Analysis of cephalometric for orthognathic surgery: Determination of norms applicable to Rajasthani population

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ABSTRACT

Aims: To determine the hard tissue surgical cephalometric norms statistically and geometrically in well-balanced faces having clinically acceptable facial profile in the Rajasthan population. To compare the cephalometric analyses of Rajasthani males and females and to compare the craniofacial pattern of Rajasthani population with Caucasian norms. Materials and Methods: Lateral cephalograms of 200 subjects (100 males and 100 females) in the age group of 18–25 years, class I malocclusion and acceptable facial profile were obtained. Cephalometric analysis was performed and studied. Results: The study revealed that parameters, such as all horizontal skeletal parameters, PNS-N, PNS-ANS, Ar-Go, Go-Pg and upper OP to HP angle show no statistical significant difference between Rajasthani males and females. When comparing Rajasthani males and Caucasian males, the study suggested statistically significant difference in the mean values of parameters, such as PTM-N, L1-MP, 6-MP, Go-Pog, B-Pog, Ar-Go-Gn, U1 to NF and L1 to MP. When comparing Rajasthani females and Caucasian females, the study revealed no statistically significant difference between the mean values of parameters, such as N-A-Pg, N-A, N-B, L1-MP, Ar-Go-Gn, upper OP to HP angle and AB-OP and rest of the parameters showed highly significant difference between Caucasian females and Rajasthani females. Conclusion: This study indicates that Rajasthani population has a bimaxillary protrusion with predominant tendency toward horizontal growth pattern of the mandible and this tendency is further exaggerated in females. Rajasthani females also showed an increased length of the anterior cranial base, maxilla and mandible and in dental parameters they showed increased maxillary dental height and both Males and females showed decreased mandibular dental height.

Key words: COGS analysis, orthognathic surgery, lateral cephalograms

INTRODUCTION

The most challenging task in any diagnostic system is the establishment of the range of normality. To determine the very existence of an abnormality, we must first be able to demonstrate the cardinal sign of pathology, “Changes in structure.” Thus, to demonstrate
changes, we should first establish a normal range from which to measure and evaluate the changes.\cite{1}

Cephalometrics has assisted the clinician in making an accurate diagnosis, treatment planning and evaluating the progress of orthodontic treatment.\cite{1} Cephalometric norms can be valuable aids to the clinicians in determining patient abnormalities. Norms defined ideal cephalometric measurements for a patient based on factors, such as age, sex, size and race. It has become apparent over the years that significant variations do occur among and between individuals of different racial origins.

The research of the last 2 decades of Cotton, Takanon, Wong, Haralabakis, Altemus and Kotak\cite{2} had indicated that the normal measurements of one group cannot be considered normal for other racial groups. Thus, different racial groups will have to be traced according to their own individual's characteristics. India is a subcontinent with a large number of racial subgroups and several religious and interracial mixtures.

The skeletal, dental, as well as soft tissue variations exist in different groups of population. The cephalometric parameters of hard and soft tissue of one population cannot be applied to another group. So, it becomes necessary to understand the cephalometric norms for different populations. Thus, the present study was conducted to determine the norms of cephalometrics for orthognathic surgery (COGS) in the Rajasthani population.

COGS analysis has the following characteristics, which make it particularly adaptable for the evaluation of surgical orthognathic problems. The chosen landmarks and measurements can be altered by various surgical procedures; the comprehensive appraisal includes all of the facial bones and a cranial base reference; rectilinear measurements can be readily transferred to a study case for mock surgery.\cite{3}

**Aims and Objectives**

To determine the cephalometric surgical norms statistically and geometrically for horizontal and vertical relationship of the cranial base, jaws and teeth in well-balanced faces and clinically acceptable facial profile in Rajasthani population.

- To compare the craniofacial pattern of Rajasthani population with Caucasian norms.
- To evaluate the skeletal, dental variation between Rajasthani males and females.

**Materials and Methods**

The study was conducted in the Department of Orthodontics and Dento facial Orthopedics in collaboration with the Department of Oral and Maxillofacial Surgery, Darshan Dental College and Hospital, Loyara, Udaipur (Rajasthan).

The present analysis was made on lateral cephalograms of 200 subjects with a well-balanced and acceptable facial profile of Rajasthani population. Subjects in the age group of 18–25 years with dentoalveolar class I occlusion with normal overjet and overbite and those who had not undergone any orthodontic treatment or orthognathic surgery in the past were considered for this analysis. All lateral cephalometric radiographs were taken in a standardized manner in centric occlusion with lips in repose and the FH plane oriented horizontally according to the natural head position.\cite{4} A total of 224 lateral cephalograms were studied. Of the 224 lateral cephalograms, 24 (11 males, 13 female) lateral cephalograms were excluded because cephalometrically they indicated skeletal class II or class III pattern. After selecting 200 patients, Burstone hard tissue analysis was done and the measurements and angles were calculated and documented in Table 1.\cite{3}[Figure 1].

The base line for the comparison of most of the data in this analysis is a constructed plane called as Horizontal Plane, which is constructed by drawing a line 7° to the SN plane. Most of the measurements were made from projections either parallel to HP or perpendicular to HP.\cite{3}

**Statistical analysis**

The data were collected, tabulated and statistically analyzed using the SPSS 10 software. [Contractor/manufacturer is SPSS Inc., 233 South Wacker Drive, 11th Floor, Chicago, IL]

To determine the errors associated with radiographic measurements, 20 radiographs were selected at random
from the observational group. Their tracing and measurements were repeated and compared with first measurements by using Independent t test. Mean and standard deviation were calculated for each subject. To find out any significant difference between Rajasthani male and female, Rajasthani male and Caucasian male and between Rajasthani female and Caucasian female, Independent t test was applied, which is represented in Table 2 and 3.

**RESULTS**

The statistical analysis to check the error between repeated measurements showed no significant difference between them (P > 0.05). Data relating to measurements, such as mean, standard deviation and t test for Rajasthani males and females are presented in Table 1. The results of the study revealed that parameters, such as all horizontal skeletal parameters, PNS-N, PNS-ANS, Ar-Go, Go-Pg and upper OP to HP angle showed no statistically significant difference between them. When comparing Rajasthani males with Caucasian males, statistically significant difference was found in the mean values of the parameters, such as PTM-N, L1-MP, L6-MP, Go-Pog, B-Pog, Ar-Go-Gn, U1 to NF and L1 to MP angle, which are represented in Table 2.

When comparing Rajasthani females with Caucasian females, the study revealed statistically significant difference between the mean values of the parameters, such as N-Ar and all the vertical parameters, such as PNS-ANS, Ar-Pog, B-Pog, U1 to NF and L1 to MP, which are represented in Table 3.

**DISCUSSION**

The attainment of facial proportionality is one of the principal goals in the treatment of dentofacial deformities and can be achieved with properly planned and executed orthognathic surgical techniques. The goal of maxillofacial surgery is to treat any jaw imbalance and the resulting incorrect bite, which could adversely affect the cosmetic (esthetic) appearance as well as the proper functioning of the teeth. This involves diagnosis, treatment planning and execution of the treatment, by combining orthodontics and oral and maxillofacial surgery to correct musculoskeletal, dento-osseous and soft tissue deformities of the jaws and associated structures.

In diagnosis of orthognathic surgical case, the cephalometric norms play a major role. Even though there are plenty of surgical cephalometric norms, they

### Table 1: Burstone hard tissue analysis in Rajasthani population

| Parameter               | Rajasthani male | Rajasthani female | t value | P value |
|-------------------------|------------------|-------------------|---------|---------|
| Cranial base            |                  |                   |         |         |
| Ar-PTM (HP horizontal) mm | 37.04 ± 3.32     | 36.11 ± 3.14      | -2.035  | < 0.05  |
| PTM-N (HP horizontal) mm | 54.66 ± 2.72     | 53.8 ± 3.06       | -2.101  | < 0.05  |
| Horizontal (skeletal)   |                  |                   |         |         |
| N-A-Pg (angle)          | 3.7° ± 5.9°      | 2.4° ± 5.3°       | 1.64    | NS      |
| N-A (HP horizontal) mm  | -1.26 ± 2.82     | -0.53 ± 3.28      | 1.688   | NS      |
| N-B (HP horizontal) mm  | -5.6 ± 4.85      | -4.25 ± 5.75      | 1.795   | NS      |
| N-Pog (HP horizontal) mm| -4.44 ± 5.13     | -2.94 ± 6.2       | 1.864   | NS      |
| Vertical (skeletal and dental) |       |                   |         |         |
| N-ANS (HP vertical)     | 55.01 ± 3.09     | 53.64 ± 3.21      | -3.075  | < 0.01  |
| ANS-Gn (HP vertical)    | 68.5 ± 4.82      | 65.28 ± 4.92      | -4.675  | < 0.01  |
| PNS-N (HP vertical)     | 53.89 ± 2.9      | 53.06 ± 3.4       | -1.857  | NS      |
| HP to Go-Gn angle       | 21.62 ± 3.3      | 19.48 ± 3.83      | -4.233  | < 0.01  |
| Upper incisor to NF (mm)| 31.12 ± 3.08     | 29.03 ± 2.02      | -5.674  | < 0.01  |
| Lower incisor to MP (mm)| 40.55 ± 5.93     | 39.04 ± 3.14      | -2.250  | < 0.05  |
| Upper molar to NF (mm)  | 26.55 ± 2.58     | 24.85 ± 1.95      | -5.257  | < 0.01  |
| Lower molar to MP (mm)  | 33.29 ± 2.64     | 31.57 ± 4.36      | -3.375  | < 0.01  |
| Maxilla and mandible    |                  |                   |         |         |
| PNS-ANS                 | 57.54 ± 3.4      | 57.07 ± 4.5       | -0.833  | NS      |
| Ar-Go (mm)              | 50.84 ± 4.39     | 50.05 ± 5.29      | -1.149  | NS      |
| Go-Pog (mm)             | 80.87 ± 5.04     | 80.31 ± 4.28      | -0.544  | NS      |
| B-Pog (mm)              | 7 ± 1.85         | 6.21 ± 1.81       | -3.052  | < 0.01  |
| Ar-Go-Gn angle          | 125.08 ± 4.84    | 122.69 ± 4.11     | -3.764  | < 0.01  |
| Dental                  |                  |                   |         |         |
| Upper OP to HP angle    | 7.25 ± 3.63      | 6.35 ± 2.92       | -1.932  | NS      |
| Upper incisor to NF (degree) | 117.19 ± 5.99 | 119.23 ± 5.25 | 2.561  | < 0.05  |
| Lower incisor to MP (degree) | 103.49 ± 6.42 | 101.66 ± 6.03 | -2.078  | < 0.05  |
| AB (OP) mm              | -1.1 ± 2         | 0.4 ± 2.5         | 4.685   | < 0.01  |
Table 2: Comparison of norms between Rajasthani and Caucasian Males

| Parameter                               | Caucasian male | Rajasthani male | t value | P value |
|-----------------------------------------|----------------|-----------------|---------|---------|
|                                         | Mean           | SD              | Mean    | SD      |         |         |
| Cranial base                            |                |                 |         |         |         |         |
| Ar-PTM (HP horizontal) mm               | 37.1           | 2.8             | 37.04   | 3.32    | 0.06    | NS      |
| PTM-N (HP horizontal) mm                | 52.8           | 4.1             | 54.66   | 2.72    | 2.24    | <0.05   |
| Horizontal (skeletal)                   |                |                 |         |         |         |         |
| N-A-Pg (angle)                          | 3.9            | 6.4             | 3.7°    | 5.9°    | 0.12    | NS      |
| N-A (HP horizontal) mm                  | 0              | 3.7             | -1.26   | 2.82    | 1.504   | NS      |
| N-B (HP horizontal) mm                  | -5.3           | 6.7             | -5.6    | 4.85    | 0.206   | NS      |
| N-Pog (HP horizontal) mm                | -4.3           | 8.6             | -4.44   | 5.13    | 0.08    | NS      |
| Vertical (skeletal and dental)          |                |                 |         |         |         |         |
| N-ANS (HP vertical)                     | 54             | 3.2             | 55.01   | 3.09    | 1.14    | NS      |
| ANS-Gn (HP vertical)                    | 68.6           | 3.8             | 68.5    | 4.82    | 0.074   | NS      |
| PNS-N (HP vertical)                     | 53.9           | 1.7             | 53.89   | 2.9     | 0.013   | NS      |
| HP to Go-Gn angle                       | 23             | 5.9             | 21.62   | 3.3     | 1.038   | NS      |
| Upper incisor to NF (mm)                | 30.5           | 2.1             | 31.12   | 3.08    | 0.728   | NS      |
| Lower incisor to MP (mm)                | 45             | 2.1             | 40.55   | 5.93    | 2.77    | <0.01   |
| Upper molar to NF (mm)                  | 26.2           | 2.1             | 26.55   | 2.58    | 0.484   | NS      |
| Lower molar to MP (mm)                  | 35.8           | 2.6             | 33.29   | 2.64    | 3.34    | <0.01   |
| Maxilla and mandible                    |                |                 |         |         |         |         |
| PNS-ANS                                 | 57.5           | 2.5             | 57.54   | 3.4     | 0.04    | NS      |
| Ar-Go (mm)                              | 52             | 4.2             | 50.84   | 4.39    | 0.93    | NS      |
| Go-Pog (mm)                             | 83.7           | 4.6             | 80.67   | 5.04    | 2.17    | <0.05   |
| B-Pog (mm)                              | 8.9            | 1.7             | 7.7     | 1.85    | 3.63    | <0.01   |
| Ar-Go-Gn angle                          | 119            | 6.5             | 125.08  | 4.84    | 4.21    | <0.01   |
| Dental                                  |                |                 |         |         |         |         |
| Upper OP to HP angle                    | 6.1            | 5.1             | 7.25    | 3.63    | 1.052   | NS      |
| Upper incisor to NF (degree)            | 111            | 4.7             | 117.19  | 5.99    | 3.0704  | <0.01   |
| Lower incisor to MP (degree)            | 95.9           | 5.7             | 103.49  | 6.42    | 4.37    | <0.01   |
| AB (OP) mm                              | -1.1           | 2               | -0.41   | 2.79    | 0.892   | NS      |

Table 3: Comparison of norms between Rajasthani and Caucasian females

| Parameter                               | Caucasian female | Rajasthani female | t value | P value |
|-----------------------------------------|------------------|-------------------|---------|---------|
|                                         | Mean             | SD                | Mean    | SD      |         |         |
| Cranial base                            |                  |                   |         |         |         |         |
| Ar-PTM (HP horizontal) mm               | 32.8             | 1.9               | 36.11   | 3.14    | 4.054   | <0.01   |
| PTM-N (HP horizontal) mm                | 50.9             | 3                 | 53.8    | 3.06    | 3.50    | <0.01   |
| Horizontal (skeletal)                   |                  |                   |         |         |         |         |
| N-A-Pg (angle)                          | 2.6              | 5.1               | 2.4     | 5.3     | 0.14    | NS      |
| N-A (HP horizontal) mm                  | -2               | 3.7               | -0.53   | 3.28    | 1.62    | NS      |
| N-B (HP horizontal) mm                  | -6.9             | 4.3               | -4.25   | 5.75    | 1.75    | NS      |
| N-Pog (HP horizontal) mm                | -6.5             | 5.1               | -2.94   | 6.2     | 2.16    | <0.05   |
| Vertical (skeletal and dental)          |                  |                   |         |         |         |         |
| ANS-Gn (HP vertical)                    | 61.3             | 3.3               | 65.28   | 4.92    | 3.09    | <0.01   |
| PNS-N (HP vertical)                     | 50.6             | 2.2               | 53.06   | 3.4     | 2.77    | <0.01   |
| HP to Go-Gn angle                       | 24.2             | 5                 | 19.48   | 3.83    | 4.34    | <0.01   |
| Upper incisor to NF (mm)                | 27.5             | 1.7               | 29.03   | 2.02    | 2.84    | <0.01   |
| Lower incisor to MP (mm)                | 40.8             | 1.8               | 39.04   | 3.14    | 2.16    | <0.05   |
| Upper molar to NF (mm)                  | 23               | 1.3               | 24.85   | 1.95    | 3.62    | <0.01   |
| Lower molar to MP (mm)                  | 32.1             | 1.9               | 31.57   | 4.36    | 0.47    | NS      |
| Maxilla and mandible                    |                  |                   |         |         |         |         |
| PNS-ANS                                 | 52.5             | 3.5               | 57.07   | 4.5     | 3.83    | <0.01   |
| Ar-Go (mm)                              | 46.8             | 2.5               | 50.05   | 5.29    | 2.39    | <0.05   |
| Go-Pog (mm)                             | 74.3             | 5.8               | 80.31   | 4.28    | 4.91    | <0.01   |
| B-Pog (mm)                              | 7.2              | 1.9               | 6.21    | 1.81    | 2.0     | < 0.05  |
| Ar-Go-Gn angle                          | 122              | 6.9               | 122.69  | 4.11    | 0.56    | NS      |
| Dental                                  |                  |                   |         |         |         |         |
| Upper OP to HP angle                    | 7.1              | 2.5               | 6.35    | 2.92    | 0.96    | NS      |
| Upper incisor to NF (degree)            | 112              | 5.3               | 119.23  | 5.25    | 5.06    | <0.01   |
| Lower incisor to MP (degree)            | 95.9             | 5.7               | 101.66  | 6.03    | 3.54    | <0.01   |
| AB (OP) mm                              | 0.4              | 2.5               | -0.36   | 1.99    | 1.36    | NS      |
are mostly established on the Caucasian population, which might lead to wrong diagnosis in case of population other than Caucasian. This warrants the need for the establishment of surgical cephalometric norms for different populations.

India is one of the largest countries in Asia with 4 different zones—East, West, North and South. All the 4 zones have different people having different facial characteristics. People living in North India have different facial form than people living in South India.
Over the centuries, India has received large groups of people of different ethnical and cultural origins. This has lead to dispersion of different ethnic groups in the Indian population.

This study was done for the purpose of establishing the cephalometric norms for Rajasthani population and also to establish the individual cephalometric norms of males and females. It focused on 100 males and 100 females of Rajasthan origin having a class I occlusion and well-balanced faces. The young adults were examined with age range of 18–25 years. Two different comparisons were done to evaluate the facial structures for Burstone hard tissue analysis; comparison between Rajasthani males and females and comparison between Rajasthani population and Caucasian population.

Comparison between Rajasthani males and females [Table 1] revealed that males had increased anterior cranial base length. Females had increased middle and lower third facial height, anterior divergence of mandible, which is in contrast to the study done by Grewal et al.[3] on Indo-Aryans who have vertically growing mandible, but is in agreement with the study done by Mohode et al.[6] on Marathi population.

Females also had decreased maxillary and mandibular anterior and posterior dental height, which is in agreement with the Burstone analysis.[3] Rajasthani males had proclined upper anteriors and females had proclined lower anteriors.

COGS analysis comparison between Rajasthani population with Caucasian population [Tables 2 and 3] revealed an increase in the anterior cranial base length, length of maxilla, mandibular ramus and body of mandible in Rajasthani females compared with the Caucasian females. They represent increased middle and lower third facial height, posterior maxillary height and anterior divergence of the mandible.[3]

In dental parameters, Rajasthani males had decreased mandibular dental height in anterior and posterior regions. Rajasthani females had increased maxillary dental height in both anterior and posterior regions and decreased mandibular anterior dental height.

Rajasthanis had proclined and forwardly placed upper and lower incisors, which was indicative of bimaxillary protrusion as compared with Caucasians and this was further supported by the observations on Indo-Aryans,[5] Marathi population,[6] and Hindus.[2]

We have applied the Rajasthani norms for treatment planning of orthognathic surgery cases and achieved satisfying results [Figures 2–7].

**Conclusion**

The following conclusions can be drawn from our study.

- Rajasthanis have a bimaxillary protrusion with predominant tendency toward horizontal growth pattern of the mandible and this tendency is further exaggerated in females.
- The Rajasthani females have increased length of anterior cranial base, maxilla and mandible.
- Females have increased maxillary dental height.
- Decreased mandibular dental height was observed in both males and females subjects.
- The norms for the Rajasthani population are taken into account during orthognathic treatment planning. Such norms should be established in various regions of the country for achieving better results.

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