Cranio-facial growth prediction based on mandibular rotation in groups with deep and shallow mandibular antegonial notching – A cephalogram study

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Abstract

The human skull is made of four regions which are morphologically distinct but are directly contagious with each other. The morphological changes and growth patterns occurring in any of these regions can affect the growth patterns in remaining regions. The present study was done for the prediction of cranio facial growth based on mandibular rotation of groups with deep and shallow mandibular antegonial notching by cephalometric analysis using lateral cephalograms. 4 angular measurements were made using a protractor (set squires) and 2 linear measurements were made using metallic scale. The parameters taken were tabulated to calculate the Mean, Standard Deviation, P values in each deep and shallow notch groups and the measurements which were observed to be more significant are compared with previous studies.

Keywords: Mandibular rotation, Ante gonial notching, Lateralcephalometric analysis.

Introduction

Four morphogenetic distinct regions are present in the human skull; the mandible, the middle face, the cranial base and the upper face. The middle face, the cranial base, and the mandible regions are directly contiguous with each other, and the growth events that occur in any one necessarily affect the nature of reciprocal, complementary growth processes in portions of the other two.[1] Directional growth prediction has gained greater importance with the increased understanding that large individual variations occur in craniofacial growth and morphology. During an individual's life, the morphological changes undergone by the mandible are thought to be influenced by dental status and the age of the patient.

The various remodeling fields in the mandible which undergo changes include the gonial region, antegonial region, condyle and ramus. The upward curving of the inferior border of the mandible anterior to the angular process (gonion) is known as antegonial notch (AN). It lies at the junction of body and the ramus of mandible. The knowledge of facial morphology, that is the two distinct types of facial form which have been characterized in the literature as "skeletal open bite" or hyperdivergent and "skeletal deep bite" or hypodivergent and The knowledge of facial development for individuals having deep and shallow mandibular antegonial notching is necessary for the successful treatment of orthodontic and orthognatic anomalies.

Aim

To observe whether statistically significant differences occur for the measurements that represent mandibular rotation between groups with deep and shallow mandibular antegonial notching.

Objective

To determine various growth patterns (Vertical / Horizontal) in groups with deep and shallow mandibular antegonial notch depths.

Materials and Methods

The present study was carried out on lateral cephalograms of pretreatment orthodontic patients which were obtained from the files of the department of Orthodontics, Government Dental Collage and Hospital, Afzalgunj, Hyderabad. 80 Lateral cephalograms of pretreatment orthodontic patients out of which 40 with deep and 40 with shallow mandibular antegonial notches were took for the study.

The various steps that were followed were as shown below. Depth of the mandibular antegonial notch was measured on each subject's lateral cephalograms. If the distance along the perpendicular line is 3mm or more should be considered as deep notch and if it is 1mm or less should be considered as shallow notch. (Fig. 1)

Definitions of cephalometric parameters which were used in this study: (Fig. 1)
S (Sellaturcica): The center of the pituitary fossa of the sphenoid bone.
N (Nasion): The junction of the frontonasal suture at the most posterior point on curve.
Go (Gonion): The midpoint of the mandibular angle.
Ar (Articulare): Point of intersection of the inferior cranial base surface and the averaged surfaces of the mandibular condyles.
Frankfort Horizontal: A line connecting Porion (the most superior point on the periphery of external acoustic meatus)

and orbitale (the lowest point on the average of the right and left borders of the bony orbit).

Me (Menton): The most inferior point on the Symphyseal out line.

Notch depth – PMR – Notch depth posterior part of mandibular ramus: A line connecting point Ar with the point of greatest convexity on the posterior border of the angular process of the mandible.

MD-AA (Mandibular Arch Angle): Angle between corpus axis (Xi – Pm) and condylar axis (Xi – and midpoint condylar length on Ba – N axis).

4 angular and 2 linear measurements were made on each cephalometric tracing. Angular measurements were made using a protractor (set squires) with an accuracy of 0.5 degrees. Linear measurements were made using metallic scale. (Table 1)

SN-GoAr: It indicates position of posterior border of the Mandibular ramus relative to the cranial reference structure SN.

FH-ArGo: It indicates position of posterior border of the Mandibular ramus relative to the cranial reference structure FH.

Ar-Go-Me: It is an expression for the form of mandible, with reference to the relation between body and ramus. A large angle indicates more of a tendency to posterior rotation of the mandible, with condylar growth directed posteriorly. A small gonial angle on the other hand indicates vertical growth of the condyles, giving a tendency to anterior rotation of the mandible.

MD-AA: It describes the configuration of the mandible where by a large angle is indicative of a strong and square mandible a small angle represents lower jaw with a short ramus and vertical growth pattern.

Notch Depth-PMR: It is the depth of notch along posterior border of mandibular ramus. Indicates mandibular rotation, one of the structural sighns used to predict Mandibular growth.

Antegonial Notch Depth: Depth of notch along mandibular lower border indicating growth direction.

Observations

Angular Measurements: SN-GoAr, FH-ArGo indicating position of posterior border of the mandibular Ramus in relation to cranial reference structures SN and FH. The mean values for these were 2.6° and 2.38° respectively which were more in deep notch group. Both were differed significantly $p<0.05$mm between two groups. Similarly the Gonial angle, Ar-Go-Me was 4° more in deep notch group and showed significant difference, but MD-AA observed to be 6.63° more in shallow notch group and differed significantly between the two groups. (Table 2)

Linear Measurements: Ramal notch depth is more in shallow notch group whereas Antegonial notch mean value is 3.1mm more in deep notch group showing significant difference of $p<0.05$mm between two groups.(Table 3)

Table 1: Angular and linear measurements

Angular measurements	Linear measurements
SN- GoAr	Notch depth-PMR
FH-ArGo	Antegonial notch depth
Ar-Go-Me	
MD-AA	

Table 2: Comparative statistics for Angular measurements that represent Mandibular Rotation

Angular measurements	Deep		Shallow		p- value
	Mean	Standard Deviation	Mean	Standard Deviation	
SN- GoAr	87.75	4.85	85.15	4.56	0.016
FH-ArGo	78.35	4.12	75.97	4.14	0.012
Ar-Go-Me	129.95	5.61	125.95	4.5	0.001
MD-AA	29.15	6.21	35.78	5.33	<0.001

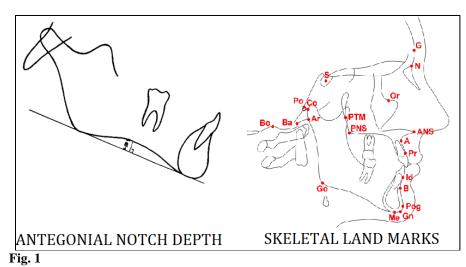**Table 3:** Comparative statistics for linear measurements that represent mandibular rotation

Linear measurements	Deep		Shallow		p- value
	Mean	Standard Deviation	Mean	Standard Deviation	
Notch depth-PMR	2.31	0.86	2.41	3.71	0.868
Antegonial notch depth	3.64	0.99	0.54	0.47	<0.001

Table 4: Comparision with previous Studies

Author Name	SN-GoAr				
	Deep		Shallow		P Value
	Mean	SD	Mean	SD	
Lambrechts et al	95	3.1	95.9	3.2	0.229
Present Study	87.75	4.85	85.15	4.56	0.016
Author Name	FH-ArGo				
	Deep		Shallow		P Value
	Mean	SD	Mean	SD	
Lambrechts et al	76	5	73.9	4.7	0.0051

Present Study	78.35	4.12	75.97	4.14	0.012
Ar-G0-Me					
Author Name	**Deep**		**Shallow**		**P Value**
	Mean	**SD**	**Mean**	**SD**	
C P Singer et al	128.82	6.55	122.96	5.53	0.001
Lambrechts et al	132.8	6.1	128.7	4.6	0.0225
Present Study	129.95	5.61	125.95	4.5	0.001
MD-AA					**P Value**
Author Name	**Deep**		**Shallow**		
	Mean	**SD**	**Mean**	**SD**	
Lambrechts et al	29.1	5.2	35.4	5.5	0.0001
Present study	29.15	6.21	35.78	5.33	<0.001
Antegonial Notch depth					**P Value**
Author Name	**Deep**		**Shallow**		
	Mean	**SD**	**Mean**	**SD**	
C P Singer et al	3.43	0.51	0.69	0.33	0.001
Lambrechts et al	3	0.9	2	0.9	0.0001
Present study	3.64	0.99	0.54	0.47	<0.001

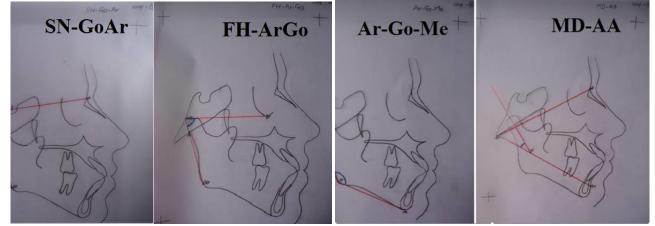**Fig. 1**
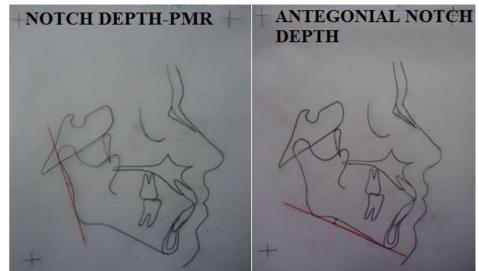

Fig. 2: Angular measurement

Fig. 3: Linear measurments

Result and Discussion

In the present study efforts were put to evaluate the cranio facial growth prediction based on mandibular rotation of groups with deep and shallow mandibular antegonial notching by cephalometric analysis done on the lateral cephalograms.

The parameters taken were tabulated to calculate the Mean, Standard Deviation, P values in each deep and shallow notch groups. The measurements which were observed to be more significant were compared with previous studies and were discussed as under.

In this study Subjects falling within 20 to 25 years were selected because of the fact that most of the growth would have been completed by that time. This is in accordance with Creekmore (1967)[2] who has mentioned that the facial patterns once established did not change much.

Mandibular Rotation-Angular Measurement
SN-Go-Ar& FH-ArGo

The mandibular rotation which was indicated by SN-GoAr, FH-ArGo, both differed significantly between both deep and shallow notch groups and the mean values were more in deep notch group than that of shallow notch group. According to Lambrechts et al (1996)[3] no significant difference was observed for SN-GoAr but statistically significant difference present for FH-ArGo and was more in deep notch subjects. Nebbe et al (1998) said that posterior rotation of the mandible may also be interpreted by an increase in angle between S-N and Ar-Go angle as well as an increase in the angle between Frankfort horizontal and Ar-Go, which represents a posterior rotation of posterior border of the mandibular ramus relative to the cranial reference structures SN&FH.

Ar-G0-Me

The Gonial angle is represented by Ar-Go-Me. The mean gonial angle was found to be significantly increased in deep notch subjects than in the subjects with shallow notching. Lundstrom and Woodside (1981)[4] as well as Odegaard (1970)[5] reported a relationship between the size of the goinal angle and the direction of mandibular growth. A similar association was observed in the present study where the group with deep notching had a more vertical direction of growth. The more anterior position of mandibles in shallow notch subjects was contributing to horizontal growth in these subjects. Pronounced notching of the lower mandibular border in conjunction with steep mandibular plane and larger gonial angles was reported by Nahoum (1975).[6] Rajat Mangla et al (2011)[7] has found that gonial angle significantly increased in hyper divergent group hen compared with hypo divergent group. The lack in the development of posterior facial height and increased anterior lower facial height results in a downward and backward rotation of mandible and an increase in mandibular angle and gonial angle. The deep antegonial notch group reflected more vertical mandibular growth patterns resulting in a longer anterior facial height than the shallow notch group. Isacson et al (1971)[8] suggested that the quantum of condylar growth indirectly affects the mandibular growth rotation. Backward rotational growth patterns are exhibited when the sum of vertical growth at the mid facial sutures and at the alveolar processes exceeds the vertical growth of the condyles.

MD-AA

The configuration of the mandible MD-AA was more in shallow notch group compared to deep notch group and differed significantly between two groups. A small angle represents lower jaw with a short ramus and vertical growth pattern. This was supported by Lambrects et al (1996).

Mandibular rotation - Linear Measurements:

Antegonial Notch

Antegonial notch depth significantly differed between two groups where it was more in deep group than in shallow group. The relation between antegonial notch depth and growth pattern was supported by many people like Singer C P et al (1987), Lambrechts et al (1996), Kolodziej et al (2002),[9] Dogan and Saglam (2009)[10] (Table 4)

Conclusion

Among the four angular measurements three were greater in deep antegonial notch group and one was greater in shallow antegonial notch group and all were statistically significantly. Out of two linear measurements one was greater in deep antegonial notch group and was statistically significant. The angular measurements (SN-Go-Ar and FH-Ar-Go) that represent mandibular rotation in relation to cranial reference planes like sella-nasion and Frankfurt's horizontal plane were more in deep notch group compared with shallow notch group. The size of the gonial angle (Ar-Go-Me) also affects the amount of mandibular rotation. Obtuse angle was seen in deep notch group and acute angle was found in shallow notch group.

Conflict of Interest: None.

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