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ORIGINAL ARTICLE

Cephalometric for Orthognathic Surgery (COGS) Analysis for Saudi Population

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ABSTRACT

Objective: To establish the cephalometric (Ceph.) norm by Ceph. for orthognathic surgery (COGS) analysis for Saudi population. **Material and Methods:** 500 adult Saudi samples (250 males and 250 females) with the age range of 18-30 years old were selected for this study. The selections of samples were based on a normal occlusal relationship, no history of facial trauma and no previous orthodontic treatment. Lateral Ceph. radiographs were tracing by CASSOS software and analyzed by SPSS software according to COGS analysis. **Results:** Significant differences were showed between the Saudi males and females on most of the Ceph. parameters. The Saudi males had a convex facial profile with chin prominent and more bimaxillary protrusion, upper and lower lip protrusion than the Saudi females. **Conclusion:** This study evaluated the craniofacial morphological difference between the male and the female population in Saudi Arabia by using COGS analysis. The finding of this study will help for better diagnosis of orthodontic and orthognathic surgical treatment planning and identify the morphological facial characteristics of Saudi patients.

Keywords: Orthodontics; Diagnostic Techniques and Procedures; Cephalometry.

Introduction

Craniofacial morphometric assessment is one of the important parts of orthodontics for the researcher and clinician. Standard landmarks of human facial structures are applied for evaluating the craniofacial morphological structures, correction of craniofacial malformation, and assessing the facial profile changes after operation. People are now more conscious about their facial aesthetic appearance due to increase social demand, global social media and improving socio-economic conditions. So, facial aesthetic and impressive facial structure takes a special place in human life. The craniofacial structures maintain the facial symmetry and coordination of the face [1].

The standard value of most cephalometric studies must be depended on races, gender and age group of the same population [2]. Cephalometric (Ceph.) analysis should obtain from people of the same race, age and sex group [3-5]. Ethnically diverse and multi subraces peoples are present in the Arabic language speaking countries of Middle East [6,7]. Saudi Arabia is a country with multiregional sub ethnical groups in the Middle East region. Saudi Arabian is considered as a subgroup of Caucasians [8]. By the influence of western global social media and movies, large numbers of Saudi Arabian peoples are looking for facial esthetic and orthodontic treatment from orthognathic surgeons and orthodontists.

Ceph. x-ray of the patient should include analysis by the orthodontist, orthognathic surgeon before starting the treatment. Successful orthodontic and facial surgical treatments are depending on the proper diagnosis of the hard tissue, soft tissue and dental structures and proper treatment planning of same ethnic group. These will prevent any unwanted results during the treatment procedure.

One of the main goals of orthognathic surgery is to achieve a well-balanced and proportional face by correcting any jaw disharmony and incorrect bite. COGS or Burstone's Ceph. analysis is particularly based on modifying the craniofacial bones with soft and dental structures [9]. COGS analysis is designed for the horizontal and vertically placed craniofacial structures. Linear landmarks represent the craniofacial bones size and angular landmarks represent the craniofacial bones contour. In this study, a comparatively large sample size was used from the population of Saudi Arabian than any previous published Ceph. study.

Material and Methods

Five hundred lateral Ceph. radiographs with class I occlusion (250 females and 250 males) were selected. These Ceph. radiographs were based on: acceptable skeletal and facial profile, no previous orthodontic treatment, sample ages range 18-30 years old, grandparents and parents are Saudi origin (By National ID). Pre-treatment lateral Ceph. x-rays were collected from the Dental Center, King Khaled General Hospital, Hafer al Batin, Saudi Arabia, using GENDEX Ceph. X-ray Machine and analyzed using Cassos Software (Table 1 and Figure 1).

Table 1. Landmarks of COGS analysis.

Landmark	Description
Cranial Base	
1. Posterior cranial base (Ar–Ptm)	Distance between Ar to Ptm.
2. Anterior cranial base (Ptm–N)	Distance between Ptm to N.
Horizontal Skeletal Lines	
3. Facial convexity (N–A–Pog)	Angle between N–A and A–Pog
4. Maxillary protrusion (N–A)	Distance between point A to Nasion.
5. Mandibular protrusion (N–B)	Distance between point B to Nasion.
6. Chin protrusion (N–Pog)	Distance between pogonion to Nasion.
Vertical Skeletal and Dental Lines and Angles	

7. Upper anterior facial height (N–ANS)	Distance between Nasion to ANS.
8. Lower anterior facial height (ANS–Gn)	Distance between ANS and Gn.
9. Upper posterior facial height (PNS–N)	Distance between PNS and HP.
10. Mandibular plane angle (MP–HP)	Angle formed between Go–Gn line and HP.
11. Upper anterior dental height (U1–NF)	Perpendicular line from the incisal edge of upper incisor to NF
12. Lower anterior dental height (L1–MP)	Perpendicular line from the incisal edge of lower incisor to MP.
13. Lower posterior dental height (L6-MP)	Perpendicular line from the mesiobuccal cusp tip of lower first molar to MP.
Maxilla and Mandible	
14. Maxillary length (PNS-ANS)	Distance from PNS to ANS, parallel to HP.
15. Mandibular ramus length (Ar-Go)	Line from Ar to Go.
16. Gonial angle (Ar-Go-GN)	Angle between ramus length and MP.
17. Mandibular body length (Go-Pog)	Distance from Go to Pog.
18. Chin depth (B-Pog)	Distance between point B and MP through Pog.
Dental	
19. Occlusal plane angle (OP-HP)	Angle from OP and HP
20. UOP-HP	Maxillary OP perpendicular to HP
21. LOP-HP	Mandibular OP perpendicular to HP
22. A-B(//OP)	Two perpendicular lines from points A and B to OP.
23. Upper incisor inclination (U1-NF)	Angle between the U1 edge through the tip of the root to NF
24. Lower incisor inclination (L1-MP)	Angle between the L1 edge through the tip of the root to MP.
Facial Form	
25.Facial convexity (G-SN-Pg)	An angle between the lines from glabella to subnasal and subnasal to soft tissue pogonion.
26. MX-Prognathism (G-SN)	A line perpendicular to horizontal plane from glabella to subnasal.
27. MD-Prognathism (G-Pg)	A line perpendicular to horizontal plane from glabella to pogonion.
28. Vertical height ratio (G-Sn/Sn-Me)	Distance from G-Sn and Sn-Me. All are perpendicular to HP
29. L face ht- depth ratio	Ratio between G-Sn and Sn-Me' perpendicular to HP.
30. L face-Throat angle	Ratio between Sn-Gn and C-Gn.
Lip Position and Form	
31. Naso-labial angle	Angle between columella -Sn and Sn-Ls.
32. U-lip protrusion	Distance between Ls and Sn-Pg' line.
33. L-lip protrusion	Distance between Li and Sn-Pg' line.
34. Mento labial sulcus	Perpendicular distance between deepest point on the mentolabial sulcus to Li-Pg'.
35. Vertical lip- chin ratio	Ratio between Sn-Stms and Stomion inferius-Me'.
36. U1 exposure	Distance between tip of the U1and Stms.
37. Inter labial gap	Distance between Stms and Stmi

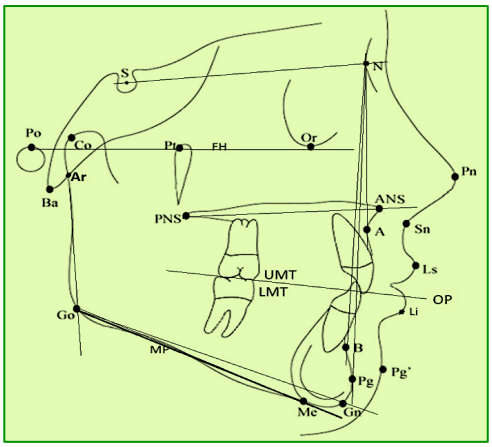

Figure 1. Major landmarks and reference planes used in COGS analysis. Nasion (N), sella (S), orbitale (Or), porion (Po), basion (Ba), anterior nasal spine (ANS), posterior nasal spine (PNS), pterygomaxillary fissure (Pt), point A (A), point B (B), pogonion (Pg), gnathion (Gn), menton (Me), gonion (Go), articular (Ar), mesiobuccal cusp tip of upper first molar (UMT), mesiobuccal cusp tip of lower first molar (LMT). Pronasale (Pn), subnasale (Sn), labrale superius (Ls), labrale inferius (Li), soft tissue pogonion (Pg'). The reference planes: S-N plane, mandibular plane (MP), frankfort horizontal plane (FH), occlusal plane (OP).

Statistical Analysis

Statistical analysis of the Saudi data was done by SPSS software version 24 (IBM SPSS, Chicago, IL, USA). Mean and SD values were calculated. To test the level of significance, Independent t-test was used between the two sexes.

Method of Error: 25 Ceph. radiographs were randomly selected to assess the error. Ceph. radiographs were digitalized again, and measurements were measured again two weeks later by same investigator. The paired t-test expressed no significant difference between the two assessments ($p<0.05$).

Ethical Clearance

This study received ethical approval by USM and protocol code was USM/JEPeM/17120719.

Results

Table 2 shows the skeletal, soft tissue and dental measurements of COGS analysis comparative data of Saudi sample. Saudi males had highly greater ($p<0.001$) anterior and posterior cranial base length, lower anterior facial height, upper posterior facial height, upper and lower anterior dental height, lower posterior dental height, maxillary length, length of mandibular ramus and mandibular body, occlusal plane length, upper occlusal plane, prognathism of mandible, vertical ratio, maxillary incisor exposure than Saudi females. Upper anterior facial height, lower occlusal plane, lower-face-throat angle, mento-labial sulcus depth were significantly greater ($p<0.01$) in Saudi males than females. Mandibular protrusion (N-B), Chin depth (B-Pog), facial convexity angle, inter-labial gap were slightly smaller ($p<0.05$) in Saudi females than males.

Table 2. Descriptive statistical comparison of cephalometric measurements between Saudi males and females using COGS analysis.

Variables	Gender	Mean	SD	SE	95% CI		p-value
					Lower	Upper	
Posterior cranial base (mm)	M	33.921	3.933	0.248	1.060	2.419	0.000***
	F	32.181	3.924	0.241	1.060	2.419	
Anterior cranial base (mm)	M	51.002	4.757	0.300	1.170	2.676	0.000***
	F	49.079	3.934	0.242	1.167	2.679	
Facial convexity (⁰)	M	6.694	7.081	0.446	-1.746	0.530	0.294
	F	7.302	6.074	0.373	-1.751	0.534	
Maxillary protrusion (mm)	M	-0.504	4.695	0.296	-0.268	1.307	0.196
	F	-1.023	4.423	0.272	-0.270	1.308	
N-B (mm)	M	-5.504	7.826	0.493	-0.019	2.556	0.053*
	F	-6.773	7.070	0.434	-0.022	2.560	
N-Pog (mm)	M	-7.359	9.488	0.598	-0.516	2.646	0.186
	F	-8.424	8.805	0.541	-0.519	2.649	
N-ANS (mm)	M	51.124	5.267	0.332	0.422	2.067	0.003**
	F	49.880	4.216	0.259	0.417	2.071	
ANS-Gn (mm)	M	67.661	7.440	0.469	3.548	5.815	0.000***
	F	62.980	5.595	0.344	3.539	5.824	
PNS-N (mm)	M	50.912	4.548	0.286	1.747	3.133	0.000***
	F	48.473	3.416	0.210	1.742	3.138	
MP-HP (⁰)	M	28.257	7.530	0.474	-1.803	0.757	0.423
	F	28.780	7.283	0.447	-1.804	0.758	
U1-NF (mm)	M	28.234	3.815	0.240	0.879	2.101	0.000***
	F	26.744	3.245	0.199	0.877	2.103	
L1-MP (mm)	M	43.520	4.746	0.299	2.287	3.714	0.000***
	F	40.520	3.434	0.211	2.282	3.720	
L6-MP (mm)	M	24.087	3.139	0.198	1.072	2.053	0.000***
	F	22.525	2.517	0.155	1.069	2.056	

PNS-ANS (mm)	M	33.386	4.204	0.265	1.807	3.089	0.000***
	F	30.938	3.165	0.194	1.803	3.094	
Ar-Go (mm)	M	54.139	5.714	0.360	1.234	2.928	0.000***
	F	52.058	3.976	0.244	1.226	2.936	
Go-Pog (mm)	M	74.102	7.923	0.499	1.584	3.958	0.000***
	F	71.331	5.688	0.349	1.574	3.968	
B-Pog (mm)	M	7.118	2.414	0.152	-0.007	0.751	0.054*
	F	6.746	1.958	0.120	-0.009	0.753	
Ar-Go-Me (⁰)	M	126.570	7.513	0.473	-0.646	1.972	0.320
	F	125.907	7.630	0.469	-0.646	1.972	
OP-HP (⁰)	M	7.015	4.850	0.306	-2.297	-0.609	0.001***
	F	8.468	4.915	0.302	-2.297	-0.609	
UOP-HP (⁰)	M	5.123	5.094	0.321	-2.490	-0.729	0.000***
	F	6.732	5.094	0.313	-2.490	-0.729	
LOP-HP (⁰)	M	9.062	6.185	0.390	-2.380	-0.277	0.013**
	F	10.390	5.984	0.368	-2.381	-0.276	
A-B (mm)	M	0.487	3.802	0.240	-0.765	0.478	0.651
	F	0.631	3.387	0.208	-0.767	0.480	
U1-NF (⁰)	M	46.989	6.738	0.424	2.333	4.532	0.000***
	F	43.557	5.977	0.367	2.330	4.535	
L1-MP (⁰)	M	74.102	7.923	0.499	1.584	3.958	0.000***
	F	71.331	5.688	0.349	1.574	3.968	
Facial Convexity (⁰)	M	7.118	2.414	0.152	-0.007	0.751	0.054*
	F	6.746	1.958	0.120	-0.009	0.753	
MX-prognathism G-Sn (mm)	M	126.570	7.513	0.473	-0.646	1.972	0.320
	F	125.907	7.630	0.469	-0.646	1.972	
MD-Prognathism G-Pg (mm)	M	7.015	4.850	0.306	-2.297	-0.609	0.001***
	F	8.468	4.915	0.302	-2.297	-0.609	
Vertical height Ratio	M	5.123	5.094	0.321	-2.490	-0.729	0.000***
	F	6.732	5.094	0.313	-2.490	-0.729	
L Face–Throat Angle (⁰)	M	9.062	6.185	0.390	-2.380	-0.277	0.013**
	F	10.390	5.984	0.368	-2.381	-0.276	
L Face ht- depth ratio	M	0.487	3.802	0.240	-0.765	0.478	0.651
	F	0.631	3.387	0.208	-0.767	0.480	
Naso-labial Angle (⁰)	M	119.011	6.607	0.416	-2.033	0.255	0.127
	F	119.900	6.629	0.407	-2.033	0.255	
U-lip Protrusion (mm)	M	96.570	7.842	0.494	-2.307	0.386	0.162
	F	97.531	7.738	0.475	-2.308	0.386	
L-Lip Protrusion (mm)	M	21.182	7.611	0.479	-0.755	1.692	0.452
	F	20.714	6.529	0.401	-0.760	1.696	
Mentolabial Sulcus (mm)	M	8.601	5.413	0.341	0.386	2.167	0.005**
	F	7.325	4.889	0.300	0.384	2.169	
Vertical lip-chin Ratio	M	-6.766	10.497	0.661	-0.929	2.576	0.356
	F	-7.589	9.783	0.601	-0.932	2.579	
U1 Exposure (mm)	M	96.710	12.457	0.785	-8.562	-4.469	0.000***
	F	103.225	11.220	0.689	-8.567	-4.463	
Interlabial Gap (mm)	M	105.380	10.928	0.688	0.284	3.947	0.024*
	F	103.265	10.270	0.631	0.281	3.950	

M= Male; F= Female; SD= Standard Deviation; SE= Standard Error; CI= Confidence Interval; p = Level of significance; *p<0.05; **p<0.01; ***p<0.001.

Discussion

The goal of COGS analysis is to improve the dento-facial and soft tissue structural functions and treating any jaw abnormality with the help of orthodontic and maxillofacial surgical treatment. In this study, cephalometric measurements of the dento-facial and soft tissue structures of the adult Saudi sample were compared using COGS analysis.

The mandible of the males sample was more posteriorly present than Saudi females in relation to maxillary posterior surface and this represents by posterior cranial base (Ar-Ptm) plane. On the other hand,

anterior cranial base (Ptm-N) plane and upper anterior dental height (U1-NF) were greater in Saudi males, so maxilla placed more posteriorly in relation to nasion and increased maxillary proclination in males compared to Saudi females.

Upper and lower incisors were proclined with chin prominent and backwardly rotation of the mandible for Saudi males, represented by upper and lower anterior facial height. Lower posterior dental height, maxillary length and mandibular ramus length were higher in Saudi males than females and it may increase the vertical height. Mandibular protrusion and Mandibular body length (Go-Pog) planes were higher in Saudi males than females and increase the chance of skeletal class III facial occlusion with prognathic mandible. Saudi females showed shorter upper and lower occlusal planes and occlusal plane angle than males, which may cause skeletal deep bite and shorter anterior facial height in Saudi females. Upper and lower incisors were more procline in Saudi males than females.

Saudi males had more convex facial profile than females, indicated by larger facial convexity angle and females had relatively straighter facial profiles than males. Saudi males had higher vertical height depth ratio values, deeper mento-labial sulcus than females that causes mandibular retraction. Greater soft tissue inter-labial gap in Saudi males and it produce more protruded lips than females. In Saudi males, chin depth (B-Pog) was more than females. Saudi males had a greater lower-face throat angle compares to females. Greater lower face-throat angle should consider during a surgical procedure to not reduce the chin prominence [10].

Different researchers used several cephalometric analyses for Saudi population and found that Saudi sample has a bimaxillary protrusion tendency [11-14]. Saudis sample was compared with European-Americans and found that Saudi had higher skeletal facial convexity, less low vertical height depth ratio, shorter neck and lesser chin depth than Caucasians [1]. Yemini sample a had greater convex skeletal profile, greater lower face – throat angle, deeper mento-labial sulcus depth, shorter inter-labial gap and more incisors exposure than Caucasians samples [15].

Black American adults had greater maxillary prognathism with lower facial height, procline lower incisor, thicker lips and chin with short nasal projection [16]. Japanese samples had lesser protrusion of maxilla, less prominent chin, greater nasolabial angle and protruded lips than Caucasian [17]. North Indian people had convex facial features, protruded lips, smaller naso-labial angle, mento-labial sulcus depth, and shorter soft tissue inter-labial gap than Caucasians [18]. Bangladeshi males had bimaxillary prognathism with a more prominent chin than females [3].

Conclusion

Saudi males have greater craniofacial morphological features than females. Saudi males have proclined upper and lower incisors with predominant convex skeletal facial profile, protrusive lips and prominent chin. This result can be kept in mind for the Saudi population during the orthodontic and orthognathic treatment planning and postoperative follow-up after orthognathic surgical procedures to prevent relapse tendency.

Authors' Contributions

AS	https://orcid.org/0000-0002-9203-6910	Conceptualization, Methodology, Investigation, Formal Analysis, Writing – Original Draft Preparation and Writing – Review and Editing.
SAR	https://orcid.org/0000-0001-9216-4026	Conceptualization, Methodology, Investigation, Formal Analysis, Writing – Original Draft Preparation and Writing – Review and Editing.
MKA	https://orcid.org/0000-0001-7131-1752	Conceptualization, Methodology, Investigation, Formal Analysis, Writing – Original Draft Preparation and Writing – Review and Editing.

All authors declare that they contributed to critical review of intellectual content and approval of the final version to be published.

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None.

Conflict of Interest

The authors declare no conflicts of interest.

Data Availability

The data used to support the findings of this study can be made available upon request to the corresponding author.

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