Consideration of whole body posture in relation to dental development and treatment of malocclusion in children

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Introduction

The ability to control our body's position in space is fundamental to everything that we do because all tasks have postural requirements. Although it has been established that dental health can have an impact on general health, when dentists are trained not much emphasis is given to teaching them about the relationship between dental development, oral function and posture.

The aims of this paper are to provide an overview of what is meant by posture, its development and how it is controlled. The relationship between posture and eruption of the deciduous dentition will be discussed. Examples of how posture may be influenced by specific dental factors, including various types of malocclusion and the effects of functional orthopaedic treatment will be provided.

Some general thoughts about mature standing posture in humans

A good standing posture in adults is seen when their head is supported by their vertebral column, which in turn is supported by their pelvis, legs and feet. The arms are suspended from the individual's shoulders that are level with respect to the pelvis and feet. This ideal posture requires minimal muscle activity to maintain a person in the standing position. Control of posture involves two different components; stability and orientation. Stability is the factor which controls the individual's centre of gravity within the body, such that the person's weight is distributed evenly through all the vertebrae and the person is comfortable. The feet are at the centre of the physical forces acting on the body whilst standing. McCollum and Leen have studied this phenomenon and concluded that the limits of stability were defined by the length of the feet and the distance between them. The second factor; orientation can be defined as the ability to maintain an appropriate relationship between body segments as well as between the body and its environment. This is related to general muscle tone, which refers to the force with which the muscles resist being lengthened. Orientation is often tested clinically by passively flexing and extending a relaxed patient's limbs and assessing the stiffness and ease of movement in their joints. In a relaxed state there is no electrical activity in the muscles even though there is some general tone, which is reported to be provided by a non-neural mechanism. One possible explanation for this is that there are free calcium ions within the muscle fibres that allow some recycling of the cross-bridges that form when muscle contracts. In addition, there is postural tone, which is the background level of activity in various groups of muscles which work together and are responsible for maintaining an individual's posture. There are several factors that can contribute to good postural tone including: somatosensory inputs especially from the feet and cervical vertebrae, as well as sensory inputs from the vestibular and ocular systems. Maintenance of an erect head posture depends upon the interaction between gravity and the muscles, bones and joints that are coordinated by the individual's nervous system. This brief overview is clearly a simplification but conveys the essence of the general principles involved in control of mature posture.

Postural control in children

As a baby, posture is controlled by reflex coordination of the neuromotor system. Development of postural control in children has been linked with the well established sequence of developmental motor milestones; crawling, creeping, sitting, pulling to stand and walking. The classical neuromaturational theory describes the control of posture as being dependent upon the appearance and then integration of reflexes. The pattern of emergence and subsequent disappearance of these reflexes is said to correspond with maturation of cortical, volitional brain function. This integrates the reflexes that are controlled at lower levels within the brain and central nervous system to allow functional and volitional postural responses.
The infant’s use of their body is initially homolateral but as each motor stage is mastered an alternating pattern of limb use is observed. The emphasis in the research for the classical theories of child development was that the emergence of postural and motor control are dependent upon the appearance and integration of reflexes. Studies in this field found that the development of postural control follows a cephalo-caudal pattern, i.e. the body seems to develop head control\(^1\). The contributions from the visual input especially and the vestibular systems are of great importance in the very early stages of postural stability\(^2\).

**A mechanistic interpretation of postural compensations in the human body**

If one considers the human body as a closed mechanical system, the genetic make-up of an individual will dictate their body shape and musculo-skeletal composition. If there are any imbalances, for example, if there is a problem with one of the joints, there will be some sort of compensation in order to maintain the overall stability of the system. So any observed postural changes will result from the interaction between both genetic and environmental factors. If an adjustment takes place in one part, for example as a result of the presence of a stone in your shoe, compensations will take place as you walk in order to maintain stability of your posture. If the stone is left in your shoe, the position of the stone in your shoe will determine the actual compensation that will result. If maintained over any extended period, the change in posture may cause symptoms distant to the foot under which the stone was placed. In addition, there may be a specific local effect, in this particular case, the formation of a blister. This hypothetical situation can be considered as an ascending effect caused by an environmental factor. The possibility of descending effects, specifically the interaction between cranial factors, including occlusion and changes in posture must also be considered. The simplest explanation for a descending factor altering body posture is that it is caused by changes in head posture, as the head has to be balanced on the neck and the vertebral column which is in turn supported by the pelvis, legs and feet. Dental factors that can alter head posture may be acute, as in the case of an abscess, or chronic, where there is a skeletal problem with a malocclusion.

**Tooth eruption in relation to the emergence of motor milestones**

The usual pattern observed is that deciduous incisors start to erupt between the ages of six to eight months. The pattern of incisor eruption can be quite variable but usually involves the lower central incisors erupting before the upper incisors. In the first six months the baby will have progressed from crawling (on the belly) to being able to sit, and in some cases to be starting to creep (on hands and knees). Although there does not appear to be any studies that have been carried out on the relationship between deciduous tooth eruption and neuromotor development, it is interesting to speculate that when the upper and lower incisors erupt they can provide some support for stability incisors erupt they can provide some support for stability of the antero-posterior position of the mandible. This in particular can have an influence on head and neck posture in particular. It must also be kept in mind that there will obviously be major contributions from the ocular and vestibular systems in relation to control of the infant’s posture and movement. However, once the baby starts to walk, usually at around twelve months, this is when the first deciduous molars erupt. Again, there are no published studies but one can speculate that the eruption of the first deciduous molars may provide some posterior dental support and this vertical dimension can also contribute to the stability of the head and neck. The deciduous canines erupt at around eighteen months of age and at this time gait is developing. The full deciduous dentition is established at around twenty-four to thirty-six months. It is during this period that infant gait matures and more complex motor tasks are undertaken which rely on the maturation of the nervous system, as well as integration of the volitional actions that can be helped by the presence of a stable gross posture. It gross posture is well developed it can serve as a stable platform to carry out tasks that require fine motor skills. Perhaps the eruption of teeth and subsequent development of the deciduous occlusion contributes to stability of the head and neck, a critical part of the posture.

In a study of postural stability from a developmental perspective, in children aged fifteen months to ten years of age, it was reported that children as young as eighteen months to three years produced well organised responses to postural perturbations\(^3\). The amplitudes of the postural sway (anteroposterior movements when in the standing position) were larger, and latencies and duration were longer than in adults. Surprisingly, responses in children between the ages of four to six years were more variable than in the children aged fifteen months to three years and in the seven to ten year age groups. The latter group were not statistically significantly different compared to adults. The explanation given for the apparent regression in the four to six year group of children was that there were developmental changes in the nervous system and due to growth of the body. This last point can be given a dental perspective; as the permanent teeth start erupting in this age group, the changes are both at the front and back of the mouth which may alter the incisal relationships as well as the vertical height posteriorly. To date there do not appear to be any studies linking the development of the dentition to posture but this is definitely an area worthy of research. Anecdotally, children whose teeth are late in erupting were reported to be late in walking.

When looking at the literature on comparative dental anatomy, it is interesting to note that animals that are born and have to stand immediately to become mobile are usually born with teeth. For example, this occurs in horses, elephants and buffalo. Whereas animals that do not have this requirement, such as marsupials, do not get teeth until much later\(^4\). Interestingly, pigs are born with teeth and when farmed, usually have their teeth clipped within 30 minutes of birth to avoid the piglets damaging their mother’s teats, birth to avoid the piglets damaging their mother’s teats.
The relationship between head posture and occlusion

Head posture and occlusion are intimately related. It has been shown that head posture can influence initial tooth contacts. You can do an experiment by bending your head forwards, biting together and notice how your bite feels. Then stop biting your teeth together, and now tilt your head back fully and bite again. Notice the difference in how your bite feels. Maintenance of head posture depends upon the interaction between the effects of gravity and the balance.
between the muscles that stabilise the head. If one considers that the teeth provide the balancing contact for stability of head posture, it is possible that changes in one's bite will also have an effect.

Using a balance platform it was shown that subjects with Class II occlusion exhibited an anteriorly displaced posture, whereas subjects with a Class III occlusion exhibited a posteriorly displaced posture. When investigating the posture adopted by the cervical vertebrae, it was reported that nearly half the patients with a Class I or Class II had a marked cervical lordosis whereas Class III had abnormal kyphosis.

The position and inclination of the hyoid bone was found to be more anterior and it had a reversed inclination when comparing Class I with Class III occlusions. The implications of this research were that occlusion can influence supra- and infra-hyoid muscle function and can also affect the direction of mandibular growth.

Patients with severe malocclusions most commonly had a head and neck forward posture. This forward head and neck posture was significantly correlated with Class II skeletal pattern.

Woda et al. reviewed the dental literature and reported that mandibular position is constantly variable and that mandibular posture greatly depends upon head posture. The study by Sakaguchi et al. demonstrated that not only could changing mandibular posture affect body posture but also changing body posture could affect mandibular posture.

The figures show typical patterns of gross body posture found with the standard types of occlusion according to Angle's classification. In the Angle's Class I (Figure 1a and b) the patient had a relaxed posture with their head in a neutral position. In the Class II (Figures 2a and b) the patient had a forwards posture and in the Class III occlusion (Figures 3a, b) the patient's neck was extended.

When posture is evaluated in relation to treating children with malocclusions, it is interesting to note that as the dental corrections are made, the patient's posture changes. Examples of the postural changes that occurred in a patient with a Class II Division 1 occlusion on Skeletal II bases (Figure 4a) that was corrected using a functional orthopaedic appliance are shown in Figures 4b, c and d. In this case as well as altering the mandible by translating its position anteriorly, the maxilla was developed transversely to accommodate the new mandibular position. The marked improvement in head posture can be seen, and this progressed through the period of functional orthopaedic treatment.
An example of the effects on gross posture, as a result of functional orthopaedic treatment of a patient who presented with a dental Class III occlusion on mild Class Skeletal III bases, is shown in Figures 5a, b, c and d. A final example of the effect on posture of treating a unilateral posterior cross bite with a mandibular displacement on closure is shown in Figures 6a, b, c and d. Posterior cross bite is one of the most prevalent malocclusions observed in the primary and early mixed dentition. It is reported to occur in between 8% and 22% of the population. They are usually accompanied with mandibular shift that causes a midline deviation. Their aetiology has been attributed to genetic factors, as well as local factors such as sucking habits. It is believed that the presence of a cross bite can influence the development of the permanent dentition, produce abnormal mandibular movement, and places a strain on the temperomandibular joints, temporal bones and masticatory system. There is also the putative increased risk of developing craniomandibular disorders. Early treatment is often advised to normalise the occlusion and create conditions for normal occlusal development.

Figure 5a The gross posture of a patient with a Class III occlusion. Note the extension of the neck and position of the feet.

However, at this time there is no scientific evidence to support preference of the various treatment modalities: grinding, Quad-helix, expansion plates and rapid maxillary expansion.

Conclusions

The development of posture, gait and general ability to carry out volitional fine motor skills involves the integration of reflexes with volitional motor control and maturation of the nervous system. If the human body is considered as a whole, any deviation from "normal" posture can be influenced from anywhere in the body. If treatment is based on diagnosing the "dental problem" in isolation of the evaluation and provision of appropriate management of any significant postural compensations, achieving a stable long-term result may become an issue. This may result in a relapse of the dental treatment, and the need for permanent retention or restorative failures. So, the management of a dental malocclusion should take into account whole body posture.

Figure 5b The intra-oral view of the Class III patient’s anterior teeth.

Figure 5c The posture of the Class III patient following treatment with a functional orthopaedic appliance and reverse pull head gear.

Figure 5d The intra-oral view of the Class III patient following correction of her malocclusion.
References


Figure 6a The gross posture of a patient with a unilateral posterior crossbite before treatment.

Figure 6b The patient's model showing the unilateral posterior crossbite on his right side before treatment.

Figure 6c The patient's gross posture following treatment for the unilateral posterior crossbite on his right side.

Figure 6d The intra-oral photograph showing the patients corrected occlusion.