Correlation of symphysis morphology with different vertical growth patterns

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Abstract

Introduction: Facial growth relative to the cranial base line proceeds along a vector composed of variable amount of horizontal forward growth and vertical downward growth. Growth of the mandible plays an important role in facial growth and development.

Objective: The purpose of this study was to determine whether there was any relationship between symphysis shape and vertical skeletal growth patterns, categorized into normodivergent, hypodivergent and hyperdivergent groups using various parameters.

Materials and Methods: Pretreatment lateral cephalometric radiographs of 330 individuals ranging in age from 18 to 30 years.

The symphysis height, symphysis depth, ratio (height of symphysis/depth of symphysis) and angulation of symphysis were analyzed statistically.

Results: It was found that the mandible with the hyperdivergent growth pattern was associated with an increased symphysis height, reduced symphysis depth and small symphysis angle and vice versa in the hypodivergent group.

Conclusions: The results for the symphysis height, symphysis depth and symphysis angle were statistically significant whereas the ratio of symphysis height to symphysis depth did not show statistically significant results.

Keywords

Symphysis morphology, Normodivergent, Hyperdivergent, Hypodivergent

Introduction

A vector of varying amounts of horizontal forward growth and vertical downward growth characterizes the direction that facial growth in relation to the cranial base line takes.(1) Mandibular growth is crucial for the development of the face.(2, 3) The terms hypodivergent and hyperdivergent used by Schudy to describe the vertical development patterns of the face. Short faces have a hypodivergent pattern, while long faces have a hyperdivergent pattern.(4, 5).

The lateral halves of the mandible`s body fuse at the mandibular symphysis, which fractures inferiorly to create the mental protruberance. The mandibular symphysis is considered a principle indicator for facial profile esthetics and it determines the proper position of lower incisors.(6, 7) In addition, for mandibular

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superimposition and for prediction and assessment of mandibular growth, inferior border of symphysis is used as stable landmark.(8-10) Thus, the structure of mandibular symphysis affects orthodontic diagnosis and treatment planning.

There has been no growth seen in the area of the anterior portion of the chin, except in a few rare cases of pathologic development. As a result, the symphysis typically thickens through apposition on its posterior surface. Resorption typically occurs below the mandibular angle and can be quite prominent. On the lower border at the angle of the jaw there may occasionally be apposition in some cases. The lower border of the mandible is individually shaped as a result of these appositional and resorptive processes, indicating the kind of growth.(8)

Mandibular symphysis accumulates material on all of its surfaces as it grows backward and upwards except area of pogonion where resorption takes place.(8, 10) The vertical growth of mandibular symphysis was found to be at its peak during puberty.(9) There is remarkable individual differences in the structure of mandibular symphysis may result from various etiological factors such as heredity, ethnicity, facial type and inclination of mandibular incisor.(7, 10-12) In past many studies have been done to find out the correlation of mandibular symphysis proportions, thickness of bone and structures with different sagittal and vertical growth patterns.(13)

According to Ricketts, the symphysis morphology can be utilized to predict the mandibular growth direction. In his research he connected an anterior growth direction with an thick symphysis.(14) It might be assumed that pogonion can move substantially forward due to forward rotating patterns of growth, resulting in a pronounced chin point. A less pronounced chin is the result of backward rotating mandibles moving the pogonion backward and downward.(15) according to Haskel, there is less projecting chin when the mandible has vertically developed.(16, 17)The purpose of this study was to determine whether there was any relationship between symphysis shape and vertical skeletal growth patterns.

Materials and Methods

This cross-sectional study was conducted in the Department of Orthodontics at the Sardar Begum Dental College Peshawar. The study included 330 individuals ranging in age from 18 to 30 years. Consecutive sampling technique was used to collect data of the study. The duration of the study was 18 months (from 10 June 2020 till 20 December 2021). Pretreatment cephalometric radiographs of all subjects were traced and analysed for various angular and linear measurements. Subjects were divided into following three groups according to vertical skeletal growth patterns, as assessed by lateral cephalometric radiograph, according to Steiner analysis. The groups were (1) Normodivergent, (2) Hyperdivergent and (3) Hypodivergent. Each group consists of 110 patients. The following inclusion criteria were checked for orthodontic patient`s pre-treatment records.

1. **All male and female patients age ranged between 18 to 30 years.**

2. **Clear and high quality cephalometric radiographs**
3. **A strong bone structure and periodontium**
4. **No previous orthodontic treatment.**

The exclusion criteria for the study were:

1. **Patients with bone diseases like paget`s disease, osteoporosis, osteogenesis imperfecta**
2. **Patients with active periodontal diseases**
3. **Patients with craniofacial deformities or cleft lip or palate patients**
4. **Patients with facial jaw surgeries done previously.**

Cephalometric linear and Angular measurements utilized in this research are shown in Table 1

Table 1: Cephalometric Angular and Linear Measurements:

SN-MP-	Angle between the sella-nasion and mandibular planes.
PP-MP	Angle between the mandibular and palatal planes.
Y-axis	A line drawn from sella to gnathion and angle measured on Frankfort horizontal plane.
Gonial angle	Angle created by the gonion, the menton, and the articulare.
Saddle angle	Angle formed between nasion, sella and articulare.
Articulare angle	Angle formed between sella, articulare and gonion.
Anterior facial height	Nasion and Menton are separated by a straight line.
Posterior facial height	Sella and gonion are separated by a straight line.
Jarabak's ratio	The proportion of posterior to anterior face height. Anterior facial height divided by the lower anterior facial height ratio.

Calculation method for symphysis dimension:

Symphysis height and depth were calculated as indicated in Fig 1. (A). As the long axis of the symphysis, a line tangent to point B that is perpendicular to the mandibular plane was chosen, and a grid was created with the grid's lines parallel and perpendicular to the produced tangent line. The inferior, anterior, and posterior limits of the symphysis were measured at the most inferior, anterior, and posterior borders of the symphysis outline, respectively. The superior limit of the symphysis was measured at point B. The distance between the superior and inferior grid limits was used to define the symphysis height. The distance on the grid between the anterior and posterior limits was used to establish the symphysis depth. By dividing symphysis height by symphysis depth, the symphysis ratio was found. The angle between the mandibular plane and the line passing between point B and the menton served as a proxy for the symphysis angle. Fig.1(B).The data obtained was recorded on a data collection form designed for this study as shown in annexure 1.

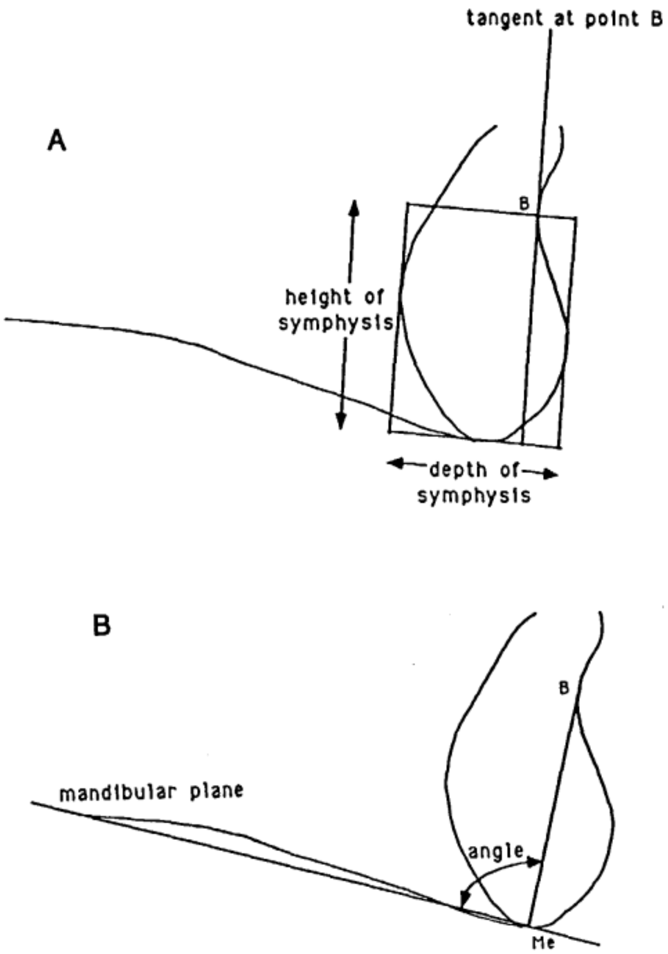

Fig 1. Measurements used to assess symphysis morphology. A, Linear measurement. B, Angular measurements

Statistical analysis:

With IBM SPSS Statistics 23, data was examined. The correlation between the variables was calculated using Pearson correlation. Using a significance level of $p \le 0.05$, and a confidence interval of 95% (CI:95%), the study's power was set at 80%.

Results

The sample was divided into three groups on the basis of their vertical growth pattern the hypodivergent, hyperdivergent and normodivergent. Each group consists of 110 patients. Each group's symphysis measurements were compared to the seven cephalometric measurements that collectively indicate the vertical growth pattern.

The mean values of cephalometric measurements in three groups which were divided according to vertical skeletal pattern as assessed by lateral cephalometric radiograph are shown in table 2. Groups were Normodivergent, Hyperdivergent and Hypodivergent.

Table 2: Average values of cephalometric measurements

Measurements	**Normodivergent** Means ±SD	**Hyperdivergent** Means ± SD	**Hypodivergent** Means ± SD
SN-MP	34.10± 3.52	40.63 ± 3.20	23.75 ± 3.20
PP-MP	29.44 ± 1.87	37.67 ± 1.96	23.12 ± 2.58
Y-axis	62.08 ±3.45	67.39 ± 4.93	56.37 ± 3.89
Gonial angle	124.30 ± 5.22	132.60 ± 4.93	118.26± 4.61
Sum of SAG	395.23 ± 6.44	402.09 ± 3.81	379.00 ± 5.90
LAFH/TAFH	57.45 ± 2.34	58.04 ± 2.62	55.14 ± 2.77
PFH/TAFH	64.22 ± 3.37	60.06 ± 2.83	70.88 ± 3.52

The mean values of symphysis height, depth, ratio and symphysis angle in three groups which were divided on the basis of vertical skeletal growth pattern are shown in table 3. Groups were Normodivergent, Hyperdivergent and Hypodivergent.

Table 3: Average values of symphysis morphology

Measurements	Normodivergent Means + SD	Hyperdivergent Means + SD	Hypodivergent Means + SD
Symphysis Height	20.34+ 2.03	19.93 + 2.18	19.59 + 2.35
Symphysis Depth	13.62 + 1.39	13.76 + 1.73	14.00 + 1.06
Symphysis Ratio	1.58 + 1.29	1.44 + 1.91	1.36 + 1.86
Symphysis Angle	80.17 + 6.55	78.90 + 6.24	84.27 + 5.07

In comparison of cephalometric measurements with symphysis height, only lower anterior face height result was statistically significant and show positive correlation with symphysis height, as shown in table 4.

Table 4: Comparison of cephalometric measurements, with symphysis height in different vertical growth pattern.

Measurements	Height of Symphysis	
	r value	**p value**
SN-MP	-0.02	0.6
PP-MP	0.04	0.4
Y-axis	-0.03	0.5
Gonial angle	0.007	0.9
Sum of saddle, articulare, Gonial ngle	-0.04	0.8
LAFH/TAFH	0.71	0.01**
PFH/TAFH	0.09	0.1

Level of significance $p \leq 0.05$.

Test of significance is Pearson correlation coefficient.

In comparison of cephalometric measurements with symphysis depth, symphysis depth showed negative correlation with SN-MP angle, gonial angle and sum of saddle, articulare, gonial angle, and only ratio of PFH/TAFH show positive correlation with symphysis depth and which were found to be highly significant, are shown in table 5.

Table 5: Comparison of cephalometric measurements, with symphysis depth in different vertical growth pattern.

Measurements	Depth of symphysis	
	r value	p value
SN-MP	-0.79	0.01**
PP-MP	-0.08	0.1
Y-axis	0.08	0.1
Gonial angle	-0.87	0.01**
Sum of saddle, articulare, Gonial angle	-0.63	0.01**
LAFH/TAFH	-0.24	0.6
PFH/TAFH	0.73	0.01**

Level of significance $p \leq 0.05$.

Test of significance is Pearson correlation coefficient.

In comparison of cephalometric measurements with symphysis ratio for all three groups. All of the cephalometric measurements did not show correlation with symphyseal ratio, as shown in table 6.

Table 6: Comparison of cephalometric measurements, with height/depth ratio of the symphysis in different vertical growth patterns.

Measurements	Height / depth ratio	
	r value	p value
SN-MP	0.60	0.2
PP-MP	0.25	0.6
Y-axis	0.79	0.1
Gonial angle	0.82	0.1
Sum of saddle, articulare, gonial angle	0.60	0.6
LAFH/TAFH	-0.22	0.6
PFH/TAFH	-0.65	0.2

Level of significance $p \leq 0.05$.

Test of significance is Pearson correlation coefficient

In comparison of cephalometric measurements with symphysis angle. All angular measurements SN-MP, PP-MP, Y-axis, Gonial angle, sum of saddle, articulare, gonial angle and ratio of LAFH/TAFH show negative correlation with symphysis angle and ratio of PFH/TAFH show positive correlation with symphysis angle. All of the results were statistically significant, as shown in table 7.

Table 7. Comparison of cephalometric measurements, with angle of the symphysis in different vertical growth patterns.

Measurements	**Angle between point B-Me and MP**	
	r value	**p value**
SN-MP	-0.97	0.01**
PP-MP	-0.76	0.01**
Y-axis	-0.46	0.01**
Gonial angle	-0.58	0.01**
Sum of saddle, articulare, gonial angle	-0.69	0.01**
LAFH/TAFH	-0.73	0.01**
PFH/TAFH	0.49	0.01**

Level of significance $p \leq 0.05$.

Test of significance is Pearson correlation coefficient

Discussion:

Evaluating orthodontic patients, the mandibular symphysis size and shape is crucial to take into account. More incisor projection is aesthetically acceptable with a larger symphysis resulting in a higher likelihood of non-extraction methods of therapy. On the other hand, individuals with a small chin and a greater symphysis height would be candidates for an extraction treatment plan to make up for differences in arch length. The size and shape of the symphysis are used by many doctors to categorize the growth pattern of the mandible as anterior or posterior. Contrary to a posterior growth pattern, which is linked to a retrusive mandible, an anterior development pattern is more positively connected with an orthognathic facial growth.

This study was carried out to find any possible correlation between symphysis morphology and different vertical growth patterns. We found out a positive correlation between ratio of LAFH/TAFH and symphysis height, means that hyperdivergent patients have increased symphysis height. Todd Aki[19] et al. conducted a study where they compared the symphysis morphology with vertical skeletal pattern of the patients; they found positive correlation of symphysis morphology with hyperdivergent pattern. The results of their study were in accordance to our study. Opdebeeck,[20] Fields,[19] Herbert[21] and Harris[22] studies also showed that hyperdivergent patients have increased lower anterior facial height.

In the present study a negative correlation was found between SN-MP, Gonial angle and sum of Saddle, Gonial Articulare angle with symphysis depth, as these angles increases, the symphysis depth decreases. It means that hypodivergent patients have increased symphysis depth. A study done by Todd Aki[19] et al. also showed that increased symphysis depth was found in hypodivergent patients which were in agreement to our study.

The symphysis ratio did not show any correlation with cephalometric measurements in this study. The results coincides with the findings of the study carried out by H.Y.A. Marghalani[23] who concluded that there was no correlation between cephalometric measurements and symphysis ratio among different vertical growth patterns. In comparison to the current study, the study done by G.Frans Currier[19], indicating that the mean symphysis depth was lower in female subjects than in male subjects, the symphysis ratio was higher in the female group. In study of Moshfeghi et al.[24] they discovered that a mandible with a vertical growth pattern had a small symphyseal ratio (height/depth), whereas a mandible with a horizontal growth pattern had a big symphyseal ratio. Also, they discovered that women had a higher ratio than men. Their study results were not in accordance to our study results as they categorized their sample into males and females.

The symphysis angle showed negative correlation with hyperdivergent pattern except the ratio of PFH/TAFH, which show positive correlation and vice versa. Our results were coincident with Shilpa Gupta[25]et al who reported that symphysis angle was greater in hypodivergent patients. Contradictory to above mentioned findings, Linjawi [26] in his study mentioned that no correlation between cephalometric measurements and symphysis angle among three facial types. Due to sample size differences and categorization of sample into males and females their study results were not in agreement to our study.

Conclusion:

From our study we concluded that:

- **The symphysis height increased in hyperdivergent patients while decreased in hypodivergent patients.**
- **Hyperdivergent patients have decreased symphysis depth as compared to hypodivergent patients.**
- **The symphysis angle decreased in hyperdivergent patients and vice versa.**

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