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RESEARCH ARTICLE

CORRELATION OF BJORK'S MORPHOLOGICAL INDICATORS WITH THE PREDICTION OF MANDIBULAR GROWTH IN SKELETALLY MATURE PATIENTS

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ABSTRACT

Background: Mandibular growth is important in determining the growth pattern of an individual and various morphological indicators are used to predict its growth pattern**.** ***Objectives****:* The objective of this study was to correlate these indicators with prediction of mandibular growth in skeletally mature patients. ***Material and methods****:* Pre–treatment lateral cephalograms were randomly selected and divided into 60 males and 60 females and were further subdivided: Average {Group I} (MPA= 28-36^0) , Hypodivergent {Group II} (MPA= ≤26^0) , Hyperdivergent {Group III} (MPA= ≥38^0) (20 each) and measurements obtained were statistically analysed. ***Results:*** Significant differences were found among all the parameters, however these differences varied from one group to another. ***Conclusion:*** Lower anterior facial height is the most important parameter while determining hyperdivergent growth pattern and Curvature of mandibular canal can be considered to be a reliable indicator for hypodivergent growth pattern.

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INTRODUCTION

The ability to predict growth is important to an orthodontist in formulating an effective treatment plan. The magnitude, amount and timing of growth varies from individual to individual. Different growth patterns are responsible for having a significant effect on the treatment outcome[1]. In order to differentiate an individual based on his growth pattern, thorough knowledge of growth indicators is required. The study of mandibular growth and its rotation plays a vital role in diagnosis and treatment planning. The skeletal maturity should be studied properly while deciding the treatment modalities for orthodontic patients. With the introduction of Bjork's morphological indicators, it became easy for the clinicians to study growth of an individual. However, limited literature is available that explains the relationship of these indicators with mandibular growth. So, the aims and objectives of the present study were to correlate Bjork's morphological indicators and the predictors of mandibular growth in skeletally mature patients.

MATERIAL AND METHODS

The study was conducted on the subjects who visited the department for seeking orthodontic treatment. Lateral cephalograms of 120 subjects which were divided into two equal groups consisting of 60 males and 60 females.

The two groups were further subdivided into three subgroups of 20 each depending upon the mandibular plane angle (Go – Gn and SN):

- Group I- Average (MPA= 28-36^0) ,
- Group II- Hypodivergent (MPA= ≤26^0)
- Group III- Hyperdivergent (MPA= ≥38^0)

The following was the selection criteria:-

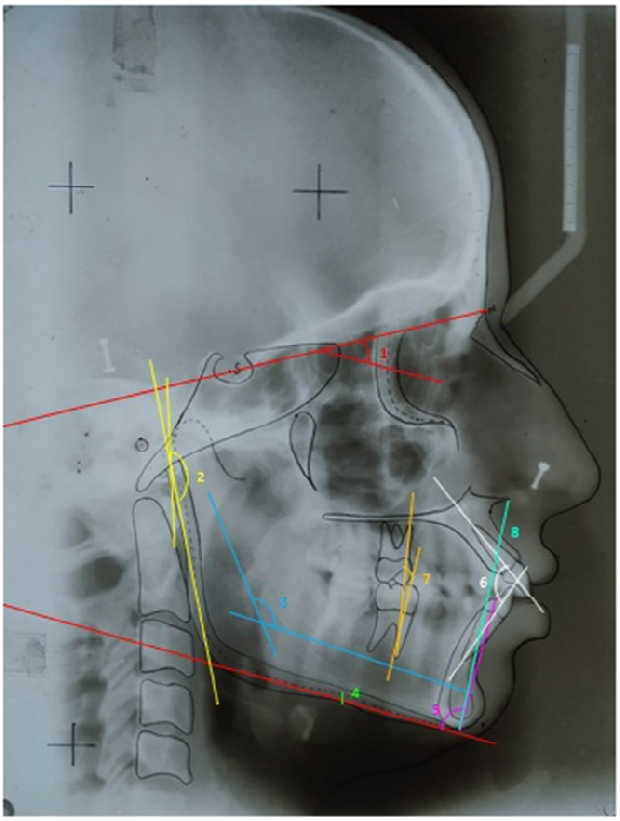
INCLUSION CRITERIA

- High quality pre-treatment lateral cephalograms .
- Post growth subjects at least CVM5 maturation stage.
- The patient should be of Himachali ethnic origin from past three generations

EXCLUSION CRITERIA

- No previous orthodontic treatment .
- No craniofacial syndromes.
- No history of maxillofacial trauma.

After obtaining standardized lateral cephalograms of the subjects, manual tracing was done on the cephalograms .Various anatomic landmarks were located on each tracing and by using these landmarks various linear and angular measurements were done as shown in Table I and Figure 1.



1) Mandibular Plane Angle , 2) Inclination Of Condylar Head , 3) Curvature Of Mandibular Canal, 4) Antegonial Notch, 5) Inclination Of Symphysis, 6) Interincisal Angle, 7) Intermolar Angle, 8) Lower Anterior Facial Height.

Figure 1. Lateral cephalogram tracing showing the parameters used in the study

The maturation stage of the subjects was evaluated according to the cervical vertebral maturation method as described by Hassal and Farman[3]. All the measurements were analysed using SPSS software version 21. Pearson correlation coefficient and ANOVA were done to analyze the results after the descriptive statistics. The level of statistical significance used in this study was set at $p \leq 0.05$.

Method Error: Lateral cephalogram tracings were evaluated twice by the same examiner with an interval of one week difference. Assessment of intraexaminer reliability was done using Kappa statistics which showed perfect agreement (Kappa = 0.80-1.00,$p<0.001$).

RESULTS

The descriptive statistics and comparison of the variables in male and female subjects are given in Table II and Table III .Pearson's correlation coefficient was calculated between age and different parameters for males and females as shown in Table IV. On Comparison of various parameters for males and females, statistically significant differences were found ($p<0.05$) and Pearson's correlation coefficient showed that age and certain parameters were significantly correlated.

DISCUSSION

Various morphological indicators given by Bjork can be used to predict mandibular growth and correlate it with the growth pattern of an individual. However, not much literature is there to suggest, whether Bjork's indicators of growth are associated with hyperdivergent and hypodivergent skeletal morphology or not. So, in the present study, these morphological indicators were correlated with the mandibular growth in skeletally mature patients. In the present study, three groups of males and females were analysed separately (that is Group I,Group II and Group III) and statistically significant difference was noted in Mandibular plane angle(MPA) (highest for Group III) as shown in Table II and Table III . It is attributed to the divisions of groups based on this angle because it has been assumed that extreme values of mandibular plane angle were prognostic criteria for predicting the direction of facial growth.

However, Baumrind *et al* [6]and Skieller and Bjork [7] suggested that a high mandibular plane angle was not a good predictor of facial growth and that individuals with high mandibular plane angle could have both forward and backward mandibular growth patterns. While comparing the mean values based on gender, the values of Mandibular plane angle were found to be slightly more for females in Group I and Group II but in Group III the values were higher for males. Further, the results showed that the values of Inclination of Condylar Head (ICH) were also found to be statistically significant in all the groups and was found to be highest in Group II and lowest in Group III as shown in Table II and Table III.

Regional remodelling changes in the condyle can result in the variation in the direction and amount of condylar growth. In Bjork's original implant study, great variation in age, direction and intensity of growth was found and this variation in condylar growth may result in vague limits between the normal and extreme skeletal groups. Bjork also stated that in forward direction of growth, condyle also rotates forward and vice versa. The results of the present study were in accordance with the study done by Gowda *et al* [8]. They stated that condylar head is inclined more backwardly in hyperdivergent and more forwadly inclined in hypodivergent subjects. On comparing Inclination of condylar head among the genders, the values were higher for females in Group I and Group II while as in Group III it was higher for males . Moreover, the mean values of Curvature of Mandibular Canal (CMC) was found to be significantly different in all the groups.

It was lowest for Group II and highest for Group III as shown in Table II and Table III. Based on Bjork's descriptions of growth patterns, the forward growers present a greater curvature of mandibular canal (smaller angle of curvature). However, the results of our study were not in accordance with the study done by Davidovitch *et al* [5] , they showed no significant differences in hyperdivergent and normal group. While evaluating the differences based on gender, the variation in the values was not very large. The result of the present study showed that the values of Antegonial Notch (AN) were found to be significantly different among all the groups with the highest values for Group III and lowest for Group II as shown in Table II and Table III .The results were similar to the study done by Davidovitch *et al* [5] and Lambrechts *et al* [9] . They observed that there occurs a strong correlation of shallow notch with horizontal mandibular plane angle , prominent chin and short lower anterior facial height . The results were supported further by Mangla *et al* [4], in their study the mean values of Antegonial notch were found to be higher for both the genders and they also concluded that no sexual dimorphism was found in the Antegonial notch values due to the difference in the definition of antegonial notch. Further, the mean values of Inclination of Symphysis (ISY) were found to be significantly significant in all the groups and was found to be highest for Group III and lowest for Group II as shown in Table II and Table III. The results of the present study were in accordance with the study done by Davidovitch *et al* [5] and were not in accordance with the study done by Mangla *et al* [4] and Aki *et al* [10] .This might be due to a more retruded chin in hyperdivergent group (Group III)because of the backward rotation of symphysis while as the lingually positioned Inclination of symphysis resulted in forward rotation and thus a prominent chin in hypodivergent group(Group II). Further when the two genders were compared , the mean values were higher for males in all the three groups.

Table 1. Linear and angular measurements used in the study

LANDMARKS	DESCRIPTION
Mandibular Plane Angle(MPA)	Angle between lines Go–Gn and S–N.
Inclination of the condylar head (ICH)	Angle between a tangent to the condylar head and a tangent to the posterior border of the ramus.
Curvature of the mandibular canal(CMC)	Angle between a line parallel with the first centimetre of the mandibular canal from the mandibular foramen and a line representing the direction of the mandibular canal closest to the mental foramen.
Antegonial notch(AN)	Vertical distance from the deepest part of notch concavity to a tangent through the two points of greatest convexity on the inferior border of the mandible, either side of the notch.
Inclination of the symphysis(ISY)	Angle formed by the line through Me and point B and the mandibular plane.
Interincisal angle (IIA)	Obtuse angle between the long axis of upper and lower incisors.
Intermolar angle(IMA)	Acute angle between the long axis of upper and lower first molars.
Lower anterior facial height(LAFH)	Distance between points ANS and Me.

Table II. Comparison of mean values of different parameters among the three groups of males

Parameters	Group I		Group II		Group III		
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	F
Age	18.4	2.37	18.2	2.13	18.1	1.52	0.12
MPA	30.4	1.76	24.6	1.64	39.7	2.00	358.70*
ICH	170.6	0.85	178.8	0.79	166.5	1.43	686.69*
CMC	132.4	1.82	126.9	1.33	137.8	1.41	249.48*
AN	1.7	0.55	1.6	0.46	2.5	0.34	19.84*
ISY	102.3	1.34	99.9	1.69	106.4	2.52	59.15*
IIA	120.0	1.61	127.2	2.46	118.4	2.28	95.59*
IMA	12.9	1.65	14.3	2.08	20.1	1.12	105.28*
LAFH	68.5	1.19	60.2	1.90	82.5	1.10	1223.00*

p>0.05 – Not Significant; p < 0.05 – Significant ; p <0.001 – Highly Significant

Table III: Comparison of mean values of different parameters among the three groups of females

Parameters	Group I		Group II		Group III		
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	F
Age	20.1	2.17	19.7	1.66	19.7	1.63	0.4
MPA	30.7	2.27	24.9	1.71	39.4	1.46	309.8*
ICH	171.3	0.70	179.3	0.72	164.3	1.53	1010.0*
CMC	132.9	1.56	127.6	1.19	137.7	1.50	251.3*
AN	1.5	0.38	0.9	0.46	2.7	0.26	118.2*
ISY	101.9	1.31	97.9	1.37	103.0	1.77	63.5*
IIA	119.1	1.00	123.8	2.15	116.2	5.16	27.1*
IMA	17.9	1.52	14.0	2.09	18.6	1.85	36.9*
LAFH	66.4	2.72	60.8	1.24	82.6	1.10	755.5*

p>0.05 – Not Significant ; p < 0.05 – Significant ; p <0.001 – Highly Significant

Table IV : Pearson's Correlation of different parameters with age for all the three groups in all the subjects

Groups	Male			Female			All subjects		
	Parameters	r	p	Parameters	r	p	Parameters	r	P
Group I	MPA	0.591	0.006	ISY	0.63	0.003	IMA	0.42	0.007
	IMA	0.473	0.035	LAFH	0.52	0.018			
	LAFH	0.481	0.032						
Group II	MPA	0.442	0.051	IIA	0.445	0.05	MPA	0.34	0.03
	ISY	0.53	0.016	LAFH	0.69	0.001	IMA	0.31	0.05
	IMA	0.680	0.001				LAFH	0.74	0.001
	LAFH	0.74	0.001						
Group III	LAFH	0.67	0.001	LAFH	0.77	0.001	LAFH	0.66	0.001

p>0.05 – Not Significant ; p < 0.05 – Significant ; p <0.001 – Highly Significant

The present study also evaluated that the Interincisal angle (IIA) was found to be statistically significant between all the groups and the mean values were found to be lowest for Group III and highest for Group II as shown in Table II and Table III. The results of this study were in accordance with Bjork's description of a smaller Interincisal angle in vertical and greater in horizontal growth patterns and also with the study of Davidovitch *et al* [5] and Gowda *et al* [8] .The reason for this is that the upper and lower incisors have a more mesial inclination in hyperdivergent group than in the hypodivergent pattern. While comparing the mean values between males and females, the values were slightly higher for males in both the groups. Further, the results of the present study showed that the mean values of Intermolar angle (IMA) showed significant differences in all the groups as shown in Table II and Table III.

This was in aggrement with Bjork's description of vertical and horizontal growth pattern. The mean values of Intermolar angle was found to be highest in Group III(using the obtuse angle formed by incisors axes) . However, this study was not in accordance with the study done by Davidovitch *et al* [5]as they found no statistically significant difference among the three groups. On comparison, the mean values were found to be higher in Group I for females and for males in both Group II and Group III., Morever, the results of the present study showed that the mean values of Lower anterior facial height (LAFH) was found to be statistically significant in all the three groups as shown in Table II and Table III. The mean values were higher for Group III and smaller for Group II and this can be attributed to the forward rotation of mandible in subjects with horizontal growth patterns while backward rotation of mandible in

subjects with vertical growth pattern. These results were in accordance with the study done by Bjork . The results were also supported by Gowda *et al* [8] , Davidovitch *et al* [5], Opdebeeck *et al* [11] , Fields *et al* [12]. Further on comparing the genders, higher values were seen in males in Group I. Moreover, when the variables were correlated with age ,Lower anterior facial height (LAFH) was found to be statistically significant as shown in Table IV. The result was supported by the studies done by Behrents *et al* [13] Isreal H.[14], Lewis *et al*[15]. Therefore, on comparison of various morphological indicators with different growth patterns, statistically significant results were obtained. So, it can be concluded that the utilization of these indicators for the correlation of different skeletal patterns should be done after careful evaluation of all the parameters involved.

CONCLUSION

- Lower anterior facial height is the most important parameter while considering a hyperdivergent growth pattern.
- While evaluating the growth in a hypodivergent subject, curvature of mandibular canal can be considered a reliable indicator.
- On correlating these indicators with age, only lower anterior facial height was found to be age related in both in males and females in Himachali population.

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