VOLUME - 11, ISSUE - 08, AUGUST - 2022 • PRINT ISSN No. 2277 - 8160 • DOI : 10.36106/gjra

Original Research Paper

Dentistry

CENTROGRAPHIC ANALYSIS VS CEPHALOMETRIC ANALYSIS AN ANALYTICAL STUDY

Dr Priya Bandu Kale	Department of Orthodontics & Dentofacial Orthopaedics
Dr Mrunal Aley	Department of Orthodontics & Dentofacial Orthopaedics
Dr. Veerendra Kerudi	Department of Orthodontics & Dentofacial Orthopaedics
Dr Sanjeev Jakati*	Department of Orthodontics & Dentofacial Orthopaedics *Corresponding Author

ABSTRACT

Context: Conventional cephalometric analysis play primary role in evaluation of skeletal discrepancy by using a method that numerical value compared with pre- established norm of other ethnic origin derived from so called preselected "normal" samples. Need of centrographic analysis which is non-numerical facial approach to evaluate facial form of individual based on volume for evaluation skeletal and facial form. It is based on centroid orientation and centroid is stable reference point for each individual. The centroGraphic analysis is unique to each patient; it supplies independent identification of anteroposterior positions of the maxilla and mandible, vertical facial proportion inequalities, and a stable reference plane, which can be used for longitudinal cephalometric superimposition. Much information can be obtained from the 4 triangles, their respective centroids, and some additional lines. **Aims:** To compare skeletal, dental and soft tissue characteristics by using centrographic analysis and cephalometric analysis in various malocclusion. **Settings and Design:** in vitro study was performed on 160 lateral cephalograms. **Methods and Material:** Conventional cephalometric analysis done to evaluate skeletal, dental and soft tissue characteristics by by Downs, Steiner, Holdaway, Rakosi and Jacobson. Nine measurements, 2 linear and 7 angular, were done on each radiograph. Centroid analysis was done as described by Fishman. Only four points (N, Ba, and A and Gn) and three lines (Na-Ba, Ba-A, and Ba-Gn) are drawn on x-ray tracing for analysis. This analysis establishes location of centroids within 3 anatomically determined triangular areas. **Statistical analysis used:** All data and measurements, were collected, tabulated, and statistically analysed using statistical package for social sciences software, (SPSS) version 24 **Results & Conclusions:** centrographic analysis is adjunctive method of analysis of cephalometric radiographs to evaluate vertical skeletal, dental, and soft tissue characteristics in various types of malocclusion.

KEYWORDS : cephalometric analysis, centrographic analysis, centroids,

INTRODUCTION

The method of radiographic cephalometry was applied when Broadbent discovered the cephalostat in 1931. This method made it possible not only to establish measurement reference points up to inner structure of maxillo-facial cranium but also to analyse morphological changes by superimposing consecutive images taken during growth using constant reference points.1

Conventional cephalometric analysis play primary role in evaluation of skeletal discrepancy by using a method that numerical value compared with pre- established norm of other ethnic origin derived from so called preselected "normal" samples.[2,3]

Morphologic homogeneity within these preselected normal samples may not exist. Therefore, concept of numerically comparing such norms and its application for evaluating individuals who do not show anatomic homogeneity may subject to inaccuracy because existing cephalometric analyses are based on chronological ages rather than maturational age and thereby ignoring individualized uniqueness of maturational development.[4]

Therefore, need of centrographic analysis2 which is non-numerical facial approach to evaluate facial form of individual5 based on volume for evaluation skeletal and facial form. It is based on centroid orientation and centroid is stable reference point for each individual that can be used for evaluation of facial form.[2]

In the original centrographic analysis, Johnson described use of center of gravity as a fixed reference point determined by the intersection of 2 lines. Johnson and Hubbold compared lines representing measures commonly identified in cephalometric analyses and coined the term centroid.[6,7]

Fishman published a centroid-based analysis reducing the task to construction of 4 centroids with common and simple methods of tracing and landmark identification, no angles to measure, and no normative values to compare. The Centrographic analysis is unique to each patient; it supplies independent identification of anteroposterior positions of the maxilla and mandible, vertical facial proportion inequalities, and a stable reference plane, which can be used for longitudinal cephalometric superimposition. Much information can be obtained from the 4 triangles, their respective centroids, and some additional lines.[8]

FACIAL CENTROID AXIS (FCA) provides a stable reference plane that can be used for cephalomorphic superimposition.2 Authors such as Decoster, Sassouni, Moorrees and Lebret presented different facial analysis that focus on nonnumerical facial approach.[9,10,11]

Aim & Objectives of the Study

1. To evaluate skeletal, dental and soft tissue characteristics by using centrographic analysis in various malocclusion.
2. To evaluate skeletal, dental and soft tissue characteristics by using cephalometric analysis in various malocclusion.
3. To compare skeletal, dental and soft tissue characteristics by using centrographic analysis and cephalometric analysis in various malocclusion.

MATERIAL AND METHODS

The present in vitro study was performed on 160 lateral

cephalogram

Inclusion Criteria

1. Adult individuals with Full complement of permanent teeth excluding third molar.
2. Age 19-30 years old.

Exclusion Criteria

Patient with history of

1. Orthodontic treatment or maxillofacial surgery.
2. Trauma.
3. Dental caries, congenital missing teeth and any retained tooth in oral cavity.
4. Deformity in nasomaxillary complex.

Study Method

1. Sample size of 160 lateral cephalogram were divided into 3 groups categorized on basis of cephalometric analysis

- Group 1: Skeletal class I malocclusion (ANB angle between 0 to 2◦) n=68
- Group 2: Skeletal class II malocclusion (ANB angle >2◦) n=52
- Group 3: Skeletal class III malocclusion (ANB angle < 0◦) n=40

2. Centrographic analysis and Conventional cephalometric analysis were applied to each lateral cephalogram.

Conventional cephalometric analysis

Done to evaluate skeletal, dental and soft tissue characteristics by cephalometric linear and angular measurements described by Downs, Steiner, Holdaway, Rakosi and Jacobson. Nine measurements, 2 linear and 7 angular, were done on each radiograph for conventional cephalometric analysis. Landmarks used in study are shown in Fig.1.

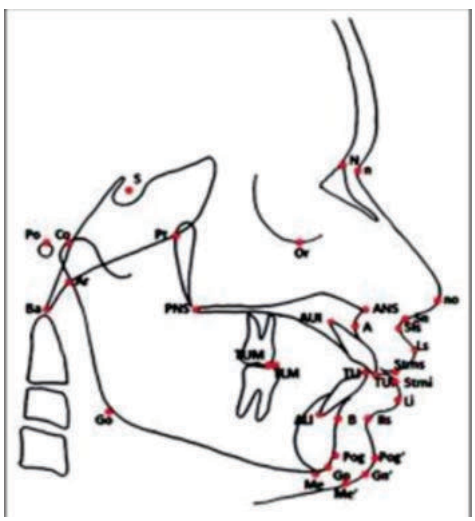

Fig.1. Landmarks used in study

Nine cephalometric measurements recorded as follows:

1.Horizontal skeletal measurements:

A. SNA angle:
B. SNB angle:

2.Vertical skeletal measurements:

A. SN/MP angle:
B. y-axis/Frankfort horizontal (FH) angle:
C. ratio of lower anterior facial height (LAFH) / total facial height (TFH):

3.Dental measurements:

A. angle UI/NA:
B. angle LI/NB:.

4. Soft tissue measurements:

A. H angle: measured to assess degree of upper lip prominence.
B. Lower lip – H-line: recorded in millimetre to evaluate degree of prominence of lower lip.

All readings of conventional cephalometric method were recorded for assessment of skeletal, dental, and soft tissue characteristics

CentroGraphic analysis:

Centroid analysis was done as described by **Fishman**. Only four points (N, Ba, and A and Gn) and three lines (Na-Ba, Ba-A, and Ba-Gn) are drawn on x-ray tracing for analysis. This analysis establishes location of centroids within following 3 anatomically determined triangular areas.

The face was divided into three triangles, as follows:

1. Upper face (Ba-N-A) triangle (Fig.3)
2. Lower face (Ba-A-Gn) triangle (Fig.4)
3. Total face (Ba-N-Gn) triangle (Fig.5)

Centroid represents center of mass or gravity of a two-dimensional area or a three-dimensional volume. Centroid of each triangle was determined centrographically by drawing a line from vertex of respective triangle and bisecting opposite leg of triangle. This is done at a second vertex to the opposite leg. The intersection of these 2 lines determines centroid and serves as point of reference for analysis in sagittal aspect (Fig.2). This was done on all 3 triangles.

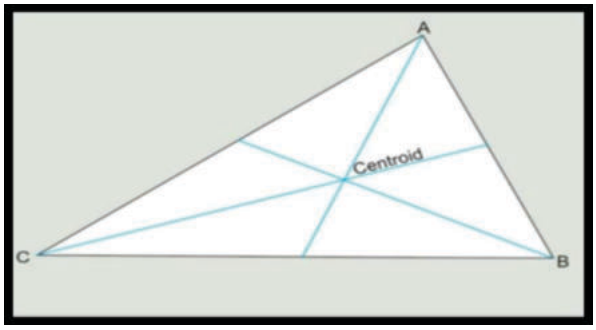

Fig.2 Centroid for triangle ABC. The intersection of 2 lines determines centroid and serves as point of reference for analysis in sagittal aspect.

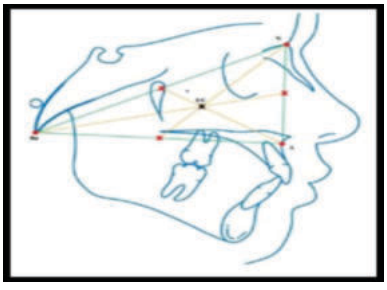

Fig.3 Upper face triangle (Ba-N-A)

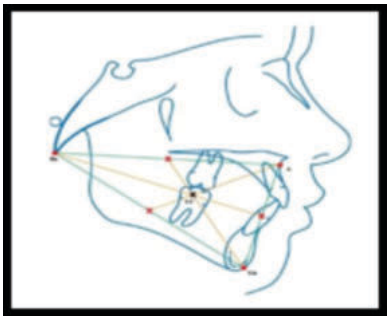

Fig.4 Lower face triangle (Ba-A-Gn)

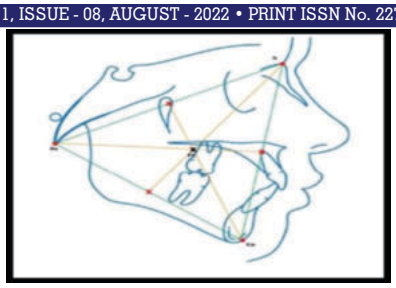

Fig.5 Total face triangle (Ba-N-Gn

Centroid plane was constructed for each tracing as a perpendicular to Ba- A through the Facial centroid (FC). (Fig. 6)

1. CentroGraphic horizontal skeletal evaluation Upper centroid (UC) and Lower centroid (LC) were evaluated in relation to centroid plane (Fig.6), as follows:

A. If UC and/or LC positioned in front of (anterior to) centroid plane, then it was recorded as protrusive or prognathic.
B. If UC and/or LC positioned posterior to centroid plane, then it was recorded as retrusive or retrognathic.
C. If UC and/or LC positioned on centroid plane, then it was considered anteroposterior balance or harmony and recorded as orthognathic.

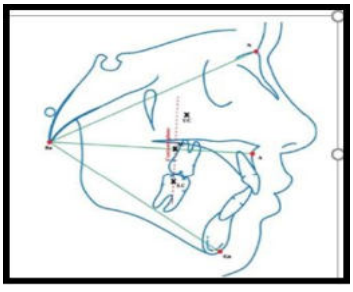

Fig.6 Centroid plane. constructed as a perpendicular to Ba-A through facial centroid

2.CentroGraphic vertical skeletal evaluation
Depending on Facial centroid (FC) location was evaluated in relation to Ba-A plane, constructed division between upper and lower faces (Fig.4) as follows:

A. Vertical harmony or balance; when FC was on Ba-A plane.
B. Vertical deficiency; when FC was within upper face.
C. Vertical excess; when FC was within lower face.

3. CentroGraphic dental evaluation (Fig.7)
Axial inclination of upper incisors was evaluated in relation to orbitale (Or) point, while that of lower incisors in relation to one- third mark of symphyseal segment of Ba-Gn plane, as follows:

A. When long axis was approximating to reference point, axial inclination was considered normal.
B. When long axis was passing posterior to reference point, it was considered proclined.
C. When long axis was passing anterior to reference point, it was considered retroclined.

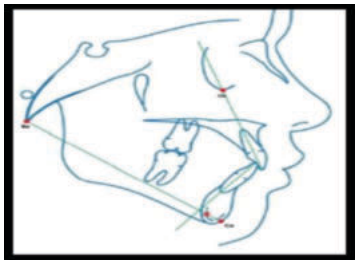

Fig.7. Dental Centrographic analysis

4.CentroGraphic soft- tissue characteristics evaluation (Fig.8)
Inner (soft tissue pogonion-subnasale) and outer (soft tissue pogonion-nasal tip) profile lines were used to evaluate positional balance of lips, as regards to relationship of lip projection to bisector line that bisects angle formed between these two lines, as follows:

A. When upper and/or lower lip positioned at half of distance between the two profile planes, it was described as being in harmony or balance.
B. When upper and/or lower lip was positioned anterior to bisector line, then it was described as protrusive.
C. When upper and/or lower lip was positioned posterior to bisector line, then it was described as retrusive.

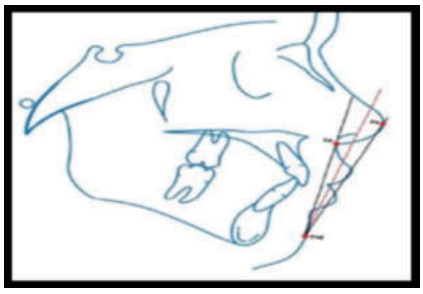

Fig.8. Soft tissue Centrographic analysis

Statistical analysis:
All data and measurements, were collected, tabulated, and statistically analyzed using statistical package for social sciences software, (SPSS) version 24. Chi-square test was applied to find out significance of differences between conventional cephalometric measurements and findings of centrographic analysis.

.$\chi 2 = \sum(Oi - Ei)2 / Ei$
$\chi 2$ tabulated value for 2 degree of freedom at 5% level of significance=0.05

RESULTS

All tables comprise of vertical columns and horizontal rows. Vertical columns are highlighting centrographic analysis i.e quantitative analysis and horizontal rows are highlighting cephalometric analysis i.e. qualitative analysis.

Table 1. Relationship between angle SNA and upper centroid for evaluation of anteroposterior position of maxilla

anteroposterior skeletal evaluation		Upper Centroid			Total	Total in %	$\chi 2$ - value	P-value
		C 1	C 2	C 3			6.9	0.1397
SNA		Orthognathic	Retrognathic	Prognathic				
Orthognathic	R 1	31	25	17	73	41		
Retrognathic	R 2	15	27	15	57	31		
Prognathic	R 3	8	10	12	30	28		
Total		54	62	44	160			
Total in %		33	40	27		100		

Table 2. Relationship between angle SNB and lower centroid for evaluation of anteroposterior position of mandible

anteroposterior skeletal evaluation		Upper Centroid			Total	Total in %	$\chi 2$ - value	P-value
		C 1	C 2	C 3			46.41	0.0001
SNB		Orthognathic	Retrognathic	Prognathic				

Orthognathic	R 1	11	0	43	54	34		
Retrognathic	R 2	0	19	34	53	33		
Prognathic	R 3	21	11	21	53	33		
Total		32	30	98	160			
Total in %		20	18	62		100		

Table 3. Relationship between angle SN/MP and facial centroid for evaluation of vertical skeletal pattern.

vertical skeletal evaluation		Facial centroid			Total	Total in %	χ2 - value	P-Value
		C 1	C 2	C 3				
SN/MP		Vertical deficiency	Balanced	Vertical excess			15.55	0.0037
Vertical deficiency	R 1	14	8	34	56	35		
Balanced	R 2	12	26	20	58	36		
Vertical excess	R 3	9	10	27	46	28		
Total		35	44	81	160			
Total in %		22	27	51		100		

Table 4. Relationship between angles y-axis/FH and Facial centroid for evaluation of vertical skeletal pattern

vertical skeletal evaluation		Facial centroida			Total	Total in %	χ2 - value	P-Value
		C 1	C 2	C 3				
y-axis/FH		Vertical deficiency	Balanced	Vertical excess			8.306	0.0810
Vertical deficiency	R 1	28	9	18	55	34		
Balanced	R 2	15	11	21	47	30		
Vertical excess	R 3	17	9	32	58	36		
Total		60	29	71	160			
Total in %		38	18	44		100		

Table 5. Relationship between ratio of lower anterior facial height / total facial height and facial centroid for evaluation of vertical skeletal pattern

vertical skeletal evaluation		Facial centroid			Total	Total in %	χ2 - value	P-Value
		C 1	C 2	C 3				
LAFH/TFH		Vertical deficiency	Balanced	Vertical excess			13.71	0.0083
Vertical deficiency	R 1	17	9	31	57	35		
Balanced	R 2	22	9	21	52	33		
Vertical excess	R 3	28	0	23	51	32		
Total		67	18	75	160			
Total in %		42	11	47		100		

Table 6 relationship between angle UI/NA and the CentroGraphic method for evaluation of axial inclination of upper incisors

axial inclination		Upper Incisor			Total	Total in %	χ2 - value	P-Value
		C 1	C 2	C 3				
UI/NA angle		Normal	Proclined	Retroclined			21.74	0.0002
Normal	R 1	3	27	10	40	25		
Proclined	R 2	9	76	7	92	57		
Retroclined	R 3	4	12	12	28	18		
Total		16	115	29	160			
Total in %		10	72	18		100		

Table 7. Relationship between angle LI/NB and Centro Graphic method for evaluation of axial inclination of lower incisors.

axial inclination		Lower Incisor			Total	Total in %	χ2 - value	P-Value
		C 1	C 2	C 3			8.409	0.0777
LI/NB angle		Normal	Proclined	Retroclined				
Normal	R 1	4	20	17	41	26		
Proclined	R 2	7	46	19	72	45		
Retroclined	R 3	10	28	9	47	29		
Total		21	94	45	160			
Total in %		13	59	28		100		

Table 8. Relationship between H angle and CentroGraphic method for evaluation of upper lip

soft tissue results		Upper lip			Total	Total in %	χ2 - value	P-Value
		C 1	C 2	C 3				
H-angle		Protrusive	Normal	Retrusive			11.59	0.0207
Protrusive	R 1	44	3	11	58	36		
Normal	R 2	34	12	8	54	34		
Retrusive	R 3	37	2	9	48	30		
Total		115	17	28	160			
Total in %		72	11	17		100		

Table 9. relationship between measurement of lower lip to H-line (mm) and CentroGraphic method for evaluation of lower lip

soft tissue results		Lower lip			Total	Total in %	χ2 - value	P-Value
		C 1	C 2	C 3				
LL-H line		Protrusive	Normal	Retrusive			11.18	0.0246
Protrusive	R 1	20	11	9	40	25		
Normal	R 2	58	8	12	78	49		
Retrusive	R 3	29	3	10	42	26		
Total		107	22	31	160			
Total in %		67	14	19		100		

DISSCUSSION

Results obtained by this study try to find co-relation between centrographic and cephalometric analysis. This study demonstrate variation in skeletal and facial morphology and to evaluate applicability of centrographic analysis as compared with conventional cephalometrics. Therefore, individualized approach such as CGA should be considered in orthodontic diagnosis and treatment planning.

CGA represents uniqueness of person. An important characteristics of centroids was they change minimally in position as a triangle increase in size and shape in contrast to

cephalometric measurements. For example: vertical position of FC affected by relative size of upper and lower triangles. If upper triangle is larger than lower triangle then FC will lie in upper triangle and vice-versa.[8]

Landmark identification error, angular and linear measurement and normative value to compare was more in cephalometric analysis that can be eliminated by CGA. To minimize errors, landmark identification was rechecked by same operator to assess intraexaminer reliability.[8]

According to AB Nhete, PV Hazare applicability of centrographic analysis in person with well-balanced face and normal occlusion Resulted that in A-P plane, Class III type of skeletal pattern was more common and 90.7% of the cases of skeletal class III showed retrognathic maxilla together with prognathic mandible. In our study, results of CentroGraphic analysis considering LC was 62% of sample diagnosed as prognathic mandible, in contrast to 33% of readings considering SNB angle showing prognathic mandible. These observation was in accordance to W.B Downs, in which he used position of mandible to determine facial harmony.

Further in their study, comparing position of Fc with angles SN/MP, angle y axis/FH and Jarabak's ratio an significant difference was observed. While no statistical relationship between position of FC with AUFH/ALFH ratio. In contrast to our study findings of CentroGraphic analysis with angle SN/MP (p value=0.003), angle y-axis/FH, and ratio of LAFH/TFH (p value= 0.008)., there was a significant statistical relationship. However, nonsignificant statistical (p value=0.08) relationship found with angle y-axis/FH.

In present study centrographic analysis was used in nongrowing patient. Hence, it was necessary to select patients in nongrowing age. Following studies support selected age group of patients in our study.[3]

Munish C Reddy et.al described a relation between skeletal, dental and soft tissue structures using centrographic analysis (CGA) in pleasing faces of population. Their sample adults had protrusive mandible and a retrusive upper lip with a sexual dimorphism. In present study, highly significant statistical (p value=0.0001) relationship between SNB angle with position of LC for evaluating anteroposterior positions of maxilla and mandible and statistical significant (p value= 0.02) relationships between both methods for assessment of upper and lower lips. In present study, no pleasing profile was selected, and data were not separated according to gender.4 Mohamed Sameh EI Kholy et.al. Study in which they identify applicability of centrographic analysis to evaluate skeletal, dental, and soft tissue morphologic characteristics of adult sample with various malocclusion and compare with conventional cephalometric analysis. This study reported nonsignificant statistical relationship between both methods for anteroposterior skeletal positions same as our study, (p value=0.13) comparing SNA angle with position of UC and highly significant statistical relationship (p value=0.0001) between SNB angle with position of LC regarding vertical skeletal pattern, a nonsignificant relationship between SN/MP angle with position of FC, a significant relationship between angle y-axis/FH and position of FC, and highly significant relationship between ratio LAFH/TFH and position of FC. In our study a significant relationship (p value= 0.003) between SN/MP angle with position of FC, nonsignificant relationship (0.08) between y-axis/FH and position of FC, and significant relationship (p value= 0.008) between ratio of LAFH/TFH and position of FC.

Further in their study, highly significant relationships was evident on dental evaluation. In our study, highly significant relationship (p value=0.0002) between angle UI/NA and axial inclination of upper incisor, nonsignificant relationship (p value=0.07) between angle LI/NB and axial inclination of lower incisor. For evaluation of axial inclination of lower incisors, result of this study not in accordance with present study because anteroposterior width of mandibular symphysis affects length of segment of Ba-Gn plane passing through symphysis and would be misleading to evaluate axial inclination of lower incisors.

Highly significant relationships found between both methods for assessment of upper and lower lips. (p value = 0.02).[5]

Yagci et al. cephalometric and cephalomorphic measurements were similar for men and women, except facial centroid. FC parameter for women was statistically greater than men. But according to Fishman, this study demonstrated a fundamental lack of understanding of analysis and methodological misapplications as it is biologically and analytically invalid to apply numerical evaluation to CentroGraphic analysis. In our study, LC was 62% of sample diagnosed as prognathic mandible. Result of this study are in contrast with our study because set values sometimes does not match to Indian population due to diverse morphogenesis.[8]

Taher and Abd El-Aziz assessed various patterns of craniofacial growth based on different facial-form assessment technique. They found disagreement between applied conventional numeric cephalometric and centroid-oriented cephalomorphic analyses in reaching a precise diagnosis regarding anteroposterior and vertical facial form. In our study also we have disagreement between both methods for evaluation of anteroposterior position of maxillary and mandibular skeletal bases.[12]

Lakshmipulagam et.al. performed study to assess and compare three superimposition methods and evaluate validity of most reliable and reproducible technique. According to results of this study, centroid remains unchanged during growth or treatment. This is in accordance to our study.[13]

It is evident in CentroGraphic analysis regarding soft tissue profile in a non-numerical way.[5]

Limitation Of Study

1. Large sample size should be screened for definite promising results
2. Data were not separated according to gender to obtain more specific and useful values.
3. In anteroposterior plane accuracy is not justified with centrographic method and complex skeletal dysplasia requires cephalometric analysis.
4. Growth direction not predictable by using this technique.

CONCLUSION

1. Centrographic analysis is quick and easy method for mass screening within less time.
2. Centrographic analysis is adjunctive method of analysis of cephalometric radiographs to evaluate vertical skeletal, dental, and soft tissue characteristics in various types of malocclusion.
3. Position of FC can be used as adjunct to commonly used parameters of cephalometric method.
4. This study demarcate border line cases like skeletal dysplasia requiring surgery.
5. Digitization technique using computer software is reliable because centroid represents least variation and most stable point of any area or volume that is increasing in size or changing in shape.

6.Acknowledgement:
SMBT IDSR GHOTI DHAMANGAON DIST NASHIK

REFERENCES

1. Broadbent BH. A new x-ray technique and its application to orthodontia. The Angle Orthodontist. 1931 Apr;1(2):45-66.
2. Fishman LS. Individualized evaluation of facial form. American journal of orthodontics and dentofacial orthopedics. 1997 May 1;111(5):510-7.
3. Nehete AB, Hazare PV. An evaluation of centrographic analysis as compared with conventional cephalometric analysis. Journal of Indian Orthodontic Society. 2012 Jan;46(1):38-42.
4. Reddy M, Gupta S, Misra V, Raghav P, Singh S. The applicability of centrographic analysis in pleasing craniofacial phenotypes. APOS Trends in Orthodontics. 2015 Jul 1;5(4):144-.
5. El Kholy MS, Ghobashy SA, Fakhry NM. Applicability of CentroGraphic analysis in evaluation of morphologic characteristics of Egyptian adult sample. Tanta Dental Journal. 2018 Jul 1;15(3):164.
6. Johnson JS. A new approach to cephalometric analysis of the dental base relationship. The Angle Orthodontist. 1978 Jan 1;48(1):23-32.
7. Johnson JS, Hubbold RJ. An introduction to centroid cephalometrics. British Journal of Orthodontics. 1982 Jan;9(1):32-6.
8. Yagci A, Ramoglu SI, Uysal T, Karaman AI. Standards of centrographic analysis in an anatolian Turkish population. Turkish J Orthod Vol. 2013;26(1).
9. DeCoster L. The network method of orthodontic diagnosis. The Angle Orthodontist. 1939 Jan;9(1):3-14.
10. Sassouni V. A roentgenographic cephalometric analysis of cephalo-facio-dental relationships. American Journal of Orthodontics. 1955 Oct 1;41(10):735-64.
11. Moorrees CF, Lebret L. The mesh diagram and cephalometrics. The Angle Orthodontist. 1962 Oct;32(4):214-31.
12. Taher S, Abd El-Aziz R. Cephalomorphic versus cephalometric assessment of facial form. J Egypt Dent Assoc. 2007 Sep;53:843–849.
13. Vijayalakshmi D, Kumar R. Reliability and accuracy of Centrographic analysis in comparison with other superimposition techniques–A Cephalometric study. IOSR Journal of Dental and Medical Sciences (IOSR-JDMS) 2017 Oct;10-16:81-86