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ORIGINAL ARTICLE

CORRELATION OF ACTUAL AND EFFECTIVE SYMPHYSIS WITH OTHER CRANIOFACIAL PARAMETERS TO DETECT THE DIRECTION OF MANDIBULAR ROTATION IN HIMACHALI POPULATION

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ABSTRACT

Aim: The purpose of this study was to evaluate the correlation of the actual and effective symphysis with other craniofacial parameters to detect the direction of mandibular growth. **Material and Methods:** The sample for the study consisted of 120 patients (60 males and 60 females) with age of the subjects ranging from 18 to 30 years, having Class I skeletal and dental relations and full permanent dentition regardless the third molars. Two symphyseal measurements with eleven measurements for mandibular rotation were assessed using AutoCAD computer program. **Statistical analysis:** Descriptive statistics, Independent samples t-test and Pearson's Correlation Coefficient were used to evaluate the correlation of the actual and effective symphysis with other craniofacial parameters, gender difference and the ethnic difference. **Results:** For both the genders and the total sample, the actual symphysis did not show any significant correlation with the facial heights and the mandibular rotation angles, whereas on the other hand, the effective symphysis showed significant positive correlations with Jarabak ratio and saddle angle, and significant negative correlations with SN-MP, PP-MP, FMA, and Sum of of posterior angles. **Conclusion:** Effective symphysis is a good predictor of the direction of mandibular rotation whereas the actual symphysis is a bad predictor. Also, actual symphysis exhibited ethnic differences when compared to the Iraqi population.

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INTRODUCTION

To an orthodontist, it is highly essential to have the knowledge of mandibular growth for the diagnosis and treatment planning, which in turn is critical in the development of balanced dentofacial structures (Aki, 1994). One of the most important regions of the craniofacial complex is the mandibular symphysis. For esthetic considerations in the lower third of the face, symphysis serves as a primary reference (Buschang, 1992) and is orthodontically said to be as an area covering the mandibular symphyseal region on the lateral cephalogram. Mandibular growth is associated with morphological changes in the mandibular symphysis (Endo *et al.*, 2007), which also is affected by different types of malocclusion (Sassouuni, 1969) and orthodontic treatments (Rosenstein, 1964). Apart from this, symphyseal growth and morphology also associates with the mandibular plane angle (Eroz *et al.*, 2000), masseter muscle thickness (Kubota, 1998), overbite (Haskell, 1979; Ceylan, 2001; Beckmann *et al.*, 1998), inheritance (Garn, 1963), and more (Chung, 2008).

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In order to predict mandibular growth, various parameters have been used with varying success. Ricketts (Ricketts, 1960) used symphyseal morphology to predict the direction of mandibular growth; he associated an anterior growth direction with thick symphysis. Bjork (Bjork, 1969) in his implant studies described multiple structural signs seen in extreme types of mandibular rotators. In forward mandibular rotators, condylar head was inclined forwardly along with a greater curvature of the mandibular canal than the mandibular contour. In backward mandibular rotation, pronounced apposition below the symphysis with more overall concavity of the lower mandibular border was seen. An indicator of a backward rotating mandible is inclination of the symphysis with proclination. Similarly, the reliability of the Skieller *et al*, (1984) prediction methods was studied by Lee *et al.* (1987). Since, the amount and direction of growth significantly alter the need for orthodontic biomechanics; the facial growth and development are of deep concern to an orthodontist. In orthodontics, knowledge of mandibular growth is highly beneficial in diagnosis and treatment planning. Even though various parameters have been used, it is very difficult to accurately predict the direction of mandibular growth using a particular parameter (Mangla, 2011).

Schudy (Schudy, 1963) mentioned firstly, the portion of the mandible that lies anterior to the plane, passing through point B as *Actual symphysis*, which is measured parallel to the mandibular plane. Secondly, the portion of the mandible that lies anterior to continuation of line NB as *Effective symphysis*, which is measured perpendicular to line NB. Since no study has been done to evaluate the correlation of the actual and effective symphysis with other craniofacial parameters to detect the direction of mandibular growth in Himachali population, this study was done to find out the correlation between the actual and effective symphysis with the measurements of mandibular rotation.

MATERIAL AND METHODS

Samples were selected from the subjects who visited the Department of Orthodontics and Dentofacial Orthopaedics. One twenty subjects (60 males and 60 females), having Class I sagittal skeletal and dental relationship were selected who fulfilled the following criteria:-

- Age between 18-30 years.
- ANB angle 2°±2°, according to Reidel (Riedel, 1952).
- Full permanent dentition regardless of third molars.
- No previous orthodontic, orthopaedic or surgical treatment.
- No craniofacial anomalies, like cleft lip and palate.
- All landmarks readily identified on lateral cephalometric radiographs.

Lateral cephalometric radiographs were taken for every patient. Every individual was positioned within the cephalostat with the Frankfort horizontal plane parallel to the floor and teeth in centric occlusion. Acetate sheet was fixed on every obtained radiograph and were traced using 0.5 lead pencil. Linear and angular measurements were then traced (Fig.1). Every traced radiograph was scanned via scanner. In order to avoid magnification errors, the linear measurements were divided by scale and then were scanned. The scanned image was then imported to the AutoCAD 2010 analyzing software program (Fig. 2). The AutoCAD software was used in order to read the minute measurements made on the symphyseal region. All the linear and angular measurements were then analyzed.

RESULTS

SPSS version 15 computer program was used for the statistical analysis of the data. The statistical analyses included the Descriptive statistics, Independent samples t-test for comparison between both genders and ethnic difference and Pearson's correlation coefficient test to find out the presence of correlation between symphyseal measurements and mandibular rotation measurements.

DISCUSSION

Morphology of mandibular symphysis has a great impact on diagnosis and treatment planning in orthodontic patients. It has been considered as one of the predictors for the direction of mandibular growth rotation (Susan, 2014). Several parameters have been identified on cephalometric analysis to define the anteriorly and posteriorly directed growth patterns. It has been reported that mandibular growth and orthodontic treatment both lead to a change in morphology of mandibular symphysis. Therefore, knowledge of both growth and treatment is essential to know whether what changes could take place during and after the treatment process. Several studies done previously were mainly concentrated on the symphysial morphology. This study was aimed to find out whether any correlation existed between the actual and effective symphysis with the mandibular rotation. In the present study, the mean value of actual symphysis was 6.67 in males and 7.24 in females (Table 1). No statistical significant difference was found between males and females ($p>0.05$). The slight increase in the actual symphysis in females might be due to downward and backward rotation of the mandible as reflected by the SN-MP, FH-MP, PP-MP, Gonial angle, Sum of posterior angles and the Jaraback ratio; which is higher in females as compared to males. This downward and backward rotation of the mandible leads to the decrease in the value of actual symphysis in females. The mean value of effective symphysis was slightly increased in females compared to males, i.e, in males it was 2.10 and in females it was 2.34; the reason being the same as above. Effective symphysis was also statistically non-significant between males and females. The mean value of the Anterior, Posterior and Lower facial heights were found to be increased in males as compared to females. Anterior and posterior facial heights were statistically significant between the genders. This is in accordance with the study done by Kharbanda *et al*. (1991), who said which may have been caused by age difference between males and females. However, there is a chronological gap between growth and development of males and females in the phase of adolescence, including the vertical development of the face. Additionally, females in have their pubertal growth spurt at an earlier age than males. Therefore, growth will likely be more balanced between males and females in this condition, with a mean age difference of 1.56 years during adolescence, particularly because females represented the group with the lower average age. Similar findings were also reported in other studies (Jones, 1996; Kapoor *et al*., 2000; Yassir, 2013; Johannsdottir, 2004).

The mean values of SN-MP, FH-MP and PP-MP were found to be slightly increased in females as compared to males. SN-MP was found to be statistically significant between genders. This is in accordance to the study done by Behrents (1985)**,** who showed that the Y-axis decreases slightly in males and does not change in females. Relative to pterygomaxillary (PT) vertical, the mandible becomes forward in males (approximately 2mm) but not in females. The mandibular plane angle decreases in males and increases in females. The maxillary and mandibular planes are more downward positioned relative to the cranial base in females compared to males; this may relate to a caudal jaw growth rotation in females. Forseburg (1991) and colleagues reported an increase (0.3mm) of mandibular plane angle in males and females between 25-45 years of age. The mean value of Saddle angle (N-S-Ar) was found to be slightly increased in females compared to males and was statistically significant between genders. The significantly higher N-S-Ar angle in females denotes the more backward position of the female mandible. The mean value of articular angle (S-Ar-Go) was found to be slightly higher in males compared to females. This is in accordance to the study done by Kapoor *et al*. (2000). The mean value of Gonial angle in our study was found out to be more in females as compared to males. This is in accordance to a survey done by Jensen *et al*. (1954), where he said that usually the mean angle is 3 to 5 degrees larger in the female than in the male.

Table 1. Showing descriptive statistics and gender differences

Variableeeees	Females(N=60)				Males(N=60)				Total(N=120)				G.D (df=118)	
	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	T	P
AS	3	12.4	7.24	2.33	2	10.2	6.67	2.00	2	12.4	7.37	2.13	1.42	0.15
ES	-1.5	7	2.34	1.98	-1.5	6.53	2.10	1.74	-1.5	7	2.43	1.93	0.69	0.49
AFH	110	132	120.8	5.87	108	135	123.8	8.32	108	135	122.60	7.09	-2.32	0.06*
PFH	67	91	80.6	6.79	70	96	83.25	6.87	67	96	81.73	6.27	-2.05	0.04*
LFH	57	82	68.2	5.31	55	80	68.9	6.24	55	82	68.10	5.63	0.72	0.02*
SN-MP	20	45	31.0	5.52	22	41	30.93	4.41	20	45	30.66	4.98	-2.14	0.03*
FH-MP	12	33	25.96	4.58	12	35	25.5	5.10	12	35	25.68	4.68	-0.45	0.65
PP-MP	15	38	24.3	5.07	9	33	24.16	4.86	9	38	23.86	4.93	0.16	0.86
SADDLE	116	145	126.5	6.84	112	142	124.35	6.85	112	145	125.5	6.38	1.75	0.08
AR	124	150	138.3	6.48	127	153	140.21	7.77	124	153	139.4	6.78	-2.20	0.02*
GONIAL	110	142	127.4	5.89	116	133	126.1	5.16	110	142	127.2	5.77	1.23	0.21
SUM	381	408	392.8	6.29	384	402	392.3	4.90	381	408	392.3	7.12	2.01	0.04*
JR	55.8	77.7	66.26	5.75	60.4	73.7	67.86	3.95	55.8	77.7	66.99	4.80	-2.43	0.01*

*significant ** highly significant

Table 2. Showing Pearson correlation coefficient for symphyseal measurements and other variables

Variables		FEMALES (N=60)		MALES (N=60)		TOTAL (N=120)	
		Actual symphysis	Effective Symphysis	Actual symphysis	Effective Symphysis	Actual symphysis	Effective Symphysis
AFH	R	-0.019	-0.178	0.164	-0.008	0.153	-0.114
	P	0.88	0.173	0.210	0.951	0.24	0.385
PFH	R	-0.146	0.641	0.076	0.225	0.146	0.284
	P	0.265	0.06	0.56	0.08	0.26	0.56
LFH	R	-0.036	-0.261	0.105	-0.207	0.200	-0.136
	P	0.784	0.07	0.424	0.110	0.125	0.27
SN-MP	R	0.242	-0.549	0.243	-0.492	0.144	-0.413
	P	0.06	0.000*	0.06	0.000*	0.27	0.001*
FH-MP	R	0.065	-0.065	0.235	-0.062	0.140	-0.0286
	P	0.324	0.02*	0.07	0.001*	0.28	0.03*
PP-MP	R	0.060	-0.473	0.082	-0.396	0.038	-0.351
	P	0.324	0.000*	0.53	0.000*	0.77	0.00*
SADDLE	R	-0.166	0.298	0.117	0.409	-0.108	0.258
	P	0.204	0.02*	0.373	0.001*	0.411	0.04*
ARTICULARE	R	-0.136	0.223	-0.139	0.209	-0.010	0.1288
	P	0.300	0.08	0.289	0.109	0.939	0.329
GONIAL	R	0.169	-0.538	0.043	-0.081	0.082	-0.327
	P	0.196	0.000*	0.744	0.538	0.533	0.01*
SUM	R	0.053	-0.0253	0.045	-0.407	0.175	-0.407
	P	0.68	0.05*	0.73	0.001*	0.18	0.001*
JR	R	-0.165	0.325	-0.026	0.317	-0.203	0.384
	P	0.207	0.001*	0.87	0.001*	0.119	0.002*

*significant **highly significant

Table 3. Comparison between Himachali and Iraqi males

Variable Males (df=99)	Himachali males(N=60)		Iraqi Males (N=41)			
	Mean	SD	Mean	SD	T	P
AS	6.67	2.00	6.37	1.41	0.89	0.20
ES	2.10	1.74	1.83	1.15	0.87	0.14
AFH	123.8	8.32	121.7	6.48	1.35	0.90
PFH	83.25	6.87	83.77	4.79	0.46	0.32
LFH	68.9	6.24	69.94	5.53	0.86	0.19
SN-MP	30.93	4.41	30.1	4.59	0.91	0.18
FH-MP	25.5	5.10	25.37	5.25	0.56	0.28
PP-MP	24.16	4.86	22.38	4.9	1.29	0.10
SADDLEEE	124.35	6.85	122.98	5.04	1.89	0.02*
AR	140.21	7.77	142.88	6.18	1.83	0.03*
GONIAL	126.1	5.16	124.27	5.37	1.72	0.04*
SUM	392.3	4.90	390.12	4.62	2.26	0.01*
JR	67.86	3.95	68.92	3.82	2.10	0.01*

These sexual differences in the size of the gonial angle may be explained by differences in the dimensions of the mandible. According to Hrdli Eka *et al.* (1940) the female mandible of all races has a wider gonial angle, but is smaller in all dimensions. It deviates most from the male mandible in symphyseal heightand especially in height of the ramus. In females, a relatively short ramusis combined with a wider gonial angle. A1so, the amount of muscle mass which is greater in males than in females.

The Sum of posterior angle was more in females and conversely the Jarabak ratio more in males. Both the Sum of posterior angles and Jarabak ratio were statistically significant between genders.

Correlation of Actual and Effective symphysis with the mandibular rotation angles: The actual and effective symphysis did not show any significant correlation with the facial heights (Table 2).

Table 4. Comparison of Himachali and Iraqi females

Variable Females	(df=111)	Himachali Females (N=60)		Iraqi females (N=53)			
		Mean	SD	Mean	SD	t	P
AS		7.24	2.33	5.87	1.58	3.60	0.00**
ES		2.34	1.98	1.95	1.45	1.18	0.12
AFH		120.8	5.87	111.2	4.36	9.76	0.00**
PFH		80.6	6.79	73.65	4.22	6.43	0.00**
LFH		68.2	5.31	62.15	3.98	6.78	0.00**
SN-MP		31.0	5.52	31.98	3.98	1.06	0.143
FH-MP		25.96	4.58	23.96	4.83	1.73	0.04*
PP-MP		24.3	5.07	22.75	4.39	1.72	0.04*
SADDLE		126.5	6.84	126.53	5.44	0.00	0.50
AR		138.3	6.48	142.21	6.13	3.28	0.00**
GONIAL		127.4	5.89	123.42	4.92	3.86	0.00**
SUM		392.8	6.29	392.15	4.03	0.19	0.42
JR		66.26	5.75	66.27	3.68	0.65	0.25

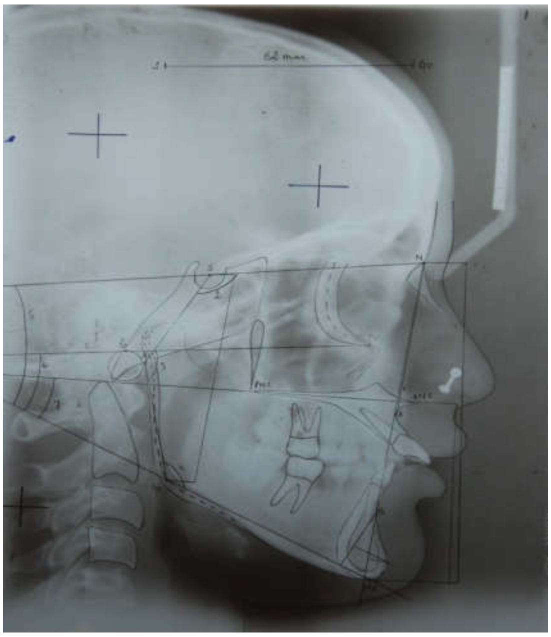

Figure 1. Cephalometric points,planes and measurements

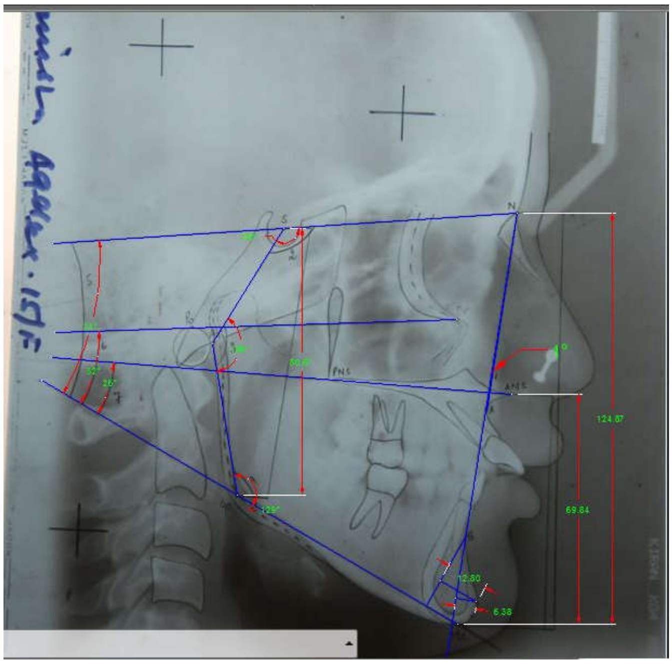

Figure 2. Angular and linear measurements done on AutoCAD software

Also, the actual symphysis did not show any significant correlation with the mandibular rotation angles in both the genders as well as in the total sample (p>0.05). Whereas the effective symphysis showed significant correlation with the mandibular rotation angles in both the genders as well as in the total sample. The effective symphysis showed a significant negative correlation with SN-MP, FMA, PP-MP and Sum of posterior angles in both the genders and in the total sample. This implies that, the effective symphysis increases as the mandibular rotation angles decrease. With the Gonial angle, the effective symphysis showed a significant negative correlation in females and the total sample. The effective symphysis showed a positive correlation with the Jarabak ratio, apart from the fact that it did not show any significant correlation with the facial heights. This implies that, as the anterior facial height increases, the effective symphysis decreases and vice versa. Whereas, as the posterior height increases, the effective symphysis also increases. With the Articular angle, the effective symphysis showed a non-significant negative correlation between the genders and the total sample. This is in accordance with the study conducted by Bahn Gh Agha (2013). The effective symphysis showed significant positive correlations with the Saddle angle.

This is in accordance with the study conducted by Bahn Gh Aghain which he said that this might be due to the fact that when the condyle is posteriorly positioned; there will be a compensatory forward rotation of the mandible. Therefore, as the mandible is positioned posteriorly, the effective symphysis would increase. The above relations of actual and effective symphysis to the mandibular rotation angles implies that as the actual symphysis is constructed by the points located within the mandible, it makes it less responsive to the mandibular rotation whereas, as the effective symphysis is constructed by the points located both on the cranium and the mandible, so any change in the mandibular rotation would be easily be detected by the effective symphysis, making it more responsive to mandibular rotation. The routinely used cephalometric analysis for the diagnosis and treatment planning in orthodontics is generally based on the Caucasian cephalometric standards. There has been concern on elaborating cephalometric analysis more specific to the young Himachali patients. Jarabakcephalometric analysis considers the skeletal pattern in the anteroposterior and vertical dimension. Therefore, considered to be one of the tools in cephalometric analysis in orthodontic patients which aids in treatment planning. Even this is based on the cephalometric values that were initially developed from Caucasian population (Khan, 2013). Hence, in order to provide better results and well-designed treatment plans, a modification of these normal values to suit a particular racial group should be done, since all humans are not alike and differences exist between the facial characteristics of various racial groups. In the present study, Himachali females exhibited significantly greater facial heights, actual symphysis and gonial angle, whereas the Himachali males exhibited significantly greater Saddle angle, Gonial angle and Sum of posterior angles as compared to the Iraqi population (Table 3 & 4). This might be because of the downward and backward rotation of the mandible. Besides the significant ethnic differences, the clinical relevance of the whole study revolves around the importance of the thickness of the dentoalveolarsymphysis in orthodontic diagnosis and treatment planning. By evaluating the thickness of the dentoalveolarsymphysis, the extent of the safe orthodontic movement of lower incisors could be established. There could be a risk of instability or iatrogenesis, if the orthodontic tooth movement exeeds the limit which is imposed by the alveolar symphysis morphology.

Conclusion

Based on these results, it was concluded that

- Effective symphysis is negatively correlated to most of the mandibular rotation angles and the actual symphysis correlating positively.
- Actual symphysisis not a good predictor as the points constructing the line to which the actual symphysis is measured is located within the mandible making it less responsive to mandibular rotations.
- Effective symphysis is a good predictor for the direction of mandibular rotation.
- Actual symphysis exhibited ethnic difference when compared with Iraqi population.

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