CEPHALOMETRIC MEASURMENTS OF A SAUDI ADULT SAMPLE ACCORDING TO JARABAK'S ANALYSIS

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ABSTRACT

The aim of this study was to establish cephalometric norms of Saudi adults according to Jarabak's analysis and to evaluate whether a significant difference exists between Saudi measurements and Jarabak's norms. The inclusion criteria were normal occlusion, pleasant soft tissue profiles, no history of trauma, and no previous orthodontic treatment. The study was carried out on sixty-two standardized lateral cephalometric radiographs of 31 female and 31 male Saudi adults with a mean age of 23 ± 1 years. Descriptive analysis and independent Student's t-test were carried out. The results showed statistically significant differences in the anterior cranial base length, mandibular length, lower gonial angle, and posterior facial height ($p < 0.05$) between the Saudi males and females when compared to Jarabak's norms ($p < 0.05$). The results demonstrated that the Saudis have distinct cephalometric facial features. It can be concluded that Saudi males and females have distinct craniofacial features when compared to Caucasians. These distinct features should be considered when orthodontists and orthognathic surgeons set their treatment objectives.

INTRODUCTION

Cephalometric radiography is a diagnostic tool used widely by orthodontists and surgeons since its introduction by Broadbent[1] in 1931. It is useful in assessing skeletal, dental, and soft tissue relationships as well as individual patterns resulting from particular ethnic and racial backgrounds. Thus, various cephalometric analyses were carried out using different landmarks and planes.[2-9]

Different racial and ethnic groups have different facial and dental characteristics that warrant the establishment of cephalometric norms for each group. Studies showed that the Saudi population has distinct facial and dental features when compared with European and American populations, as verified by different analyses.[10-18]

Jarabak cephalometric analysis considers the skeletal pattern in the anteroposterior and vertical dimensions in reference to a stable craniofacial structure.[19] Jarabak analysis is clinically useful in assessing skeletal anomalies, intermaxillary relationships, and the possible reaction to orthodontic treatment of such anomalies. In addition, it can be used as a template for the prediction of growth patterns.[20]

There are no previous studies establishing cephalometric norms for a Saudi population according to Jarabak's analysis. Therefore, the aims of this study were to establish cephalometric norms using Jarabak's analysis for a Saudi sample with normal skeletal patterns and occlusion, and to compare these norms to the norms used by Jarabak.

MATERIALS AND METHODS

The study was carried out on sixty-two lateral cephalometric radiographs divided into 31 female and 31 male Saudi adults with a mean age of 23 ± 1 year. These radiographs were taken by the 4th year students

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as part of their undergraduate orthodontic course requirements (the students were informed about their rights to take the radiographs). All Radiographs were taken in a standardized manner by the same technician. The investigators confirmed that the cephalometric radiographs were taken in standardized manner. The sample was selected according to the following criteria:

- A pleasing and harmonious face
- Angle class I molar and canine relationship
- Normal overjet (1-4mm)
- Normal overbite (35-50%)
- Average skeletal relationship (ANB = 1-4.5)
- No history of trauma or jaw fracture
- No craniofacial malformation and syndromes
- No previous orthodontic treatment

All lateral cephalometric radiographs were obtained in centric occlusion with the head in the natural head position and lips in the rest position. Each radiograph was scanned into an X-Y coordinate system using the Epson® perfection 4990 photo scanner (Seiko Epson Corporation, Nagano, Japan), and was digitized by a single investigator in a darkened room using specific points required by the software. Linear and angular measurements were calculated electronically using the Dolphin® version 10 software (Dolphin Imaging and Management Solutions, Chatsworth, Calif., USA) according to Jarabak's analysis.[19] Landmarks, angular and linear measurements are illustrated in Figure1 and defined in Table 1. The magnification factor of the radiographic image for linear measurements was adjusted in the computer by marking two points on the radiograph at a set distance. The error of the measurement method was evaluated using a coefficient of reliability[21] by repeated measurements of 15 cephalometric radiographs after a 2-week interval, with both sets of measurements performed by the same investigator. The coefficient of reliability was calculated as follows: coefficient of reliability=1- ($Se^2 \div St^2$), where Se^2 is the variance due to random error, and St^2 is the total variance of the measurements. The measurements demonstrated high correlation and ranged between 0.99 and 0.97.

TABLE 1: CEPHALOMETRIC MEASUREMENTS OF JARABAK'S ANALYSIS

Measurement	Definition
Angular measurements (°)	
N-S-AR	Saddle angle: Measured at the angle between anterior and posterior cranial base.
S-AR-GO	Articular angle: Measured at the angle between posterior cranial base and ramus height.
AR-GO-ME	Gonial angle: Measured at the angle between ramus height and mandibular plane.
AR-GO-N	Upper gonial angle: Measured at the angle between ramus height and Gonion constructed- Nasion line
N-GO-ME	Lower gonial angle: Measured at the angle between Gonion constructed-Nasion line and mandibular plane
Jarabak Sum	Sum of angles (Saddle angle + Articular angle + Gonial angle)
Linear measurements(mm)	
S-N	Anterior cranial base: A linear distance from Sella to Nasion.
S-AR	Posterior cranial base: A linear distance from Sella to Articulare.
AR-GO	Ramus height: A linear distance from Articulare to Gonion constructed.
N-ME	Anterior facial height: A linear distance from Nasion to Menton.
S – GO	Posterior facial heigth: A linear distance from Sella to Gonion constructed.
GO-ME	A linear distance from Gonion to Menton (mandibular corpus).
Proportional measurements (%)	
% Jarabak	Facial Proportion: A ratio of the Posterior facial heigth to Anterior facial height (S –GO/N-ME).

TABLE 2: STATISTICAL COMPARISON OF CEPHALOMETRIC MEANS BETWEEN SAUDI MALES AND JARABAK'S ANALYSIS

Measurement	Jarabak Analysis		Saudi males		t-test	p-value
	Mean	SD	Mean	SD		
N-S-AR(⁰)	123	6	125.81	5.22	2.065	0.086
S-N (mm)	71	3	74.37	4.26	3.702	0.001**
S-AR (mm)	32	3	36.78	3.46	6.026	0.000***
S-AR-GO(⁰)	143	5	140.90	8.01	1.269	0.418
AR-GO-ME(⁰)	130	7	127.28	6.58	1.649	0.208
AR-GO-N (⁰)	53.5	1.5	52.16	4.58	1.556	0.249
N-GO-ME (⁰)	72.5	2.5	75.10	4.01	3.135	0.005*
AR-GO mm	44	5	51.37	5.38	5.810	0.000***
GO-ME (mm)	71	5	86.32	5.19	12.324	0.000***
Jarabak sum (⁰)	396	6	393.99	3.78	1.682	0.195
S-GO mm	77.5	7.5	83.03	5.99	3.378	0.002*
N-ME mm	112.5	7.5	127.65	5.85	9.352	0.000***
%JARABAK	63.5	1.5	65.04	3.70	2.171	0.067

* P < 0.05, ** P < 0.01, *** P <0.001

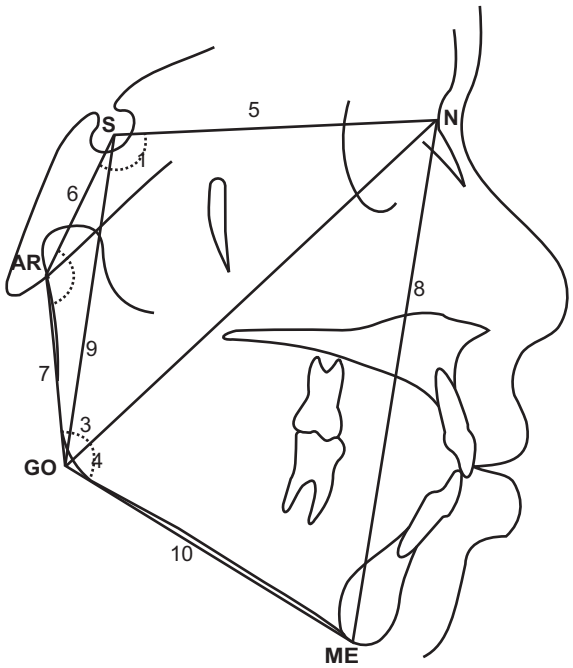

Fig 1:Cephalometric measurements of Jarabak's analysis.
Angular measurements: 1. N-S-AR (saddle angle); 2. S-AR-GO (articular angle); 3&4. AR-GO-ME (gonial angle); 3. AR-GO-N (upper gonial angle); 4. N-GO-ME (lower gonial angle) and 1+2+3+4(Jarabak sum).
Linear measurements: 5. S-N (anterior cranial base); 6. S-AR (posterior cranial base); 7. AR-GO (ramus height); 8. N-ME (anterior facial height); 9. S-GO (posterior facial height), and 10. GO-ME (mandibular corpus).

Statistical evaluation

Data were transferred to the computer for analysis using the SPSS program for Windows (version 12 SPSS Inc., Chicago, IL, USA). Descriptive statistics (mean, standard deviation,) were determined for each variable in both sexes separately. An independent Student's t-test was used to determine whether there was significant difference between the Saudi males and the females and to compare the results of the present study with Jarabak's standards, at a significance level of P < 0.05.

RESULTS

The means and standard deviations of angular and linear measurements for Saudi males and females according to Jarabak's analysis are presented in Table 2 and 3.

Statistical analysis of cephalometric measurements for the Saudi male and female sample as compared to Jarabak's norms revealed significant differences in the anterior cranial base length, mandibular length, lower gonial angle, and posterior facial height (p < 0.05) (Tables 2, 3). The posterior cranial base length, ramus height, and anterior facial height in Saudi males were significantly greater than Jarabak's norms (p <0.05) (Table 2). The upper gonial angle in Saudi females was significantly lower than Jarabak's norms (p <0.05) (Table 3).

TABLE 3: STATISTICAL COMPARISON OF CEPHALOMETRIC MEANS BETWEEN SAUDI FEMALES AND JARABAK'S ANALYSIS

Measurement	Jarabak Analysis		Saudi females		t-test	p-value
	Mean	SD	Mean	SD		
N-S-AR(⁰)	123	6	125.73	4.99	2.050	0.089
S-N (mm)	71	3	66.88	4.29	4.505	0.000**
S-AR (mm)	32	3	32.72	3.50	0.668	1.013
S-AR-GO(⁰)	143	5	142.90	7.67	0.062	1.901
AR-GO-ME(⁰)	130	7	126.17	8.15	2.058	0.087
AR-GO-N (⁰)	53.5	1.5	51.11	4.51	2.830	0.012*
N-GO-ME (⁰)	72.5	2.5	75.32	5.49	2.640	0.021*
AR-GO mm	44	5	45.39	4.17	1.247	0.433
GO-ME (mm)	71	5	79.84	6.33	6.300	0.000***
Jarabak sum (⁰)	396	6	394.79	5.58	0.860	0.786
S-GO mm	77.5	7.5	73.46	4.90	2.668	0.019*
N-ME mm	112.5	7.5	114.47	6.80	1.136	0.520
%JARABAK	63.5	1.5	64.28	4.24	0.975	0.667

* P < 0.05, ** P < 0.01, *** P <0.001

TABLE 4: STATISTICAL COMPARISON OF CEPHALOMETRIC MEANS BETWEEN SAUDI MALES AND FEMALES.

Measurement	Saudi Male		Saudi female		t-test	p-value
	Mean	SD	Mean	SD		
N-S-AR(⁰)	125.810	5.215	125.732	4.993	0.060	1.905
S-N(mm)	74.371	4.262	66.877	4.292	6.898	0.000***
S-AR(mm)	36.784	3.463	32.716	5.297	3.578	0.001**
S-AR-GO(⁰)	140.897	8.011	142.900	7.670	1.006	0.637
AR-GO-ME(⁰)	127.281	6.579	126.168	8.151	0.592	1.113
AR-GO-N(⁰)	52.165	4.578	51.106	4.505	0.917	0.725
N-GO-ME(⁰)	75.100	4.011	75.323	5.495	0.182	1.712
AR-GO(mm)	51.371	5.380	45.387	4.169	4.895	0.000***
GO-ME(mm)	86.316	5.190	79.842	6.334	4.402	0.000***
Jarabak sum(⁰)	393.987	3.776	394.790	5.584	0.663	1.019
S-GO(mm)	83.026	5.986	73.458	4.901	6.885	0.000***
N-ME(mm)	127.652	5.851	114.471	6.799	8.181	0.000***
%JARABAK	65.039	3.700	64.281	4.243	0.750	0.913

* P < 0.05, ** P < 0.01, *** P <0.001

Statistical comparisons of Saudi male and female measurements showed significant differences in the anterior and posterior cranial base lengths ($p < 0.05$). Additionally, Saudi males displayed significantly greater values for anterior and posterior face height, ramus height, and mandibular length ($p < 0.05$) (Table 4).

DISCUSSION

Radiographic cephalometery is an important diagnostic aid for orthodontists and orthognathic surgeons. Additionally, it has been used for studying craniofacial form and growth in different ethnic and racial groups. Studies have shown that different ethnic groups have different dentofacial characteristics. [10-18] Cephalomet-

ric norms for the different ethnic groups indicate that normal measurements in one group might not be normal for the other group. Therefore, orthodontists and orthognathic surgeons must consider these differences in their treatment objectives and treat different ethnic and racial groups according to their craniofacial standards.

Previous cephalometric studies conducted on Saudi adults and adolescents with acceptable profile and normal occlusion showed that Saudis have more protrusive dentofacial characteristics as compared to North Americans and British Caucasian individuals.[10-18] Al Jasser [16] conducted two cephalometric studies comparing Saudi students to North Americans Caucasians according to Steiner's and Down's analyses. It was shown in his studies that Saudis have distinct dentofacial features.

Al Barakati and Talic [18] established cephalometric norms according to McNamara's analysis and compared their data to measurements of North Americans and Europeans. It was concluded that Saudis have a class II facial pattern and reduced chin prominence when compared with North Americans and Europeans. Additionally, Saudis have a more protrusive dentoalveolar structure.

The present study compared the cephalometric measurements of untreated Saudi males and females with pleasant soft tissue profile and normal occlusion to the norms presented by Jarabak [19] and found that the mean values of the anterior cranial base length, mandibular length, lower gonial angle, and posterior facial height in both Saudi males and females were significantly different from the means of Jarabak's norms. These findings are in agreement with previous studies that show that Saudi males and females have distinct craniofacial features.[10-18] Furthermore, Saudi males showed significantly greater anterior face height mean values as compared to Jarabak's means. This finding is important when considering hyperdivergent profiles prior to setting orthodontic and/or orthognathic treatment objectives. Similar results were found by Al Barakati and Talic, who reported a pattern of backward downward rotation of the mandible and a tendency toward a class II pattern among the Saudi population. [18] This could explain geometric increase in anterior face height that was observed in this study.

The increase in the mandibular length demonstrated in this study is in agreement with the overall characteristic protrusive profiles in Saudis when compared to Caucasians.[10-18] This increase in the mandibular length could explain the tendency for protrusive profiles.

Future cephalometric studies examining Saudi samples from different parts of the Saudi kingdom are needed to verify the findings presented in this study. Additional cephalometric studies to establish norms for Saudi adolescents are warranted.

CONCLUSIONS

- Saudi males and females demonstrated a significant difference in anterior cranial base length, mandibular length, lower gonial angle, and posterior facial height when compared to Jarabak's mean measurements.
- The posterior cranial base length, ramus height, and anterior facial height in Saudi males were significantly greater than Jarabak's norms.
- The upper gonial angle in Saudi females was significantly greater than that of Jarabak's norms.
- Statistical comparisons of Saudi male and female measurements showed significant differences in the anterior and posterior cranial base lengths. Additionally, Saudi males have significantly greater anterior and posterior facial height, ramus height, and mandibular length.
- This study confirms the notion that Saudi males and females have distinct craniofacial features when compared to Caucasians. These distinct features should be considered when orthodontists and orthognathic surgeons set their treatment objectives.

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