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CORRELATION BETWEEN ANTEGONIAL NOTCH DEPTH, SYMPHYSIS MORPHOLOGY AND RAMUS LENGTH IN DIFFERENT GROWTH PATTERNS OF ANGLE'S CLASS II DIV 2 SUBJECTS

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ABSTRACT:
In orthodontics and dentofacial orthopaedics ,thorough knowledge of skeletal and dental components that contribute to Angle's class II div 2 malocclusion is essential because these elements may influence the approach to treatment.When planning of orthodontic treatment for malocclusion, one has to take into account the growth pattern , because it would considerably affect the success of the treatment. Facial growth and development is important because amount and direction growth will alter the need for orthodontic biomechanics.The aim of this study was to compare between antegonial notch depth, symphysis morphology, and ramus morphology in different growth patterns in skeletal class II div 2 subjects. In this study, lateral cephalograms of 47 skeletal class II div 2 subjects were traced. The sample was divided into average, horizontal, and vertical growth patterns based on jarabak's ratio. An analysis of variance (ANOVA) test was performed to determine the comparison between groups for all these variables.Pearson correlation coefficient analysis was done to determine correlation between all variables within all the groups. Results showed that Depth of antegonial notch is found to be greater in vertical growth patterns compared to horizontal and average growth patterns. Large symphysis angle and symphysis width is noted in the horizontal growth pattern. Small ramus height is noted in vertical growth pattern compared to horizontal and average growth patterns. In horizontal growth pattern antegonial notch depth was found to be highly correlated with symphyseal angle (r=0.374) and low correlation was found with symphysis width (0.147) and ramus length(r=0.178).In vertical growth pattern , antegonial notch depth was found to be highly correlated with symphyseal angle (r=0.353) and negative correlation was found with ramus length (r = -0.021),symphysis width (r= - 0.676).In average growth pattern , antegonial notch depth was found to be highly correlated with ramus length(r=0.169) and low correlation was found with symphysis width (r=0.033) and negative correlation was found with symphysis angle (r=-0.403).This study concluded that antegonial notch depth ,symphysis morphology and ramus height are significantly correlated with different growth patterns in skeletal class II malocclusion but are highly significant in horizontal growth patterns. All parameters are significantly correlated with different growth patterns.

Key words: Antegonial notch depth; growth patterns; ramus height; symphysis morphology.

INTRODUCTION :

Skeletal class II malocclusion is a frequently seen dentoskeletal disharmony among the other skeletal malocclusion which was treated worldwide by an orthodontist. Among other malocclusions class II is the most encountered malocclusions to treat hence, skeletal and dental components that contribute to Angle's Class II div 2 malocclusion is essential because these elements may influence the treatment planning(Isik *et al.*, 2006). 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; Baumrind *et al.*, 1978).Prediction of growth pattern of mandible plays an important role in diagnosis and treatment planning(Lundstr m, Lundstr m and Woodside, 1981). Backward and downward rotation of mandibles occur during growth due to apposition beneath the gonial angle with excessive resorption under the symphysis . This results in upward curving of the inferior border of the mandible anterior to the angle of mandible is known as antegonial notching(Björk, 1963, 1969a; Skieller, Björk and Linde-Hansen, 1984; Singh *et al.*, 2011). 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, Mamandras and Hunter, 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). Thick symphysis is noted in horizontal growth pattern(Ricketts, 1960). Extraction and nonextraction treatment plan depends on the symphysis morphology and movement of incisors in alveolar bone such as non extraction treatment plan is acceptable in thick symphysis and extraction treatment plan is indicated in 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 is to evaluate the mandibular morphology in different growth patterns of Angle's class II div 2 subjects.

MATERIALS AND METHODS:

This retrospective cross sectional study was based on the pretreatment lateral cephalograms of 47 individuals of either gender in the age group of 12-30 years who reported to the Department of Orthodontics , saveetha dental college , chennai. This study setting is related to saveetha study setting and has an advantage of early retrieval of data and has an disadvantage of small population and got approved by the ethical review board of saveetha university. Simple random sampling methods have been used to avoid sampling bias.

Inclusion Criteria:

1. Patients with Angle's class II div 2 malocclusion.
2. High quality radiographs with adequate sharpness were taken by using standard techniques and exposure conditions in natural head position.

Exclusion Criteria:

1. Patients with previous history of orthodontic treatment and other mandibular surgery.
2. Patients with any other congenital anomalies or syndromes.
3. Patients with facial asymmetry and congenital malformations.

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 Angle's class div 2 subjects.
Average growth pattern - 13
Horizontal growth pattern - 27
Vertical growth pattern - 7
Cephalometric linear and angular measurements as follows,

- Anterior facial height – the linear distance measured between Nasion and Menton
- Posterior facial height – the linear distance measured between Sella and Gonion
- Jarabak's ratio – posterior facial height divided by Anterior facial height
- Antegonial notch depth – 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).
- Symphysis angle – the posterior-superior angle formed by the line through Menton and point B and the mandibular plane(Aki *et al.*, 1994)(figure2).
- Symphysis width: The perpendicular distance from the pogonion to the most convex point of the lingual curvature of the symphysis(figure 3).
- 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. Mean and SD for all variables were determined for all the groups.
Pearson correlation coefficient analysis was done to determine correlation between all variables within all the groups.

RESULTS AND DISCUSSION:

Table 1 showed that antegonial notch depth ($p<0.05$) was found to be greater in vertical growth pattern than horizontal and average growth pattern in class II div 2 subjects.
Large symphysis width and symphysis angle is noted in horizontal growth patterns compared to vertical and average growth patterns($p<0.05$)(Graph 1).
Small ramus height is noted in vertical growth pattern compared to horizontal and average growth patterns($p<0.05$)(Graph 2&3).
Table 2 showed that in horizontal growth pattern antegonial notch depth was found to be highly correlated with symphyseal angle ($r=0.374$) and low correlation was found with symphysis width (0.147) and ramus length($r=0.178$)(Graph 4).

Table 3 showed that in vertical growth pattern , antegonial notch depth was found to be highly correlated with symphyseal angle ($r=0.353$) and negative correlation was found with ramus length ($r = -0.021$),symphysis width ($r= - 0.676$).

Table 4 showed that in average growth pattern , antegonial notch depth was found to be highly correlated with ramus length($r=0.169$) and low correlation was found with symphysis width ($r=0.033$) and negative correlation was found with symphysis angle ($r=-0.403$).

Previously our team had conducted numerous clinical trials (Kamisetty, 2015; Krishnan, Pandian and Kumar S, 2015; Viswanath *et al.*, 2015; Sivamurthy and Sundari, 2016; Felicita, 2017; Samantha *et al.*, 2017; Vikram and Raj Vikram, 2017), lab animal studies(Ramesh Kumar *et al.*, 2011; Jain, 2014; Rubika, Sumathi Felicita and Sivambiga, 2015; Felicita and Sumathi Felicita, 2017, 2018; Pandian, Krishnan and Kumar, 2018)and in vitro studies(Felicita, Chandrasekar and Shanthasundari, 2012; Dinesh and Saravana Dinesh, 2013)over the past 5 years. Now this research study focused on prediction of growth pattern of mandible by analyzing the different anatomical structures of mandible.The present study was conducted to compare and correlate antegonial notch depth ,symphysis morphology and ramus height among different growth patterns in Angle's class II div 2 malocclusions.

Depth of antegonial notch :

Depth of antegonial notch is found to be greater in vertical growth pattern compared to horizontal and average growth pattern(p<0.05)(Table 1)(Figure 5). Antegonial notch depth was found to be highly correlated with symphyseal angle in horizontal growth pattern(r=0.374) and vertical growth pattern(r=0.353) (Table 2&3).similar findings have been reported by Singer et al(Singer, Mamandras and Hunter, 1987) , Bjork and Skieller(Björk and Skieller, 1983) and Bjork(Björk, 1969a; Björk and Skieller, 1983) in their implant studies. Lambrechts et al stated that the deep antegonial notch group found more in vertical mandibular growth patterns that result in a increase in the anterior facial height than the shallow notch group ,hence antegonial notch depth may be considered as possible predictor for the direction of facial growth(Lambrechts *et al.*, 1996). Kolodziej et al suggested that a statistically significant negative relationship was found between mandibular antegonial notch depth and horizontal growth pattern and (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, Yamada and Hanada, 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 ramus-corpus angle is closed and a much more prominent antegonial notch is observed if it becomes opened(Enlow and Moyers, 1982).Hovell showed that, the antegonial notch is produced by 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 muscular imbalance will occur if the condylar area, an important growth site injured by inflammatory reactions, results in growth changes that produce antegonial notching(Becker, Coccaro and Converse, 1976). On contrary no reports have been found against positive relationship between vertical growth pattern and antegonial notch depth.overall consensus is favourable to our study showed that these study is in agreement with the findings of this study.

Mandibular symphysis angle and symphysis width:

Large symphysis width and symphysis angle is noted in horizontal growth patterns compared to vertical and average growth patterns(p<0.05)(Table 1)(Figure 6&7). The anatomy of the mandibular symphysis is an important consideration in evaluating patients seeking orthodontic treatment(Björk, 1969b; Aki *et al.*, 1994). According to the size and shape of the symphysis many clinicians classify the growth pattern of the mandible anteriorly or posteriorly(Karlsen, 1995). In our study large symphysis width and symphysis angle is 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 ,mangla et al , gupta et al attributed that large symphyseal angle ,symphysis width and small symphysis ratio was observed in horizontal growth patterns compared to vertical growth patterns(Gupta, Dhingra and Chatha, 2018a). Roy et al also found in his study that external symphysis increases its size from vertical to horizontal growth pattern(Roy *et al.*, 2012).Thick symphysis is noted in horizontal growth pattern(Ricketts, 1960; Viazis, 1992). 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 hypodivergent growth pattern,short symphysis height, large symphyseal depth , and small symphyseal ratio is noted as compared with the hyperdivergent group the results were statistically significant but larger symphysis angle showed not statistically significant difference compared to hyperdivergent group (Kar *et al.*, 2018).] Sassouni and Nanda and Bjork have found pronounced apposition beneath the symphysis with concavity in the inferior border of mandible associated with the tendency toward backward jaw rotation of mandible(Sassouni and Nanda, 1964a; Björk, 1969a). 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:

Small ramus height is noted in vertical growth pattern compared to horizontal and average growth patterns($p<0.05$)(Table 1)(Figure 8).In average growth pattern , antegonial notch depth was found to be highly correlated with ramus length($r=0.169$)(Table 4).Similar findings have been reported in some literature such as muller et al , schudy et al ,sassouni et al , Nanda who all reported a considerable deficiency in vertical growth patterns(Muller, 1963; Sassouni and Nanda, 1964b; Schudy, 1964; Nanda, 1988; Gupta, Dhingra and Chatha, 2018b). 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. The limitations of the study was small sample size ,sample distribution was not equal among different growth patterns and restricted to specific ethnic and races.

Future Scope:

From clinical perspective, in an individual-seeking orthodontic treatment, the decision to extract, anchorage preparation and biomechanics and period of retention are dependent on different growth patterns which is greatly influenced by anatomy of mandible , hence thorough knowledge about various growth patterns should be considered as important because it will greatly helpful in diagnosis and treatment planning.

CONCLUSION:

Depth of antegonial notch is found to be greater in vertical growth pattern compared to horizontal and average growth patterns. Large symphysis width and symphysis angle is noted in horizontal growth pattern compared to vertical and average growth patterns.Small ramus height is noted in vertical growth pattern compared to horizontal and average growth patterns.All parameters are significantly correlated with different growth patterns.

AUTHOR CONTRIBUTIONS:

All three authors have equal contribution in collecting and analysing the records for bringing out this research work . We would like to thank the patients who have participated in this study and to our Department of Orthodontics in Saveetha Dental College,Chennai.

CONFLICT OF INTEREST:

There is no conflict of interest.

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FIGURE 1: Measurement of antegonial notch on lateral cephalogram.

FIGURE 2: Measurement of mandibular symphysis angle on lateral cephalogram

FIGURE 3: Measurement of mandibular symphysis width on lateral cephalogram.

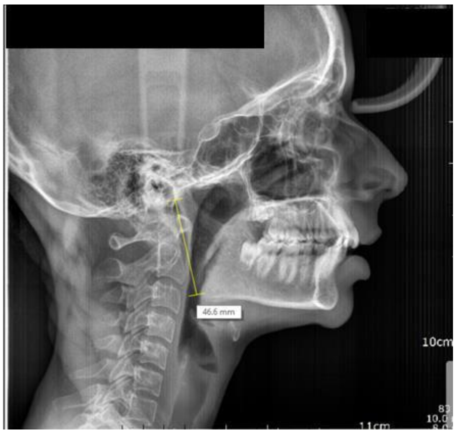

FIGURE 4: Measurement of ramus length on lateral cephalogram

Table 1 depicts descriptive statistics (Mean and SD) of antegonial notch ,symphysis angle ,symphysis width ,ramus length in average , horizontal and vertical growth patterns. One way ANOVA post hoc (Tukey HSD) test was done to determine the comparison between groups for all these variables.Antegonial notch depth ($p<0.05$) was found to be greater in vertical growth pattern than horizontal and average growth pattern in class II div 2 subjects. Large symphysis width and symphysis angle is noted in horizontal growth pattern compared to vertical and average growth patterns($p<0.05$).Smaller ramus height is noted in vertical growth pattern compared to horizontal and average growth patterns($p<0.05$).

		Antegonial notch	**Symphysis angle**	**Symphysis width**	**Ramus length**
Antegonial notch	Pearson Correlation	1	0.374	0.147	0.178
	Sig. (2-tailed)		0.054	0.463	0.374
	N	27	27	27	27
Symphysis angle	Pearson Correlation	0.374	1	-0.106	-0.187
	Sig. (2-tailed)	0.054		0.599	0.35

	N	27	27	27	27
Symphysis width	Pearson Correlation	0.147	-0.106	1	0.091
	Sig. (2-tailed)	0.463	0.599		0.652
	N	27	27	27	27
Ramus length	Pearson Correlation	0.178	-0.187	0.091	1
	Sig. (2-tailed)	0.374	0.35	0.652	
	N	27	27	27	27

Table 2 depicts pearson correlation coefficient analysis was done in a horizontal growth pattern to determine correlation between all variables within the group. Antegonial notch depth was found to be highly correlated with symphyseal angle (r=0.374) and low correlation was found with symphysis width (0.147) and ramus length(r=0.178).

Table 3 depicts Pearson correlation coefficient analysis was done in a vertical growth pattern to determine correlation between all variables within the group. Antegonial notch depth was found to be highly correlated with symphyseal angle (r=0.353) and negative correlation was found with ramus length (r = -0.021),symphysis width (r= - 0.676).

Table 4 depicts Pearson correlation coefficient analysis was done in an average growth pattern to determine correlation between all variables within the group. Antegonial notch depth was found to highly correlated with ramus length(r=0.169) and low correlation was found with symphysis width (r=0.033) and negative correlation was found with symphysis angle (r=-0.403).

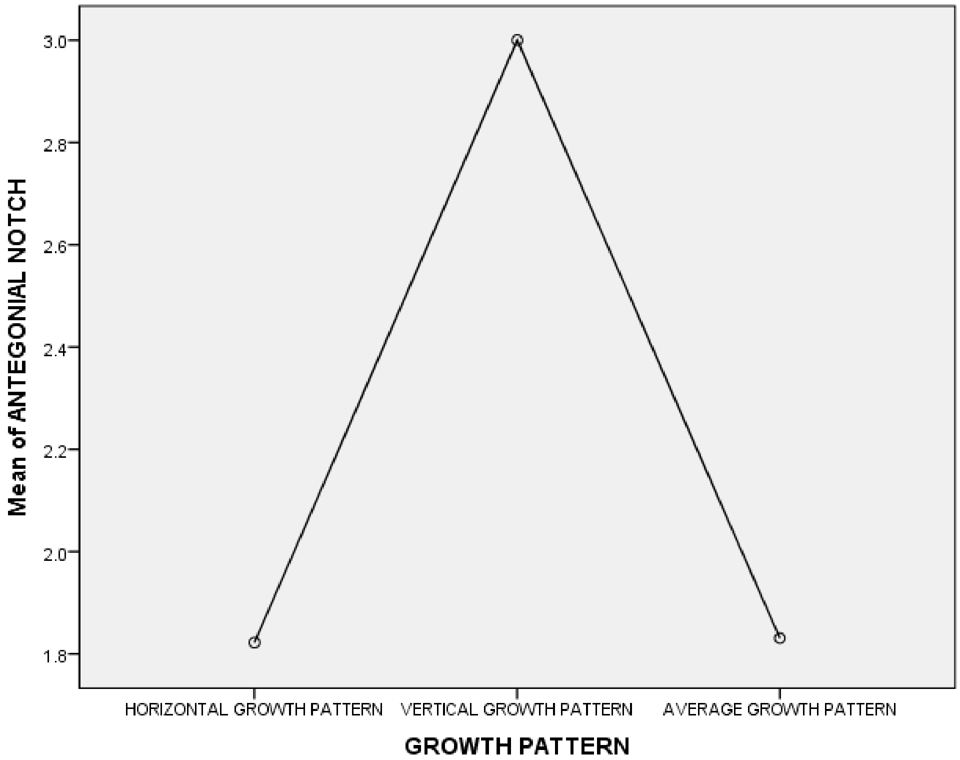

Figure 5: Mean plot represents the mean growth pattern and antegonial notch.X-axis represents the mean of growth pattern and Y-axis represents the mean of antegonial notch.one-way ANOVA was done and there was a significant difference in antegonial notch between average ,horizontal and vertical growth patterns. Mean of antegonial notch depth was found to be greater in vertical growth pattern than horizontal and average growth pattern in class II div 2 subjects.

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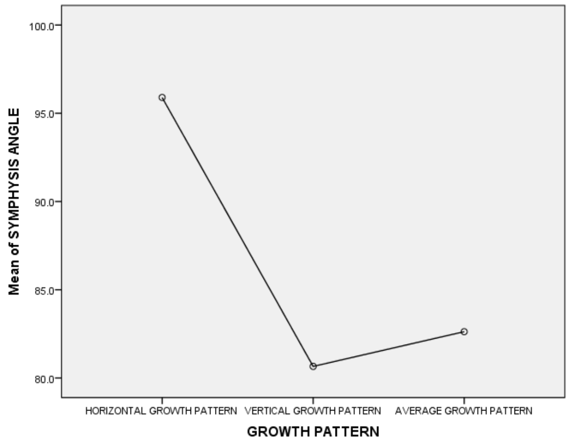

Figure 6: Mean plot represents the mean growth pattern and symphysis angle..X-axis represents the mean of growth pattern and Y-axis represents the mean of symphysis angle.one-way ANOVA was done and there was a significant difference in symphysis angle between average ,horizontal and vertical growth patterns. Mean of symphysis angle is found to be higher in horizontal growth pattern compared to vertical and average growth pattern.

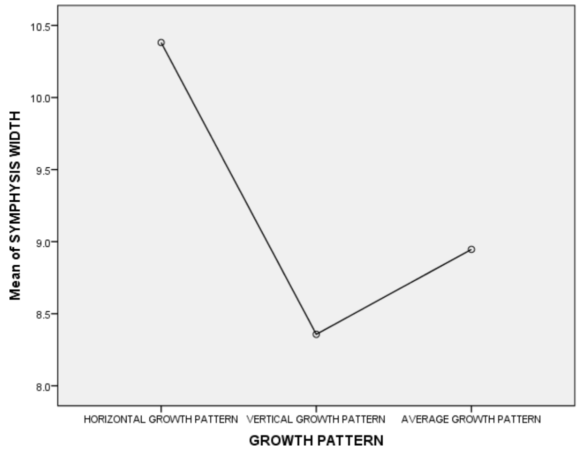

Figure 7: Mean plot represents the mean growth pattern and symphysis width.X-axis represents the mean of growth pattern and Y-axis represents the mean of symphysis width.one-way ANOVA was done and there was a significant difference in symphysis width between average ,horizontal and vertical growth patterns. Mean of symphysis width is found to be higher in horizontal growth pattern compared to vertical and average growth pattern.

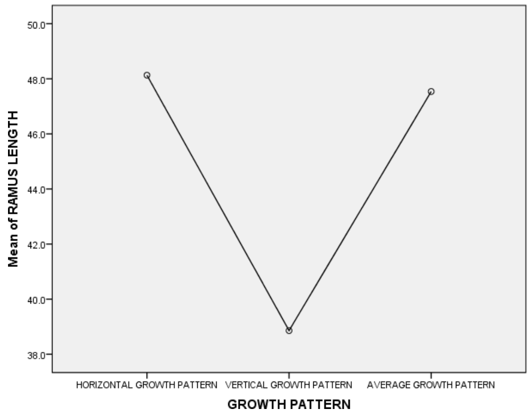

Figure 8: Mean plot represents the mean growth pattern and ramus length.X-axis represents the mean of growth pattern and Y-axis represents the mean of ramus length.one-way ANOVA was done and there was a significant difference in ramus length between average ,horizontal and vertical growth patterns. Mean of ramus length is found to be smaller in vertical growth pattern compared to horizontal and average growth patterns.