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# Cephalometric Norms for East Indian Population using Burstone Legan Analysis

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***Abstract:***

**Background:** The purpose of this study is to evaluate and compare the cephalometric hard and soft tissue cephalometric for orthognathic surgery (COGS) norms for East Indian subjects and to compare with the Caucasians.

**Materials and Methods:** 200 adults of East Indian population (100 males and 100 females), with an age range of 18-30 years were selected for the study. The subjects included had well-balanced pleasing facial profile, no craniofacial abnormality, Angle's Class I molar relationship on both sides with minimum to moderate anterior crowding, and no previous history of orthodontic treatment. The COGS analysis values for the East Indian population was established and compared with the Caucasians.

**Results:** All the cephalometric parameters except the anterior cranial base, facial convexity angle, maxillary protrusion, lower anterior face height, upper posterior dental height, chin depth; maxillary length, and mandibular body length were comparable among both the groups. The COGS soft tissue parameters such as the mandibular prognathism, upper lip protrusion, and lower lip protrusion were higher in the East Indian subjects as compared to the Caucasians.

**Conclusion:** The cephalometric parameters in the East Indian population are significantly different than those of the Caucasian population. These racial differences which are evident in this study should be kept in mind while charting out plan for orthognathic surgery for the East Indian population.

***Key Words***: Caucasians, cephalometric for orthognathic surgery, East India, ethnicity

## Introduction

Facial harmony and balance are maintained by the facial skeleton and its overlying soft tissue.[1] Orthodontic diagnosis and treatment planning are based on the evaluation of the patient's soft tissue profile.[2]

At present, a large number of adults-seeking orthodontic treatment require orthognathic surgery. For successful treatment of orthognathic surgery, accurate diagnosis of facial, skeletal, and dental problems is a must. For this reason, a specialized cephalometric appraisal system called cephalometric for orthognathic surgery analysis (COGS) concerning the hard tissue and soft tissue of the face had been developed by Burstone *et al*.[3] The values of COGS analysis proved to be very useful as they are based largely on rectilinear measurements that can be used during surgery for prediction overlays, mock surgery, and may serve as a basis for the assessment of post-treatment stability. These analyses have been extensively used for research studies.[4-8] However, all these studies were carried out in Caucasians based on sample populations of people with European-American ancestries whose reference value may not be applicable to other ethnic types.[1,3,4,9-20] For this reason, attempts have been made to investigate the differences of the human face among various ethnic groups including Africans,[12,21] African-Americans,[4,10,20] Chinese,[5,22,23] Koreans,[9] Indians,[24] Saudi Arabians,[25] Mexican-Americans,[26] and Puerto Ricans.[27]

As review of literature reveals, so far no study has been conducted on East Indian population. Hence, the purpose of this present research was to investigate the hard tissue and soft tissue COGS norms for East Indian population with normal occlusion and well-balanced faces and to compare with the Caucasians.[3]

## Materials and Methods

200 adults of East Indian population (100 males and 100 females), with an age range of 18-30 years were selected for the study.

East India is a region of India consisting of the Indian states of West Bengal, Bihar, Jharkhand, Odisha, and also the union territory Andaman and Nicobar Islands. West Bengal's capital Kolkata is the largest city of this region. The Kolkata Metropolitan Area is the country's third largest. The states of Odisha and West Bengal share some cultural and linguistic characteristics with Bangladesh and with the state of Assam. Bengali is the most spoken language of this region, and it is also the second most spoken language in India after Hindi. Odia is the only language in east India accorded the status of a Classical Language of India.[28-31]

The Caucasian race (also Caucasoid[32] or occasionally Europid[33]) is a taxon historically used to describe the physical or biological type of some or all of the populations of Europe, North Africa, the Horn of Africa, Western Asia, Central Asia, and certain parts of South Asia.[34] The term was used in biological anthropology for many people from these regions, without regard necessarily to skin tone.[35]

The subjects included in our study group had well-balanced pleasing facial profile (orthognathic facial profile), no craniofacial abnormality, Angle's Class I molar relationship on both sides with minimum to moderate anterior crowing and no previous history of orthodontic treatment. Lead aprons were used by the sample group while lateral cephalograms were recorded in centric occlusion with lips in repose and the Frankfort horizontal plane-oriented horizontally according to the natural head position.[36]

All the lateral cephalograms were traced manually on 0.003 lead acetate tracing sheets, and Burstone *et al.*[3,37] cephalometric analysis was followed. For accurate landmark identification, the tracings were reviewed on two separate occasions by two investigators. The COGS values for East Indian population was established and compared with the Caucasians.

***Statistics***

Statistical analysis was done using the version 15 of the Statistical Package for Social Sciences (SPSS Inc., Chicago, Ill, USA). The mean and standard deviations for the various values were calculated. Equality of variances was tested using the *Z*-test. When $Z > 1.96$, the result was statistically significant. Unpaired *t*-test was used to determine the mean differences for each cephalometric measurement between the East Indian population and the Caucasians. The probability value $P \leq 0.05$ was considered statistically significant.

**Results**

The mean, standard deviation, and standard error of the various hard and soft tissue COGS measurements for the East Indian population are described in Tables 1 and 2 respectively. Table 3 describes the soft tissue COGS values for the Caucausians.[37] *P* value and *Z* score of our study group are presented in Table 4. Anterior cranial base, upper anterior facial height, and Wit's analysis showed statistical significant difference between East Indian males and females. In soft tissue, COGS only nasolabial angle showed statistical significant difference between East Indian males and females.

**Discussion**

Currently, the demand for orthodontic treatment is mainly for an improvement of the soft tissue profile. Ethnicity which influences the skeletal and dental parameters definitely plays a critical role in the planning of treatment for orthodontic and orthognathic surgical corrections. One of the major goals of orthognathic surgery is to treat any jaw imbalance and the resulting incorrect bite which will aid in the achievement of a well-balanced, proportional face.

Most of the surgical cephalometric norms were established on the Caucasian population. The cephalometric norms of one ethnic group may not be applicable to another ethnic group because of marked difference of the craniofacial morphology in different ethnic groups.[37]

India is a large country with four different zones – East, West, North, and South. The previous research has been carried out on North Indians,[24] Central India,[38] Rajasthani population[39] to name a few. All the four zones have different people having different ethnic and cultural origins.

Past studies reveal that no research has been done on the East Indian population till date. The hard tissue and soft tissue COGS cephalometric values for the East India population was evaluated and compared with the Caucasians.[3]

A study by Kowalski's *et al.*[40] revealed more canted occlusal plane relative to a cranial base and more proclined lower incisors in American adult males. A similar study was done by Flynn[20] for Black American adults which concluded that the subjects had greater maxillary skeletal prognathism, reduced lower facial height, reduced nasal depth, less bony chin depth, and a reduced nasolabial angle than in White subjects. Jacobson[11,12] concluded that no significant difference were present in relation to anterior extremity of the maxilla and mandible, maxillary length, and anterior face height in between South African Blacks and Whites. Similar study was conducted by Alcalde[17] for Japanese adults.

Trivedi *et al.*[39] did a comparative study between Rajasthani males and females which revealed that males had increased anterior cranial base length. Females had increased middle and lower third facial height and anterior divergence of mandible. Jena *et al.*[24] evaluated the cephalometric norms for North Indians and concluded that the length of the mandible was more among North Indian males than females; whereas, inclination of the lower incisor was more among North Indian females than males.

Our study revealed that the anterior cranial base, facial convexity angle, and maxillary protrusion were increased in the East Indian population. The males of our study group exhibited higher values in comparison to the females with respect to the above parameters. In case of posterior cranial base, the males of both the groups had similar values, whereas the females of the present group exhibited more values than the Caucasians. And on comparing males and females of the East Indian group, both exhibited similar values.

**Table 1: Hard tissue COGS value of East India population and Caucasians.**

| East India: Males=100 nos, Females=100 nos | | | | Caucausians: Males=14 nos, Females=16 nos |
|---|---|---|---|---|
| **Variables** | **Sex** | **Mean±SD** | **Standard error mean** | **Mean±SD** |
| Cranial base | | | | |
| Posterior cranial base (Ar-PTM) | M | 40.00±5.09 | 2.55 | 37.1±2.8 |
| | F | 40.00±4.98 | 2.03 | 32.8±1.9 |
| Anterior cranial base (PTM-N) | M | 60.3±2.9 | 1.4 | 52.8±4.1 |
| | F | 58.3±6.2 | 2.5 | 50.9±3 |
| Horizontal skeletal relation | | | | |
| Facial convexity (N-A-PG) | M | 4.0±4.4 | 2.2 | 3.9±6.4 |
| | F | 2.9±3.2 | 1.3 | 2.6±5.1 |
| Maxillary protrusion (N-A [HP]) | M | 3.1±4.0 | 2.0 | 0±3.7 |
| | F | 2.1±2.1 | 0.9 | −2±3.7 |
| Mandibular protrusion (N-B [HP]) | M | −5.9±4.4 | 2.2 | −5.3±6.7 |
| | F | −7.2±6.5 | 2.7 | −6.9±4.3 |
| Chin protrusion (N-PG) | M | −3.2±5.4 | 2.7 | −4.3±8.5 |
| | F | −5.1±7.3 | 3.0 | −6.5±5.1 |
| Vertical skeletal and dental | | | | |
| Upper anterior face height (N-ANS) | M | 53.9±2.3 | 1.2 | 54.7±3.2 |
| | F | 51.6±1.0 | 0.4 | 50±2.4 |
| Lower anterior face height (ANS-GN) | M | 63.5±10.4 | 5.2 | 68.6±3.8 |
| | F | 63.5±5.7 | 2.3 | 61.3±3.3 |
| Upper posterior face height (PNS-N) | M | 72.0±5.5 | 2.7 | 53.9±1.7 |
| | F | 67.7±6.7 | 2.7 | 50.6±2.2 |
| Mandibular plane angle (MP-HP) | M | 19.8±4.9 | 2.5 | 23±5.9 |
| | F | 21.8±6.5 | 2.6 | 24.2±5 |
| Upper anterior dental height (UI-NF) M | M | 28.3±4.6 | 2.3 | 30.5±2.1 |
| | F | 23.6±4.3 | 1.7 | 27.5±1.7 |
| Upper posterior dental height (U6-NF) | M | 43.1±10.6 | 5.3 | 26.2±2 |
| | F | 44.4±5.0 | 2.0 | 23±1.3 |
| Lower posterior dental height (L6-MP) | M | 21.5±±0.6 | 0.3 | 35.8±2.6 |
| | F | 21.2±2.5 | 1.0 | 32.1±1.9 |
| Lower anterior dental height (L1-MP) | M | 36.8±6.0 | 3.0 | 45±2.1 |
| | F | 33.5±2.9 | 1.2 | 40.8±1.8 |
| Maxilla and mandible | | | | |
| Maxillary length (PNS-ANS) | M | 55.5±5.8 | 2.9 | 57.7±2.5 |
| | F | 52.8±4.5 | 1.9 | 52.6±3.5 |
| Mandibular ramus length | M | 48.8±1.7 | 0.9 | 52±4.2 |
| | F | 47.9±3.2 | 1.3 | 46.8±2.5 |
| Mandibular body length | M | 78.3±3.0 | 1.5 | 83.7±4.6 |
| | F | 77.0±4.7 | 1.9 | 74.3±5.8 |
| Chin depth (B-PG) | M | 3.4±2.7 | 1.3 | 8.9±1.7 |
| | F | 3.8±1.8 | 0.8 | 7.2±1.9 |
| Gonial angle (AR-GO-GN) | M | 118.8±2.6 | 1.3 | 119.1±6.5 |
| | F | 115.3±7.0 | 2.9 | 122±6.9 |
| Dental relationships | | | | |
| OP (OP-HP) | M | 11.3±4.5 | 2.3 | 6.2±5.1 |
| | F | 9.8±6.8 | 2.8 | 7.1±2.5 |
| Upper incisors inclination (UI-NF) | M | 116.0±9.6 | 4.8 | 111±4.7 |
| | F | 118.3±8.3 | 3.4 | 112.5±5.3 |
| Lower incisors inclination (L1/GO-ME) | M | 98.8±14.9 | 7.4 | 95.9±5.2 |
| | F | 102.3±9.1 | 3.7 | 95.9±5.7 |
| Wits analysis (A-B [OP]) | M | 1.1±3.8 | 1.9 | −1.1±2 |
| | F | 1.4±8.8 | 3.6 | −0.4±2.5 |

Ar: Articulare, PTM: Pterygomaxillary fissure, N: Nasion, A: Subspinale, B: Supramentale, PG: Pogonion, Go: Gonion, Gn: Gnathion, HP: Horizontal plane, MP: Mandibular plane, OP: Occlusal plane, ANS: Anterior nasal spine, PNS: Posterior nasal spine, NF: Nasal floor, U1: Long axis of upper incisors, L1: Long axis of lower incisors, Upper 6: Mesiobuccal cusp tip of maxillary first molar, Lower 6: Mesiobuccal cusp tip of mandibular first molar, COGS: Cephalometric for orthognathic surgery

Similar results were found when variables such as mandibular protrusion, chin protrusion, upper anterior facial height, mandibular ramus length, lower incisor inclination, lower posterior dental height, and lower anterior dental height were compared. Reduced cephalometric mean values were found in case of East Indian males when evaluating lower

**Table 2: COGS soft tissue values for East India population.**

| Variables | Sex | N | Mean±SD | Standard error mean |
|---|---|---|---|---|
| Facial form | | | | |
| Facial convexity angle G-Sn-Pg' | M | 100 | 21.5±7.9 | 3.9 |
| | F | 100 | 12.0±3.6 | 1.5 |
| Maxillary prognathism G-Sn (llel HP) | M | 100 | 8.5±3.3 | 1.7 |
| | F | 100 | 6.4±3.6 | 1.5 |
| Mandibular progmatism G-Pg' (llelHP) | M | 100 | 8.8±3.5 | 1.8 |
| | F | 100 | 11.1±4.6 | 1.9 |
| Lip position and form | | | | |
| Nasolabial angle Cm-Sn-Ls | M | 100 | 103.5±15.9 | 7.9 |
| | F | 100 | 101.7±5.5 | 2.3 |
| Upper lip protrusion Ls to (Sn-Pg') | M | 100 | 8.3±4.3 | 2.2 |
| | F | 100 | 6.5±1.4 | 0.6 |
| Lower lip protrusion Li to (Sn-Pg') | M | 100 | 7.3±4.8 | 2.4 |
| | F | 100 | 5.4±2.5 | 1.0 |
| Mentolabial sulcus Si to (Li-Pg') | M | 100 | 3.4±2.8 | 1.4 |
| | F | 100 | 5.4±2.7 | 1.1 |
| Maxillary incisor exposure Stms-U1 | M | 100 | 2.3±1.3 | 0.6 |
| | F | 100 | 2.2±2.1 | 0.9 |
| Interlabial gap Stms-Stmi (HP) | M | 100 | 2.3±1.2 | 1.7 |
| | F | 100 | 2.0±2 | 1.8 |

COGS: Cephalometric for orthognathic surgery, G: Glabella, Cm: Columella point, Sn: Subnasale, Stms: Stomion superius, Stmi: Stomion inferius, Li: Labrale inferius, Ls: Labrale superius, Si: Mentolabial sulcus, Pg': Soft tissue pogonion, Gn': Soft tissue gnathion, Me': Soft tissue menton, C: Cervical point, HP: Horizontal plane, llel: Parallel, U1: Long axis of upper incisors

**Table 3: Established soft tissue COGS norms for the Caucasians.**

| Variables | N | Mean±SD |
|---|---|---|
| Facial form | | |
| Facial convexity angle G-Sn-Pg' | 40 | 12±4 |
| Maxillary prognathism G-Sn (llel HP) | 40 | 6±3 |
| Mandibular prognathism G-Pg' (llel HP) | 40 | 0±4 |
| Lip position and form | | |
| Nasolabial angle Cm-Sn-Ls | 40 | 102±8 |
| Upper lip protrusion Ls to (Sn-Pg') | 40 | 3±1 |
| Lower lip protrusion Li to (Sn-Pg') | 40 | 2±1 |
| Mentolabial sulcus Si to (Li-Pg') | 40 | 4±2 |
| Maxillary incisor exposure Stms-U1 | 40 | 2±2 |
| Interlabial gap Stms-Stmi (HP) | 40 | 2±2 |

G: Glabella, Cm: Columella point, Sn: Subnasale, Stms: Stomion superius, Stmi: Stomion inferius, Li: Labrale inferius, Ls: Labrale superius, Si: Mentolabial sulcus, Pg': Soft tissue pogonion, Gn': Soft tissue gnathion, Me': Soft tissue menton, C: Cervical point, HP: Horizontal plane, llel: Parallel, COGS: Cephalometric for orthognathic surgery

anterior face height, upper posterior dental height, chin depth, maxillary length, and mandibular body length when compared to Caucasian norms. Increased values were found in the upper incisor inclination and upper posterior face height in the East Indian group. The females of the present study group had lesser gonial angle as compared to the Caucasians. Whereas the males exhibited higher upper incisor inclination and upper posterior face height in comparison to the females.

The increased convexity of the Indian facial profile and procumbency of the teeth are similar to the study conducted by Valiathan.[41] Bimaxillary protrusion were reported by Nanda and Nanda,[42] similar to our results although different samples and analyses were used.

In the present study, there was a marked difference between the soft tissue cephalometric parameters between East Indian population and Caucasians as shown in Tables 2 and 3.

The facial convexity angle and maxillary prognathism in males were greater in present sample as compared to the Caucasians. The soft tissue COGS parameters such as the mandibular prognathism, upper lip protrusion, and lower lip protrusion were higher in the East Indian population as compared to the Caucasians. Mandibular prognathism was greater in females in our study as compared to the males. In contrast, males of our study group exhibited greater upper lip protrusion and lower lip protrusion. The findings of nasolabial angle, mentolabial sulcus, maxillary incisor exposure, and interlabial gap were almost similar to the values given by Burstone[3] and both males and females exhibited comparable values in our study group.

Although there are plenty of surgical cephalometric norms, they are mostly established on the Caucasian population, which might lead to misinterpretation, in the case of population other than Caucasians. Our study reveals that there are some fundamental variations in the COGS analysis of East Indian adults. These differences should be kept in mind to facilitate better diagnosis and treatment of our orthodontic and orthognathic patients.

## Conclusion

The study reveals that some of the cephalometric parameters in the East Indian population are significantly different from the Caucasian population. These racial differences which are evident in this study should be kept in mind while charting out plan for the orthognathic surgery for East Indian population.

**Table 4: *P* value and *Z* score for East India population.**

| Variables | *P* value (*t*-test) | *Z* score | Standard error difference | 95% confidence interval of the difference | |
|---|---|---|---|---|---|
| | | | | Lower | Upper |
| Ar-Ptm (llel HP) | 0.934 | 0.00 | 3.24 | −7.48 | 7.48 |
| Ptm-N (llel HP) | 0.027* | 1.917 | 3.355 | −5.819 | 9.653 |
| N-A-Pg (angle) | 0.296 | 3.08333* | 2.37399 | −2.39111 | 8.55777 |
| N-A (llel HP) | 0.227 | 0.04167 | 1.89429 | −4.32657 | 4.4099 |
| N-B (llel HP) | 0.419 | 0.70833 | 3.74319 | −7.92349 | 9.34015 |
| N-Pg (llel HP) | 0.53 | 0.54167 | 4.30235 | −9.37957 | 10.4629 |
| N-ANS (⊥HP) | 0.038* | 2.29167* | 1.05564 | −0.14263 | 4.72597 |
| ANS-Gn (⊥HP) | 0.238 | 0 | 5.03374 | −11.6078 | 11.60783 |
| PNS-N (⊥HP) | 0.869 | 4.33333* | 4.03973 | −4.98231 | 13.64897 |
| MP-HP (angle) | 0.946 | −2 | 3.82988 | −10.8317 | 6.83172 |
| Upper 1-NF (⊥NF) | 0.758 | 4.66667* | 2.83172 | −1.8633 | 11.19663 |
| Lower 1-MP (⊥MP) | 0.387 | −1.29167 | 4.90746 | −12.6083 | 10.02495 |
| Upper 6-NF (⊥NF) | 0.083 | 0.33333 | 1.28763 | −2.63594 | 3.30261 |
| Lower 6-MP (⊥MP) | 0.257 | 3.25* | 2.81597 | −3.24364 | 9.74364 |
| PNS-ANS (llel HP) | 0.922 | 2.66667* | 3.25827 | −4.84692 | 10.18025 |
| Ar-Go (linear) | 0.153 | 0.83333 | 1.76715 | −3.24173 | 4.9084 |
| Go-Pg (linear) | 0.123 | 1.25 | 2.66878 | −4.90422 | 7.40422 |
| B-Pg (llel MP) | 0.585 | −0.375 | 1.4172 | −3.64308 | 2.89308 |
| Ar-Go-Gn (angle) | 0.084 | 3.41667* | 3.7227 | −5.1679 | 12.00123 |
| OP -HP (angle) | 0.732 | 1.5 | 3.87718 | −7.4408 | 10.4408 |
| A-B (llel OP) | 0.042* | −0.29167 | 4.72359 | −11.1843 | 10.60095 |
| Upper 1-NF (⊥angle) | 0.751 | −4.33333 | 5.66115 | −17.388 | 8.7213 |
| Lower 1-MP (⊥angle) | 0.201 | −3.58333 | 7.47943 | −20.8309 | 13.66426 |
| G-Sn-Pg' | 0.155 | 9.5 | 3.60122* | 1.19558 | 17.80442 |
| G-Sn (llel HP) | 0.672 | 2.08333 | 2.2443* | −3.09204 | 7.2587 |
| G-Pg' (llel HP) | 0.402 | −2.33333 | 2.72869* | −8.6257 | 3.95904 |
| Cm-Sn-Ls | 0.026* | 1.83333 | 6.87816* | −14.0277 | 17.69439 |
| Ls to (Sn-Pg') | 0.051 | 1.75 | 1.85756 | −2.53354 | 6.03354 |
| Li to (Sn-Pg') | 0.28 | 1.83333 | 2.29309* | −3.45453 | 7.1212 |
| Si to (Li-Pg') | 0.942 | −2.04167 | 1.76623 | −6.1146 | 2.03127 |
| Stms U1 | 0.373 | 0.08333 | 1.1986 | −2.68063 | 2.8473 |
| Interlabial gap | 0.704 | −0.75 | 2.549* | −6.628 | 5.128 |

*Significant; Hard tissue landmarks – llel: Parallel, ⊥: Perpendicular, Ar: Articulare, PTM: Pterygomaxillary fissure, N: Nasion, A: Subspinale, B: Supramentale, Pg: Pogonion, Go: Gonion, Gn: Gnathion, HP: Horizontal plane, MP: Mandibular plane, OP: Occlusal plane, ANS: Anterior nasal spine, PNS: Posterior nasal spine, NF: Nasal floor, U1: Long axis of upper incisors, L1: Long axis of lower incisors, Upper 6: Mesiobuccal cusp tip of maxillary first molar, Lower 6: Mesiobuccal cusp tip of mandibular first molar, Soft tissue landmarks – G: Glabella, Cm: Columella point, Sn: Subnasale, Stms: Stomion superius, Stmi: Stomion inferius, Li: Labrale inferius, Ls: Labrale superius, Si: Mentolabial sulcus, Pg': Soft tissue pogonion, Gn': Soft tissue gnathion, Me': Soft tissue menton, C: Cervical point

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