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Comparison between antegonial notch depth, symphysis morphology and ramus morphology among different growth patterns in skeletal class I and class II subjects

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Abstract

In orthodontics and dentofacial orthopaedics, a thorough knowledge of growth and development is essential in order to understand various factors that contribute as to how a particular type of growth takes place. When planning of orthodontic treatment for a malocclusion, one has to take into account the growth pattern, because it would considerably affect the success of the treatment. The purpose of this study was to compare antegonial notch depth, symphysis morphology, and ramus morphology in different growth patterns in skeletal class I and class II subjects. In this study, a total of 60 cephalograms were taken which comprised 30 cephalograms in skeletal class I and 30 cephalograms of skeletal class II patients. The groups were further divided into three groups, namely average, horizontal, and vertical growth patterns based on Jarabak's ratio. Antegonial notch depth, symphysis width and symphysis angle, and ramus height were measured and compared between the growth patterns and between class I and class II skeletal patterns. An analysis of variance (ANOVA) test was performed to determine the comparison between groups for all these variables in both skeletal class I and class II. Independent 't' test was done to determine the comparison between skeletal class I and class II subjects for all variables. Mean and SD values for all variables were determined for all the groups. Depth of antegonial notch was found to be greater in vertical growth patterns compared to horizontal and average growth patterns. Large symphysis angle and symphysis width were noted in a horizontal growth pattern. Increased ramus height was noted in horizontal and average growth patterns. There was no significant difference between skeletal class I and class II malocclusion for all parameters.

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INTRODUCTION

Skeletal Malocclusions are a part of frequently seen dentoskeletal disharmony that occur due to a wide variety of etiology that includes genetics, environmental factors etc. Skeletal growth of the mandible varies widely in both the sagittal as well as vertical dimensions. Sagittally, the skeletal growth is classified into Class I, Class II and Class III while vertically the growth pattern is divided into horizontal growth pattern, average growth pattern and vertical growth patterns. Knowledge of dental and skeletal characteristics, together with different growth patterns is a necessity in determining treatment plans for successful treatment outcomes. The success of the treatment of malocclusions may be improved or impaired depending on the variations in the direction, timing, and duration of the development in the facial areas (Nahoum, 1977).

Prediction of the growth pattern of the mandible plays an important role in diagnosis and treatment planning. Backward and downward rotation of mandibles occurs during growth due to apposition beneath the gonial angle with excessive resorption under the symphysis. This results in the upward curving of the inferior border of the mandible anterior to the angle of the mandible are known as antegonial notching (Björk, 1963). In adolescents with Deep antegonial notches, the mandible showed some characteristics such as retrusive mandible, short corpus length and ramus height and greater gonial angle when compared with shallow mandibular antegonial notches (Singer *et al.*, 1987).

The mandibular symphysis also considered as one of the predictors for the direction of mandibular growth rotation and as the primary reference for esthetic considerations in lower one-third of the face (Aki *et al.*, 1994). Morphology and dimension of the symphysis may be indirectly affected by lower incisor inclination and dentoalveolar compensation occurred as a result of anteroposterior jaw discrepancy (Al-Khateeb *et al.*, 2014). The thick symphysis is noted in horizontal growth patterns (Ricketts, 1960). Extraction and non-extraction treatment plan depend on the symphysis morphology and movement of incisors in alveolar bone such as non-extraction treatment plan are acceptable in thick symphysis and extraction treatment plan is indicated in the small chin (Mangla *et al.*, 2011). Mandibular ramus morphology is an important indicator for mandibular growth and mandibular ramus height is deficient in vertical growth pattern compared to horizontal growth pattern (Muller, 1963).

Very few studies have been reported about mandibular morphology in different growth patterns. Thus the purpose of this study was to evaluate the mandibular morphology in different growth patterns of skeletal class I and class II subjects.

MATERIALS AND METHODS

The sample size for this retrospective cross-sectional study consists of 60 pretreatment lateral cephalograms of individuals. The Sample included lateral cephalograms of individuals between the age group of 18 to 30 years with skeletal class I or class II malocclusion with full permanent dentition. The Skeletal class pattern was decided based on the ANB angle measured on the lateral cephalograms. An ANB angle of 0-4 degrees was considered as Skeletal Class I and an ANB angle of more than 4 degrees were considered as Skeletal Class II. Individuals with congenital anomalies, syndromes, hypodontia, other malformations and those with a previous history of orthodontic treatment or mandibular surgery were excluded from the study. The sample was divided into two groups consisting of 30 skeletal class I and 30 Class II cases which were further grouped based on the growth pattern as described below. Simple random sampling methods have been used to avoid sampling bias.

All cephalograms were traced digitally by using FACAD software. Based on Jarabak's ratio sample was divided into average, horizontal, and vertical growth patterns in both the control group and case group. Group 1 is the control group which included 30 lateral cephalograms of individuals with a skeletal class I pattern. These were further divided into three subgroups based on the growth pattern (Average Growth Pattern, Horizontal growth pattern and Vertical growth pattern) with each subgroup comprising of 10 lateral cephalograms. While Group 2 is the case group which included 30 lateral cephalograms of individuals with a skeletal class II pattern. These were further divided into three subgroups based on the growth pattern (Average Growth Pattern, Horizontal growth pattern and Vertical growth pattern) with each subgroup comprising of 10 lateral cephalograms.

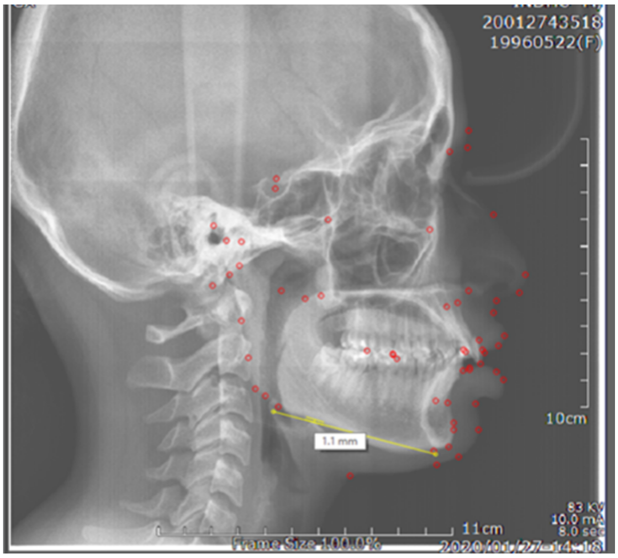

Figure 1: Measurements of Antegonial notch

The Cephalometric linear and angular measurements made on the lateral Cephalograms are as follows (i)Anterior facial height which is the lin-

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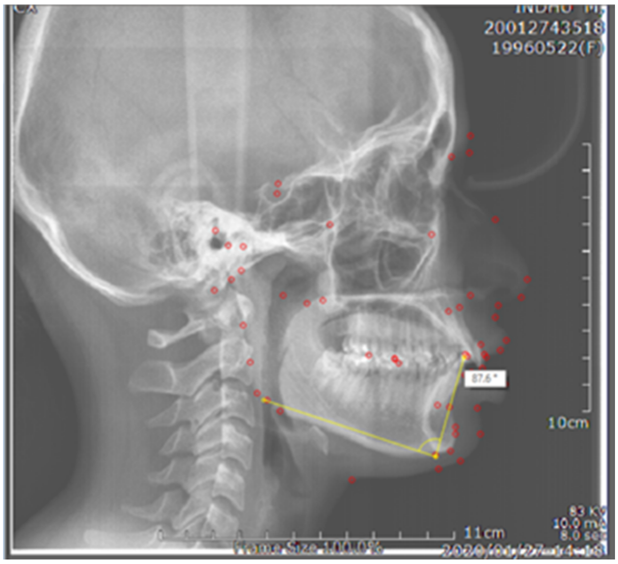

Figure 2: Measurements of symphysis angle

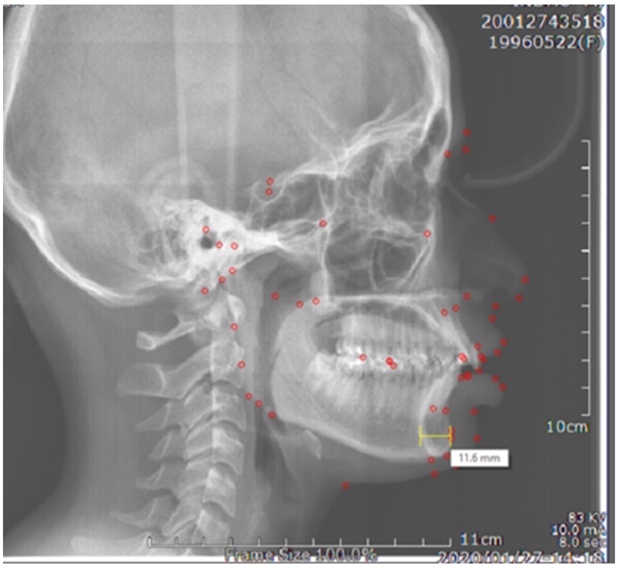

Figure 3: Measurements of symphysis width

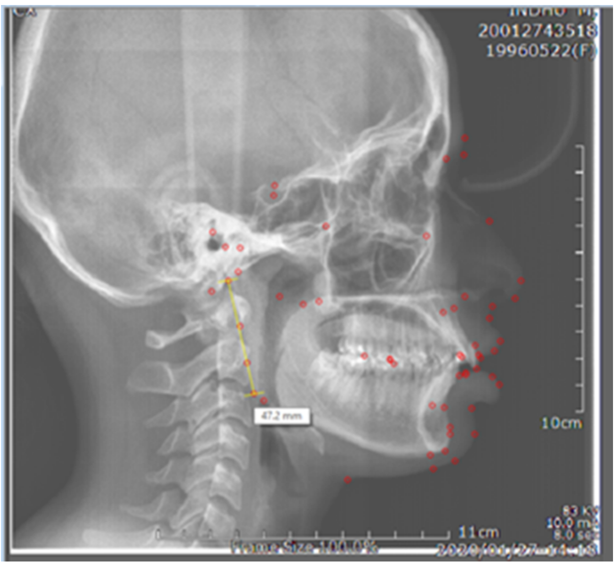

Figure 4: Measurements of ramus height.

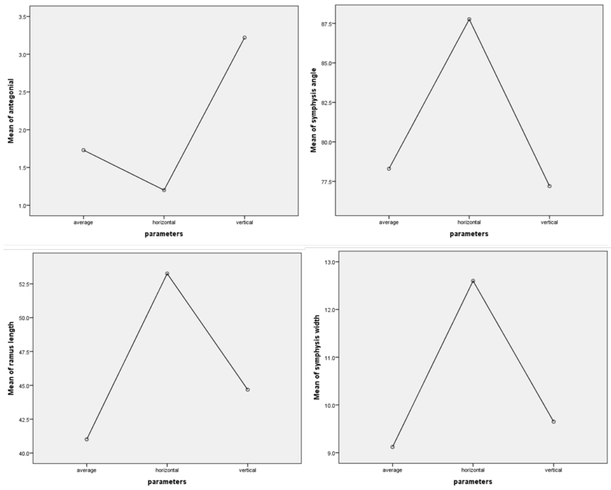

Figure 5: Mean plots of skeletal class I for all variables.

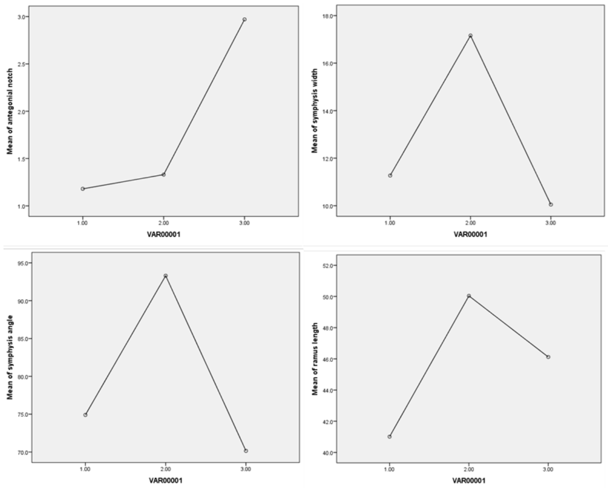

Figure 6: Mean plots of skeletal class IIfor all variables.

ear distance measured between Nasion and Menton. (ii)The posterior facial height which is the linear distance measured between Sella and Gonion. (iii) Jarabak's ratio which is posterior facial height divided by Anterior facial height.

(iv) Antegonial notch depth which is the linear distance measured along a perpendicular drawn from deepest part of convexity to a tangent through two points on either side of the notch on the lower border of the mandible(Mangla *et al.*, 2011) (Figure 1). (v) Symphysis angle – the posterior-superior angle formed by the line through Menton and point B and the mandibular plane(Aki *et al.*, 1994) (Figure 2). (vi) Symphysis width: The perpendicular distance from the pogonion to the most convex point of the lingual curvature of the symphysis. (Figure 3) and (vii) Ramus height – the linear distance between Articulare and Gonion (Mangla *et al.*, 2011) (Figure 4).

Statistical Analysis

An analysis of variance (ANOVA) test was performed to determine the comparison between groups for all these variables in both skeletal class I and class II. Independent t-test was done to determine the comparison between skeletal class I and class II subjects for all variables. Mean and SD values for all variables were determined for all the groups.

RESULTS AND DISCUSSION

For skeletal class II, as can be seen from Tables 1 and 2, the antegonial notch depth was found to be greater in vertical growth pattern than horizontal and average growth pattern ($p<0.05$). Large symphysis width and symphysis angle are noted in horizontal growth patterns compared to vertical and average growth patterns ($p<0.05$). Ramus height is significantly increased in horizontal and average groups compared to vertical growth patterns ($p<0.05$). While Tables 3 and 4 show that in skeletal class, I, antegonial notch depth was found to be greater in vertical growth pattern than horizontal and average growth pattern ($p<0.05$). Large symphysis width and symphysis angle are noted in horizontal growth patterns compared to vertical and average growth patterns ($p<0.05$). Ramus height is significantly increased in horizontal and average groups compared to vertical growth patterns ($p<0.05$).Table 5 showed that there was no significant difference between skeletal class I and class II malocclusion for all parameters ($p>0.05$). Figures 5 and 6 show the mean plots of skeletal class I and class II for all the variables, respectively.

Previously our team had conducted numerous clinical trials involving various topics like recycling of brackets (Kamisetty *et al.*, 2015), Stress distribution on micro-implants (Sivamurthy and Sundari, 2016), retraction with mini implants (Felicita, 2017b), Bonding adhesives (Samantha *et al.*, 2017), intrusion with mini-implant anchorage (Jain *et al.*, 2014), Reviews like growth pattern prediction with gonial angle (Rubika *et al.*, 2015), Bisphosphate use in orthodontics (Krishnan *et al.*, 2015), Case reports in special situations (Felicita, 2017a, 2018), and in vitro studies determination of craniofacial relations (Felicita *et al.*, 2012), apparatus for measurement of orthodontic force (Dinesh *et al.*, 2013), facial analysis with photographs (Krishnan *et al.*, 2018) over the past five years. Now this research study focused on the prediction of the growth pattern of the mandible by analyzing the different anatomical structures of mandible.

Depth of antegonial notch

Depth of antegonial notch was found to be greater in vertical growth pattern compared to the horizontal and average growth pattern. Similar findings have been reported by Singer et al. (Singer *et al.*, 1987), Bjork and Skieller (Björk and Skieller, 1983) and Bjork (Björk, 1969) in their implant studies. Lambrechts et al. stated that the deep antegonial notch group found more in vertical mandibular growth patterns that result in an increase in the anterior facial height than the shallow notch group, hence antegonial notch depth may be considered as a possible predictor for the direction of facial growth (Lambrechts, 1996). Kolodziej et al. suggested that a statistically significant negative relationship was found between mandibular antegonial notch depth and horizontal growth pattern (Kolodziej *et al.*, 2002). Condylar bone change is not only related to retrognathic mandible but also to antegonial notch depth and ramus notch depth (Ali *et al.*, 2005).

For Bone-formation mechanism of the antegonial notch, Enlow demonstrated that the size of the antegonial notch is determined mainly by ramus-corpus angle and extent of bone deposition on the inferior margin of the corpus on either side of the notch and concluded that less prominent antegonial notch is noted if the ramus-corpus angle is closed and a much more prominent antegonial notch is observed if it becomes opened (Enlow, 1982). Hovell showed that the antegonial notch is produced by the role of muscles such as masseter and the medial pterygoid, especially when condylar growth fails to contribute to the lowering of the mandible (Hovell, 1965). Becker demonstrated that impaired mandibular growth and the muscular imbalance would occur if the condylar area, an important growth site injured by inflammatory reactions, results in growth changes that produce antegonial notching (Becker *et al.*, 1976). On the contrary, no reports have been found against a positive relationship between vertical growth pattern and antegonial notch depth. The overall consensus of previous studies was favourable to our present study as the present study is in agreement with the findings of previous studies.

Symphysis width and symphysis angle

The anatomy of the mandibular symphysis is an important consideration in evaluating patients seeking orthodontic treatment (Björk, 1969). In our study, large symphysis width and symphysis angle are noted in horizontal growth patterns compared to vertical and average growth patterns. Similar findings have been reported in some literature such as Aki et al., (Aki *et al.*, 1994), Mangla et

Table 1: One-way ANOVA test with descriptives to determine the values of the mean and standard deviation in skeletal class II.

		N	Mean	Std. Deviation	95% Confidence Interval for Mean	
					Lower Bound	Upper Bound
Antegonial notch	Average	10	1.18	.15	1.069	1.291
	Horizontal	10	1.33	.29	1.117	1.543
	Vertical	10	2.97	.32	2.736	3.204
Symphysis width	Average	10	11.27	2.27	9.643	12.897
	Horizontal	10	17.16	1.16	16.324	17.996
	Vertical	10	10.05	.519	9.679	10.421
Ramus length	Average	10	41.01	1.50	39.932	42.088
	Horizontal	10	48.94	3.06	46.748	51.132
	Vertical	10	46.12	1.85	44.792	47.448
Symphysis angle	Average	10	74.90	3.24	72.577	77.223
	Horizontal	10	93.30	2.83	91.275	95.325
	Vertical	10	70.1	2.31	68.493	71.807

Table 2: One-way ANOVA Post Hoc test (Tukey HSD) to determine the significant difference among different growth pattern in skeletal class II

Variables	Growth pattern		Mean Difference (I-J)	Std. Error	Sig.
Antegonial notch	Average	Horizontal	-.1500	.1210	.441
		Vertical	-1.7900*	.1210	.000
	Horizontal	Average	.1500	.1210	.441
		Vertical	-1.6400*	.1210	.000
	Vertical	Average	1.7900*	.1210	.000
		Horizontal	1.6400*	.1210	.000
Symphysis width	Average	Horizontal	-5.8900*	.6738	.000
		Vertical	1.2200	.6738	.185
	Horizontal	Average	5.8900*	.6738	.000
		Vertical	7.1100*	.6738	.000
	Vertical	Average	-1.2200	.6738	.185
		Horizontal	-7.1100*	.6738	.000
Ramus length	Average	Horizontal	-7.9300*	1.0034	.000
		Vertical	-5.1100*	1.0034	.000
	Horizontal	Average	7.9300*	1.0034	.000
		Vertical	2.8200*	1.0034	.024
	Vertical	Average	5.1100*	1.0034	.000
		Horizontal	-2.8200*	1.0034	.024
Symphysis angle	Average	Horizontal	-18.4000*	1.2628	.000
		Vertical	4.7500*	1.2628	.002
	Horizontal	Average	18.4000*	1.2628	.000
		Vertical	23.1500*	1.2628	.000
	Vertical	Average	-4.7500*	1.2628	.002
		Horizontal	-23.1500*	1.2628	.000

Table 3: One-way ANOVA test with descriptives to determine the values of the meanand standard deviation in skeletal class I.

Variables		N	Mean	Std. Deviation	95% Confidence Interval for Mean	
					Lower Bound	Upper Bound
Antegonial notch	Average	10	1.73	.69	1.235	2.225
	Horizontal	10	1.20	.29	.989	1.411
	Vertical	10	3.22	.28	3.013	3.427
Symphysis angle	Average	10	78.30	1.70	77.082	79.518
	Horizontal	10	87.76	1.84	86.437	89.083
	Vertical	10	77.20	.79	76.631	77.769
Symphysis width	Average	10	9.12	.62	8.674	9.566
	Horizontal	10	12.60	.45	12.271	12.929
	Vertical	10	9.65	1.02	8.882	10.418
Ramus length	Average	10	41.01	1.50	39.932	42.088
	Horizontal	10	53.26	1.42	52.238	54.282
	Vertical	10	47.99	4.23	44.958	51.022

Table 4: One-way ANOVA Post Hoc test (Tukey HSD) to determine the significant difference among different growth patterns in skeletal class I.

Variable	Growth pattern		Mean Difference (I-J)	Std. Error	Sig.
Antegonial notch depth	Average	Horizontal	.5300*	.2079	.043
		Vertical	-1.4900*	.2079	.000
	Horizontal	Average	-.5300*	.2079	.043
		Vertical	-2.0200*	.2079	.000
	Vertical	Average	1.4900*	.2079	.000
		Horizontal	2.0200*	.2079	.000
Symphysis angle	Average	Horizontal	-9.4600*	.6809	.000
		Vertical	1.1000	.6809	.256
	Horizontal	Average	9.4600*	.6809	.000
		Vertical	10.5600*	.6809	.000
	Vertical	Average	-1.1000	.6809	.256
		Horizontal	-10.5600*	.6809	.000
Symphysis width	Average	Horizontal	-3.4800*	.3417	.000
		Vertical	-.5300	.3417	.284
	Horizontal	Average	3.4800*	.3417	.000
		Vertical	2.9500*	.3417	.000
	Vertical	Average	.5300	.3417	.284
		Horizontal	-2.9500*	.3417	.000
Ramus length	Average	Horizontal	-12.2500*	1.2186	.000
		Vertical	-6.9800*	1.2186	.000
	Horizontal	Average	12.2500*	1.2186	.000
		Vertical	5.2700*	1.2186	.001
	Vertical	Average	6.9800*	1.2186	.000
		Horizontal	-5.2700*	1.2186	.001

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Table 5: Independent t test to determine the comparison between skeletal class I and class II subjects

Variables		N	Mean	Std. Deviation	p values
Antegonial average	Skeletal class I	10	1.000	.1563	0.92
	Skeletal class II	10	1.180	.1549	
Antegonial horizontal	Skeletal class I	10	3.610	1.2706	0.087
	Skeletal class II	10	1.330	.2983	
Antegonial vertical	Skeletal class I	10	3.160	.4502	0.143
	Skeletal class II	10	2.970	.3268	
Symphysis angle average	Skeletal class I	10	86.540	1.3850	0.045
	Skeletal class II	10	81.430	2.3353	
Symphysis angle horizontal	Skeletal class I	10	82.830	1.2019	0.317
	Skeletal class II	10	80.990	1.6100	
Symphysis angle vertical	Skeletal class I	10	70.330	22.1718	0.057
	Skeletal class II	10	72.780	.8025	
Symphysis width average	Skeletal class I	10	11.160	.5758	0.399
	Skeletal class II	10	12.990	.7578	
Symphysis width horizontal	Skeletal class I	10	11.820	.8574	0.207
	Skeletal class II	10	16.610	.6027	
Symphysis width vertical	Skeletal class I	10	13.430	1.1451	0.084
	Skeletal class II	10	10.170	.3653	
Ramus length average	Skeletal class I	10	46.450	.8606	0.098
	Skeletal class II	10	41.010	1.5066	
Ramus length horizontal	Skeletal class I	10	52.040	1.6153	0.07
	Skeletal class II	10	48.940	3.0642	
Ramus length vertical	Skeletal class I	10	44.950	3.2654	0.748
	Skeletal class II	10	46.120	1.8558	

al., (Mangla *et al.*, 2011) attributed that large symphyseal angle, symphysis width and small symphysis ratio was observed in horizontal growth patterns compared to vertical growth patterns. Roy et al. also found in his study that external symphysis increases its size from vertical to horizontal growth pattern (Roy, 2012). The thick symphysis is noted in a horizontal growth pattern (Ricketts, 1960). Gracco et al. showed that symphysis thickness was greater in short-faced subjects than in long-faced subjects (Gracco *et al.*, 2010). In patients with horizontal growth pattern, short symphysis height, large symphyseal depth, and the small symphyseal ratio are noted as compared with the hyperdivergent group the results were statistically significant but larger symphysis angle showed not a statistically significant difference compared to hyperdivergent group (Kar *et al.*, 2018). Sassouni and Nanda (Sassouni and Nanda, 1964) and Bjork (Björk, 1969) have found pronounced apposition beneath the symphysis with a concavity in the inferior border of the mandible associated with the tendency toward backward jaw rotation of the mandible. Symphysis width was wider in the hypodivergent Class II group, but symphysis height was similar among all the groups (Esenlik and Sabuncuoglu, 2012). No findings have been found against the positive relationship between horizontal growth pattern and symphysis morphology. Hence overall consensus is in agreement with the findings of the study.

Ramus height

Ramus height is significantly increased in horizontal and average groups compared to vertical growth patterns. Similar findings have been reported in some literature such as Muller et al. (Muller, 1963), Sassouni et al. (Sassouni and Nanda, 1964), Nanda (Nanda, 1988) who all reported a considerable deficiency in vertical growth patterns. Ramus height is significantly smaller in vertical growth patterns and larger in hypodivergent groups (Mangla *et al.*, 2011). No findings have been found against a positive relationship between horizontal growth pattern and ramus height. Hence overall consensus is in agreement with the findings of this study.

There was no significant difference between skeletal class I and class II malocclusion for all parameters (p>0.05), hence concluded that sagittal relationship does not alter the vertical measured variables between skeletal class I and class II malocclusion.

CONCLUSION

The study revealed that the depth of antegonial notch was found to be greater in vertical growth pattern compared to the horizontal and average growth pattern. Large symphysis width and symphysis angle were noted in horizontal growth patterns compared to vertical and average growth patterns. The ramus height was significantly increased in horizontal and average groups compared to vertical growth patterns in both skeletal class I and class II malocclusion. The study shows that the vertical pattern of growth is independent of the type of sagittal pattern of growth.

Conflict of Interest

The authors declare that they have no conflict of interest for this study.

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