European Journal of Orthodontics 32 (2010) 430–434
doi:10.1093/ejo/cjp113
Advance Access Publication 16 December 2009

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Comparison of dentoalveolar protrusion values in Moroccans and other populations

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SUMMARY The aim of this retrospective study was to evaluate bimaxillary protrusion among Moroccans and to compare the Moroccan population with other Arabic, Caucasian, and Mediterranean populations. Cephalometric radiographs of 102 Moroccan adult university students (73 females and 29 males, mean age: 21 years 6 months ± 1 year 6 months) with a normal occlusion were traced. Fifteen measurements concerning the upper and lower incisors, upper and lower lips, and the Frankfort to mandibular plane angle were assessed. Statistical analysis of the data was undertaken using independent *t*-tests.

Eight angular and six linear measurements were statistically significantly different compared with Caucasian cephalometric norms ($P<0.001$). Significant differences were observed compared with other adult Arabic populations (Palestinians and Saudis) and with Turkish Anatolian adults. Relative to Caucasian cephalometric norms, Moroccans showed bimaxillary protrusion and, therefore, these norms cannot be applied to Moroccan faces. In general, there was a great similarity in incisor position between the Moroccan and Saudi populations.

Introduction

Improvement in facial aesthetics and functional occlusion are the main objectives of orthodontic treatment (Bishara *et al.*, 1990). Cephalometric norms have been used to determine the location and severity of any existing dentofacial discrepancies and subsequently to evaluate the changes that accompany orthodontic treatment. Differences in the dentofacial relationships of various ethnic groups have been observed by many investigators (Loutfy *et al.*, 1970; Chan, 1972, Shalhoub *et al.*, 1987; Cooke and Wei, 1988; Al-Jasser, 2000; Hamdan and Rock, 2001; Behbehani *et al.*, 2006), and, as a result, a number of standards have been developed regarding various racial and ethnic groups. All these studies indicate that normal measurements for one group should not be considered normal for others. Different racial groups must be treated according to their own characteristics.

Bimaxillary protrusion is characterized by protrusive and proclined upper and lower incisors and increased protrusion of the lips. It is observed mainly in African American (Fonseca and Klein, 1978; Rosa and Arvystas, 1978; Keating, 1985; Farrow *et al.*, 1993; Scott and Johnston, 1999) and Asian (Lamberton *et al.*, 1980; Lew, 1989; Tan, 1996) populations. Many Moroccan patients seek orthodontic care to correct dental and labial protrusion because of the negative perception of a protrusive dentition and lips. The aetiology of bimaxillary protrusion is multifactorial and consists of a genetic component as well as environmental factors, such as mouth breathing, tongue and lip habits, and tongue volume (Bills *et al.*, 2005).

Many publications in the orthodontic literature describe bimaxillary protrusion in African Americans, Asians, and other communities (Keating, 1985; Farrow *et al.*, 1993), but descriptions for Arabs (Hussein and Abu Mois, 2007) and Moroccans (Khattabi and Palot, 1980) are rare. Sarhan and Nashashibi (1988) compared the cephalometric radiographs of Saudi boys (10–14 years of age) with a similar British sample. They found that Saudis had slightly more prognathic faces, more protruded incisors and lower gonial and saddle angles when compared with the British sample. Al-Jasser (2000) described the craniofacial characteristics of 87 Saudi students with acceptable profiles and occlusions. In comparison with European-American standards (Steiner, 1960), it was concluded that Saudis have different craniofacial features.

European-American norms are still used in orthodontic treatment planning of Moroccan patients despite the different ethnic backgrounds. The Moroccan population is historically composed of Arabs, Amazighs (Berber), Jews, and Africans. Since Morocco's independence, this population is fairly stable with no racial mix from other countries (Reffas, 1987). Insufficient published data exists to establish cephalometric values useful for diagnosis and treatment planning for Moroccan young adults. Therefore, the aims of this study were to evaluate the severity of bimaxillary protrusion in the Moroccan population for clinical and research purposes, to compare the measurements of dental and labial protrusion with Caucasian cephalometric norms, essentially concerning the decision for first premolar extractions, to study the difference between Moroccan males and females regarding their facial features, to compare the results with classic standards of bimaxillary protrusion in other nationalities, and to determine if the cephalometric averages and norms for Caucasians can be applied to the Moroccan population.

Subjects and methods

Subjects

This study was a retrospective analysis of radiographs and approved by the medical research ethics committee of the Medical School of Rabat.

A total of 102 healthy student volunteers (73 females and 29 males) were recruited from 272 students currently enrolled at the Dental School of Mohamed V-Souissi University of Rabat, Morocco. Their mean age was 21 years 6 months ± 1 year 6 months. The inclusion criteria were Moroccan nationality, good general health, a Class I molar and canine relationship, no missing teeth (except third molars), crowding that did not exceed 4 mm, no visible asymmetry, an overjet and an overbite that did not exceed 3 mm, and no previous orthodontic or surgical treatment. Facial aesthetics were not considered.

Nine students meeting the inclusion criteria refused to participate in the study. All other subjects signed consent forms that explained the nature and purpose of the study before beginning the project.

Data collection and measurements

The following information was recorded for each student: age, gender, and nationality of parents and grandparents. Lateral cephalograms were taken in a cephalostat (Orthophos XG 5 DS/Ceph; Sirona Dental System, Bensheim, Germany; C3 30 × 23, at 200–240 V, 12mA) in maximal intercuspation with the lips in repose and the Frankfort plane horizontal to the floor, according to the natural head position, by a single technician. The distance from the focus of the radiographic device to the midsagittal plane of the patient was 150 cm, and the distance from the film to the midsagittal plane was 15 cm. Since no correction was made for cephalometric measurements, all linear measurements had a 10 per cent enlargement factor included.

The radiographs were traced by one author (KL), in order to eliminate inter-examiner variability and analysed using Orthalis V4.0 (Software Dental Suite 2003, Diedendorf, France). The reference planes and measurements used for the analyses are shown in Figure 1.

The position of the upper incisors was determined by measuring them relative to the palatal plane, to the sella-nasion plane, to the nasion-A line, and the A-pogonion line. The lower incisors were measured by relating them to the mandibular plane, to the nasion-B line, and to the A-pogonion line, while inter-incisal angle was measured as an indicator of the presence of anterior tooth flaring and proclination. The nasolabial angle was measured to study soft tissue protrusion and the position of the upper and lower lips relative to Ricketts' E plane, and the mandibular plane to the Frankfort horizontal to determine the relationship between bimaxillary protrusion and the vertical dimension (Figure 1).

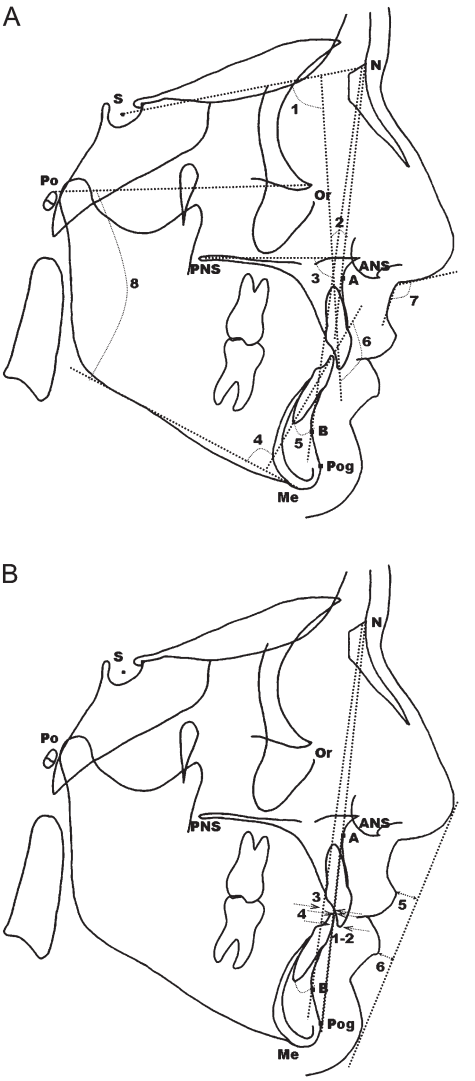

Figure 1 Landmarks: nasion (N), sella (S), porion (Po), orbitale (Or), anterior nasal spine (ANS), posterior nasal spine (PNS), pogonion (Pog), menton (Me), Point A (A), Point B (B), upper incisal axis (U1), lower incisal axis (L1), palatal plane (PP: ANS–PNS), mandibular plane (MP), angular (**A**) [1: U1–SN, 2: U1–NA, 3: U1–PP, 4: L1–MP, 5: L1–NB, 6: U1–L1, 7: nasolabial angle, and 8: FMA] and linear (**B**) [1: U1–NA, 2: L1–NB, 3: U1–A Pog, 4: L1–A Pog, 5: UL–E, and 6: LL–E] measurements used in the study.

Statistical analysis

The mean values and standard deviations (SDs) of eight angular and six linear variables were determined for each measurement. The resulting norms for Moroccans were compared with those derived from the analyses of Riedel (1952), Tweed (1954), Downs (1956), Ricketts (1960), and Steiner (1960) using an independent *t*-test (Table 1). Males and females were compared using a *t*-test (Table 2). Finally, the Moroccan results were compared with other adult Arabic and Mediterranean populations: Palestinian (Hussein and Abu Mois, 2007), Saudi (Hassan, 2006), and Anatolian Turkish (Basciftci *et al.*, 2004; Table 3).

The Levene test was performed to determine similarities of variance. All variables were checked for normality using the Kolmogorov–Smirnoff test. Data analyses were performed with the Statistical Package for Social Sciences, version 13.0 (SPSS Inc., Chicago, Illinois, USA), and with the Primer of Biostatistics statistical software program, version 4.02 (1996; McGraw Hill, New York, USA).

Results

Reliability

All the radiographs were retraced by the same author after a 2 week period and reanalysed to determine reproducibility. A *t*-test showed no statistically significant difference at the 5 per cent level.

Combined norms, means, and SDs for the Moroccan adults and their comparison with Caucasian norms are shown in Table 1. The Moroccan sample showed significant differences ($P<0.001$). The maxillary and mandibular central incisors were more proclined and more protruded than in the Caucasian sample. The inter-incisal angle was smaller than that of Steiner's (1960) norms, indicating bimaxillary protrusion. The relationship of the lips to Ricketts' E line indicated a proclined position of the lips compared with Ricketts' mean. The low value of the inter-incisal angle resulted in bimaxillary proclination features in individuals with a Class I occlusion. The nasolabial angle was decreased compared with the average value.

Table 1 Combined norms, means, and standard deviations (SDs) for Moroccan adults as compared with European-American cephalometric standard values as defined by Riedel (1952), Tweed (1954), Downs (1956), Ricketts (1960), and Steiner (1960).

Variable	Moroccans (adults), $n=102$		European-American norms	
	Mean	SD	Mean	*t*
U1–SN (°)	96.10	3.87	104	−20.58***
U1–NA (mm)	4.99	2.59	4	3.85***
U1–PP (°)	113.64	6.04	109	7.75***
U1–NA (°)	22.92	6.37	22	1.467
U1–APog	7.33	2.48	2.7	18.84***
L1–MP	95.43	7.09	90	7.74***
L1–NB (mm)	6.06	2.51	4	8.29***
L1–NB (°)	28.09	6.38	25	4.90***
L1–APog	3.40	2.11	1	11.48***
U1–L1	124.98	9.51	131	−4.84***
FMA	21.56	6.01	25	−5.76***
Nasolabial angle (°)	93.33	10.15	102	−8.61***
UL–E	−1.23	2.75	−7	21.10***
LL–E	−0.05	2.22	−2	8.86***

***$P=0.001$.

Table 2 Means and standard deviations (SDs) of the measurements for both genders in the Moroccan sample of young adults.

Variable	Females ($n=73$)		Males ($n=29$)			
	Mean	SD	Mean	SD	*t*	*P*
U1–SN (°)	95.77	3.77	96.94	4.06	1.38	NS
U1–NA (mm)	4.46	2.35	6.31	2.73	3.40	***
U1–NA (°)	21.71	6.21	25.98	5.82	3.18	**
U1–PP	113.15	6.56	114.86	4.36	1.28	NS
U1–APog	7.23	2.35	7.58	2.80	0.64	NS
L1–MP	96.47	6.78	92.81	7.29	−2.41	**
L1–NB (mm)	6.16	2.30	5.82	3.02	−0.60	NS
L1–NB (°)	29.32	5.93	25.00	6.50	−3.23	NS
L1–APog	3.35	1.96	3.51	2.48	0.34	NS
U1–L1	124.48	9.53	126.22	9.51	0.83	NS
FMA	21.94	5.84	20.62	6.42	−0.995	NS
Nasolabial angle (°)	94.00	10.50	91.63	9.18	−1.06	NS
UL–E	0.08	2.05	−0.37	2.61	−1.95	NS
LL–E	−0.71	1.92	−0.78	2.760	−0.94	NS

NS, not significant. **$P<0.001$; ***$P<0.0001$.

Table 3 Comparison of measurements for Moroccans compared with Palestinian, Saudi, and Anatolian Turkish standards.

Variable	Moroccans (adults), $n=102$		Moroccans versus Palestinians (Hussein and Abu Mois, 2007)		Moroccans versus Saudis (Hassan, 2006)		Moroccans versus Turkish (Basciftci *et al.*, 2004)	
	Mean	SD	Mean difference	*t*	Mean difference	*t*	Mean difference	*t*
U1–SN (°)	96.10	3.87	9.7	−13.3***	11.7	−12.68***	6	−5.79***
U1–NA	4.99	2.596			1.81	−4.28***	−0.91	2.73***
U1–NA (°)	22.92	6.37			4.11	−3.86***	−1.45	1.68
U1–PP	113.64	6.04	0.26	−0.28				
U1–APog	7.33	2.58	−0.25	0.68			−4.9	15.26***
L1–MP	95.43	7.09	−0.48	0.44	−1.53	1.34	1.07	−1.05
L1–APog	3.40	2.11	0.71	1.48			−0.97	3.29***
L1–NB	6.06	2.51			1.46	−3.67***	−1.24	3.92***
L1–NB (°)	28.09	6.38			1.25	−1.22	−0.41	0.51
U1–L1	122.98	8.90	3.25	−2.23	−4.38	2.67**	3.32	−2.84**
FMA	21.56	6.01	2.5	0.066***	6.94	−8.06***		
Nasolabial angle (°)	93.33	10.15	16.97	6.42				
UL–E	−1.23	2.75	−4.61	−2.93**			−3.76	11.01***
LL–E	−0.04	2.22	−2.21	5.98***			−2.21	6.52***

**$P=0.01$; ***$P=0.001$.

The Frankfort mandibular angle indicated that the faces of the Moroccan sample were slightly hypodivergent. The increase in incisor proclination was not associated with any significant change in vertical height.

When the data were separated according to gender to obtain more specific cephalometric normative values, gender-related dimorphism was found to be significant for three variables: U1–NA (angle and distance) and L1–MP (angle; Table 2).

When the data were compared with values from other investigations (Table 3), no significant differences were found except for four measurements: UL–SN ($P<0.001$), UL–E ($P<0.01$), LL–E ($P<0.001$), and FMA ($P<0.001$) of the Palestinian sample. Significant differences were found when the sample was compared with Saudis except for L1–MP and L1–NB. Saudis were found to have a steeper mandibular plane angle and more proclined incisors and lips. Significant differences were also found when the Moroccans were compared with Anatolian Turks except for the upper lip relative to the Na–A line (angle) and for the position of the lower incisor relative to the mandibular plane and to NB.

Discussion

The present study focused on a sample of untreated Moroccan students representative of the northern population of Morocco. Two dental schools exist in Morocco, one in Rabat, the administrative capital, and the other in Casablanca (south of Rabat). The students of the Dental school of Rabat come from the north of Morocco and the dental school of Casablanca receives students from the south of the country.

The inclusion criteria and methodology used in the study were orientated to identify normative values that can assist in the diagnosis of bimaxillary protrusion and treatment planning for Moroccan young adults. This investigation could be considered the first cephalometric study to determine the prevalence of bimaxillary protrusion using a sample of Moroccans. Only one previous investigation has been published (Khattabi and Palot, 1980) concerning cephalometric norms of the Moroccan population. The objectives of the present research were to evaluate the importance of bimaxillary protrusion and to compare the subjects with Caucasian norms in order to provide clinical guidance in the diagnosis and treatment planning for adult Moroccan patients, essentially concerning the decision of first premolar extraction.

The results showed highly significant differences between Moroccan values and reported norms for other ethnic groups. In comparison with Caucasians (Tweed, 1954; Steiner, 1960), Moroccans had a reduced lower face height, proclined upper and lower incisors, in relation to their corresponding dental bases, and a reduction in inter-incisal angle. The lower incisors were also significantly forward of the A-Pog line in relation to the incisors of Caucasian populations. U1–SN was the only value that showed a reduced mean in the Moroccan sample, probably due to the counterclockwise rotation of the cranial base (SN).

In agreement with previous finding for other ethnic groups (Gianelly, 1970; Chan, 1972; Hamdan and Rock, 2001), the present study showed no significant differences between Moroccan males and females except for three variables: U1–NA (angle and distance) and L1–MP (angle).

Notably, the findings showed significant differences from the results reported by Hassan (2006). Saudi adults living in the western region of Saudi Arabia were found to have excessive bimaxillary protrusion compared with the Moroccan population and a steeper mandibular plane angle. Compared with Palestinian norms (Hussein and Abu Mois, 2007), the Moroccan sample showed differences for Frankfort mandibular

plane angle and for lip position relative to the E line. Moroccan and Anatolian Turkish populations (Basciftci *et al.*, 2004) showed significant differences in cephalometric mean values, Turkish means being comparable with those of Caucasians.

The limitations of the present research include those associated with cross-sectional studies. All the subjects were volunteers, so the sample is not necessarily representative of the general population. Further investigations are needed to confirm the present results. The finding should be complemented by a study of people from the south of Morocco to allow definitive conclusions as to the norms of the Moroccan population in general.

Conclusion

Cephalometric norms taken from European-American means are useful diagnostic aids, but should not be used as treatment goals for individual patients. Moroccan means show more bimaxillary protrusion, implying that in diagnosis and treatment planning for Moroccans, dentoalveolar protrusion is more acceptable than in a Caucasian population. Similar results concerning biprotrusion were found for Saudis and Palestinians.

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Acknowledgements

We wish to express our thanks to Professor Bouchaib Jidal, Dean of the Dental School of Rabat, to Professor Jean Delaire for the software 'Orthalis', which was essential for this study, and to Professor Mogens Kilian (Aarhus University, Denmark) for his invaluable help.

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