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Original Article

Dentistry Section

Determination of Craniofacial Morphometry of Saudi Adults by Steiner's Analysis

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ABSTRACT

Introduction: Evaluation of craniofacial morphology plays a vital role both in clinical practice and research purpose in dentistry and lateral cephalometric radiograph is the most commonly used and appropriate implement for the evaluation of craniofacial morphology.

Aim: The aim of the study was to investigate the craniofacial morphometry of Saudi adults using Steiner's angular and linear measurements and also to compare their mean values with the established values of Caucasian adults.

Materials and Methods: Eighty digital lateral cephalometric radiographs of Saudi adults including 43 males and 37 females with an average age of 22 years were studied. Patients with no craniofacial/skeletal abnormalities and no previous Orthodontic treatment were included in the study. Seventeen cephalometric landmarks were determined, 11 angular and 4 linear measurements of Steiner's analysis were done using Cassos software. Error study was done on 20% of randomly selected cephalometric radiograph after two weeks of interval. Statistical analysis was done by SPSS software version 22. Independent t-test was used to test the level of significance. $p<0.05$ considered as significant.

Results: Acceptable errors were observed using Dahlberg formula. The results of the present study revealed non-significant difference between the genders on almost all measured values. Saudi females showed larger SNA, SNB, ANB, SND, S to E, U6 to NA and L6 to NB (8 out of 15) than Saudi males. Mean values of cephalometric norms of Saudi adults were different than the Steiner's established craniofacial morphometric norms.

Conclusion: The results revealed non-significant linear and angular differences in craniofacial morphometry among Saudi males and females. Measured craniofacial morphometry showed disparities between Caucasian established values.

Keywords: Cephalometry, Craniofacial, Saudi arabia, Skeletal, Standards

INTRODUCTION

The awareness of the aesthetically pleasing face and the seeking of professional help is increasing day by day among the Saudi adults [1]. Treatment plans and clinical procedures should be done only after total consideration of the racial groups [2-9] involved and only after detailed investigations and understanding of the differences between races and their normal cephalometric values (Mean±SD) found in Saudi, Bangladeshi, Malaysian, Egyptian, American and Japanese populations [Table/Fig-1] [2,5-9]. It has become apparent that there is the need to determine what constitutes a pleasing or normal face for the Saudi population. Craniofacial appearances play a dynamic role in the treatment planning of malocclusions in Orthodontics [10]. Therefore, it is necessary to determine the incidence and characteristics of different craniofacial morphologies from different geographic locations as well as different populations in different parts of the world which provide a baseline data and help Orthodontist to make available treatment possibilities [1,2,5,6-9].

Many studies, such as Steiner's [1,2], Down's [1], combined analysis [3-9], Downs [11], Holdway's [12,13], Bjork-Jarabak's [14,15], Mcnamara [16,17], Harvold's [18], Tweed's and Wit's analysis [19], lip morphology analysis [20-25], Cephalometric for orthognathic surgery [26], different sagittal analysis [27-30] and analyses of Pancherz [31] have been conducted in different populations and races to determine the cephalometric standards of different ethnic groups and mostly all the studies have shown considerable differences in the skeletal features by their lateral cephalograms analysis. Accordingly, the standards differ among the studies. Cephalometric characteristics in different malocclusion [32-34] and their comparison [35], as well as genetic influences [36] have been studied extensively. A comparison was done by Bishara SE et al., between the Egyptian adolescent boys

Variables	Saudi population		Bangladeshi population		Egyptian population		American population		Malaysian population				Japanese population	
									Malaysian Indian		Malaysian Chinese			
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Variables	Mean
SNA	83.6	4.3	82.18	1.07	82.7	3.6	82.3	3.4	83.71	1.22	87.03	2.85	Maxillary length	54.57
SNB	81	3.7	79.77	0.94	79.5	3.5	79.2	2.8	80.86	1.09	84.29	2.58	Mandibular ramus length	54.24
ANB	2.5	2	2.41	1.52	3.2	1.7	3.1	1.6	2.85	1.70	2.74	1.39	Mandibular body length	80.95
SND	×	×	76.10	1.88	×	×	×	×	×	×	×	×	Mandibular plane angle	25.21
GO-GN-SN	31	5.1	28.52	2.25	×	×	×	×	×	×	×	×	Gonial angle	117.97
OP-SN	13.3	4.3	13.19	1.61	×	×	×	×	×	×	×	×	Occlusal plane	8.77
Interincisal angle	124.8	6.9	125.08	2.2	124.1	8.4	130.0	8.8	132.70	1.30	116.06	2.29	Wits analysis	0.40
U1 TO NA	24.8	5.6	24.37	1.91	×	×	×	×	×	×	×	×	Maxillary protrusion	-1.96
U1 TO NA linear	5.3	2.6	4.10	0.77	×	×	×	×	×	×	×	×	Mandibular protrusion	-7.92
L1 TO NB	27.8	4.3	27.15	2.67	×	×	×	×	×	×	×	×	Upper incisor inclination	116.35
L1 TO NB linear	6.1	2.1	5.50	1.64	×	×	×	×	×	×	×	×	Lower incisor inclination	95.09

[Table/Fig-1]: Craniofacial morphology of Saudi [1], Bangladeshi [2], Egyptian [7] and American [7], Malaysian [5] and Japanese population [9].

and girls and North American adolescents [7]. The overall dentofacial morphologies of the Egyptian and Iowa boys and girls were found quite similar in that study, however, the trends of dental protrusion were found in the Egyptian groups [7]. Al-Jasser NM evaluated the cephalometric features of a Saudi population and revealed distinct cephalometric features [1].

Orthodontic diagnosis and treatment procedures among Orthodontists in the world showed that, the most commonly used analysis was the Steiner analysis and it is still used in most of the countries as a reliable investigation to determine the craniofacial morphologic features [2]. Steiner analysis is among the pioneer in cephalometric analysis. Steiner used sella and nasion line as a key plane for analysis which requires S (sella) and N (nasion) points. These points are located in mid sagittal plane of the head and move minimally with the deviation of any from true profile position which adds extra benefit for Steiner's analysis.

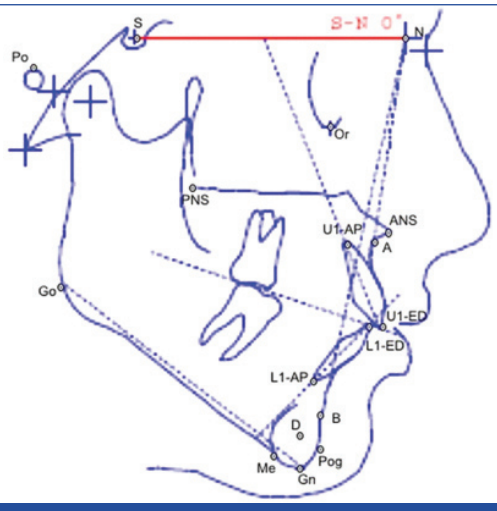
Cephalometric X-ray is an indispensable diagnostic tool for craniofacial assessment in Orthodontics [36]. Hence, the prime purpose of this study was to investigate the craniofacial characteristics of Saudi adults and to formulate their craniofacial morphometry using Steiner's angular and linear measurements and to compare their mean differences with the established values of Steiner's craniofacial morphometric norms.

MATERIALS AND METHODS

This retrospective study was carried out among patients attended in Orthodontic division for the Orthodontic screening, College of Dentistry, Jouf University from October 2017 to February 2018. Eighty (80) digital lateral cephalometric radiographs of Saudi adults including 43 males and 37 females with an average age of 22 years (19-25) were included. All radiographs were collected from the archive of the radiology department for the Orthodontic screening. There were inclusion and exclusion criteria applied in this study. The criteria of selection were no craniofacial/skeletal abnormality or deformity, no dental deformity, good quality X-rays, and no previous Orthodontic treatment. Subjects who underwent for facial surgery, Orthodontic treatment and having any craniofacial deformity were excluded.

Ethical Clearance: This study protocol has been approved by the Local Committee of Bioethics (LCBE) with the approval number of 9-16-8/39, Al Jouf University.

Assessment: Seventeen (17) cephalometric landmarks were determined, 11 angular and 4 linear measurements of Steiner's analysis were done using Cassos software [Table/Fig-2]. One calibrated researcher performed all cephalometric landmark assessment and analysis.



[Table/Fig-2]: Craniofacial morphometric tracing of Steiner analysis by Cassos software. The major landmarks used in Steiners's analysis are Sella (S), nasion (N), porion (Po), orbitale (Or), anterior nasal spine (ANS), posterior nasal spine (PNS), pointA(A), pointB(B), pogonion (Pog), gnathion (Gn), menton (Me), gonion (Go), articular (Ar), upper incisal apex (U1-AP), upper incisal edge (U1-ED), lower incisal edge (L1-ED), lower incisal apex (L1-AP).

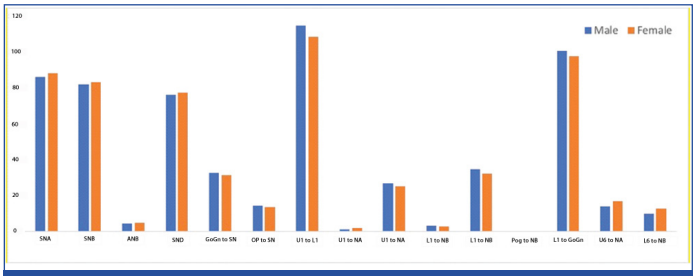
STATISTICAL ANALYSIS

All data were input in Statistical Package for the Social Sciences (SPSS) and verified. Statistical analysis was done by SPSS software version 22 (Chicago IL, USA). Mean±SD were calculated. Independent t-test was used to test the level of significance between genders. $p<0.05$ considered as significant.

RESULTS

Error study was done on 20% of randomly selected cephalometric radiograph after two weeks of interval using Dahlberg's formula [37], which did not exceed 0.58 mm for the linear variables, 0.93 degree for the angular variables. The combined error for any of the variable was small and considered to be within acceptable limit [37].

Descriptive statistics (Mean±SD) of the Saudi adult males and females were generated [Table/Fig-3]; comparative statistics between the two genders were carried out using t-test with 95 percent confidence intervals of cephalometric measurements [Table/Fig-4]. Out of 15 variables, none of them showed significant differences between Saudi male versus Saudi female. SNA, SNB and ANB are larger in Saudi female in comparison to Saudi male. The measured values of SNA, SNB and ANB for Saudi females are 88.11, 83.09 and 5.02, respectively. Whereas, the measured values of SNA, SNB and ANB for Saudi males are 85.92, 81.68 and 4.24, respectively. Dental proclinations are more in Saudi male in comparison to Saudi female (U1-L1, U1-NA and L1-NB). The measured values of U1-L1, U1-NA and L1-NB for Saudi males are 114.57, 26.69 and 34.51 respectively. Whereas, the measured values of U1-L1, U1-NA and L1-NB for Saudi females are 108.33, 25.17 and 32.00, respectively.



[Table/Fig-3]: Craniofacial morphometric disparities between Saudi male and female data.

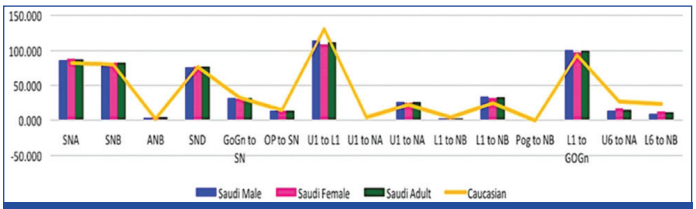
The mean values obtained from the present study differed from the established values according to Steiner analysis [Table/Fig-5]. SNA, SNB and ANB values are higher in Saudi population in comparison to Steiner's standard values. In relation to dental alignment, Steiner's standard value (U1-L1) was higher than Saudi population values, which indicates, Saudi population has proclined incisors in comparison to Steiner's standard value.

DISCUSSION

Based on current study, it can be speculated that, Saudi adult have a distinct craniofacial morphology. These results suggest that, Saudi adults have a tendency towards the skeletal Class II with a more convex profile, especially in females. In addition, females have reduced interincisal angles and more proclined lower incisors. For the linear dimensions, the males showed longer anterior cranial bases as well as greater anterior facial height measurements. This study compared the craniofacial measurements of adult Saudi men and women with the measurements determined by Steiner's Norms. Al-Jasser NM compared the means, standard deviations, and ranges of the measurements with the norms established by Steiner. Statistically, several significant differences were noticeable in their results, when the cephalometric mean values for the selected Saudi population were compared with the norms suggested for a white

Variables	Unit	Male		Female				95% CI		p-value	Standard
		Mean	SD	Mean	SD	MD	SE	Lower	Upper		value
SNA	° (Degree)	85.916	4.321	88.111	6.088	-2.194	1.406	-5.012	0.624	0.124	82
SNB	° (Degree)	81.681	4.482	83.090	7.047	-1.408	1.545	-4.505	1.688	0.366	80
ANB	° (Degree)	4.235	2.937	5.021	3.099	-0.786	0.844	-2.479	0.907	0.356	2
SND	° (Degree)	75.965	4.797	77.379	6.945	-1.414	1.582	-4.586	1.758	0.375	76
GoGn to SN	° (Degree)	32.424	7.305	31.347	7.835	1.077	2.113	-3.159	5.313	0.612	32
OP to SN	° (Degree)	14.238	4.591	13.426	7.173	0.812	1.577	-2.349	3.972	0.609	14
U1 to L1	° (Degree)	114.570	12.059	108.332	29.458	6.239	5.546	-4.881	17.359	0.266	122.7
U1 to NA	mm	1.157	1.757	1.774	2.917	-0.617	0.625	-1.869	0.635	0.328	4
U1 to NA	° (Degree)	26.689	7.005	25.168	9.614	1.521	2.249	-2.989	6.031	0.502	22.7
L1 to NB	mm	3.230	1.728	2.690	3.277	0.540	0.666	-0.795	1.876	0.421	4
L1 to NB	° (Degree)	34.511	7.006	32.000	10.608	2.511	2.365	-2.231	7.253	0.293	25
Pog to NB	° (Degree)	-1.049	1.725	-0.490	2.422	-0.559	0.560	-1.682	0.564	0.323	×
L1 to GOGn	° (Degree)	100.397	7.983	97.574	10.772	2.824	2.543	-2.274	7.921	0.272	×
U6 to NA	mm	14.003	12.265	17.047	10.727	-3.045	3.323	-9.707	3.618	0.364	×
L6 to NB	mm	9.892	8.744	12.616	7.423	-2.194	1.406	-5.012	0.624	0.124	×

[Table/Fig-4]: Descriptive and comparative cephalometric analysis values for Saudi male and female and standard Steiner's value.



[Table/Fig-5]: Craniofacial morphometric disparities between Saudi male and Saudi female.

Caucasian population by Steiner. They observed somewhat slightly protrusive maxillae in normal Saudi population which predisposes to class II facial pattern and a high mandibular plane angle [1]. These results coincide with the findings of present study.

All of the subjects were adults who had lateral cephalometric radiographs taken for Orthodontic routine diagnostic purposes. Therefore, the study had some sampling bias. The sample of the study were chosen without allowing any selection criteria which depended on the evaluation of occlusal and aesthetics of face thus, facilitated the reduction of sampling bias. Therefore, the normal distribution of the different craniofacial morphologies of the Saudi's sample was more distinctive. It is difficult to obtain random samples due to ethical considerations and radiation hazards; however, they are pondered to have less bias or subjectivity from varieties that are based on a balanced profile and occlusion. Conversely, only few studies have used random samples that were more representative of the population. In a Saudi population study on malocclusion, sample was selected from the records of Orthodontic patients without considering their occlusion status or facial characteristics [10]. Aboul-Azm SF et al., analysed lateral cephalometric radiographs of Emirates adults (91 males and 85 males) and found significant gender disparities [6]. Bishara SE et al., chosen only 90 (39 boys and 51 girls) out of 500 Egyptian school children who had Class-I molar and canine relationships and no apparent skeletal discrepancies and reported that the boys had larger linear dimensions of the cranial base and face heights compared to the girls and also found that Egyptian girls had comparatively more convex profile and also trends of mandibular dental protrusion [7]. Adel M et al., took the sample size consisting of 299 Egyptian adults (218 females and 81 males) and reported significant gender disparities [8]. Another study conducted on Japanese population, also found statistically significant differences [9]. They found statistically significant differences in the Japanese sample, who had a shorter maxilla, larger upper anterior face height, and lower posterior dental height than Burstone's white sample. A less prominent chin was observed in the Japanese male group. Soft tissue analysis of the Japanese subjects displayed a retrognathic maxilla and mandible in relation to the soft tissue glabella and bilabial protrusion when equated with the white adult standards [9].

The results of our study showed a non-significant difference between male and female in almost all measured values which is quite similar to the results of a study done on Bangladeshi adult cephalometric norms [Table/Fig-1] [2]. There are some basic disparities in the craniofacial structure of Saudi subjects when compared with Steiner norms. These should be recognised and should take precaution to serve in diagnosis and treatment of Saudi patients [1]. The result of the current study should not be applied to other groups, this supports the view that a single standard of facial aestheticsis not applicable for other races and ethnics [1,2,5-9].

Numerous studies have been done in regard to cephlaometrics and showed variations such as some authors found significant differences whereas some did not find any significant differences statistically [1,2,5-9]. [Table/Fig-1-3] showed the details of the findings of Saudi, Bangladeshi, Malaysian, Egyptian, American and Japanese population.

LIMITATION

The limitation of our study was the relatively small sample size. In this study, the sample size consisted of 80 adult patients (37 females and 43 males) who were selected for the cephalometric investigation.

CONCLUSION

From this study we found, 8 out of 15 cephalometric values are larger in female than male. However, no significant linear and angular differences in craniofacial morphometry among Saudi males and females were found using Steiner's analysis. Steiner's standard values are smaller in comparison to Saudi standards, especially for the maxilla and mandible in relation to cranial base and higher value for inter-incisor angle, which indicates, bimaxillary proclination tendencies in Saudi adults. Such variations in cephalometric values are important for Orthodontist for the management of malocclusion and for Oral and maxillofacial surgeon while performing any craniofacial surgeries. Our results have clinical implications in the diagnosis and management of adult Saudis with dentofacial abnormalities. A larger sample size would deliver better depth to the current hypothesis and results. We encourage researchers to do research with larger sample using same protocol.

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