COMPARISON AND CORRELATION BETWEEN ANTEGONIAL NOTCH DEPTH, SYMPHYSIS MORPHOLOGY AND CURVATURE OF MANDIBULAR CANAL AMONG DIFFERENT GROWTH PATTERNS IN ANGLE'S CLASS II DIVISION 1 MALOCCLUSION : A RADIOGRAPHIC STUDY

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ABSTRACT:

BACKGROUND AND OBJECTIVES: Morphological indicators within the cranium for prediction of mandibular growth patterns as reported by Bjork are: (1) Inclination of the condylar head (ICH), (2) Curvature of mandibular canal (CMC), (3) Shape of the lower border of the mandible and specifically depth of the antegonial notch (AN), (4) Inclination of the symphysis (ISY), (5) Interincisal angle (IIA), (6) Intermolar angle (IMA), (7) Lower anterior facial height (LAFH). The purpose of this study was to examine the association of AN, ISY and CMC in Angle's Class II Division 1 malocclusion among three skeletal facial type (average, horizontal and vertical) and to assess which amongst these signs are more representative of each skeletal facial types in the vertical plane in skeletally mature subjects.

MATERIALS AND METHOD: The pre-treatment lateral cephalometric radiographs of 30 post-growth subjects undergoing orthodontic treatment from Dept. of Orthodontics, M.R. Ambedkar Dental College, Bengaluru were selected and divided into three groups according to their MP-SN (according to Steiner's analysis) 1. Normal: 26-38 degrees (G1), 2. Horizontal: <26 degrees (G2), and 3. Vertical: >38 degrees (G3).

RESULT: Statistical test carried out were One way ANOVA and post hoc Tukey's test. It was found that AN, ISY and CMC were statistically significant between the groups.

CONCLUSION: Bjork's implant studies have contributed much to understanding facial-skeletal growth. The present study concluded that Antegonial notch depth (AN), Symphysis morphology (ISY) and Curvature of mandibular canal (CMC) were the reliable parameters evaluating Bjork's indicators in Angle's Class II Division 1 malocclusion among extreme skeletal Patterns.

KEYWORDS: Bjork's structural signs ; Vertical skeletal morphology ; Cervical vertebral maturation (CVM) method ; Angle's Class II division 1 malocclusion.

INTRODUCTION

Mandibular growth is expressed at the condyle and remodeling of bone surfaces concomitant to downward and forward translation due to growth of surrounding tissues. The body of the mandible grows in length by relocation of the ramus. The main sites of growth of the ramus are its posterior surface and the condylar and coronoid process. Ramal height occurs by endochondral bone formation at the condyles[1]

Bjork[2] used metallic implants placed in the jaws of growing children, and with emphasis on detecting extreme types of mandibular rotation, he suggested seven structural signs for evaluating growth direction. Although these signs are not clearly developed before puberty, their accumulation increases the reliability of prediction. Not all the morphologic features would be found in a particular individual, but the greater the number present more reliable the prediction would be. Although related, multiple morphologic factors were most useful in explaining the clinical vertical evaluation of facial patterns (Fields HW et al)[3].

In orthodontics, knowledge of mandibular growth is highly beneficial in diagnosis and treatment planning and is critical in the development of balanced dentofacial structures[4]. Patients with hyperdivergent growth pattern are more difficult to treat than those with hypodivergent growth pattern. So it is important to identify the existing mandibular growth pattern before initiating treatment[5]. Ricketts[6] stated that the symphysis morphology may be used to predict the direction of mandibular growth. He associated a thick symphysis with an anterior growth direction. Backward mandibular rotation is associated with a pronounced apposition below the symphysis with overall concavity of the lower mandibular border. An inclination of the symphysis with proclination is an indicator of a backward rotating mandible.Symphysis found to be a reliable growth predictor[4].

Angle's Class II Division 1 malocclusion is a frequently seen dentoskeletal disharmony which constitutes a marked percentage of patients treated worldwide by orthodontists. A thorough knowledge of the different growth patterns and skeletal, dental components that contribute to the Angle's Class II Division 1 malocclusion and is essential because these elements may influence the approach to treatment[7].

Several investigators have extensively defined mandibular rotation types and various parameters have been found useful in prediction of mandibular rotations[8].

Hence this study designed to compare and correlate between:

- Curvature of mandibular canal(CMC)
- Inclination of the symphysis(ISY)
- Depth of the Antegonial notch(AN)

Many cephalometric studies have attempted with emphasis on detecting extreme types of mandibular rotation with Bjork's seven structural signs. Hence this study aimed to compare and correlate between antegonial notch depth, symphysis morphology and curvature of mandibular canal among different growth patterns in Angle's Class II Division malocclusion.

AIMS AND OBJECTIVES

The Aim of the present study is to compare and correlate between Curvature of mandibular canal, Inclination of the symphysis, the Antegonial notch depth in different growth patterns in Angle's Class II Division 1 malocclusion.

The objectives of this study are:

1. To determine the antegonial notch depth, symphysis morphology and curvature of mandibular canal in Angle's Class II Division 1 malocclusion.
2. To find a correlation between these factors in different growth patterns in Angle's Class II Division 1 malocclusion.

SOURCE OF DATA

The pre-treatment orthodontic lateral cephalometric radiographs of 30 post-growth subjects undergoing orthodontic treatment from Dept. of Orthodontics, M.R.Ambedkar Dental College will be selected after taking informed consent and divided into 3 groups based on their Sella-Nasion Mandibular plane angle.(according to Steiner's analysis)

- Average (Group 1) : 26–38 degrees
- Horizontal(Group 2) : < 26 degrees
- Vertical (Group 3) : > 38 degrees

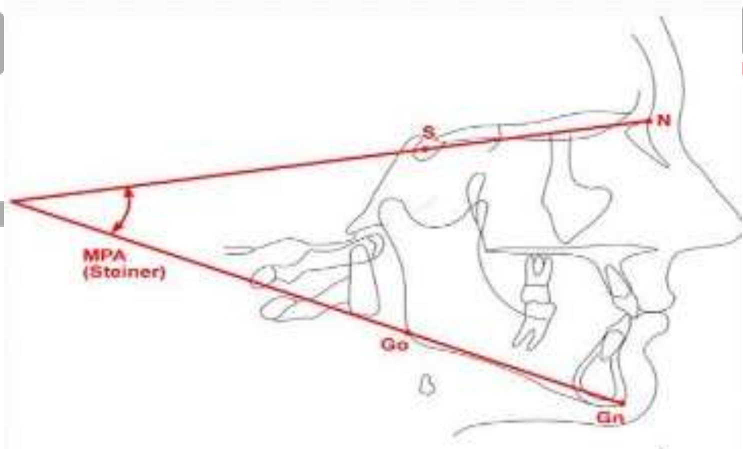


Fig 1: Mandibular plane angle (According to Steiner's analysis)

The inclusion criteria for the patient will be the following:

- Presence of high-quality pre-treatment lateral cephalometric radiograph.
- No previous orthodontic treatment.
- No craniofacial syndromes.
- No history of facial trauma.
- Patient should have completed stage CVM5 or should atleast be in stage CVM5 (CVMS-Baccetti.T,Franchi.L and McNamara J.A, Jr.(2005)

Twenty-five anatomic landmarks were located on each tracing and manually plotted using acetate tracing sheet & pencil.

METHOD OF COLLECTION OF DATA

On each of the radiographs the following parameters will be recorded :

- Name of the patient
- Gender of the patient

- Chronological age of the patient

MATERIALS AND METHODS

- Lateral cephalograms (KODAK 8000C digital panoramic and cephalometric system)
- 0.3mm graphite pencil
- 0.7mm acetate sheet of 8x10" size
- A protractor
- Masking tape.

The films for all the radiographs will be of size 8x10'' and the magnification will be around 1.3x.
The software used for this will be Kodak software.

RADIOGRAPHS	KVP	mA	EXPOSURE TIME (*in seconds)*
LATERAL CEPHALOGRAM	78	12	1

METHODOLOGY

The cephalograms will be taken in natural head position using a Kodak 8000C cephalostat and traced manually according to the methods of Jacobson,A and Jacobson,R.L[9]

- The radiographs will be chosen on the basis of CVM method.
- The maturation stage of the subjects will be evaluated according to the cervical vertebral maturation (CVM) method[10].

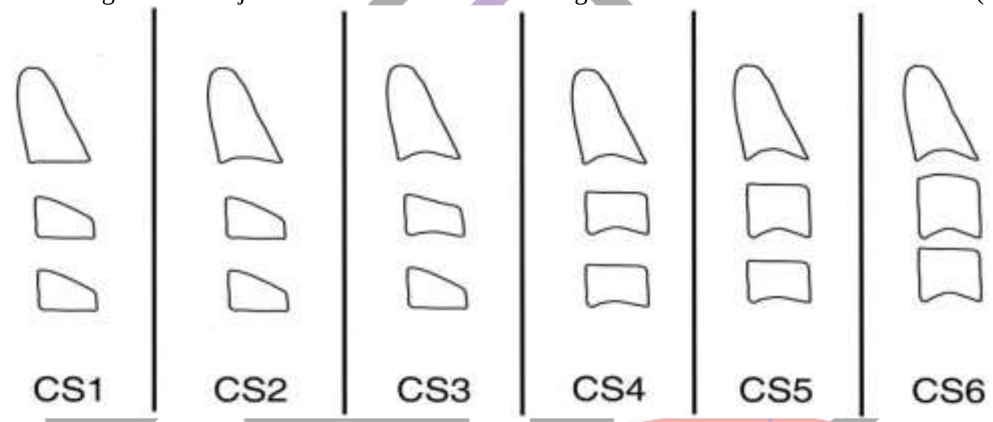


Fig 2: Baccetti Cervical vertebral maturation stages

- Twenty-five anatomic landmarks will be located on each tracing and manually plotted.
- To test landmark identification reliability,intra-examiner test will be performed by retracing 30 lateral cephalograms after a period of 30 days.
- To avoid inter-examiner error,two separate examiners will trace the radiographs after an interval of 30 days.

Fig 3: Anatomic landmarks for tracing on cephalogram

The landmarks to be plotted will be:

1.Sella (S)
2.Nasion(N)
3.Gnathion (Gn)
4.Gonion (Go)
5.Posterior root condyle (Ar)
6.Posterior condyle curve (Pcc)
7.Supra gonion (Sg)
8.Mandibular foramen (MCAN1)
9.One centimetre of the mandibular canal from the foramen,(MCAN2)
10.Two landmarks representing the direction of the mandibular canal closest to the mental foramen (Mental1, Mental2)
11.The most inferior point of the lower border of the mandible (LowerBorder1)
12.The deepest point of the antegonial notch (GonialNotch)
13.The most inferior point of the gonial area (Mid-Notch Gonion)
14.Point B (B)
15.Menton (Me)
16.Upper central incisal edge (UI)
17.Upper central root apex (UR)
18.Lower central incisal edge (LI)
19.Lower central root apex(LR)
20.Upper molar occlusal edge (UO)
21.Upper molar mesial root apex (UMR)
22.Lower molar occlusal edge (LO)
23.Lower molar root apex (LMR)
24.Anterior nasal spine (ANS)
25.Condylion(CO)

Measurements:

1.MPA- Angle between lines Go-Gn and S-N.
2.CMC- Angle between a line parallel with first centimeter of the mandibular canal from the mandibular foramen and a line representing the direction of the mandibular canal closest to the mental foramen.
3.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.
4.ISY - Angle formed by the line through Me and point B and mandibular plane.

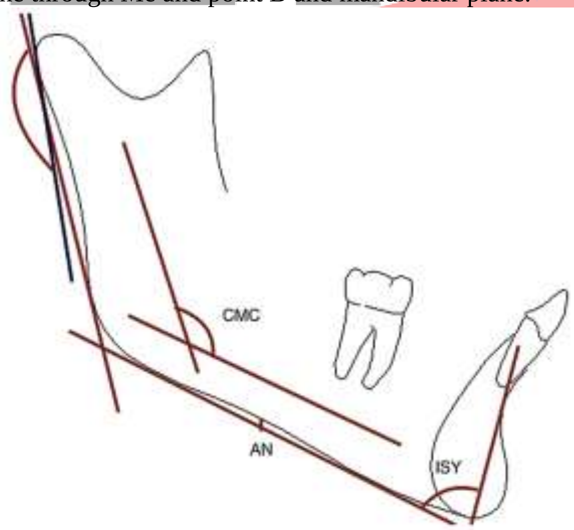


Fig 4: Measurements for Bjork's indicators of growth

- The growth pattern was evaluated and divided into hypodivergent, average and hyperdivergent.
- The Curvature of the mandibular canal, antegonial notch depth and symphysis morphology was determined.

Statistical Analysis:

Statistical Package for Social Sciences [SPSS] for Windows, Version 22.0. Released in 2013. Armonk, NY: IBM Corp., was used to perform statistical analyses.

Descriptive Statistics:
Descriptive analysis of all the study parameters was done using Mean & SD.
Inferential Statistics:
One-way ANOVA test followed by Tukey's Post hoc test was used to compare the mean values of different parameters between different growth patterns.
The level of significance [P-Value] was set at $P<0.05$.

RESULTS

TABLE – 1

Comparison of mean Antegonial Notch Depth (in mm) between 03 groups using One-way ANOVA Test						
Groups	N	Mean	SD	Min	Max	P-Value
Group 1	10	2.00	0.82	1	3	0.004*
Group 2	10	1.30	0.48	1	2	
Group 3	10	2.50	0.85	1	4	

** - Statistically Significant*
Note:
Group 1 – Average growth pattern, Group 2 – Horizontal growth pattern,, Group 3 – Vertical growth pattern.

The difference in Antegonial Notch Depth (AN) between the groups were assessed by One Way ANOVA test.

Group 3 showed highest AN linear measurement value compared to the other groups.

The AN linear measurement is highest in Group 3 (2.50mm) followed by Group 1 (2.00mm) And Group 2 (1.30mm).

TABLE - 2

Multiple comparison of mean difference in Antegonial Notch Depth b/w groups using Tukey's Post hoc Analysis					
(I) Group	(J) Group	Mean Diff. (I-J)	95% CI for the Diff.		P-Value
			Lower	Upper	
Group 1	Group 2	0.70	-0.12	1.52	0.10
	Group 3	-0.50	-1.32	0.32	0.30
Group 2	Group 3	-1.20	-2.02	-0.38	0.003*

** - Statistically Significant*

Following ANOVA, Pair wise multiple comparison between the groups was done using Tukey's Post Hoc Test by determining HSD (Honest Significant Difference).

Group 1 does not show statistically significant difference in AN linear measurement with Group 2 and 3.

But Group 2 shows statistically significant difference with Group 3.

GRAPH - 1

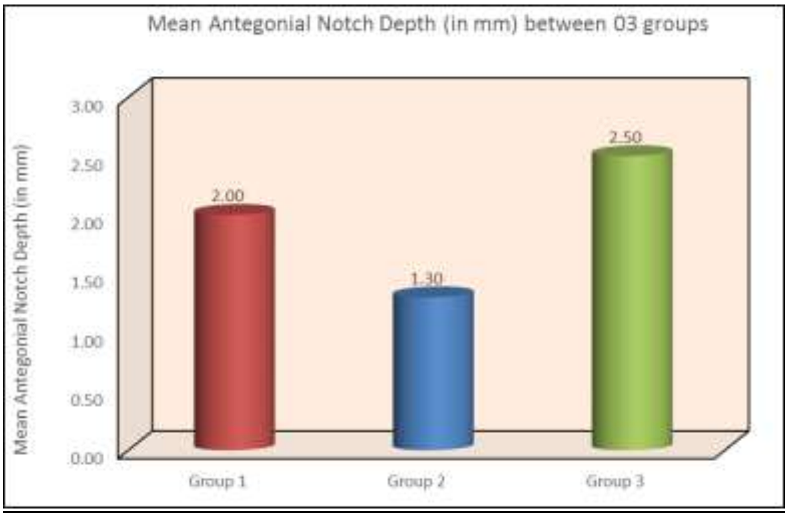


TABLE 3

Comparison of mean ISY Angle (in Degrees) between 03 groups using One-way ANOVA Test						
Groups	N	Mean	SD	Min	Max	P-Value
Group 1	10	87.80	4.57	80	92	0.001*
Group 2	10	89.90	6.71	78	98	
Group 3	10	80.20	4.76	74	90	

** - Statistically Significant*

The difference in Inclination of Symphysis (ISY) between the groups were assessed by One Way ANOVA test.

Group 2 showed highest ISY angle value compared to the other groups.

The ISY angle value is highest in Group 2 (89.90˚) followed by Group 1 (87.80˚) And Group 3 (80.20˚).

TABLE 4

Multiple comparison of mean difference in ISY Angle (in Degrees) b/w groups using Tukey's Post hoc Analysis					
(I) Group	(J) Group	Mean Diff. (I-J)	95% CI for the Diff.		P-Value
			Lower	Upper	
Group 1	Group 2	-2.10	-8.12	3.92	0.67
	Group 3	7.60	1.58	13.62	0.01*
Group 2	Group 3	9.70	3.68	15.72	0.001*

** - Statistically Significant*

Following ANOVA, Pair wise multiple comparison between the groups was done using Tukey's Post Hoc Test by determining HSD (Honest Significant Difference).

Group 1 shows statistically significant difference in ISY angle with Group 3 but not with Group 2.

Group 2 shows statistically significant difference in ISY angle with only Group 3.

GRAPH – 2

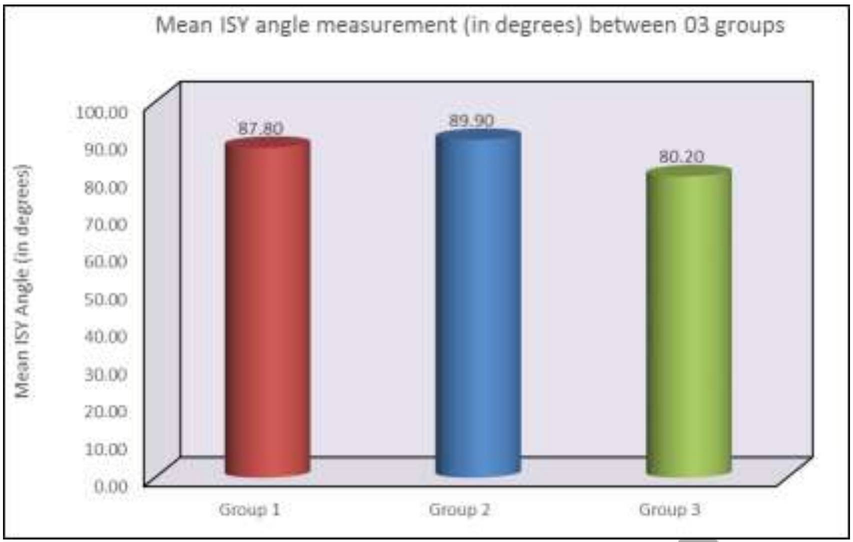


TABLE 5

Comparison of mean Curvature of Mandibular Canal (in degrees) between 03 groups using One-way ANOVA Test						
Groups	N	Mean	SD	Min	Max	P-Value
Group 1	10	140.40	6.67	132	152	<0.001*
Group 2	10	133.30	3.95	128	140	
Group 3	10	153.10	4.18	148	160	

- **Statistically Significant*

The difference in Curvature of Mandibular Canal (CMC) between the groups were assessed by One Way ANOVA test.

Group 3 showed highest CMC angle value compared to the other groups.

The CMC angle value is highest in Group 3 (153.10˚) followed by Group 1 (140.40˚) And Group 2 (133.30˚).

TABLE 6

Multiple comparison of mean difference in Curvature of Mandibular Canal b/w groups using Tukey's Post hoc Analysis					
(I) Group	(J) Group	Mean Diff. (I-J)	95% CI for the Diff.		P-Value
			Lower	Upper	
Group 1	Group 2	7.10	1.46	12.74	0.01*
	Group 3	-12.70	-18.34	-7.06	<0.001*
Group 2	Group 3	-19.80	-25.44	-14.16	<0.001*

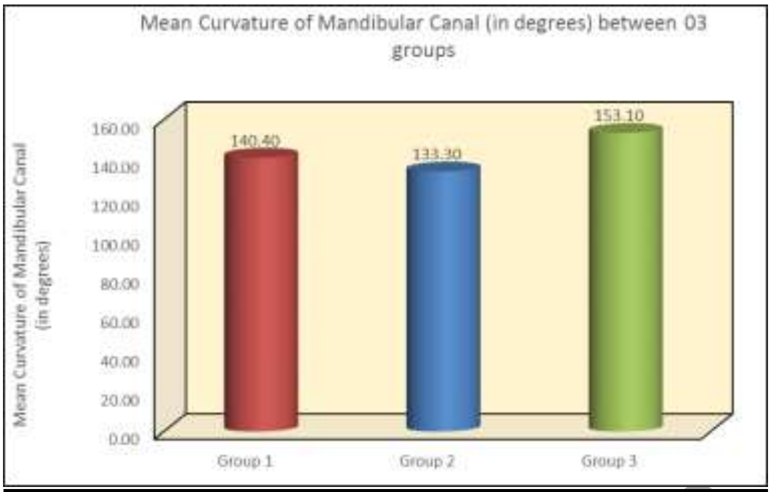
** - Statistically Significant*

Following ANOVA, Pair wise multiple comparison between the groups was done using Tukey's Post Hoc Test by determining HSD (Honest Significant Difference).

Group 1 shows statistically significant difference in CMC angle with Group 2 and Group 3.

Group 2 shows statistically significant difference in CMC angle with only Group 3.

GRAPH – 3



DISCUSSION

Using metal implants as references, in 1955, Bjork[11] described the phenomena of anterior and posterior mandibular growth rotation. In a later publication[12], he differentiated between three types of mandibular rotation and described total, matrix and intramatrix rotations. The total rotation is the rotation of mandibular corpus relative to anterior cranial base. The matrix rotation is the rotation of the soft tissue matrix of the mandibular plane relative to anterior cranial base.

Bjork[2] has classified rotation of mandible into forward and backward rotations. Forward rotation has three types and occur in the following ways. In Type I, there is a forward growth rotation about centers in the joints which gives rise to a deep-bite, resulting in underdevelopment of the anterior face height. In Type II, there is a forward growth rotation about centers located at the incisal edges of the lower anterior teeth is due to the combination of marked development of the posterior face height and normal increase in the anterior height. The posterior part of the mandible then rotates away from the maxilla. In Type III, the center of rotation no longer lies at the incisors but it is displaced backward in the dental arch, to the level of the premolars. In this type of rotation, the anterior face height becomes underdeveloped when the posterior face height increases. The dental arches are pressed into each other and basal deep-bite develops.

Backward rotation of the mandible is less frequent than forward rotation. Two types have been recognized. In Type I, the center of the backward rotation lies in the temporomandibular joints. In case of incomplete development in height of the middle cranial fossa, as in oxycephaly. This underdevelopment of the posterior face height leads to a backward rotation of the mandible, with overdevelopment of the anterior face height and possibly open-bite as a consequence. The mandible is, in principle, normal. In Type II, the center situated at the most distal occluding molars. This occurs in connection with growth in the sagittal direction at the mandibular condyles. As the mandible grows in the direction of its length, it is carried forward more than it is lowered in the face and because of its attachment to muscles and ligaments it is rotated backward.

All previous studies on the validity of Bjork's structural method were concerned with the prediction of mandibular growth rotation[2, 11]. This study also dealt with mandibular growth rotation but focuses especially on the outcome of that rotation on skeleton-facial morphology. Bjork based his growth prediction on untreated subjects, and in the present

Study, the subjects also were evaluated before orthodontic therapy.

The present study employed to compare and correlate Antegonial notch depth (AN), Symphysis morphology (ISY) and Curvature of mandibular canal (CMC) in different growth patterns in Angle's Class II Division 1 malocclusion.

Antegonial notch depth (AN) is highly characteristic sign in evaluating the shape of the lower border of the mandible. Below the angle of the mandible there is normally resorption, which may be very pronounced. In some cases, there is apposition on the lower border of the mandible. These appositional and resorptive processes result in an individual shaping of the lower border of the mandible which characterizes the type of growth.

In the present study, Antegonial notch depth (AN) was found to be statistically significant ($P< 0.004$). There was a statistically significant difference between G1, G2 and G3. This suggest that shallow antegonial notch depth is seen in horizontal growth pattern and deep antegonial notch depth seen in vertical growth pattern.

Highest Antegonial notch depth (AN) was seen in vertical grower, followed by average and horizontal growth pattern. This study is in accordance with Bjork studies[2].

The finding is in accordance with a study that reported the antegonial notch was found to be highest in hyperdivergent group with no sexual dichotomy[13]. Another study reported that the depth of the notch was strongly correlated with skeletal morphology[14]. In the same study, shallow notch depth cases presented more horizontal mandibular planes, more prominent chins and shorter anterior heights than deep notch cases. Another study concluded that the Clinical presence of a deep mandibular antegonial notch is indicative of a diminished mandibular growth potential and a vertically directed mandibular growth pattern[15]. It was found that the antegonial notch depth values were greater in the hyperdivergent group as compared with the normodivergent and hypodivergent groups and the results were statistically significant[16].

However, a study has reported that there is statistically negative relationship between mandibular antegonial notch depth and subsequent horizontal jaw growth. Thus antegonial notch depth fails to sufficiently indicate future facial growth to warrant its application as a growth predictor in a nonextreme population[17].

The size and shape of mandibular symphysis is an important factor in evaluation of orthodontic patients. With a larger symphysis, more protrusion of the incisors is esthetically acceptable and therefore a greater chance of a non-extraction approach to treatment. Whereas,Patients with greater symphysis height and a small chin would be candidates for an extraction treatment plan to compensate for arch length discrepancies[18].

In this study, Inclination of symphysis (ISY) was found to be statistically significant (P< 0.001). There was a statistically significance between G1, G2 and G3. The results were in accordance with the results of the study which reported that symphysis in hypodivergent growth pattern was found to be associated with short height, large depth, smaller ratio and a larger angle. In contrast, a symphysis with a larger height, smaller depth, larger ratio and a smaller angle found in hyperdivergent group and the results were statistically significant[13].

However, some other study concluded that the internal inclination of the symphysis was more obtuse in the hyperdivergent group, whereas patients in hypodivergent group had the smallest value[18].

Curvature of mandibular canal (CMC) may also be a clear sign. The mandibular canal is not remodeled to the same extent as the outer surface of the jaw and the trabeculae related to the canal are therefore relatively stationary. The curvature of the mandibular canal reflects the earlier shape of the mandible[2].

In the present study, Curvature of mandibular canal (CMC) was found to be statistically significant (P< 0.001). There was a statistically significant difference between G1, G2 and G3. Bjork explained the complex rotation processes in normal and abnormal mandibular development and revealed that the mandibular canal is a stable structure during growth[2].

Highest curvature of mandibular canal was seen in the vertical group followed by average and horizontal group. This study is in accordance with Bjork studies[2].

The results were in accordance with the results of another study which demonstrated a significant association between the various facial types and anatomical variations of the mandibular canal[19]. Another study reported that the morphology and course of the mandibular canal are interrelated with external mandibular morphology[20]. However, some other study concluded that the morphology of the mandibular canal was not associated with the facial type[21].

In the present study, AN, ISY and CMC were found to have statistically significant differences when the normodivergent , hypodivergent and hyperdivergent growth patterns. It was concluded from the present study that AN, ISY and CMC were the reliable parameters among extreme skeletal patterns in Angle’s Class II Division 1 malocclusion.

CONCLUSION

It is important to detect extreme types of mandibular rotation occurring during growth. Bjork’s seven structural signs of extreme growth rotation were considered in relation to condylar growth direction. Not all of them were found in a particular individual, but the greater the number that are present, the more reliable the prediction will be.

The lack of unanimity concerning Bjork’s structural method suggests that it may be used in a guarded fashion together with parallel evaluation of all the parameters involved.

The results of the present study evaluating Bjork’s indicators among extreme skeletal patterns in Angle’s Class II Division 1 malocclusion concluded that AN, ISY and CMC were the reliable parameters to categorize the various growth types in the vertical plane.

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