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An assessment of skeletal craniofacial asymmetry in Gujarati population – An autocad study

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Abstract

Objectives: To assess and to compare the skeletal craniofacial asymmetry by manual and digital methods in patients having symmetrical and clinically pleasing profile.

Materials and Method: Posteroanterior cephalograms of 60 Gujarati subjects with pleasing profile and no evident facial asymmetry were taken. Along with the manual method, AUTOCAD software version(2014) was used to measure the surface area of various craniofacial triangles on these radiographs.

Results: Cranial base region shows asymmetry with left side being larger than right when done by both autocad and manual methods. Lower maxillary region and mandibular region shows asymmetry with left side larger than right in males when done by manual method.

Conclusions: One of the possible reasons for the greater amount of asymmetry in the cranial base region and mandibular region could be due to difficulty in locating the condylar point. Clinically pleasing and symmetrical faces exhibit some amount of skeletal asymmetry which may not be evident because of the soft tissue envelope, which tries to minimize the underlying asymmetry.

Keywords: Asymmetry; Craniofacial traingles; Autocad software; Surface area.

Introduction

Asymmetry is a usual finding in human craniofacial bones and is usually observed throughout the population.[5-9] Harmonious faces, apparently symmetrical, may show skeletal asymmetry on radiographic examination suggesting that the soft tissues minimizes the subjacent asymmetry.[10] To make an objective distinction between minor and major asymmetry, it is advisable to quantify asymmetry. Quantification makes it possible to demonstrate the amount of asymmetry for diagnostic purpose and to evaluate treatment results.[12-13]

Craniofacial asymmetry has been investigated by various methods. Direct measurement on the dry skull is the oldest method.[14] Various other methods include anthropometries, stereophotogrammetry,[12] digital methods like cone beam computed tomography, 3d scanning with digital scanners etc.

Post-eroanterior cephalogram is the most readily available tool to diagnose facial asymmetry.[15-17] These were measured manually as well as with autocad software. Autocad software analyses all drawing superimposed on an invisible grid or co-ordinate system with horizontal and vertical axis. This is used for accurate assessment of areas representing various triangles. Skeletal asymmetry was measured manually as well as by Autocad software.

Aims and Objectives

1. To assess the skeletal craniofacial asymmetry in Gujarati population by a post-eroanterior cephalometric radiographic method.
2. To compare the skeletal craniofacial structures on one side of the face with that of the other, by drawing various triangles representing different craniofacial regions.
3. To measure the surface area of the above triangles and compare the surface area of one side of the face with that of the other.
4. To compare the manual and digital method of assessing asymmetry.
5. To compare the prevalence of asymmetry in males and females.

Materials and Method

60 Gujarati subjects with pleasing profile and no evident facial asymmetry were chosen for this study. Ethical clearance was obtained by institutional ethical committee. Informed consent was obtained from all the subjects included in this study.[20]

The following selection Criteria were considered in selection of the subjects for the study.

Inclusion criteria

1. The age range of 60 subjects was from 18-25 years with mean age of 21 years.
2. Subjects had pleasing profile and no evident facial asymmetry
3. Subjects with previous orthodontic treatment were not considered for this study
4. Subjects selected were Gujarati, whose previous two generations were Gujaratis, residing in Gujarat.

Exclusion criteria

1. Patient with clinically evident facial asymmetry were not selected
2. Patient with a history of trauma, temporomandibular joint disorders, pathology of craniofacial region and functional deviation were excluded from this study

Armamentarium

- Postero anterior cephalogram of patients
- 0.3 H lead pencil with set squares
- 0.36 μm lead acetate paper
- tracing table
- AUTOCAD Software (version 2014)

Post-eroanterior radiographic cephalograms of the 60 subjects with head oriented in natural head position with teeth in centric occlusion were taken, using a standardized cephalometric technique.[Fig. 2]

The distance between the transporionic axis and film was kept constant for each subject to minimize the magnification error. The central ray of X-rays passed through the center of the midsagittal plane so the magnification of right and left sides of the face was the same. With the X-ray source behind the patient's head and the film cassette in front of the patient's face, the X-ray beam passed perpendicular to the patient's coronal plane.

Following cephalometric landmarks were located and corresponding triangles were plotted bilaterally and their areas measured to determine symmetry between them. [Fig. 3]

1. **Sella turcica(S):** Geometric centre of the pituitary fossa located by visual inspection
2. **Condylar point (Co):** Most superior point of the head of the condyle
3. **Mastoidale(M):** lowest point on the contour of the mastoid process
4. **Anterior nasal spine (ANS):** Tip of the nasal spine just below the nasal concavity and above the hard palate
5. **Zygomatic(Z):** The lateral border on the center of the zygomatic arch
6. **Molar point (Mo):** The junction of the occlusal surfaces of the upper and lower molars bilaterally.
7. **Incisor point (I):** The junction of the mesial contact areas of the upper incisors.
8. **Gonion (Go):** A point on the curvature of the angle of the mandible located by bisecting the angle formed by lines tangent to the posterior border of ramus and inferior border of mandible.
9. **Menton (Me)**: The lowest point on the symphyseal shadow of the mandible as seen on posteroanterior cephalogram.

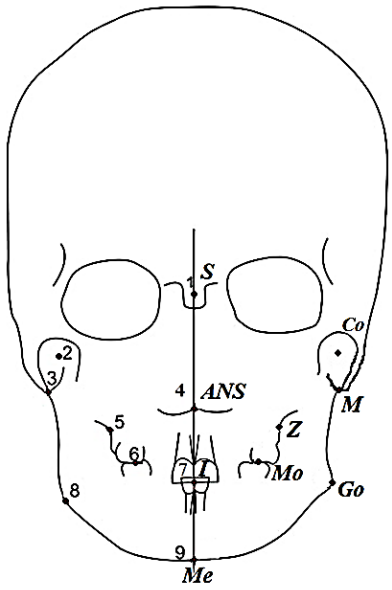

Fig. 1: Cephalometric landmarks that are located and traced

To assess the relative asymmetry of the component areas of the facial complex, the method of triangulation was used. Each left and right side were divided into several triangles using various reference points [Fig. 4].

Triangles used

1. **Triangle A:** It is formed by the intersection of S point and the superior most and medial most point of the condyle.

It represents the right and left cranial base region.

2. **Triangle B (SMZ):** It is formed by the intersection of S, M and Z point.

It represents the ridht and left lateral maxillary region.

3. **Triangle C (SZ Ans):** It is formed by the intersection of S, Z and Ans.

It represents the right and left upper maxillary region.

4. **Triangle D (Ans ZMo):** It is formed by intersection of Ans, Z and Mo.

It represents the right and left middle maxillary regions.

5. **Triangle E:** It is formed by intersection ANS, Mo and median point perpendicular to Mo on the midsaggital reference plane.

It represents the right and left lower maxillary regions.

6. **Triangle F:** It is formed by intersection of I, Mo and a median point perpendicular to Mo on the midsaggital reference plane.

It represents the right and left dental regions, and

7. **Triangle G(CGMe):** It is formed by the intersection of C, G and Me.

It represents the right and left mandibular region.

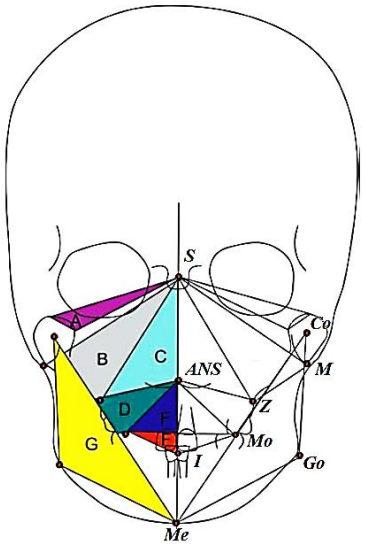

Fig. 2: Method of triangulation using the reference points

The measurements were made to the nearest 0.5 mm and the surface area in the male and female groups were calculated using the geometrical formula as follows:

S = 0.5 × L × H

Where,

S = surface area

L = length of the base of the triangle, and

H = height of the triangle.

Soft copies of postero anterior cephalograms (true size) were imported to AUTOCAD software.

Cephalometric points were located on cephalogram. Triangles were formed digitally with the software and their surface areas were measured. The data thus obtained from Autocad software (version 2014) and from manual tracing were subjected to statistical analyses.

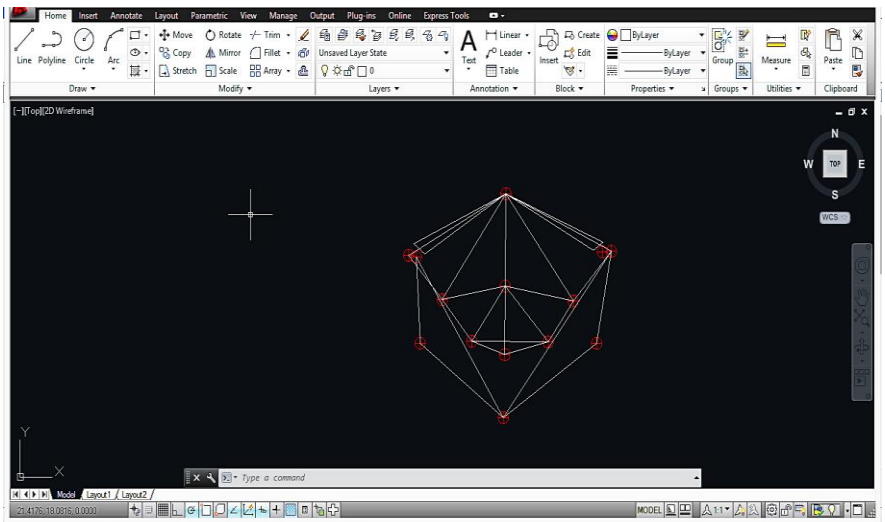

Fig. 3: Use of Autocad software for Digital tracing

Table 1: Comparison of surface area between right and left sides; manual overall

Parameters	Mean	N	Std. Deviation	Mean Difference	Standard deviation	P Value
Cranial Base Triangle (CBT) Right	301.30	60	176.35	24.43	26.78	<0.001
Cranial Base Triangle (CBT) Left	325.73	60	175.43			
Lateral Maxillary Triangle (LMT) Right	702.46	60	379.36	19.37	23.53	0.212
Lateral Maxillary Triangle (LMT) Left	723.25	60	384.55			
Upper Maxillary Triangle (UMT) Right	942.43	60	557.47	9.28	35.15	0.355
Upper Maxillary Triangle (UMT) Left	951.71	60	564.34			
Middle Maxillary Triangle (MMT) Right	428.73	60	230.23	27.58	29.73	0.160
Middle Maxillary Triangle (MMT) Left	456.31	60	231.51			
Lower Maxillary Triangle (LT) Right	302.85	60	145.02	22.88	32.10	0.036
Lower Maxillary Triangle (LT) Left	325.73	60	149.97			
Dental Triangle (DT) Right	66.06	60	20.27	8.91	14.06	0.198
Dental Triangle (DT) Left	74.98	60	23.39			
Mandibular Triangle e(MT) Right	1450.81	60	887.45	29.5	49.44	0.012
Mandibular Triangle (MT) Left	1480.31	60	903.36			

Total Facial Surface Area (TFSA) Right	4196.66	60	2300.91	143.38	102.45	0.514
Total Facial Surface Area (TFSA) Left	4338.05	60	2346.34			
Total Maxillary Triangle (TMT) Right	2376.48	60	1266.15	80.53	70.34	0.816
Total Maxillary Triangle (TMT) Left	2457.01	60	1286.46			

Results: Data Tables & Graphs

Table 2: Comparison of surface area between right and left sides; autocad overall

Parameters	Mean	N	Std. Deviation	Mean Difference	Standard deviation	P Value
Cranial Base Triangle (CBT) Right	279.16	60	166.43	18.45	23.05	<0.001
Cranial Base Triangle (CBT) Left	297.61	60	165.92			
Lateral Maxillary Triangle (LMT) Right	642.53	60	333.93	10.68	30.32	0.523
Lateral Maxillary Triangle (LMT) Left	653.21	60	340.32			
Upper Maxillary Triangle (UMT) Right	912.11	60	524.80	17.56	109.02	0.755
Upper Maxillary Triangle (UMT) Left	929.68	60	535.04			
Middle Maxillary Triangle (MMT) Right	413.25	60	203.31	21.25	25.47	0.115
Middle Maxillary Triangle (MMT) Left	434.50	60	210.54			
Lower Maxillary Triangle (LT) Right	293.15	60	136.65	15.28	34.19	0.03
Lower Maxillary Triangle (LT) Left	308.43	60	147.37			
Dental Triangle (DT) Right	61.08	60	24.44	8.20	15.96	0.998
Dental Triangle (DT) Left	69.28	60	26.06			
Mandibular Triangle (MT) Right	1487.71	60	883.60	-27.33	202.00	0.152
Mandibular Triangle (MT) Left	1460.38	60	833.10			
Total Facial Surface Area (TFSA) Right	4089.01	60	2150.30	64.10	231.09	0.514
Total Facial Surface Area (TFSA) Left	4153.11	60	2151.46			
Total Maxillary Triangle (TMT) Right	2261.05	60	1135.78	64.78	126.25	0.416
Total Maxillary Triangle (TMT) Left	2325.83	60	1174.27			

$P < 0.05$ significant; $p < 0.01$ highly significant

Discussion

This study was conducted to assess craniofacial asymmetry in Gujarati population. To measure asymmetry method of triangulation was used. The method of triangulation as described by Hewitt has been a valuable diagnostic procedure for the analysis of overall facial asymmetry.[4] According to this method the facial area is divided into seven triangles on each side representing various craniofacial regions. The surface area of each triangle was measured and it was compared with that of the other side. To compare accuracy of manual measurement, in this era of digitization, Autocad Software (version 2014) was used to measure the areas representing various craniofacial regions to measure asymmetry. The advantage of this software is that it is time saving, more meticulous and precise in measuring minor asymmetries which are otherwise indiscernible.

Table 1 shows mean, standard deviation, 'p' value, mean difference and standard deviation of mean difference of various triangles representing craniofacial region of right and left sides in males by manual method.

The Cranial base region (Table 1) of right side shows mean area of 301.30 mm^2 with S.D. ± 176.35 whereas this of left side shows mean area of 325.73 mm^2 with S.D. ± 175.43.When right side of cranial base region is compared to left side, shows mean difference of 24.43mm^2 with S.D. of ± 26.78 which is statistically highly significant ($p < 0.001$) with left side being larger than the right side.

All other regions such as Lateral, Upper and Middle maxillary region(Table 1) do not show any statistically significant findings in the mean difference between right and left side with the left side being larger than the right side.

Lower maxillary region(Table 1) shows mean area of 302.85 mm^2 with S.D. ± 145.02 whereas this of left side shows mean area of 325.73 mm^2 with S.D. ± 149.97. When right side of lower maxillary region is compared to left side, shows mean difference of 22.88 mm^2 with S.D. of ± 32.10 which is statistically significant ($p = 0.036$) with left side is larger than the right side. Mandibular region(Table 1) formed by intersection of C, G and Me point of right side shows mean area of 1450.81 mm^2 with S.D. ± 887.45 whereas this of left side shows mean area of 1480.31 mm^2 with S.D. ±903.36. When right side of mandibular region is compared to left side, shows mean difference of 29.50 mm^2 with S.D. of ± 49.44 which is moderately statistically significant ($p = 0.01$) with left side being larger than the right side. Total facial surface

area(Table 1)shows mean area of 4196.66 mm^2 with S.D. ± 2300.91 whereas this of left side shows mean area of 4338.05 mm^2 with S.D. ± 2346.34. When right side of total facial surface area is compared to left side, shows mean difference of 143.38 mm^2 with S.D. of ± 102.45 which is statistically significant (p = 0.514) with left side being larger than the right side.

Dental triangle region and Total maxillary triangles (Table 1) do not show any statistically significant findings in the mean difference between right and left sides.

An attempt is made to digitally compare the surface areas of craniofacial region with Autocad Software version 2014(Table 2). Table 2 shows mean, S.D., mean difference and P value of surface area of various craniofacial regions of all 60 subjects bilaterally compared with Autocad software version 2014.

Cranial base triangle region(Table 2) right side shows mean of 279.16 mm^2 ± 166.43 and that of left side shows mean of 297.61 mm^2 ± 165.92 with a mean difference of 18.45 mm^2 ± 23.05 which is statistically significant (p = 0.02) with the left side being larger than the right side. This is similar to the results found in manual method.

All other regions such as lateral, upper and middle maxillary regions (Table 2) do not show any statistically significant findings in the mean difference between right and left side with the left side being larger than the right side similar to that found with manual method.

Lower maxillary region(Table 2) right side shows mean of 293.15 mm^2 ± 136.65 and that of left side shows area of 308.43 mm^2 ± 147.37 with a mean difference of 15.28 mm^2 ± 34.19 which is statistically significant (p = 0.03) with the left side being larger than the right side. This is similar to the results found in manual method.

All the other regions such as Dental, Mandibular, Total facial surface area and Total maxillary triangles (Table 2) do not show any statistically significant findings in the mean difference between right and left sides, though left side being larger than the right side similar to that found with manual method.

Summary and Conclusion

The conclusion of this study are:

1. Cranial base region shows asymmetry with left side being larger than right.
2. Lower maxillary triangle region and Mandibular triangle region also shows asymmetry with left side being larger than right side.
3. Total surface area shows left side larger than the right side.
4. Cranial base region shows asymmetry with left side larger than right in males and females when done by manual and autocad method. Lower maxillary region and mandibular region shows asymmetry with left side larger than right in males when done by manual method. Mandibular region shows asymmetry with left side larger than right in females when done by manual method.
5. Measurements with Autocad method shows difference only in cranial base region similar to manual method. This could be due to segmentation into invisible grid, hence more accurate measurement.
6. One of the possible reasons for the greater amount of asymmetry in the cranial base region and mandibular region could be due to difficulty in locating the condylar point.
7. Clinically pleasing and symmetrical faces exhibit some amount of skeletal asymmetry which may not be evident because the soft tissue envelope which tries to minimize the underlying asymmetry.

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