DOI: http://doi.org/10.54079/jpmi.37.1.3126

COMPARISON AND CORRELATION BETWEEN MANDIBULAR ANTEGONIAL NOTCH DEPTH AND RAMUS MORPHOLOGY AMONG DIFFERENT PATTERNS OF GROWTH IN SKELETAL CLASS I, II AND III MALOCCLUSION SUBJECTS: AN OBSERVATIONAL STUDY

Alaina Mughal✉, Obaid Akhtar, Abdullah Jan, Rooma Shahid, Fareena Ghaffar, Sundas Mehmood, Asif Khursheed

Department of Orthodontics, Armed Forces Institute of Dentistry, Rawalpindi - Pakistan

Address for correspondence:
Alaina Mughal
Department of Orthodontics, Armed Forces Institute of Dentistry, Rawalpindi - Pakistan

E-mail:
naina.mughal@hotmail.com

Date Received:
4th July, 2022
Date Revised:
27th January, 2023
Date Accepted:
28th January, 2023

ABSTRACT

Objective: To provide a comprehensive comparison and correlation of these indicators among all skeletal patterns.

Methodology: A total of 180 lateral cephalograms (81 males, 99 females) of patients between ages 18 to 25 years, were distributed equally (60 each) among class I, II, and III malocclusion groups in this observational study conducted at AFID, Rawalpindi. These were further sub-grouped (20 each) as average, horizontal and vertical growth patterns based on Jarabak's ratio.

Results: The AND was considerably deep in class I and class II vertical growers ($p < 0.01$) than in average and horizontal growers. Also, RH values were greatest for class I and class II horizontal growers ($p < 0.05$). In class I vertical group, a strong relationship between RH and RW (r=0.521) was observed. In class II horizontal group, AND showed a negative correlation with RH (r= -0.520) and RW (r= -0.516). In class III average group, RW was significantly correlated with RH (r=0.50) and AND (r=0.489).

Conclusion: Vertical growers manifested the greatest AND values contrasted to both average and horizontal growers except class III subjects. Ramal height and width measurements were greatest in horizontal growers as opposed to the other two forms. Also, correlation exists between mandibular morphology and growth pattern. Thus, a thorough knowledge of varying mandibular anatomical patterning for all malocclusion groups is essential for diagnosis and treatment planning.

Keywords: Angle class I; Angle class II; Angle class III; Growth; Malocclusion; Mandible

INTRODUCTION

Dentoskeletal disharmonies are encountered by orthodontists worldwide. The aptitude to anticipate the direction, timing and duration of a person's craniofacial growth, permits the practitioner to recognize individuals that can be rendered functional jaw orthopedic treatment at an appropriate time so that unnecessary treatment procedures can be avoided, later in life.[1,2]

Although to forecast the growth of entire face is highly prudent, predicting the pattern of mandibular growth can provide substantial assistance in diagnosis and subsequent treatment planning. This motivated some investigators to assess different methods that can anticipate the direction in which mandible will grow. Researchers have shown that this directional growth of craniofacial region comes with great variation among different individuals but their studies were mostly focused on class I and class II malocclusion groups.[3,4]

Bjork's unprecedented work reported that individuals in which mandible tends to grow forward manifest a pattern of surface apposition under symphysial region and surface resorption beneath its angle. Opposite is observed in individuals with backward pattern of mandibular growth that shows up as a concavity on the lower border, just ahead of mandibular angle designated as "antegonial notch".[5,6] Hence this acts as a notable indicator of growth pattern determination and can easily be measured both on a lateral cephalogram and an orthopantomogram.

Patterning of mandibular ramus is also a crucial indicator for determining the direction of growth in an individual as to maintain a harmonious dentofacial rela-

This article may be cited as
Mughal A, Akhtar O, Jan A, Shahid R, Ghaffar F, Mehmood S, Khursheed A. Comparison and correlation between mandibular antegonial notch depth and ramus morphology among different patterns of growth in skeletal class I, class II and class III malocclusion subjects: An observational study. J Postgrad Med Inst 2023;37(1): 54-63. http://doi.org/10.54079/jpmi.37.1.3126

tionship, it remodels to attain its alignment in vertical and antero-posterior dimension.[7,8] A study conducted by Muller showed reduced ramal height measurements in individuals who had growth in vertical dimension than those with growth in horizontal dimension.[9] Therefore, ramal height and width show significant variability with varying growth patterns in different skeletal malocclusion groups.

Several cephalometric parameters have already been reported in earlier researches[1,2,7,8,10-14] to relate mandibular morphology with differing growth patterns but not many have reported comparisons together with correlation especially for skeletal class III subjects.

Growth pattern prediction together with knowledge of dentoskeletal characteristics has important clinical implication for establishing correct diagnosis and formulating a proper treatment plan. When considering orthodontic treatment, the necessity of tooth extractions, the appropriate type of anchorage, the methods used to achieve orthodontic tooth movement, and the retention plan to be implemented, all hinge on the individual's growth pattern.[10] Hence this study was conducted with the aim to establish a comprehensive comparison and to find correlation between antegonial notch depth (AND), ramus height (RH) and ramus width in individuals with distinct skeletal growth both in sagittal (skeletal class I, skeletal class II and skeletal class III malocclusion) and vertical (average, vertical and horizontal growth patterns) dimensions.

METHODOLOGY

This observational study was conducted with the approval of the ethical review board of the Armed Forces Institute of Dentistry (AFID) in Rawalpindi. The sample size of 180 pre-treatment lateral cephalograms was determined through a power analysis using G*Power software, Version 3.1.9.7, based on equal distribution (1:1) and effect size (f) = 0.40, with a significance level of α = 0.05.[15]

The cephalograms were collected from patients reporting to the department of orthodontics at AFID from October 2018 to August 2021, and were selected using the purposive sampling technique. The sample consisted of 180 pre-treatment lateral cephalograms of individuals with skeletal Class I (ANB angle value 0º-4º), Class II (ANB angle > 4º), and Class III (ANB angle < 0º) malocclusions, who were between the ages of 18 to 25 years and had completed their growth stage. Patients with facial asymmetry, congenital anomalies, syndromes, or trauma were excluded from the study.

The cephalometric radiographs were hand-traced by the same observer (A.T.) on an acetate matte sheet after placing it on an illuminator. The linear and angular measurements were taken twice by the same observer (R.S.) without any magnification error, using a ruler and a protractor. To ensure accuracy, the measurements were recorded again after an interval of 15 days to determine intra-examiner reliability. Cohen's Kappa coefficient was used to calculate intra-observer variability, with readings ranging from 0.89 to 0.95. The sample was divided into three groups based on ANB values: Group 1 (skeletal Class I), Group 2 (skeletal Class II), and Group 3 (skeletal Class III). The sample was further sub-divided based on maxillary mandibular plane angle (MMA) and Jarabak's ratio into average (MMA 20-28 degrees, Jarabak's ratio 61% - 69%), vertical (MMA >28, Jarabak's ratio <61%), and horizontal (MMA <20 degrees, Jarabak's ratio >69%) growth patterns, with an equal distribution of 20 in each sub-group.[16]

The study assessed antegonial notch depth and ramus morphology (ramal height and width) for all sub-groups. The data was analyzed using IBM SPSS software Version 26 (2019). Cross tabulation was used to evaluate gender distribution from the sample size, and ANOVA was used to determine differences between the three groups for all variables, followed by a post-Hoc Tukey test with a significance level of $p < 0.05$. The mean and standard deviation values for all variables were calculated for each group. Pearson's correlation coefficient analysis was performed to determine the correlation between ANB and ramus morphology (height and width) for average, vertical, and horizontal growers for all three malocclusion groups, with a significance level of 5%. The cephalometric landmarks and planes used for measurement are shown in Figure 1, while the linear and angular measurements recorded are defined in Table 1.

RESULTS

Table 2a and 2b illustrate differences among varied patterns of growth in a skeletal class I malocclusion group, the AND values were significantly greater in individuals with vertical pattern of growth ($p < 0.01$) than both average and horizontal growers. RH appeared significantly increased for horizontal growers ($p < 0.05$) in contrast to the other two groups. No significant change was observed for RW measurements in any of the groups.

For skeletal class II as illustrated in Table 3a and 3b, antegonial notch measurements were raised significantly for patients with increased vertical component of growth ($p < 0.01$) followed by average and horizontal growers. RH measurements were significantly increased in patients with horizontal pattern ($p < 0.05$) of growth as opposed to vertical growth pattern, whereas, ramus width values were increased in horizontal growers ($p < 0.05$) contrasted to average growers.

Table 4a and 4b showed statistically

insignificant differences among the three groups (average, vertical and horizontal) in skeletal class III patients for AND, RH and RW measurements.

Pearson's correlation coefficient analysis results of individual comparisons between different groups are illustrated in Table 5. In subjects with average growth pattern, significant correlation was not found among any of the variables in class I and class II malocclusion groups, while in class III subjects RW showed definitive but small correlation with RH (r =0.50) and AND (r =0.489).

Class I subjects with vertical pattern of growth showed moderate correlation of RH with RW (r =0.521). AND was also moderately correlated with RH (r =0.510) in class II and RW (r =0.509) in class III vertical growers. In horizontal growth pattern, AND showed moderate but negative correlation with RH (r = -0.520) and RW (r = -0.516) in class II subjects. RH was found to be highly correlated with RW (r=0.696) in case of class III while no significant correlation was observed in class I subjects.

DISCUSSION

Several studies determining the plausibility of Bjork's structural method have been carried out to predict mandibular growth and its effect on facio-skeletal morphology.[1,3,8,10,12,17] This study employed to not only provide detailed comparison but also to find correlation between AND and ramus morphology (height and width) on untreated subjects in different skeletal growth patterns

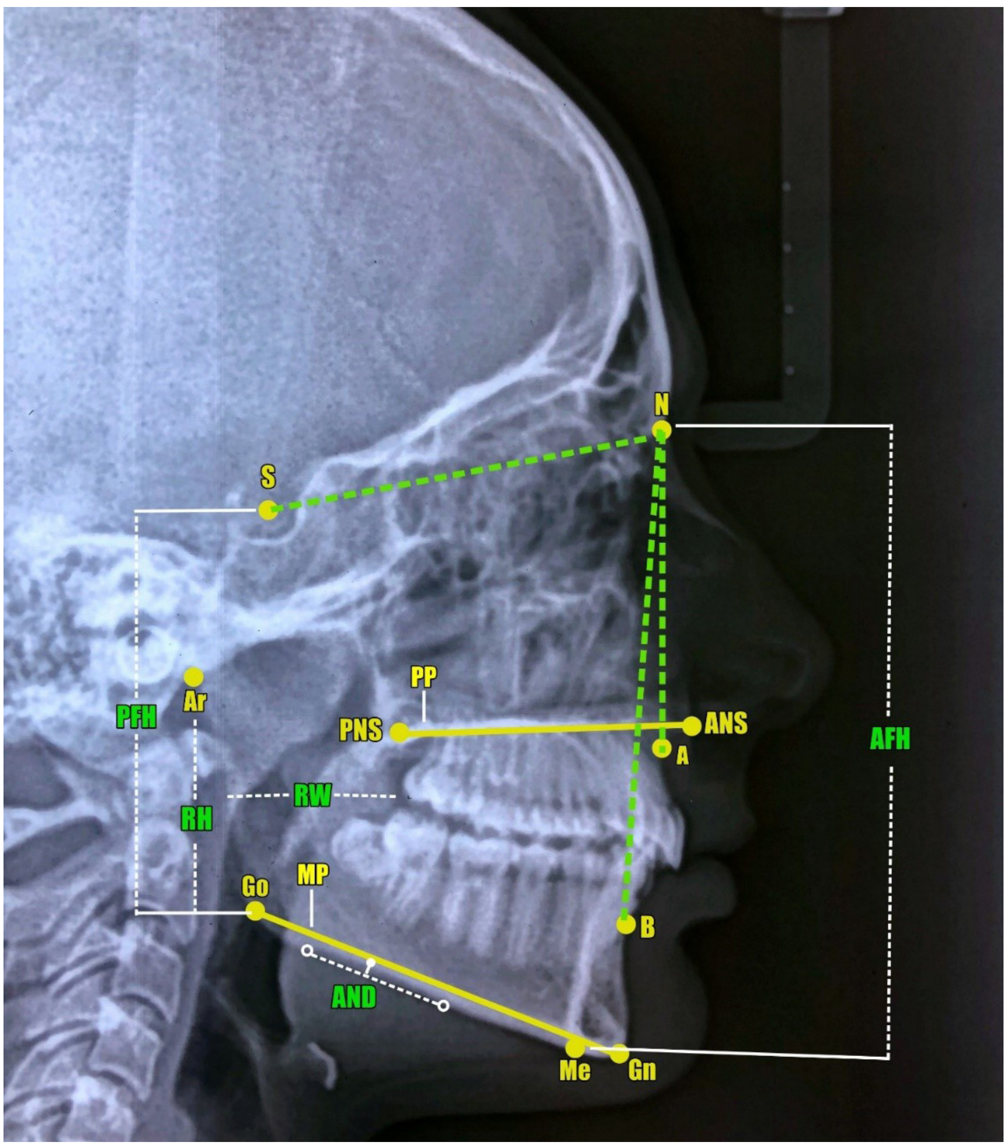

Figure 1: S= Sella, N=Nasion, A= Point A, B= Point B, Ar= Articulare, Gn= Gnathion, Go= Gonion, Me= Menton, ANS= Anterior nasal spine, PNS= Posterior nasal spine, MP= Mandibular plane, PP= Palatal plane, AFH= Anterior facial height, PFH= Posterior facial height, AND= Antegonial notch depth, RH= Ramus height, RW= Ramus width

Table 1: Linear and angular measurements obtained from lateral cephalograms

Variables	Definition
A point, nasion, B point (ANB)	Difference between SNA (Sella-Nasion to point A) angle and SNB (Sella-Nasion to point B) angle
Anterior facial height (AFH)	The linear distance recorded from Nasion to Menton
Posterior facial height (PFH)	The linear distance recorded from Sella to Gonion
Jarabak's ratio	Posterior facial height divided by total Anterior facial height
Antegonial notch depth (AND)	The perpendicular distance recorded from deepest part of convexity located anterior to angle of mandible on the lower border of mandible to a tangent drawn through two points on either side of the notch 14
Ramus Height (RH)	The linear distance measured from Articulare point to Gonion 14
Ramal width (RW)	The linear distance measured between anterior and posterior border of mandibular ramus at the level of occlusal plane 10

Table 2a: ANOVA test with descriptives in skeletal class I

Variables	N	Mean	SD	SE	95% Confidence Interval for Mean	
					Lower Bound	Upper Bound
Ramus Height	Average (20)	40.60	5.04	1.12	38.24	42.96
	Vertical (20)	39.70	3.52	0.78	38.05	41.35
	Horizontal (20)	45.10	5.00	1.11	42.76	47.44
Ramus Width	Average (20)	25.40	1.93	0.43	24.50	26.30
	Vertical (20)	24.75	2.05	0.45	23.79	25.71
	Horizontal 20)	25.10	3.39	0.75	23.52	26.68
Antegonial Notch	Horizontal (20)	1.27	0.69	0.15	0.94	1.60
	Vertical (20)	2.60	0.55	0.12	2.34	2.85
	Horizontal (20)	1.75	0.61	0.13	1.11	1.69

N = Number of samples, SD = Standard Deviation, SR = Standard Error

Table 2b: Post Hoc test to determine significant differences among different growth patterns n skeletal class I

Variables			Mean Difference (I-J)	SE	Sig.
Ramus Height	Average	Vertical	0.90	1.44	0.809
		Horizontal	-4.50**	1.44	0.008
	Vertical	Average	-0.90	1.44	0.809
		Horizontal	-5.40***	1.44	0.001
	Horizontal	Average	4.50**	1.44	0.008
		Vertical	5.40***	1.44	0.001
Ramus Width	Average	Vertical	0.65	0.80	0.699
		Horizontal	0.30	0.80	0.926
	Vertical	Average	-0.65	0.80	0.699
		Horizontal	-0.35	0.80	0.901
	Horizontal	Average	-0.30	0.80	0.926
		Vertical	0.35	0.80	0.901
Antegonial Notch	Average	Vertical	-1.32****	0.19	0.000
		Horizontal	-0.12	0.19	0.803
	Vertical	Average	1.32****	0.19	0.000
		Horizontal	1.20****	0.19	0.000
	Horizontal	Average	0.12	0.19	0.803
		Vertical	-1.20****	0.19	0.000

** p= 0.01, *** p=0.001, **** p=0.000 SE = Standard Error, Sig. = Significance

Table 3a: ANOVA test with descriptives in skeletal class II

Variables	N	Mean	SD	SE	95% Confidence Interval for Mean	
					Lower Bound	Upper Bound
Ramus Height	Average (20)	40.05	4.04	0.90	38.16	41.94
	Vertical (20)	38.75	5.79	1.29	36.04	41.46
	Horizontal (20)	42.35	3.70	0.82	40.62	44.08
Ramus Width	Average (20)	24.55	2.32	0.52	23.46	25.64
	Vertical (20)	24.75	2.88	0.64	23.40	26.10
	Horizontal 20)	26.70	2.88	0.64	25.35	28.05
Antegonial Notch	Horizontal (20)	0.87	0.60	0.13	0.59	1.15
	Vertical (20)	2.70	1.29	0.28	2.09	3.30
	Horizontal (20)	1.45	0.64	0.14	1.14	1.75

N = No. of samples, SD = Standard Deviation, SE = Standard Error

Table 3b: Post Hoc test to determine significant differences among different growth patterns n skeletal class II

Variables			Mean Difference (I-J)	SE	Sig.
Ramus Height	Average	Vertical	1.30	1.45	0.647
		Horizontal	-2.30	1.45	0.263
	Vertical	Average	-1.30	1.45	0.647
		Horizontal	-3.60*	1.45	0.043
	Horizontal	Average	2.30	1.45	0.263
		Vertical	3.60*	1.45	0.043
Ramus Width	Average	Vertical	-0.20	0.85	0.970
		Horizontal	-2.15*	0.85	0.039
	Vertical	Average	0.20	0.85	0.970
		Horizontal	-1.95	0.85	0.068
	Horizontal	Average	2.15*	0.85	0.039
		Vertical	1.95	0.85	0.068
Antegonial Notch	Average	Vertical	-1.82****	0.28	0.000
		Horizontal	-0.57	0.28	0.119
	Vertical	Average	1.82****	0.28	0.000
		Horizontal	1.25****	0.28	0.000
	Horizontal	Average	0.57	0.28	0.119
		Vertical	-1.25****	0.28	0.000

* p=0.05, **** p= 0.000, SE = Standard Error, Sig. = Significance

Table 4a: ANOVA test with descriptives in skeletal class III

Variables	N	Mean	SD	SE	95% Confidence Interval for Mean	
					Lower Bound	Upper Bound
Ramus Height	Average (20)	39.65	5.39	1.20	37.13	42.17
	Vertical (20)	38.95	6.00	1.34	36.14	41.76
	Horizontal (20)	43.70	7.62	1.70	40.13	47.27
Ramus Width	Average (20)	23.05	2.85	0.63	21.71	24.39
	Vertical (20)	22.65	2.90	0.65	21.29	24.01
	Horizontal 20)	24.75	2.63	0.58	23.52	25.98
Antegonial Notch	Horizontal (20)	2.02	1.12	0.25	1.49	2.55
	Vertical (20)	2.05	0.74	0.16	1.70	2.39
	Horizontal (20)	2.21	1.10	0.25	1.67	2.74

N = No. of samples, SD = Standard Deviation, SE = Standard Error

Table 4b: Post Hoc test to determine significant differences among different growth patterns n skeletal class III

Variables			Mean Difference (I-J)	SE	Sig.
Ramus Height	Average	Vertical	0.70	2.02	0.936
		Horizontal	-4.05	2.02	0.122
	Vertical	Average	-0.70	2.02	0.936
		Horizontal	-4.75	2.02	0.058
	Horizontal	Average	4.05	2.02	0.122
		Vertical	4.75	2.02	0.058
Ramus Width	Average	Vertical	0.40	0.88	0.894
		Horizontal	-1.70	0.88	0.143
	Vertical	Average	-0.40	0.88	0.894
		Horizontal	-2.10	0.88	0.054
	Horizontal	Average	1.70	0.88	0.143
		Vertical	2.10	0.88	0.054
Antegonial Notch	Average	Vertical	-0.02	0.31	0.997
		Horizontal	-0.18	0.31	0.834
	Vertical	Average	0.02	0.31	0.997
		Horizontal	-0.16	0.31	0.873
	Horizontal	Average	0.18	0.31	0.834
		Vertical	0.16	0.31	0.873

* p=0.05, **** p= 0.000, SE = Standard Error, Sig. = Significance

Table 5: Correlation analysis among different growth patterns (average, horizontal, vertical) in skeletal class I, skeletal class II, skeletal class III subjects

Variables	Growth pattern			Mean Difference (I-J)	SE	Sig.
Average	Class I (N=20)	RH	P. correlation	1	0.163	0.265
			Sig. (2-tailed)		0.491	0.259
		RW	P. correction	0.163	1	0.012
			Sig. (2-tailed)	0.491		0.961
		AND	P. correlation	0.265	0.012	1
			Sig. (2-tailed)	0.259	0.961	
	Class II (N=20)	RH	P. correlation	1	0.226	-0.030
			Sig. (2-tailed)		0.338	0.901
		RW	P. correlation	0.226	1	-0.098
			Sig. (2-tailed)	0.338		0.680
		AND	P. correlation	-0.030	-0.098	1
			Sig. (2-tailed)	0.901	0.680	
	Class III (N=20)	RH	P. correlation	1	0.500*	0.231
			Sig. (2-tailed)		0.025	0.328
		RW	P. correlation	0.500*	1	0.489*
			Sig. (2-tailed)	0.025		0.029
		AND	P. correlation	0.231	0.489*	1
			Sig. (2-tailed)	0.328	0.029	

Vertical	Class I (N=20)	RH	P. correlation	1	0.521*	-0.430
			Sig. (2-tailed)		0.019	0.059
		RW	P. correction	0.521*	1	-0.209
			Sig. (2-tailed)	0.019		0.376
		AND	P. correlation	-0.430	-0.209	1
			Sig. (2-tailed)	0.059	0.376	
	Class II (N=20)	RH	P. correlation	1	0.261	0.510*
			Sig. (2-tailed)		0.267	0.022
		RW	P. correlation	0.261	1	0.092
			Sig. (2-tailed)	0.267		0.700
		AND	P. correlation	0.510*	0.092	1
			Sig. (2-tailed)	0.022	0.700	
	Class III (N=20)	RH	P. correlation	1	0.310	-0.082
			Sig. (2-tailed)		0.184	0.731
		RW	P. correlation	0.310	1	0.509*
			Sig. (2-tailed)	0.184		0.022
		AND	P. correlation	-0.082	0.509*	1
			Sig. (2-tailed)	0.731	0.022	
Horizontal	Class I (N=20)	RH	P. correlation	1	0.152	-0.056
			Sig. (2-tailed)		0.523	0.815
		RW	P. correction	0.152	1	0.093
			Sig. (2-tailed)	0.523		0.697
		AND	P. correlation	-0.056	0.093	1
			Sig. (2-tailed)	0.815	0.697	
	Class II (N=20)	RH	P. correlation	1	0.286	-0.520*
			Sig. (2-tailed)		0.221	0.019
		RW	P. correlation	0.286	1	-0.516*
			Sig. (2-tailed)	0.221		0.020
		AND	P. correlation	-0.520*	-0.516*	1
			Sig. (2-tailed)	0.019	0.020	
	Class III (N=20)	RH	P. correlation	1	0.696***	0.280
			Sig. (2-tailed)		0.001	0.232
		RW	P. correlation	0.696***	1	0.326
			Sig. (2-tailed)	0.001		0.161
		AND	P. correlation	0.280	0.326	1
			Sig. (2-tailed)	0.232	0.161	

* p = 0.05, ***p = 0.001, N = No. of subjects, RH = Ramus height, RW = Ramus width, AND = Antegonial notch depth. Pearson correlation coefficient

both in sagittal and vertical dimensions with emphasis on growth pattern prediction by analyzing aforementioned structures of the mandible. Two-dimensional lateral cephalometric films were utilized in the present study, as patients were routinely advised for orthodontic treatment being an essential diagnostic tool that did not add any extra cost or radiation exposure.

The eventual form of a completely developed mandible is due to a complex interplay of growth determinating and environmental factors that influence function and direct the jaw bone. Antegonial notch deepening appears as a result of appositional and resorptive processes that shape the mandible in such a way which exemplifies the type of growth in an individual. In existing study, the depth of antegonial notch in class I and class II were greatest for subjects with vertical growth pattern than average or horizontal growth patterns. This result is congruent with Bjork's report and various studies done previously.[2-5,10,18] Howell[19] reported that due to the action of masseter and medial pterygoid muscle antegonial notching is produced along the lower border of the mandible when condylar growth fails to contribute to downward mandibular growth. A study[11] showed that highest proportion of shallow notch was observed in skeletal class III and in our study no statistically significant differences could be found in class III subjects.

A low correlation was found between AND and RW in class III individuals with average growth pattern (r=0.489) as well as class III with vertical growth pattern (r=0.509). No previous studies reporting any significant relationship could be found for skeletal class III individuals. Class II vertical growers showed moderate relationship between antegonial notch depth and ramus height (r=0.510). Lambrechts et al[20] concluded in his study that patients with more vertical pattern of mandibular growth have deep antegonial notches and result in increased anterior facial height than those with shallow notch depth and no contradictory reports against this positive relationship have been found. In class II horizontal growers a notable negative relationship was found for antegonial notch depth with both ramus height (r=-0.520) and ramus width (r=-0.516) which was significant statistically. These findings are in conformity with Kolodziej et al who also reported significant negative relationship between mandibular AND and imminent horizontal jaw bone development.[21] Enlow highlighted the importance of ramus-corpus angle as it directly influences the amount of bone turnover on the inferior margin of mandibular corpus. He demonstrated that individuals in which ramus-corpus angle is opened, deep antegonial notch was noticed whereas if it becomes closed, shallow notch depths were observed.[22]

Overall, previous studies unanimously are in consensus with the results of our study, hence, antegonial notch may possibly forecast the direction of facial growth. The correlation of AND with RW in class III average and vertical growers should be taken in account when treatment for such subjects is forethought.

RH was greatest in horizontal growth pattern for both class I and class II subjects as compared to average and vertical growth pattern groups. A significantly increased RW was observed in skeletal class II subjects only with horizontal growth pattern. These findings are compatible with observations reported by renowned researchers, who promulgated reduced ramal dimensions in subjects with vertical growth pattern. [1, 9, 23-25] Another study reported large RH values in individuals with hypodivergence of mandible and smaller values in hyperdivergent growth patterns[26]. In the present study RH was moderately correlated with RW in class I vertical growers (r=0.510) and class III average growers (r=0.50) whereas a high correlation was observed between the two (RH and RW) for class III horizontal growers (r=0.696). Hence, ramus morphology is a reliable and potent indicator of determining how mandibular growth will respond to future orthodontic treatment thus treatment needs to be planned, executed and retained accordingly by the practitioner.

The outcomes of this study have important clinical implications when planning and executing orthodontic treatment as factors like extraction decision, anchorage preparation, application of biomechanics and retention protocol are subject to individual's growth pattern demands, hence a rigorous understanding of skeletal patterns both in sagittal and vertical dimensions is of paramount importance. Further studies are encouraged to validate the results among various ethnicities with an elaborate sample size especially for class III pattern and taking in account all Bjork's seven structural parameters.[3] Also, three-dimensional modalities can be used in future studies for an in-depth knowledge on the same.

CONCLUSION

Antegonial notch depth was deepest in individuals with vertical growth pattern for both skeletal class I and class II groups. Class II vertical growers showed moderate correlation between antegonial notch depth and ramus height.Class III individuals also showed significant correlation between depth of antegonial notch and ramus width in both average and vertical growth patterns. A negative relationship was observed for antegonial notch depth with both ramus height and ramus width in class II horizontal growers.

Ramus height values were greatest in horizontal growth pattern for both class I and II subjects as compared to average and vertical growth pattern groups. A significantly increased ramus width was observed in skeletal class II subjects only with horizontal growth pattern. Correlation between ramal height and width was found in class I vertical growers and class III average and horizontal growers.

Orthodontic diagnosis and treatment planning can be regulated by determining anatomical variability of antegonial notch depth, ramus height and width as growth pattern plays an evident role in carrying out a successful treatment. Thus, from clinical perspective thorough understanding of these parameters help the clinician in making an accurate decision.

REFERENCES

1. Gupta S, Dhingra P, Chatha S. A study of comparison and correlation between antegonial notch depth, symphysis morphology, and ramus morphology among different growth patterns in angle's Class II Division 1 Malocclusion. Ind J Dent Sci. 2018;10(1):21. DOI:10.4103/ijds.ijds_109_17
2. Abirami S, George Am, Varghese Rm. Correlation Between Antegonial Notch Depth, Symphysis Morphology And Ramus Length In Different Growth Patterns Of Angle's Class Ii Div 2 Subjects. European Journal Of Molecular & Clinical Medicine. 2020;7(01):1134-39.
3. Bjork A. Prediction of mandibular growth

rotation. Am J Orthod. 1969;55(6):585-99. DOI:10.1016/0002-9416(69)90036-0.

4. Björk A, Skieller V. Normal and abnormal growth of the mandible. A synthesis of longitudinal cephalometric implant studies over a period of 25 years. Eur J Orthod. 1983;5(1):1-46. DOI:10.1093/ejo/5.1.1.
5. Björk A. The use of metallic implants in the study of facial growth in children: method and application. Am J Phys Anthropol. 1968;29(2):243-54. DOI:10.1002/ajpa.1330290217.
6. Dr Irfan Basha S DAN, Dr. Sindhu D, Dr. Ranjitha G, Dr. Nirajita Bhaduri,, Dr. Sanjula Sinha DGJ. Comparison and correlation between antegonial notch depth, symphysis morphology and Curvature of mandibular canal among different growth patterns in angle's class ii Division 1 malocclusion : A radiographic study. Int J Sci Res Eng Dev. 2020;5(3):139-48.
7. Roshni Mahajan1 RT, Garg A, Tripathi A. Amit Singh Choudhary. Comparison and correlation between mandibular morphology among diferent vertical growth patterns: A cephalometric study. Journal of Contemporary Orthodontics. 2022;6(1):14–9.
8. Muller G. Growth and development of the middle face. 1963;42(1):385-99. DOI: 10.1177/0022034563042001460
9. Kisan R, Nehete A, Gulve N, Shah K, Aher S. A Comparative Evaluation of Antegonial Notch Depth, Symphysis Morphology, Ramus and Mandibular Morphology in Different Growth Patterns in Angle’s Class I Malocclusion: A Cross-Sectional Retrospective Lateral Cephalometric Study in Contemporary Indian Population. Int J of Trend Res Dev. 2020;4(4):1588-952020;4(4):1588-95
10. Yassir YA, Al-Mulla AA. Mandibular antegonial notch depth distribution and its relationship with craniofacial morphology in different skeletal patterns. J Baghdad Coll Dent. 2009;21:107–11.
11. Navaneethan A, Remmiya Varghese. Comparison Between Antegonial Notch Depth, Symphysis Morphology and Ramus Morphology Among Different Growth Patterns In Skeletal Class I And Class II Subjects. International Journal of Dentistry and Oral Science. 2021;8(1):1510-7.
12. Jimenez Silva A, Carnevali Arellano R, Vivanco Coke S, Tobar Reyes J, Araya Diaz P, Palomino Montenegro H. Craniofacial growth predictors for class II and III malocclusions: A systematic review. Clin Exp Dent Res. 2021;7(2):242-62. DOI:10.1002/cre2.357.
13. Knigge RP, McNulty KP, Oh H, Hardin AM, Leary EV, Duren DL, et al. Geometric morphometric analysis of growth patterns among facial types. Am J Orthod Dentofacial Orthop. 2021;160(3):430-441. DOI:10.1016/j.ajodo.2020.04.038.
14. Faul F, Erdfelder E, Buchner A, Lang AG. Statistical power analyses using G*Power 3.1: tests for correlation and regression analyses. Behav Res Methods. 2009 Nov;41(4):1149-60. DOI:10.3758/BRM.41.4.1149.
15. Periago DR, Scarfe WC, Moshiri M, Scheetz JP, Silveira AM, Farman AG. Linear accuracy and reliability of cone beam CT derived 3-dimensional images constructed using an orthodontic volumetric rendering program. Angle Orthod. 2008;78(3):387-95. DOI:10.2319/122106-52.1.
16. BJORK A. Facial growth in man, studied with the aid of metallic implants. Acta Odontol Scand. 1955;13(1):9-34. DOI:10.3109/00016355509028170.
17. Singer CP, Mamandras AH, Hunter WS. The depth of the mandibular antegonial notch as an indicator of mandibular growth potential. Am J Orthod Dentofacial Orthop. 1987;91(2):117-24. DOI:10.1016/0889-5406(87)90468-9.
18. Hovell JH. Variations in mandibular form. Ann R Coll Surg Engl. 1965;37(1):1-18.
19. Lambrechts AH, Harris AM, Rossouw PE, Stander I. Dimensional differences in the craniofacial morphologies of groups with deep and shallow mandibular antegonial notching. Angle Orthod. 1996;66(4):265-72. (1996)066<0265:DDITCM>2.3.CO;2.
20. Kolodziej RP, Southard TE, Southard KA, Casko JS, Jakobsen JR. Evaluation of antegonial notch depth for growth prediction. Am J Orthod Dentofacial Orthop. 2002;121(4):357-63. DOI:10.1067/mod.2002.121561.
21. Enlow DH, Moyers RE Merow WW. Handbook of facial growth. WB Saunders Company; 1982.. Handbook of facial growth. WB Saunders Company; 1982.
22. Nanda SK. Patterns of vertical growth in the face. Am J Orthod Dentofacial Orthop. 1988;93(2):103-16. DOI:10.1016/0889-5406(88)90287-9.
23. Sassouni V, Nanda S. Analysis of dentofacial vertical proportions. Am J Orthod. 1964;50(11):801–23. DOI:10.1016/0002-9416(64)90039-9
24. Schudy F. Vertical growth versus anteroposterior growth as related to function and treatment. 1964;34:75–93.
25. Mangla R, Singh N, Dua V, Padmanabhan P, Khanna M. Evaluation of mandibular morphology in different facial types. Contemp Clin Dent. 2011;2(3):200-6. DOI:10.4103/0976-237X.86458.

Author's Contribution

AM designed the study, did the statistical analysis and writeup of the manuscript. OA contributed in data collection and drafted the manuscript. AJ designed the study, collected the data, and supervised the study. RS contributed in Data collection and data analysis. SM Contributed in Data collection and revision of the manuscript. AK conceived the idea and revised the article.. Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Conflict of Interest

Authors declared no conflict of interest

Grant Support and Financial Disclosure

None

Data Sharing Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.