ORIGINAL RESEARCH

Cephalometric Comparison of Dentofacial Variables in Class I and Class II Jaw Bases: A Study for Different Growth Patterns

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Abstract

Aim: To compare six dentofacial variables among different growth patterns in skeletal class I and class II jaw bases in a lateral cephalogram.

Materials and methods: The sample consisted of 120 lateral cephalograms of patients with ages ranging from 18 to 35 years. The sample was divided equally on the basis of ANB angle, Wits appraisal, and beta angle into skeletal class I (group I, n = 60), and class II jaw bases (group II, n = 60). Each group was then further divided into average (SN–MP 28–32°), horizontal (SN–MP <28°), and vertical growth patterns (SN–MP >32°). Hence, there were a total of six groups with 20 cephalograms each. The six parameters: interincisal angle (IIA), intermolar angle (IMA), inclination of symphysis (ISY), antegonial notch depth (AGN), lower anterior facial height (LAFH), and ramus height (RH) were traced, and a comparison was made among different growth patterns in class I and class II jaw bases. Statistical analysis was done using one-way analysis of variance (ANOVA) followed by *post hoc* Bonferroni test.

Results: Ramus height (RH) and AGN show an insignificant difference between class I and class II jaw bases irrespective of growth pattern. LAFH is significantly increased for class II jaw bases, and ISY is more for class I jaw bases for normodivergent and hypodivergent patterns. IIA and IMA are significantly more for class I jaw bases for normodivergent and hypodivergent growth patterns, respectively.

Conclusion: There is a suggestive effect of anteroposterior jaw base relationship on the parameters considered in the study which were formerly considered to be influenced only by growth patterns.

Clinical significance: From a clinical perspective, in an individual seeking orthodontic treatment, the decision to extract, anchorage preparation, biomechanics applied, and period of retention are dependent on different growth patterns and the anteroposterior relationship of jaw bases which is shown to be influenced by the parameters considered in this study.

Keywords: Antegonial notch, Growth pattern, Interincisal angle, Intermolar angle, Lateral cephalogram, Lower anterior facial height, Malocclusion, Ramal height.

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Introduction

The key to unveiling the true characteristics of an existing dentofacial deformity is orthodontic diagnosis. The infrastructure of this clinical diagnosis and treatment planning is comprised by growth and development. For a long time, orthodontists have been concerned with a myriad of diversity in diagnosis, treatment planning, and responses between various growth patterns. Facial growth analogous to cranial baseline continues along a vector composed of variable amount of horizontal forward growth and vertical downward growth.

An important point of consideration is the fact that facial types of multidimensional nature are derived not only from vertical growth pattern but by interplay of vertical and anteroposterior dimensions. The terms "hypodivergent" or "hyperdivergent" alone are inadequate for describing the facial forms, the variations which are present anteroposteriorly classified as "retrognathic" or "prognathic" are also significant when identifying them. Of special importance is the fact that mandible as a result of rotation can develop either protrusively or retrusively relating to maxilla and cranial base in different subjects.[1–3] Hence, defining multidimensional combinations is crucial for reaching a more accurate identification.

A high percentage of studies conducted in the past which took into consideration cephalometric features of maxillary and mandibular jaw bases have given importance to sagittal and vertical sagittal malocclusion separately. Bjork theorized that morphological variations in LAFH, IIA, IMA, ISY, shape of lower border of mandible, curvature of mandibular canal, and inclination of condylar head occurred due to rotation of mandibular jaw base in clockwise or counterclockwise direction.[4] It is concluded that subjects having shallow notches present with a horizontal growth pattern, prominent chins, and decreased facial heights as compared to deep notch subjects. In an investigation by Davidovitch et al., RH was detected to be increased in horizontal

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growers in comparison to vertical growers. There is also an expected short face pattern in subjects having counterclockwise rotation and long face pattern in subjects showing clockwise rotation.[5]

But, till date, very little research has concentrated on the interrelation between sagittal and vertical skeletal patterns. Since it can be said that when aberrations ensue in growth pattern, a trend towards a balancing mechanism from skeletal and dental structures is used to preserve a proportional and equilibrated facial pattern, therefore, considering both anteroposterior and vertical dimensions simultaneously would lead to a more accurate diagnosis from which a more specific treatment could be planned.[6,7]

Thus, this study's objective is to correlate various cephalometric parameters like IIA, IMA, ISY, AGN, LAFH, and RH which are predominantly considered to vary according to the vertical growth pattern among skeletal class I and class II jaw bases.

Materials and Methods

This retrospective study was based on data derived from pretreatment lateral cephalometric radiographs of 120 subjects who had reported to the Department of Orthodontics and Dentofacial Orthopedics, Guru Nanak Dev Dental College and Research Institute, Sunam (Punjab, India) for orthodontic treatment during 2018–2020. All the subjects were in the age range of 18–35 years. The inclusion criteria of the study were that the subjects should be in the age group of 18–35 years with no history of previous orthodontic treatment, craniofacial syndrome and orthognathic surgery, trauma, or missing teeth except third molars.

Method

The sample, which consisted of 120 lateral cephalograms, was divided into skeletal class I and class II jaw bases on the basis of the following parameters (Fig. 1).

- Group I (skeletal class I jaw bases) (n = 60)
  - ANB 0–4°
  - Wits appraisal ≤0–1 mm
  - Beta angle 27–35°
- Group II (skeletal class II jaw bases) (n = 60)
  - ANB >4°
  - Wits appraisal >1 mm
  - Beta angle <27°

Each group was further divided equally into average (A), horizontal (B), and vertical (C) growth patterns on the basis of MP-SN angle (Fig. 1).

- Group I: Skeletal class I jaw bases (n = 60)
  - Group I A: Normodivergent—MP-SN angle of 28–32° (*n* = 20)
  - Group I B: Hypodivergent—MP-SN angle of <28° (*n* = 20)
  - Group I C: Hyperdivergent—MP-SN angle of >32° (*n* = 20)
- Group II: Skeletal class II jaw bases (n = 60)
  - Group II A: Normodivergent—MP-SN angle of 28–32° (*n* = 20)
  - Group II B: Hypodivergent—MP-SN angle <28° (*n* = 20)
  - Group II C: Hyperdivergent—MP-SN angle of >32° (*n* = 20)

Hence, there were a total of six groups with 20 cephalograms in each.

Cephalometric Analysis

All the cephalometric radiographs were traced by a single investigator manually on a cellulose acetate tracing paper of 36 µm with 3H microlead pencil and checked twice. Similar conditions of lightbox and general illumination were sustained during observing and tracing of all headfilms. All reference points were first identified, located, marked, and then reference lines were drawn (Fig. 2). Three linear (Fig. 3) and three angular measurements (Fig. 4) were taken.

Linear Measurements

- Lower anterior facial height: The linear distance between points anterior nasal spine and menton.
- Antegonial notch depth: Vertical distance from the deepest part of notch concavity to a tangent through the two points of greatest convexity on the inferior border of the mandible, either side of the notch.
- Ramus height: The linear distance between articulare and gonion.

Angular Measurements

- Inclination of symphysis: Angle formed by the line through menton and point B and the mandibular plane, which is tangent to the lower border of mandible.

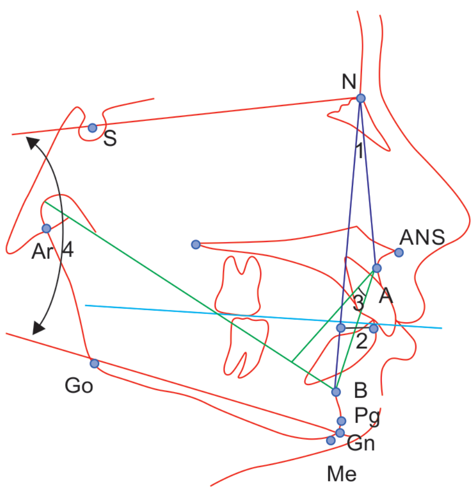

Fig. 1: Classifying parameters for skeletal class I and class II jaw bases: ANB, Wits appraisal, Beta angle, and SN-MP angle

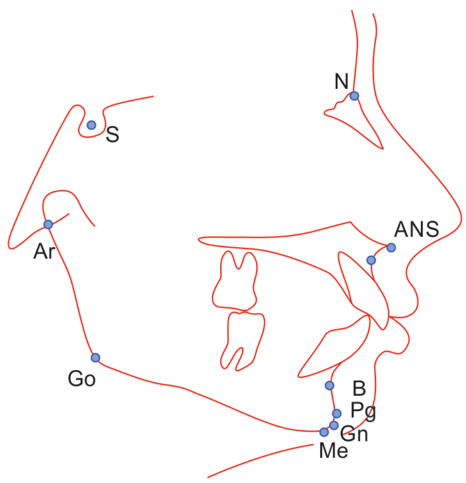

Fig. 2: Cephalometric landmarks used in this study: Sella (S), Nasion (N), Articulare (Ar), Anterior nasal spine (ANS), Gonion (Go), Point (B), Pogonion (Pg), Gnathion (Gn), and Menton (Me)

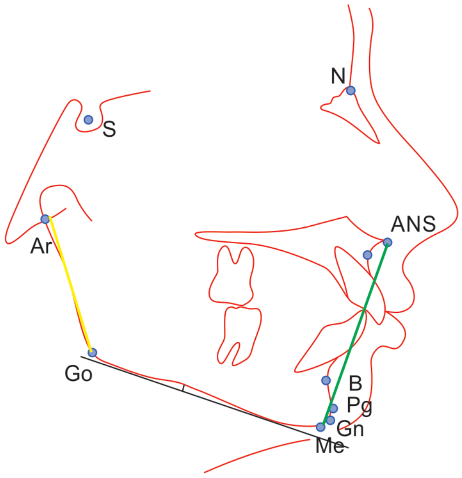

Fig. 3: Linear measurements used in this study

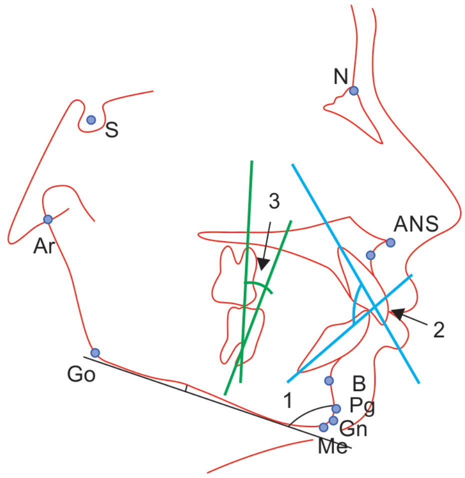

Fig. 4: Angular measurements used in this study

- Interincisal angle: Obtuse angle between the long axis of upper and lower incisors.
- Intermolar angle: Acute angle between the long axis of upper and lower first molars.

Statistical Analysis

Data obtained were subjected to statistical analysis, and a comparison was made of various dentofacial characteristics among different growth patterns in skeletal class I and class II jaw bases. The mean values were obtained and one-way ANOVA followed by *post hoc* Bonferroni test was used to analyze the difference between groups.

Results

This retrospective study was done with 60 subjects in group I (35 females and 25 males) and 60 subjects in group II (38 females and 22 males). It was a young adult population of Sunam (Sangrur, Punjab, India) with age ranging from 18 to 35 years with a mean age of 23 ± 0.6 years.

Comparison of Various Parameters in Skeletal Class I and Class II Jaw Bases in Normodivergent Group (Table 1)

All the six parameters in this study, when compared among both the skeletal jaw bases for normodivergent growth pattern showed RH, IMA, and AGN was similar for class I (I A) and class II jaw bases (II A). However, LAFH, IIA, and ISY showed statistically significant differences between class I (I A) and class II jaw bases (II A) with mean value being more for class II jaw bases.

Comparison of Various Parameters in Skeletal Class I and Class II Jaw Bases in Hypodivergent Group (Table 1)

All the six parameters in this study, when compared among both the skeletal jaw bases for hypodivergent growth pattern showed that RH, IIA, and AGN were similar for class I (I B) and class II jaw bases (II B).

Lower anterior facial height was more for class II jaw bases (IIB) as compared to class I jaw bases (IIB), and the difference was statistically significant.

IMA and ISY showed statistically significant differences between both the jaw bases with values being greater for class I jaw bases.

Comparison of Various Parameters in Skeletal Class I and Class II Jaw Bases in Hyperdivergent Group (Table 1)

All the six parameters in this study, when compared among both the skeletal jaw bases in hyperdivergent growth pattern showed no statistically significant differences between class I (IC) and class II jaw bases (IIC).

Thus it can be inferred from the study that RH and AGN show insignificant difference between class I and class II jaw bases irrespective of growth pattern. LAFH is significantly increased for class II jaw bases and ISY is more for class I jaw bases for both normodivergent and hypodivergent patterns. IIA and IMA are significantly more for class I jaw bases for normodivergent and hypodivergent growth patterns, respectively.

Discussion

Current concepts in diagnosis and treatment planning focus on balance and harmony of various facial features, which includes careful evaluation of dentofacial complex in transverse, sagittal, and vertical dimensions. In this study, a total of 120 subjects were considered and divided into two groups with 60 subjects in each group on the basis of ANB, Wits appraisal, and beta angle. These three parameters were considered for assessing sagittal dysplasia because a single cephalometric analysis cannot be deemed to be sufficient in such a large population which shows so much variability. These two groups were further divided into three subgroups having 20 subjects each on the basis of SN-MP angle as it was found to be the most reliable indicator for assessment of vertical growth pattern.[6] All the subjects were in the age range of 18–35 years. This age group represented a very stable period in growth and development of face. The influence of growth is less and permanent dentition present is beyond variability seen during mixed dentition. Moreover, a constant skeletal pattern is established, which is subjected to less changes.[7]

Ramal Height

Class I vs Class II

The difference in ramal height is established to be statistically insignificant among class I and class II jaw bases irrespective of growth pattern which means that there is no effect of

Table 1: Comparison of various parameters among class I and class II jaw bases

	Ramus height		*Lower anterior facial height*		*Interincisal angle*		*Intermolar angle*		*Inclination of symphysis*		*Depth of antegonial notch*	
Variables	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
IA	44.2800	3.19	57.4800	3.80	117.5600	8.6	16.4400	4.64	79.6400	5.72	1.4400	0.56
IIA	42.9600	3.56	61.6000	5.08	111.8400	6.74	14.5600	3.89	75.0400	6.14	1.4600	0.57
p-value	NS		*		*		NS		**		NS	
IB	44.6400	3.61	56.3200	5.48	114.5200	9.67	13.4400	2.91	81.0000	5.70	1.7800	0.73
IIB	46.0400	4.82	58.9600	3.35	114.4400	7.37	11.2000	3.25	77.8800	4.03	1.9800	1.30
p-value	NS		*		NS		*		*		NS	
IC	39.9200	3.66	62.7600	3.35	111.2000	7.72	15.4800	4.90	75.5600	3.99	1.9200	0.75
IIC	41.6800	4.90	64.1600	4.81	109.7600	6.83	16.0800	3.93	76.2800	5.38	2.1600	0.95
p-value	NS		NS		NS		NS		NS		NS	

$p > 0.05$; **Highly significant ($p \leq 0.001$); *Significant ($p \leq 0.05$); NS, Non significant

anteroposterior jaw base relationship on ramal height. This was also confirmed by a study conducted by Stahl et al. who found no significant variations in RH in class I and class II malocclusions.[8] Jacob and Buschang also concluded in their study that RH underestimates growth which occurs at condylion and the differences in growth of RH in different classes were much smaller than the difference in growth of condyle. This difference can be explained by resorption at gonion because for every 1 mm of superior growth of condyle, resorption relocated gonion almost 0.5 mm. These class variations observed for growth direction of gonion over time are somewhat more posterior and less superior for class II jaw bases reducing differences in RH. Due to this, RH was observed to be similar in class I and class II jaw bases irrespective of growth pattern.[8,9]

Lower Anterior Facial Height

Class I vs Class II

Lower anterior facial height shows a significantly higher value for class II jaw bases when compared with class I jaw bases for normodivergent and hypodivergent growth patterns in this study. The results were in accordance with the study by Riesmeijer et al. which stated that LAFH had a greater increase in class II jaw bases than in class I groups.[10] Bjork also theorized that as mandible rotates more backward when sagittal growth occurs at condyle, an increased LAFH is induced. However on comparison of LAFH between class I and class II hyperdivergent growth pattern no significant difference was found between the two indicating that SN-MP increases in class I jaw bases, effect of sagittal discrepancy is masked and values of LAFH becomes similar for class I and class II jaw bases.[4]

Interincisal Angle

Class I vs Class II

Interincisal angle values show no significant variances in skeletal class I and class II jaw base in hypodivergent or hyperdivergent growth patterns. However, a statistically significant variance is noted for normodivergent growth pattern value being more in class I jaw bases. Ishikawa et al. stated in their study that lower incisor inclination is regulated by anteroposterior jaw base relationship and it plays an important role in obtaining normal incisor relationship.[11] Since majority of class II jaw bases are caused by retrognathic mandible, lower incisors are proclined as a result of dentoalveolar compensation, which reduces IIA in class II jaw bases.[5]

Intermolar Angle

Class I vs Class II

The IMA shows no significant differences in class I and class II jaw base in normo- and hyperdivergent growth patterns. Class II jaw bases are expected to have a posterior position of mandibular molar relative to maxillary molars as equated to class I jaw bases, due to retrognathic mandible or prognathic maxilla. It has been manifested that increasing SN-MP positions molar more posteriorly because as ramus tips increasingly forward, molar would occupy a more posterior position to compensate for forward tipping of mandibular body.[12,13] This might be the reason no difference was observed due to sagittal discrepancy in normodivergent and hyperdivergent growth patterns as this was masked by posterior positioning of molars, leading to similar characteristics among class I and class II jaw bases. However difference is statistically significant for hypodivergent growth pattern value being more in class I jaw bases.

Inclination of Symphysis

Class I vs Class II

The values of ISY are significantly more for skeletal class I jaw bases as compared to skeletal class II jaw bases in normodivergent and hypodivergent growth patterns. There is no significant variance in ISY in hyperdivergent growth pattern. Although it was quantified that outcome of an atypical vertical skeletal pattern is greater than that of an atypical sagittal skeletal pattern on symphyseal morphological characteristics yet morphological changes in symphyseal region between class II and class I malocclusions were found in a study by Esenlik and Sabuncuoglu.[1] Similar results were found from a study by Al-Khateeb et al.[14] Other studies have reported a strong relationship between lower incisor inclination and mandibular symphyseal inclination.[1,5] Contrary to our study, Jain et al. concluded that inclination of alveolar part of mandibular symphysis was similar for class I and class II jaw bases, however reference point taken in the study (Id-B/MP) was different from our study (B-Me/MP). Since reference plane to determine inclination of alveolar part of mandibular symphysis passed through B point, therefore, it is expected that change of this point in different skeletal patterns will affect angular measurements because point B recedes with increase in lower incisor inclination, which is generally seen as dentoalveolar compensation in skeletal class II jaw bases.[15]

Depth of Antegonial Notch

Class I vs Class II

The values of depth of AGN showed no statistically significant variation between skeletal class I and class II jaw bases irrespective of growth pattern. This recommends that anteroposterior jaw base relationship has no definitive effect on depth of AGN irrespective of variations observed as a result of variations in growth pattern. The results of this study are in accordance with study done by Yassir which concluded that the highest percentage of AGN depth was observed for class II jaw bases, while the highest percentage of shallow depth was found in skeletal class III. Although there was no substantial difference between AGN amid skeletal class I and class II jaw bases but mean value was less for skeletal class I.[16–18]

Limitation of the Study

The empirical results reported here should be considered in light of some limitations. The first limitation is that skeletal class III jaw bases could not be included in the study due to lack of sufficient records for the same. Another limitation was that the skeletal class II jaw bases were not further classified into division I and division II subjects which seem to have significantly affected the parameter of interincisal relationship as the incisors tend to be proclined in division I cases and retroclined in division II cases. Thus further studies are required to establish and elaborate correlation between sagittal and vertical growth patterns.

Conclusion

Thus, our study is suggestive of the fact that LAFH, IMA, IIA, and ISY are significantly affected by sagittal growth of the jaw bases when the growth pattern is normodivergent or hypodivergent, however, none of the variables showed any significant differences between class I and class II jaw bases when the growth pattern was hyperdivergent stating that as the class I jaw base rotates in a clockwise direction, the dentofacial variables start showing class II characteristics. It can be concluded that there is an effect of sagittal discrepancy on various parameters which were formerly considered to be influenced only by growth patterns.

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