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Original Research Article

Mandibular growth direction prediction using symphysis morphology

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ABSTRACT

Objective: To determine whether the morphology of symphysis could be used as a predictor of the direction of mandibular growth in Indian population and to determine if any gender variability exists in the aforementioned study.

Materials and Methods: Randomly chosen and traced lateral cephalograms of 30 adult patients (18 years and older), 15 males and 15 females, reporting to the Department of Orthodontics and Dentofacial Orthopaedics, Inderprastha Dental College and Hospital, Sahibabad, Ghaziabad (U.P). Seven cephalometric parameters and four symphyseal parameters (Height of Symphysis, Depth of Symphysis, andSymphysis Ratio, Symphysis Angle) were measured.

The data was subjected to pearson's correlation test to find any correlation between symphysis morphology and cephalometric parameters in male, female and overall group.

Results: Increase in depth and height of symphysis is associated with horizontal growth pattern in overall sample. Increase in height and symphyseal ratio is associated with horizontal growth pattern in males. In females symphyseal parameters fail to predict the direction of mandibular growth.

1. Introduction

Growth and development are integral processes, which define the existence of life. Growth of an organism is the interplay between its genetic constitution and the environment in which it thrives. At the macroscopic or clinical level, growth is exemplified by an increase in height and weight, while at the microscopic level, it is accompanied by an increase in the number of cells and their size.[1,2]

The mandible develops from the mandibular process of the first branchial arch. Mandibular growth occurs as a result of the combined processes of proliferation and ossification of secondary cartilage at the condyle, as well as differential formation and remodeling of bone along the entire surface of the mandible.

It is important to predict the magnitude and direction of mandibular growth in any case of orthodontic treatment. Mandibular growth is very critical in the development of balanced dentofacial structures and hence, influence the therapeutic result of orthodontic treatment. With the knowledge of mandibular growth, better therapeutic decisions can be made regarding timing and duration of the treatment, extraction pattern and possible need for surgery.

Prediction of mandibular growth pattern has been done by various parameters like condylar morphology,[3] shape of lower border of mandible,[4] anterior facial height,[5] cervical vertebrae,[6] craniocervicalangle,[7] frontal sinus[8] with varying degree of success.

Some authors found a significant association between mandibular morphology and growth direction[3,5,9–11] whereas others have annulled any correlation between the two.[12]

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Among the mandibular structures the mandibular symphyseal morphology serves as a reference anatomical landmark for esthetics and beauty of the face in general and of the lower part in particular.[13,14] Functional environment can affect the shape and size of mandibular symphysis demonstrating an adaptive morphological response to the biomechanical loads experienced at various points in the masticatory cycle.[15,16][15,16] Studies conducted so far to find the correlation between symphysis morphology orantegonial notch and mandibular growth direction have got varied conclusions with some of studies concluding the relationship of symphysis morphology or antegonial notch with mandibular growth direction while some of the studies concluding that there is no relationship between the two. Most of these studies have been done on American and Caucasians population. Only few studies have been conducted on Asian population and hence the present study is undertaken to assess the reliability of symphyseal morphology as a predictor of direction of mandibular growth in Indian population.

2. Aims and Objectives

1. To determine if morphology of symphysis morphology could be used as a predictor of the direction of mandibular growth in Indian population.
2. To determine if any gender variability exists in above study.

3. Materials and Methods

Pretreatment lateral cephalograms of 30 adult patients (15 males and 15 females) aged 18 years and above reporting to the Department of Orthodontics and Dentofacial Orthopaedics at Inderprashta Dental College and Hospital, Ghaziabad requiring orthodontic treatment were randomly selected.

3.1. Materials: (Figure 1)

Lateral cephalograms, tracing sheet (Company- Gateway; Thickness- 90 Micron), 0.3mm lead pencil, metallic scale and set squares.

3.2. Inclusion criteria

1. Good general and dental health.
2. Age- 18 years and above.
3. Complete dental occlusion (except third molars).

3.3. Exclusion criteria

Patient with history of

1. Temporomandibular Joint Disorder
2. Orthognathic Surgery.
3. Craniofacial anomaly or Facial Asymmetry.

Figure 1: Armamentarium

4. History of trauma to mandible.
5. Previous Orthodontic Treatment.

3.4. Methods

Lateral cephalograms were taken in natural head position so that all landmarks were readily identifiable on lateral cephalogram. Lateral cephalograms were traced manually using acetate tracing paper and 0.3 mm lead pencil

1. **SN to Y-axis angle–** It is the angle between SN plane and Y-axis
   (a) **SN Plane**- It is the cranial line between the centre of sellaturcica (Sella) and the most anterior point of the fronto-nasal suture (Nasion).
   (b) **Y-axis**- It is measured as the acute angle formed by the intersection of a line from the sellaturcica to Gnathion with the Frankfort horizontal plane.
2. **SN- Mandibular Plane Angle-** It is the angle between SN plane and mandibular plane.
   (a) **Mandibular Plane**- Plane formed by a line joining Gonion and Menton.
3. **Palatal Plane- Mandibular Plane -** It is the angle between Palatal Plane and Mandibular Plane.
   (a) **Palatal Plane**- It is a plane formed by joining Anterior Nasal Spine (ANS) to Posterior Nasal Spine (PNS).
4. **Gonial Angle (Ar-Go-Me)-** It is the angle formed by joining Articulare to Gonion and to Menton.
   (a) **Articulare**- The point of intersection of the dorsal contours of the articular process of the mandible and the temporal bone.
   (b) **Gonion**- The mostposteroinferior point on the angle of the mandible.
   (c) **Menton**- The most inferior point on the chin.
5. **Bjork Sum-** It is the sum of Saddle angle (N-S-Ar),Articulare angle (S-Ar-Go) and Gonial angle (Ar-Go-Me)

(a) **Saddle angle (N-S-Ar)-** It is the angle between the anterior and posterior cranial base.
(b) **Articulare angle (S-Ar-Go)-**It is the constructed angle between Sella, Articulare and Gonion.

6. **Percentage of LFH/TFH**-It is the percentage of Lower Facial Height to Total Facial Height.

(a) **LFH (Lower Facial Height)** - It is a linear measurement from the Anterior Nasal Spine to Menton (ANS-Me).
(b) **TFH (Total Facial Height) -** It is a linear measurement from Nasion to Menton (N-Me).

7. **Posterior Facial Height (PFH)/Anterior Facial Height (AFH)-** It is the percentage of PFH to AFH.

(a) **PFH (Posterior Facial Height)-** It is a linear measurement from Sella to Gonion (S-Go).
(b) **AFH (Anterior Facial Height)-** It is defined as the linear measurement from Nasion to Menton (N-Me).

3.5. Cephalometric evaluation of symphysis

1. **Calculation of Symphysis Dimensions**- A line tangent to point B was taken as the long axis of the symphysis. A grid was placed with lines of grid parallel and perpendicular to constructed tangent line. Superior limit of symphysis was taken at point B with inferior, anterior and posterior limits taken at most inferior, anterior and posterior borders of symphyseal outline respectively. (Figure 2).

(a) **Symphysis Height-** Distance from superior to inferior limit on grid.
(b) **Symphysis Depth-** Distance from anterior to posterior limit on grid.
(c) **Symphysis Ratio-** Divide symphysis height by symphysis depth.
(d) **Symphysis Angle-**Postero superior angle formed by line through menton and point B and mandibular plane.

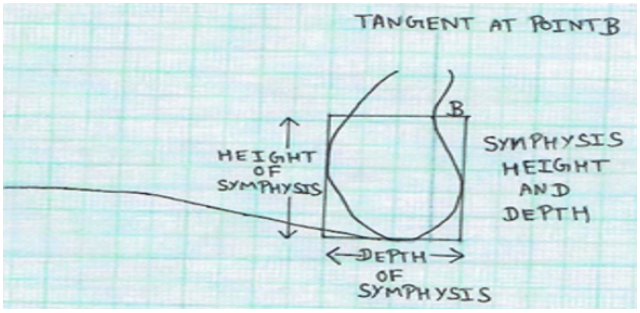

Figure 2: Measurement of symphyseal parameters

4. Results

Lateral Cephalograms of 30 adult patients (15 males and 15 females) reporting to the Department of Orthodontics and Dentofacial Orthopaedics, Inderprastha Dental College and Hospital, Sahibabad, Ghaziabad (U.P) aged 18 years and above were randomly selected and traced. Four symphyseal parameters (Height of Symphysis, Depth of Symphysis, and Symphysis Ratio, Symphysis Angle) and seven cephalometric parameters (S.N to Y-axis angle, SN-Mandibular Plane Angle, Palatal Plane- Mandibular Plane Angle, Gonial Angle, Bjork Sum, Percentage of Lower Facial Height to Total Facial Height, Posterior Facial Height to Anterior Facial Height) were measured.

The data was subjected to Pearson's Correlation test to find any correlation between symphysis morphology and cephalometric parameters.

Tables 1, 2 and 3 shows the correlation between symphysis height and cephalometric parameters. In the overall sample (Table 1), there was a significant negative relationship between symphysis height and Bjork sum with p-value 0.016. There was no significant relationship between symphysis height and other cephalometric parameters. In the male group (Table 2) posterior facial height / anterior facial height ratio and symphysis height parameter showed a significant positive relationship with p-value 0.040 while all other values showed no significant relationship. In female group (Table 3), there was no significant relationship between height of symphysis and cephalometric parameters.

Tables 4, 5 and 6 shows correlation between symphysis depth and cephalometric parameters. In the over-all sample (Table 4), it was found that there is significant positive relationship between depth of symphysis and posterior facial height/ anterior facial height ratio with p-value 0.033. In the male and female groups (Tables 5 and 6), there was no significant correlation between depth of symphysis and cephalometric parameters.

Tables 7, 8 and 9 shows correlation between symphysis ratio and cephalometric parameters. In the overall group (Table 7), there was not a significant relationship between symphysis ratio and cephalometric parameters. In the male group (Table 8), it was found that there was a significant positive relationship between symphysis ratio and posterior facial height to anterior facial height with p-value 0.022 while all other values showed no significant relationship. In the female group (Table 9), there was not a significant relationship between symphysis ratio and cephalometric parameters.

5. Discussion

The present study was undertaken to find the correlation if any between symphyseal morphological parameters or antegonial notch depth and mandibular growth direction.

Table 1: Correlation of height of symphysis with cephalometric parametersin overall group

Over-all Group		**Height of Symphysis (mm)**
S.N to Yaxis	Pearson Correlation	-0.278
Angle	P-value	0.138
(Degree)	N	30
SN-Mandibular Plane	Pearson Correlation	-0.291
Angle	P-value	0.119
(Degree)	N	30
Palatal Plane-Mandibular	Pearson Correlation	-0.161
Plane Angle	P-value	0.397
(Degree)	N	30
Gonial	Pearson Correlation	-0.338
Angle	P-value	0.068
(Degree)	N	30
Bjork	Pearson Correlation	-0.437
Sum	P-value	0.016*
(Degree)	N	30
Percentage of Lower	Pearson Correlation	0.057
Facial Height to Total	P-value	0.766
Facial Height (%)	N	30
Posterior Facial	Pearson Correlation	0.312
Height to Anterior	P-value	0.094
Facial Height (%)	N	30

*. Correlation is significant at the 0.05 level (2-tailed).

Table 2: Correlation of height of symphysis with cephalometric parameters in male group

Male Group		
		Height of Symphysis (mm)
S.N to Yaxis	Pearson Correlation	-0.429
Angle	P-value	0.110
(Degree)	N	15
SN-Mandibular	Pearson Correlation	-0.464
Plane Angle	P-value	0.082
(Degree)	N	15
Palatal Plane-Mandibular Plane	Pearson Correlation	-0.291
Angle	P-value	0.292
(Degree)	N	15
Gonial	Pearson Correlation	-0.068
Angle	P-value	0.811
(Degree)	N	15
Bjork	Pearson Correlation	-0.411
Sum	P-value	0.128
(Degree)	N	15
Percentage of Lower	Pearson Correlation	0.179
Facial Height to Total	P-value	0.524
Facial Height (%)	N	15
Posterior Facial	Pearson Correlation	0.534
Height to Anterior	P-value	0.040*
Facial Height (%)	N	15

*. Correlation is significant at the 0.05 level (2-tailed).

Table 3: Correlation of height of symphysis with cephalometricparameters in female group

Female group		
		Height of Symphysis (mm)
S.N toYaxis	Pearson Correlation	-0.073
Angle	P-value	0.797
(Degree)	N	15
SN-Mandibular	Pearson Correlation	0.076
Plane Angle	P-value	0.787
(Degree)	N	15
Palatal Plane-Mandibular	Pearson Correlation	0.197
Plane Angle	P-value	0.482
(Degree)	N	15
Gonial	Pearson Correlation	-0.386
Angle	P-value	0.156
(Degree)	N	15
Bjork	Pearson Correlation	-0.386
Sum	P-value	0.156
(Degree)	N	15
Percentage of Lower	Pearson Correlation	0.141
Facial Height to Total	P-value	0.617
Facial Height (%)	N	15
Posterior Facial	Pearson Correlation	-0.023
Height to Anterior Facial	P-value	0.934
Height (%)	N	15

Table 4: Correlation of depth of symphysis with cephalometric parameters in overall group

Over-all Group		**Depth of Symphysis (mm)**
S.N to Yaxis	Pearson Correlation	-0.358
Angle	P-value	0.052
(Degree)	N	30
SN-Mandibular Plane	Pearson Correlation	-0.337
Angle	P-value	0.069
(Degree)	N	30
Palatal Plane-Mandibular	Pearson Correlation	-0.280
Plane Angle	P-value	0.134
(Degree)	N	30
Gonial	Pearson Correlation	-0.357
Angle	P-value	0.053
(Degree)	N	30
Bjork	Pearson Correlation	-0.345
Sum	P-value	0.062
(Degree)	N	30
Percentage of Lower	Pearson Correlation	-0.206
Facial Height to Total	P-value	0.276
Facial Height (%)	N	30
Posterior Facial Height to	Pearson Correlation	0.390
Anterior Facial	P-value	0.033*
Height (%)	N	30

*. Correlation is significant at the 0.05 level (2-tailed).

Table 5: Correlation of depth of symphysis with cephalometric parameters in male group

Male		
		Depth of Symphysis (mm)
S.N toYaxis	Pearson Correlation	-0.419
Angle	P-value	0.120
(Degree)	N	15
SN-Mandibular	Pearson Correlation	-0.141
Plane Angle	P-value	0.617
(Degree)	N	15
Palatal Plane-Mandibular	Pearson Correlation	-0.104
Plane Angle	P-value	0.712
(Degree)	N	15
Gonial	Pearson Correlation	0.077
Angle	P-value	0.785
(Degree)	N	15
Bjork	Pearson Correlation	0.013
Sum	P-value	0.965
(Degree)	N	15
Percentage of Lower	Pearson Correlation	0.162
Facial Height to Total	P-value	0.564
Facial Height (%)	N	15
Posterior Facial	Pearson Correlation	0.066
Height to Anterior	P-value	0.817
Facial Height (%)	N	15

Table 6: Correlation of depth of symphysis with cephalometric parameters in female group

Female		**Depth of Symphysis (mm)**
S.N toYaxis	Pearson Correlation	-0.440
Angle	P-value	0.101
(Degree)	N	15
SN-Mandibular	Pearson Correlation	-0.360
Plane Angle	P-value	0.187
(Degree)	N	15
Palatal Plane-Mandibular	Pearson Correlation	-0.381
Plane Angle	P-value	0.161
(Degree)	N	15
Gonial	Pearson Correlation	-0.396
Angle	P-value	0.144
(Degree)	N	15
	Pearson Correlation	-0.460
Bjork Sum (Degree)	P-value	0.084
	N	15
Percentage of Lower	Pearson Correlation	-0.307
Facial Height to Total	P-value	0.266
Facial Height (%)	N	15
Posterior Facial	Pearson Correlation	0.469
Height to Anterior	P-value	0.078
Facial Height (%)	N	15

Table 7: Correlation of symphysis ratio with cephalometric parameters in overall group.

Over-all sample		**Symphysis ratio**
S.N to	Pearson Correlation	0.088
Yaxis Angle	P-value	0.643
(Degree)	N	30
SN-Mandibular	Pearson Correlation	0.033
Plane Angle	P-value	0.861
(Degree)	N	30
Palatal Plane-Mandibular	Pearson Correlation	0.102
Plane Angle	P-value	0.591
(Degree)	N	30
Gonial	Pearson Correlation	0.072
Angle	P-value	0.704
(Degree)	N	30
Bjork	Pearson Correlation	-0.058
Sum	P-value	0.759
(Degree)	N	30
Percentage of Lower	Pearson Correlation	0.228
Facial Height to	P-value	0.225
Total Facial Height (%)	N	30
Posterior Facial	Pearson Correlation	-0.059
Height to Anterior	P-value	0.758
Facial Height (%)	N	30

Table 8: Correlation of symphysis ratio with cephalometric parameters in male group

Male		**Symphysis ratio**
S.N to	Pearson Correlation	-0.246
Yaxis Angle	P-value	0.376
(Degree)	N	15
SN-Mandibular	Pearson Correlation	-0.461
Plane Angle	P-value	0.084
(Degree)	N	15
Palatal Plane-Mandibular	Pearson Correlation	-0.275
Plane	P-value	0.320
Angle(Degree)	N	15
Gonial	Pearson Correlation	-0.125
Angle	P-value	0.656
(Degree)	N	15
Bjork	Pearson Correlation	-0.483
Sum	P-value	0.068
(Degree)	N	15
Percentage of Lower	Pearson Correlation	0.103
Facial Height to	P-value	0.715
Total Facial Height (%)	N	15
Posterior Facial	Pearson Correlation	0.585
Height to Anterior	P-value	0.022*
Facial Height (%)	N	15

*. Correlation is significant at the 0.05 level (2-tailed).

Table 9: Correlation of symphysis ratio with cephalometric parameters in female group

Female		**Symphysis ratio**
S.N to	Pearson Correlation	0.383
Yaxis Angle	P-value	0.159
(Degree)	N	15
SN-Mandibular	Pearson Correlation	0.323
Plane Angle	P-value	0.241
(Degree)	N	15
Palatal	Pearson Correlation	0.434
Plane-Mandibular	P-value	0.106
Plane Angle(Degree)	N	15
Gonial	Pearson Correlation	0.154
Angle	P-value	0.585
(Degree)	N	15
Bjork	Pearson Correlation	0.178
Sum	P-value	0.526
(Degree)	N	15
Percentage of Lower	Pearson Correlation	0.340
Facial Height to	P-value	0.215
Total Facial Height (%)	N	15
Posterior Facial	Pearson Correlation	-0.395
Height to Anterior	P-value	0.145
Facial Height (%)	N	15
	N	15
Gonial	Pearson Correlation	0.097
Angle	P-value	0.730
(Degree)	N	15
Bjork	Pearson Correlation	0.025
Sum	P-value	0.928
(Degree)	N	15
Percentage of Lower	Pearson Correlation	-0.332
Facial Height to	P-value	0.227
Total Facial Height (%)	N	15
Posterior Facial	Pearson Correlation	0.168
Height to Anterior	P-value	0.550
Facial Height (%)	N	15

Symphyseal parameters (height, depth, ratio and angle), antegonial notch depth and seven cephalometric parameters (S.N to Y-axis angle, SN-Mandibular plane angle, Palatal plane- Mandibular plane angle, Gonial angle, Bjork sum, Percentage of lower facial height to total facial height, Percentage of posterior facial height to anterior facial height) predicting growth directions were measured for 30 patients (15 Males, 15 Females).

Pearson correlation test was done to find any correlation between symphysis morphology and cephalometric parameters among overall group and separately for male and female group.

Pearson correlation test indicated that in overall group, there was a significant negative relationship between symphysis height and Bjork sum. This further indicates that the decrease in symphyseal height is associated with vertical growth pattern. Also it was found that in overall group, there is a positive correlation between depth of symphysis and posterior facial height / anterior facial height ratio. This indicates that increase in depth of symphysis is associated with horizontal growth pattern.

In male group, Pearson correlation test indicated that there is significant positive correlation between symphysis height and posterior facial height / anterior facial height ratio. It denotes that increase in symphyseal height is associated with increase in Posterior Facial Height/ Anterior Facial Height ratio i.e. horizontal growth pattern.

Symphysis ratio and Posterior Facial Height/Anterior Facial Height was found to be having significant positive correlation in male sample which further indicates that increase in symphyseal ratio is associated with increase in Posterior Facial Height/ Anterior Facial Height i.e. horizontal growth pattern.

Thus, the present study results indicate that increase in height and depth of symphysis are associated with horizontal growth pattern in overall sample. In males increase in height and symphysis ratio is associated with horizontal growth pattern.

The results of this study are similar to the study done by Aki et al (1994)[5] in context to depth of symphysis where increase in depth was associated with horizontal growth pattern.

6. Conclusion

The conclusion of the present study-

1. Increase in depth and height of symphysis is associated with horizontal growth pattern in overall sample.
2. Increase in height and smphyseal ratio is associated with horizontal growth pattern in males.
3. In females symphyseal parameters fail to predict the direction of mandibular growth.

7. Source of Funding

None.

8. Conflicts of Interest

None.

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