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Comparative Assessment of Facial Asymmetry in Malocclusion Using Posteroanterior View

Anshu Sahu[1]

Abstract

Introduction: The study was conducted to assess facial asymmetry in various dental malocclusions and to determine asymmetry in lower, mid, and upper face, and jaws using posteroanterior (PA) cephalometric analysis.

Method: A total of 120 PA cephalograms were taken of individuals between 12 and 25 years age group of both sexes and were divided into fourgroups, Angle's Class I excellent occlusion, Angle's Class I malocclusion, Angle's Class II malocclusion, and Angle's Class III malocclusion. These cephalograms were traced,and Grummons analysis was performed.

Results: In Angle'sClass I occlusion and Angle'sClass II malocclusion the results obtained showed asymmetry was present in the upper face. The correlationwas found between occlusion, malocclusion, and facial asymmetry.

Conclusion: Facial asymmetry was found in all dental occlusions whether excellent or malocclusion group, with maximum asymmetry having an upward trend toward upper face starting from lower.

Keywords: Facial asymmetry, posteroanteriorcephalogram, craniofacial skeleton.

Introduction

Asymmetry in the craniofacial areas can be recognized as differences in the size or relationships of the two sides of the face. This may be the result of discrepancies either in the form of individual bones or malposition of one or more bones in the craniofacial complex. The asymmetry may also be limited to the overlying soft tissues [1]. Facial asymmetries are imbalances that occur between the homologous parts of the face affecting the proportion of these parts to one another with regard to size, form,and position on opposite sides of the plane, line, or point. Facial asymmetry exists in orthodontic as well as non-orthodontic individuals. Because facial asymmetries are very often present with dental asymmetries,they are of clinical importance in the treatment of malocclusions of the teeth [2]. Lundstrom [4] explained that asymmetry can be genetic or non-genetic in origin and that it is usually a combination of both. Asymmetries can be classified according to the structures that are involved. Dental asymmetries can be caused by local factors such as early loss of primary teeth, congenitally missing teeth, and habits such as thumb sucking. Lack of exactness in genetic expression affects the teeth on the right and left sides, causing asymmetries in mesiodistal crown diameters [4]. The aims and objectives of the study were to assess the asymmetry in lower, mid, and upper face, and jaws using posteroanterior (PA) cephalometry, and to ascertain the correlations between occlusion and facial asymmetry.

Materials and Method

In all, 120 subjects were selected from the population of Moradabad city of Uttar Pradesh, India, using the variables as defined below. The sample selected ranged in the age group of 12–25 years, in both sexes. Selected individuals were subjected to cephalometric radiography in the department of oral medicine and radiology using a cephalostat of a cephalometric machine manufactured by Villa Sistemi (Italy). The selected subjects had Angle's Class I excellent occlusion, Angle's Class I malocclusion, Angle's Class II malocclusion,and Angle's Class III malocclusion and were named as GroupsA–D, respectively. These subjects were selected on the following basis:

1. Harmonious and apparently symmetrical face.
2. Full complement of teeth with good posterior interdigitation excluding 3rdmolars.
3. No history of trauma.
4. No history of prior orthodontic or surgical treatment.
5. No evidence of temporomandibular joint (TMJ) dysfunction or congenital TMJ ankylosis.

The parameters used for Group A were detailed as having Angle's Class I molar relation, overjet =2–4mm, overbite=2–4mm, symmetrical upper and lower arch, spacing =0–2mm, contact point displacement= 0–2mm and rotation = mild degree [5]. The subject's name, age, and sex were recorded,and consent was taken, following clinical examination, their PA cephalogram wastaken using the standardized technique. The exposure parameters were 75 KVP, 10 mA, and exposure time was 1.60 s.

Following landmarks and planes were included in the study Fig. 1and Table 1.

1. Cg-Cristagalli - A vertically elongated diamond shaped radiopacity appearing between the orbital outline onPA cephalogram. Used to establish amidsagittal reference (MSR) (mid reference line)[7].
2. Z - Zygomatic suture point-medial and the

[1]Department of Orthodontics, Hazaribag College of Dental Sciences, Hazaribag,Jharkhand

Address of Correspondence:
Dr. Anshu Sahu
Department of Orthodontics, Hazaribag College of Dental Sciences, Hazaribag,Jharkhand.

Table No 1: showing cephalometric line

1) Reference (vertical line)- MSR- mid sagittal reference line.9
2) Maxillary width (horizontal line) - J to MSR jugale- crossing of the outline of the tuberosity with the outline of the jugal process. (the medial aspects of the jugal processes).9
3) Nasal cavity width (horizontal width)- NC to MSR widest points in nasal capsule.9
4) Mandibular width (horizontal line)- Ag to MSR antegonian- trihedral eminence above gonial notch.9

Table No 2 : Showing Mean, SD, SEM, CV and t-test in Group A Having Class-1Excellent Occlusion for Assessing Facial Asymmetry in Different variables.

Horizontal	MEAN Left	MEAN Right	SD Left	SD Right	SEM Left	SEM Right	CV Left	CV Right	t-Test
Z-MSR	47.87	49.36	2.12	3.02	0.36	0.51	4.43	6.11	-4.51***
ZA-MSR	66.67	67.73	3.39	4.27	0.57	0.72	5.09	6.3	-1.64
NC-MSR	14.97	15.69	1.49	2.04	0.25	0.34	9.98	12.98	-1.66
J-MSR	32.96	33.5	2.22	2.29	0.38	0.39	6.75	6.83	-1.43
A6-MSR	30.43	30.83	2.25	2.54	0.38	0.43	7.39	8.23	-0.98
B6-MSR	30.39	31	2.28	2.38	0.39	0.4	7.5	7.69	-1.21
Ag-MSR	43.84	43.27	3.48	3.19	0.59	0.54	7.93	7.37	0.84

Level of Significance oft-test is >0.05 is N.S;<0.05 is 2.03*; <0.01 is 2.73**and <0.001 is 3.60*** at 33 df.

Table No 3: Showing Mean, SD, SEM, CV and t-test in Group B Having Class-I Malocclusion for Assessing Facial Asymmetry in Different variables

Horizontal	MEAN Left	MEAN Right	SD Left	SD Right	SEM Left	SEM Right	CV Left	CV Right	t-Test
Z-MSR	47.77	48.95	3.18	3.03	0.58	0.55	6.65	6.18	-2.39
ZA-MSR	67.63	66.72	4.01	4.12	0.73	0.75	5.93	6.17	1.31
NC-MSR	15.87	15.5	2.19	2.48	0.4	0.45	13.82	16.03	0.77
J-MSR	33.98	33.52	2.25	2.83	0.41	0.52	6.61	8.45	0.89
A6-MSR	30.9	29.2	2.56	5.95	0.47	1.09	8.28	20.39	1.69
B6-MSR	30.62	29.92	2.65	2.93	0.48	0.54	8.66	9.81	1.23
Ag-MSR	43.95	41.73	3.96	3.55	0.72	0.65	9.02	8.51	2.31

Level of Significance oft-test is >0.05 is N.S;<0.05 is 2.05*; <0.01 is 2.76**and <0.001 is 3.67*** at 28 df.

Table No. 4: Showing Mean, SD, SEM, CV and t-test in Group C Having Class-II Malocclusion for Assessing Facial Asymmetry in Different variables.

Horizontal	MEAN Left	MEAN Right	SD Left	SD Right	SEM Left	SEM Right	CV Left	CV Right	t-Test
Z-MSR	46.87	48.1	3.57	3.68	0.65	0.67	7.63	7.66	-2.67*
ZA-MSR	65.27	65.93	5.43	5.14	0.99	0.94	8.33	7.8	-0.68
NC-MSR	15.53	16.25	3.46	3.84	0.63	0.7	22.27	23.61	-1.5
J-MSR	31.8	32.32	4.85	5.13	0.89	0.94	15.25	15.86	-1.33
A6-MSR	30.33	30.17	3.45	3.71	0.63	0.68	11.37	12.29	0.27
B6-MSR	29.65	29.73	3.31	3.15	0.6	0.57	11.17	10.59	-0.14
Ag-MSR	42.37	42.52	4.37	3.85	0.8	0.7	10.33	9.05	-0.2

Level of Significance oft-test is >0.05 is N.S;<0.05 is 2.05*; <0.01 is 2.76**and <0.001 is 3.67*** at 28 df.

Table No. 5: Showing Mean, SD, SEM, CV and t-test in Group D Having Class-III malocclusion for assessing facial asymmetry in different variables

Horizontal	MEAN Left	MEAN Right	SD Left	SD Right	SEM Left	SEM Right	CV Left	CV Right	t-Test
Z-MSR	47.9	48.32	3.21	3.88	0.64	0.78	6.7	8.03	-0.58
ZA-MSR	66.04	66.22	4.68	4.7	0.94	0.94	7.09	7.1	-0.21
NC-MSR	15.04	15.44	1.43	1.77	0.29	0.35	9.5	11.46	-0.95
J-MSR	32.7	33.6	3.15	3.22	0.63	0.64	9.64	9.6	-2.34*
A6-MSR	29.68	30.34	2.33	3.16	0.47	0.63	7.84	10.41	-1.28
B6-MSR	29.84	30.6	2.63	3.11	0.53	0.62	8.81	10.17	-1.43
Ag-MSR	42.76	43.36	4.02	4.3	0.8	0.86	9.41	9.93	-0.58

Level of Significance oft-test is >0.05 is N.S;<0.05 is 2;07*; <0.01 is 2.81 **and <0.001 is 3.77*** at 23 df.

Table No. 6: Showing variables having asymmetry in all four groups

Group	GroupA	GroupB		Group C	Group D
Variables	Z-MSR	Z-MSR	Ag-MSR	Z-MSR	J-MSR
Difference of mean	1.49	-1.18	2.22	-1.24	-0.9
SD	1.95	2.71	5.26	2.53	1.93
SEM	0.33	0.5	0.96	0.46	0.39
t test	-4.51 ** *	-2.39*	2.31 *	-2.67*	-2.34*
CV	131.25	-229.16	237.51	-204.86	-213.97

FOR Group A, Level of Significance of t-test is >0.05 is N.S;<0.05 is 2.03*; <0.01 is 2.73**and <0.001 is 3.60*** at 33 df.

FOR Group B & C, Level of Significance of t-test is >0.05 is N.S;<0.05 is 2.05*; <0.01 is 2.76**and <0.001 is 3.67*** at 28 df.

FOR Group D - Level of Significance of t-test is >0.05 is N.S;<0.05 is 2.07*; <0.01 is 2.81 **and <0.001 is 3.77*** at 23 df.

anterior junction of zygomatic bone with frontal bone(right and left) [8].

3. ZA - Centers of the zygomatic arches (right and left) [8].

4. J -Jugal process-lowest point on the curve of the zygomatic bone. Furthermore, the point on the jugal process of the maxilla at a crossing with the tuberosity of the maxilla, in the frontal [8].

5. NC -Lateral most point on inside surface of bony nasal cavity (right and left) [8].

6. Ag-Antegonion. Highest point in the antegonial notch. Antegonialpoint on the mandibular border at the lower margin of trihedral eminence above gonial notch(right and left) [9].

7. A6-Upper first permanent molar. In the frontal (cephalogram) it is the buccalmost point on the crown of the upper first molar [8].

8. B6-Lower first permanent molar. Frontally, it is the buccal most point on the crown of the lower molar [8].

9. Me- Menton. Lowermost point of the contour of the chin [8].

Areas for maxillomandibular comparison:

- Maxillary- Cg-J-MSR.
- Mandibular-Cg-Ag-MSR.

Horizontal asymmetry assessment involved measurement of the horizontal lines which were the perpendicular projections of the bilateral landmarks on the MSR, i.e., Z-MSR, ZA-MSR, NC-MSR, J-MSR, A6-MSR, B6-MSR, and Ag-MSR and were measured for right and left side. A difference in reading of right and left side of a pair of landmarks provided the horizontal asymmetry of the landmarksFig. 2. The vertical lines between the points of perpendicular projections on MSR were drawn to depict any vertical discrepancy between the landmarks of right and left side. A vertical difference in the left and right points provided the vertical asymmetry of the landmarksFig. 3. Mandibular deviation was assessed by measuring the linear horizontal distance, between the points of line MSR falling on the lower border of the mandible and MentonFig. 2. Four lines were constructed, perpendicular to MSR, from Ag toJ, bilaterally. Lines connecting Cg and J and lines from Cg to Ag were also drawn. Two pairs of triangles are constructed,andeach pair is bisected by MSR. Their areas were calculated and compared to that of the opposite sideFig. 4.

Results and Discussion

Table 2 Group A is showing mean,coefficient of variation (CV), standard deviation (SD), and standard error of mean (SEM) for both right and left:Side. When mean values of all parameters are compared between right and left side, it is observed that Z to MSR variables are significantly different at 5% level of significance. Whereas, among other parameters,the insignificant difference was observed, indicating that in most of the variables there is no evidence of any facial asymmetry. Table 3 Group B is showing mean, CV, SD, and SEM for both right and left side. When mean values of all parameters are compared between right and left side, it is observed that Z to MSR and Ag to MSR variables are significantly different at 5% level of significance. Whereas, among other parameters,the

Table No. 7: Showing mean, SD, SEM, CV, and t-test in all groups for variable CG-J-MSR and CG-AG-MSR to assess asymmetry

CG-J-MSR									
Groups.	MEAN		SD		SEM		CV		t-Test
	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	
A	1057.53	1069.44	141.99	136.3	24	23.04	13.43	12.74	-0.97
B	1082.75	1086.98	172.8	179.96	31.55	32.86	15.96	16.56	-0.19
C	978.98	1004.43	216.69	206.27	39.56	37.66	22.13	20.54	-2.18*
D	1020.13	1049.41	120.71	142.46	24.14	28.49	11.83	13.58	-2
CG-AG-MSR									
Groups.	MEAN		SD		SEM		CV		t-Test
	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	
A	2299.06	2279.99	249.56	275.92	42.18	46.64	10.85	12.1	0.57
B	2347.05	2244.3	340.5	286.68	62.17	52.34	14.51	12.77	2.25*
C	2186.17	2212.16	364.53	333.71	66.55	60.93	16.67	15.09	-0.68
D	2227.49	2225.63	346.39	314.05	69.28	62.81	15.55	14.11	0.04

FOR Group A - Level of Significance oft-test is >0.05 is N.S;<0.05 is 2.02*; <0.01 is 2.70**and <0.001 is 3.46*** at 53or58or63 df.

FOR Group B & C - Level of Significance of t-test is >0.05 is N.S;<0.05 is 2.05*; <0.01 is 2.76**and <0.001 is 3.67*** at 28 df.

FOR Group D - Level of Significance of t-test is >0.05 is N.S;<0.05 is 2.07*; <0.01 is 2.81 **and <0.001 is 3.77*** at 23 df.

insignificant difference was observed, indicating that in most of the variables there is no evidence of any facial asymmetry in an individual having Angle's Class I malocclusion. Table 4 Group C is showing mean, CV, SD, and SEM for both right and left side. When mean values of all parameters are compared between right and left side, it is observed that Z to MSR variables are significantly different at 5% level of significance. Whereas, among other parameters,the insignificant difference was observed, indicating that in most of the variables there is no evidence of any facial asymmetry in an individual having Angle's Class II malocclusion. Table 5 Group D is showing mean, CV, SD, and SEM for both right and left side. When mean values of all parameters are compared between right and left side, it is observed that J to MSR variables are significantly different at 5% level of significance. Whereas, among other parameters, the insignificant difference was observed, indicating that in most of the variables there is no evidence of any facial asymmetry in an individual having Angle's Class III malocclusion. Table 6 shows variables having asymmetry in all four Groups A-D. Table 6 and Fig.5 showvariables having a highly significant difference in Z-MSR between right and left measurement in Group A and same is true in Group B and C whereas insignificant difference exists in Angles Class III malocclusion. Measurement Ag-MSR in Group Band J-MSR in Group D both are showing a significant difference at 5% which is an indication of asymmetry. Table 7 showsthe mean, CV, SD, and SEM between right and left maxillomandibular comparison measurement using CG-AG-MSR and CG-J-MSR to assess the asymmetry. From the table, it is observed that measurement CG-J-MSR is showing a significant difference at 5% level for right and left side indicating thereby asymmetry in the maxillary region for Group C and variable CG-AG-MSR in Group B. For rest of the groups, in maxillomandibular comparison, measurements are having an insignificant difference at 5% level for right and left side indicating thereby symmetry between right and left side. The CV was also found to be consistent in all parameters used to assess asymmetry. Table 8 shows the mean SD, SEM,and CV of variables used to assess the asymmetry in all the four groups. The CV was found to be variable in a parameter used to assess mandibular deviation. The CV was found to be highest in Group B, compared to other groups. Table 9 shows excellent occlusion having molar Class I relation correlated for different variables having malocclusion for asymmetry in horizontal, vertical plane, and difference in maxillomandibular comparison measurements and mandibular deviations. There are four types of dentofacial asymmetries studied by Cheney [10] among which the vertical displacements are asymmetrical variations which result from height difference in size shape, and/or form between dentofacial parts on the two sides of the face. Thompson [11] studied facial symmetry and stated that it must be recognized that there is no truly symmetrical face regardless of race, age or period of an individual. Fischer [2] noted that the factors responsible for asymmetries in the dentofacial complex are not confined to the teeth and alveolar process. They may be found in the various components parts of the face and all the structures surrounding the teeth. It was seen that variable Z-MSR in the GroupsA-C; Ag-MSR of Class I malocclusion and J-MSR ofGroup D showed a significant difference in comparison of right and left side. The right side was more deviated as compared to left side. This was in accordance with the

Table No. 9: Showing Correlation Coefficient Between Various Variables With Excellent Occlusion And Malocclusion

CORRELATION IN HORIZONTAL PARAMETERS			
EX.Occ	MALOCCLUSION		
	Group A vs Group B	GroupA VS Group C	Group A vs Group D
Z- MSR	0.076	0.133	0.239
ZA-MSR	0.33	0.211	0.064
NC-MSR	-0.202	-0.108	0.208
J-MSR	-0.068	0.059	0.194
A6-MSR	0.066	0.252*	0.09
B6-MSR	0.008	0.096	-0.196
Ag - MSR	-0.2 I	-0.03	-0.053
CORRELATION IN VERTICAL PARAMETERS			
Z- MSR	0.048	0.430***	-0.364***
ZA-MSR	-0.271 *	0.390**	-0.017
NC-MSR	-0.357**	0.213	0.308*
J-MSR	-0.288*	0.026	-0.045
A6-MSR	-0.008	-0.107	0.105
B6-MSR	0.049	-0.08	-0.326**
Ag - MSR	-0.122	-0.191	0.008
CORRELATION IN MAXILLOMANDIBULAR VARIABLE			
CG-AG-MSR	0.23	-0.041	0.011
CG-J-MSR	0.369**	-0.03	-0.108
CORRELATION WITH MANDIBULAR DEVIATION			
M-MSR	-0.016	-0.196	0.001

previous study done by Haraguchiet al. [12] in 2002 who stressed that the frequent laterality of face maybe ascribed to the dominant growth potential of the jaw's right side. It was observed that measurement CG-J-MSR is showing a significant difference for right and left side indicating thereby asymmetry in the maxillary region for Group C. Bjork suggested that there is a slight tendency for most of the cranial bones to be larger on the right side in the underformed (normal) crania. Asymmetry of upper face occurs to prevent midline deviations. This means that at the cost of maintenance of midline, asymmetry of the face results. Measurement CG-Ag-MSR is showing a significant difference between right and left side indicating thereby asymmetry in the mandibular region for group B.In accordance with the study done by Haraguchiet al. [12], there was a general tendency of the inferior landmarks to deviate more frequently and at greater distances than the more superiorly located landmark because growth of mandible is largely seen at the condylar region, the mandible is likely to show gradual deviation during growth period, as if it swings with a condylar head on the affected side as its centerof rotation.Chiericiet al. [16]described this gradual deviation with the help of an animal experiments and stressed asymmetry of the face is related to functional demands of the masticatory apparatus and the musculoskeletal systems. Skeletal asymmetry reflects onto the soft tissue of the face. In this study, asymmetry was obvious in the upper jaw but could not extend up to the zygoma. Maximum CVin mandibular deviation was noticed in Group C, and minimumdeviationwas seen in the GroupB.This shows that although individuals have excellent occlusion, still they exhibit asymmetry which has been stressed by Utreja [13] in 1973. Futhermore,by Sheatset al. [14] who studied the prevalence of orthodontic asymmetries stated in a study that among orthodontic patients, the most common asymmetry trait was mandibular midline deviation from the facial midline.Significant correlation was found between Group B andC, in measurement A6-MSR which demonstrates that as the malocclusion increases in severity from Group A to Group C the value ofA6-MSR increases as well. When correlation was evaluated in a verticalvariable, it was observed that as malocclusion increases from Group A to Group C, the Z-MSR value increases and when the value of measurement decreases, the correlation demonstrated that as malocclusion increases from Group A to Group D, which is evident in the measurement of Z-MSR. Similarly, increase in ZA-MSR was observed with increase in the severity of malocclusion from Group B to Group C.Measurement ZA-MSR, NC-MSR, and J-MSR demonstrated that with an increase in the severity of malocclusion from Group A to Group B, the value of these variables also decreases. Measurements of variable B6-MSR demonstrate that with an increase in the severity of malocclusion from Group A to Group D, the value decreases. For NC-MSR variable, it was seen that with an increase in the severity of malocclusion from Group A to Group D the value increases. When correlation was done in the maxillomandibular parameter, it was seen that as the severity of malocclusion increases from Group A to Group C, the value of Cg-J-MSR also increases. Our findings were contrary to the findings of Thompson [11]in which he observed insignificant difference between malocclusion and asymmetry while Fischer [2] reported that facial asymmetry was very often present with malocclusion. Shah and Joshi [15] reported in their study that significantly more subjects were chewing on the right side than on the left side as a matter of habit and since the force of mastication are transmitted from the teeth to the facial and cranial bones, this may be a factor responsible for the right side being larger than the left.

Conclusion

Following conclusions were drawn:
1. Asymmetry of the faceiscommon findings in case of all types of dental malocclusion.
2. In Angle's Class I occlusionand Angle's Class II malocclusion, the results of parameters obtained show that increased asymmetry is present in the upper face, and the asymmetry increases in magnitude as we approach higher in the craniofacial skeleton.
3. The correlationwas found between occlusion, malocclusion, and facial asymmetry.

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