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Vertical relation and implication of reduced vertical dimension of occlusion on body

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Abstract
The various parameters of maxillomandibular relation are orientation relation, centric relation and vertical relation. Of these, the vertical relation of occlusion has been modified since a long time. Parafunctional habits can lead to generalized attrition, abrasion and loss of molar support and teeth and thereby altering the vertical dimension. Till today the debate about alteration of vertical dimension of occlusion remains. Following is a review on implication of reduced vertical dimension of occlusion on body.

Keywords: Vertical relation of occlusion, loss of vertical dimension of occlusion, mandibular and body posture

Introduction
Occlusion forms an indispensable part of treatment planning in dentistry. A well-established occlusal relation not only ensures patient comfort but also guarantees longevity of the prosthesis. Occlusion is established by a harmonious relation between maxilla and the mandible. The various parameters of maxillomandibular relation are orientation relation, centric relation and vertical relation. Of these, the vertical relation of occlusion has been modified since a long time.

Definition
GPT- 9 defines vertical dimension of occlusion as the distance between two selected anatomic or marked point (usually one on the tip of the nose and the other on the chin) when in maximal intercuspal position.
GPT-9 defines vertical dimension of rest as the postural jaw relation when the patient is resting comfortably in an upright position and the condyles are in a neutral, unstrained position in the glenoid fossa.
GPT-9 defines physiologic rest position as the mandibular position assumed when the head is in an upright position and the involved muscles, particularly the elevator and the depressor groups, are in equilibrium in tonic contraction, and the condyles are in a neutral, unstrained position.
Interocclusal distance or freeway space has been defined as the difference between the rest vertical dimension and the occlusal vertical dimension [1].

Mandibular posture: The habitual mandibular position cannot be reliably estimated. It may be helpful in determining the vertical dimension of occlusion in clinical conditions. However, the habitual rest position may not be the same as the physiologic rest position. The levels achieved clinically may not signify tonic equilibrium between the elevator and the depressor group electromyographically. This defies age-old belief that mandibular position is a result of the viscoelasticity of the muscles; instead it could be because of regulation by central action.

Methods of determining vertical dimension of rest and occlusion
Whether in fixed or removable, measuring vertical dimension has been an important step. A variety of techniques are available for measuring vertical dimension.

1. Ridge relation
   a. Distance of incisive papilla from mandibular lower ridge
   b. Incisive papilla distance from crest of molar pad
   c. Parallelism of posterior ridge
   d. Esthetic values
2. Measurement of former dentures
3. Interarch distance and physiologic rest position tests
4. Pre-extraction records:
   a. Profile radiographs
   b. Radiographs of position of condyles
   c. Profile photographs
   d. Casts of teeth in occlusion
   e. Facial measurements
5. Vertical determination by means of power point
6. Interpupillary distance on old photographs in relation to interpupillary distance on face and other craniofacial landmarks
7. Physiological methods
   a. Phonetics and esthetics
   b. Swallowing threshold
8. Electronic method of vertical determination
9. Vertical determination using pantograph
10. Vertical determination by measuring muscle strength and activity
11. Vertical determination using cephalometry
12. Biting force
13. Special devices
14. Anthropometric measurements of the hand, thumb, and other digits [2, 3, 4].

Can vertical dimension be altered?

In clinical scenario, several patients come with generalized attrition, abrasion and loss of molar support and teeth. All of these may affect the vertical dimension of occlusion. There is still a controversy with regards to loss of vertical dimension and its restoration.

Dawson was of the opinion that vertical dimension of occlusion is always constant. He did not believe in the concept of freeway space and that lost vertical dimension will not have any effect on the temporomandibular joint. Urbanowicz also believed that it increasing vertical dimension of occlusion is an unsafe procedure [5].

While some others chose to believe that vertical dimension of occlusion is lost in various clinical scenario. Also, that it is safe to restore the lost vertical dimension of occlusion for functional and esthetic rehabilitation of masticatory system [6, 7, 8, 9, 10, 11, 12].

Irrespective, the decision to increase the vertical dimension of occlusion varies from case to case.

Turner and Missirlian [13] classified patients with wear as follows:

Category 1: Excessive wear with loss of VDO

Category 2: Excessive wear without loss of VDO but with space available

Category-3: Excessive wear without loss of VDO but with limited space.

Breaker's [14] classification:

- Group 1:
  - Class I: patients with collapse of vertical dimension of occlusion because of shifting of existing teeth caused by failure to replace missing teeth
  - Class II: patients with collapse of vertical dimension of occlusion because of loss of all posterior teeth in one or both jaws with remaining teeth in unsatisfactory occlusal rehabilitation.
  - Class III: patients with collapse of vertical dimension of occlusion because of excessive attritional wear of occlusal surfaces.
- Group II:
  - Class I: patients with all or sufficient natural teeth present, with satisfactory occlusal relationship.
  - Class II: patients with limited teeth present but in satisfactory occlusal relationship requiring aid in the form of occlusal rims
- Group III: patients requiring maxillofacial surgery of orthodontic treatment as an aid in restoring the lost vertical dimension.
- Group IV: patients in whom sectional treatment is required over extended periods of time because of status of health of the patient, age or economic factor.

Effects of lost vertical dimension on

1. **Oral structures:** Amongst the most prominent effect of loss of vertical dimension of occlusion is traumatic occlusion. Effects such as perio-dontoclasia, gingival irritation, erosion, and lack of masticating efficiency accompany the loss of vertical dimension. Other changes include angular cheilitis, facial disharmony.
2. **TMJ:** Temporomandibular disturbances such as partial subluxation, clicking, disc displacement and symptoms of Costen's syndrome; such as impaired hearing, stuffiness of the ear, sinus disturbances, headaches, burning of the side of the nose and throat, tenderness of the temporomandibular joint on palpation, burning tongue, and vertigo. Meniscus may be damaged or even develop perforation. This may further lead to erosion of tympanic plate and glenoid fossa and impingement of auriculotemporal nerve and chorda tympani [15]. Those later studies couldn't confirm these symptoms [16].
3. **Head and Neck region:** Changes are also seen in the head and neck posture. Though occlusal diseases and changes in mandibular posture have been shown to cause forward head posture, stiff neck, sore facial muscles, and changes in cervical spine; studies related to the effect of vertical dimension of occlusion on head and neck posture has seen some conflicting results [17, 18].
4. **Body changes:** Studies have also found effect of changes in mandibular posture and occlusal diseases and changes in vertical dimension of occlusion on body posture and body sway, weight distribution, balance, fatigue, muscle activity, performance in different kinds of sports and exercise, gaze, postural stability, strength and endurance capability as well as dynamic posture [19, 20, 21, 22, 23, 24, 25]. Though on further review the studies were found to have major flaws and no conclusive relation between occlusion and posture has yet been established [26, 27].

Estimating relation between vertical dimension and rest of the body

The connection between the head posture and occlusion was studied by Schwarz [28] in the year 1926. He argued that extension of head can cause development of class II malocclusion. Ayub [29] in 1984, studied the effect of manual physical therapy on forward head correction and vertical dimension of occlusion correction. Several studies have been also carried out to check the effect of vertical dimension on body.

The different means of checking posture are radiography, photogrammetry, photography, kinesiography,

electromyography, electromagnetic, 6 degree-of-freedom tracking instrument, force platforms, 3-D motion capture system, 3-D accelerometers based devices, electro goniometers, laser-displacement sensors, etc. to name a few.

The mechanism behind the connection has been attributed to muscle fascial chain [MFC] and the trigeminal nerve theory.

An MFC is a group of muscles that are connected through the fasciae and are longitudinally positioned in the human body. They run in the same direction and overlap in a continuous chain, like tiles on a roof, which efficiently conducts tension. All of the muscles in the chain are mutually dependent and behave as if they were a single muscle.

Fasciae are dense, fibrous connective tissues that interpenetrate and surround the human body to protect, nourish and hold organs in place. The three layers of fasciae are superficial, deep and visceral layers. Deep fasciae surrounds muscles, bones, nerves and blood vessels and is densely populated with myofibroblasts and several types of receptors (nociceptors, proprioceptors, mechanoreceptors, chemoreceptors, thermoreceptors). Myofibroblasts are fascial cells that are created as a response to mechanical stress and actively contract in a smooth, muscle-like manner.

The fascial system can passively distribute tension in the body muscles when mechanically stimulated because it contains mechanoreceptors and possesses an autonomous contractile ability that influences the tension of the fasciae. The stimulation of intrafascial mechanoreceptors (mostly interstitial and Ruffini endings) causes the vegetative nervous system and the CNS to change the tension in intrafascial myofibroblasts and regulate fascial pre-tension. These tensions are transmitted along the MFC, thereby influencing the posture of the entire body.

The extensive orofacial representation in the motor and the sensory areas of the cerebral cortex is suggestive of the extensive afferent and efferent innervations of the stomatognathic system. A loss of vertical dimension of occlusion will lead to changes in the TMJ and cause shortening of the masticatory muscles. These changes will send afferent signals to the mesencephalic nucleus of the trigeminus.

This nucleus extends from the dorsal portion of the spinal trigeminal nucleus to the caudal part of the superior colliculus. In the MNT, neurons associated with extraocular muscles are present as along with the primary afferent neurons associated with the stomatognathic system. From the MNT, the neural pathways connect with the cerebellum and with the reticular formation and the medial, inferior, lateral, and superior vestibular nuclei. They then continue to the spinal motor neurons and the extra-ocular efferents. Indirect evidence also suggests a functional connection between the vestibular and trigeminal systems. Studies have also revealed connections between the main nucleus of the trigeminus and the oral, interpolar and caudal portion of the spinal trigeminal nucleus on the one hand, with the vestibular nucleus and the prepositus nucleus of the hypoglossus on the other. Prepositus nucleus is also an important nerve center for controlling the position and movement of the eyes, due to its strict relationship with the vestibular nuclei, the cerebellum, and the oculomotor nuclei. The MNT also makes connections with lobes IX and X of the cerebellum. The superior colliculus is a relay center in the midbrain that receives visual, somesthetic, and proprioceptive afferent fibers; it is involved in postural, motor, and gait control, as well as gaze movements. In fact, the lateral SC region is part of the neuronal circuits that are involved in eye movements, and the region is associated with eyelid movements and lid saccades. This lateral superior colliculus region receives trigeminal somatic afferent information.

Thus, a stimulus sent to MNT nucleus, because of its connection with the vestibular system, cerebellum and superior colliculus, would stimulate these areas and thus send efferent signals to the postural system as well, causing postural adjustments [30].

However**,** on systematic review, it was found that the relation still remained unverified because of the bias seen in most of previous studies and that there is still a need for more studies to be carried out in this direction.

Conclusion:

Regardless of the controversy, restoring the vertical dimension of occlusion should be done mindful of the entire stomatognathic system and related and nearby structures. In edentulous patients, this involves complete dentures and implant supported prosthesis. In dentulous patients, treatment needs more attention and care. It can be done in two ways; one by restoring the vertical in cases with lost vertical dimension of occlusion and other is by raising the vertical in cases with no lost vertical dimension of occlusion but non-restorable remaining tooth structure. It should be done in phased manner as any haste will only lead towards failure of the case. Various philosophies have been proposed from a long time for rehabilitation of worn out dentition, namely, Gnathological concept, Pankey-Mann-Schyuler concept, Hobo concept, biological concept occlusion, Youdelis concept, and Nyman and Lindhe concept.

Vertical dimension can be, thus, modified if proper principles and concept of occlusion has been followed, in order to achieve the best possible esthetic and optimum function for the patient and to reverse any kind of negative side effects seen from altered vertical dimension.

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