

# An Evaluation of Centrographic Analysis as Compared with Conventional Cephalometric Analysis

<sup>1</sup>AB Nehete, <sup>2</sup>PV Hazare

## ABSTRACT

**Objective:** This study was undertaken to find whether persons with well-balanced face and normal occlusion demonstrate variation in skeletal and facial morphology and to evaluate the applicability of centrographic analysis as compared with conventional cephalometrics.

**Materials and methods:** Lateral cephalograms of 50 individuals consisting of 18 males and 32 females in the age range of 18 to 25 years with normal occlusion and well-balanced pleasing profile were selected. Lateral cephalograms for these individuals were evaluated by centrographic analysis and cephalometric analysis in A-P plane and vertical plane.

**Results:** As per centrographic analysis, Class I skeletal pattern was observed in 34%, Class II in 10% and Class III in 56%. In vertical plane, 38% of cases had normal growth pattern, 42% of cases had horizontal growth pattern and 20% of cases had vertical growth pattern. Comparison of centrographic analysis with cephalometric measurements revealed significant differences. In A-P plane, Class III type of skeletal morphologic pattern is more common while in vertical plane, horizontal growth pattern is more common when evaluated with centrographic analysis.

**Conclusion:** Individuals belonging to same sample group and with well-balanced skeletal and soft tissue profiles and normal occlusion demonstrated wide variations in craniofacial structure as evaluated with centrographic analysis and routinely used conventional cephalometric measurements.

**Keywords:** Centographic analysis (CGA), Centroid, Cephalometrics.

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## INTRODUCTION

Cephalometrics is an established diagnostic and research tool in orthodontic practice. Its primary role has been the evaluation of facial form through the use of angular and linear measurements. The large majority of cephalometric analyses numerically compare the findings with norms obtained from preselected normal subjects.

However, each individual expresses his/her own unique pattern of craniofacial development. Hence, morphologic homogeneity within these preselected 'normal' samples may not exist. Therefore, the concept of numerically comparing such norms and its application for evaluating the individuals who do not demonstrate anatomic homogeneity may subject to

inaccuracy. Also, existing cephalometric analyses are based on chronological ages rather than maturational age and thereby, ignoring the individualized uniqueness of maturational development.<sup>1</sup>

Identifying the morphologic and developmental uniqueness of a person is certainly a desirable goal for the clinician. Treatment modality and treatment timing can be advantageously planned and coordinated, thereby achieving more optimum results that benefit the patient. Therefore, a need has always been felt for nonnumeric facial analyses that would not compare an individual's facial measurements with the preestablished norms, rather evaluate the facial form individually and would help in diagnosis and treatment planning unique to that individual.

Many investigators like Camper,<sup>2</sup> Simon,<sup>3</sup> Decoster<sup>4</sup> and Moorees,<sup>5</sup> Koski<sup>6</sup> and Sassouni,<sup>7</sup> and Johnson<sup>8</sup> presented different facial analyses that focus on a nonnumerical morphologic evaluation of the individual. Dipaolo R<sup>9</sup>, introduced quadrilateral analysis that was a nonnumeric analysis. Johnson JS<sup>8</sup> emphasized the application of centroids for the evaluation of cranial and facial structure.

Leonard Fishman,<sup>1</sup> introduced the centrographic analysis (CGA), which is a nonnumeric, centroid-based analysis for evaluation of skeletal and facial form.

Based on the principles of centroid orientation,<sup>1</sup> the centrographic analysis demonstrates vertical and horizontal balance and disharmony in skeletal, dental and soft tissue form and position. The centrographic analysis provides the clinician an individualized approach to cephalomorphic evaluation.

<sup>1</sup>Reader, <sup>2</sup>Professor and Head

<sup>1</sup>Department of Orthodontics and Dentofacial Orthopedics, Mahatma Gandhi Vidyamandir Dental College and Hospital, Nashik Maharashtra, India

<sup>2</sup>Department of Orthodontics and Dentofacial Orthopedics, Sharad Pawar Dental College and Hospital, Wardha, Maharashtra, India

**Corresponding Author:** AB Nehete, Reader, Department of Orthodontics and Dentofacial Orthopedics, Mahatma Gandhi Vidyamandir Dental College and Hospital, Nashik, Maharashtra India, e-mail: dr\_amit0202@yahoo.com

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This study was carried out with following objectives:

To find whether persons having clinically well-balanced facial profile and normal occlusion will demonstrate a variation in skeletal and facial morphology. To find the applicability of centrographic analysis to evaluate the skeletal form and to compare it with conventional cephalometric measurements.

**MATERIALS AND METHODS**

A total of 50 individuals consisting of 18 males and 32 females (ages 18-25 years) with normal occlusion and well-balanced facial profiles were selected for the study. All individuals had pleasing profile with well-balanced facial proportions, normal occlusion with normal overjet and overbite, molar relationship Class I, full complement of teeth were present and no previous orthodontic treatment was taken.

Lateral cephalograms were taken and analyzed by applying the principles of centroid orientation cephalomorphically. The term ‘cephalomorphic analysis’ is more appropriate as it implies a non-numerical analysis of morphology. Conventional cephalometric measurements were also done. Centroid represents the center of mass or gravity of a two-dimensional area or a three-dimensional volume. The centroid is constructed by the intersection of two or three planes derived by connecting a triangular vertex to the midpoint of the opposing side as shown in Figure 1.

The following centroids are used in this study:

1. Facial centroid—Fc point of triangle (Ba-Na-Gn) represents total face.
2. Upper facial centroid—Uc point of triangle (Ba-Na-A) represents upper face.
3. Lower facial centroid—Lc point of triangle (Ba-A-Gn) represents lower face.

In addition, SN plane, functional occlusal plane, Na-Me plane, centroid plane (perpendicular to Ba-A plane passing through Fc) and mandibular plane were used in this study.

Applying the Archimedes principle very superficially to facial form, if two adjacent triangles representing the upper face and lower face are equal in size and share the two common sides (Ba-A and Na-Gn plane), the two centroids representing the smaller triangles and centroid representing the larger combined triangle are all positioned along a common centroid plane that is perpendicular to Ba-A plane. The centroid representing the total face (Na-Ba-Gn) is positioned on the common side (Ba-A plane) (Figs 2 and 3).

In sagittal plane, the anteroposterior position of the Uc, Lc points with respect to the centroid plane was studied for evaluating sagittal relation.

In vertical plane the vertical position of the facial centroid with respect to Ba-A plane was studied for evaluating vertical plane disharmony.

The cephalometric measurements used in the study were SNA angle, SNB angle, ANB angle, SN-SGn angle, SN-GoGn angle, Wit’s appraisal, Jarabak’s ratio and AUFH/ALFH ratio.

The measurements thus obtained by nonnumeric approach, i.e. centrographic analysis (CGA) and conventional cephalometrics were compared in anteroposterior and vertical plane.

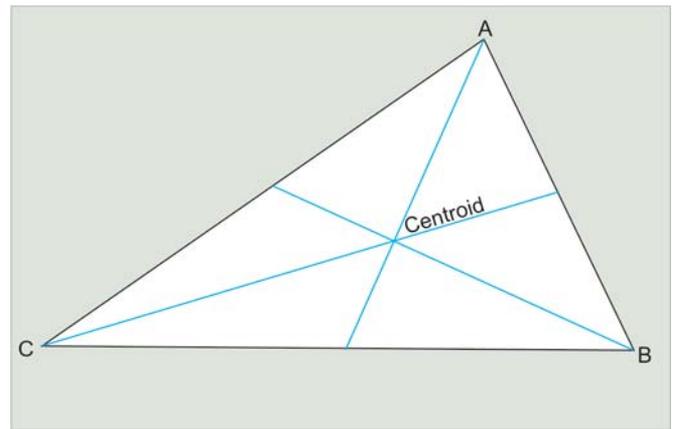


Fig. 1: Centroid for triangle ABC

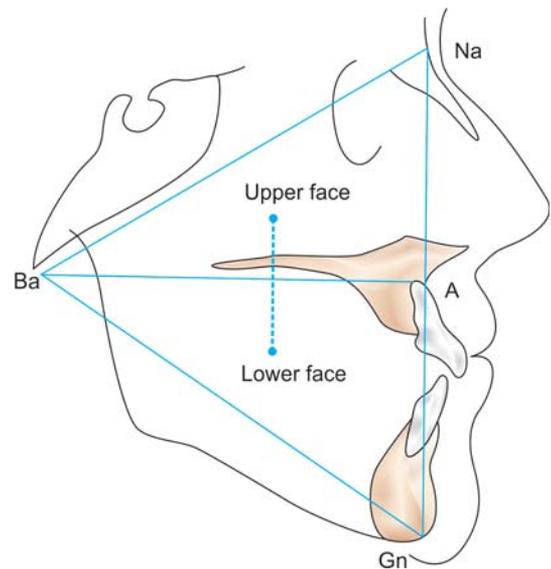


Fig. 2: Centroids of upper face represented by triangle Ba-Na-A and lower face represented by triangle Ba-A-Gn

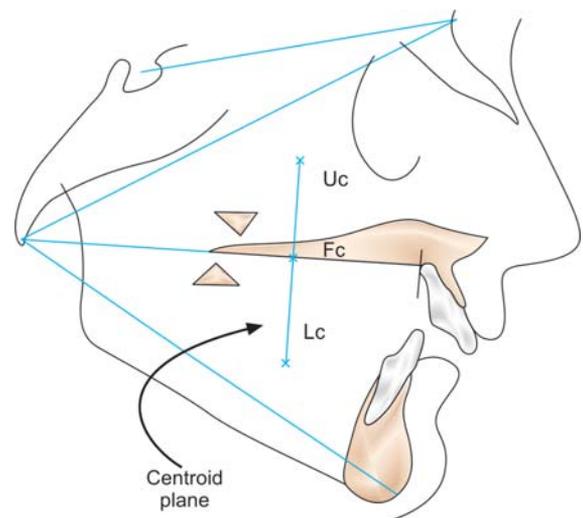


Fig. 3: Centrographic analysis applied to facial form

1. Anteroposterior plane: Anteroposterior position of Uc point and Lc points with respect to centroid plane were compared with angles SNA, SNB, ANB and Wit’s appraisal.

- Vertical plane: Vertical position of Fc point with respect to Ba-A plane was compared with SN-SGn angle, SN-GoGn angle, Jarabak's ratio and AUFH/ALFH ratio.

### RESULTS AND STATISTICAL ANALYSIS

As per centographic analysis in anteroposterior plane, it was observed that Class I type of skeletal morphologic pattern was present in 34% of cases.

Class II type skeletal morphologic pattern was present in 10% of cases, among these Class II cases, maxillary prognathism was observed in 80% of cases, no case had mandibular retrognathism whereas combination of maxillary prognathism and mandibular retrognathism was present in 20% of cases.

Class III type of skeletal morphologic pattern was observed in 56% of cases wherein 15% of these cases had mandibular prognathism and 85% of cases had combination of maxillary retrognathism and mandibular prognathism whereas no case had maxillary retrognathism.

Whereas, in vertical plane it was observed that 38% of cases had normal growth pattern, 42% of cases had horizontal growth pattern and 20% of cases had vertical growth pattern.

Further comparison of centographic analysis with conventional cephalometric analysis was carried out. Number code was given for quantification of the various conditions for subjecting the observations to statistical analysis.

In A-P plane Class I, Class II and Class III type of skeletal morphologic patterns were coded as 1, 2 and 3 respectively. Maxillary prognathic, orthognathic and retrognathic conditions were coded as 4, 5 and 6 respectively, whereas mandibular prognathic, orthognathic and retrognathic conditions were coded as 7, 8 and 9 respectively.

In a vertical plane, normal growth pattern, horizontal growth pattern and vertical growth patterns were coded as 10, 11 and 12 respectively.

Chi-square test was applied to find out the significance of differences between cephalometric measurements and cephalomorphic finding.

$$\chi^2 = \sum(O_i - E_i)^2/E_i$$

$\chi^2$  tabulated value for 2 degree of freedom at 5% level of significance = 5.99.

### DISCUSSION

On evaluating the skeletal pattern of individuals with CGA, following interesting findings were observed:

#### Anteroposterior Plane

The anteroposterior position of the Uc (centroid of triangle Ba-Na-A that represents upper face) and Lc (centroid of triangle Ba-A-Gn that represents lower face) with respect to centroid plane were studied for evaluating sagittal relation of upper face (maxilla) with lower face (mandible).

In centographic analysis for evaluating sagittal discrepancy, the relation of Uc and Lc with respect to centroid plane is seen. The Class I condition is where Uc and Lc fall on centroid plane (Fig. 4). In this study, the possibility of Uc and Lc of falling on

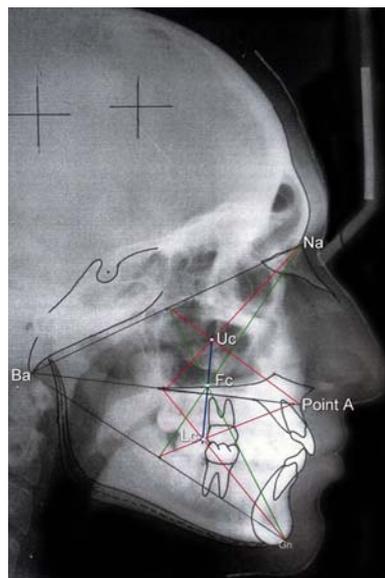


Fig. 4: Skeletal Class I pattern: Fc, Uc, Lc lying on centroid plane

centroid plane was observed to be minimum even though the subjects studied had clinically well-balanced facial profile. Wherever, there is deviation of Uc or Lc from the centroid plane, the skeletal pattern is diagnosed as Class II or Class III.

When the same sample was evaluated cephalometrically, variation was seen in angle SNA, SNB and Wit's appraisal, it was observed that skeletal variation existed. While skeletal variation was not observed in sagittal plane when assessed with angle ANB.

Further in A-P plane on comparing centographic analysis with conventional cephalometric measurements, significant differences existed between Uc-Lc and angle ANB (Table 1),

Table 1: Comparison of CGA (Uc-Lc), Angle ANB and Wits appraisal (A-P plane)

	Uc- Lc	Angle ANB	Wit's appraisal
Class I	17	43	12
Class II	5	0	17
Class III	28	7	21

$\chi^2$  calculated = 78.720, Significant,  $p < 0.05$

Table 2: Comparison of position of Uc and angle SNA (A-P plane)

	Uc	Angle SNA
Prognathic	5	11
Orthognathic	21	20
Retrognathic	24	19

$\chi^2$  calculated = 4.638, Nonsignificant,  $p > 0.05$

Table 3: Comparison of position of Lc and angle SNB (A-P plane)

	Lc	Angle SNB
Prognathic	28	14
Orthognathic	21	24
Retrognathic	1	12

$\chi^2$  calculated = 24.45, Significant,  $p < 0.05$

**Table 4:** Comparison of position of Fc, angle SN-GoGn, angle SN-SGn, Jarabak's ratio and AUFH/ALFH ratio (vertical plane)

	Position of Fc	Angle SN-GoGn	Angle SN-SGn	Jarabak's ratio	AUFH/ALFH ratio
Normal	19	13	39	5	41
Horizontal	21	36	10	43	6
Vertical	10	1	1	2	3
Sum	50	50	50	50	50

UC and angle SNA (Table 2) Lc and angle SNB (Table 3) and Uc-Lc and Wit's appraisal (Table 1).

**Vertical Plane**

In vertical plane, the vertical position of the facial centroid (centroid of triangle Ba-Na-Gn representing total face) was studied for evaluating vertical plane disharmony (Fig. 5). When Fc lies in the upper triangle, i.e. above Ba-A plane, it shows the horizontal growth pattern and when it lies in lower triangle, i.e. below Ba-A plane, it shows the vertical growth pattern.

Vertical position of Fc is affected by relative size of the upper and lower triangles. If upper triangle is larger than lower triangle then Fc will lie in upper triangle and vice-versa.

When same samples were assessed cephalometrically with angle SN-GoGn, angle SN-SGn and Jarabak's ratio (Table 4), it was observed that skeletal variation existed. While skeletal variation was not observed for AUFH/ALFH ratio (Table 4).

On comparing position of Fc (Table 4) with angle SN-GoGn, angle SN-SGn, Jarabak's ratio and AUFH/ALFH ratio, significant difference was observed.

Dolce,<sup>10</sup> used the centroid centrographic analysis to study the effects of 1-phase and 2-phase orthodontic treatment in Class II malocclusion. Centrographic analysis showed that early treatment has effects on the mandible. However, the skeletal effects of phase 1 treatment disappear by the end of fixed mechanotherapy.

According to Fishman,<sup>11</sup> the Dolce study<sup>10</sup> showed a fundamental lack of understanding of the centrographic analysis

and was a methodological misapplication of data for Class II treatment. Fishman clarified the issues for accurately applying the centrographic analysis. It is biologically and analytically invalid to apply numerical evaluation to the CGA. Centroid position is relatively stable. The authors mistakenly measured small centroid changes to evaluate the results between 1 and 2 phase Class II treatment. Also, another mistake of measuring the area values to evaluate difference between 1 and 2 phase Class II treatment violates the underlying nonnumerical premise of the analysis.

From this study, it is evident that significant variation exists anatomically even within so-called 'normal' sample of persons. This shows that the sample selected, i.e. individuals with good, well-balanced facial profile demonstrate a wide range of skeletal and facial variation in both A-P and vertical plane.

**CONCLUSION**

Following conclusions were drawn from this study:

1. Individuals with well-balanced skeletal and soft-tissue profiles and normal occlusion when evaluated with centrographic analysis demonstrated:
  - i. Wide variations in craniofacial structure.
  - ii. In A-P plane, Class III type of skeletal morphologic pattern is more common.
  - iii. In vertical plane, horizontal growth pattern is more common.
2. Centrographic analysis which is an individualized approach and cephalometric measurements which are group-based norms, differ widely from each other.

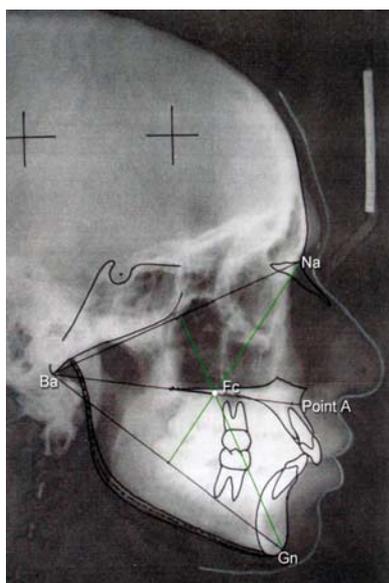
Centrographic analysis has certain advantages over cephalometric analysis.

1. It reliably represents the uniqueness of the person in contrast to cephalometric measurements which are dependent on nonrepresentative group-based numerical standards.
2. Centroids change minimally in position as a triangle increases in size and shape in contrast to cephalometric landmarks.

Therefore, individualized approach such as CGA should be considered in orthodontic diagnosis and treatment planning.

**REFERENCES**

1. Fishman LA. Individualized evaluation of facial form. *Am J Orthod Dentofacial Orthop* 1997;111:510-17.
2. Moorrees AF. Twenty centuries of cephalometry. In: Alex Jacobson: Radiographic cephalometry from basics to videoimaging. Quintessence: 25 and 26.
3. Simon P. Fundamental principles of a systematic diagnosis of dental anomalies (transl BF Lischer) Boston: Stratford Company, 1926.



**Fig. 5:** Normal growth pattern: Fc point lying on Ba-A plane

4. Decoster L. A network method of orthodontic diagnosis. *Angle Orthod* 1939;9:3-14.
5. Moores FA, Laure Lebet. The mesh diagram and cephalometrics. *Angle Orthod* 1962;32:214-31.
6. Krogman WM. The review of cephalometry. In: Krogman WM, Sassouni V (Eds). *Syllabus in roentgenographic cephalometry*. Philadelphia: College Offset; 1957:281.
7. Sassouni V. A roentgenographic cephalometric analysis of cephalofacial-dental relationships. *Am J Orthod Dentofacial Orthop* 1955;41:735-64.
8. Johnson JS. The use of centres of gravity in cephalometric analysis: A preliminary report. *Dental Pract* 1960;10:107-13.
9. Di Paolo RJ. The quadrilateral analysis, cephalometric analysis of lower face. *J Pract Orthodont* 1969;3:523-30.
10. Dolce C, Schader R, McGorray S, Wheeler T. Centographic analysis of 1-phase versus 2-phase treatment for class II malocclusion. *Am J Orthod Dentofacial Orthop* 2005;128:195-200.
11. Fishman LA. Misinterpretation of centographic analysis and class II treatment. *Am J Orthod Dentofacial Orthop* 2006;129:321-22.