Morphological features of bimaxillary protrusion in Saudis

Abdullah M. Aldrees, BDS, DMSc, *Manal A. Shamlan,* BDS, MSD.

ABSTRACT

الأهداف: تحليل الخواص القياسية قبل المعالجة لعينة من السعوديين البالغين الذين يُعانون من بروز الأسنان في الفكين والخروج بمقاييس معيارية لتوضيح المواصفات العامة لهذا النوع من عيوب إطباق الأسنان للأطباء المختصين.

الطريقة: صممت دراسة وصفية، استرجاعية وجمعت 60 صورة شعاعية قياسية جانبية للرأس تخص أشخاصاً ذوي علاقة هيكلية وسنية من الصنف الأول مع وجود نقص ملموس في الزاوية بين السنية لقواطعهم الأمامية خلال الفترة من يونيو 2007م حتى ديسمبر 2008م في عيادات تقويم الأسنان، كلية طب الأسنان، جامعة الملك سعود، الرياض، المملكة العربية السعودية. أجريت مُقارنة لهذه الصور بمقاييس 60 شخصاً يحملون العلاقة الهيكلية والسنية ذاتها، ولكن بزاوية سنية طبيعية. أُجريت حسابات المقاييس باستخدام برنامج الدولفين®، كما تم تحليل البيانات باستخدام الاختبار الإحصائي -T.

النتائج: لدى الأشخاص السعوديون الذين يُعانون من بروز الأسنان في الفكين علاقة هيكلية عمودية مماثلة للعينة الضابطة، وظهر لديهم بروز في الشفتين العُليا والسفلى. وعند مقارنة الذكور بالإناث ذوي الأسنان البارزة في الفكين، وجد ازدياد كبير في سُمك الشفاه لدى الذكور، في حين لا يبدو أنّ هناك فرقاً في بروز الشفاه بين الذكور والإناث.

خاتمة: أظهر الأشخاص السعوديون ذوي الأسنان البارزة في الفكين ملامح خاصة للأنسجة الرخوة تميّزهم عن الأفراد في المجموعة الضابطة، وعن المجموعات العرقية الأخرى ذات الأسنان البارزة في الفكين.

Objectives: To analyze the pre-treatment cephalometric features in Saudi adults with bimaxillary protrusion and to develop cephalometric standards to clarify the overall presentation of this malocclusion for clinicians.

Methods: A descriptive retrospective study was designed in which lateral cephalometric radiographs of 60 individuals with Class I skeletal and dental relationship and decreased interincisal angle were collected between June 2007 and December 2008 at the Orthodontic Clinic, College of Dentistry, King Saud University, Riyadh, Kingdom of Saudi Arabia. Radiographs were studied and compared to those of 60 individuals with similar skeletal and dental relationships, but with normal interincisal angle. The measurements were calculated electronically using Dolphin® software. The data were analyzed using the t-test.

Results: Saudi individuals with bimaxillary protrusion had a vertical skeletal pattern that is similar to that of the control group, however, they demonstrated increased procumbency of the upper and lower lips. Comparing females to males with bimaxillary protrusion revealed significant increase in male lip thickness. On the other hand, no significant difference was detected in the amount of lip protrusion between males and females.

Conclusion: Saudi subjects with bimaxillary protrusion demonstrated distinctive soft tissue features when compared to the control group and to other ethnic groups with bimaxillary protrusion.

Saudi Med J 2010; Vol. 31 (5): 512-519

From the Department of Pediatric Dentistry and Orthodontics (Aldrees), College of Dentistry, King Saud University, Riyadh and Dental Department (Shamlan), College of Health Science, King Abdulaziz University, Jeddah, Kingdom of Saudi Arabia.

Received 21st December 2009. Accepted 19th April 2010.

Address correspondence and reprint request to: Dr. Abdullah M. Aldrees, Department of Pediatric Dentistry and Orthodontics, College of Dentistry, King Saud University, PO Box 60169, Riyadh 11545, Kingdom of Saudi Arabia. Tel. +966 (1) 4676057. Fax. +966 (1) 4679017. E-mail: amaldrees@ksu.edu.sa

Bimaxillary protrusion is characterized by protrusive teeth in both jaws and greater than average degree of lip prominence. It is considered one of the malocclusion types that stimulate patients to seek orthodontic treatment to improve facial harmony. Several studies were conducted on different populations to study the relationship between the different components of

bimaxillary protrusion. Bimaxillary protrusion was defined as the concomitant proclination of both upper and lower dental arches in the same face. While Bills et al[1] defined the condition as flaring of upper and lower teeth with the resultant protrusion of lips and convexity of the face. Different studies on bimaxillary protrusion indicated that this malocclusion is associated with varieties of underlying skeletal, dental, and soft tissue patterns. Normal molar relationship and a relatively normal overjet and overbite were found to be features of this malocclusion. Maxillary prognathism and Class II skeletal pattern were common features among bimaxillary protrusion patients.[2] Posterior cranial base length was evaluated by some researchers. It was found to decrease by Keating[3] and normal by Baek and Kim.[2] The mandibular length and sagittal position were found normal.[2] Some ethnic groups with bimaxillary protrusion were found to demonstrate a vertical facial pattern,[1] while others did not show this type of pattern.[4] A predominant soft tissue feature was the protrusion of the upper and lower lips.[2,5] However, Hussein and Abu Mois[4] found that incisors proclination has no impact on lip protrusion. The nasolabial angle was found to be decreased by some researchers[1] and normal by others.[4] Studies on samples of Saudi individuals with pleasing, balanced and harmonious facial profiles showed that the incisors tend to be more procumbent than in the Caucasians.[6-8] Mean values of upper and lower incisors inclination in relation to several reference lines studied revealed that the incisors are inclined forwarded and protruded in Saudis.[6-8] Although many studies on the Saudi population have indicated that there is a high prevalence of bimaxillary protrusion among Saudis,[6-8] there is a lack of descriptive studies of this malocclusion in the Saudi population. This study aimed to investigate the characteristic features of this malocclusion in Saudi adults and to compare the features to individuals with normal occlusion and matching anteroposterior molar and skeletal relationship from the same ethnic background.

Methods. The study sample included 60 lateral cephalometric radiographs of Saudi adults (30 females and 30 males) diagnosed with bimaxillary protrusion and 60 cephalometric radiographs that represented the control group (30 females and 30 males) with normal occlusion. The study sample radiographs were taken from files of patients with bimaxillary protrusion at the Orthodontic Clinic in the College of Dentistry, King Saud University, Riyadh, Kingdom of Saudi Arabia between June 2007 and December 2008. The Ethics Committee of College of Dentistry Research Center, Riyadh, Kingdom of Saudi Arabia approved this study. The control group was selected to match the study group in the sagittal molar and skeletal relationship from the archive of cephalometric radiographs of the fourth year dental students, which were taken as a part of their undergraduate orthodontic course requirements. The selection criteria of the 2 groups were must be Saudi patient, age is >16 years if female and >18 if male, with an average skeletal relation (angle between Nasion-point A and Nasion-point B [ANB] = 1-4.5 degrees, the combined average of Saudi norms was: 2.72 ±2.14 degrees),[6] Class I molar relationship, overjet = 2-4 mm, and with no previous orthodontic treatment. In addition to the above criteria, the study group was selected to have an overbite of = 0 to ½ of the lower incisor crown height, and an interincisal angle less than 118 degrees (the combined average of Saudi norms was: 125.24 ±7.4 degrees).[6,7] The control group was selected to have an overbite of = ⅓ to ½ of the lower incisor crown height, and an interincisal angle greater than 123 degrees. Cephalometric radiographs were scanned using an Epson® Perfection 4990 photo scanner (Seiko Epson Corporation, Nagano, Japan) linked to a DELL computer running on Microsoft Windows XP. Cephalometric radiographs were then captured using Dolphin Imaging® 10.0 software (Dolphin Imaging and Management Solutions, Chatsworth, California, United States).

A previously collected custom analysis was then selected from the analysis toolbar. The actual length of the ruler from the head positioner was entered in the software because this allows the Dolphin software to recognize the actual size. Then the ruler's 2 ends as well as the anatomical landmarks were identified. The linear and angular measurements were calculated electronically. The hard and soft tissue landmarks and measurements are presented in **Figure 1**. The random errors were evaluated by calculating the intra-examiner errors. A total of 15 cephalographs were randomly selected, re-digitized, and retraced 2 weeks later by one of the investigator (Shamlan M) to evaluate the error of measurement. The error was assessed using the coefficient of reliability. Data were evaluated using Statistical Package Software System, version 16 (SPSS 16.0®), and independent student t-test was used to evaluate the differences between groups.

Results. The method error was examined by re-measuring all variables of 15 cephalometric radiographs, and it was calculated using the coefficient of reliability. Random error values for all landmarks were above 0.897. The mean difference was 0.21 degrees for the 13 angular measurements, and 0.22 mm for the 9 linear measurements. The cephalometric measurements of the Saudi males and females with bimaxillary protrusion were measured and compared to Saudi males and

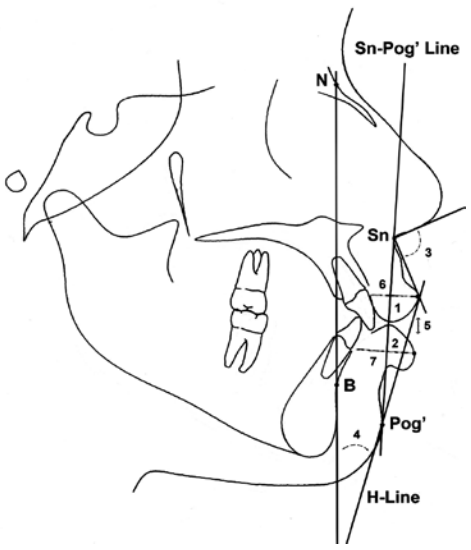

Figure 1 - Soft tissue landmarks and measurements: 1. LL-SnPog' (mm) - Perpendicular distance from most anterior point of the lower lip to the line connecting soft tissue Subnasale to soft tissue Pogonion 2. LL-SnPog' (mm) - Perpendicular distance from most anterior point of the lower lip to the line connecting soft tissue Subnasale to soft tissue Pogonion, 3. NLA (°) - Angle between line tangent to base of the nose and line tangent to upper lip. 4. NB-H Line (°) - Angle between line tangent to the chin and upper lip with NB 5. ULI-LLS (mm) - Distance between the most inferior point located on the upper lip and the most superior point located on the lower lip, 6. UL thickness (mm) - Distance between upper lip inside and upper lip outside, and 7. LL Thickness (mm) - Distance between lower lip inside and lower lip outside.

females in the control group by using the independent student t-test (**Tables 1**). No significant differences in the vertical skeletal measurements between males and females in both groups. The mean differences were statistically significant at $p<0.001$ for all dental variables and at $p<0.05$ for the overbite in the female group. Soft tissue evaluation indicated significant increase in the upper and lower lips protrusion in relation to subnasale to soft tissue pogonion (SnPog') in both gender of the bimaxillary group. No significant differences were detected among males in the nasolabial angle. The interlabial gap was found to decrease to a significant level in the males and females of the bimaxillary group. The lower lip thickness was found significantly increased in males and females of the study group.

Using the independent student t-test, the cephalometric measurements of the Saudi males with bimaxillary protrusion were evaluated and compared to Saudi females with bimaxillary protrusion (**Table 2**). Significant differences between males and females in the bimaxillary group in the Sella-Nasion line and Nasion-A (SNA) and Sella-Nasion line and Nasion-B point line (SNB) measurements were detected. Dentally, no significant differences in the dentoalveolar measurements were detected between males and females in the study group except for angle between long axis of upper incisors and S-N (U1-SN angle), which was increased in the males. Soft tissue comparison revealed no significant differences between males and females in the amount of lips protrusion. Male measurements showed a significant increase in the upper and lower lips thickness. The nasolabial angle was also found to be less obtuse in the females. Some of the skeletal, dental, and soft tissue variables that have been investigated in this study were used in a previous study on Caucasians with bimaxillary protrusion.[3] The common variables between the 2 studies are displayed in **Table 3**. Significant differences were found in all the measurements except for the SNA angle. The interincisal angle was found be decreased in the Saudi subjects while the inclination of the upper and lower incisors presented as Angle between long axis of upper incisors and N-A (U1-PP) and Angle between long axis of lower incisor and mandibular plnae (Go-Me) (L1-MP) were found to be increased. The H-angle was significantly increased in the Caucasian sample.

Comparison with the African Americans measurements studied by Diels et al[9] is illustrated in **Table 4**. The lips were found to be more protruded, and their thickness was found to be increased in the African Americans (males and females).

Discussion. In order to avoid the projection errors, which are considered as part of the systematic errors, the linear measurements were adjusted to the actual subject dimension by introducing the ruler with the actual size to the Dolphin software system. This study was an exploratory descriptive study, which evaluated the characteristic features of bimaxillary protrusion in Saudi adults attending the orthodontic clinics of a teaching institution. Basic cephalometric analyses were included to investigate these features, however, correlations between the soft tissue profile and the underlining hard tissue structures can be applied to measures the strength of the overall relationships between the independent and dependent variables on a larger sample. This study did not evaluate the effect of orthodontic treatment on the profiles of patients with bimaxillary protrusion, and assessment of changes in facial soft tissues as a result of incisor retraction in Saudi bimaxillary protrusion patients should be documented in future studies. In the present study, the study group was selected to match the control group in the sagittal jaw relationship to eliminate the effect of skeletal discrepancies on the soft tissue values, therefore, no significant difference was found between the 2 groups in the sagittal dimension. Korean subjects with bimaxillary protrusion demonstrated a skeletal

Table 1 - Comparison of cephalometric measurements for Saudi males and females with bimaxillary protrusion and control group using t-test.

Variables	Saudi male bimaxillary	Saudi male control	*P*-value	95% Confidence interval of the difference		Saudi female bimaxillary	Saudi female control	*P*-value	95% Confidence interval of the difference	
	Mean ± SD	Mean ± SD		Lower	Upper	Mean ± SD	Mean ± SD		Lower	Upper
SNA (°)	83.36 ± 3.11	83.00 ± 4.75	0.732	-1.71	2.43	81.40 ± 2.35	81.42 ± 3.50	0.973	-1.57	1.51
SNB (°)	80.34 ± 3.23	80.36 ± 4.03	0.983	-1.90	1.87	78.37 ± 2.29	78.62 ± 3.33	0.743	-1.72	1.23
ANB (°)	3.02 ± 1.24	2.64 ± 1.23	0.241	-0.26	1.02	3.01 ± 0.96	2.81 ± 1.25	0.478	-0.37	0.78
SN-PP (°)	7.58 ± 3.91	8.02 ± 2.80	0.622	-2.19	1.32	8.82 ± 3.41	8.49 ± 2.93	0.687	-1.31	1.98
SN-MP (°)	34.56 ± 4.76	33.06 ± 4.98	0.239	-1.02	4.01	35.31 ± 3.90	37.77 ± 5.72	0.056	-4.99	0.069
LFH %	57.44 ± 3.01	56.27 ± 1.89	0.078	-0.13	2.46	56.39 ± 2.95	56.12 ± 2.35	0.700	-1.11	1.64
U1-L1 (°)	110.4 ± 5.89	129.47 ± 3.30	0.000†	-21.52	-16.59	110.76 ± 4.12	127.98 ± 3.64	0.000†	-19.23	-15.20
U1-SN (°)	114.96 ± 5.74	104.47 ± 4.94	0.000†	7.72	13.26	111.80 ± 3.80	103.79 ± 4.70	0.000†	5.79	10.22
U1-PP (°)	122.66 ± 5.23	111.73 ± 4.16	0.000†	8.49	13.38	120.98 ± 4.42	112.04 ± 4.34	0.000†	6.68	11.21
U1-NA (°)	31.59 ± 4.52	21.45 ± 5.05	0.000†	7.66	12.62	30.43 ± 3.94	22.19 ± 4.47	0.000†	6.07	10.42
U1-NA (mm)	7.62 ± 2.31	4.43 ± 1.84	0.000†	2.11	4.27	7.30 ± 1.75	4.45 ± 1.49	0.000†	2.00	3.69
L1-NB (°)	35.11 ± 4.38	25.31 ± 3.31	0.000†	7.79	11.80	35.75 ± 2.20	26.76 ± 4.05	0.000†	7.30	10.68
L1-NB (mm)	9.21 ± 2.22	5.30 ± 1.82	0.000†	2.859	4.96	8.53 ± 1.39	5.37 ± 1.45	0.000†	2.42	3.90
L1-MP (°)	100.24 ± 4.94	91.89 ± 3.52	0.000†	6.13	10.57	102.29 ± 4.32	89.82 ± 5.02	0.000†	10.04	14.89
OB (mm)	1.37 ± 0.80	2.27 ± 1.08	0.001†	-1.41	-0.39	1.78 ± 0.75	2.24 ± 1.00	0.047*	-0.92	-0.005
OJ (mm)	2.63 ± 0.83	2.66 ± 0.52	0.833	-0.39	0.32	2.78 ± 0.57	2.73 ± 0.46	0.677	-0.21	0.32
UL-SnPog' (mm)	5.13 ± 1.96	4.11 ± 1.65	0.034*	0.0823	1.96	5.11 ± 1.46	3.42 ± 1.42	0.000†	0.95	2.44
LL-SnPog' (mm)	6.47 ± 2.34	3.15 ± 1.97	0.000†	2.20	4.43	5.65 ± 2.04	3.20 ± 1.81	0.000†	1.44	3.44
NLA (°)	102.44 ± 11.0	104.01 ± 10.90	0.582	-7.26	4.11	96.03 ± 10.27	106.97 ± 9.55	0.000†	-16.06	-5.80
NB-H Line (°)	14.18 ± 3.73	10.79 ± 3.73	0.001†	1.46	5.32	14.13 ± 2.74	10.12 ± 3.93	0.000†	2.25	5.76
ULI-LLS (mm)	3.62 ± 2.60	2.49 ± 1.29	0.037*	0.07	2.19	4.18 ± 2.75	2.42 ± 1.69	0.004†	0.58	2.94
UL thickness (mm)	12.51 ± 1.71	12.22 ± 2.17	0.573	-0.73	1.29	10.67 ± 1.74	10.12 ± 1.76	0.235	-0.36	1.45
LL thickness (mm)	14.15 ± 1.67	12.12 ± 1.67	0.000†	1.17	2.90	11.57 ± 1.78	10.49 ± 1.32	0.010*	0.27	1.89

*Significant at $p<0.05$, †Significant at $p<0.01$.

SNA (°) - Angle between Sella-Nasion line and Nasion-A point line, SNB (°) - Angle between Sella-Nasion line and Nasion-B point line, ANB (°) - Angle between Nasion-point A and Nasion-point B, SN-PP (°) - Angle between palatal plane and S-N line, SN-MP (°) - Angle between mandibular plane (Go-Me) nd S-N line, Ll-MP ((°) - Angle between long axis of lower incesor and mandibular plae (Go-Me), Angle between mandibular plane and S-N line, LFH% - The lower anterior facial heights as a percentage of total anterior facial height, U1-L1 (°) - Angle between long axis of upper incisors and long axis of lower incisors, U1-SN (°) - Angle between long axis of upper incisors and S-N, U1-PP (°) - Angle between long axis of upper incisors and palatal plane, U1-NA (°) - Angle between long axis of upper incisors and N-A, U1-NA (mm) - Perpendicular distance between upper incisor's edge and N-A line in mm, L1-NB(°) - Angle between long axis of lower incisor and mandibular plane, L1-NB (mm) - Angle between long axis of lower incisor and N-B line, OB (mm) - Vertical distance between the lower incisor to the upper central incisor when upper and lower teeth are in centric occlusion, OJ (mm) - Horizontal distance between the lower incisor to the upper central incisor when upper and lower teeth are in centric occlusion, UL-SnPog' (mm) - Perpendicular distance from most anterior point of the upper lip to the line connecting soft tissue Subnasale to soft tissue Pogonion, LL-SnPog' (mm) - Perpendicular distance from most anterior point of the lower lip to the line connecting soft tissue Subnasale to soft tissue Pogonion, NLA (°) - Angle between line tangent to base of the nose and line tangent to upper lip. NB-H Line (°) - Angle between line tangent to the chin and upper lip with NB, ULI-LLS (mm) - Distance between the most inferior point located on the upper lip and the most superior point located on the lower lip, UL thickness (mm) - Distance between upper lip inside and upper lip outside, LL Thickness (mm) - Distance between lower lip inside and lower lip outside.

Table 2 - Comparison between measurements of males and females with bimaxillary protrusion.

Variables	Saudi male bimaxillary	Saudi female bimaxillary	*P*-value	95% Confidence interval of the difference	
	Mean ± SD	Mean ± SD		Lower	Upper
SNA (°)	83.36 ± 3.11	81.40 ± 2.35	0.008†	0.54	3.39
SNB (°)	80.34 ± 3.23	78.37 ± 2.29	0.009†	0.51	3.41
ANB (°)	3.02 ± 1.24	3.01 ± 0.96	0.982	-0.57	0.58
SN-PP (°)	7.58 ± 3.91	8.82 ± 3.41	0.196	-3.13	0.66
SN-MP (°)	34.56 ± 4.76	35.31 ± 3.90	0.508	-3.00	1.5
LFH %	57.44 ± 3.01	56.39 ± 2.95	0.178	-0.49	2.59
U1-L1 (°)	110.41 ± 5.89	110.76 ± 4.12	0.795	-2.97	2.29
U1-SN (°)	114.96 ± 5.74	111.80 ± 3.80	0.015*	0.64	5.68
U1-PP (°)	122.66 ± 5.23	120.98 ± 4.42	0.184	-0.82	4.18
U1-NA (°)	31.59 ± 4.52	30.43 ± 3.94	0.297	-1.03	3.34
U1-NA (mm)	7.62 ± 2.31	7.30 ± 1.75	0.544	-0.73	1.38
L1-NB (°)	35.11 ± 4.38	35.75 ± 2.20	0.477	-2.43	1.14
L1-NB (mm)	9.21 ± 2.22	8.53 ± 1.39	0.164	-0.28	1.63
L1-MP (°)	100.24 ± 4.94	102.29 ± 4.32	0.093	-4.45	0.35
OB (mm)	1.37 ± 0.80	1.78 ± 0.75	0.054	-0.83	0.007
OJ (mm)	2.63 ± 0.83	2.78 ± 0.57	0.399	-0.52	0.21
UL-SnPog' (mm)	5.13 ± 1.96	5.11 ± 1.46	0.973	-0.88	0.91
LL-SnPog' (mm)	6.47 ± 2.34	5.65 ± 2.04	0.151	-0.31	1.96
NLA (°)	102.44 ± 11.0	96.03 ± 10.27	0.024*	0.87	11.93
NB-H Line (°)	14.18 ± 3.73	14.13 ± 2.74	0.947	-1.63	1.75
ULI-LLS (mm)	3.62 ± 2.60	4.18 ± 2.75	0.420	-1.94	0.82
UL Thickness (mm)	12.51 ± 1.71	10.67 ± 1.74	0.000†	0.94	2.73
LL Thickness (mm)	14.15 ± 1.67	11.57 ± 1.78	0.000†	1.69	3.48

*Significant at $p<0.05$, †Significant at $p<0.01$.

SNA (°) - Angle between Sella-Nasion line and Nasion-A point line, SNB (°) - Angle between Sella-Nasion line and Nasion-B point line. ANB (°) - Angle between Nasion-point A and Nasion-point B, SN-PP (°) - Angle between palatal plane and S-N line, LFH% - The lower anterior facial heights as a percentage of total anterior facial height, U1-L1 (°) - Angle between long axis of upper incisors and long axis of lower incisors, U1-SN (°) - Angle between long axis of upper incisors and S-N, U1-PP (°) - Angle between long axis of upper incisors and palatal plane, U1-NA (°) - Angle between long axis of upper incisors and N-A, U1-NA (mm) - Perpendicular distance between upper incisor's edge and N-A line in mm, L1-NB (°) - Angle between long axis of lower incisor and mandibular plane, L1-NB (mm) - Angle between long axis of lower incisor and N-B line, Ll-MP (°) - Angle between long axis of lower incisor and mandibular plnae (Go-Me), OB (mm) - Vertical distance between the lower incisor to the upper central incisor when upper and lower teeth are in centric occlusion, OJ (mm) - Horizontal distance between the lower incisor to the upper central incisor when upper and lower teeth are in centric occlusion, UL-SnPog' (mm) - Perpendicular distance from most anterior point of the upper lip to the line connecting soft tissue Subnasale to soft tissue Pogonion, LL-SnPog' (mm) - Perpendicular distance from most anterior point of the lower lip to the line connecting soft tissue Subnasale to soft tissue Pogonion, NLA (°) - Angle between line tangent to base of the nose and line tangent to upper lip. NB-H Line (°) - Angle between line tangent to the chin and upper lip with NB, ULI-LLS (mm) - Distance between the most inferior point located on the upper lip and the most superior point located on the lower lip, UL Thickness (mm) - Distance between upper lip inside and upper lip outside,
LL Thickness (mm) - Distance between lower lip inside and lower lip outside.

Table 3 - Comparison between the combined Saudi data with bimaxillary protrusion with the available published data of Caucasians.[3]

Variables	Saudi bimaxillary		Caucasian bimaxillary		*P*-value	95% Confidence interval of the difference	
	Mean	SD	Mean	SD		Lower	Upper
SNA (°)	82.38	2.91	82.45	3.12	0.856	-0.82	0.68
SNB (°)	79.35	2.95	77.72	3.04	0.000†	0.876	2.40
ANB (°)	3.02	1.10	4.73	1.79	0.000†	-1.99	-1.425
SN-MP (°)	34.93	4.33	36.36	5.6	0.014*	-2.545	-0.31
U1-L1 (°)	110.58	5.04	115.25	5.88	0.000†	-5.96	-3.35
U1-PP (°)	121.82	4.88	118.17	5.55	0.000†	2.39	4.91
L1-MP (°)	101.26	4.72	97.7	6.34	0.000†	2.35	4.79
OB (mm)	1.57	0.83	2.66	1.55	0.000†	-1.29	-0.87
OJ (mm)	2.70	0.71	4.92	1.84	0.000†	-2.39	-2.03
NB-H line (°)	14.15	3.25	15.95	3.99	0.000†	-2.63	-0.95

*Significant at $p<0.05$, †Significant at $p<0.01$.
SNA (°) - Angle between Sella-Nasion line and Nasion-A point line, SNB (°) - Angle between Sella-Nasion line and Nasion-B point line. ANB (°) - Angle between Nasion-point A and Nasion-point B, SN-MP (°) - Angle between mandibular plane (Go-Me) and S-N line. U1-L1 (°) - Angle between long axis of upper incisors and long axis of lower incisors, U1-PP (°) - Angle between long axis of upper incisors and palatal plane, L1-MP(°) - Angle between long axis of lower incisor and mandibular plane (Go-Me), OB (mm) - Vertical distance between the lower incisor to the upper central incisor when upper and lower teeth are in centric occlusion, OJ (mm) - Horizontal distance between the lower incisor to the upper central incisor when upper and lower teeth are in centric occlusion, NB-H Line (°) - Angle between line tangent to the chin and upper lip with NB

Table 4 - Comparison between the Saudi males and females with bimaxillary protrusion data with the available published data of African Americans.[9]

Variables	Saudi male bimaxillary	African male bimaxillary	*P*-value	95% Confidence interval of the difference		Saudi female bimaxillary	African female bimaxillary	*P*-value	95% Confidence interval of the difference	
	Mean ± SD	Mean ± SD		Lower	Upper	Mean ± SD	Mean ± SD		Lower	Upper
U1-L1 (°)	110.41 ± 5.89	103.6 ± 9.1	0.000†	4.62	9.02	110.76 ± 4.12	101.5 ± 8.5	0.000†	7.72	10.80
L1-MP (°)	100.24 ± 4.94	104.7 ± 7.1	0.000†	-6.30	-2.61	102.29 ± 4.32	106.2 ± 7.6	0.000†	-5.52	-2.29
OB (mm)	1.37 ± 0.8	2.8 ± 1.7	0.000†	-1.76	-1.11	1.78 ± 0.75	3.2 ± 1.5	0.000†	-1.69	-1.13
OJ (mm)	2.63 ± 0.83	3.6 ± 1.8	0.000†	-1.28	-0.66	2.78 ± 0.57	3.2 ± 1.8	0.001†	-0.63	-0.19
UL-SnPog' (mm)	5.13 ± 1.96	11.3 ± 2.0	0.000†	-6.90	-5.43	5.11 ± 1.46	9.8 ± 2.4	0.000†	-5.22	-4.13
LL-SnPog' (mm)	6.47 ± 2.34	13.0 ± 3.0	0.000†	-7.39	-5.65	5.65 ± 2.04	10.7 ± 3.1	0.000†	-5.82	-4.28
NLA (°)	102.44 ± 11.0	92.3 ± 15.4	0.000†	5.99	14.28	96.03 ± 10.27	90.0 ± 13.0	0.003†	2.19	9.87
ULI-LLS (mm)	3.62 ± 2.60	0.1 ± 0.7	0.000†	2.55	4.49	4.18 ± 2.75	1.0 ± 1.9	0.000†	2.16	4.21
UL Thickness (mm)	12.51 ± 1.71	15.4 ± 2.9	0.000†	-3.53	-2.24	10.67 ± 1.74	13.3 ± 1.8	0.000†	-3.28	-1.98
LL Thickness (mm)	14.15 ± 1.67	18.8 ± 2.2	0.000†	-5.27	-4.02	11.57 ± 1.78	17.6 ± 2.7	0.000†	-6.69	-5.36

*Significant at $p<0.05$, †Significant at $p<0.01$
U1-L1 (°) - Angle between long axis of upper incisors and long axis of lower incisors, L1-MP(°) - Angle between long axis of lower incisor and mandibular plnae (Go-Me), OB (mm) - Vertical distance between the lower incisor to the upper central incisor when upper and lower teeth are in centric occlusion, OJ (mm) - Horizontal distance between the lower incisor to the upper central incisor when upper and lower teeth are in centric occlusion, UL-SnPog' (mm) - Perpendicular distance from most anterior point of the upper lip to the line connecting soft tissue Subnasale to soft tissue Pogonion, LL-SnPog' (mm) - Perpendicular distance from most anterior point of the lower lip to the line connecting soft tissue Subnasale to soft tissue Pogonion. NLA (°) - Angle between line tangent to base of the nose and line tangent to upper lip, ULI-LLS (mm) - Distance between the most inferior point located on the upper lip and the most superior point located on the lower lip. UL Thickness (mm) - Distance between upper lip inside and upper lip outside. LL Thickness (mm) - Distance between lower lip inside and lower lip outside.

Class II pattern.[2] Caucasians showed significant increase in the sagittal jaw relationship among the bimaxillary protrusion group, although the cases were assisted clinically as skeletal Class I.[3] The mandibular plane angle presented as SN-MP displayed an insignificant difference between the groups in this study and in the Caucasian study by Keating,[3] while an increase in this angular measurement was found in the ethnically diverse group.[1,3] The relation of the palatal plane with the cranial base showed insignificant differences in this study between the 2 groups. Significant difference was found in the palatal plane with cranial base angle in the Korean subjects.[2] The facial height ratio was not different between the Saudi bimaxillary group and the control group. This was in agreement with the findings of Keating.[8] Bills et al[1] found significant increase in the lower anterior facial height in the ethnically diverse subjects with bimaxillary protrusion. This clearly indicates that racial differences can affect the nature of the configuration of the skeletal structures even if dental features appear similar. Males and females in the study group showed more lip protrusion when compared to the control group. In the male group, differences in the upper lip position in relation to SnPog' showed a low level of significance, and the nasolabial angle showed an insignificant difference between the male groups. Based on these findings, it can be inferred that the Saudi males with bimaxillary protrusion demonstrated minimal protrusive features in the upper lip compared to the males in the control group. The lower lip was found to be thicker in the males (p=0.001) and females (p=0.01) of the study group. The increase in the lip thickness could result in more lip protrusion in this group. The observed decrease in SNA and SNB angles in females compared to the males could be attributed to the anterior cant of the anterior cranial base in the male sample. No significant differences in the dental relationship were found between the males and females in the bimaxillary protrusion group except for the upper teeth inclination in relation to the cranial base, which showed more incisors proclination in males (significant at 5% level). This could be attributed to the anterior cant of the anterior cranial base in males group, which was observed in the previously discussed increase in SNA and SNB angles. However, all other upper incisal inclination measurements did not indicate more proclination of the upper incisors in the male subjects. Significant differences between males and females in the soft tissue variables were present. Male soft tissue thicknesses were statistically greater than that of the females. The nasolabial angle was found to be less obtuse in the female subjects. This difference may be attributed to difference in the orientation of the base of the nose since no significant difference in the amount of lip protrusion was detected between the 2 genders. Palestinian males with bimaxillary protrusion demonstrated increase in the nasolabial angle compared to Palestinian females.[4] Comparison between Saudi subjects with bimaxillary protrusion and Caucasians indicated that the interincisal angle was found to be decreased in the Saudi group in comparison with the Caucasian group studied by Keating with the upper and lower incisors more proclined in relation to their basal bone.[3] The mandibular plane was found to be more posteriorly rotated in relation to the cranial base in Caucasians compared to the Saudis with bimaxillary protrusion. This could be attributed to the increase in the sagittal jaw relations among the Caucasian subjects. The H-angle was found to be greater in Caucasians than in the Saudi group. This increase could be attributed to the increase in the skeletal convexity as indicated by the decrease in SNB angle. Comparing the Saudi sample with the African American sample studied by Diels et al[9] revealed that all variables were significantly different in Saudis with bimaxillary protrusion when compared to African Americans.[9] The African American measurements showed more protrusive appearance and significantly decreased interincisal angle.[9] Both gender of the African American group had significant increase in the upper and lower lip protrusion and thickness.[9] This is due to the ethnic background differences between the 2 groups.[10,11] The significant decrease in the nasolabial angle confirms the upper lip protrusion in the African American sample.[9] These results confirm that variables such as race and gender affect the normal skeletal, dental and soft tissues characteristics of an individual. Identifying the normal features of a specific race or ethnic group should be the basis for proper diagnosis and treatment planning of orthodontic patients. These findings also reveal that there are fundamental variations in the dento-skeletal structures between the Saudi population and the widely used Caucasian norms, and the application of these standards as objectives for treatment should not be a routine orthodontic practice. Previous studies performed to derive cephalometric norms from representative samples of Saudi population selected the subjects based on their acceptable profiles and Class I molar or skeletal relationship.[6-8] The reported results showed a wide range of normal measurements, but the mean values of incisors sagittal position were significantly higher than the published norms of Caucasians.[6-8] The current study looked at the soft tissue features of a sample of Saudi adults who were selected to have a significant degree of protrusion compared to the normal range observed in the literature. And when their values were compared to a control group, the accompanying soft tissue measurements reflected distinct protrusion. For clinicians, appreciating the

differences between Saudi patients in the normal range of incisor inclination values and those who present with significant bimaxillary protrusion is essential for wise clinical judgment of the proper orthodontic management.

In conclusion, both males and females of the bimaxillary protrusion group exhibited a vertical skeletal pattern that is similar to the control group. Saudis with bimaxillary protrusion showed more protrusive soft tissue features compared to the control group. Both males and females had more protruded upper and lower lips, and thicker lower lips, however, females tend to have significantly less obtuse nasolabial angle. Comparison with other ethnic groups indicated that dental protrusion in Saudis is greater than Caucasians, but less than African Americans.

References

1. Bills DA, Handelman CS, BeGole EA. Bimaxillary dentoalveolar protrusion: traits and orthodontic correction. ***Angle Orthod*** 2005; 75: 333-339.
2. Baek SH, Kim BH. Determinants of successful treatment of bimaxillary protrusion: orthodontic treatment versus anterior segmental osteotomy. ***J Craniofac Surg*** 2005; 16: 234-246.
3. Keating PJ. Bimaxillary protrusion in the Caucasian: a cephalometric study of the morphological features. ***Br J Orthod*** 1985; 12: 193-201.
4. Hussein E, Abu Mois M. Bimaxillary protrusion in the Palestinian population. ***Angle Orthod*** 2007; 77: 817-820.
5. Langberg BJ, Todd A. Treatment of a Class I malocclusion with severe bimaxillary protrusion. ***Am J Orthod Dentofacial Orthop*** 2004; 126: 739-746.
6. Al-Jasser NM. Cephalometric evaluation for Saudi population using the Downs and Steiner analysis. ***J Contemp Dent Pract*** 2005; 6: 52-63.
7. Hashim HA. A cephalometric study of soft tissue relationship among Saudi female dental students. ***Saudi Dental Journal*** 2003; 15: 41-44.
8. Hassan AH. Cephalometric norms for Saudi adults living in the western region of Saudi Arabia. ***Angle Orthod*** 2006; 76: 109-113.
9. Diels RM, Kalra V, DeLoach N, Jr., Powers M, Nelson SS. Changes in soft tissue profile of African-Americans following extraction treatment. ***Angle Orthod*** 1995; 65: 285-292.
10. Hwang HS, Kim WS, McNamara JA, Jr. Ethnic differences in the soft tissue profile of Korean and European-American adults with normal occlusions and well-balanced faces. ***Angle Orthod*** 2002; 72: 72-80.
11. Brock RA, 2nd, Taylor RW, Buschang PH, Behrents RG. Ethnic differences in upper lip response to incisor retraction. ***Am J Orthod Dentofacial Orthop*** 2005; 127: 683-691.