

Comparison and Correlation Between Gonial Angle, Symphysis Morphology, Ramus Morphology and Mandibular Depth Among Different Growth Patterns in Angle's Class II Division 1 Malocclusion in Bhopal Population - A Cross Sectional Study

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Abstract

Introduction: Variability in mandibular growth pattern is seen in different malocclusion. Variations such as direction, timing, and duration of the development in facial areas should be carefully interpreted to determine the success rate of treatment of Class II malocclusion. The implication of this study is to compare and correlate between Gonial angle, Symphysis morphology, Ramus morphology and Mandibular depth and to differentiate the treatment planning of different growth patterns according to morphology of mandible among Angle's Class II division 1 malocclusion in Bhopal population. **Material & Methods:** 120 pre- treatment cephalograms were selected. Based on Jarabak's ratio the sample were divided into 3 subgroups: Vertical, Average and Horizontal growing. **Results:** There was significant difference between the two variables for gonial angle & lower gonial angle. In horizontal growth pattern symphysis height was reduced and symphysis depth and angle was increased. The ramus height and depth was increased in horizontal growth. The increase in mandibular depth is related to increase in ramus height; therefore, mandibular depth is increased in horizontal grower. **Conclusion:** There was strong correlation seen with Gonial Angle and Lower Gonial Angle while moderate correlation was seen between Ramus Height and Ramus Depth and mild or low correlation was seen with Mandibular depth and symphysis height while non-significant correlation was seen with Upper Gonial Angle, Symphysis Angle and Symphysis depth.

Keywords: Malocclusion, Jarabak's ratio, Gonial angle, Ramus, Symphysis, Mandibular depth

INTRODUCTION

Malocclusion is a morphological variation, which may or may not be associated with oral pathologies. Malocclusion is ranked third among worldwide public health dental diseases priorities after dental caries and periodontal disease.¹ Although Class I malocclusion is the commonly seen malocclusion, however, Class II Div 1 malocclusion is the most commonly reported malocclusion for seeking orthodontic treatment.

Variability in mandibular growth pattern is seen in different malocclusion. Variations such as direction, timing, and duration of the development in facial areas should be carefully interpreted to determine the success rate of treatment of Class II malocclusion. Cephalometric radiographs have served as a boon to orthodontists by aiding in growth prediction.²

By using Jarabak's Cephalometric Analysis, the pattern of mandibular growth can be detected. A ratio of 56- 62% indicated vertical growth pattern, 62- 65% indicated average growth pattern, 65%- 80% indicated horizontal growth pattern.²

In lower 1/3rd of face, the symphysis serves as a chief reference for aesthetic consideration. In forward rotation of mandible symphysis swings forward and chin becomes prominent where as in backward rotation the symphysis swings back causing a receding chin.^{3,4}

In individuals with horizontal growth pattern, the gonial angle is acute while in vertical pattern the angle is obtuse. According to Sassouni, in vertical growth pattern the increased anterior facial height and decreased posterior facial height results in backward and downward rotation of mandible due to which there is an increase in mandibular plane angle and gonial angle.^{5,6}

Ramus height decreases and gonial angle increases with advancing age. Increase in ramus height, bigonial width and a sharp gonial angle is more common in males. Ramus width and height was found to be increased in horizontal growth pattern when compared with average and vertical growing pattern.⁵

Study conducted by Mangla et al concluded that the mandibular depth was significantly increased in horizontal growing individuals when compared with average and vertical growing individuals. According to Hellman who stated that decrease in mandibular depth in vertical growing individuals was due to shorter corpus length.^{5,7}

MATERIAL AND METHODS

A cross-sectional study was conducted amongst the orthodontic patients visiting Department of Orthodontics & Dentofacial Orthopedics in various dental colleges of Bhopal. 120 pre-treatment cephalograms were selected based on inclusion and exclusion criteria. Based on Jarabak's ratio the sample were divided into 3 subgroups: Vertical, Average and Horizontal growing. All the patients with Angle's Class II Division 1 malocclusion, no history of

orthodontic treatment, having full complement of teeth up to 2nd molars, in the age group of 12-25yrs were selected and patients with class I and class III malocclusion, previous Orthodontic treatment, congenital anomaly, with trauma and surgery in the dentofacial region, with missing and impacted teeth, any prosthesis / restorations were excluded from the study.

The radiographs were traced by a single assessor on an x-ray view box with a 0.3mm tracing pencil on a 0.003mm acetate matte tracing paper. The linear and angular measurements were recorded with the aid of a scale and a protractor respectively.

The following parameters were used for the study:

Cephalometric Linear Measurements:

1. Anterior facial height – the linear distance measured between Nasion and Menton
2. Posterior facial height – the linear distance measured between Sella and Gonion
3. Jarabak's's ratio – measured as posterior facial height divided by anterior facial height
4. Symphysis Height- A grid was constructed with lines perpendicular and parallel to the tangent to Point B which represented the long axis of the symphysis. Symphysis superior limit was taken at Point B with the inferior, anterior, and posterior limits taken at the inferior, anterior and posterior borders of the symphysis respectively.³ Height is measured as the linear distance between inferior and the superior limits of the grid.
5. Symphysis Depth- on the grid the linear distance measured between the anterior and the posterior limit.
6. Ramus Height- the linear distance between Articulare and Gonion.

7. Ramus Depth- the linear distance measured at the occlusal plane between the anterior and posterior borders of the ramus.
8. Mandibular Depth- the linear distance between Articulare and Pogonion.

Cephalometric Angular Measurements:

1. Symphyseal Angle- the posterosuperior angle formed between Mandibular Plane (Tweed's) and a line joining Me and Point B.
2. Gonial Angle- angle formed at Go by the points Ar (Articulare), Go (Gonion), Me (menton).
3. Upper Gonial Angle- angle formed at Go by the points Ar, Go, N.
4. Lower Gonial Angle- angle formed at Go by the points N, Go, Me.

SATISTICAL ANALYSIS

Data comparison was done by applying specific statistical tests to find out the statistical significance of the comparisons. Quantitative variables were compared using mean values and was compared with help of ANOVA Test (Analysis of variance) test followed by post Hoc Tuckey Test. The correlation between group and comparing variables was done with the help of spearman's Correlation.

RESULTS

Comparative evaluation of Gonial Angle, Upper Gonial Angle & Lower Gonial Angle is shown in Table 1. The mean Gonial angle for Horizontal grower was $116.27^{\circ} \pm 18.29^{\circ}$, Average grower was $126.05^{\circ} \pm 3.05^{\circ}$ and Vertical Grower was $131.67^{\circ} \pm 5.67^{\circ}$. The mean Upper Gonial angle for Horizontal grower was $52.27^{\circ} \pm 4.93^{\circ}$, Average grower was $52.55^{\circ} \pm 3.98^{\circ}$ and Vertical Grower was $54.17^{\circ} \pm 8.52^{\circ}$. The mean Lower Gonial angle for Horizontal grower was $66.45^{\circ} \pm 5.44^{\circ}$, Average grower was $73.45^{\circ} \pm 3.29^{\circ}$ and Vertical Grower was $77.37^{\circ} \pm 6.32^{\circ}$. There was significant difference between the two variables for gonial

angle & lower gonial angle while statistically non-significant for upper gonial angle.

In Table 2, Post Hoc Tuckey Test shows that there was significant difference in mean values between all the three groups. There was statistically significant difference for Gonial Angle and Lower Gonial Angle between Horizontal & Average growth pattern ($p=.001$, $.000$ respectively), Horizontal & Vertical growth pattern ($p=.000$, $.000$ respectively) and Average & Vertical growth pattern ($p=0.041$, $.003$ respectively) while non-significant difference for Upper Gonial Angle.

Comparative evaluation of Symphyseal angle, Symphyseal Height and Symphyseal Depth is shown in Table 1, Graph 2. The mean Symphyseal angle for Horizontal grower was $91.35^{\circ} \pm 6.71^{\circ}$, Average grower was $90.35^{\circ} \pm 6.60^{\circ}$ and Vertical Grower was $89.45^{\circ} \pm 5.28^{\circ}$. The mean Symphyseal Height for Horizontal grower was 21.17 ± 2.41 mm, Average grower was 21.85 ± 2.87 mm and Vertical Grower was 22.75 ± 2.41 mm. The mean Symphyseal depth for Horizontal grower was 14.90 ± 2.27 mm, Average grower was 14.47 ± 1.55 mm and Vertical Grower was 14.17 ± 1.25 mm. There was significant difference between the two variables for symphyseal height while statistically non-significant difference for symphyseal angle and depth.

In table 2, Post Hoc Tuckey Test shows that there was statistically significant difference for Symphyseal Height between Horizontal & Vertical growth pattern ($p=0.047$) and statistically non-significant difference between Horizontal & Average ($p=.473$), Average & Vertical ($p=.553$). There was statistically non-significant difference for Symphyseal Angle and Symphyseal Depth between all the three groups.

Comparative evaluation of Ramus Height and Ramus Depth is shown in Table 1. The mean Ramus Height for Horizontal grower was 45.22 ± 5.23 mm, Average grower was 39.70 ± 4.08 mm and Vertical Grower was 37.55 ± 3.27 mm. The mean Ramus Depth for Horizontal grower was 32.37 ± 3.54 mm, Average grower was 29.67 ± 2.91 mm and

vertical Grower was 29.00 ± 2.98 mm. There was significant difference between the two variables for both ramus depth and height.

In table 2, The Post Hoc Tuckey Test shows that there was statistically significant difference for Ramus Height between Horizontal & Average grower ($p=.000$) and Horizontal & Vertical grower ($p=.000$) while statistically non-significant difference was seen between Vertical and Average grower ($p=0.67$). The Post Hoc Tuckey Test for Ramus Depth shows there was statistically significant difference between Horizontal & Average grower ($p=.001$) and Horizontal & Vertical grower ($p=.000$) while non-significant difference is seen between Vertical and Average grower ($p=.606$).

Comparative evaluation of Mandibular Depth between the groups is shown in Table 1. The mean Mandibular Depth for Horizontal grower was 95.37 ± 6.95 mm, Average grower was 92.05 ± 4.50 mm and Vertical Grower was 91.37 ± 5.11 mm. There was significant difference between the two variables.

In table 2, The Post Hoc Tuckey Test shows that there was significant difference in mean values between Horizontal & Average grower ($p=.025$) and Horizontal & Vertical grower ($p=.005$) while non-significant difference was seen between Vertical and Average grower ($p=.853$)

Spearman correlation is shown in table 3, which was done to find out the correlation between different growth patterns with different variables used in the study. The correlation result shows there was strong correlation seen with Gonial Angle ($\rho=0.709$) and Lower Gonial Angle ($\rho=0.731$) while moderate correlation was seen between Ramus Height ($\rho=0.59$) and Ramus Depth ($\rho=-0.381$) and mild or low correlation was seen with Mandibular depth ($\rho=0.245$) and symphysis height ($\rho=0.203$) while non-significant correlation was seen with Upper Gonial Angle, Symphysis Angle and Symphysis depth.

DISCUSSION

While several parameters were used for describing mandibular morphology, there have been very few studies which recorded comparison and correlation in various growth patterns. So, taking this into consideration, the present study was designed to compare and correlate between gonial angle, symphysis morphology, ramus morphology and mandibular depth in different growth patterns in Angle's Class II Division 1 malocclusion.

The Gonial angle in different groups are as follows

Vertical grower > Average grower > Horizontal grower

The Upper Gonial angle in different groups are as follows

Vertical grower \approx Average grower \approx Horizontal grower

The Gonial angle in different groups are as follows

Vertical grower > Average grower > Horizontal grower

The results in our study are similar with the study done by Sassouni et al (1964)⁶, Subtelny (1964)⁸, Nahoum (1975)⁹, Schendel (1976)¹⁰, Opdebeeck (1978)¹¹, Trouten (1983)⁷, Rubica J et al (2015)¹² who concluded that Vertical growers have an obtuse Gonial angle. The Upper Gonial angle is almost the same in horizontal, vertical and average growth pattern. In comparison, the Lower Gonial angle increases the angulation from horizontal, average and vertical pattern of growth and may be able to indicate the measure growth pattern. According to Sassouni, due to backward and downward rotation of mandible in vertical growers there is an increase in gonial angle.

Table 1: Comparison of all the variables between the groups using analysis of variance test

VARIABLE	HORIZONTAL		AVERAGE		VERTICAL	
	N= 40	P	N= 40	P	N= 40	P
Gonial angle	116.27±18.29	0.001*	126.05±3.85	0.001*	131.67±5.77	0.001*
Upper gonial angle	52.27±4.93	0.129	52.55±3.98	0.129	54.17±8.52	0.129
Lower gonial angle	66.45±5.44	0.001*	73.45±3.29	0.001*	73.45±3.29	0.001*
Symphyseal angle	91.35±6.71	0.39	90.35±6.60	0.39	89.45±5.28	0.39
Symphysis height	21.17±2.41	0.043*	21.85±2.87	0.043*	22.75±2.41	0.043*
Symphysis depth	14.90±2.27	0.18	14.47±1.55	0.18	14.17±1.23	0.18
Ramus height	45.22±5.23	0.001*	39.70±4.08	0.001*	37.55±3.27	0.001*
Ramus depth	32.37±3.54	0.001*	29.67±2.91	0.001*	29.00±2.98	0.001*
Mandibular depth	95.37±6.95	0.004*	92.05±4.50	0.004*	91.37±5.11	0.004*

Table 2: Post Hoc Tuckey Test for comparison of all the variables between the groups

VARIABLE	HORIZONTAL VS AVERAGE		HORIZONTAL VS VERTICAL		AVERAGE VS VERTICAL	
	Mean Difference	P	Mean Difference	P	Mean Difference	P
Gonial angle	-9.77	.001*	-15.40	.000*	-5.62	.041*
Upper gonial angle	0.27	0.97	-1.90	.352	-1.62	.464
Lower gonial angle	-7.00	.000*	-10.92	.000*	-3.92	.003*
Symphyseal angle	1.00000	.754	1.90000	.363	.90000	.795
Symphysis height	-.90	.473	-1.58	.047*	-.60	.553
Symphysis depth	.42500	.522	.72500	.155	.30000	.722
Ramus height	5.52*	.000*	7.68*	.000*	2.15	.067
Ramus depth	2.70*	.001*	3.37*	.000*	.67	.606
Mandibular depth	3.32500*	.025*	4.00000*	.005*	.67500	.853

Table 3: Spearman Correlation between groups and various parameters

Parameters	Correlation Coefficient (rho)	P value
Gonial Angle	.709**	.001*
Upper Gonial Angle	.111	.129
Lower Gonial Angle	.731**	.000*
Symphyseal Angle	-0.099	.280
Symphysis Height	0.203	.027*
Symphysis Depth	-0.096	.298
Ramus Height	-.590**	.001*
Ramus Depth	-.381**	.001*
Mandibular Depth	-.245**	.007*

According to **Rakosi**¹³ the Caucasians having average growth pattern the standard value for gonial angles range is from $128^{\circ} \pm 7^{\circ}$ that was closely like our measurements ($126.05^{\circ} \pm 3.05^{\circ}$). Upper gonial angle in Caucasians with average growth pattern ranged from 52° to 55° but in our sample it had a mean value of $52.55^{\circ} \pm 3.98^{\circ}$. In the Caucasians, lower gonial angle was 70° to 75° . The mean Lower Gonial angle in the current study was within range given for the Caucasians with mean value $73.45^{\circ} \pm 3.29^{\circ}$.

The mean Gonial angle in the Nigerian population¹⁴ was 128.42 ± 5.05 which was similar to a mean value of Caucasian population 128 ± 70 as stated by **Riolo et al.**¹⁵

Folaranmi N (2009)¹⁴ identified a mean gonial angle for the Nigerian population of 128.42 ± 5.05 , close to the median value of the Caucasian population of 128 ± 70 given by **Riolo et al (1974)**¹⁵ which was similar to the results of the present study.

The Symphyseal Height in different groups are as follows

Vertical grower > Horizontal grower

The Symphyseal Depth in different groups are as follows

Vertical grower \approx Average grower \approx Horizontal grower

The Symphyseal Angle in different groups are as follows

Vertical grower \approx Average grower \approx Horizontal grower

Gupta S et al (2018)¹⁶ in their study showed that the morphology of symphysis was related to short height, wide depth and wider angle in the horizontal growers. By comparison, in vertical growers, symphysis with a higher height, smaller depth and a short angle was found.

The result of our study had shown similar result but non-significant difference had been shown with symphysis height and angle.

Roy et al. (2012)¹⁷ in his study observed that the quantity of external symphysis increases because the facial shape varies from the vertical to the horizontal pattern of development. The thick symphysis as recorded by **Ricketts (1960)**¹⁸ was related to an anterior direction of growth in the mandible.¹⁸ **Sassouni and Nanda (1964)**⁶ and **Bjork (1969)**¹⁹ had reported heavy apposition underneath symphysis and extreme concavity of the lower mandibular border connected with the propensity in the direction of backward rotation of mandibular jaw.

Esenlik (2012)²⁰, Moshfeghi (2014)²¹ stated that aesthetically appropriate protrusion of the incisors is attributable to pronounced symphysis, which makes for a greater likelihood of treatment by using non extraction method. Conversely, the patients with greater symphyseal height and small chin, the treatment approach with extraction should be preferred in order to compensate the arch length discrepancies.

The findings are identical because of the deepest symphyseal depth observed in the horizontal growth trend of males and thus non-extraction approaches can be utilized in those patients, while in vertical growers the extraction approach is preferable, because the symphyseal depth of those patients is less pronounced.²

The Ramus Height in different groups are as follows

Vertical grower \approx Average grower < Horizontal grower

The Ramus Depth in different groups are as follows

Vertical grower \approx Average grower < Horizontal grower

Our study result was similar to the result of **S Gupta et al. (2018)¹⁶** Ramus width was found to be higher in horizontal pattern growth than in average and vertical group growth trends and statistically important for males. In Average and Horizontal growers a substantial increase in ramus was observed while in the horizontal group of males significant sexual differences was also observed.

The observations of **Müller (1963)²², Schudy (1964)²³ and Sassouni (1969)²⁴** were in line with the results of our study and all suggested a major deficiency in vertical producers' sizes as opposed to horizontal growers. Thus, the morphology of mandibular ramus is an important predictor of in what way mandibular growth will react to Class II treatment.

The Mandibular Depth in different groups are as follows

Vertical grower \approx Average grower < Horizontal grower

The result in our study is similar to the study by **Mangla et al (2011)⁵** who found that Mandibular Depth is increased in vertical and average growers when compared with the horizontal growers. **Pollard et al (1995)²⁵**, also observed that overall increase in mandibular depth is related to ramus height.

CONCLUSION

The present study shows that:

1. The gonial angle and lower gonial is more in vertical growing as compared to horizontal growing. There was not much difference in upper gonial angle in the different growth patterns.
2. The symphyseal height is more in vertical growing pattern and the symphyseal depth and symphyseal angle did not show much variation.
3. The ramus height and ramus depth is more in horizontal growing individuals.
4. The mandibular depth is more in horizontal growing individuals.

REFERENCES

1. Agarwal SS, Jayan B, Chopra SS (2015) An overview of Malocclusion in India. J Dent Health Oral Disord Ther 3(3): 00092
2. Aki T, Nanda RS, Currier GF, Nanda SK. Assessment of symphysis morphology as a predictor of the direction of mandibular growth. Am J Orthod Dentofacial Orthop 1994;106:60-9.
3. Al-Khateeb SN, Al Maaitah EF, Abu Alhaja ES, Badran SA. Mandibular symphysis morphology and dimensions in different anteroposterior jaw relationships. The Angle Orthodontist. 2014 Mar;84(2):304-9.
4. Oz U, Rubendz M. The difference in symphysis morphology in Class II malocclusion with different vertical growth pattern. Clinical Dentistry and Research. 2013; 37(2): 3-12.

5. Mangla R, Singh N, Dua V, Padmanabhan P, Khanna M. evaluation of mandibular morphology in different facial types. *Contemp Clin Dent* 2011;2:200-6.
6. Sassouni V, Nanda S. Analysis of dentofacial vertical proportions. *American Journal of Orthodontics* 1964;50:801-23.
7. Trouten J.C, Enlow D.H, Rabine M, Phelps A.E, Swedlow D. Morphologic factors in open bite and deep bite. *The Angle Orthodontist*. 1983 Jul;53(3):192-211.
8. Subtelny JD, Sakuda M. Open-bite: diagnosis and treatment. *American Journal of Orthodontics*. 1964 May 1;50(5):337-58
9. Nahoum HI. Vertical proportions and the palatal plane in anterior open-bite. *American Journal of Orthodontics*. 1971 Mar 1;59(3):273-82.
10. Schendel SA, Eisenfeld J, Bell WH, Epker BN, Mishelevich DJ. The long face syndrome: vertical maxillary excess. *American Journal of Orthodontics*. 1976 Oct 1;70(4):398-408.
11. Opdebeeck H, Bell WH. The short face syndrome. *American Journal of Orthodontics*. 1978 May 1;73(5):499-511.
12. Rubika J, Felicita AS, Sivambiga V. Gonial angle as an indicator for the prediction of growth pattern. *World Journal of Dentistry*. 2015;6(3):161-3.
13. Rakosi T. An Atlas and manual of cephalometric radiography. Wolfe Medical Publications Ltd. p. 47- 49.
14. Folaranmi N. Gonial angle values in 12 to 15 year-old Nigerians. *Journal College of Medicine*. 2009 Dec;14:2.
15. RioloML, Moyers RE, McNamara JA Jr, Hunter WS. An Atlas of Craniofacial Growth: Cephalometric Standards from the University School Growth Study, The University of Michigan. Monogram Z, Craniofacial Growth Series 1974.
16. Gupta S, Dhingra PS, 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. *Indian J Dent Sci* 2018;10:21-5
17. Roy AS, Tandon P, Chandna AK, Sharma VP, Nagar A, Singh GP. Jaw morphology and vertical facial types: A Cephalometric Appraisal. *J Orofacial Research* 2012;2:131-8
18. Ricketts RM. A foundation for cephalometric communication. *American Journal of Orthodontics*. 1960 May 1;46(5):330-57.
19. Björk A. Prediction of mandibular growth rotation. *Am J Orthod* 1969;55:585-99
20. Esenlik E, Sabuncuoglu FA. Alveolar and symphysis regions of patients with skeletal class II division 1 anomalies with different vertical growth patterns. *European Journal of Dentistry* 2012;6:123-32.
21. Moshfeghi M, Nouri M, Mirbeigi S, Baghban AA. Correlation between symphyseal morphology and mandibular growth. *Dental Research Journal*. 2014 May;11(3):375.
22. Muller G. Growth and development of the middle face. *Journal of Dental Research* 1963;42:385-9.
23. Schudy FF. Vertical growth versus anteroposterior growth as related to function and treatment. *Angle Orthodontist* 1964;34:75-93.
24. Sassouni V. A classification of skeletal facial types. *American Journal of Orthodontics* 1969;55:109-23.
25. Pollard LE, Mamandras AH. Male postpubertal facial growth in Class II malocclusions. *American Journal of Orthodontics and Dentofacial Orthopedics*. 1995 Jul 1;108(1):62-8.