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# Cephalometric norms for north indian population using burstone analysis

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ABSTRACT

**Background:** Cephalometric norms are extremely useful to the orthodontist for providing guidance during diagnosis and treatment planning. But they are subjected to variability in morphologic characteristics in different ethnic and racial groups.
**Materials and Methods:**The study was conducted on 76 subjects of 18-28 years of age with class I occlusion with acceptable facial profile. Standardized lateral cephalograms were taken in a natural head position and analyzed.
**Results:** North Indians exhibit increased facial convexity, greater mandibular prognathism, more obtuse lower face- throat angle and greater amount of upper lip - lower lip protrusion. Males showing larger cranial base length, vertical positioning and length of maxilla, ramal length, and the chin prominence. On dental analysis, females tend to have lesser proclined anterior teeth**.**
**Conclusion:** The present study was an attempt to provide better knowledge of facial morphology in the North Indians hence a comprehensive treatment planning can be done based on the norms derived for the correction of skeletal discrepancies.



## 1. Introduction

Cephalometrics is a reliable and reproducible diagnostic technique. Numerous osseous cephalometric analyses were developed to diagnose and plan treatment. By placing the skeletal parts within the range of skeletal cephalometric norms of normal individual's best facial balance and best facial harmony would be achieved.[1]

A number of investigators noticed the variation of the craniofacial morphology in different ethnic groups.[2] Richardson defined the term "ethnic group" as a "nation or population with a common bond such as geographical boundary, a culture or language, or being racially or historically related".[2]

It is apparent from the information gathered that the widely studied Caucasian norms developed by the use of numerous cephalometric analyses were inadequate for application to different racial or ethnic groups.[2] Normal values for Cephalometric analysis of dental and facial form have been extensively developed for North American and Northwestern European populations.

A specialized cephalometric appraisal for orthognathic surgery (COGS), was developed at the University of Connecticut by Burstone and Legan.[3]Normal values for Cephalometric analysis of dental and facial form have been extensively developed for North American and Northwestern European populations.[4–9]Though widely used worldwide but limited data is available for North Indian population. These analyses have been extensively used for research[10–14] and in treatment planning for orthgnathic surgery.

Therefore, the present study was designed to derive the normal Cephalometric norms of the normal, well balanced and esthetically pleasing faces from the adult North Indian population which will be useful in providing racially specific values for diagnosis and treatment planning for

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orthognathic surgery.

## 2. Materials and Methods

The 76 subjects of 18-28 years (38 males and 38 females) were selected for the present study having class I occlusion with acceptable facial profile. There was no history of trauma, orthodontic, orthognathic, or plastic surgery treatment. The subjects were shielded appropriately from the radiation by utilizing a lead apron prior to taking lateral cephalograms. The lateral cephalograms were standardized using a fluid/spirit level device (Showfety et al., 1983)[14] on subject's head to attain the natural head position and also to orient Frankfort horizontal (FH) plane parallel to the fluid device. The film was exposed while operating the Planmeca Proline CC Cephalostat at a constant of 75 KVP, 12 mA and 0.8 second film exposure time. All the exposed films were developed and fixed manually by a single technician using standard procedure.

Tracings of the cephalometric radiographs were made by hand on 0.003 lead acetate tracing sheets. The cephalometric landmarks were identified according to the definitions used by Burstone and Legan.[15–17]

## 3. Results

All readings obtained were subjected to statistical analysis for calculating mean and standard deviation for both hard and soft tissues.

The North Indian population is different from Caucasians in several aspects (Table-1). There are marked difference in the soft tissue cephalometric parameters namely they exhibit increased facial convexity (mean 13.06 $\pm$ 3.03$^o$), greater mandibular prognathism (mean 2.25 $\pm$ 3.99 mm), more obtuse lower face- throat angle (mean 110.04$^o$ $\pm$ 6.31$^o$) and greater amount of upper lip (mean 4.74 $\pm$ 2.83 mm) and lower lip protrusion (mean 4.00 $\pm$ 2.62 mm). These differences were evident when comparison was made between these two individual populations. These differences were also evident when the analysis of the skeletal tissues was carried out using Burstone and Legan COGS analysis.

### *3.1. The North Indian male population demonstrated (Table 1 )*

Greater anterior cranial base length (55.19 $\pm$ 4.90 mm), Greater ramal length (55.02 $\pm$ 4.97 mm), Reduced chin depth (5.98 $\pm$ 4.85 mm), Greater inclination of the upper incisors (116.65 $\pm$ 4.72 mm), Greater inclination of the lower incisors (102.36 $\pm$ 5.31), than their Caucasian counterpart and there was significant difference on statistical analysis applying Z-test on 1.96 level of significance which could be of use in diagnostic importance during treatment planning.

### *3.2. Similarly, the North Indian Female population demonstrated (Table 2 )*

Greater posterior cranial base (37.77 $\pm$ 2.98 mm), Greater mandibular protrusion (-4.5 $\pm$ 4.7 mm), Retrusive chin (-3.48 $\pm$ 5.09 mm), Greater Upper anterior facial height (53.02 $\pm$ 2.99 mm), Greater Upper posterior facial height (52.14 $\pm$ 3.20 mm), Greater maxillary length (54.69 $\pm$ 3.16 mm), Greater ramal length (49.81 $\pm$ 3.96 mm), Greater mandibular body length (77.06 $\pm$ 4.29 mm), Reduced chin depth (5.47 $\pm$ 4.05 mm), Greater inclination of lower incisors (100.96 $\pm$ 6.39$\circ$), than their female Caucasian counterpart and these were also significantly differing when subjected to statistical analysis applying Z-test on 1.96 level of significance.

## 4. Discussion

Most of cephalometric analyses[3,6,18] which are used today in this country have originated in White North American children and young adults. The norms set by their authors are for their ethnic groups. With time it became evident that cephalometric norms of one ethnic group need not necessarily apply to another ethnic group because of noticeable variation of the craniofacial morphology in different ethnic groups. Most importantly in country like India where the intra country variation in population vary to a great extent morphogenetically as well as linguistically, so developing a specific normative standard for entire population can be erroneous in nature.

Previous studies have established specific cephalometric norms with different ethnic backgrounds, showing different facial features. Up till now, there is a paucity of information about the cephalometric features of the population living in the North region of India, who has distinct social and climatic characteristics. The racial, facial, and skeletal characteristics of the patient play a critical role in orthognathic treatment planning. Therefore, existence of such data base becomes an absolute necessity for carrying out these surgical procedures.

Keeping this background and scarcity of such data base in mind, present study was designed and carried to establish the norms for North Indian population. Taking in consideration the lack of data reported in the literature till now, this seems to be a first trial to establish norms for North Indian population with the adult subjects whose age group was between the age ranges of 18-28 years. The subjects in the sample were selected on the basis of a harmonious facial profile.

Further the gender based intra-population skeletal differences are also seen between the male and female population

1. Males showing the larger cranial base length both anterior and posterior while there was increased tendency towards straighter profile in females than the

**Table 1:** Descriptive statistics for hard tissue in males.

| | Measurement | Mean | SD | 95% confidence limits | |
|---|---|---|---|---|---|
| | | | | Lower | Upper |
| Cranial Base | Ar-Ptm (llel HP) | 38.16 | 3.23 | 38.69 | 40.82 |
| | Ptm-N (llel HP) | 55.19 | 4.90 | 53.58 | 56.80 |
| Horizontal (Skeletal) | N-A-Pg (Angle) | 3.19 | 3.16 | 2.15 | 4.23 |
| | N-A (llel HP) | 1.07 | 3.98 | -2.75 | -0.13 |
| | N-B (llel HP) | -4.07 | 5.12 | -6.76 | -3.39 |
| | N-Pg (llel HP) | -3.85 | 5.38 | -5.62 | -2.08 |
| Vertical (Skeletal, Dental) | N-ANS (^ HP) | 55.72 | 3.56 | 55.55 | 57.89 |
| | ANS-Gn (^ HP) | 67.67 | 3.34 | 67.57 | 69.77 |
| | PNS-N (^ HP) | 54.78 | 2.90 | 54.83 | 56.74 |
| | MP-HP (Angle) | 21.98 | 3.55 | 18.72 | 21.06 |
| | Upper 1-NF (^ NF) | 29.44 | 2.51 | 28.62 | 30.27 |
| | Lower 1-MP (^ MP) | 43.53 | 4.19 | 42.18 | 44.94 |
| | Upper 6-NF (^ NF) | 26.36 | 3.78 | 25.12 | 27.61 |
| | Lower 6-MP (^ MP) | 35.60 | 1.94 | 34.96 | 36.24 |
| Maxilla, Mandible | PNS-ANS (llel HP) | 58.07 | 2.44 | 57.27 | 58.88 |
| | Ar-Go (Linear) | 55.02 | 4.97 | 53.39 | 56.66 |
| | Go-Pg (Linear) | 84.17 | 4.53 | 82.68 | 85.66 |
| | B-Pg (llel MP) | 5.98 | 4.85 | 4.39 | 7.58 |
| | Ar-Go-Gn (Angle) | 121.86 | 4.28 | 120.45 | 123.27 |
| Dental | OP -HP (Angle) | 6.01 | 2.79 | 5.09 | 6.93 |
| | A-B (llel OP) | 0.07 | 2.23 | -0.65 | 0.81 |
| | Upper 1-NF (Angle) | 116.65 | 4.72 | 118.10 | 121.21 |
| | Lower 1-MP (Angle) | 102.36 | 5.31 | 100.62 | 104.11 |

**Table 2:** Descriptive statistics for hard tissue in females.

| | Measurement | Mean | SD | 95% confidence limits | |
|---|---|---|---|---|---|
| | | | | Lower | Upper |
| Cranial Base | Ar-Ptm (llel HP) | 37.77 | 2.98 | 36.79 | 38.75 |
| | Ptm-N (llel HP) | 51.00 | 2.50 | 52.17 | 53.82 |
| Horizontal (Skeletal) | N-A-Pg (Angle) | 2.27 | 2.80 | 1.35 | 3.19 |
| | N-A (llel HP) | 0.86 | 3.01 | -1.85 | 0.12 |
| | N-B (llel HP) | -4.5 | 4.7 | -6.04 | -2.95 |
| | N-Pg (llel HP) | -3.48 | 5.09 | -5.16 | -1.81 |
| Vertical (Skeletal, Dental) | N-ANS (^ HP) | 53.02 | 2.99 | 52.04 | 54.01 |
| | ANS-Gn (^ HP) | 62.23 | 3.73 | 61.00 | 63.46 |
| | PNS-N (^ HP) | 52.14 | 3.20 | 51.09 | 53.19 |
| | MP-HP (Angle) | 22.34 | 3.21 | 19.28 | 21.39 |
| | Upper 1-NF (^ NF) | 27.05 | 3.01 | 26.06 | 28.04 |
| | Lower 1-MP (^ MP) | 39.88 | 3.10 | 38.86 | 40.90 |
| | Upper 6-NF (^ NF) | 23.57 | 1.74 | 23.00 | 24.15 |
| | Lower 6-MP (^ MP) | 32.36 | 2.87 | 31.42 | 33.31 |
| Maxilla, Mandible | PNS-ANS (llel HP) | 54.69 | 3.16 | 53.65 | 55.73 |
| | Ar-Go (Linear) | 49.81 | 3.96 | 49.86 | 52.47 |
| | Go-Pg (Linear) | 77.06 | 4.29 | 77.65 | 80.47 |
| | B-Pg (llel MP) | 5.47 | 4.05 | 4.14 | 6.80 |
| | Ar-Go-Gn (Angle) | 120.86 | 2.96 | 119.89 | 121.84 |
| Dental | OP -HP (Angle) | 6.96 | 2.27 | 5.21 | 6.70 |
| | A-B (llel OP) | -0.02 | 2.26 | -1.92 | -0.44 |
| | Upper 1-NF (Angle) | 114.43 | 4.87 | 115.83 | 119.03 |
| | Lower 1-MP (Angle) | 100.96 | 6.39 | 98.85 | 103.06 |

**Table 3:** Descriptive statistics for soft tissue in North Indian population.

| | Measurement | Mean | SD | 95% confidence limits | |
|---|---|---|---|---|---|
| | | | | Lower | Upper |
| Facial Form | Facial Convexity Angle G-Sn-Pg' | 13.06 | 3.03 | 12.37 | 13.76 |
| | Maxillary Prognathism G-Sn (llel HP) | 5.93 | 3.23 | 5.19 | 6.67 |
| | Mandibular Prognathism G-Pg' (llel HP) | 2.25 | 3.99 | 1.34 | 3.16 |
| | Vertical Height Ratio G-Sn/Sn-Me' (^ HP) | 1.03 | 0.13 | 1.00 | 1.06 |
| | Lower Face-Throat Angle Sn-Gn'-C | 110.04 | 6.31 | 108.60 | 111.48 |
| | Lower Vertical Height-Depth Ratio Sn-Gn'/C-Gn' | 1.31 | 0.18 | 1.27 | 1.35 |
| Lip Position and Form | Nasolabial Angle Cm-Sn-Ls | 102.19 | 7.50 | 100.48 | 103.91 |
| | Upper Lip Protrusion Ls to (Sn-Pg') | 4.74 | 2.83 | 4.09 | 5.39 |
| | Lower Lip Protrusion Li to (Sn-Pg') | 4.00 | 2.62 | 3.39 | 4.60 |
| | Mentolabial Sulcus Si to (Li-Pg') | 3.92 | 1.42 | 3.59 | 4.24 |
| | Vertical Lip-Chin Ratio Sn-$Stm_s$/$Stm_i$-Me' (HP) | 0.50 | 0.08 | 0.48 | 0.52 |
| | Maxillary Incisor Exposure $Stm_s$ $U_1$ | 2.23 | 1.20 | 1.96 | 2.51 |

**Table 4:** "Z" Value of hard tissue for North Indian Population.

| LANDMARKS | Caucasian Population Male | North Indian Population Male | Z Value | Caucasian Population Female | North Indian Population Female | Z Value |
|---|---|---|---|---|---|---|
| Cranial Ba | | | | | | |
| Ar-Ptm (llel HP) | 37.1 ± 2.8 | 38.16 ± 3.23 | 1.16 | 32.8 ± 1.9 | 37.77 ± 2.98 | **2.9** † |
| Ptm-N (llel HP) | 52.8 ± 4.1 | 55.19 ± 4.90 | **1.96** * | 50.9 ± 3.0 | 51.00 ± 2.50 | 0.117 |
| **Horizontal (Skeletal)** | | | | | | |
| N-A-Pg (Angle) | $3.9^o \pm 6.4^o$ | 3.19 ± 3.16 | 0.39 | $2.6^o \pm 5.1^o$ | 2.27 ± 2.80 | 0.249 |
| N-A (llel HP) | 0.0 ± 3.7 | 1.07 ± 3.98 | 0.906 | 2.0 ± 3.7 | 0.86 ± 3.01 | 1.090 |
| N-B (llel HP) | -5.3 ± 6.7 | -4.07 ± 5.12 | 0.623 | -6.9 ± 4.3 | -4.5 ± 4.7 | **1.97** * |
| N-Pg (llel HP) | -4.3 ± 8.5 | -3.85 ± 5.38 | 0.185 | -6.5 ± 5.1 | -3.48 ± 5.09 | **1.988** * |
| **Vertical (Skeletal,Dental)** | | | | | | |
| N-ANS (^ HP) | 54.7 ± 3.2 | 55.72 ± 3.56 | 0.988 | 50 ± 2.4 | 53.02 ± 2.99 | **3.912** † |
| ANS-Gn (^ HP) | 68.6 ± 3.8 | 67.67 ± 3.34 | 0.808 | 61.3 ± 3.3 | 62.23 ± 3.73 | 0.909 |
| PNS-N (^ HP) | 53.9 ± 1.7 | 54.78 ± 2.90 | 1.346 | 50.6 ± 2.2 | 52.14 ± 3.20 | **2.036** * |
| MP-HP (Angle) | $23.0^o \pm 5.9^o$ | 21.98 ± 3.55 | 0.608 | $24.2^o \pm 5^o$ | 22.34 ± 3.21 | 1.374 |
| Upper 1-NF (^ NF) | 30.5 ± 2.1 | 29.44 ± 2.51 | 1.529 | 27.5 ± 1.7 | 27.05 ± 3.01 | 0.695 |
| Lower 1-MP (^ MP) | 45.0 ± 2.1 | 43.53 ± 4.19 | 1.668 | 40.8 ± 1.8 | 39.88 ± 3.10 | 1.363 |
| Upper 6-NF (^ NF) | 26.2 ± 2.0 | 26.36 ± 3.78 | 0.197 | 23.0 ± 1.3 | 23.57 ± 1.74 | 1.32 |
| Lower 6-MP (^ MP) | 35.8 ± 2.6 | 35.60 ± 1.94 | 0.262 | 32.1 ± 1.9 | 32.36 ± 2.87 | 0.391 |
| **Maxilla, Mandible** | | | | | | |
| PNS-ANS (llel HP) | 57.7 ± 2.5 | 58.07 ± 2.44 | 0.476 | 52.6 ± 3.5 | 54.69 ± 3.16 | **2.061** * |
| Ar-Go (Linear) | 52.0 ± 4.2 | 55.02 ± 4.97 | **2.185** * | 46.8 ± 2.5 | 49.81 ± 3.96 | **3.358** † |
| Go-Pg (Linear) | 83.7 ± 4.6 | 84.17 ± 4.53 | 0.32 | 74.3 ± 5.8 | 77.06 ± 4.29 | **1.98** * |
| B-Pg (llel MP) | 8.9 ± 1.7 | 5.98 ± 4.85 | **3.214** † | 7.2 ± 1.9 | 5.47 ± 4.05 | **2.13** * |
| Ar-Go-Gn (Angle) | $119.1^o \pm 6.5^o$ | 121.86 ± 4.28 | 1.475 | $122^o \pm 6.9^o$ | 120.86 ± 2.96 | 0.637 |
| Dental | | | | | | |
| OP -HP (Angle) | $6.2^o \pm 5.1^o$ | 6.01 ± 2.79 | 0.132 | $7.1^o \pm 2.5^o$ | 6.96 ± 2.27 | 0.193 |
| A-B (llel OP) | -1.1 ± 2.0 | 0.07 ± 2.23 | 1.813 | -0.4 ± 2.5 | 0.02 ± 2.26 | 0.580 |
| Upper 1-NF (Angle) | $111.0^o \pm 4.7^o$ | 116.65 ± 4.72 | **3.845** † | $112.5^o \pm 5.3^o$ | 114.43 ± 4.87 | 1.251 |
| Lower 1-MP (Angle) | $95.9^o \pm 5.2^o$ | 102.36 ± 5.31 | **3.951** † | $95.9^o \pm 5.7^o$ | 100.96 ± 6.39 | **2.872** † |

* - Significant † - Highly Significant

**Table 5:** "Z" Value of soft tissue for North Indian Population.

| Landmark | Mean | Z-Value |
|---|---|---|
| **Facial Form** | | |
| Facial Convexity Angle G-Sn-Pg' | $13.06^o \pm 3.03^o$ | **1.967 *** |
| Maxillary Prognathism G-Sn (llel HP) | $5.93 \pm 3.23$ | 0.968 |
| Mandibular Prognathism G-Pg' (llel HP) | $2.25 \pm 3.99$ | **1.961 *** |
| Vertical Height Ratio G-Sn/Sn-Me' (^ HP) | $1.03 \pm 0.13$ | 0.089 |
| Lower Face-Throat Angle Sn-Gn'-C | $110.04^o \pm 6.31^o$ | **6.049** † |
| Lower Vertical Height-Depth Ratio Sn-Gn'/C-Gn' | 1.31 | - |
| Lip Position & Form | | |
| Nasolabial Angle Cm-Sn-Ls | $102.19^o \pm 7.50^o$ | 0.560 |
| Upper Lip Protrusion Ls to (Sn-Pg') | $4.74 \pm 2.83$ | **2.069 *** |
| Lower Lip Protrusion Li to (Sn-Pg') | $4.00 \pm 2.62$ | **3.532 *** |
| Mentolabial Sulcus Si to (Li-Pg') | $3.92 \pm 1.42$ | 0.825 |
| Vertical Lip-Chin Ratio Sn-$Stm_s$/$Stm_i$-Me' (HP) | 0.50 | - |
| Maxillary Incisor Exposure $Stm_s$ $U_1$ | $2.23 \pm 1.20$ | 1.395 |

* - Significant * - Significant † - Highly Significant

males.

2. Vertical positioning of maxilla was greater in males, which was evident from increased maxillary anterior skeletal height. The maxillary anterior and posterior dental heights were also greater than the females.
3. The length of the maxilla was found to be greater in males than the females.
4. Similarly, the ramal length, body length and the chin prominence were all greater in males.
5. On dental analysis, females tend to have lesser proclined anterior teeth to their respective jaw bases as compared to their male counterparts where the level of proclination was more.
6. The Wits appraisal also displayed greater tendency towards the straighter profile with reduced skeletal discrepancy in female.

The facial structure of North Indian men in general is larger than that of North Indian women. Similar study using COGS analysis was done for Black American adults and Japenese adults, in the Black American adults, conclusion was drawn that the subjects had greater maxillary skeletal prognathism, skeletal lower face height, skeletal facial convexity, lower incisor proclination, anterior dental heights, upper and lower lip lengths, and soft tissue thickness of the lips and chin, less nasal depth and projection, less bony chin depth, and a smaller nasolabial angle than in white subjects. In the Japenese adults, there was a shorter maxilla, less prominent chin, larger upper anterior face height, and lower posterior dental height than Burstone's white sample. Soft tissue analysis showed a retrognathic maxilla and mandible and bilabial protrusion when compared with the white adult standards.

## 5. Summary and Conclusion

Orthognathic surgery has become more prevalent today in the treatment of adult patients with facial deformities. Currently, the cephalometric norms used for assessment of the deformity and the treatment planning are those for the Caucasian population and thus all patients, regardless of race, are evaluated by these established standards. In the present study, surgically useful rectilinear cephalometric norms for the diagnosis and treatment planning of orthognathic surgery in adult North Indian population were evaluated for its practical implementation in the treatment of the facial deformities. This study concludes with the following results:

### *5.1. The North Indian male population demonstrated:*

Greater anterior cranial base length, Greater ramal length, Reduced chin depth, Greater inclination of the upper incisors, Greater inclination of the lower incisors, than their Caucasian counterpart and there was significant difference on statistical analysis which could be of use in diagnostic importance during treatment planning.

### *5.2. Similarly, the North Indian Female population demonstrated:*

Greater posterior cranial base, Greater mandibular protrusion, Greater Upper anterior facial height, Greater Upper posterior facial height, Greater maxillary length, Greater ramal length, Greater mandibular body length, Reduced chin depth, Greater inclination of lower incisors, than their female Caucasian counterpart and these were also significantly differing when subjected to statistical analysis.

Thus, the study reveals that some of the cephalometric parameters in the North Indian population are different quite significantly than the Caucasian population especially the female gender. These racial differences are evident in this

study and can be of clinical importance while charting out plan for the orthognathic surgery for North Indian population.

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None.

## 7. Conflict of Interest

None.

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