bridge

The communication bridge between teeth and brain functions is through mechanoreceptors in the periodontal ligament, that play an important role in the tactile function of natural teeth. (12) There is a generating center with its sensory feedback, which is a neural network called the central masticatory pattern generator (CPG), located in a region ranging from the middle pontine to the upper bulbar of the brainstem. This CPG produces the pharyngeal stage of swallowing and causes mastication due to mandibular and tongue movements and perioral muscle action.

It is modulated by sensory information provided during mastication itself and by higher-order sensory areas such as the subcortical motor areas, basal ganglia, and sensorimotor cortex, comprising intraoral tactile receptors, elevator muscles, and mechanoreceptors of the periodontal ligament that monitor the activity of the elevator jaw muscles.

3. Main mechanoreceptor functions

These mechanoreceptors fulfill two main functions: they transmit peripheral sensory information for the control of motor functions, and they emit tactile information regarding the texture of food. (12)

4. Mechanoreceptors stimulation

Alterations in mechanoreceptor stimulation result in a reduction of chewing forces and a lack of control of mandibular movement. To collaborate more, changing the afferent information coming from the mechanoreceptors in the periodontal ligament membrane may occur due to bilateral occlusal disharmony, which in turn leads to instability of head and body posture. This can explain the relationship between occlusion and posture on the brain level through PDL.

5. Occlusion effect on the brain and muscles

The occlusion and masticatory functions of the teeth, lips, and tongue are represented in the postcentral gyrus. (13) Thus, different parts of the cerebral cortex are stimulated by occlusal function and mastication. However, these areas are not exclusive to components of the oral cavity; they also have close relationships with other bodily functions, such as posture.

Sakatani et al., 2013 (14) showed that reduced chewing caused by occlusal disharmony, tooth loss, improper dentures, or decreased bite force may impair cognition, including working memory, which proves the relation between occlusion and brain activity. Kordass et al., 2007; Ohkubo et al., 2013(13). Ariji et al., 2016;

Narita et al., 2009 (15) suggested that occlusion with splints may reduce brain activation and relax muscle activation.

6. Increasing VDO with splints

Differences between the left and right hemispheres have been associated with masticatory laterality, and functionality during mastication has been related to the function of the sensorimotor cortex. It has been reported that by increasing the vertical dimension through the use of a rigid splint, areas associated with reasoning, coordination of movements, and memory are activated, producing more generalized brain activity and a marked reduction in muscle activity during tightening. Dammann et al., 2020; Lickteig et al., 2013 (16) claimed that the use of a soft guard could affect afferent inputs in the same way as tightening without a splint. In addition, the soft orthotics will act as a soft pillow that stimulates chewing as if training the muscles thus increasing muscle strain. However, they are good for acute, not chronic, injuries.

The use of splints redistributes the distances between the condyle and the fossa of the temporomandibular joint and increases the symmetry of mandibular movements. Moreover at the beginning of treatment, the right cerebellar hemisphere is activated, and once the mandibular movements become symmetrical, greater activation of the left cerebellar hemisphere is observed. Solow and Siersbæk-Nielsen, 1992 (17) claimed that in children, extremely extended head posture is associated with a vertical facial development of long-face morphology.

Sonnesen et al., 2001 (18) observed that in low bite force cases (long face morphology), TMD is seen in connection with a marked forward inclination of the upper cervical spine and an extended head posture. From all previous evidence, it is concluded that the sensorimotor cortex has a function in the motor function of the body and posture. This is how occlusion is related to brain and body posture. Moreover, orthotics can not only reduce compression in the TMJ capsule by removing muscle strain but also increase the oropharynx volume, reducing airway restriction, and the patient gains better healthier breathing.

6. Tongue position

Yumi Sasaki, Masatoshi Otsugu, Hidekazu Sasaki, Naho Fujikawa, Rena Okawa, Takafumi Kato, and Kazuhiko Nakano (19),(20),(21) found that tongue position influences the body and head posture. On the other hand, airway patency affects the mandibular position which in turn affects the tongue position and head posture. The airway will be discussed in detail in Chapter 4 of this thesis, what is needed to be clear here is that everything is connected and the body posture can be affected by a sequence of factors that already affect one another such as occlusion, mandible, tongue, and airway.

C). Mandible In Relation To Body Posture

Sakaguchi et al (22) evaluated the effect of changing the mandibular position relative to the body posture and, reciprocally, changing the body posture relative to the mandibular position.

Additionally, to illustrate the relationship between occlusion and posture, cervical nerves C1 to C4 are primarily involved in controlling head and body posture, and the proprioceptive inputs from muscles and articulations of the neck are important in the maintenance of postural balance. Broser et. al (23) bilateral occlusal contacts in centric occlusion caused a change bilaterally in the peripheral inputs from each organ in the stomatognathic system and resulted in acquiring both the stability of the neck and the head position. Consequently, body posture was more stable when the mandible was in centric occlusion compared to when it was in a rest position.

1. Trigeminal nerve and CCJ

Changes in the information through the terminal nerve may have caused a disharmony of the neuromuscular system in the craniocervical complex, resulting in instability of the neck, head, and body posture.

Nobili (24) reported that body posture is maintained by a sense of equilibrium, which consists of vestibular, visual, and somatic sensations. In detail, **(25)** it was claimed that the craniocervical junction (CCJ) consists of the kinematically complex connection between the skull and the first two cervical vertebrae, also referred to as the occipital-Atlas-axial (OAA) joint complex. (figure.2)

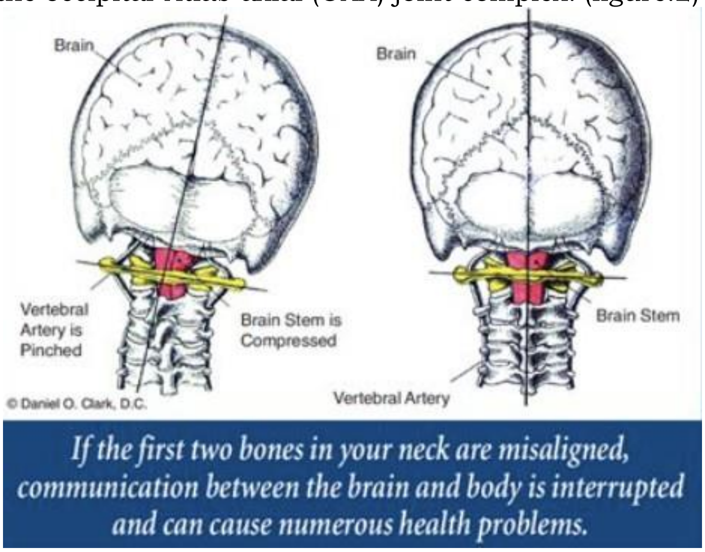


Figure (2)

TMJ is also a kinematically complex bilateral connection between the mandible and the temporal bones of the skull. (figure.3)

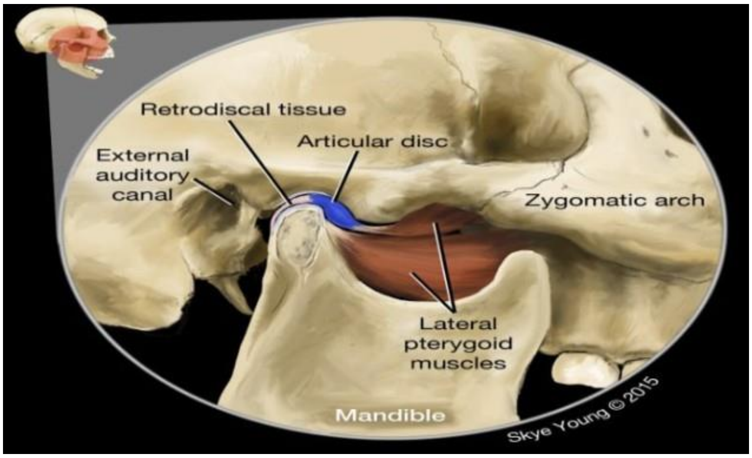


Figure (3)

If the CCJ is displaced from its normal neutral juxtaposition and the positional neutral is no longer attainable by the head, this malposition is directly transferred to the temporal portion of the TMJ, creating the potential for a shift in occlusal contact.

2. TMJ and muscles

TMJ is the only joint in the body with a set terminal endpoint in flexure adduction: the occlusion of the maxillary and mandibular dentition. The occlusal terminal set point determines how and where the condyle is positioned within the articular fossa of the temporal bone. (26) Any change to the occlusion will require a change in the activity of all of the muscles of mastication, including the muscles associated with the head and neck.

3. CCJ, TMJ, and mandibular position

The biomechanical interaction between the occlusal forces upon clenching and the position and balance of the CCJ may be more intimate than previously thought. (27),(28),(29),(30),(31),(32),(33) The influence of the CCJ on the action of the mandible or the position of the TMJ within the mandibular fossa and the consequences that variations in the position of the CCJ would have on muscle and ligamentous tissue associated with the TMJ.

4. Trigeminal loop

(34),(35),(36),(37) According to occlusion, a complex interaction exists between the proprioceptive afferent neural inputs from mechanoreceptors within the periodontal ligament (PDL) and the efferent masticatory muscle activation. This trigeminal nerve sensory/motor loop guides the mandible on a learned path of closure into the approximation of mandibular and maxillary teeth during the final stages of occlusion. The importance of this neuromotor loop is to decrease the potential damage to tooth structures from excessive forces during mastication.

5. Occlusion sensitivity in microns

(38),(39),(40) In addition, within the PDL are mechanoreceptors that are myelinated nerves, that communicate with the Mesencephalic Nucleus of the Trigeminal Nerve within the Pons.

The Mesencephalic Nucleus communicates with the Trigeminal motor Nucleus to provide rapid response to afferent input from the PDL mechanoreceptors. **(41)** The dental force plate utilized was a T-Scan sensor that is 98 microns thick. The sensitivity of the T-scan system can be increased to allow the recording of light occlusal forces or decreased to allow the measurement of heavy occlusal forces. Studies of the proprioceptive sensitivity within the PDL show a range of occlusal change awareness at 20–70 µm. This proves that there is often a change in the force of occlusion when head and neck positions are altered. The sense of which teeth touch first changes with the way the head is postured. This can be demonstrated by having a patient tap their teeth together while upright and looking straight ahead, and then having them tap their teeth together while extending or flexing their head. Small changes in occlusal contacts are registered by the neuromotor loop via the sensory feedback from the proprioceptive receptors in the PDL; this results in an alteration of motor nucleus stimulation of the masticatory muscles and gives an immediate accommodative response to the changes in the occlusion.

6. Occlusion disharmony and gait

Another piece of evidence that occlusion affects the head and whole body posture is that according to occlusion, one gait can get better or worse. Flavel et al.2003 (42),(43),(44), observed that the locomotion is always followed by rapid deceleration of the downward movement of the head and slightly less rapid deceleration of the downward movement of the mandible, while no tooth contact occurred in any forms of gait at any inclination; the movement of the mandible seemed to depend on the nature and velocity of the locomotion, probably due to the passive soft-tissue visco-elasticity and the stretch reflexes in the jaw-closing muscles.

Fujimoto et al. (45) also suggested that the change of mandibular position can affect the gait stability because the gait cycle, and the coefficient of variation, and gait velocity changed significantly in the 5 mm opening position from the intercuspal position, and in the 5 mm left and 5 mm right position from the 3 mm opening position at fast speed. In a study (46), (47), cotton rolls were inserted between the dental arches not to distribute the occlusal load over several teeth and minimize the impact of incongruous dental contacts, but to create an immediate slow imbalance of occlusion when the cotton roll was inserted in one of the two sides, which was also associated to a change in the activity of masticatory muscles and neck muscles. When a single cotton roll was positioned in the left or right dental arch, the percentage of loading and the loading surface on the left or right foot were significantly lower than in habitual occlusion.

7. Malocclusion affects body posture

Malocclusion is defined as a developmental disturbance that affects teeth, bones, and muscles, which in turn will affect the head and body posture according to many factors. One of these factors is the postural load. Since the spinal cord housed in the vertebral column supports the head, once the secondary curves are formed, head positioning, the relationship of the mandible with the maxilla and the relationship of mandibular teeth with maxillary teeth play a role in the stabilization of the cervical spine. For the spine to remain neutral, core muscles play the role of stabilizer. Along with the core muscles, the articulation of the mandible with the maxilla and the relationship of mandibular teeth with maxillary teeth in three dimensions dictate posture.

If the relationship is normal, the spine remains neutral. Posture is defined as an optimal body position where an individual holds the body standing, sitting, lying down or working in such a way that the spine remains neutral. If the spine is neutral, it is termed “good posture”.

8. Postural loads

(48) The spine can withstand only 4–4.5 kg of load. If the spine is subjected to more load than it can withstand, it begins to degenerate. That is the start of the onset of diseases. It can differ throughout the ages as follows: spine formation in a child is completed by 5–6 years (48). Growing spine (secondary curves) now requires stability. It is provided by the core muscles, the relationship of the mandible with the maxilla and the size, angle, and height of first molars in particular. At the age of 6–7 years, the first molar tooth appears to give that stability to the cervical spine. The first molars are the teeth with the biggest surface area, and they can withstand the maximum biting force.
Optimal height and relationship ensure that the cervical spine remains in the most neutral position. In this position, the head generates an optimum force on the spine, which it can withstand with ease and with the least amount of energy expenditure. This explains the relation between malocclusion (in which the first molar position is altered) with body and head posture. (48)

Therefore, changes in the position of the mandible influence body posture. Reciprocally, body posture seems to affect the position of the mandible. Rocabado et al.(49) stated that there is an association between mandibular position and forward head posture. It has been authenticated that subjects with backward mandibular positions had forward head posture, and those with forward mandibular positions had backward head posture. Likewise, the head posture can also influence the mandibular position.

An association between head posture and the development of malocclusion was proposed by Schwartz in 1926(50). If the mandibular molars meet the maxillary molars in such a way that one side is higher than the other side, the head is likely to be tilted to one side. This results in a cant of the maxilla, leading to the body posture condition called scoliosis. Forward Head Posture (FHP) is a condition when the skull protrudes forwards more than an inch over the vertebra (atlas) in the neck associated with anterior tilting of the cervical spine, (Schwartz 1926)

(50). (figure 4)

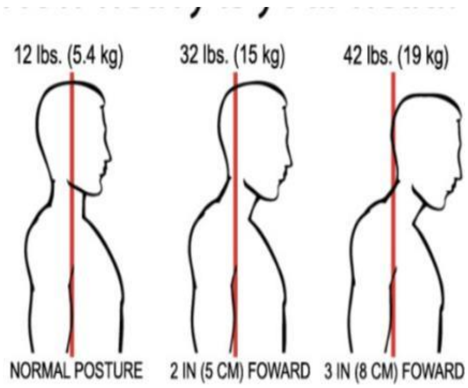


Figure (4)

For every inch of forward movement of the head on the shoulders, the weight of the head increases by 4–5 kg. (48) That in turn leads to the hyperactivity of some muscles and the weakening of others. Along with altered muscle actions, all the functions routed through the spine get affected. Diseases associated with overload on the spine and bad posture are namely: headache, jaw pain, neck pain, shoulder pain, back pain, hip pain, knee pain, ankle pain, foot pain, tinnitus, watery eyes, sinus pain, chronic cough, snoring, bruxing, impaired digestion, ulcers, weight gain, hormonal imbalance, and sleep apnea. (54)

D). Occlusion, airway, and posture

(51) For the normal growth of craniofacial structures, the airway must be normal. Between ages 6 and 18 years old, the normal upper pharyngeal space is 17–20 mm, while the lower pharyngeal airway space is 10–12 mm. When an individual breathes through the nose, the air is warmed, moistened, conditioned and mixed with nitric oxide, which is produced in the paranasal sinuses, especially the maxillary sinus. All this leads to sinuses ventilation providing the continuing of nitric oxide production. Using recent modalities like CBCT will show that an airway constriction is commonly said to be less than 200 mm2. However it's important to note that by using a 2D radiographic image, the volume of an airway can not be seen. Nevertheless, this can not be reliable because there is no relationship between a wide airway and health. Large airways can collapse at night, creating many sleep disturbance issues if the muscles themselves are weak.

(51) Another benefit of nasal breathing is that bacteria in the inhaled air are controlled. Nitric oxide also works as a vasodilator on the airways. (52) The human body has a gene called T2R38 that stimulates receptors in the nose when air passes through. These receptors release nitric oxide, which reacts with the chemicals that bacteria in the air use to communicate. The nitric oxide thus eliminates the bacteria, resulting in the intake of relatively fresh air. (53) The vasodilation by nitric oxide increases the surface area of the alveoli, where oxygen is absorbed in the bronchial tubes, which means more oxygen is absorbed when we breathe through our nose.

Nasal breathing thus increases circulation, controls blood oxygen and carbon dioxide levels, slows the breathing rate, and improves overall lung volumes. (54) The nasal cycle, which is part of an overall body cycle, is controlled by the hypothalamus. Sympathetic dominance on one side causes nasal vasoconstriction of the ipsilateral turbinate, while parasympathetic dominance on the other side causes nasal vasoconstriction of the contralateral turbinate. (55) Increased airflow through the right nostril is correlated to increased left brain activity and enhanced verbal performance. (56) Increased airflow through the left nostril is associated with increased right brain activity and enhanced spatial performance.

(57) When we exhale air through small nostrils compared to the mouth, a back-pressure is created and exhaled air is restricted and slowed down, which is exactly the time lungs absorb more oxygen. It slows the air escape, so the lungs have more time to extract oxygen from them. When there is proper oxygen-carbon dioxide exchange, the blood maintains a balanced pH. Our oxygen uptake happens mostly during the restricted process of exhalation through the nose. (58) Our nose is enabled to filter the air that we breathe. When we bypass the nose and breathe through the mouth, nothing prevents the bad bacteria from gaining entry inside the body. One of the bacteria is Staphylococcus aureus, which may cause diseases due to direct infection or produce toxins that could cause a Staph infection in the heart and blood.

(59) Our nasal passages have afferent stimulation of the nerves that regulate breathing. When inhaled air passes through the nose, the nasal mucosa carries the stimuli to the reflex nerves that control breathing. When we breathe through the mouth, we bypass the nasal mucosa which is resulting in loud snoring and irregular breathing. Snoring by itself is a precursor to sleep apnea. Sleep apnea is a temporary pause in breathing that occurs during sleep. Apneas are either obstructive or central.

Apnea is obstructive when air cannot move in and out due to complete or partial blockage of the upper airway. This blockage is commonly caused by throat muscles relaxing too much, and collapsing, causing the airway to narrow or shut down. When someone is experiencing obstructive sleep apnea, his or her body must work harder to open the airway and bring air into the lungs. Loud snoring or gasping can usually be heard during obstructive sleep apnea. Though snoring may be present in the absence of apnea. Furthermore, snoring can not be reliable as the only indication of possible sleep apnea because it is simply a vibration of tissue due to these restrictions of air entering and exiting the lungs, but one can be a silent apneic with no snoring present. Also can have serious nighttime airway disturbance with snoring. Both cases exist.

To clarify the types of apneas: central apnea occurs when an individual stops breathing for periods of time during sleep. During central apnea, the brain signal that normally tells the body to breathe is not transmitted to the rest of the body. Mixed apnea is a combination of obstructive and central apnea. During mixed apnea, both central and obstructive episodes occur in the same sleep cycle. Individuals with mixed apnea usually experience central apnea at the beginning of their sleep cycle.(51) This is followed by episodes of obstructive apnea and then a return to regular breathing. Apnea is considered a precursor to low cellular oxygen. This, in very severe cases, might lead to heart attacks or even death in one's sleep. If the breathing is not stopped but the airways is significantly reduced, for example it is only 12 mm, the air that an individual would be able to inhale will be only 2964 ml per minute.

This is then not "sleep apnea" (which is a breathing pause during sleep), but a condition called "hypoxic load, which is the strain on the body due to either not enough air coming into the lungs or too much resistance to air entering the lungs. Also as the airway space of only 12 mm is not sufficient, the body will try to get more air through fast and short breathing. That is a breathing inefficiency. Eventually, to compensate, an individual breathes more than 12 times at rest. As a result, the brain instructs the heart-lung machine to overwork. This leads to increased blood pressure, an increased heartbeat, and increased levels of the stress hormone cortisol in the bloodstream, leading to stress buildup.

1. The influence of occlusion in professional athletes performance and llew gnieb llew

Occlusion studies (60),(61),(62), postulate a possible relationship between dental occlusion and posture control. (63),(64),(65) Some coaches advise high-level sportsmen to wear occlusal splints during competitions to increase motor performances in such sports as baseball, football, and race-running. Sensorial afferents are provided by proprioceptive, tactile, vestibular, and visual receptors. Proprioception of the mandibular system, which arises from the masticatory muscular system and dento-alveolar ligaments, is secured by the trigeminal nerve.

2. Complex nervous interactions

Complex nervous interactions regulate the function of oculo-cephalogyr synergetic centers. Such interactions can help in maintaining a proper masseter tone to keep the mandibular axis in the correct position. Besides, Buisseret-Delmas et al.(68) and Pinganaud et al. (69) have demonstrated the existence of relationships between trigeminal and vestibular nuclei in the rat. As vestibular inputs represent an important afferent mechanism for postural stabilization, the position of the mandibular axis could impact postural control.

In addition, Pinganaud et al. (69) have shown that neurons in the caudal part of the trigeminal mesencephalic nucleus project mainly to the medial, inferior, and lateral vestibular nuclei and moderately to the peripheral part of the superior vestibular nucleus. Individual neurons of the mesencephalic nucleus send collaterals to the vestibular nuclei and the vestibule-cerebellum. These results suggest that these anatomical connections are involved in mechanisms of eye-head coordination, which are considered to be examples of complex nervous interactions related to body posture.

Meyer et al. (70) claimed that for shooters, the lower performance and increase in shooting dispersion surface when the mandible is in an unwedged position indicate that gaze stabilization is not optimal in this, however natural, circumstance. Also showed relationships between dental-muscular joint afferents and the cranial nerve nucleus, responsible for ocular motricity (oculomotor nerve:

III; trochlear nerve: IV; abducens nerve: VI). Buisseret-Delmas et al. (68) have shown that, in vestibular nuclei (VN), sensory information from facial receptors is added to that retrieved from proprioceptive afferents of the neck and body. The connections of the respective zones of the VN receiving trigeminal afferents suggest that sensory inputs from the face may influence vestibular control of eye and head movements.

Result

Evidently, there is a direct correlation between occlusion, head posture, and body posture. This relation is made through the periodontal ligament mechanoreceptors, trigeminal nerve nucleus, and sensorimotor cortex in the brain. The best occlusion to protect teeth is canine-guided occlusion, in which the teeth, muscles, and jaws are in harmony. Any disharmony in this relation will cause malocclusion, which will cause an alteration in head and body posture. Class II malocclusion will cause forward head and body posture. Class III malocclusion will cause backward head and body posture. This is due to the large first molar surface area, which if malocclusion occurs, will cause postural loads of more than 4.5-5.5 kg leading to an alteration of correct head posture.

Tongue position also affects head and body posture by being in the correct position inside the mouth. The patent airway also affects nasal breathing, which in turn affects body and head posture. A symmetrical mandibular position is proven to help athletes walk, run, or perform sports better.

Conclusion

There is a great correlation between mandible position, occlusion and head and body posture through trigeminal nerve and head and neck muscles. However, further investigations are needed to understand better the exact medical outcome of this correlation from orthodontic prespective.

Declaration of Conflicting Interest

Review title: The relatioship between occlusion and body posture
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Ethical Statement for Solid State Ionics
Hereby, I\ **Mahmoud Omar** consciously assure that for the review / **The relationship between occlusion and body posture**
following is fulfilled:
1) This material is the authors' own original work, which has not been previously published elsewhere.
2) The paper is not currently being considered for publication elsewhere.
3) The paper reflects the authors' own research and analysis in a truthful and complete manner.

4) The paper properly credits the meaningful contributions of co-authors and co-researchers.
5) The results are appropriately placed in the context of prior and existing research.
6) All sources used are properly disclosed (correct citation). Literally copying of text must be indicated as such by using quotation marks and giving proper reference.
7) All authors have been personally and actively involved in substantial work leading to the paper, and will take public responsibility for its content.

I agree with the above statements and declare that this submission follows the policies of Solid State Ionics as outlined in the Guide for Authors and in the Ethical Statement.
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