ORIGINAL ARTICLE

Cephalometric Norms of Orthognathic Surgery (COGS) For Patients Visiting a Public Sector Institute of Southern Punjab.

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Abstract:

Background: Precise cephalometric analysis is crucial for successful orthognathic surgery, yet most existing standards come from Western and regional populations. This is the first study in southern Punjab to use the COGS method to develop local cephalometric norms for adults and to assess for sexual dimorphism.

Objectives: This study aims to establish COGS-derived cephalometric norms for the southern Punjab population.

Material and Methods: We analyzed 100 standardized lateral cephalograms of adult patients (48 male, 52 female; aged 18 - 30 years) visiting Nishtar Institute of Dentistry, Multan. Hard tissue COGS protocol was manually traced, and measurements were taken. Gender differences were assessed through independent samples *t*-test.

Results: Clear and significant sexual dimorphism was observed. Males showed statistically greater values in key skeletal parameters, including upper anterior facial height (N-ANS), mandibular ramus length (Ar-Go), mandibular body length (Go -Pog), and chin depth (B-Pog) ($p < 0.05$). While maxillary length (ANS-PNS) and posterior facial height (PNS-N) were also larger in males but these differences were not statistically significant. These findings reveal distinct craniofacial characteristics and emphasize variations from established Western and regional norms.

Conclusion: This study is the first to establish COGS-based cephalometric standards for the southern Punjab population. It also confirms clear gender-based differences in facial structure, which are crucial for accurate diagnosis and surgical treatment planning.

Keywords: *Cephalometric analysis, Orthognathic surgery, COGS.*

Introduction

Orthognathic surgery continues to play a vital role in correcting skeletal discrepancies that impair occlusion, function, and facial aesthetics. Achieving optimal results in these procedures relies on accurate cephalometric analysis which is used to assess bone and soft tissue structures. Cephalometric for Orthognathic Surgery (COGS) Norms were developed by Legan and Burstone, which remained the benchmark for its detailed evaluation of facial anatomy.[1] However, since they had derived COGS norms from Caucasian population, its generalized use for people from diverse ethnic and racial groups was questioned.

Over the years, research has highlighted prominent differences in craniofacial anatomy across the world. For instance, Sudanese adults showed distinct cranial base and jaw dimensions compared to European-Americans,[2] while Malay and Chinese population of Malaysia showed unique dental and skeletal traits.[3] Similarly, Saudi Arabian population revealed more pronounced lip protrusion, proclined incisors, and convex facial profiles that deviate from traditional Western norms.[4] These findings clearly demonstrate the necessity of establishing region-specific cephalometric standards.

In South Asia, studies from India, Bangladesh, and neighboring regions have further emphasized this variability. Bengali [5] and Indians [6-9], for example, show differences in jaw structure, skull base length, and tooth positioning compared to established norms. Most existing cephalometric reference studies [10-14] are based on Caucasian samples, mainly individuals of European-American descent. As a result, their measurements may not apply well to people from other ethnic backgrounds. This highlights that using the same approach can lead to misdiagnosis and unsatisfactory surgical results in diverse populations.

Even though the awareness of importance of ethnic diversity in research is increasing now worldwide, Pakistan's diverse population is still mostly missing from cephalometric studies. A few studies have been done [15,16], but none have used the COGS method to create reference values specific to different regions.

Therefore, this study aims to establish COGS-derived cephalometric norms for the southern Punjab population. By filling this gap, the study helps improve diagnostic accuracy and surgical planning, and offers important baseline information for future research on craniofacial morphology in Pakistan.

Material and Methods

This descriptive cross-sectional study was conducted at the Orthodontics Outpatient Department of Nishtar Institute of Dentistry (NID), Multan, from January 2025 to March 2025. Ethical clearance was granted by the Research Ethics Committee of the Nishtar institute of Dentistry, Multan (Reference code: 420/NID) and all participants provided informed consent prior to enrollment, with strict adherence to anonymity and confidentiality protocols. A total of 100 participants were recruited through non-probability consecutive sampling, with the sample size calculated using Raosoft software. A population size of approximately 10,000 orthodontic patients visiting Nishtar Institute of Dentistry annually was used as the reference population. The expected standard deviation was derived from previously reported N–ANS measurements in males (SD = 2.88 mm).[17] A 95% confidence level and a 1% margin of error (confidence interval) were selected, resulting in a minimum recommended sample size of 94 participants. To increase reliability and account for potential exclusions, the sample size was rounded up

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to 100. Eligible participants were aged 18–30 years, native to southern Punjab, and had esthetically balanced facial profiles with full dentition (excluding third molars) and having Angle's Class I molar relationship on both sides with minimum to moderate anterior crowing. Individuals with prior orthodontic treatment, skeletal deformities, anterior/posterior crossbites, or vertical skeletal discrepancies were excluded.

Demographic details including name, age, and sex were documented for each participant. Names were collected only to help match X-rays with demographic forms during data checking. Before analysis, they were replaced with codes to protect privacy and avoid any mix-ups, ensuring the data was handled ethically and accurately.Lateral cephalometric radiographs were acquired in a standardized setting using a cephalostat, with heads of participants stabilized in natural head position (NHP) via ear rods. Images were captured with teeth in maximum intercuspation and lips relaxed. Following the Cephalometric for Orthognathic Surgery (COGS) protocol, radiographs were manually traced by a postgraduate orthodontic resident using a standardized protocol to identify anatomical landmarks and reference planes as shown in Figure 1, This diagram of cephalometric landmarks and planes is an original illustration prepared by the authors based on the COGS protocol

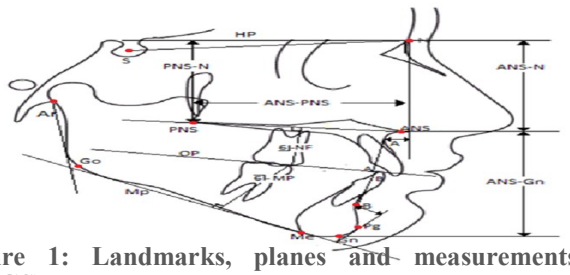

Figure 1: Landmarks, planes and measurements (COGS).

COGS measurements used in the study are given in Table 1.

This cephalometric analysis method was adapted from *Cephalometrics for Orthognathic Surgery* by Burstone et al.[1] Linear measurements were obtained using digital vernier caliper, with precision recorded to 0.01 mm.

All the data was entered into Statistical Package for the Social Sciences software version 24 (IBM SPSS, Chicago, IL, USA). Mean and SD were calculated for quantitative variables. Frequency and percentage were computed for the qualitative variables like gender. Normality of data was assessed and independent sample t-tests were applied to compare cephalometric measurements between male and female subjects. In addition, 95% confidence intervals were reported for key parameter estimates. P-value <0.05 was considered as significant.

Results

The study included 100 participants including 48 males (48%) and 52 females (52%) aged between 18–30 years, with an average age of 24.15 ± 4.07 years. Key cephalometric parameters are shown in Tables 1. N–ANS, Ar–Go, Go–Pog, and B–Pog, showed statistically significant differences between genders (p = 0.001, 0.001, 0.021, and 0.001, respectively), with males consistently exhibiting larger values. For instance, upper anterior facial height (N–ANS) averaged 54.35 ± 2.25 mm in males compared to 49.92 ± 1.55 mm in females. Similarly, mandibular ramus length (Ar–Go) was significantly longer in men (51.81 ± 2.81 mm) than in women (46.87 ± 1.73 mm). Chin depth (B–Pog) also showed marked differences, averaging 9.00 ± 0.74 mm in males versus 5.50 ± 1.09 mm in females.

Table 1: COGS Variables used in the present study

Sr.No	Cephalometric measurements	Landmarks
1	Upper anterior facial height	N-ANS
2	Lower anterior facial height	ANS-GN
3	Upper posterior facial height	PNS-N
4	Maxillary length	ANS-PNS
5	Mandibular ramus length	Ar-Go
6	Mandibular body length	Go-Pog
7	Chin depth	B-Pog
8	Upper posterior dental height	UMT-NF
9	Lower posterior dental height	LMT-MP
10	Witts value	A-B(//OP)
11	Maxillary protrusion	N-A

Maxillary and mandibular lengths followed the same trend: ANS–PNS measured 57.73 ± 1.78 mm in men compared to 51.85 ± 1.78 mm in women, while Go–Pog was 83.73 ± 3.08 mm in males versus 73.96 ± 3.95 mm in females. Posterior dental heights and Wits appraisal (A–B//OP) demonstrated smaller, non-significant variations between genders. Other variables, such as maxillary protrusion (N–A) and lower posterior dental height (LMT–MP), showed no significant gender-based differences.

Discussion

The primary aim of this study was to establish cephalometric norms using the Cephalometric for Orthognathic Surgery (COGS) method for adults native to southern Punjab, Pakistan. As our findings demonstrate, the craniofacial characteristics of this population, for both males and females, differ from those reported in other regions, highlighting the necessity of establishing local norms.

Regarding upper anterior facial height (N–ANS), our population generally exhibited higher dimensions than several international cohorts. Males in our study showed significantly greater N–ANS values compared to those reported for the Chhattisgarhi population in India[7] and slightly larger values than Saudi Arabian males.[5] Females in our cohort also showed values that were comparable to values of Chhattisgarhi population and marginally higher than those found in the Saudi cohorts.

Nonetheless, the study had limitations:The sample size was small and may not fully capture the complete ethnic and biological diversity of southern Punjab.This study focused only on hard tissue landmarks, while soft tissue landmarks, which are critical for aesthetic surgical planning, were not included. Potential intra- and inter-examiner variability during manual tracing of cephalograms was not formally assessed. Future research should incorporate soft tissue measurements and larger participation to develop even more comprehensive normative datasets.

Conclusion

This study established COGS-derived cephalometric norms for adults native to southern Punjab, Pakistan. The findings revealed significant craniofacial differences compared to other regional and international populations, highlighting the necessity for localized normative data in orthognathic surgical planning. Furthermore, notable sexual dimorphism was observed, highlighting the importance of gender-specific references. These results provide a critical foundation for improving diagnostic precision, enhancing surgical

Table 2. Comparison of Cephalometric Linear Measurements (mm) between Male and Female Adults.

Cephalometric Parameter	Male (Mean ± SD) (mm)	Female (Mean ± SD) (mm)	P-value
N–ANS	54.35 ± 2.25	49.92 ± 1.55	0.001*
ANS–GN	68.79 ± 2.28	61.02 ± 2.12	0.08
PNS–N	53.48 ± 1.07	50.35 ± 1.34	0.12
ANS–PNS	57.73 ± 1.78	51.85 ± 1.78	0.07
Ar–Go	51.81 ± 2.81	46.87 ± 1.73	0.001*
Go–Pog	83.73 ± 3.08	73.96 ± 3.95	0.021*
B–Pog	9.00 ± 0.74	5.50 ± 1.09	0.001*
UMT–NF	26.50 ± 1.36	22.77 ± 1.62	0.09
LMT–MP	35.38 ± 1.86	28.35 ± 1.91	0.06
A–B/OP	-1.10 ± 1.47	-0.79 ± 1.61	0.25
N–A	0.90 ± 2.27	-0.73 ± 1.92	0.13

outcomes, and guiding future research aimed at developing comprehensive, region-specific cephalometric standards within Pakistan. These norms can serve as a reference for orthodontic diagnosis and orthognathic surgical planning in Pakistani populations.

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Author Contributions

1. **Rabia Anwar:** Conceptualization of the study, Methodology development, Data analysis, and Original draft writing.
2. **Zubair Hassan Awaisi:** Conceptualization of the study, supervision, data interpretation, and critical review/editing of the manuscript.
3. **Sarwat Memon:** Analysis and Critical review/editing of the manuscript.
4. **Farah Saleem:** Data Collection and Data interpretation.
5. **Zubair Ahmed:** Critical review, Data Collection and Data interpretation.