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A centrographic appraisal of skeletal class III malocclusion

[1]Dr. Prateek Shakti, MDS (Orthodontics), Senior Resident, All India Institute of Medical Sciences, Bhopal

[2]Dr. Suja Ani G, MDS (Orthodontics), PhD, Professor and Head, Government Dental College, Kottayam

[3]Dr. Elbe Peter, MDS (Orthodontics), PhD, Associate Professor, Government Dental College, Kottayam

Corresponding author: Dr. Prateek Shakti, MDS (Orthodontics), Senior Resident, All India Institute of Medical Sciences, Bhopal

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Abstract

Introduction: Non numeric facial analyses has always been in need for evaluation of facial forms individually rather than comparing individual's facial measurements with the pre-established facial norms. The aim of the study was to compare the centroid geometry in two groups of Class III malocclusions and to check for any statistically significant difference between them with respect to horizontal and vertical skeletal, dental and soft tissue features.

Methods and Material: Cephalograms of 40 patients with Class III malocclusion were divided in two groups [Group 1 (ANB angle>-4), Group 2 (ANB angle≤-4)]. Centrographic analysis was performed on all the cephalograms to evaluate the vertical skeletal relation, horizontal skeletal relation, dental and soft tissue relation. Unpaired t-test was performed to compare the means between two groups.

Results: A highly significant difference was observed in horizontal skeletal evaluation between the two groups ($p < 0.001$). Also, a statistically significant difference was observed in lower incisor to Point A- Pogonion (Pt. A-Pog) value between the two groups ($p<0.05$). No significant difference was seen in all the other parameters between the two groups.

Conclusions: The horizontal skeletal relation between the two groups showed statistically significant difference as the Upper centroid was positioned posterior to vertical centroid plane by 2.84mm in Group 1 and by 5.47mm in Group 2. Also, a statistically significant difference was seen in the lower incisor to Pt. A- Pog value between the two groups ($p <0.05$); values being 5.89mm (Group 1) and 7.83mm (Group 2).

Keywords: Centrographic analysis, Centroid, Angle Class III malocclusion

Introduction

Class III malocclusion shows a range of prevalence,[1] being most common among Chinese and Malaysian [2-4] and less among Europeans[5]. Skeletal

variations[6], cranial base[7] and maxillary hypoplasia[8] in skeletal Class III have been reported.

Cephalometric analysis involves lines/planes through anatomical landmarks[9]; a centroid approach defines two relatively stable lines, for analyzing craniofacial changes.[10] Fishman et al evaluated centroid geometry[11]; application of this among south Asian is attempted in this study.

The present study aimed to compare the facial, upper and lower centroid positions; the objectives were to evaluate angles (Na-Ba-Pt.A, Pt.A-Ba-Gn); lip and incisor positions, in Class III malocclusion.

Subjects and methods

The present study is a descriptive cross-sectional study conducted in Department of Orthodontics. Institution ethics committee clearance was obtained prior to the conduct of the study (IEC/M/14/2017/DCK dated 20/10/2017). Lateral cephalograms of 40 patients with Class III malocclusion who reported for orthodontic treatment in the post graduate clinic of the Department of Orthodontics were divided into two groups, designated as Group 1 (ANB>-4) and Group 2 (ANB≤-4). The cephalograms were manually traced on a matte acetate paper using 3H lead pencil and landmarks were identified as Sella(S), Nasion(Na), Basion(Ba), Point A(Pt. A), Gnathion(Gn), Cranial centroid(CC), Facial centroid (FC), Upper centroid(UC) and Lower centroid(LC). Landmarks were marked as per standard textbook definitions.[12,13] The centroid plane was constructed perpendicular to the Ba-Pt.A plane through FC. All tracings were performed by a single operator to avoid bias. A Kappa of 0.88 and 0.97 ensured good intra observer and inter observer reliability. The centroids are defined as shown in Figure 1.

1. The Facial Centroid represented by triangle Na-Ba-Gn
2. The Upper Centroid represented by triangle Na-Ba-PtA
3. The Lower Centroid represented by triangle Pt.A-Ba-Gn

A vertical skeletal evaluation of facial balance based on the relationship of Facial Centroid to Ba-Pt.A planes and horizontal skeletal evaluation of facial balance based on relations of Upper Centroids and Lower Centroid to the vertical Centroid Plane (CP) was done for Group 1 and Group 2.

The data was entered on a Microsoft excel (Microsoft Corporation, Redmond, USA) spread sheet and imported to SPSS version 16 (SPSS Inc., Chicago, USA) for statistical analysis. Unpaired t-test was performed to compare the means between groups. The significance level of $p<0.05$ was considered as significant for all statistical tests.

Results

Results are presented in Table 1. The Facial Centroid was positioned above the Ba-Pt.A plane by 0.761 mm in Group 1 and by 0.500 mm in Group 2 suggestive of vertical lower face deficiency in both the groups. The Upper Centroid (UC) was located posterior to vertical CP by 2.84mm in Group 1 and by 5.47 mm in Group 2 suggestive of sagittal maxillary deficiency in both the groups whereas the Lower Centroid (LC) was positioned anterior in vertical CP by 2.45 mm in Group 1 and by 2.67 mm in Group 2 suggestive of sagittal mandibular excess in both the groups. However, the difference was found to be statistically significant only for upper centroid position and not for lower centroid.

The Na-Ba-Pt.A angle was found out to be 33.26^0 in Group 1 and 33.97^0 in Group 2 while the Pt.A-Ba-Gn angle was found out to be 29.28^0 in Group 1 and 27.76^0 in Group 2. The values suggested vertical inequality of upper and lower halves of the face; however, the difference was not statistically significant ($p>0.05$).

The long axis of the upper incisor was located posterior to orbitale by 7.30 mm in Group 1 and by 8.05 mm in Group 2 suggestive of proclined upper incisors in both the groups; and the long axis of the lower incisor was found to be positioned anterior to a point at 1/3rd of the symphysis by 3.13 mm in Group 1 and by 2.41 mm in Group 2 indicating retroclined lower incisors in both groups. No statistically significant difference was found in both groups (p>0.05).

The lower incisor tip was positioned anterior to the Pt. A-pog line by 5.89 mm in Group 1 and 7.83 mm in Group 2 indicative of forwardly placed lower incisors in both groups and a statistically significant difference was also observed between the two groups. Also, the lower incisor tip was positioned above the incisal plane by 1.13 mm in Group 1 and 2.23 mm in Group 2 suggestive of highly placed lower incisors in its jaw base in both groups.

The upper lip was positioned anterior to the centre of V-shaped area formed by Sn-pog-nasal tip line by 0.65 mm in Group 1 and 0.41 mm in Group 2 suggestive of mildly protrusive upper lip in both groups. While the lower lip was positioned anterior to the centre of V- shaped area formed by Sn-pog-nasal tip line by 3.95 mm in Group 1 and 5.23 mm in Group 2 indicative of protrusive lower lip in both groups. No statistically significant difference was observed in soft tissue evaluation in both groups (p>0.05).

A statistically significant difference was observed in the horizontal skeletal evaluation based on the relationship of UC to the vertical CP between the two groups (p <0.001). Also, a statistically significant difference was observed in the lower incisor to Pt. A- pog value between the two groups (p<0.05). There was no significant difference seen in all the other parameters between the two groups (p>0.05).

Discussion

Traditional cephalometry depends upon measuring the relationship of anatomical points and lines (or planes) to each other.[10] A new approach to cephalometric measurement based on centers of area, i.e. centroids, has been developed to overcome the pitfalls of conventional liner and angular measurements. A suite of programs was described by Wastell[9] for performing centroid analyses ranging from analysis of facial and cranial segments to template matching of cyclical curves. Leonard Fishman[14] has taken an unconventional approach to facial harmony; his "centrographic analysis" uses four triangles, constructed over the cranium, upper face, lower face, and overall face on two-dimensional cephalometric radiographs; According to the relationships of the centroids of these triangles and various anatomic structures, facial harmony and symmetry is evalated.[11]

Many of the present ‘norms’ or average values for various cephalometric parameters are now relied upon the assumption that these average, or mean, values should be considered as treatment goals; but the average, or mean, appearance would fall ‘squarely in the middle’ and 'Treating to the mean' may or may not result in an esthetically desirable outcome.[11] Centroid analysis holds great promise in surgical orthodontics. The reliability of centrographic analysis have been established before for the studied population.[15]

Centroid is defined as the center of mass or center of gravity in a three dimensional object or a two dimensional area.[12] The centroid of the triangle is geometrically constructed by dividing either 2 or 3 sides of the triangle and connecting the midpoints with the opposite vertices. But it is also clear that since all the 3 planes intersect at 1 point, only 2 intersecting planes are required. According to Nanda and Kapila,[12] as the face increases in size with growth, even though the skeletal triangular area increases,

the centroids demonstrate relative stability; this relative positional stability demonstrated by the centroids is a fundamental principle on which centrographic analysis is based. After the eruption of first permanent molars, the upper and lower facial areas demonstrate vertical equality or minimal difference in values, in well balanced faces. This has been demonstrated by longitudinal comparison of Na-Ba-Pt.A and Pt.A-Ba-Gn angles.

For vertical evaluation, the position of facial centroid is assessed in relation to Ba-pt.A line. In a well-balanced face, the facial centroid should lie on the Ba-pt.A line.[12] In the present study, it was found to be present above the Ba-pt.A line by 0.761mm in Group 1 and 0.500mm in Group 2. However, this difference was not statistically significant. In contrary to this, Vanessa Costa Farias et al[16] has reported increased posterior facial height in children with Class III malocclusion earlier. Ellis and Mcnamara[17] has reported increased lower facial height in Class III adults.

The position of the upper centroid determines the sagittal position of maxilla which lies on the vertical centroid plane in well balanced faces.[12] In the present study, the upper centroid was found to be present posterior to the vertical centroid plane by 2.48mm in Group 1 and 5.47mm in Group 2. This difference was statistically significant. This finding agrees with many cephalometric studies that have identified a retrognathic maxilla is skeletal class III subjects.[17-22]

The position of the lower centroid determines the sagittal position of mandible which lies on the vertical centroid plane in well balanced faces.[12] In the present study, the lower centroid was found to be present anterior to the vertical centroid plane by 2.45mm in Group 1 and 2.67mm in Group 2, and this difference was not statistically significant. These findings also agree with previous cephalometric studies suggesting mandibular prognathism in Class III subjects.[16,17,20,21,22]

According to Nanda and Kapila,[12] well balanced faces, the upper and lower facial areas show vertical equality, as evaluated by the longitudinal comparison of posterior facial angles (Na-Ba-pt.A and Pt.A-Ba-Gn). In the present study of Class III patients, the Na-Ba-Pt.A angle was found to be 33.26^0 in Group 1 and 33.97^0 in Group 2, and this difference was not statistically significant (p=.389). The lower facial angle, Pt.A-Ba-Gn, was found to be 29.28^0 in Group 1 and 27.76^0 in Group 2. However, this difference was also statistically insignificant (p=.106). Previous cephalometric studies have shown increased posterior facial height in Class III subjects.[16,17,22]

The upper incisor angulation is evaluated by comparing the long axis of upper incisor to the orbitale. In well balanced faces, the long axis of upper incisor coincides with the orbitale.[12] In the present study on Class III patients, the long axis of upper incisor was found to be posterior to orbitale by 7.30mm in Group 1 and 8.05mm in Group 2, suggestive of proclined upper incisor in both the groups. But this difference was not statistically significant (P>0.05). The above finding is agreement with previous cephalometic studies suggestive of proclined maxillary incisors in Class III cases.[17,20,21]

Angulation of the lower incisors is evaluated by its relation to the symphysis. In normal individuals, the long axis of the lower incisor approximates with the one third mark of the Ba-Gn plane as it crosses the symphysis.[12] In the present study of Class III patients, the long axis of lower incisor was found to be passing anterior to a point at one third of the symphysis by 3.13mm in Group 1 and 2.41mm in Group 2 suggestive of retroclined lower incisor in both the groups but this difference was not statistically significant.

Positionally, the tip of the lower incisor should coincide or lie slightly in front of the Pt.A-pog line, in normal individuals.[12] In the present study, the lower incisor tip was found to be anterior to the Pt.A-pog line by 5.89mm in Group 1 and 7.83mm in Group 2 suggestive of forwardly placed lower incisors in both the groups with a statistically significant difference seen between the two groups (p=0.038).

Vertically, the tip of the lower incisor should approximate at the level of the incisal plane in well balanced faces.[12] In the present study, the tip of the lower incisor was found to be positioned superior to the incisal plane by 1.13mm in Group 1 and 2.23mm in Group 2 suggestive of a superiorly placed lower incisors in both the groups. However, this difference was not statistically significant.

The retroclined lower incisors in the present study, is in agreement with the findings of Marcus Barreto Vasconcelos et al[20] who reported retroclined lower incisors in Brazilian Class III subjects and Baratali Ramezanzadeh et al[21] who had similar observation in Iranian Class III subjects. Similar findings were also reported by Ellis and Mcnamara[17] in their study of Class III subjects. However, the retroclined lower incisor in the present study is not in agreement with the findings of Camelia Szuhanek et al[22] who reported proclined lower incisors in Romanian Class III patients.

Soft tissue balance is evaluated by utilizing two planes at the same time (ST pog- subnasale and ST pog- nasal tip). This graphically provides a V-shaped area to evaluate both the lips. When the lips occupy one half the space within this area, they are said to be in balance with the rest of face.[12] In the present study on Class III patients, the upper lip was found to be positioned anterior to the center of V-shaped area by 0.65mm in Group 1 and 0.41mm in Group 2, indicative of slightly forwardly placed upper lip in both the groups with no statistically significant difference between the two groups. Camelia Szuhanek et al[22] has reported retruded upper lip in Romanian Class III subjects. The lower lip was found to be positioned anterior to the center of V- shaped area by 3.95mm in Group 1 and 5.23mm in Group 2, indicative of forwardly placed lower lip in both the groups with no statistically significant difference between the two groups. This finding is similar to Camelia Szuhanek et al[22] who reported protruded upper lip in Romanian Class III subjects.

The present study differentiates between Skeletal Class III malocclusion of different degrees of severity and contributes to the work of authors in analyzing and comparing cephalometric changes of facial soft tissue in patients with skeletal class III problems.

Before surgery, the Upper lip to E-line distance was -7.31 ± 2.88 mm, Lower lip to E-line distance was -1.44 ± 3.79 mm i.e. the lips were positioned forward.[23] In the present study also, the lips, both upper and lower were positioned forward in both the groups in the study, with no statistically significant difference between both the groups.

Limitation of the study includes; a lack of comparison with normal skeletal class I subjects belonging to the geographical area of study. The values were compared to the prescribed norms for Caucasians. An immediate clinical outcome of the study is to consider the maxillary deficiency component in severe class III subjects especially when treating them surgically. Performing single jaw surgery to reduce morbidity may compromise the esthetic out come in such patients.

Conclusions

This study evaluated the skeletal and dental position and relations in two groups of true class III malocclusion using a centerographic analysis. To our knowledge no such comparative studies have been done before. The following conclusions were made;

1. A statistically significant difference was observed in the horizontal skeletal evaluation ($p < 0.001$) as the Upper centroid was positioned posterior to vertical CP by 2.84mm in Group 1 and by 5.47mm in Group 2.This is suggestive of a more retrognathic maxilla in severe skeletal class III subjects under study.
2. A statistically significant difference was observed in the lower incisor to Pt. A- pog value between the two groups ($p < 0.05$), the values being 5.89mm in Group 1 and 7.83mm in Group 2.
3. No statistically significant difference was observed in vertical maxillary, position, sagittal mandibular position, upper and lower incisor angulations and soft tissue relation between 2 groups of skeletal class III malocclusion.

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Legends Figure

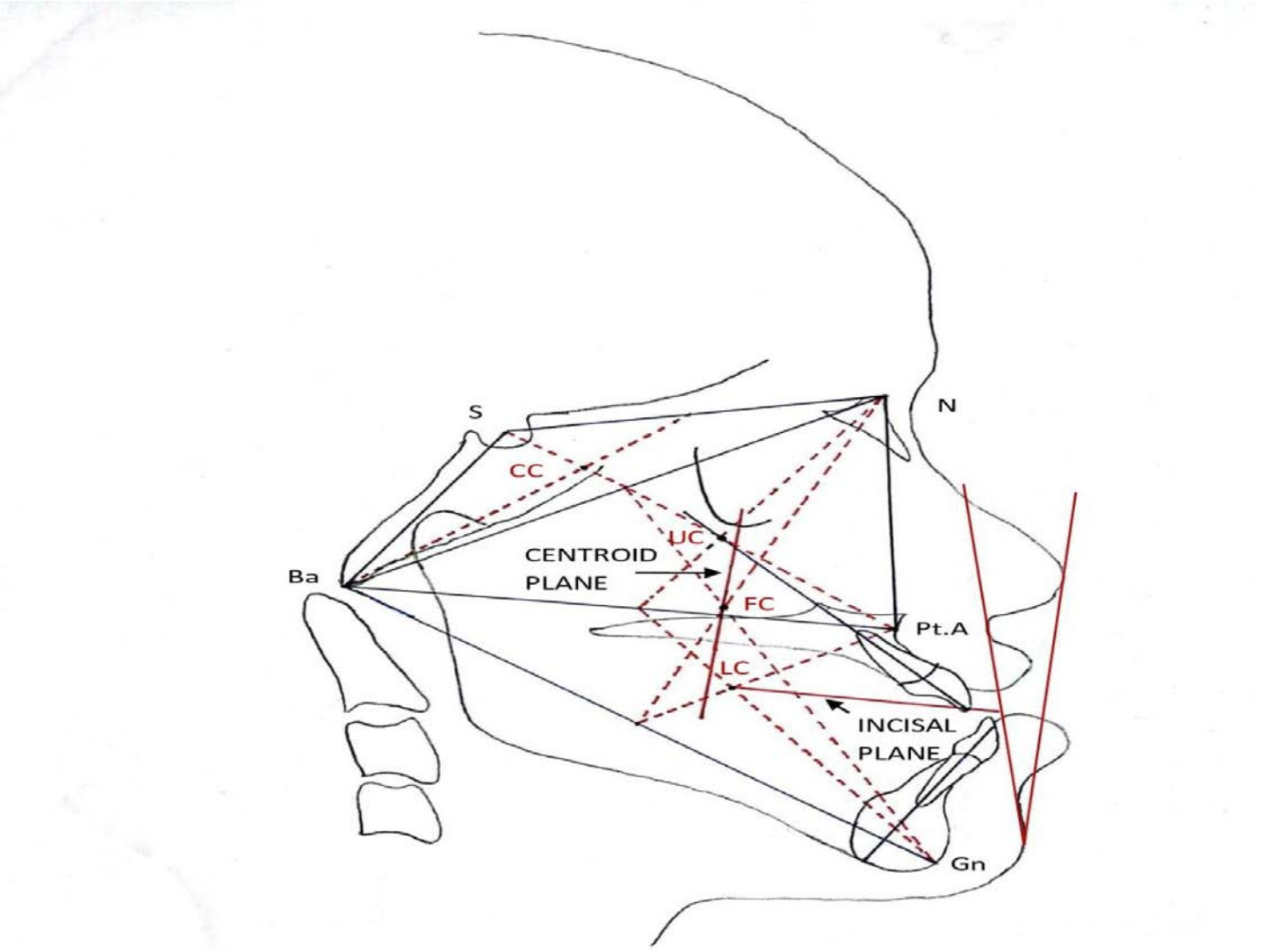

Figure 1:Figure showing components of the Centrographic analysis

Figure 1: Figure showing components of the Centrographic analysis

1. Landmarks

a. S – Sella

b. N – Nasion

c. Ba – Basion

d. Pt.A – Point A

e. Gn – Gnathion

2. Centroids

a. CC – Cranial Centroid

b. FC – Facial Centroid

c. UC – Upper Centroid

d. LC – Lower Centroid

3. Plains

a. Centroid plane

b. Incisal plane

Table 1. Comparison between mean and SD in Group I and Group II using independent t test.

Parameter	Group	N	Mean±SD	Std. Error Mean	P value
Facial Centroid Vertical	1	23	0.761±1.5141	0.3157	0.634
	2	17	0.500±1.9203	0.4657	
Lower Centroid horizontal	1	23	2.457±1.0651	0.2221	0.633
	2	17	2.676±1.8109	0.4392	
Upper Centoid horizontal	1	23	-2.848±1.6127	0.3363	0.000*
	2	17	-5.471±2.0877	0.5063	
N-Ba-Pt.A angle	1	23	33.261±2.7464	0.5727	0.389
	2	17	33.971±2.2394	0.5431	
Pt.A-Ba-Gn angle	1	23	29.283±2.5886	0.5398	0.106
	2	17	27.765±3.2167	0.7802	
Upper Incisor to Orbitale	1	23	7.304±5.7579	1.2006	0.654
	2	17	8.059±4.3977	1.0666	
Lower Incisor to Symphysis	1	23	3.130±1.5316	0.3194	0.166
	2	17	2.412±1.6699	0.4050	
Lower Incisor to A-Pog	1	23	5.891±2.4493	0.5107	0.038*
	2	17	7.835±3.2880	0.7975	
Lower Incisor to Incisal Plane	1	23	1.130±1.2081	0.2519	0.134
	2	17	2.235±3.1776	0.7707	
Upper Lip to Sn-Pog	1	23	0.652±2.4422	0.5092	0.769
	2	17	0.412±2.6765	0.6491	
Lower Lip to Sn-Pog	1	23	3.957±2.1738	0.4533	0.098
	2	17	5.235±2.5807	0.6259	

*significant