

Prevalence of facial asymmetry in tirupathi population-a postero anterior cephalometric and photographic study

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Abstract

Aims & Objective: The human face is the most prominent aspect in human social interactions, and therefore it seems reasonable coming for orthodontic treatment is to overcome psycho-social difficulties relating to facial and dental appearance and enhance the quality of life in doing so. **Methods:** Postero anterior cephalograms and frontal photographs of 100 subjects (50 males and 50 females) were analyzed to evaluate skeletal asymmetry by the analysis suggested by **Grummons(1987)** and soft tissue facial asymmetry by using composite photographic analysis. The data were statistically analyzed using the SPSS 16.0 programme statistical analysis package software. Independent *t*-test was used to find the differences between different measurements. **Results:** All subjects showed mild asymmetry and right-sided laterality. The difference between the right and left sides were statistically insignificant ($p > 0.01$). The test revealed that only Co distance was statistically significant ($p < 0.01$).and all other values are not statistically significant. **Conclusion:** Composite photographs of hundred subjects revealed that facedness is towards right but this laterality was not statistically significant. Both posteroanterior cephalograms and composite photographs showed right-sided laterality. Gender difference in both skeletal and soft tissue asymmetry is not statistically significant.

Keywords: Composite Photographs, Facial asymmetry, Frontal Photographs, Grummon's Analysis, Photographic Evaluation, Posteroanterior Cephalometry.

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Introduction

From early times, human beauty has puzzled mankind for its variety and peculiarities. It has been argued that the degree of asymmetry in bilateral features is one of the fundamental factors underlying human attractiveness[1].

Many Epidemiological studies pertaining to facial asymmetry were done across the globe. One such study done by Goel S. et al (2003), to detect the asymmetries and their correlation with malocclusions in Karnataka population and concluded that there was decrease in magnitude of the asymmetry as higher regions of cranio-facial skeleton was approached.² Studies conducted by Profitt and Severt(1997) assessing facial asymmetries in orthodontic patients clinically found a prevalence ranging from 12% to 37% in the North Carolina, United States^{3,4}, 23% in Belgium and 21% in Hong Kong. Radiographic examination reveals values higher than 50%[3]

Mossey et al (2002) had done a similar study to evaluate the size and shape related cranio-facial skeletal asymmetries and concluded that wider left side of the face and a shorter vertical dimension on the right side[6]. Robert Kowner in a classic experiment on perception of attractiveness based on symmetry conducted in Japan has concluded that limited asymmetry may be simply more aesthetic, that is, regardless of its function[7]. Fong et al in a study conducted in Taiwan had concluded that 68% of the study population showed chin deviation to the left side and (32%) to the right side[8].

In another study Daniela Anistoroaei et al have conducted a study and concluded that facial asymmetry was present in 4.7% of patients and had also concluded that a significant correlation was evidenced between facial asymmetry and type of malocclusions, age and type of dentition[9].

While most of the studies have concluded that no quantitative differences in different types of measurements of face exists in relation to face, some studies such as the one conducted by Ercan et al concluded that the number of significantly asymmetric linear distances between the two halves of the face was greater in females than in males. Cheng in his review had concluded the symmetry of the face is highly influenced by the soft tissue landmarks[10-13].

The purpose of the present study was to evaluate the prevalence of skeletal facial asymmetry using frontal cephalograms and frontal photographs among the adults of Tirupati, Andhra Pradesh hitherto

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assessing the correlation of skeletal facial asymmetry and soft tissue facial asymmetry and also to assess the gender differences in the prevalence of facial asymmetry

Materials and methods

A total of 100 residents (50 male and 50 female) of Tirupathi, Andhra Pradesh between the age groups 18-25 years were selected for the study through randomized sampling (Table I & II). Before conduction of the study a written informed consent was taken from The sample size was calculated using the following formula

$$E = Z_{\alpha/2} \frac{\sigma}{\sqrt{n}}$$

Facial Photographs were taken with a canon power shot A 650 IS camera and by the same photographer. Subjects were made to stand and assume natural head position, so that their FH planes will be parallel to the floor. The cephalograms were taken in the PA projection.

The analysis for assessment of transverse frontal facial asymmetry was done by using frontal asymmetry analysis suggested by Grummons(1987)¹ (Fig-1). For subjective evaluation frontal photographs were assessed by using composite photographs[2,3]

the participants of the study. Ethical approval was obtained from the ethical committee. The study was entirely planned and done over a period of three months.

The inclusion criteria were clinically acceptable facial symmetry, presence of full complement of teeth, no history of pathology/trauma/surgical intervention or orthodontic treatment and no congenital abnormalities in the maxillofacial region.

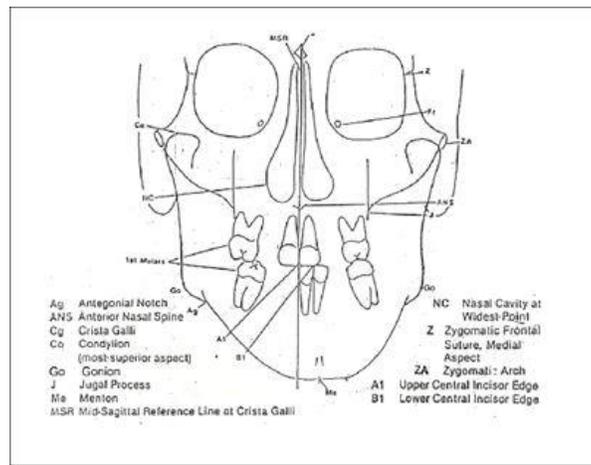


Fig-1: List of Land marks used in this study

Mid sagittal reference

This is the vertical reference line. According to Grummons (1987) MSR closely follows visual plane formed by subnasale and the midpoint between the eyes and eyebrows, so MSR was selected as the key reference line. (fig 2,3)

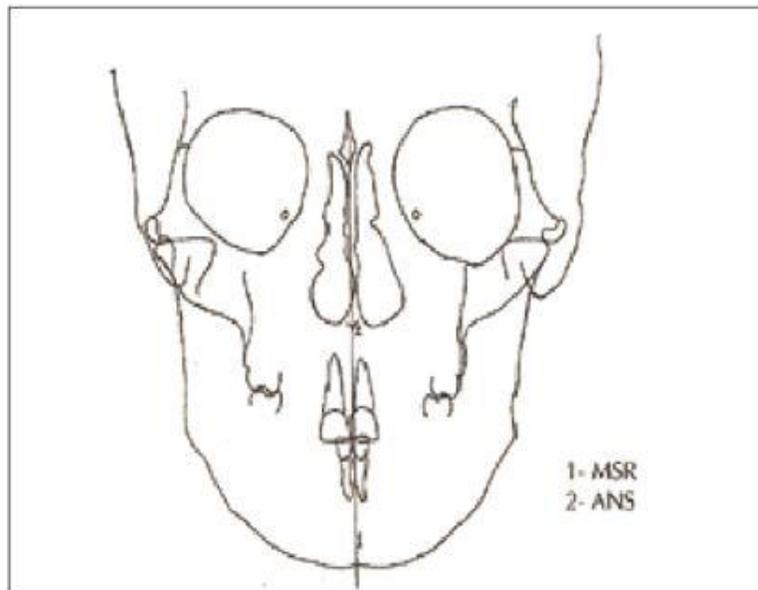


Fig-2 : Midsagittal reference line

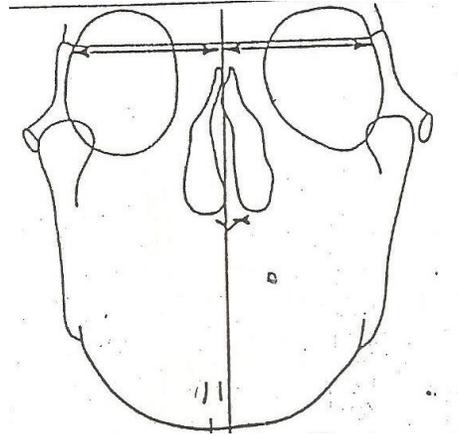


Fig-3 : Alternate methods of constructing

Horizontal planes: Four planes are drawn to show the degree of parallelism and symmetry of the facial structures. Three planes connect the medial aspects of the zygomatic frontal sutures (**Z-Z**), the centers of the zygomatic arches (**ZA**), and the medial aspects of the jugal processes (**J**). Another plane is drawn at menton parallel to the **Z** plane. (fig 4)

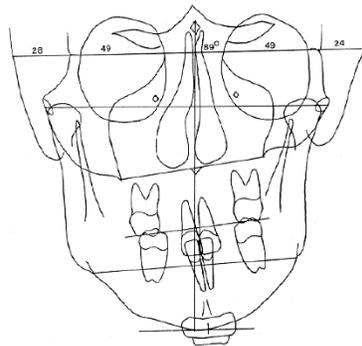


Fig-4: Horizontal plane

Mandibular morphology

Two triangles (right and left) were formed by joining the AG, Me and Co points on both sides, representing the mandibular morphology. The linear measurements for all the three sides of the triangles were recorded along with the measurements of the angles formed by joining Co, Go and Me points on both sides. (fig 5)

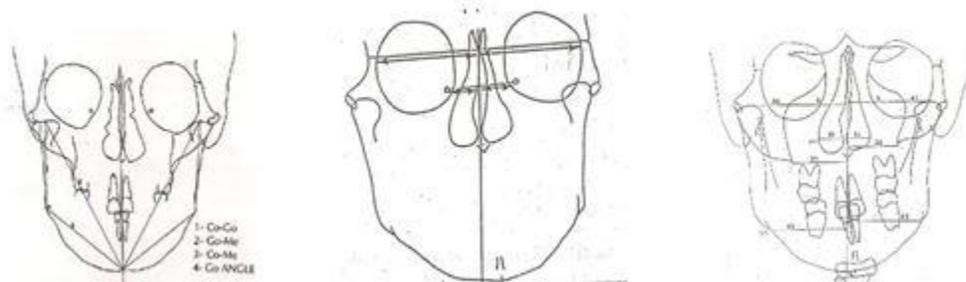


Fig-5 : mandibular morphology

Linear asymmetry (transverse)

The vertical offset as well as the linear distance is measured from **MSR** to **Co, NC, J, Ag, Go** and **Me** were measured. The linear distance to MSR from the landmarks **Co, Nc, J, Ag, Go, U, L, Me** will be calculated for paired structures the distance away from the midline will be determined for both landmarks and the difference between the distances will be calculated. For unpaired points, the horizontal distance to the midline will be determined. (fig-6)

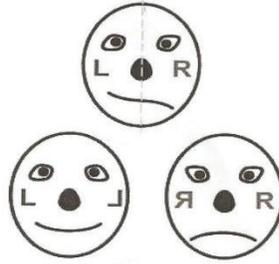


Fig-6: Linear asymmetries

L - Left Side R - Right Side

Frontal photographs of the subjects were taken and each photograph is divided into left and right sides and left half of the face and its mirror image are joined together and similarly right half of the face and its mirror image were joined to form two facial composites: L-L (Left composite); R-R (Right composite). Facedness of the sample or population refers to the side with highest total prevalence. (Fig-7)

FIG 7:Composite photographs



RESULTS

The data were statistically were collected, tabulated in Microsoft excel. The data was stastically analyzed using the SPSS 16.0 programme statistical analysis package software. Independent *t*-test was used to find the differences between different measurements and if any significance in the measurements of the right and left side dimensions. The data was checked for the normal distribution using *t*-statistics and then the correlation coefficients between the various parameters were calculated using Pearson's correlation to determine which combination would produce a higher value.

1. Linear asymmetries(transverse)

Table III shows the bilateral facial widths observed at Z, Co, Za, J, Nc, Ag, Go distances, as total widths, right side and left side.

Table 3: bilateral facial widths observed at Z, Co, Za, J, Nc, Ag ,Go distance, as total width, right side and left side.

	RIGHT		LEFT		't' value	'p' value
	Mean	SD	Mean	SD		
'Z' distance	47.257	2.25	47.129	2.166	0.144	0.676
'Co' distance	59.173	3.60	57.708	3.62	2.88	0.004**
'Za' distance	66.78	3.3	66.74	3.9	0.081	0.7
'Nc' distance	16.41	1.52	16.31	1.51	0.412	0.68
'J' distance	32.98	1.81	33.01	1.96	0.13	0.897
'Ag' distance	44.05	2.8	43.64	3.1	0.9	0.34
'Go' distance	46.72	2.65	45.81	2.81	0.862	0.429

Table IV shows total bilateral facial widths observed at Z. Co, Za, J, Nc, Ag, Go-Males. Table V shows total bilateral facial widths observed at Z. Co, Za, J, Nc, Ag, Go-Females.

Table 4: Bilateral facial widths observed at Z. Co, Za, J, Nc, Ag, Go –Males

PARAMETERS	RIGHT		LEFT		't' value	'p' value
	MEAN	SD	MEAN	SD		
Z	46.69	2.2	46.55	2.07	0.331	0.741
Co	56.24	3.9	54.27	3.0	-2.110	0.035*
Za	65.26	2.7	65.18	2.7	0.0	1.000
Nc	16.11	1.6	16.07	1.5	0.09	0.922
J	32.46	1.9	32.64	1.9	-0.469	0.64
Ag	43.07	2.6	42.81	2.9	0.463	0.644
Go	45.06	2.6	45.16	2.9	0.463	0.64

The results showed statistically significant difference between the mean Z. Co, Za, J, Nc, Ag, Go-values of males and females ($p < 0.01$). The difference between the right and left sides were statistically insignificant ($p > 0.01$). The test revealed that only Co distance was statistically significant ($p < 0.01$). The means and standard deviation of vertical distances from the right and left Z. Co, Za, J, Nc, Ag, Go to the MSR on both groups are shown in table V.

Table 5 : Bilateral facial widths observed at Z. Co, Za, J, Nc, Ag, Go - Females

	Right		Left		't' value	'p' value
	Mean	SD	Mean	SD		
Co-Go	66.87	6.0	66.12	5.7	0.88	0.37
Go-Me	58.32	5.7	58.21	4.0	0.2	0.81
Co-Me	105.001	5.6	103.79	5.7	2.62	0.09*
Gonial angle	123.67	4.5	121.99	5.9	3.557	0.003**

No significant difference was observed between males and females ($p > 0.01$).

Table VI, VII and VIII shows bilateral widths of Co-Go, Go-Me, Co-Me and Gonial Angle to assess the Mandibular Morphology. ($P < 0.05$) There is statistically significant difference between the mean Co-Me value and gonial angle of right and left sides.

Table 6 : Vertical offset of Z. Co, Za, J, Nc, Ag, Go

	TOTAL NO	MALES		TOTAL NO	FEMALES		't' value	'p' value
		MEAN	SD		MEAN	SD		
'Z' distance	1	1		1				
'Co' distance	34	3.18	1.62	32	2.28	1.47	2.18	0.032
'Za' distance	33	2.9	1.3	25	3.2	1.5	0.631	0.531
'Nc' distance	16	1.93	0.854	19	1.097	0.25	0.673	0.506
'J' distance	31	3.66	7.71	24	2.865	1.219	0.999	0.322
'Ag' distance	26	2.8	1.9	27	3.2	1.8	0.717	0.476
'Go' distance	26	2.8	1.926	27				

Table 7: Total bilateral widths and Gonial angle to assess the mandibular morphology

	Right		Left		't' value	'p' value
	Mean	SD	Mean	SD		
Co-Go	67.42	4.6	66.12	7.8	0.47	0.504
Go-Me	58.84	3.9	58.12	4.4	0.88	0.37
Co-Me	108.58	5.2	106.33	5.6	2.06	0.042*
Co-Go-Me	122.98	4.7	119.48	6.4	3.1	0.003**

Table 8: Bilateral widths and Gonial angle to assess the mandibular morphology in males

PARAMETERS	RIGHT		LEFT		't' value	'p' value
	MEAN	SD	MEAN	SD		
Z	47.81	2.31	47.69	2.07	0.273	0.785
Co	59.77	3.08	57.025	3.6	-2.625	0.010*
Za	68.26	3.3	68.24	3.1	0.031	0.975
Nc	16.68	1.38	16.49	1.36	-0.691	0.491
J	33.27	1.8	33.65	1.9	0.74	0.461
Ag	45.01	3.1	44.57	2.7	0.732	0.466
Go	47.63	3.1	46.57	2.7	0.862	0.429

Table 9: Bilateral widths and Gonial angle to assess the mandibular morphology in females

	Right		Left		't' value	'p' value
	Mean	SD	Mean	SD		
Co-Go	61.02	7.8	59.24	4	1.025	0.263
Go-Me	58.80	3.18	58.30	3.6	0.957	0.34
Co-Me	103.24	5.08	101.22	4.54	2.113	0.037*
Co-Go-Me	124.36	4.3	121.34	5.11	3.62	0.002**

Table X shows Mandibular offset at menton. Menton deviated to left side in 55% (2.6 ±1.4mm) and deviated to right in 3% (1.6 mm. ±0.28). In 58% males there is deviation towards left (2.8 ± 1.6). Whereas towards right in 2% (1.5 m). In 52% females deviation towards left (2.4 ± 1.02) and towards right 4% (1.7 ±0.3mm.) The difference between males and females is statistically insignificant (p > 0.01).

Table 10: Mandibular offset at menton.

Me	Left			Right		
	No	Mean	SD	No	Mean	SD
Total	55	2.6	1.42	3	1.6	0.28
Males	29	2.8	1.6	1	1.5	-
Females	26	2.4	1.02	2	1.7	0.3

Table XI shows Parallelism of facial structures .Mean angles formed by Z ,Za , J, Me ,and occlusal planes with MSR shows that there was no statistically significant canting observed. The difference between males and females is statistically insignificant.

Table 11: Parallelism of facial structures

	MEAN	SD
'Z' plane Z-MSR	89.863	0.94
'Za' plane Za-MSR	89.76	0.62
'J' plane J-MSR	89.78	0.71
Plane at Me Me-MSR	90.09	0.7
Occlusalplane MSR-OCC	89.0	1.2

Tables XII, XIII shows the sidedness of the face by subjective evaluation of composite photographs of 100 subjects. Out of a total of 100 subjects, it was observed that 81 were right faced (R-R) and 19 were left faced. 39 Males were observed as right faced (R-R) and 11 were observed to be left faced (L-L). Where as in females 42 were observed as right faced (R-R) and 8 were observed to be left faced (L-L). Therefore it shows that both in males and females facedness is towards right and female faces were more right faced than males. ('p' > 0.01)

Table 12: Composite photographic analysis -sidedness of face

Total	Right Faced	Left Faced	Faced Ness
100	81	19	Right

Table 13: Composite photographic analysis in males and females

Sex	R-R	L-L
M	39	11
F	42	8

Discussion

Asymmetries in the human craniofacial skeleton are a rule rather than exception. This has been verified and stressed upon by many researchers dating back from Thomson(1943),Lundstrom, (1961),Shah and Joshi, (1978); Peck & Peck, (1991) and Garnet al (1996).

A postero-anterior cephalometric radiographic study of 100 subjects with pleasing symmetrical faces and normal occlusions was conducted with the objective of evaluating the extent of facial asymmetry and **frontal photographs** were taken and studied for subjective evaluation of facial asymmetry seen in the selected Tirupati population. The frontal analysis suggested by Grummons was used to assess the patients for the transverse (skeletal) facial asymmetries as it provides clinically relevant information about specific locations and amounts of facial asymmetry and measures mandibular morphology, which can be seen clinically to play the major in asymmetries.

The results of the present study (Table I) showed that the bilateral total widths of Z, Co, Nc, Ag and Co on right side was greater than those on left side but the difference was statistically insignificant except for Co. Only the Co distance was statistically significant ($p < 0.01$).

Table 1: Sample size and Mean age group of the sample.

Total sample	Age range	Males	Females
100	18-25 yrs	50	50

This shows that asymmetry is present more in the condylar region and towards right side. Similar findings were reported by **Farkas and Cheung (1987)**⁴. The difference between the right and left side mean absolute asymmetry for Z, Nc, J distances are less than those for Co, Ag, Go. These are in agreement with findings of **Letzer and Kronman (1967)**¹⁴ and **Peck et al (1991)**¹⁵.

None of the studies on facial asymmetry measured vertical offsets. In the present study vertical offsets of Z, Co, Za, J, Nc, Ag, Go were also measured and no statistical difference between males and females ($p > 0.01$).

For the assessment of the mandibular morphology CO-Ag; CO-Me and Ag-Me and gonial angle were statistically analyzed (Table II).

Table 2: Mean age group of the study groups

Total sample	sex	Mean age	SD
50	males	20.92 yrs	2.3 yrs
50	females	20.92 yrs	1.9 yrs

Gonial angle ' $p < 0.001$ ' showed statistically significant value at 1 % level length. The possible cause of asymmetry in gonial angle are asymmetry functional patterns such as unilateral chewing patterns, muscular atrophies etc as suggested by Shah and Joshi(1978)¹⁶. It shows that gonial angle is the only region where the right side is larger than the left side. Mandibular length (Co-Me), Gonial angle (Co-Go,Me), showed statistically significant difference between right and left sides, right side being larger in total as well as in males and females. This is in accordance with a similar study conducted by **Shah and Joshi (1978)**[16] and **Azevedo et al (2006)**[17]

Chin deviations in our study showed a left sidedness which is in agreement with findings of **Severt and proffit (1997)**[3]. The high incidence of chin deviation may be due to the asymmetries of mandibular length, which also showed high incidence. The possible reason given by **Woo (1931)** is the increased size of the right hemisphere of brain. The right side dominance in brain affects the functional activities and facial structures[18]

The mean values obtained for the angles formed by the various planes used in this analysis were more or less parallel to each other. These findings are in agreement with **Ricketts and Grummons (2003)**[19]

In our study on composite photographic analysis it was observed that 81% shows right sidedness and 19% shows left sidedness. The findings in our study are in concordance with **Scott Hardie et al (2005)**¹¹, **Seiji Haraguchi et al (2008)**[10]

Mild asymmetry was observed both in males and females with males having wider faces than females. 'Co' distance showed statistically significant right sidedness ($p < 0.01$). Me-Co length showed statistically significant right sidedness in total ($p < 0.01$), males ($p < 0.05$), females ($p < 0.05$). The findings in our study are in concordance with many studies. but left side laterality was observed in few a studies[2,4,16,18-21]

78% of males and 88% females, were observed as right faced (R-R) on composite photographic analysis. The difference between males and females was statistically insignificant ($p > 0.01$). The findings in our study are in concordance with those carried out by **Farkas and Cheung (1981)**⁴, **Ferrario Virgilio et al (2001)**²⁴. The findings in our study differ with **Smith W M (2000)**²⁵.

According to Kim et al²⁶, generally skeletal deviation must be greater than 4 mm in order to render the asymmetry visible in an individual's face. For this reason, other authors consider an asymmetrical face as having bone deviations equal to or greater than 2 mm. This might be the major drawback of the study because the present study utilized photographs also for determining the depth of facial asymmetries.

Some other main limitations of the study are the errors in identifying the anatomical landmarks in PA cephalograms due to superimposition of many cranio-facial structures. A 3-dimensional topographic study or Cone beam computed tomography could be used in the future to diagnose facial asymmetries. Complete CBCT software to identify different landmarks three dimensionally could also be helpful in marking the facial asymmetries. Other advanced means such as the use of stereophotogrammetry[27-29] (3-dimensional photography) or quantifying facial soft tissue asymmetry by a 3D imaging based method[30-32] or use of the weibull distribution-based comparison of a person's asymmetry with respect to a large sample of symmetrical faces would be more accurate [27,33,34]

SUMMARY AND CONCLUSION

All subjects showed mild skeletal asymmetry on postero-anterior cephalograms which was not statistically significant. Composite photographs of hundred subjects revealed that facedness is towards right but this laterality was not statistically significant. Both postero-anterior cephalograms and composite photographs showed right-sided laterality. Gender difference in both skeletal and soft tissue asymmetry is not statistically significant.

In the evaluation for an orthodontic treatment, asymmetry of the face should be considered and may only be noticed with a morphometric analysis. The present data may be of use for future clinical studies but studies with larger sample at different geographical locations is warranted. A classification for asymmetry based on the data collected for the Asian group would be useful for future research on this subject.

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