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RESEARCH ARTICLE

EVALUATION OF CONDYLAR-RAMAL MORPHOLOGY IN DIFFERENT FACIAL TYPES IN KASHMIR POPULATION

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ABSTRACT

Background: The purpose of this study was to evaluate and compare condular-ramal morphology in various vertical and sagittal facial types.The sample consisted of lateral cephalograms of 90 subjects in the age group of 15-25 years. Cephalometric tracings were done and various measurements taken. The Sample was differentiated into 3 classes using ANB angle, Wits appraisal and Beta angle.The sample was also differentiated into various vertical patterns on the basis of Jarabak's ratio. Parameters depicting condylar- ramal morphology like mandibular arc angle, lower facial height angle, gonial angle, ramus height, ramus width and antegonial notch depth were measured. The recorded data was compiled and entered in a spreadsheet (Microsoft Excel) and then exported to data editor of SPSS Version 20.0 for analysis. ***Results:*** There was no significant difference in various condylar-ramal parameters in 3 sagittal malocclusions however the gonial angle was increased in Class III malocclusion probably consequent to the increased effective mandibular length. Ramus height was also significantly greater in Class III malocclusion when compared to the Class I and II groups. On comparing the vertical facial types, vertical growth pattern showed decreased ramus height and width, increased gonial angle, decreased mandibular arc angle, increased lower facial height angle and increased antegonial notch depth. ***Conclusion:*** The parameters used were more related to the facial patterns in the vertical dimension and less to the sagittal patterns. In the hyperdivergent pattern the mandible appears to have retained its infantile characteristics with different processes (condylar and ramal) appearing to be underdeveloped.

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INTRODUCTION

Understanding the facial growth and development is of utmost importance to a clinician in order to successfully treat skeletal malocclusions in all the three planes of space. The most important aspects of growth are its timing, amount and direction which have a significant effect on the use of orthodontic biomechanics. Also there has been a constant research towards finding a reliable method of growth prediction. The pioneer work in this regard was done by Bjork[1] using metallic implants to study the growth trends occurring in human life. However, the advent of cephalometry has opened the gateways to a plethora of possibilities in prediction of the direction of growth. Investigators in the past have assessed different methods to predict the growth of the mandible and various parameters have been used with varying success. Schudy[2] investigated the interaction of anteroposterior and vertical facial dysplasias and emphasized the importance of the vertical facial dimension in the orthodontic treatment. It is still very difficult to reasonably and accurately predict the direction of mandibular growth using certain parameter.

According to Bjork[3] not all the morphologic features would be found in a particular individual, but the greater the number present the more reliable the prediction would be. The purpose of this study was to

- Evaluate and compare the condylar-ramal morphology in different sagittal and vertical facial types.
- To implicate the achieved results into diagnosis and treatment planning of patients in need of orthodontic treatment.

MATERIAL AND METHODS

The sample consisted of lateral cephalograms of 90 subjects. Cephalometric tracings were done and various measurements taken.
The Sample was differentiated into 3 classes using ANB angle, Wits appraisal and Beta angle as described in Table no. 1.

Parameter	Class I	Class II	Class III
SAMPLE(N)	**30**	**30**	**30**
1.ANB	2-4degrees	>4degrees	<2degrees
2.Wits			
Male	-1mm	>-1mm	<-1mm
Female	0mm	>0mm	< 0mm
3.Beta angle	27-35degrees	<27 degrees	>27degrees

Usually all the three parameters should be used to help arrive at a more accurate diagnosis of anteroposterior skeletal relationship. The cases where inferences from all these parameters did not match, were not included in the study. The sample was also divided into normodivergent, hypodivergent, and hyperdivergent subgroups based on Jarabak's ratio.

VERTICAL FACIAL TYPE	JARABAK'S RATIO	SAMPLE
Normodivergent	62-65%	39
Hypodivergent	>65%	30
Hyperdivergent	<65%	21

Cephalometric landmarks

- **N: Nasion—**the anterior most point of the frontonasal suture in the median plane.
- **Or: Orbitale—**lowermost point of the orbit in the radiograph.
- **Po: Porion**—the most superiorly positioned point of the external auditory meatus (anatomical porion).
- **Ba: Basion**—lowest point on the anterior margin on the foramen magnum in the median plane.
- **Dc: Condyle**—the point in the center of the condyle neck along the Ba-N plane.
- **Point B**—the most posterior point in the outer contour of the mandibular alveolar process in the median plane.
- **PM (Suprapogonion)—**the point at which the shape of the symphysis mentalis changes from convex to concave, also known as protuberance menti.
- **Pog: Pogonion**—most anterior point of the bony chin, in the median plane.
- **Gn: Gnathion—**point constructed by intersecting a line drawn perpendicularly to the line connecting Pog and Me with the bony outline.
- **Me: Menton**—lowermost point on the outline of symphysis as seen in norma lateralis.
- **Go: Gonion**—point of intersection of lines tangent to lower and posterior ramal borders of mandible projected on mandible (Brodie 1941).
- **Ar: Articulare**—the point of intersection of the images of the posterior margin of ascending ramus and the outer margin of cranial base.

Xi point

Xi point: A point located at the geometric center of the ramus, location of Xi is keyed geometrically to Po-Or(Frankfort horizontal) and perpendicular through pterygoid vertical(PtV) ;a line perpendicular to FH at the posterior margin of the pterygopalatine fossa) in the following steps;

- Planes perpendicular to FH and PtV are constructed,
- The constructed planes are tangent to points R1, R2, R3 and R4 on the borders of ramus.
- The constructed planes form a rectangle at the rectangle enclosing the ramus,
- Xi is located in the center of the rectangle at the intersection of the diagonals.

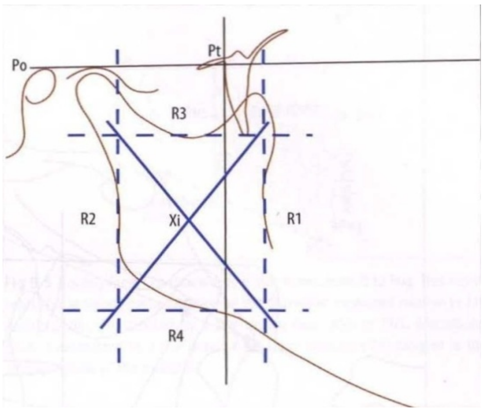

Figure 3. Xi point location

R1-mandible: The deepest point on the curve of the anterior border of the ramus, one half the distance between the inferior and superior curves.

R2 -mandible: A point located on the posterior border of the ramus of the mandible.

R3-mandible: A point located at the center and most inferior aspect of the sigmoid notch of the ramus of the mandible.

R4-mandible: A point on the lower border of the mandible, directly inferior to the center of the sigmoid notch of the ramus.

Cephalometric planes

- **FHP:** Frankfort horizontal plane—extends from Porion to Orbitale.
- **PTV:** Pterygoid vertical—the vertical line drawn through the distal radiographic outline of the Pterygomaxillary fissure and perpendicular to the Frankfort horizontal plane.
- Mandibular plane (Tweed's)—tangent to the lower border of the mandible.
- **Ba-N:** Basion-nasion plane—extends from Basion to Nasion.
- Occlusal plane—plane passing posteriorly through mesiobuccal cusp of first permanent molar and anteriorly bissecting the overbite.

ANGULAR MEASUREMENTS:

1.	Mandibular arc angle	Angular relationship of the ramus to the body of the mandible; measured by the posterosuperior angle formed by the corpus and condyle axis at Xi point.
2.	Lower facial height angle	Intersection of two planes i:e ANS-Xi and Xi-Pog.
3.	Gonial angle	Angle formed between cephlometric points- Ar, Go and Me.

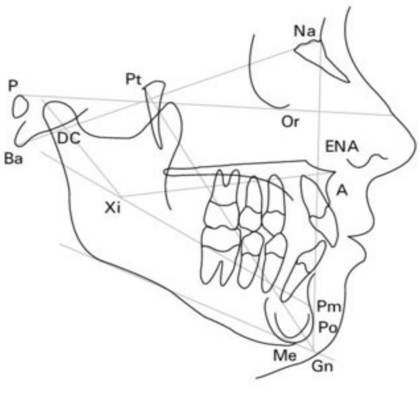

Figure 4. Lower Facial Height Angle(ANS- Xi- Pm)

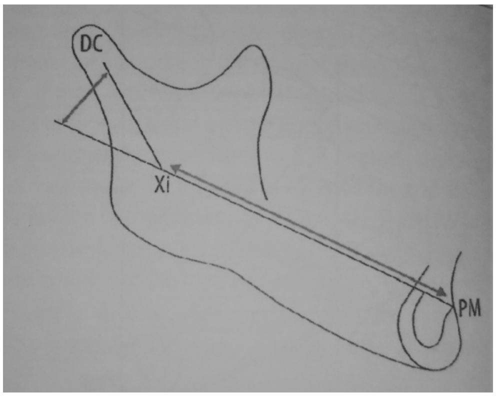

Figure 5. Mandibular arc angle

and linear measurements like

1..	Mandibular ramus width	The distance between R and R`. R and R` are anterior and posterior intersecting points of a posterior extension of the palatal plane on the mandibular ramus.
2.	Antegonial notch depth	The linear distance measured along a perpendicular drawn from deepest part of convexity to a tangent through two points on either side of notch on the lower border of the mandible.
3.	Ramus height (linear),	Distance between gonion(Go) and articulare(Ar).
4.	Ramus width	Width of mandibular ramus along the occlusal plane.

The recorded data was compiled and entered in a spreadsheet (Microsoft Excel) and then exported to data editor of SPSS Version 20.0 for analysis

RESULTS

Table below show the age distributrion of the 3 sagittal malocclusionm groups

Table 2. Age distribution of malocculusion groups

Class	N	Mean	SD	Range	P-value
Class I	30	17.6	2.30	15-25	0.556
Class II	30	17.1	3.76	16-27	
Class III	30	18.0	3.38	17-28	

Table below show the age distributrion of the 3 sagittal malocclusionm groups Table above shows that the age group used in Class I, Class II and Class III were 15-25, 16-27 and 17-28 years respectively with mean age of 17.6, 17.1 and 18years respectively. The difference between three classes on the basis of age was statistically non-significant(P-value=0.556) indicating that there was no effect of age on different parameters.

Gender distribution in the three classes given in the table and bar diagram below:

Table. Gender distribution of malocculusion groups

Gender	Class I		Class II		Class III	
	No.	%age	No.	%age	No.	%age
Male	10	33.3	14	46.7	16	53.3
Female	20	66.7	16	53.3	14	46.7
Total	30	100	30	100	30	100

Chi-square=2.52; P-value=0.284

There was no significant difference in various condylar-ramal parameters in 3 sagittal malocclusions however the gonial angle was increased in Class III malocclusion probably consequent to the increased effective mandibular length. Ramus height was also significantly greater in Class III malocclusion when compared to the Class I and II groups. On comparing the vertical facial types, vertical growth pattern showed decreased ramus height and width, increased gonial angle, decreased mandibular arc angle, increased lower facial height angle and increased antegonial notch depth.

DISCUSSION

In this study, the sample of 90 subjects was selected and divided into sagittal facial types on the basis of ANB angle, Wits appraisal and Beta angle. The subjects were also divided into 3 vetical groups based on the Jarabak's ratio as used earlier by Wylie[4]. The subjects selected belonged to the age group of 17-25 years as by that age most of the growth is completed. Also according to Brodie[5], a constant skeletal pattern gets established by this age. The parameters like Mandibular arc angle which determines the position of ramus and condyle in respect to the corpus of the mandible; it was highest in Class III group, however the difference was not statistically significant between the groups. In vertical facial types the value was highest in hypodivergent group and lowest in the hyperdivergent group. Mandibular arc angle measurement is related to the direction of condylar growth (Mc Dowell)[6]. Small Mandibular arc angle suggests steep mandibular plane associated with a vertically growing mandible while as a larger angle is correlated with a square mandible associated with more favourable forward growing mandible. As used by Ricketts[7] in his analysis mandibular arc(corpus- condyle axis) was found to be 27.8 degrees in mesofacial (standard) face while it was greater than normal in brachyfacial type and reverse pattern was seen in dolichofacial types(Platau). Owen AH[8] used mandibular arc angle to indicate the tendency of the mandible for clockwise or counterclockwise growth with values <21 degree indicating clockwise and >31 degrees indicating counterclockwise growth trend. Bench et al.[9] also in his study said that mandibular arc of 25 degree and above was a strong indicator for strong functional (muscular) response. Mandibular arc angle was more related to lower facial height angle and the two had inverse relation and the relation was statistically significant. Both the angles were suggested by Ricketts in his cephalometric analysis and related to mandibular growth in vertical direction.

The difference in the lower facial height angle and ramal height values in Class I versus Class II, Class I versus Class III were statistically insignificant. In vertical groups, the ramal height was found to be significantly increased in hypodivergent and normodivergent groups when compared with hyperdivergent group.The findings were in agreement with the observation of Sassouni[10], Muller[11], Schudy[2] and Swinehart[12]. All of whom found a considerable deficiency in dimension in hyperdivergent group. Lower facial height angle that has not been much used parameter in earlier studies was found to be highest in hyperdivergent group and least in hypodivergent group. Ramal width measured at the level of occlusal plane did not show statistically significant correlation between the 3 sagittal groups.

Table. Descriptive statistics of cephalometric variables according to sagittal malocculusion groups

Cephalometric variable	Class I		Class II		Class III	
	Mean	SD	Mean	SD	Mean	SD
Lower facial height angle (degree)	44.1	5.92	45.4	5.49	42.8	6.06
Mandibular arc angle (degree)	28.9	7.71	28.9	6.61	29.3	7.95
Ramal height (mm)	39.0	3.07	38.0	3.57	40.5	7.47
Ramal width (mm)	25.7	3.07	26.6	2.94	25.2	5.10
Antegonial notch depth (mm)	0.4	0.51	0.1	0.25	0.4	0.57
Mandibular length (mm)	89.4	4.13	89.0	6.36	93.5	8.73
Articular angle (degree)	140.9	6.69	142.0	5.82	141.4	6.78
Gonial angle(degrees)	126.4	4.34	125.6	3.21	130.3	3.55

Table: Descriptive statistics of cephalometric variables according to vertical malocculusion groups

Cephalometric variable	**Normodivergent**		**Hypodivergent**		**Hyperdivergent**	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**
Mandibular arc angle (degree)	28.2	3.67	30.7	6.68	24.3	5.15
Lower facial height angle (degree)	43.12	4.61	41.0	5.49	48.9	5.65
Ramal height (mm)	38.9	4.33	42.7	3.58	34.5	5.78
Ramal width (mm)	25.1	2.09	26.5	1.92	23.1	4.23
Antegonial notch depth (mm)	0.7	0.55	0.5	0.25	1.0	0.57
Gonial angle(degrees)	127.7	3.31	123.1	2.12	132.7	6.70

However, it was increased in hypodivergent group when compared to hyperdivergent and normodivergent groups. Gonial angle was highest in Class III group as compared to Class I and Class II groups. This may be consequent to the increased mandibular length. In vertical groups, Gonial angle was highest in hyperdivergent group than other two groups. Investigators like Decoster[13], Swinehat[13], Subtenly[15], Nahoum[16], Fields et al.[17], Sassouni[14], Jensen[13] have reported an obtuse gonial angle associated with vertical growth pattern and skeletal open bite wit a relatively small angle associated with the horizontal growth pattern and deep bite. The increase in goniaql angle as well as mandibular plane angle is due to the deficiency in the development of posterior facial height which results in a downward and backward rotation of mandible as suggested vby Sassouni. Antegonial notch depth showed higher values in Class II and Class III than in Class I. The difference was statistically significant in Class I vs Class II and Class III vs Class II. In vertical groups Antigonial notch depth was highest in the hyperdivergent group than in the normodivergent and hypodivergent groups.

Prediction of growth pattern of mandible plays an important role in diagnosis and treatment planning (Lundstrom, Lundstrom and Woodside, 1981)[20]. Backward and downward rotation of mandibles occur during growth due to apposition beneath the gonial angle with excessive resorption under the symphysis. This results in upward curving of the inferior border of the mandible anterior to the angle of mandible and is known as antegonial notching (Björk, 1963, 1969a; Skieller, Björk and Linde-Hansen, 1984[19]; Singh *et al.*, 2011[18]). In adolescents with deep antegonial notches, the mandible showed some characteristics such as retrusive mandible, short corpus length and ramus height and greater gonial angle when compared with shallow mandibular antegonial notches (Singer, Mamandras and Hunter, 1987)[21]. For Bone-formation mechanism of the antegonial notch, Enlow[22]demonstrated that the size of the antegonial notch is determined mainly by ramus-corpus angle and extent of bone deposition on the inferior margin of the corpus on either side of the notch and concluded that less prominent antegonial notch is noted if ramus-corpus angle is closed and a much more prominent antegonial notch is observed if it becomes opened (Enlow and Moyers, 1982)[22]. Hovell[23] showed that, the antegonial notch is produced by role of muscles such as masseter and the medial pterygoid especially when condylar growth fails to contribute to the lowering of the mandible(Hovell, 1965)[23]. Becker demonstrated that impaired mandibular growth and muscular imbalance will occur if the condylar area, an important growth site injured by inflammatory reactions, results in growth changes that produce antegonial notching (Becker, Coccaro and Converse, 1976)[24].

CONCLUSION

- The parameters depicting condylar-ramal morphology like mandibular arc angle , lower facial height angle, gonial angle, antegonial notch depth were more related to the facial pattern in vertical dimension than to the anteroposterior dimension.
- The parameters used in this study like mandibular arc angle, lower facial height angle, gonial angle, ramus height and antegonial notch depth were reliable and sensitive indicators of growth pattern in vertical dimension irrespective of the Class.
- In the hyperdivergent vertical group the condylar and ramal processes were underdeveloped, indicating that the mandible appears to have retained its infantile characteristics.
- It is necessary to conduct more extensive and deeper studies in search for evidence which confirm the findings of this research, and thus determine the standards that apply to our population.

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