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Comparison and Correlation between Antegonial Notch, Symphysis Morphology and Ramus Morphology among Different Skeletal Patterns – A Cephalometric and OPG Study

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Abstract

Aim- To compare and correlate between antegonial notch depth, symphysis morphology and ramus morphology in different skeletal patterns in Class I, Class II and Class III relationships. ***Methodology:*** 72 lateral cephalogram and orthopantomograms were be divided into three groups according to the skeletal parameters. Each group is subdivided into three groups based on Y axis: average skeletal pattern Horizontal skeletal pattern and Vertical skeletal pattern. Cephalometric linear and angular measurement and antegonial measurement using OPG were taken. ***Results and conclusion:*** The antegonial notch depth, symphysis height, symphyseal ratio was found to be highest in Class III Vertical skeletal pattern. Symphysis depth, ramal width was found to be highest in Class II Horizontal skeletal pattern. The symphysial angle was highest in Class I Horizontal skeletal pattern. The ramal height was more in Class III Horizontal skeletal pattern and least in Class II Vertical skeletal pattern. Antegonial notch shows strong positive corelation with symphysis height in Class III Horizontal skeletal pattern, and ramal height in Class III Average skeletal pattern. Symphysis height shows strong positive correlation with ramal height in Class I Average skeletal pattern, Class II Horizontal skeletal pattern, Class II Average skeletal pattern and Class III Horizontal skeletal pattern. Symphysis depth shows strong positive correlation with ramal height in Class II Horizontal skeletal pattern and Class III Average skeletal pattern, symphysis angle shows strong positive correlation with Class III Horizontal skeletal pattern.

Keywords: Symphysis height, Symphysis depth, Symphysis ratio, Symphysis angle, Ramus height, Ramus width, Antegonial notch depth, growth pattern, malocclusion.

INTRODUCTION

Mandibular symphysis is one of the anatomical structures of the mandible that contributes to the balance of facial harmony. Ricketts in his study associated a thick symphysis with an anterior growth direction [1]. It has been agreed in the field of Orthodontics that the dimensions and the morphology of the mandibular symphysis has an impact on both the diagnosis and treatment planning of orthodontic patients.

Björk established the relationship between height and width of the mandibular symphysis in mandibular rotational pattern during growth [2]. Enlow states that the symphysis is one of the most variable areas in the entire mandible in different facial types and pattern. In prominent symphysis cases protrusion of incisors are aesthetically acceptable and therefore a greater chance of a non-extraction approach to treatment can be considered.

A marked apposition beneath the symphysis is noticed in mandibles with backward and downward growth rotation of mandible [2]. The antegonial notch is a result of upward curving of the lower border of the mandible anterior to the angular process when condylar growth fails to contribute to the lowering of the mandible. Hence antegonial notch is a significant parameter in different growth patterns and this can be easily measured using an OPG.

The important significance of ramus of the mandible is to provide attachments for masticatory muscles. However, the ramus is also an integral part for placing the corpus and dental arch into harmonious relationship with the maxilla and other facial structures. An appropriate relationship is maintained by critical remodelling and adjustments in ramus alignment, vertical length and anteroposterior dimensions. Hence the ramus height and width shows a significant change in different growth patterns and in different skeletal relationships.

Lateral cephalogram and Orthopantomogram (OPG) are the most commonly advised radiographs in orthodontics to visualise the entire maxillary and mandibular vital structures in a single film. They are most commonly used radiograph to analyze morphology and treatment effects since it has high rate of prescription and it is a useful tool to study of morphological changes of the maxilla and mandible [3].

A thorough knowledge of the dental components, skeletal components and their correlation in skeletal Class I, Class II and Class III is essential because it may influence the treatment plan. Each malocclusion depends on the variations in the direction, timing and duration of the development in the facial areas, because these variations influence the orthodontic diagnosis and to produce an appropriate treatment plan. Hence the purpose of this study is to compare and correlate between antegonial notch depth, symphysis morphology and ramus morphology in different skeletal patterns in Class I, Class II and Class III relationships.

METHODOLOGY

The study was carried out on 72 lateral cephalograms and orthopantomograms of head and neck region of individuals of age above 20 years, which were taken from the archives of Department of Orthodontics and Dentofacial Orthopedics for the orthodontic treatment purpose.

Inclusion Criteria were Age group 21- 40 years (patients younger than 21 years will have incomplete development of their craniofacial structures), Patients cephalometric values with ANB angle (Steiner's cephalometric analysis) equal to 2^0 to 4^0, less than 2^0 and greater than 4^0, YEN angle equal to 117^0-123^0, less than 117^0, greater than 123^0, β angle 27° – 35°, less than 27° , greater than 35°Exclusion criteria were patients with cleft lip and palate, patients below 21 years of age, patients with enlarged tonsils and adenoids, patients undergone orthodontic treatment, patients undergone orthognathic surgery, patients with pathologies in head and neck region.

The lateral cephalograms were taken for each subject, with the Frankfort horizontal plane parallel to the ground and patient's teeth occluding in maximum intercuspation. The orthopantomogram were taken for each subject, with the Frankfort horizontal plane parallel to the floor and patient's teeth occluding in maximum intercuspation.

All the pre-treatment lateral cephalograms and OPGs were traced on matte acetate tracing paper manually by a single examiner with a 0.5mm lead pencil. The linear and angular measurements were taken with the help of a scale and protractor.

The patients will be divided into three groups according to the skeletal parameters ANB angle, YEN angle and β angle. Group I (ANB angle= 0°-4°,YEN angle= 117° – 123°, β angle 27°– 35°)**,** Group II (ANB angle > 4°, YEN angle <117, β angle <27°),Group III (ANB angle < 0°, YEN angle >123°, β angle > 35°) Each group is subdivided into three groups based on Y axis: average skeletal pattern (Y axis : 53°- 66°)**,** Horizontal skeletal pattern (Y axis : <59°) and Vertical skeletal pattern (Y axis : >66°).

Cephalometric linear and angular measurement like Symphysis height, Symphysis depth, Symphysis ratio, Symphysis angle, Ramus height, Ramus width and Antegonial notch depth measurement using OPG were taken.

STATISTICAL ANALYSIS

72 lateral cephalograms and OPGs were taken from the repository of Department of Orthodontics and Dentofacial Orthopedics and included in the study. The test used for sample size calculation was ANOVA with post hoc Bonferroni test.

Level of significance 5%, power 80%, effect size =0.6 computed using the software 'G*power'.

RESULTS

The collected data were analysed using descriptive and inference statistical methods. Descriptive methods such as sequencing, percentage, mean and standard deviation were computed to summarize the data. P test was used to compare the outcome parameters between skeletal patterns. Pearson correlation was used to calculate and to identify the correlation between the outcome parameters. Further regression equation was established using regression analysis tool. Analysis was performed using SPSS version 23. Level of significance in the present study was 5%. The results of the study showed that there is a statistically significant differences in volume in different skeletal pattern with a p value <0.001and mean value.

Table-1a:-Comparison of variables between skeletal pattern in Class I

Class I	Skeletal	N	Mean	SD	Min	Max	ANOVA	
							F	p-value
Ramal height	Horizontal	8	52.88	7.43	42	65	4.39	0.03*
	Average	8	49.25	2.44	46	52		
	Vertical	8	45.50	3.63	41	51		
Ramal width	Horizontal	8	35.88	2.70	32	40	2.50	0.11(NS)
	Average	8	33.88	2.30	30	36		
	Vertical	8	33.50	1.77	30	35		
Symphysis height	Horizontal	8	22.63	1.69	20	25	24.41	<0.001*
	Average	8	22.75	1.49	21	25		
	Vertical	8	26.88	0.84	26	28		
Symphysis depth	Horizontal	8	17.25	1.83	15	20	2.26	0.13(NS)
	Average	8	15.25	2.25	11	18		
	Vertical	8	15.88	1.64	14	18		
Symphysis angle	Horizontal	8	87.63	5.04	80	95	18.41	<0.001*
	Average	8	79.75	1.98	77	83		
	Vertical	8	77.88	2.36	76	83		
Symphysis ratio	Horizontal	8	1.28	0.12	1.2	1.5	11.36	<0.001*
	Average	8	1.53	0.23	1.3	2		
	Vertical	8	1.69	0.16	1.4	1.9		
Antegonial notch	Horizontal	8	1.00	0.53	0	1.5	16.42	<0.001*
	Average	8	1.25	0.38	1	2		
	Vertical	8	2.31	0.53	2	3.5		

*p<0.05 Statistically Significant p>0.05 Non-Significant, NS

By comparing the skeletal patterns in Class I Ramal height, Symphysis height, Symphysis angle, symphysis ratio and antegonial notch are statistically significant but ramal width and symhysis depth are nonsignificant as shown in table 1a.

Table-1b: Pairwise comparison of variables between skeletal patterns in Class I

Class I	(I) Skeletal	(J) Skeletal	Mean Difference (I-J)	Std. Error	p-value	95% Confidence Interval	
						Lower Bound	Upper Bound
Ramal height	Horizontal	Average	3.63	2.49	0.33(NS)	-2.65	9.90
		Vertical	7.38	2.49	0.02*	1.10	13.65
	Average	Vertical	3.75	2.49	0.31(NS)	-2.52	10.02
Symphysis height	Horizontal	Average	-0.13	0.69	0.98(NS)	-1.87	1.62
		Vertical	-4.25	0.69	<0.001*	-5.99	-2.51
	Average	Vertical	-4.13	0.69	<0.001*	-5.87	-2.38
Symphysis angle	Horizontal	Average	-7.88	1.71	<0.001*	-12.17	-3.58
		Vertical	9.75	1.71	<0.001*	5.45	14.05
	Average	Vertical	1.88	1.71	0.53(NS)	-2.42	6.17
Symphysis ratio	Horizontal	Average	-0.25	0.09	0.02*	-0.47	-0.03
		Vertical	-0.41	0.09	<0.001*	-0.63	-0.19
	Average	Vertical	-0.16	0.09	0.17(NS)	-0.38	0.06
Antegonial notch	Horizontal	Average	-0.25	0.24	0.57(NS)	-0.86	0.36
		Vertical	-1.31	0.24	<0.001*	-1.93	-0.70
	Average	Vertical	-1.06	0.24	0.001*	-1.68	-0.45

Tukey Post Hoc Test

*p<0.05 Statistically Significant p>0.05 Non Significant, NS

In pair wise comparison between each parameter. These the following parameters shows statistically significant as shown in table 2a: Ramal height was significant when comparing Horizontal and Vertical skeletal pattern. Symphysis height was significant when comparing Horizontal with Vertical skeletal pattern and Average with Vertical skeletal pattern. Symphysis angle was significant when comparing Horizontal with Average skeletal pattern and Horizontal with Vertical skeletal pattern. Symphysis

ratio was significant when comparing Horizontal with Average skeletal pattern and Horizontal with Vertical skeletal pattern. Antegonial notch was significant when comparing Horizontal with Vertical skeletal pattern and Average with Vertical skeletal pattern.

Table-2a: Comparison of variables between skeletal patterns in Class II

Class II	Skeletal	N	Mean	SD	Min	Max	ANOVA	
							F	p-value
Ramal height	Horizontal	8	52.86	5.87	47	61	5.08	0.02*
	Average	8	50.57	3.95	43	55		
	Vertical	8	45.29	3.50	42	52		
Ramal width	Horizontal	8	35.43	3.60	31	40	1.84	0.19(NS)
	Average	8	33.86	3.13	29	38		
	Vertical	8	32.14	2.85	29	37		
Symphysis height	Horizontal	8	23.43	2.99	19	28	0.10	0.91(NS)
	Average	8	24.29	6.10	17	36		
	Vertical	8	24.43	4.08	20	29		
Symphysis depth	Horizontal	8	16.57	2.15	14	19	2.96	0.08(NS)
	Average	8	14.43	1.51	12	16		
	Vertical	8	14.57	1.81	13	18		
Symphysis angle	Horizontal	8	85.29	2.93	82	91	0.92	0.42(NS)
	Average	8	82.86	7.01	73	92		
	Vertical	8	82.14	2.04	78	84		
Symphysis ratio	Horizontal	8	1.43	0.15	1.2	1.6	1.82	0.19(NS)
	Average	8	1.67	0.35	1.2	2.2		
	Vertical	8	1.66	0.27	1.4	2.2		
Antegonial notch	Horizontal	8	1.21	0.91	0	2	10.94	0.001*
	Average	8	1.57	0.35	1	2		
	Vertical	8	2.71	0.49	2	3		

*p<0.05 Statistically Significant p>0.05 Non- Significant, NS

By comparing the values in Class II skeletal pattern ramal height and antegonial notch are statistically significant but ramal width symphysis height, symphysis depth, symphysis angle and symphysis ratio are non-significant as shown in table 2a.

Table-2b: Pairwise comparison of variables between skeletal pattern in Class II

Class II	(I) Skeletal	(J) Skeletal	Mean Difference (I-J)	Std. Error	p-value	95% CI	
						Lower Bound	Upper Bound
Ramal height	Horizontal	Average	2.29	2.44	0.62(NS)	-3.93	8.50
		Vertical	7.57	2.44	0.02*	1.35	13.79
	Average	Vertical	5.29	2.44	0.10(NS)	-0.93	11.50
Antegonial notch	Horizontal	Average	-0.36	0.34	0.55(NS)	-1.21	0.50
		Vertical	-1.50	0.34	0.001*	-2.36	-0.65
	Average	Vertical	-1.14	0.34	0.008*	-2.00	-0.29

Tukey Post Hoc Test

*p<0.05 Statistically Significant p>0.05 Non- Significant, NS

In pair wise comparison between each parameter. These the following parameters shows statistically significant as shown in table 2b- Ramal height was significant when comparing Horizontal and Vertical skeletal pattern. Antegonial notch was significant when comparing Horizontal with Vertical skeletal pattern and Average with Vertical skeletal pattern.

Table-3a:-Comparison of variables between skeletal pattern in Class III

Class III	Skeletal	N	Mean	SD	Min	Max	ANOVA	
							F	p-value
Ramal height	Horizontal	8	56.13	5.94	45	61	3.70	0.04*
	Average	8	50.50	7.17	41	62		
	Vertical	8	48.50	3.82	43	54		
Ramal width	Horizontal	8	34.75	2.49	30	37	3.24	0.06(NS)
	Average	8	32.63	3.70	29	40		
	Vertical	8	31.00	2.51	28	35		
Symphysis height	Horizontal	8	22.63	2.45	18	25	1.35	0.28(NS)
	Average	8	24.25	2.66	20	29		
	Vertical	8	25.25	4.27	20	33		
Symphysis depth	Horizontal	8	14.13	2.36	10	18	0.24	0.79(NS)
	Average	8	14.63	1.60	13	18		
	Vertical	8	14.63	0.52	14	15		
Symphysis angle	Horizontal	8	88.13	3.27	82	92	20.65	<0.001*
	Average	8	80.00	7.27	73	93		
	Vertical	8	72.00	3.46	68	78		
Symphysis ratio	Horizontal	8	1.60	0.16	1.3	1.8	0.55	0.59(NS)
	Average	8	1.65	0.26	1.4	2.2		
	Vertical	8	1.73	0.29	1.3	2.2		
Antegonial notch	Horizontal	8	1.50	0.96	0	3	5.29	0.01*
	Average	8	1.81	0.70	1	3		
	Vertical	8	2.81	0.84	2	4		

*p<0.05 Statistically Significant p>0.05 Non- Significant, NS

By comparing the values in Class III skeletal pattern ramal height, symphysis angle and antegonial notch are statistically significant but ramal width, symphysis height, symphysis depth and symphysis ratio are statistically non-significant as shown in table 3a.

Table-3b:-Pairwise comparison of variables between skeletal pattern in Class III

Class III	(I) Skeletal	(J) Skeletal	Mean Difference (I-J)	Std. Error	p-value	95% CI	
						Lower Bound	Upper Bound
Ramal height	Horizontal	Average	5.63	2.91	0.15(NS)	-1.70	12.95
		Vertical	7.63	2.91	0.04*	0.30	14.95
	Average	Vertical	2.00	2.91	0.77(NS)	-5.32	9.32
Symphysis angle	Horizontal	Average	8.13	2.51	0.01*	1.80	14.45
		Vertical	16.13	2.51	<0.001*	9.80	22.45
	Average	Vertical	8.00	2.51	0.01*	1.68	14.32
Antegonial notch	Horizontal	Average	-0.31	0.42	0.74(NS)	-1.38	0.75
		Vertical	-1.31	0.42	0.01*	-2.38	-0.25
	Average	Vertical	-1.00	0.42	0.07(NS)	-2.06	0.06

Tukey Post Hoc Test

*p<0.05 Statistically Significant p>0.05 Non- Significant, NS

In pair wise comparison between each parameter. These the following parameters shows statistically significant as shown in table 3b-Ramal height was significant when comparing Horizontal and Vertical skeletal pattern. Symphysis angle was significant when comparing Horizontal with Average skeletal pattern, Horizontal with Vertical skeletal pattern and Average with Vertical skeletal pattern. Antegonial notch was significant when comparing Horizontal with Vertical skeletal pattern.

Table-4: Correlation table – Class I Horizontal skeletal pattern

	Ramal height	Ramal width	Symphysis height	Symphysis depth	Symphysis angle	Symphysis ratio	Antegonial notch
Ramal height	1						
Ramal width	0.19	1					
Symphysis height	0.49	0.50	1				
Symphysis depth	0.52	0.65	0.63	1			
Symphysis angle	-0.27	-0.38	-0.41	-0.37	1		
Symphysis ratio	-0.25	-0.44	0.09	-0.72*	0.15	1	
Antegonial notch	0.07	0.87	0.15	0.43	-0.13	-0.45	1

*P<0.05 is statistically significant (Pearson correlation table)

As shown in table 4, symphysis ratio shows strong negative correlation with symphysis depth

Table-5: Correlation table – Class I Average skeletal pattern

	Ramal height	Ramal width	Symphysis height	Symphysis depth	Symphysis angle	Symphysis ratio	Antegonial notch
Ramal height	1						
Ramal width	0.22	1					
Symphysis height	0.80*	0.66	1				
Symphysis depth	0.66	0.14	0.44	1			
Symphysis angle	-0.54	0.44	-0.14	-0.59	1		
Symphysis ratio	-0.35	0.31	0.02	-0.85*	0.67	1	
Antegonial notch	0.54	-0.15	0.50	0.01	-0.36	0.08	1

*P<0.05 is statistically significant (Pearson correlation table)

As shown in table 5, symphysis height with ramal height shows strong positive correlation and symphysis depth with symhysis ratio shows strong negative correlation.

Table-6: Correlation table – Class I Vertical skeletal pattern

	Ramal height	Ramal width	Symphysis height	Symphysis depth	Symphysis angle	Symphysis ratio	Antegonial notch
Ramal height	1						
Ramal width	0.24	1					
Symphysis height	0.68	-0.14	1				
Symphysis depth	0.63	0.36	0.29	1			
Symphysis angle	-0.15	-0.18	-0.22	0.34	1		
Symphysis ratio	-0.32	-0.36	0.09	-0.90*	-0.52	1	
Antegonial notch	- 0.31	0.03	-0.06	-0.19	-0.42	0.21	1

*P<0.05 is statistically significant (Pearson correlation table)

As shown in table 6, symphysis depth with symphysis ratio shows very strong negative correlation.

Table-7: Correlation table – Class II Horizontal skeletal pattern

	Ramal height	Ramal width	Symphysis height	Symphysis depth	Symphysis angle	Symphysis ratio	Antegonial notch
Ramal height	1						
Ramal width	0.63	1					
Symphysis height	0.73*	0.53	1				
Symphysis depth	0.76*	0.50	0.73	1			
Symphysis angle	-0.73*	-0.48	-0.55	-0.79*	1		
Symphysis ratio	-0.05	-0.02	0.34	-0.38	0.38	1	
Antegonial notch	-0.21	-0.30	-0.58	-0.10	0.03	-0.45	1

*P<0.05 is statistically significant (Pearson correlation table)

As shown in table 7, there is a strong positive correlation between symphysis height and ramal height and also with symphysis depth and ramal height.

Table-8: Correlation table – Class II Average skeletal pattern

	Ramal height	Ramal width	Symphysis height	Symphysis depth	Symphysis angle	Symphysis ratio	Antegonial notch
Ramal height	1						
Ramal width	0.47	1					
Symphysis height	0.78*	0.78*	1				
Symphysis depth	-0.10	0.79*	0.42	1			
Symphysis angle	-0.71	0.06	-0.42	0.41	1		
Symphysis ratio	0.91*	0.44	0.86	-0.07	-0.62	1	
Antegonial notch	0.05	0.67	0.29	0.57	0.32	0.05	1

*P<0.05 is statistically significant (Pearson correlation table)

As shown in table 8, there is very strong positive correlation between symphysis ratio and ramal height and strong positive correlation between symphysis height with ramal height, symphysis height with ramal width and symphysis depth with ramal width.

Table-9: Correlation table – Class II Vertical skeletal pattern

	Ramal height	Ramal width	Symphysis height	Symphysis depth	Symphysis angle	Symphysis ratio	Antegonial notch
Ramal height	1						
Ramal width	0.41	1					
Symphysis height	-0.49	-0.52	1				
Symphysis depth	-0.09	-0.33	0.56	1			
Symphysis angle	0.13	-0.34	0.04	0.47	1		
Symphysis ratio	-0.44	-0.39	0.74*	-0.13	-0.31	1	
Antegonial notch	-0.74*	-0.15	0.10	0.33	0.25	-0.20	1

*P<0.05 is statistically significant (Pearson correlation table)

As shown in table 9, there is a strong positive correlation between symphysis ratio with symphysis height and strong negative correlation between antegonial notches with ramal height.

Table-10: Correlation table – Class III Horizontal skeletal pattern

	Ramal height	Ramal width	Symphysis height	Symphysis depth	Symphysis angle	Symphysis ratio	Antegonial notch
Ramal height	1						
Ramal width	0.47	1					
Symphysis height	0.84*	0.63	1				
Symphysis depth	0.33	0.15	0.67	1			
Symphysis angle	0.86*	0.24	0.70	0.23	1		
Symphysis ratio	0.25	0.10	-0.14	-0.79*	0.38	1	
Antegonial notch	0.54	0.44	0.72*	0.66	0.58	-0.27	1

*P<0.05 is statistically significant (Pearson correlation table)

As shown in table 10, there is very strong positive correlation between symphysis height with ramal height and symphysis angle with ramal height and strong positive correlation between antegonial notch with symphysis height and strong negative correlation between symphysis ratio and symphysis depth.

Table-11: Correlation table – Class III Average skeletal pattern

	Ramal height	Ramal width	Symphysis height	Symphysis depth	Symphysis angle	Symphysis ratio	Antegonial notch
Ramal height	1						
Ramal width	0.81*	1					
Symphysis height	0.02	0.22	1				
Symphysis depth	0.74*	0.84*	0.05	1			
Symphysis angle	0.33	0.21	-0.43	-0.07	1		
Symphysis ratio	-0.40	-0.30	0.77*	-0.57	-0.28	1	
Antegonial notch	0.94*	0.76*	0.06	0.69	0.34	-0.33	1

*P<0.05 is statistically significant (Pearson correlation table)

As shown in table 5, there is very strong positive correlation between ramal width with ramal height, symhysis depth with ramal width and antegonial notch with ramal height and strong positive correlation between symphysis depth with ramal height, symphysis ratio with symphysis height and antegonial notch with ramal width.

Table-12: Correlation table – Class III Vertical skeletal pattern

	Ramal height	Ramal width	Symphysis height	Symphysis depth	Symphysis angle	Symphysis ratio	Antegonial notch
Ramal height	1						
Ramal width	-0.28	1					
Symphysis height	0.08	0.04	1				
Symphysis depth	0.32	-0.33	0.17	1			
Symphysis angle	-0.27	0.93*	0.31	-0.31	1		
Symphysis ratio	-0.01	0.07	0.97*	-0.02	0.36	1	
Antegonial notch	-0.75*	0.27	0.51	-0.18	0.37	0.55	1

*P<0.05 is statistically significant (Pearson correlation table)

As shown in table 12, there is very strong positive correlation between symphysis angle with ranal width, symhysis ratio with symphysis height and strong negative correlation between antegonial notches with ramal height.

DISCUSSION

This study was conducted to evaluate and compare the correlation between antegonial notch, symphysis morphology and ramus morphology among different skeletal patterns and skeletal relationship using cephalograms and OPG.

The depth of antegonial notch was compared among different skeletal patterns. In Class III Vertical skeletal pattern the depth of antegonial notch was highest (2.81±0.84), and Class I Horizontal **s**keletal pattern the depth of antegonial notch was the least (1.00±0.53). Similar result was reported by Singer *et al*. [4], Björk and Skieller [5] showed Vertical **s**keletal pattern has the highest antegonial notch depth. Hovell [6] in 1964 stated that "when the condylar growth fails to contribute to the lowering of the mandible, the bone in the region of the angle grows downward producing antegonial notching caused by the masseter and the medial pterygoid.

The height of the symphysis was highest in Class III Vertical skeletal pattern (25.25±4.27), and least in Class II Horizontal **s**keletal pattern (23.43±2.99). Rickets in his study associated a thick symphysis with an anterior growth direction. Symphysis morphology was found to be associated with the direction of mandibular growth.

The depth of the symphysis was highest in Class II Horizontal skeletal pattern (16.57±2.15), and least in Class III Vertical skeletal pattern (14.63±0.54). These results are consistent with the findings of Aki *et al*. [7]. and Mangla *et al*. [8], in their study reported that symphysis with a larger height, smaller depth, larger ratio, and a smaller angle found in Vertical growers. An anterior growth direction of the mandible has been associated with thick symphysis as reported by Ricketts [1].

The symphysial angle was highest in Class I Horizontal skeletal pattern (87.63±5.04), and least in Class III Vertical skeletal pattern (72.00±3.46). The symphysial ratio was highest in Class III Vertical skeletal pattern (1.73±0.29), and least in Class II Horizontal skeletal pattern (1.43±0.15).

It has been noted that a dentoalveolar compensation occurs in the vertical plane, when the lower anterior facial height increases, the upper and lower anterior teeth have a tendency to erupt to continue maintaining their positive overbite and the alveolar bone is remodelled thus resulting in an increase in the length of the mandibular symphysis.

The ramal width was highest in Class II Horizontal skeletal pattern (35.43±3.60), and least in Class III Vertical skeletal pattern (31.00±2.51). However the result was not statistically significant. The ramal height was more in Class III Horizontal skeletal pattern (56.13±5.94), and least in Class II Vertical skeletal pattern (45.29±3.50).These findings were consistent with observations by Muller [9], Schudy [10], and Sassouni [11], who all reported a considerable deficiency in dimension in vertical growers. Thus, mandibular ramus morphology is an important indicator of how mandibular growth will respond to treatment mechanics.

Antegonial notch shows strong positive corelation with symphysis height in Class III Horizontal skeletal pattern, and ramal height in Class III Average skeletal pattern and strong negative corelation with ramal height in Class II and Class III Vertical skeletal pattern.

Symphysis height shows strong positive correlation with ramal height in Class I Average skeletal pattern, Class II Horizontal skeletal pattern, Class II Average skeletal pattern and Class III Horizontal skeletal pattern. Symphysis depth shows

strong positive correlation with ramal height in Class II Horizontal skeletal pattern and Class III Average skeletal pattern, ramal with in Class II Average skeletal pattern and Class III Average skeletal pattern. Symphysis angle shows strong positive correlation with Class III Horizontal skeletal pattern and strong negative correlation with Class II Horizontal skeletal pattern.

In the present study, random samples were taken in and around Mangalore. Further studies are required to validate the results among various racial and ethnic groups of Indian populations. Therefore, similar studies have to be conducted with greater samples with gender differences.

CONCLUSION

- The antegonial notch depth was found to be highest in Class III Vertical skeletal pattern the and least in Class I Horizontal skeletal pattern.
- Symphysis height was found to be highest in Class III Vertical skeletal pattern and least in Class II Horizontal skeletal pattern
- Symphysis depth was found to be highest in Class II Horizontal skeletal pattern and least in Class III Vertical skeletal pattern
- The symphysial angle was highest in Class I Horizontal skeletal pattern and least in Class III Vertical skeletal pattern
- The symphysial ratio was highest in Class III Vertical skeletal pattern and least in Class II Horizontal skeletal pattern
- The ramal height was more in Class III Horizontal **s**keletal pattern and least in Class II Vertical **s**keletal pattern
- The ramal width was highest in class II Horizontal skeletal pattern and least in Class III Vertical skeletal pattern
- Generally, Vertical skeletal pattern shows deep antegonial notch, the symphysis morphology is found to be associated with a smaller depth, larger height, larger ratio, and a smaller angle.
  Horizontal skeletal pattern shows shallow antegonial notch, the symphysis morphology is found to be associated with large depth, short height, small ratio (height/depth), and larger angle, ramus height and width is found to be greater.
- Antegonial notch shows strong positive corelation with symphysis height in Class III Horizontal skeletal pattern, and ramal height in Class III Average skeletal pattern and strong negative corelation with ramal height in Class II and Class III Vertical skeletal pattern.
- Symphysis height shows strong positive correlation with ramal height in Class I Average skeletal pattern, Class II Horizontal skeletal pattern, Class II Average skeletal pattern and Class III Horizontal skeletal pattern.
- Symphysis depth shows strong positive correlation with ramal height in Class II Horizontal skeletal pattern and Class III Average skeletal pattern, ramal with in Class II Average skeletal pattern and Class III Average skeletal pattern.
- Symphysis angle shows strong positive correlation with Class III Horizontal skeletal pattern and strong negative correlation with Class II Horizontal skeletal pattern.
- From clinical perspective, in an individual-seeking orthodontic treatment, the decision to extract, biomechanics applied, anchorage preparation and period of retention are dependent on different skeletal patterns which are influenced by anatomy of antegonial notch depth, mandibular symphysis, and ramus height and width as observed from the present study.

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