Evaluation of Skeletal Cephalometric Values for Orthognathic Surgery in Adult Patients Visiting Chitwan Medical College

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ABSTRACT

Introduction: Successful orthognathic surgery relies on the accurate diagnosis of facial, skeletal, and dental issues. The purpose of this study is to evaluate and compare Skeletal cephalometric values for orthognathic surgery in Nepalese adults and to compare with Caucasians.

Materials and Methods: One hundred adult patients (33 males and 67 females), with an age range of 18-36 years, were selected for the study. The subjects included had skeletal Class I, Average Growth Pattern, no craniofacial abnormality, and no previous history of orthodontic treatment. The Skeletal cephalometric norms for orthognathic surgery analysis values for the Nepalese population were established and compared with those of Caucasians.

Results: All the cephalometric parameters, except for facial convexity angle in females, maxillary protrusion in females, mandibular prognathism, chin protrusion, mandibular plane angle, and gonial angle, were less in the Nepalese population than in Caucasians.

Conclusion: The cephalometric parameters in the Nepalese adults are significantly different from those of the Caucasian population. These racial differences, which are evident in this study, should be kept in mind while charting out a plan for orthognathic surgery for the Nepalese adults.

Keywords: Lateral cephalogram, Orthognathic Surgery, Nepalese population, Skeletal

INTRODUCTION

Orthognathic treatment is effective for moderate to severe facial discrepancy in the antero-posterior, vertical or transverse planes. The combination of orthognathic surgery and orthodontic treatment aids in correcting both skeletal imbalance and malocclusion, with the ultimate aim of achieving acceptable facial harmony with a good functional bite.[1]

People are now more conscious about their facial aesthetic appearance due to increase social demand, global social media and improving socio-economic

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conditions.[2] To sum up, a total of 27 cases were referred, consulted, and treated in the Kulliyyah of Dentistry, International Islamic University Malaysia orthognathic joint clinic. 57.14% of orthognathic patients agreed to orthognathic treatment, 32.14% of them opted for orthodontic treatment alone, whilst 10.7% refused any treatment so the Demand for orthognathic surgery is increasing.[2] Orthognathic surgery depends upon accurate diagnosis of facial skeletal and dental problems. A cephalometric for orthognathic surgery analysis (COGS) concerning the hard tissue of the face had been developed by Burstone and colleagues.[3] The COGS analysis of the hard tissue depicts the horizontal and vertical positions of facial bones through linear measurement for size bone and angular measurements for shape bone.

In 1978, Burstone established cephalometric norms for orthognathic surgery in the Caucasian population. The standard value of most cephalometric studies must depend on the races, gender and age group of the same population. Cephalometric analysis obtained from people of one race may not necessarily apply to the other race.[4, 5]

The desired outcomes have both functional and aesthetic components, both of which are strongly influenced by the soft tissues and hard tissues of the head and neck.[6,7] Soft tissue COGS analysis has been conducted in the Nepalese adults, focusing the treatment of dentofacial problems that has emerged in orthodontics and orthognathic surgery.[8] Therefore, a need has arisen for a more accurate and comprehensive set of skeletal cephalometric reference parameters for the Nepalese adults.

MATERIALS AND METHODS

The present cross-sectional study was conducted in the Department of Orthodontics and Dentofacial Orthopedics of Chitwan Medical College, school of Dental science. This study was approved by Institutional Review Committee of Chitwan Medical College, School of Dental science, Chitwan, Nepal (CMC-IRC /80/81-023). The duration of the study was from October 2023 to May 2025. One hundred lateral cephalograms (33 Males and 67 Females) were selected from records of the patients who visited the Department of Orthodontics and Dentofacial Orthopaedics of Chitwan Medical College, Chitwan, Nepal. Magnification error of 1.04 was used in this Study. The sample size was calculated based on study done by Arunkumar et al.9 using the formula $Z^2\sigma^2/ e^2$.

where,

Standard deviation (σ)= 1.6

Z value (z) = 1.96

Level of precision (e) = 0.322

Sample Size = $1.96^2\times1.6^2/0.322^2=96.04\cong100$

The inclusion criteria were: individuals with Skeletal Class I malocclusion based on an ANB angle between 0° and 4°,[10] an average growth pattern indicated by an SN-GoGn angle between 28° and 36°,[11]aged between 18 and 36 years, with no previous history of orthodontic treatment, possessing good quality cephalometric radiographs, and holding Nepalese citizenship. The criteria for exclusion were gross facial asymmetry and craniofacial syndromes.

Cephalometric tracing was performed using 0.004-inch-thick acetate tracing paper and 0.5mm 4H pencil. A vernier caliper was used for linear measurements, and a geometry box was used for angular measurements of skeletal values for the COGS analysis. The baseline used for comparison of most of the data in this analysis is a constructed plane called as Horizontal Plane (HP). It is constructed by drawing a line 7° from SN, intersecting at N point. The reference plane used in the study was arbitrary and was constructed assuming SN plane is normal.

From the digitized points, 15 measurements were obtained and divided into 4 Groups.

Cranial base

1. Posterior cranial base (AR–PTM) mm: a distance from AR to PTM, parallel to HP.
2. Anterior cranial base (PTM–N) mm: a distance from PTM to N, parallel to HP.

Horizontal skeletal relationship:

3. Facial convexity (N–A–PG): an angle formed by the line N–A and the line A–PG.
4. Maxillary protrusion (N–A) mm: a distance from point A to perpendicular line from N, parallel to HP.
5. Mandibular protrusion (N–B) mm: a distance from point B to perpendicular line from N, parallel to HP.
6. Chin protrusion (N–PG) mm: a distance from Pogonion to a perpendicular line from N, parallel to HP.

Vertical skeletal relationship:

7. Upper anterior facial height (N–ANS) mm: a distance from N to ANS, perpendicular to HP.
8. Lower anterior facial height (ANS–GN) mm: a distance from ANS to GN, perpendicular to HP.
9. Upper posterior facial height (PNS–N) mm: a perpendicular distance from HP to PNS.
10. Mandibular plane angle (MP–HP): an angle formed between GO–Me line and HP.

Maxilla and mandible:

11. Maxillary length (PNS–ANS) mm: a distance from PNS to ANS, parallel to HP.

12. Mandibular ramus length (AR–GO) mm: a line from AR to GO.
13. Mandibular body length (GO–PG) mm: a distance from GO to PG
14. Chin depth (B–PG) mm: a distance from B point to a perpendicular line to MP through PG.
15. Gonial angle (AR–GO–GN): an angle between ramal length and MP.

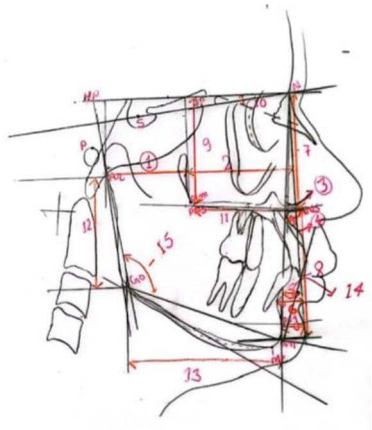

Figure 1. A major landmark and reference plane in the skeletal GOGS.

All the collected data was entered in Microsoft Excel 2013 and converted into IBM Statistical Package for Social Science (SPSS)(version 24.0; IBM, Armonk, NY, USA) for statistical analysis.[12] Intra-observer reliability was assessed on 25% of randomly selected samples by repeating the measurements after a two-week interval, and the intraclass correlation coefficient (ICC) was subsequently calculated. Normality of data distribution was checked using Shapiro-Wilk test. The mean and standard deviation (SD) for all linear and angular parameters of all cephalometric measurements were calculated for both sexes.

The level of statistical significance was set at $p \leq 0.05$. An independent t-test was conducted to determine whether there were any significant differences between Nepalese adults and the Caucasian population, Nepalese males and females.

RESULTS

The ICC values for repeated cephalometric measurements were greater than 0.9, indicating excellent intra-observer reliability. Data on measurements, including the mean, standard deviation, and t-test results for Nepalese and Caucasian males, are presented in Table 1. The results of the study revealed that parameters such as maxilla-mandible relationship, PTM-N, and vertical skeletal measurements—except for the MP-HP angle—showed statistically significant differences between the two groups. When comparing Nepalese females with Caucasian females, no statistically significant differences were observed in the mean values of parameters such as AR-PTM, N-A-PG angle, and AR-GO-GN angle, as presented in Table 2. As shown in Table 3, no statistically significant differences were found in parameters including all horizontal skeletal measurements, ANS-GN, and the AR-GO-GN angle when comparing Nepalese males and females.

Table 1. Comparison of orthognathic cephalometric analysis measurement of hard tissue between Nepalese male and Caucasian male

Measurement	Mean ± Standard Deviation		T value	P value
	Nepalese Male	Caucasian male		
AR-PTM	34.18 ± 2.40	37.1± 2.8	0.40	0.96
PTM-N	45.82 ± 3.02	52.8 ± 4.1	-13.46	0.00
Horizontal Skeletal				
N-A-PG	3.09°±3.29°	3.9°±6.4°	-1.40	0.17
N-A	-0.19±3.42	0.0±3.7	-315	0.75
N-B	-3.99±4.84	-5.3±6.7	153	0.16
N-PG	-2.26±5.20	-4.3± 8.5	2.22	0.34
Vertical Skeletal				
N-ANS	49.47±2.98	54.7±3.2	-10.06	0.00
ANS-GN	59.08±4.39	68.6±3.8	-12.06	0.00
PNS-N	48.22±3.38	53.9±1.7	-9.30	0.00
MP-HP	24.09°±3.65°	23°±6.9°	1.70	0.95

Maxilla and mandible				
ANS-PNS	50.36±3.82	57.7±2.5	-11.02	0.00
AR-GO	46.55±4.23	52.0±4.2	-15.10	0.00
AR-GO-GN	122.97°±5.13°	119.1°±6.5°	4.32	0.01
GO-PG	70.41±4.25	83.7±4.6	-17.90	0.00
B-PG	7.58±1.09	8.9±1.7	82.90	0.00

Table 2. Comparison of orthognathic cephalometric analysis measurement of hard tissue between Nepalese female and Caucasian female.

Measurement	Mean ± Standard Deviation		T value	P value
	Nepalese Female	Caucasian Female		
AR-PTM	32.43±2.33	32.8±1.9	-1.20	0.21
PTM-N	44.03±3.36	50.9±3.0	-16.70	0.00
Horizontal Skeletal				
N-A-PG	2.85°±3.64°	2.6°±5.1°	0.58	0.56
N-A	-0.22±2.96	-2.0±3.7	4.80	0.00
N-B	-3.90±4.50	-6.9±4.3	5.80	0.00
N-PG	-2.60±5.20	-6.5±5.1	6.18	0.00
Vertical Skeletal				
N-ANS	47.05±2.34	50.0±2.4	-10.23	0.00
ANS-GN	56.68±3.61	61.3±3.3	-10.44	0.00
PNS-N	45.20±3.06	50.6±2.2	-13.67	0.00
MP-HP	26.12°±3.19°	24.2°±5.0°	3.80	0.00
Maxilla and Mandible				
ANS-PNS	48.38±3.20	52.6±3.5	-10.06	0.01
AR-GO	41.73±4.45	46.8±2.5	-9.20	0.00
AR-GO-GN	123.85°±5.17°	122.0°±6.9°	2.60	0.10
GO-PG	65.96±3.99	74.3±5.8	-17.02	0.01
B-PG	6.37±1.19	7.2±1.9	-6.13	0.00

Table 3. Comparison of orthognathic cephalometric analysis measurement of hard tissue between Nepalese male and Nepalese female.

Measurement	Mean ± Standard Deviation		T value	P value
	Nepalese Male	Nepalese Female		
AR-PTM	34.18± 2.40	32.43±2.33	3.47	0.001
PTM-N	45.82±3.02	44.03±3.36	2.58	0.011
Horizontal Skeletal				
N-A-PG	3.09°±3.29°	2.85°±3.64°	0.311	0.757
N-A	-0.19±3.42	-.22±2.96	0.057	0.955

N-B	-3.99±4.84	-3.90±4.50	-0.09	0.927
N-PG	-2.26±5.2	-2.60±5.20	0.31	0.761
Vertical Skeletal				
N-ANS	49.47±2.98	47.05±2.34	4.39	0.008
ANS-GN	59.08±4.39	56.68±3.61	2.88	0.273
PNS-N	48.22±3.38	45.20±3.06	4.48	0.000
MP-HP	24.09°±3.65°	26.12°±3.19°	-2.49	0.014
Maxilla and mandible				
ANS-PNS	50.36±3.82	48.38±3.2	2.73	0.008
AR-GO	46.55±4.23	41.73±4.45	5.16	0.002
AR-GO-GN	122.97°±5.13°	123.85°±5.17°	-.75	0.456
GO-PG	70.41±4.25	65.96±3.99	5.13	0.000
B-PG	7.58±1.09	6.37±1.19	4.91	0.001

DISCUSSION

Cephalometric norms have been established using various analysis such as McNamara's,[14] Steiner's,[7] Down's,[6] etc., for the Nepalese population. These studies have established the differences between the different ethnic groups as far as the craniofacial characteristics are concerned. Burstone's analysis used for orthognathic surgery provides cephalometric norms for the Caucasians.

The mandible (AR)of the males was more posteriorly present than females in relation to the maxillary posterior surface (PTM). In this study mandible of the male was more anteriorly present than Caucasian male in relation to maxillary posterior surface and this was represented by posterior cranial base (AR-PTM) plane. Anterior cranial base (PTM-N) plane, maxilla is placed more anterior in relation to nasion and decreases the length of the anterior cranial base compared to the Caucasian population. This is similar to the results observed in a comparison study between Black American adults and White American adults by Flynn T.R. et al.[15]

The facial convexity angle(N-A-PG) were more convex in the Nepalese female as compared to the Caucasians population , similar result were found in study conducted in east India.[16] The combined Nepalese group exhibited retrognathic profile mainly due to a protrusive maxilla as compared to Caucasians. The position of the maxillary and chin prominence in relation to nasion, as determined by `N-A and `N-PG Measurements, was found to be prognathic in females compared to males. N-A in female , N-B and N-PG placed forward placement than Caucasian population . This result was supported by study conducted in Bangladesh population,[17] East Indian population,[16] Kerala population.[18] These skeletal measurements suggest that Nepalese male exhibit a prognathic facial pattern. This may be attributed to the forward positioning of the mandible and maxilla, a prominent chin, and a backward rotation of the mandible. The present findings are consistent with those reported by Nanda and Nanda.[19]

With respect to the vertical skeletal measurements, posterior maxillary height(PNS-N), Middle third facial height(N-ANS), Lower anterior facial height (ANS-GN) was only marginally decreased compared to Caucasians population but the mandibular plane angle, `MP-HP', was found to be most significantly increased, for male and female in relation to Caucasian population. Comparison between Nepalese male and female [Table 3] revealed that male had increased middle third facial height, posterior maxillary height which is similar to Soft tissue Cephalometric norms for Orthognathic Surgery in Nepalese Adults.[8]

Maxilla-mandible measurements did show, total effective length of the maxilla(PNS-ANS), ramal length (AR-GO) mandibular body length(GO-PG) and Chin depth (B-PG) was found to be significantly decreased. Supported by east Indian, Japanese population[20]; The length of maxilla, mandible body length and chin depth were increased observed in the Kerala[18] cohort aligned with the results of studies by Rafael E. Alcaide et al[20] and Flynn T.R[15] et al. In this study also gonial angle in increase than Caucasian population. The significant increase total effective length of the maxilla(PNS-ANS), ramal length(AR-GO), mandibular body length(Go-PG) ,Chin depth (B-PG) in Nepalese male than female groups.(Table 3)

The study was conducted on a relatively limited sample size, which may not fully represent the diverse ethnic groups within the Nepalese population. Cephalometric analysis was based on 2D radiographs, which can be limited by magnification errors and difficulties in landmark identification. Three-dimensional imaging such as CBCT (cone-beam computed tomography) could offer more accurate measurements. Using the data obtained, future work could aim at developing digital surgical planning tools tailored to the Nepalese population for enhanced precision in orthognathic procedures.

CONCLUSION

This study compared cephalometric skeletal differences between the Nepalese adults and Caucasian populations. The findings revealed greater facial convexity, a forwardly positioned mandibular apical base, a prominent chin, and, in females, a more forwardly placed maxillary base. Nepalese female exhibited more maxillary and mandibular protrusion than males.

Compared to Caucasians, Nepalese individuals had reduced posterior maxillary height, midfacial height, lower anterior facial height, mandibular ramus length, maxillary length, mandibular body length, and chin depth, with the exception of the mandibular plane angle and gonial angle.

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