



## Review Article

# Vertical dysplasia

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### ABSTRACT

In orthodontics, vertical dysplasia is complex and the most difficult problem to treat because most methods to control vertical dimensions are patient-dependent. They have multifactorial etiology. Vertical dimension problems are the last to treat out of all the dimensions. Careful diagnosis and examination of this malocclusion will help the orthodontist to gain good treatment outcomes. Inadequate treatment mechanics leads to improper treatment outcomes. Thereby compromising the patient's facial esthetics. This article reviews the detailed description of vertical dysplasia.

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## 1. Introduction

The vertical dimension of the lower face is a prerequisite for facial balance harmony. Vertical dimension is the relationship between the Frankfort and mandibular planes or it may also be defined as the relative relationship between the anterior and posterior facial heights.<sup>1</sup> Its importance was first recognized by Downs and later by Wylie and Johnson.<sup>2</sup> Frakas and Frakas and Munro<sup>3</sup> divided the face vertically into equal thirds horizontal lines at the hairline, bridge, and ala of the nose and menton, and the lower third of the face was further divided into the upper third and lower two thirds (Figure 1). Assessment of the vertical proportions helps in the better diagnosis of problems in the vertical dimension of the face. Increased lower facial height may be due to either vertical maxillary excess or excessive height of the chin.<sup>3</sup> The following are the most commonly used different terms to describe the condition. They are dolichofacial, leptoprosopic, hyperdivergent, skeletal open bite, high angle, backward rotator, adenoid faces, long

face syndrome, and vertical maxillary excess (Figure 2).<sup>2</sup> Decreased lower facial height may occur due to either vertical maxillary deficiency or decreased chin height.<sup>3</sup> Different terms are used to describe the condition as brachycephalic, euryprosopic, hypodivergent, skeletal deep bite, low angle, forward rotator, short face syndrome, and vertical maxillary deficiency (Figure 3).

According to Haas,<sup>4</sup> patients with vertical discrepancy exhibits the following features:

1. Poor facial depth
2. Short posterior facial height, viz., a short mandibular ramus and antegonial notching in mandible
3. Body with deficient height at molar area and excessive height at the symphysis
4. Poor depth to the symphysis compared with the height
5. Lack of chin button
6. An anterior slope to the anterior surface of the symphysis

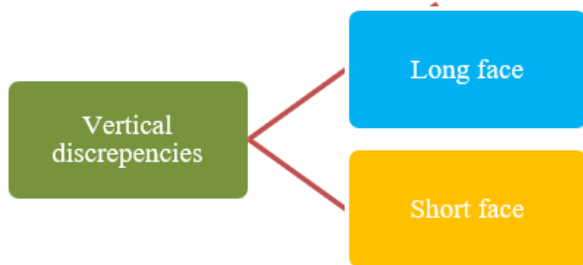
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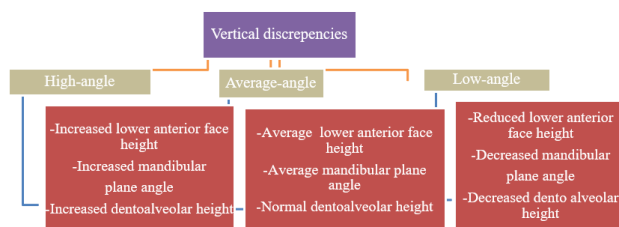
## 1.1. Classification of vertical discrepancies

### 1.1.1. Skeletal classification of basic facial types

According to Sassouni,<sup>5</sup> there are two basic types with vertical disproportions (the skeletal deep-bite and open-bite).



According to Ashok karad,<sup>6</sup> vertical discrepancies are divided into the following categories:



## 1.2. Dental

According to Graber,<sup>7</sup> vertical relationships are divided into four major categories:

1. Anterior open bite
2. Anterior deep bite
3. Posterior open bite

### 1.3. Posterior collapsed bite with overclosure

Open bite and deep bite exhibit variation in both skeletal and also in dental types (Table 1).

## 2. Development of Vertical Discrepancies

During the growth period because of the interplay of many etiological factors, vertical malocclusions may develop.<sup>8</sup> Vertical malocclusions can be divided into those that are dentoalveolar in origin and those that are predominantly skeletal due to the growth patterns of the jaw.<sup>8</sup> Facial growth with the cranial base proceeds along a vector with variable amounts of horizontal and vertical growth. It is important to understand and appreciate the value of vertical growth, as it relates to anteroposterior growth. Vertical growth carries

the chin downward, while anteroposterior growth carries it forward. The major sites of bony additions contributing to facial growth include the facial sutures, maxillary alveolar processes, mandibular condyle, and mandibular alveolar processes.<sup>9</sup> If vertical growth increments at the facial sutures and the maxillary and mandibular alveolar processes exceed the condylar growth, the mandible will rotate backward. However, if growth at the condyle exceeds the total vertical growth at the facial sutures and alveolar processes, the mandible will rotate forward.<sup>10</sup> These growth changes significantly alter the lower facial height and the position of the chin horizontally and vertically.

1. According to Sassouni and Nanda,<sup>5</sup> mandibular growth in open-bite skeletal type is vertical whereas in deep-bite it is predominantly horizontal.
2. Vertical dysplasia is due to the interaction of many etiological factors during the development of the maxilla and mandible, lips, tongue, and dentoalveolar region.<sup>8</sup>

### 2.1. Mandibular growth and vertical discrepancies

Mandible has direct articulation with the skull, therefore if the vertical growth increases in the anterior face then the same amount of vertical growth increases in the posterior facial height.<sup>11</sup> Understanding the maxillomandibular rotations helps in the diagnosis of vertical variations. Bjork and Skieller<sup>12</sup> conducted a study to demonstrate the direction of growth of the mandible and concluded that the most common direction of condylar growth is vertical. Patients with upward and forward growth of the mandibular condyle are characterized by reduced lower facial height with a deep vertical overbite, deep mentolabial sulcus, and strong overclosed appearance whereas patients with downward and backward growth are characterized by an increase in lower facial height with the most posterior position of chin and sometimes anterior open bite may develop depending on the clinical situation.

Bjork<sup>13</sup> in 1969 has given 7 structural signs of extreme growth rotation in relation to condylar growth direction. They are as follows:

1. Inclination of the condylar head,
2. Curvature of the mandibular canal,
3. Shape of the lower border of the mandible,
4. Inclination of the symphysis,
5. Interincisal angle,
6. Interpremolar or intermolar angles,
7. Anterior lower facial height

Pearson<sup>14</sup> has given 7 criteria to assess the difference between forward(low-angle) and backward(high-angle) rotators, based on Bjork 7 structural signs (Table 2).

Mandible rotates both in a clockwise and counterclockwise direction.<sup>15</sup> These rotations can alter the facial heights as follows:

1. Clockwise rotation of the mandible is due to excessive vertical growth as it relates to horizontal growth and reduces the vertical overbite.
2. Counterclockwise rotation of the mandible is due to deficiency of vertical growth as it relates to horizontal growth and increases the vertical overbite.

## 2.2. Etiology of long face

According to Rakosi,<sup>16</sup> the etiology of the open bite can be broadly divided into:-

1. Epigenetic in nature – Tongue morphology, size and posture, growth pattern of maxilla and mandible
2. Environmental factors – Respiratory dysfunction

According to Subtnley,<sup>17</sup> 3 etiological factors have been associated with open bite:

1. Vertical growth deficiencies – vertical deficiency in the anterior portion of the maxilla
2. Disproportionate muscle growth or aberrant muscle function
3. Thumb and finger-sucking habits

## 2.3. Etiology of short face

Based on the etiology, deep bite can be divided into developmental deep bite and acquired deep bite.<sup>16</sup>

Developmental deep bite<sup>16</sup>: It is of 2 types

1. Skeletal deep bite with a horizontal growth pattern
2. Dentoalveolar deep bite due to supraeruption of incisors.

According to Nanda<sup>2</sup>, skeletal deep bite may be caused by either genetic or environmental factors or a combination of both. Other factors include changes in tooth morphology, mesiodistal width of anterior teeth.

Acquired deep bite<sup>16</sup>: Deep bite developed due to environmental factors are known as acquired deep bite. It may occur due to the following reasons:

1. (a) A lateral tongue thrust or postural position of the tongue results in posterior teeth infraeruption.  
Example: Class II div 2 malocclusion
- (b) Premature loss of primary teeth or early loss of posterior permanent teeth.
- (c) Tooth abrasion or occlusal surface wearing.

## 3. Diagnostic Considerations of Vertical Discrepancies

A careful differential diagnosis has to be made to assess the long and short face. The clinician must mainly focus on the force systems that are planned for the management of the discrepancies. Inappropriate forces

can lead to unwanted problems.<sup>3</sup> Low-angle patients will have strong musculature which will counteract the extrusive forces whereas high-angle patients will have weaker musculature which allows greater expression of the vertical forces.<sup>18</sup> Role of skeletal and dental relationships: Dentoalveolar abnormalities can affect the skeletal pattern and discrepancies in skeletal patterns can affect the dentoalveolar region. These variations can occur alone or in combination: In maxilla - maxillary posterior alveolar excess and inferiorly positioned maxilla, in mandible - mandibular posterior alveolar excess and short mandibular rami. Other conditions like superiorly positioned condylar fossa, obtuse cranial base angle, and condylar resorption. Any of these conditions can be causative factors for the discrepancy in vertical dimension.<sup>3</sup> Diagnosis of the vertical dimension includes a complete examination of the patient. It includes:

1. Case history
2. Clinical examination
3. Radiographs
4. Study models
5. Photographs

## 4. Management of Vertical Discrepancies

Vertical discrepancies are to be corrected in such a way that the adjustments must be made by favourable growth of the mandible and the alveolus of the mandible and maxilla. A rational approach for planning treatment for a patient with a vertical discrepancy begins with the identification of the dental and skeletal components contributing to the malocclusion in vertical dimensions. Generally, vertical malocclusions are the most difficult to correct. The prognosis of anterior open bite may be either very good when treated at an early age or very poor if the patient exhibits severe discrepancy. For deep bite cases, a good prognosis can be seen with the passing of time.<sup>19</sup>

### 4.1. Management of long face

Management of open bite varies depending on the age of the patient. In growing individuals, the main aim is to control the eruption of molars. Whereas in adults, the vertical excess length can be treated with orthognathic surgery and camouflage treatment depending on the severity of the open bite.<sup>2</sup> The goal of the treatment is to control the vertical development or intrusion of the buccal dentoalveolar region and to allow the forward and upward rotation of the mandible.<sup>2</sup>

### 4.2. Methods to control the open bite in growing patients

1. Habit breaking appliances: Helps in altering tongue posture which helps in the correction of anterior open

bite. A Palatal tongue crib is beneficial in patients with prolonged thumb-sucking habits. Example: Tongue crib (Figure 4 ), Lingual spurs.<sup>2</sup>

2. Functional appliances: Uses a series of tongue exercises that help in muscle retraining to correct the abnormal deleterious resting and functional postures. Example: Frankel regulator.<sup>20</sup>
3. Headgear: Occipital and vertical-pull headgears are the most commonly used extraoral maxillary traction appliances to control the vertical dimension. They exhibit intrusive force on maxillary molars.<sup>21</sup>
4. Posterior bite blocks: They are passive acrylic functional bite blocks that open the mandible by 3-4 mm beyond interocclusal distance and also it will maintain the pressure which is applied on the posterior teeth by masticatory muscles. Also, spring loaded bite blocks and magnetic bite blocks (active vertical correctors) apply continuous vertical force on posterior teeth occlusal surfaces.<sup>2</sup>
5. Vertical-Pull chin cup: During the mixed and early permanent dentition period, a vertical pull chin cup is used to control the increase in the anterior facial height.<sup>2</sup>
6. Masticatory muscle exercises: The contractile force of the elevator muscles of the mandible can be increased with isometric clenching exercise thereby reducing the anterior facial height, gonial angle, and counterclockwise rotation of the mandible.<sup>2</sup>
7. Vertical holding appliance: It is a modified transpalatal arch introduced by Deberardinis et al,<sup>22</sup> used in high-angle patients to control vertical dimension.

#### 4.3. Methods to control the open bite in non-growing patients:

1. Temporary Anchorage Devices (TADs): In open bite patients, TADs are used for the control of vertical dimension by intruding molars. They reduce the anterior facial height; lip incompetency can be reduced by rotating the mandible counterclockwise (Figure 5).<sup>23</sup>
2. Orthognathic surgery: Patients with vertical maxillary excess can be treated in 3 ways: Superior repositioning of maxilla/mandibular surgery/superior repositioning of chin by a mandibular lower-border osteotomy.<sup>24</sup>
3. Extractions for open bite closure: Anterior open bite can be closed by extracting different teeth depending on the clinical scenario<sup>2</sup>

- (a) Second molar extractions
- (b) First molar extractions
- (c) Premolar extractions

#### 4.4. Management of short face

##### 4.4.1. Treatment by various mechanics

Deep overbite in orthodontics can be corrected by following methods:<sup>25</sup>

- Intrusion of anterior teeth
- Extrusion of posterior teeth
- Proclination of incisors



**Figure 1:** Ideal proportions of face



**Figure 2:** Excessive lower facial



**Figure 3:** Diminished lower facial



**Figure 5:** Miniplate



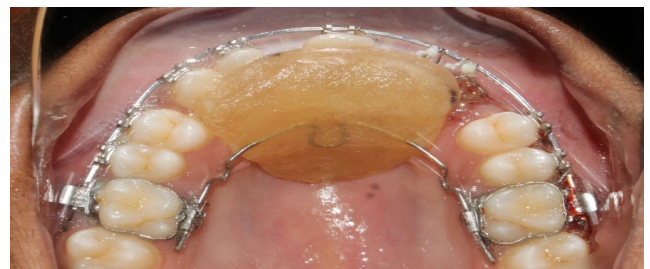
**Figure 4:** Tongue crib



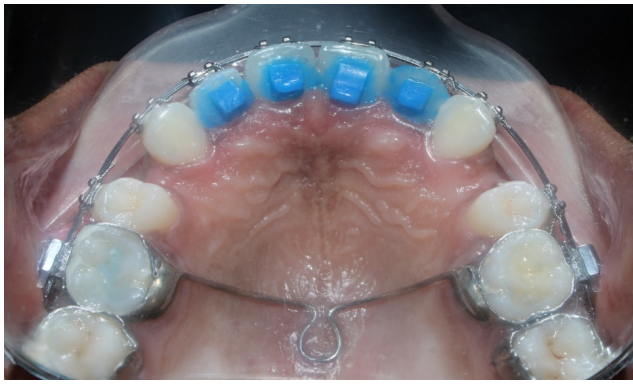
**Figure 6:** Intrusion utility arch

**Table 1:** Difference between deep bite and open bite

<b>Deep bite</b>	<b>Open bite</b>
Short face syndrome	Long face syndrome
Concave profile	Convex profile
Reduced anterior facial height & Increased posterior facial height	Increased anterior facial height & Reduced posterior facial height
Hypodivergent growth pattern	Hyperdivergent growth pattern
Mandibular rotation-Downward and	
Mandibular rotation-Upward and Forward	Backward
Shorter gonial angle	Larger gonial angle
Anteriors - Supraerupted	Anteriors - Infraerupted
Posteriors - Infraerupted	Posteriors - Supraerupted



**Figure 7:** Anterior bite plane



**Figure 8:** Anterior bite turbos

**Table 2:** Pearson's criteria based on Bjork 7 structural signs

Bjork 7 structural signs		Forward Rotators	Backward rotators
1	Inclination of the condylar head	Curve forward and back	Straight/slopes up
2	Curvature of the mandibular canal	Curved	Straight
3	Shape of the mandibular lower border	Curved downward	Notched
4	Inclination of the symphysis	Slopes backward	Slopes forward
5	Interincisal angle	Obtuse	Acute
6	Interpremolar or intermolar angles	Obtuse	Acute
7	Anterior lower facial height	Short	Tall

## 5. Combination of Intrusion and Extrusion

### 5.1. Intrusion of anterior teeth

Incisors are intruded in deep bite patients with vertical maxillary excess, a large interlabial gap, a long lower facial height, or a steep mandibular plane. Force should be applied through the centre of resistance of the incisors to avoid their proclination.<sup>26</sup> Anteriors can be intruded by 2 methods: continuous and segmental techniques.

**Continuous technique:** It includes an increased curve of spee and selective vertical steps in the archwire. Molar extrusion and also buccal tipping can occur with this technique.<sup>25</sup>

**Segmental technique:** It includes the following appliances:

1. Rickets utility arch (Figure 6)
2. Burstone intrusion arch
3. Three-piece intrusion arch

The above-mentioned appliances differ in the wire size and material, method of attachment to the brackets, force

amounts, and the inclusion of torque within the force system. Additionally, high-pull headgear can also be used to control molar extrusion.<sup>25</sup>

### 5.2. Extrusion of posterior teeth

This is the most common method for the correction of deep bite in patients with short lower facial height, excessive curve of spee, and also incisor exposure.

Various methods are employed for the extrusion of posterior teeth in deep bite patients, including the following:

1. Placement of anterior brackets more occlusally.<sup>25</sup>
2. Levelling the arches using the reverse curve of spee wire in the mandible and the exaggerated curve of spee in the maxilla (ROCKING CHAIR).<sup>25</sup>
3. Bonding of 2<sup>nd</sup> molars in both the arches.<sup>25</sup>
4. Inclusion of step bends in the archwires which gradually increase from incisors to premolars.
5. Anterior bite planes: They can be given as removable or fixed appliances. Bite planes are effective in growing patients particularly on the mandibular arch since they level the mandibular curve of spee. In fixed appliances, the levelling is maintained with stiffer wires in the mandibular arch (Figure 7).<sup>25</sup>
6. Other auxiliaries like bite turbos can also be bonded on the palatal surface of maxillary incisors to separate the posterior teeth (Figure 8).<sup>25</sup>

### 5.3. Proclination of incisors

Incisors are to be proclined in cases with lingually tipped incisors (Class II div 2 and Class III malocclusions). Proclination of incisors reduces the amount of overbite.<sup>25</sup>

### 5.4. Combination of intrusion and extrusion

Simultaneous intrusion and extrusion can be performed by placing anterior brackets occlusal and posterior brackets gingivally. And also reverse curve archwires can also be used.<sup>2</sup>

**Considerations in growing patients:** In growing patients, a removable anterior bite plane can be given for deep bite correction which helps in the eruption of posterior teeth while maintaining the incisor's heights.<sup>25</sup>

**Considerations in non-growing patients:** In non-growing patients with severe skeletal discrepancy orthognathic surgery is performed since there is no growth left. Extractions are usually avoided in a deep bite patient to overcome the worsening of the bite.<sup>25</sup>

## 6. Conclusion

Three-dimensional diagnosis and a good understanding of the interaction between the neuromuscular parts of the orofacial region and craniofacial skeleton help in

achieve the ideal treatment outcomes. Control of vertical dimension is important in treating patients with vertical discrepancies. While dealing with these patients, clinicians should remember that all the cases cannot be treated similarly due to extreme variation in facial patterns and morphological characteristics.<sup>6</sup> But in reality, the vertical dimension is the easiest to deal out of all the dimensions since it grows most in magnitude for a longer period.

## 7. Conflict of Interest

None.


## 8. Source of Funding

None.

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