Muscle exercises in Interceptive Orthodontics

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Abstract: Malocclusion can occur in three planes of space i.e. sagittal, transverse and vertical plane. Dental vertical relationships can be divided into four major categories: anterior open bite, anterior deep bite, posterior open bite and posterior collapsed bite with over closure. Since the same occlusal relation can result from skeletal jaw proportions or from infraeruption or supraeruption of teeth, the descriptive terminology should be as precise as possible in indicating whether jaw or tooth positions are basically at fault in producing a vertical problem. This article examines the biomechanics involved in the treatment of patients who exhibit an anterior open bite or a deep overbite related to excessive or deficient vertical facial dimensions. Diagnosis and management of the vertical dimension is a complex problem. Yet, it can be as simple as studying a face and applying common diagnostic tools to ascertain the reason that the lower face is too long or too short. The vertical dimension has been a subject of study and debate since orthodontics became a speciality. Most of the contemporary treatments of both open bite and deep bite, ranging from the management of simple dental problems in the anterior region to severe skeletal dysplasias. Generally, the more severe the skeletal imbalance, the less effective are the non-surgical approaches to correction. Often, orthognathic surgery is the only viable option in difficult open bite and deep bite situations, associated with facial disfigurations

Keywords- Vertical control, Openbite, Deepbite.

I. INTRODUCTION

Malocclusion can occur in three planes of space i.e. sagittal, transverse and vertical plane. Dental vertical relationships can be divided into four major categories: anterior open bite, anterior deep bite, posterior open bite and posterior collapsed bite with over closure. Since the same occlusal relation can result from skeletal jaw proportions or from infraeruption or supraeruption of teeth, the descriptive terminology should be as precise as possible in indicating whether jaw or tooth positions are basically at fault in producing a vertical problem.[1]

Vertical malocclusions result from the interplay of many different etiological factors during the growth period. These factors include growth of the maxilla and mandible, function of lips and tongue and dentoalveolar development with the eruption of the teeth. Thus, vertical malocclusion is mainly either a condition of open bite or deep bite. Both of these can be of dentoalveolar or skeletal in nature. In turn, they can be either developmental or acquired, if only dentoalveolar structures are involved, the terms open bite and deep bite are used and if skeletal structures are involved, facial pattern is either hyperdivergent or hypodivergent. One particularly important factor in the development of deep bite and open bite is the pattern of growth of the mandible. Variations in the rate of growth

in both the maxillary sutures and the mandibular condyles can further influence the development of vertical malocclusion. In addition, functional factors also modify the developing occlusion and can play a significant role in the development of malocclusion in vertical plane.[2]

II. ETIOLOGICAL FACTORS IN VERTICAL MALOCCLUSION

Vertical malocclusion and disfiguration results from the interaction of many different etiological factors.

Etiological factors associated with open bite are:

(1) Faulty postural performance of associated musculature.

(2) Digit sucking habit, tongue activity.

(3) Lymphatic tissue and obstructed naso-respiratory function.

(4) Unfavourable growth pattern.

(5) Imbalance between jaw posture.

(6) Occlusal and eruptive forces.

(7) Head position.

(8) Mental retardation and hereditary.

Etiological factors that have been cited for development of deep bite are:

(1) Over eruption of maxillary incisors.

(2) Incisor angulation.

(3) Width of anterior teeth.

(4) Excessive overjet.

(5) Under eruption of molars.

(6) Mandibular ramal height and failure of natural eruption.[2]

III. DIAGNOSTIC CONSIDERATION FOR VERTICAL MALOCCLUSION

Vaden and Pearson[3] diagnosis of vertical dimension

• Facial, dental, and skeletal

- Facial proportions.
- Role of skeletal and dental relationships.
- Condylar growth and vertical dimension diagnosis.
- Anterior and posterior facial height. Environmental role - respiration, swallowing and tongue posture.

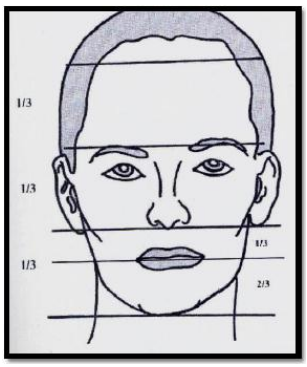


Fig. 1 Facial Proportion

Patients with the so-called "long face syndrome," and a pronounced increase in lower face height, in contrast have a more posteriorly directed growth pattern of the mandibular condyle (Fig4). The direction of mandibular growth, as expressed at the chin, is mostly vertical. The malocclusion most commonly observed in this type of patient is an anterior open bite often in combination with a Class I or II malocclusion.[4]

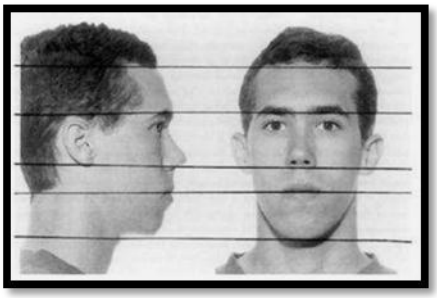


Fig. 2 Example of patient with excessive lower facial height

Fig. 3 Example of patient with diminished lower facial height

The short face syndrome is a clinically recognizable facial type with reduced lower facial height. “Vertical maxillary deficiency” and ‘‘idiopathic short face” attribute reduced lower face height to a reduced maxillary dentoalveolar height which allows the mandible to rotate in acounterclockwise manner. This syndrome is associated with deep overbites.[5]

IV. CEPHALOMETRIC ASSESSMENT

Cephalometrics is used to express relationships within the craniofacial and dentofacial complexes. In addition, it has enabled clinicians to locate the probable causative areas of the dysplasia. The language of cephalometrics is based on measurements that quantify spatial relationships of parts of the face and dentures and their relationship to each other.[6]

High angle patients are usually characterized by the following:

• Steep MP angle

• Rotation of palatal plane down posteriorly.

• Large gonial angle

• Short ramus height or decreased posterior face height

• Increased maxillary and mandibular dentoalveolar height

• Antegonial notching

Low angle patients are usually characterized by the following:

• Decreased MP angle

• Decreased lower face height

• Normal or long posterior face height

• Reduced molar height is the strongest measure of vertical maxillary

deficiency

• Reduced incisor height may be associated with deficient incisor display

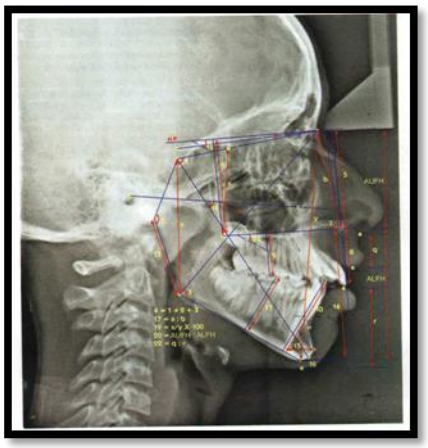


Fig. 4 Cephalometric assessment of vertical discrepancies

Cephalometric assessment of vertical discrepancies .

1)Saddle angle

2) Articular angle

3) Gonial angle

4) Bjork's sum

5) Distance between N and ANS

6) Distance between N and PNS

7) J angle –angle between palatal plane and N-Se line passing through N'

8) Upper incisor edge to nasal floor (NF)

9) Upper molar mesiobuccal cusp to NF

10) Lower incisor edge to Mandibular plane (MP)

11) Lower molar mesiobuccal cusp to MP

12) MP-HP angle

13) Length of ramus

14)Distance between ANS and Gn

15) Width of symphsis measured at Pg, parallel to true horizontal

16) Symphysis angle- angle between line passing through point B and Pog and true horizontal

17) Ratio of posterior maxillary height (E-PNS) and anterior maxillary height (N-ANS)

18) Angle between FH plane and Y axis (S-Gn)

19) Jarabak's ratio {(S-Go/N- Me) x100}

20) Anterior upper facial height (N-ANS): anterior lower facial height (ANS-Me)

21) Angle between palatal plane and mandibular plane.[6]

BIOMECHANICAL CONSIDERATIONS IN THE MANAGEMENT OF THE VERTICAL DIMENSION

The vertical dimension has been defined by some as the relationship between the Frankfort and mandibular planes and by others as the relative relationship between the anterior and posterior facial heights. Alterations in the vertical dimension can occur purposefully or unintentionally during therapy by dental extrusion, intrusion, growth modification, or surgical intervention. Vertical changes result in the mandible rotating either open or closed with corresponding alterations in inter arch dental relationships, facial aesthetics, and lip and tongue function. This article examines the biomechanics involved in the treatment of patients who exhibit an anterior open bite or a deep overbite related to excessive or deficient vertical facial dimensions.[7]

TREATMENT MODALITY OF OPEN BITE

High Pull Headgear

High pull headgear has traditionally seen appliance of choice for treating hyperdivergent open-bite patients because it has been shown to effectively hold maxillary sutural growth and vertical dentoalveolar development. Although animal studies have reported absolute distal and superior displacement of metallic implants in the maxilla, human studies do not support increased autorotation. In high pull patients displayed relative increases in the MPA and reduced condylar growth. Acrylic splints with high pull head gear create one large anchor unit that prevents unfavourable tipping of the upper molars. The approach produced a superiorand distal displacement of the maxilla, reductions of the Sella-Nasion-A (SNA) angle, clockwise rotation of the palatal plane, and relative intrusion of the upper molars. Importantly, they also reported increased lower molar eruption, decreased mandibular growth, and increased Sella-Nasion-B (SNB) angulation. [2,8]

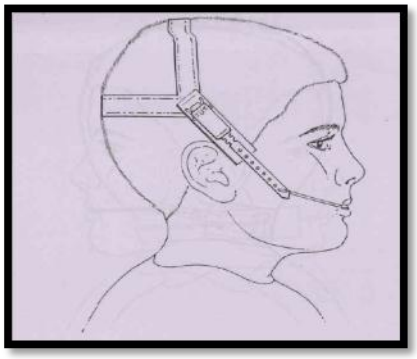


Fig. 7 High Pull Headgear

Extraction

Extraction therapy for hyperdivergent patients is prediction on the belief that molars moved mesially out of the occlusal wedge increase mandibular autorotation, decrease anterior facial height, and reduce open-bite malocclusions. However, Yamaguchi and Nanda[9] reported no differences in molar position or the A point-Nasion-B (ANB) angulation between extraction and non-extraction patients treated with high full face bows.

Posterior bite blocks

Posterior bite blocks have been shown to effectively modify vertical skeletal patterns to control anterior facial heights in animal models and humans. However, they hinge the mandible open beyond its resting position which tends to increase the gonial angle. Animal studies evaluating repelling magnets embedded in the bite block appliances show superoanterior maxillary displacement and molar intrusion.

Fig. 8 Posterior Bite Block

Spring Loaded Bite Block

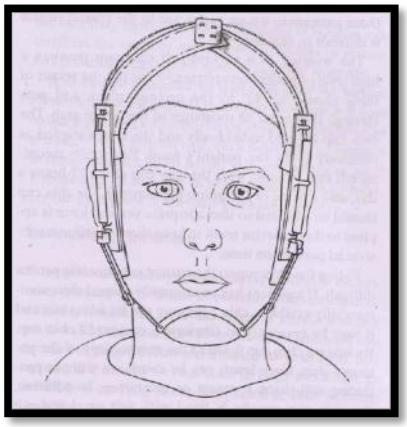
Spring-loaded posterior bite-blocks (SLPBB) have been used for the treatment of dental and skeletal openbites. They have been utilized to maintain continuous tension in the neuromuscular system supporting the mandible and reported to be effective in closing the anterior open bites in a short period of time.[10]

Fig. 9 Spring Loaded Bite Block

Fig 10. spring loaded bite bite block

Vertical Chin cup

Pearson has used the vertical chin cup in the mixed and permanent dentition to reduce the mandibular plane angle and limit increases in anterior facial height. Chin cups have also been used during active rapid palatal expansion (RPE) therapy to minimize the vertical displacement of the mandibular plane angle. Importantly, the vertical chin cup is the only appliance shown to effectively alter mandibular shape by increasing posterior heights, redirecting condylar growth, and decreasing gonial angulation. [2,11]



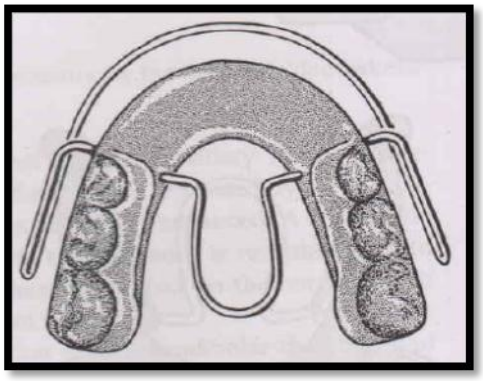


Fig 12. Vertical Chin Cup

Frankel IV regulator

Frankel IV regulator is used primarily in correction of open bite and to a lesser extent/degree in Bimaxillary patients. Frankel IV is mainly confined to mixed dentition. The palatal bow is placed distally (opens distally) and is placed behind the last erupted molar. Frankel IV works mainly by withholding muscle pressure from developing jaws and dentoalveolar area, having its area of operation largely in the vestibule surrounding the dentoalveolar area.

Frankel IV is capable of producing the following changes in the orofacial complex:

- Increase of vertical intraoral space
- Increase in sagittal and transverse intraoral space
- Forward position of mandible

Development of new pattern of motor function , improvement of muscle tonus and establishment of proper lip seal

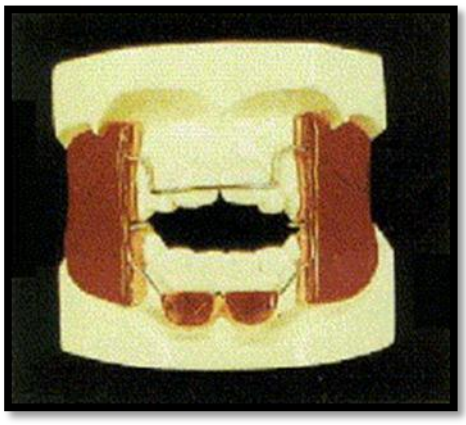


Fig 13. Frankel IV

Fig 14. Bionator to close the bite

Bionator to close the bite

This bionatar is constructed with posterior bite blocks and may or may not have anterior occlusal contact or coverage depending on the nature of the open bite. When using this type of bionatar, the clinician should differentiate between the presence of a dental open bite (alveolar deformation most likely to be caused by a thumb or tongue habit) and a skeletal open bite caused by vertical maxillary excess, a tipped up palatal plane, and/or a steep mandibular plane angle. In patients with a dentoalveolar anterior open bite, the Occlusal acrylic is processed in full contact with the maxillary and mandibular posterior teeth to prevent vertical alveolar development in the buccal segments. The wire and acrylic, however, do not contact the anterior teeth to allow for vertical eruption of the incisors and bite closure.

Activator

Activator is not indicated for treatment of skeletal open bite; it may be used treatment of open bite if open bite is caused by tongue thrust and finger sucking. Activator is constructed such that eruption of posterior teeth is prevented and elongation of anterior teeth is encouraged i.e. acrylic is not ground away from Occlusal surface of posterior teeth but anterior teeth are allowed to erupt freely. Activator also can be used for treatment of habits by intercepting tongue lip contact.[12]

Fig 15. Activator

Mini Implants and MiniPlates

The use of surgical bone plates in a skeletal anchorage unit was first described in 1985. Later, titanium miniplates at the mandibular corpus area were used as anchorage during the intrusion of the mandibular posterior dentoalveolar segment in the correction of anterior open bite. In two case reports, the lower molars were intruded by about 3–5 mm, with the open bite significantly improved. The titanium miniplate, named the Skeletal Anchorage System, is temporarily implanted in the maxilla and/or mandible as an immobile intraoral anchor, particularly to achieve considerable intrusion of the molars in the case of anterior open bite. Such an effect can also be obtained by minimum extrusion of the lower incisors and counter clockwise rotation of the Occlusal plane. Recently, miniscrews and micro screws have been applied to provide absolute anchorage In addition, maxillary micro screws provide anchorage for intruding posterior teeth and retracting anterior teeth, whereas mandibular micro screws provide an intrusion force distal to mandibular first molars to prevent mesial tipping of the posterior teeth during space closure.

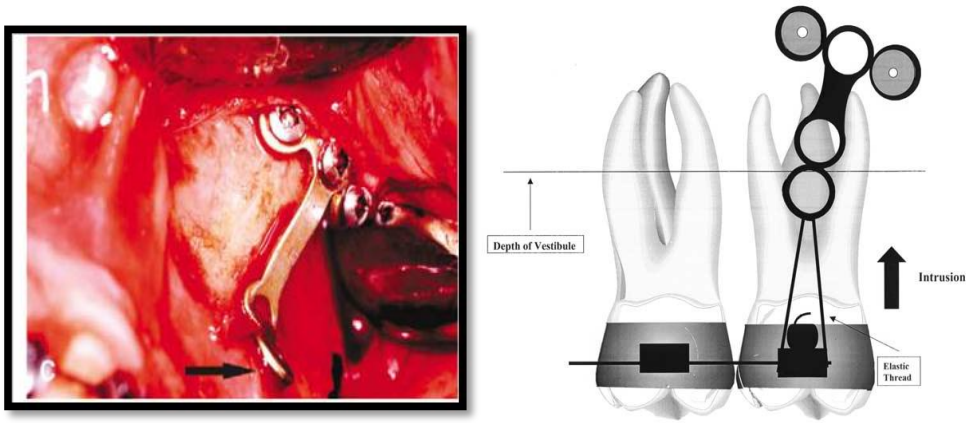


Fig 16. Mini implants And Miniplates

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Lip seal exercises

One of the most useful treatments for patients with lip incompetence is a regimen of lip seal exercises, as advocated by Frankel. Lip Seal Exercises are an integral part of Frankel Therapy, but also can be incorporated successfully into routine orthodontic, orthopaedic, and surgical treatments. Lip seal training can also be initiated without orthodontic interventions, in an attempt to improve facial balance and soft and hard tissue aesthetics and function. The underlying goal of this type of treatment is to establish normal neuromuscular function, particularly as it pertains to perioral and masticatory musculature, as well as a pattern of nasal rather than oral breathing. The patient is instructed to keep the lips together at all times, doing so nasal respiration is encouraged. Patients are often given some kind of reminder sticker that should be placed on the desk at school and in the study at home. These reminders are useful in encouraging lip closure.[2]

Surgical approach

The surgical approach to long face patients almost always includes a Lefort I osteotomy to superiorly reposition the maxilla. Maxillary segments, mandibular ramus osteotomy to advance or set back mandible, and lower border osteotomy to reposition the chin are added as the requirements of the individual case dictate.[13,14]

V. TREATMENT MODALITIES OF DEEP BITE

CLINICAL MANAGEMENT:

1) Relative intrusion: It is achieved by preventing eruption of the incisors while growth provides vertical space into which the posterior teeth erupt.

2) Absolute intrusion: There is pure intrusion of the incisors without extrusion of the posterior teeth.

3) Extrusion of molars.[14]

Anterior bite plane:

The anterior bite plane is a modified Hawley's appliance with a built-in flat acrylic bite plate or inclined plane or platform lingual to the maxillary incisors. The anterior bite plane consists of Adam's clasps on the molars which help in retaining the appliance. A labial bow is also incorporated to counter any forward component of force on the upper anteriors. The bite plane may be extended labially not to

Fig 19. Anterior Bite Plane

covermore than 1/3rds to produce the same effect ie., to prevent the protusion of upper anteriors.

Bonded bite planes:

Used in class I and class II div1 and div 2 malocclusion cases for correction of deep bite with moderate overjet. From standpoint of functional orthopaedics, the best time to use bonded bite planes is end of mixed dentition. The mandible is then unlocked from occlusion so that its mobility and excursive capability increase greatly and mandibular growth is no longer inhibited. Muscular equilibrium determines the appropriate balance of incisor intrusion and molar extrusion.

Bite can be corrected alone with this appliance, although headgear as an adjunct is sometimes required.

Fig 20. Bonded Bite Plane

VI. RELATIVE INTRUSION:

Conventional treatment:

A) Reverse curve of Spee:

Continuous archwires with bite opening curves or Reverse curve of Spee for the lower arch and a curve of Spee for the upper arch are incorporated in these archwires. In other words, the curves in the archwires face in the opposite upper and lower dental arches. The archwires could be round or rectangular, and made in SS, TMA or Niti (The performed wires with such curves are called the "rocking chair design"). They engage brackets on all the teeth. Their actionmainly causes extrusion of the premolars, distal tipping of molars and some intruding effect on the incisors(and perhaps on molars) that is adequate to prevent the continued eruption of the incisors rather than to actively intrude them.

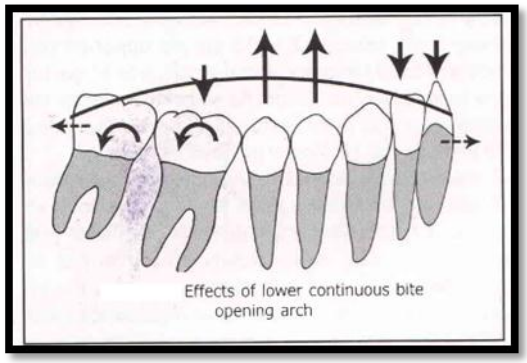

Fig 21. Reverse cuve of spee

B)Anchor bend:

This is an intrinsic part of the Begg's technique. These bends are incorporated in the arch wire, just mesial to the first molars and are used in conjunction with Class II elastics.[15]

C) Utility arches:

It is a continuous wire that extends across both buccal segments but engages only the first permanent molars and four incisors and is most commonly made of rectangular Elgiloy. It causes intrusion and possible torquing of the incisors as well as tipping back, of the molars and so consists of molar segment, posterior vertical segment, anterior vertical segment and vestibular segment. With a .018" appliance, the recommended wire for the mandibular arch is .016" × .016" or .016" × .022" Blue Elgiloy (not heat-treated). For most maxillary arches, .016" × .022" Blue Elgiloy is recommended. With a .022" appliance, .019" × .019" Blue Elgiloy can be used in either arch.

The intrusion utility arch is activated to intrude the lower anterior teeth. After activation, a light continuous force is delivered by the long lever arm from the molars to the incisors. As with the passive arch, the intrusion arch is stepped down at the molars, passes through the buccal vestibule, and is stepped up at the incisors to avoid distortion from occlusal forces.

Fig 22. Utility arch

D) Three Piece Intrusion Arch:

It was introduced by Burstone.[16] A three-piece base arch is used to intrude the anterior segment. A heavy stainless steel segment (0.018 x 0.025 or larger) with distal extensions below the centre of resistance of the anterior teeth is placed passively in the anterior brackets. The distal extensions end 2 to 3 mm distal to the centre of resistance of the anterior segment. The intrusive force is applied with a 0.017 × 0.025 TMA tip-back spring (Ormco, Glendora, Calif.)

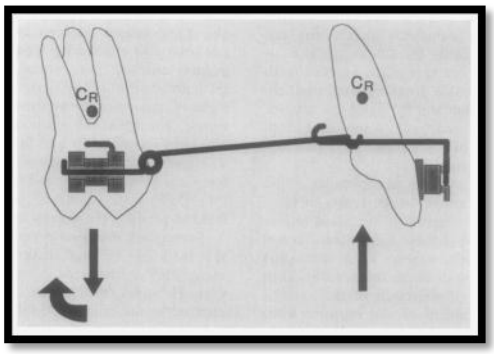

Fig 23. Three piece intrusion arch

E) K-SIR arch:

It was introduced by Dr.VarunKalra and is a modification of the segmented loop mechanics of Burstone and Nanda.[17] It is a continuous 0.019 x 0.025" TMA arch wire with closed 7mm x 2mm loops at the extraction site. Simultaneous intrusion and retraction can be achieved with KSIR arch.[17]

Fig 24. K-Sir arch

Extraoral Traction:

An adjunctive method of treatment in over closed patients with maxillary skeletal protrusion is the use of a headgear, perhaps a cervical face bow combines with a bite plate, to obtain simultaneous anteroposterior and vertical correction. The clinician should monitor the width of the face bow carefully, however, so as not to produce unwanted widening of the maxillary dental arch.[2]

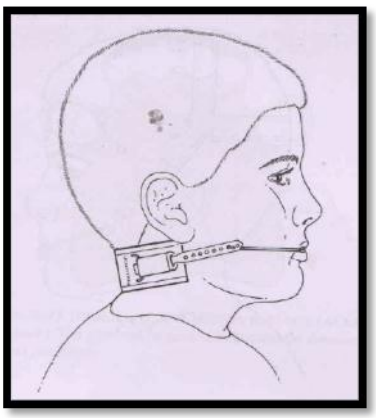

Fig 25. Cervical headgear

VI. Implants:

Implants can be used for true intrusion of anteriors or a combination of intrusion and retraction depending upon the site of implant placement and direction of force delivery. Intrusion of anterior teeth is carried out in deep bite cases while intrusion of posterior teeth is carried out either for prosthodontics purpose or in vertical growers. Conventional intrusion mechanics causes reciprocal effects that are extrusion of posterior teeth.

Implants positioned for applying intrusive forces directly from implants

(a) Implant placed between central incisors is favourable for applying intrusive force.

(b) Implant located on the mesial side of canine is advantageous for intruding the six anterior teeth and for controlling the canine axis.

(c) Implants located on the distal side of canine are advantageous for increasing the retractive force vector.[15]

Fig 26. Micro implants for Intrusion and retraction

J-Hook headgear :

J-Hook headgear can also be used for intrusion of the anterior segment and it produces absolute intrusion. The effect of applying intrusive force on upper incisors directly by using J-hook was described by Terrel Root. The forces produced by extra oral traction also can be attached anteriorly by means of J-hooks to archwire or soldered to archwire. Flared maxillary incisors can be retracted using either a high-pull or a straight-pull headgear, combined with J-hooks that are attached to the archwire anteriorly. Headgears with J-hooks also are used to potentiate archwire mechanics by helping control forces incorporated into archwire (e.g. torque, intrusion).

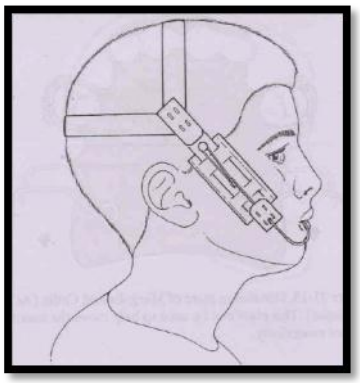

Fig 27. J hook Headgear

Orthognathic Surgery

Conventional orthodontic correction of the class II deep bite deformity with a decreased lower anterior facial height tendency can be mechanically difficult, inefficient and in many instance, impossible. The combination of surgical-orthodontic approach can provide increased treatment efficiency, long term stability and optimal esthetic result. Excellent results can be obtained with a sagittal split osteotomy with reverse autorotation. [18]

In Class II patients with extremely short lower facial dimensions, two-jaw surgery may be required. A maxillary LeFort I osteotomy can be used to move the maxilla inferiorly along with a mandibular advancement with autorotation. An inter-positional genioplasty also can be performed to increase lower anterior facial height.Unfortunately it appears that one of the least stable orthognathic surgical procedures is the maxillary inter-positional bone graft to lengthen the vertical dimension of the face.[14]

VII. SUMMARY AND CONCLUSION

Vertical discrepancies comprise some of the most challenging situations facing the orthodontist in everyday practice. Even the title of the 1999 Moyers Symposium, "the Engima of the Vertical Dimension" reflects the difficulty of dealing with these complex clinical issues. Diagnosis and management of the vertical dimension is a complex problem. Yet, it can be as simple as studying a face and applying common diagnostic tools to ascertain the reason that the lower face is too long or too short. The vertical dimension has been a subject of study and debate since orthodontics became a speciality.

Many different etiological factors have been implicated in the development of hyper and hypodivergent faces. For some of those, definitive proof has been provided, for most of them not. Important concept to keep in mind is that open bite and deep bite are the two ends of the same spectrum. For example, orthodontists recognize skeletally based open bite and deep bite as being problems difficult to treat, but these clinical conditions often are not put into the same conceptual framework. Most of the contemporary treatments of both open bite and deep bite, ranging from the management of simple dental problems in the anterior region to severe skeletal dysplasias. Generally, the more severe the skeletal imbalance, the less effective are the non-surgical approaches to correction. Often, orthognathic surgery is the only viable option in difficult open bite and deep bite situations, associated with facial disfigurations.

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