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Comparison and correlation between mandibular morphology among diferent vertical growth patterns: A cephalometric study

Roshni Mahajan[1],*, Rakesh Thukral[1], Ashish Garg[1], Amit Tripathi[1], Amit Singh Choudhary[1]

[1]*Dept. of Orthodontics and Dentofacial Orthopedics, Shri Aurobindo Dental College, Indore, Madhya Pradesh, India*

A R T I C L E   I N F O

A B S T R A C T

Introduction: In the field of Orthodontics and Dentofacial Orthopedics, in-depth knowledge of mandibular morphology and different types of growth pattern is essential to reach to ideal treatment for every patient.
Objectives: To compare antegonial notch depth, symphysis morphology and ramus morphology among different growth patterns. 2) To correlate antegonial notch depth with other parameters of mandibular morphology.
Materials and Methods: In this study, lateral cephalogram of total 90 patients were traced. The sample was divided into horizontal, average and vertical growth pattern based on Jarabak's ratio. The antegonial notch depth, symphysis morphology (i.e. its height, depth, ratio and angle) and ramus morphology (its height and width) were evaluated and analysed statistically. The symphysis ratio is the ratio of symphysis height to symphysis width.
Results: This study revealed that antegonial notch depth, symphysis angle and ramus height shows statistically significant difference among different growth patterns. In vertical growth pattern, antegonial notch depth is positively correlated with symphysis height, symphysis depth, ramus height and ramus width whereas it is negatively correlated with symphysis ratio and symphysis angle and exactly opposite is true for horizontal growing individuals.
Conclusion: This study concluded that there is correlation between mandibular morphology and growth pattern of an individual.

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1. Introduction

Sicher in a meeting of American Board of Orthodontists in 1946 told that "Orthodontists are the one who not only talk about growth of human body but try to do something about it". But, unfortunately, facial growth prediction and modification are still controversial topics among orthodontists. Hence, this article deals with the growth pattern of an individual in vertical plane and their comparison with mandibular morphology, viz., antegonial notch depth, symphysis morphology and

ramus morphology. The growth pattern and mandibular morphology significantly affects the treatment planning of a case e.g. various decisions such as type of anchorage to be used, to undergo extraction or non-extraction treatment, biomechanics to be used, duration of retention depends upon the growth pattern of an individual.[1]

In available literature, many researches have reported that mandibular morphology can be used as the predictor of growth pattern but a very few have reported the comparison of various parameters of mandibular morphology in different growth patterns, knowledge of which can help the orthodontists to design a better treatment plan.[2] This

* Corresponding author.
  E-mail address: Dr.roshnimahajan@gmail.com (R. Mahajan).

study is unique in a way that it will not only give insight to predictors of mandibular growth but also vice-versa i.e. it deals with the average values of various mandibular parameters in all three patterns of growth in vertical plane. Thus, the aim of this study was to compare and correlate antegonial notch depth, symphysis morphology and ramus morphology among individuals with different facial growth patterns in vertical plane with the null hypothesis that there is no correlation between mandibular morphology and different facial growth patterns in vertical plane.

2. Materials and Methods

The present study consists of Pre-treatment lateral cephalograms of total 180 patients (this sample size was based on previous study having similar methodology)[1] including 60 horizontal, 60 average and 60 vertical growers based on *Jarabak's* ratio. Out of these 180, there was random selection of 90 lateral cephalogram which were divided into three groups of 30 each depending upon the Jarabak's ratio[3] as follows:

1. Group:- Vertical growers (Jarabak's Ratio) < 59%
2. Group: Average grower (Jarabak's Ratio) = 59% — 63%
3. Group:- Horizontal growers (Jarabak's Ratio) >63%

This study has 80% power. The inclusion criteria included adult non-growing patients of age 18-40 years, no history of previous orthodontic treatment or congenital anomaly or facial trauma. And the exclusion criteria were growing patients, any history of previous orthodontic treatment, presence of congenital anomaly and previous history of facial trauma.

The cephalometric parameters and landmarks (Figure 1) used were as follows[4]

1. Sella – central point of sella tursica
2. N: Nasion — the anteriormost point of the frontonasal suture present in the midsagittal plane
3. Point B: Supramentale — the posteriormost point present in the concavity of mandible between infradentale (i.e. superiormost point of alveolar bone of mandibular incisor) and pogonion (anteriormost point on chin).
4. Me: Menton — the lowermost point of mandible in midsagittal plane
5. Go: Gonion — lowest and posteriormost point derived on the angle of mandible which is located by bisecting the angle which is formed by tangent to posterior border of mandibular ramus and inferior border of mandible.
6. Ar: Articulare — point of intersection of posterior border of mandibular ramus and inferior border of posterior cranial base.

Fig. 1: Cephalometric landmarks used (1- Sella, 2- Nasion, 3-Point B, 4- Menton, 5- Gonion, 6-Articulare)

2.1. Cephalometric plane[4]

1. Mandibular plane (tweed's) — the tangent to lower border of mandible
2. Occlusal plane — the line bisecting posteriorly the occlusion of molars and premolars and anteriorly bisecting the overbite.

2.2. Cephalometric linear and angular measurements[1] (Figure 2)

1. Anterior facial height –linear distance between Nasion and Menton.
2. Posterior facial height –linear distance between Sella and Gonion.
3. Jarabak's ratio — ratio of posterior facial height divided by anterior facial height.
4. Antegonial notch depth — the shortest distance between deepest part of antegonial notch and tangent through two points on both sides of notch on lower border of mandible.
5. Symphysis height — calculated as follows: A grid was constructed with the parallel and perpendicular lines to the line drawn tangent to anterior border of symphysis through point B. The line perpendicular to this line through point B was taken as upper limit of the symphysis with anterior, posterior and inferior

limits taken at the most anterior, posterior and inferior borders of the symphyseal outline, respectively. The symphyseal height is measured as linear distance between superior and inferior limit on grid.

6. Symphysis depth — the linear distance between anterior and posterior limit on grid.
7. Symphysis ratio — measured as symphysis height divided by symphysis depth
8. Symphysis angle — the posterior-superior angle which is formed by a line drawn through point B and Menton and the mandibular plane.
9. Ramus height — the distance between Articulare and Gonion.
10. Ramus width — the distance between anterior and posterior border of mandibular ramus at the height of the occlusal plane. linear and angular measurements were taken with the help of digital caliper and protractor.

The linear and angular measurements were taken with the help of digital caliper and protractor.
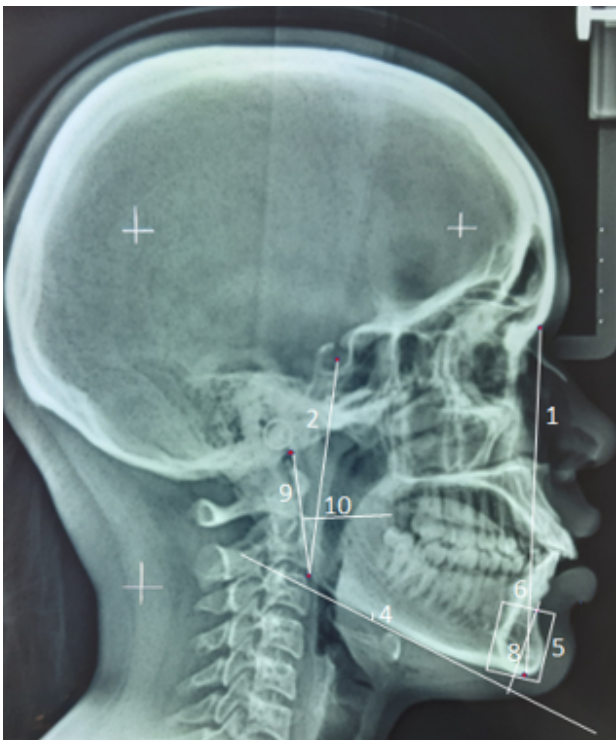
Fig. 2: Cephalometric Parameters used (1. Anterior facial height, 2. Posterior facial height, 3. Jarabak's ratio, 4. Antegonial notch depth, 5. Symphysis height, 6.Symphysis depth, 7. Symphysis ratio, 8. Symphysis angle, 9. Ramus height,10. Ramus width)

3. Statistical Analysis

The data collected was entered in Microsoft Excel and subjected to statistical analysis using Statistical Package for Social Sciences (SPSS, IBM version 22.0). The level of significance was fixed at 5% and $p \leq 0.05$ was considered statistically significant. After checking the normality of the data one-way ANOVA for intra group comparison was done. When ANOVA indicated statistically significant difference, then t-test for multiple comparison was applied. Pearson correlation was done to determine the correlation between variables. Results of all parameters with continuous measurement were presented as Mean± SD.

4. Results

Table 1 Shows the comparison of all the variables among three groups using ANOVA test. It shows that antegonial notch depth, symphysis angle and ramus height shows statistically significant difference among different growth patterns.

Table 2 Shows multiple comparison of statistically significant parameters (Antegonial Notch depth, Symphysis Angle and Ramus Height). It reveals that antegonial notch depth showed statistically significant difference between vertical grower and average grower as well as between vertical grower and horizontal grower. The symphysis angle showed significant difference between vertical and horizontal growers. Moreover, Ramus height showed statistically significant difference between horizontal growers and vertical growers as well as between horizontal growers and average growers.

Table 3 Shows correlation ofantegonial notch depth with other parameters of mandibular morphology for vertical growers. This correlation reveals that in vertical growth pattern, antegonial notch depth is positively correlated with symphysis ratio and symphysis angle and negatively correlated with symphysis height, symphysis depth, ramus height and ramus width.

Table 4 Shows correlation of antegonial notch depth with other parameters of mandibular morphology for average growers. This correlation reveals that in average growth pattern, antegonial notch depth is positively correlated with symphysis ratio, symphysis angle and ramus height and negatively correlated with symphysis height, symphysis depth and ramus width.

Table 5 Shows correlation of antegonial notch depth with other parameters of mandibular morphology for horizontal growers. This correlation reveals that in horizontal growth pattern, antegonial notch depth is positively correlated with symphysis height, symphysis depth, ramus height and ramus width whereas it is negatively correlated with symphysis ratio and symphysis angle.

Hence, this study showed that null hypothesis is not true i.e. there exists a correlation between mandibular morphology and growth pattern of an individual in the following ways:

Table 1: Comparison of all the variables among three groups

S.No.	Variable	Vertical Grower		Average Grower		Horizontal Grower		p value
		Mean	S.D.	Mean	S.D.	Mean	S.D.	
1	Antegonial Notch Depth	1.95	0.81	1.45	0.96	1.10	0.68	0.01*
2	Symphysis Depth	13.43	2.16	13.60	1.69	14.06	1.98	0.43
3	Symphysis Height	20.40	3.26	19.83	2.24	21.40	3.09	0.11
4	Symphysis Ratio	1.50	0.22	1.44	0.24	1.50	0.23	0.49
5	Symphysis Angle	77.26	7.97	79.23	7.98	82.43	7.72	0.043*
6	Ramus Height	38.80	3.79	40.73	4.03	44.70	4.85	0.001*
7	Ramus Width	26.73	3.24	26.73	3.49	26.53	3.15	0.97

Test – ANOVA significant = p≤0.05

Table 2: Multiple comparison of antegonial notch depth, symphysis angle and ramus height.

Parameter	Groups compared		Mean difference	Sig.
Antegonial notch depth	Vertical grower	Average grower	0.50	0.03*
		Horizontal grower	0.85	0.01*
	Average grower	Vertical grower	-0.50	0.03*
		Horizontal grower	0.35	0.04
	Horizontal grower	Vertical grower	-0.85	0.01*
		Average grower	-0.35	0.04
Symphysis Angle	Vertical grower	Average grower	-1.97	0.34
		Horizontal grower	-5.17	0.013*
	Average grower	Vertical grower	1.97	0.34
		Horizontal grower	-3.2	0.22
	Horizontal grower	Vertical grower	5.17	0.013*
		Average grower	3.2	0.22
Ramus Height	Vertical grower	Average grower	-1.93	0.06
		Horizontal grower	-5.9	0.001*
	Average grower	Vertical grower	1.93	0.06
		Horizontal grower	-3.97	0.001*
	Horizontal grower	Vertical grower	5.9	0.001*
		Average grower	3.97	0.001*

Test – t-test significant = p≤0.05

Table 3: Correlation of antegonial notch depth with other variables for vertical growers

Variabes	N	Pearson correlation	Sig.
Jarabak ratio	30	0.023	0.90
Symphysis depth	30	-0.09	0.60
Symphysis height	30	-0.004	0.98
Symphysis ratio	30	0.004	0.98
Symphysis angle	30	0.169	0.37
Ramus height	30	-0.172	0.36
Ramus width	30	-0.137	0.46

Table 4: Correlation of antegonial notch depth with other variables for average growers

Variabes	N	Pearson correlation	Sig.
Jarabak ratio	30	-0.226	0.23
Symphysis depth	30	-0.118	0.53
Symphysis height	30	-0.115	0.54
Symphysis ratio	30	0.047	0.80
Symphysis angle	30	0.013	0.94
Ramus height	30	0.151	0.42
Ramus width	30	-0.152	0.42

Table 5: Correlation of antegonial notch depth with other variables for horizontal growers

Variabes	N	Pearson correlation	Sig.
Jarabak ratio	30	-0.117	0.53
Symphysis depth	30	0.053	0.78
Symphysis height	30	0.088	0.64
Symphysis ratio	30	-0.001	0.99
Symphysis angle	30	-0.046	0.80
Ramus height	30	0.293	0.11
Ramus width	30	0.028	0.88

1. Antegonial notch is significantly deeper in vertical growers than average and horizontal growers.
2. Horizontal growth pattern is related to more symphysis height, more depth and greater angle than those with average growers and vertical growers.
3. Symphysis ratio did not show any significant difference between these growth patterns.
4. Ramus height was more than average growers in horizontal growers and less than average growers in vertical growers while ramus width showed no statistically significant difference between three growth patterns.
5. The correlation of antegonial notch depth with other parameters reveals that in vertical growth pattern, antegonial notch depth is positively correlated with symphysis height, symphysis depth, ramus height and ramus width whereas it is negatively correlated with symphysis ratio and symphysis angle.
6. The correlation of antegonial notch depth with other parameters reveals that in average growth pattern, antegonial notch depth is positively correlated with symphysis ratio, symphysis angle and ramus height and negatively correlated with symphysis height, symphysis depth and ramus width.
7. Correlation of antegonial notch depth with other parameters of mandibular morphology for horizontal growers that reveals it is positively correlated with symphysis height, symphysis depth, ramus height and ramus width whereas it is negatively correlated with symphysis ratio and symphysis angle.

5. Discussion

This study was designed to compare and correlate between Antegonial Notch Depth, Symphysis and Ramus Morphology among individuals with different growth patterns, viz., vertical, average and horizontal growing individuals. These morphological parameters have not been previously studied in central region population of India. Upward curving of the inferior border of the mandible anterior to the angular process is known as antegonial notch (AN), and the AN is broadly classified into deep AN (> 3 mm), neutral AN (1–3 mm) and shallow AN (< 1 mm).[5] In our study, it was found that antegonial notch was deeper in vertical growers than average and horizontal growers. These results were statistically significant and the similar findings were confirmed by Singer et al.[6], Lambrecht's et al.[7], Omar H et al.[8], Roy et al.[9], Dua R et al.[10] and Gupta et al.[1] It has been reported in previous studies that individuals with deeper antegonial notch have condylar growth disturbances with decreased growth potential[11] and these individuals are more commonly associated with condylar abnormalities, muscle hypoactivity, TMJ ankylosis and brachial arch syndrome.[12].

Mandibular symphysis is an anatomical structure of the mandible in which the lower incisors are found including the anterior portion of the chin. Mandibular symphysis contributes to the composition and balance of facial harmony and must be considered when deciding on orthodontic treatment. The normal value of symphsis height is 44.78 ± 3.79mm and symphysis width is 15.61mm.[13] In our study it was found that horizontal growth pattern was related to more symphysis height, more depth and greater angle than those with average growers and vertical growers. This indicates that individuals with horizontal growth

pattern have thicker and longer symphysis than vertical growth pattern individuals. Symphysis ratio is the ratio of symphysis height to symphysis width. The smaller ratio represents a short and wide symphysis and vice-versa. It did not show any statistically significant difference between these growth patterns. This observation is consistent with the finding of Kim and Son[14] but was contradictory with the findings of Gupta et al.[1] Moshfeghi et al.[14] and Aki et al.[15] who found that symphysis ratio is more in vertical growth pattern individuals. Symphyseal morphology can be a useful tool to determine the amount of lower incisor's labiolingual movement like in cases with narrow symphysis, the excessive buccal movement of incisors may lead to dehiscences, fenestration, periodontal defects and iatrogenic effects.[16] Hence, these patients should be treated with caution. With regards to ramus morphology, it was observed in our study that ramus height was more than average growers in horizontal growers and less than average growers in vertical growers. The normal values for ramus height and ramus width are 46mm and 26mm respectively.[17] This indicates that there is significant deficiency in ramus height in vertical growers. Ramus width showed no statistically significant difference between three growth patterns. This finding was contradictory to the observation by Gupta et al.[1] who observed more ramus width in horizontal growers than vertical growers. Clinically, in individuals with more ramus height, there is greater mechanical advantage to jaw muscles thus requiring more extrusive force in these individuals.

6. Conclusion

This study concluded that there is correlation between mandibular morphology and growth pattern of an individual.

7. Source of Funding

None.

8. Conflict of Interest

None.

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Author biography

Roshni Mahajan, Post Graduate Student

Rakesh Thukral, Professor

Ashish Garg, Professor and Head

Amit Tripathi, Reader

Amit Singh Choudhary, Senior Lecturer