 DOI: 10.18231/2455-6785.2018.0003

Vertical control in fixed orthodontics- A review

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Abstract
Control of vertical dimension is recognised as an important as well as often difficult part of orthodontic treatment. Ineffective vertical control cause downward and backward rotation of mandible, prolonged treatment times, and compromised treatment results. Vertical control is often difficult, as most methods used to exert vertical control are highly patient-dependent. Controlling vertical dentoalveolar development is often difficult, because most orthodontic mechanotherapy tends to produce vertical movement of teeth. Vertical movement of teeth are least resisted therefore immediate effect is seen. Vertical control is difficult also because most methods depends on patient compliance.

Keywords: Vertical control, Hyperdivergent.

Many terms have been used to describe the excessive vertical facial height, including hyperdivergency, dolichofacial pattern, and leptoprosopic pattern.[1] The adequate control of the vertical dimension is crucial for a successful anteroposterior correction. Extreme clockwise rotation, high angle type, hyperdivergency, dolichofacial pattern, adenoid faces, idiopathic long face, total maxillary alveolar hyperplasia, and vertical maxillary excess all have excessive vertical growth of the maxilla as their common denominator. Thus it is difficult to classify this vertical maxillary dysplasia in traditional anteroposterior classification. Maxillary molars are considered to be the primary 'bite openers' and mandibular incisors, the primary 'bite closers' (Schudy,1964)[2] Increase in the vertical facial dimension cause more vertical displacement and rotation of maxilla and mandible, resulting often in prolonged treatment times, compromised treatment objectives, and, often, poor esthetic results. The treatment objective in a patient having sufficient potential for growth should be to restrain and control maxillary descent and prevent eruption of anterior teeth. When the severity of vertical deformity is so great that reasonable correction cannot be obtained by growth modification or camouflage, the combination of orthodontics and orthognathic surgery may provide the only viable treatment. The following article provides a review on the control of vertical growth during the active fixed orthodontic treatment.

Predictors of Vertical Growth

The various morphological features associated with hyperdivergent growth includes the increased lower anterior facial height, increased gonial angle, short mandibular ramaus, decreased posterior facial height[1]. Skieller[3] et al found that mandibular morphology may be used to anticipate the direction of residual growth based on the type of previous development. The morphological descriptors suggested by Bjork[4] in his study by impants include inclination of the mandibular symphysis, the shape of the lower border of the mandible, the curvature of the mandibular canal, the inclination of condylar head, and the thickness of the cortical bone below the symphysis.

Why it is Necessary

Controlling vertical dentoalveolar development is often difficult, because most orthodontic mechanotherapy tends to produce vertical movement of teeth. Vertical movement of teeth are least resisted therefore immediate effect is seen. Musculature also have a large effect on vertical control as the weaker musculature allow less resistance to increase in lower facial height during the treatment. Proffit[5] stated that there are three indicators that can be used to predict the tendency toward openbite. These are:

1. The cranial base flexure angle (saddle angle): an increased saddle angle predisposes to dental and skeletal openbite.
2. The orientation of the maxilla: being up anteriorly and down posteriorly.
3. A short ramus height and obtuse gonial angle.

Various treatment mechanics that extrude posterior teeth will hinge the mandible back, open the bite, and lengthen the anterior vertical dimension. In the adult patient, extrusion of teeth in the posterior segment will lead to an opening of the bite through backward rotation of the mandible, i.e., an increase in facial height and in overjet. Space closure can involve protraction of the posterior teeth, which can have the effect of extrusion, especially when significant tipping of molars is involved. One frequently used method of space closure and interocclusal correction is the use of Class II elastics. The side effects of the elastics are lower molar and upper anterior extrusion, with a steepening of the occlusal plane.

Vertical Control During Fixed Orthodontic Therapy

Vertical Pull Chin Cup: The vertical chincup has been used as a supplementary device with intraoral fixed applainces. It consists of a chin cup and a head bonnet connected either by elastics or an elastic strap to generate forces in the vertical direction. Haass[6] described the use of a vertical pull chin cup alone (in Class I patients with severe vertical dysplasia) or in conjunction with cervical gear (when accompanied with an anteroposterior problem).The vertical chincup displays an anterior rotation of the mandible, with the resultant force vector passing through the anterior part of the mandibular corpus and 3cm from the outer canthus of the eye. Eren[7] studied the effects of vertical chincap alone and found a decrease in the mandibular plane angle, posterior rotation of the maxilla, decrease in the lower posterior dentoalveolar height and an increase in overbite in openbite cases. The vertical control pat is requested to wear the chincup 12hrs a day the forces used is a minimum of 16 ounces on each side and the direction of pull is as forward as possible.

High Pull Headgear: High pull headgear is highly recommended to control extrusive effects of treatment and to bring a positive change in the growth pattern. High pull headgear usually attaches to the maxillary first molar, and has a strap that crosses the top of the head. The direction of the force applied to the molar varies with the design of the facebow, but is usually designed to apply an upward (intrusive) and backward (distalizing) force. The force level is generally between 250 to 300 g per side. Some clinicians have advocated much higher force levels in the range of 1,200 to 9,000 g.[8,9] Unfortunately, all treatment with a headgear or chin-cup, whether for dental movement, growth modification, or control of the vertical dimension, is compliance. Firouz et al[10] stated that high pull headgear can cause relative restriction of downward and forward maxillary growth as well as distalization and intrusion of the maxillary molars.

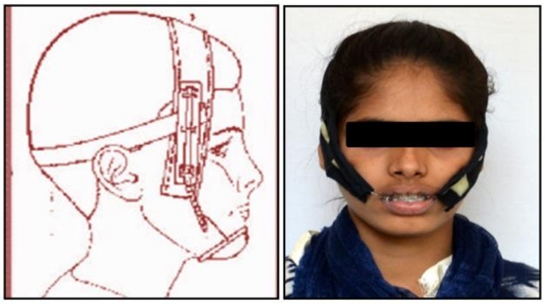

Fig. 1: (A) Diagrammatic representation of vertical pull chin cup. (B) High pull headgear

Vertical Adjustable Corrector: John P devincenzo deisgned the VAC with one buccal bar, a trans arch stabilizing wire, and three skeletal implants in which two were placed in the zygomatic processes superior to the maxillary sinuses while one anterior was placed distal or mesial to the lateral incisor. The forces were applied with the help of power cord which is attached to rings of molar implants to the arch wire between the first and second molars. It produces an initial force of 300-450gms in the posterior region and 175-250g of force in the premolar and anterior region.[11] It was observed that maxillary anterior teeth intruded at the rate of 1mm permonth and molars at the rate of 0.6mm per month. It was observed that vertical adjustable corrector can be used for intrusion of posterior as well as anterior along with retraction of anterior.

Active Vertical Corrector: It is an appliance consisting of repelling magnets placed in bite blocks which cover the posterior teeth. Dellinger[12] indicated that vertical can be controlled by constant intrusive forces by active vertical corrector which under the magnetic field causes increased cellular activity with possibility of microcurrent flow acting as an positive tissue stimulator with saliva acting as an electrolyte. KAlra[13] reported an increase in mandibular length, intrusion of teeth and an upward and forward autorotation of the mandible with the use of fixed magnetic applainces. Babre and Sinclair[14] reported maxillary and mandibular, molar intrusion and autorotation of the mandible with active vertical corrector. B Melson[15] on studying the effect of bite block with and without repelling magnets in rhesus monkey studied the histomorphological effects and mentioned remodeling in both the pterygomaxillary suture and in the zygomaticootemporal suture. Kuster and ingervall[16] compared the use of spring loaded bite blocks with bite blocks with repelling magnets. Their results showed an average improvement in openbite of 1.3mm in the spring loaded group and 3mm in magnet group.

Mandibular Bite Block: Fixed composite bite blocks on mandibular molars acts for effectively controlling the vertical height. Mc namara[17] reported no intrusion of the maxillary or mandibular teeth, although the eruption of teeth was inhibited by the appliance. Altuna and woodside[18] reported depression of maxillary molars with mandibular bite blocks. This treatment approach is claimed to be effective by inhibiting the increase in height of the buccal dentoalveolar processes, thus preventing down and back rotation of the mandible. It is most effective before cessation of growth of the jaws. The improvement was believed to be caused by mandibular anterior rotation attributed to molar intrusion and increased anterior eruption.

Vertical Holding Applaince: The vertical holding appliance was introduced by deberardinis et al[19] who modified the transpalatal arch in an attempt to control the vertical dimension of high angle patients. The acrylic button of the modified vertical holding appliance was of a uniform diameter of 17mm and thickness which was positioned midway between the maxillary first molars and premolars 6mm away from the palate to allow pressure from the tongue to act as an intrusive force as described by chiba et al.[20] Umemori et al[21] recommended initial force of 500gms while kalra et al suggested about 90gms/tooth for molar intrusion in growing children.

Low Mandibular Lip Bumper and Lingual Arch: Cetlin and Ten Hoeve[22] advocated the use of a lip bumper for the development of the lower dental arch. They suggested that if the lip bumper were adjusted low, the cheek and lip mucosa would rest above the appliance, and this will inhibit vertical mandibular molar dentoalveolar development.

Use Class II or Class III Elastics in High Angle Cases: It has been reported that attachment of Class II elastics to the lower second molars created a more horizontal vector of force (Thorow, 1970). Pearson (1997) recommended avoidance of elastic application to the lower second molars.He stated that if elastic engagement is absolutely necessary, short Class II elastics could be attached from upper first molar to a class II hook and then to the distal of the lower premolar. Roth (1985) reported that one, two, three short Class II elastics on each side may be applied from the mesial aspect of the lower first molar to the mesial of the upper second premolar, from the distal of the lower second premolar to the mesial of the upper first premolar, and from the distal of the lower first premolar to the upper canine.

Extraction of teeth for vertical control: According to pearson[23] extraction of premolar leads to mesial drift of posterior teeth which causes closure of mandibular plane angle. Garlington and Logan[24] found that enucleation of mandibular second premolars is beneficial, in selected cases, to control the vertical dimension. The criteria for selection included minimal lower arch discrepancy, a mandibular plane angle greater than 38°, a hyperdivergent skeletal pattern, and increased lower anterior facial height. Yamaguchi and Nanda[25] concluded that the changes in horizontal and vertical position of the molars were dependent on the type of force application, and not on the extraction or nonextraction strategy. When extractions are part of the treatment plan, it is important to control the vertical position of maxillary and mandibular molar teeth to avoid their vertical occlusal movement, which could nullify the desirable closing rotation of the mandible, particularly in adults.

Multiloop Edgewise Arch Wire: Kim[26] popularized the multiloop edgewise arch wire (MEAW) for correction of openbite malocclusion. The MEAW contains horizontal and vertical loops fabricated from a 16 x 22 ss wire in an L - shape fashion the vertical loops act as a break between the teeth, lowers the load deflection rate and provides horizontal control. The horizontal loops further reduces the load deflection rate and provides vertical control. Typical tip back bends of 3-5degrees are given on each tooth. Elastics are placed between the loops that lie mesial to opposing cuspids.

Mini-implant Anchorage System: Recently, the use of implants as a source of absolute skeletal anchorage has been reported.

Umemori et al[21] used the titanium miniplate to intrude posterior teeth, thereby reducing the vertical dimension in adults with openbites. The titanium miniplates were fixed to the buccal cortical bone around the apical regions of the lower first and second molar teeth and were used to intrude the posterior teeth. The lower molars were intruded 3 to 5 ram, and the openbite was significantly reduced with almost no vertical movement of anterior teeth. A lower lingual arch is required to counteract the buccal moment generated by molar intrusion when forces are applied from the buccal.

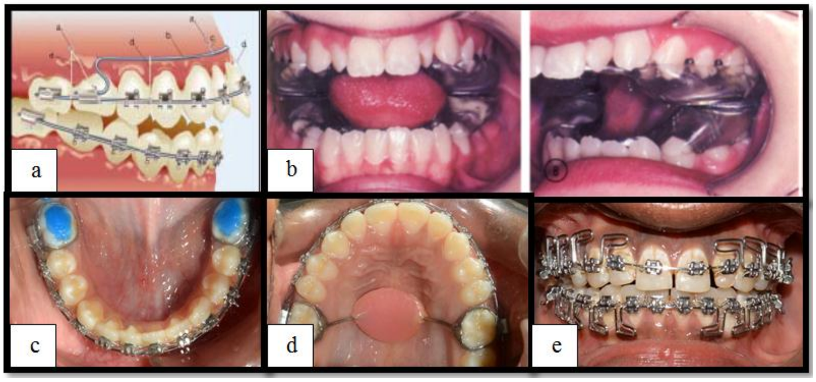

Fig. 2: (a) Maxillary Vertical Adjustable Corrector (a= skeletal anchors; b = buccal bar; c = ligature wires; d = power cords) (Devincenzo JP. A new non-surgical approach for treatment of extreme dolichocephalic malocclusions. Journal of Clinical Orthodontics. 2006;15:161-70)

[b]. Sealed active vertical corrector (Dellinger EL. A clinical assessment of the active vertical corrector—a nonsurgical alternative for skeletal open bite treatment. American Journal of Orthodontics. 1986 May 1;89(5):428-36.)

[c] Posterior bite blocks.

[d] Vertical holding appliance.

[e] MEAW Applaince.

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