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Comparative cephalometric study of class III malocclusion in Saudi and Japanese adult females

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Abstract: The cephalometric features of class III malocclusion in Saudi adult females were investigated and compared with reference data for Japanese females. The sample consisted of 30 standardized pre-treatment cephalometric radiographs of adult Saudi females diagnosed as having skeletal class III malocclusion. The radiographs were traced and digitized. Linear and angular variables were obtained for comparison of cranial base, maxilla, mandible, intermaxillary and dentoalveolar measurements. The method error in identifying and locating the anatomical landmarks was small and acceptable. Student's *t*-test was used for comparing the measurements. The results showed that Saudi females had a larger anterior cranial base, a smaller posterior cranial base, a smaller cranial base angle, smaller anterior and posterior facial heights, downward tipping of the maxilla, a retruded chin, a less steep mandibular plane, an increased joint angle, a smaller ramus, body and total mandibular length, and less retroclined mandibular incisors. The null hypothesis of no difference between the two groups was rejected. These results appear to suggest real differences in skeletal features between Saudi and Japanese adult females. (J. Oral Sci. 47, 83-90, 2005)

Keywords: cephalometric; comparison; class III malocclusion; Saudi adult female.

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Introduction

Class III malocclusion is a subject of interest and concern to the orthodontist in both research and clinical practice. The appearance of a protruding mandible with reverse overlap of the anterior teeth is easy to identify. Dental class III malocclusion has no significant skeletal discrepancy whereas skeletal class III malocclusion is associated with a wide variety of underlying skeletal and dental patterns (1-4).

The prevalence of class III malocclusion varies among different races and populations. The highest prevalence is among Asians of the Far East and the lowest is in Caucasians. It has been reported in 13.0% of Japanese (5), 14.5% of Chinese (6), 19.0% of Korean (7) and 3% of Caucasian subjects (8). However, the frequency of class III malocclusion in Asians of the Middle East is higher than in Caucasians but less than in Asians of the Far East. It varies from 5.1% to 10% (9,10) and in Saudi Arabians the occurrence of class III malocclusion is reported to be 9.4 %(11).

The etiology of class III malocclusion is a fascinating subject and there is still much to be elucidated and understood (6,12). The factors contributing to class III malocclusion are complex (13). There is considerable controversy as to the relative contributions of the size and position of the cranial base, the maxilla and the mandible (14-25).

The literature includes numerous publications describing the morphological features of class III malocclusion in different ethnic groups such as Caucasian (8-11,15-23), Mongoloid (3,5,6,24-35), and Negroid (36-40).

The lack of any comparative study between Saudi and Japanese populations with class III malocclusion stimulated our interest in conducting this study. The aim was to compare the cephalometric features of class III malocclusion between Saudi and Japanese adult females. A null hypothesis: “There is no difference between Saudi and Japanese adult females with class III malocclusion” was formulated and tested.

Materials and Methods

The study sample consisted of 30 lateral cephalometric radiographs of adult Saudi females with class III malocclusion. The mean age was 23.2 ± 1.3 years. The radiographs were derived from the files of patients diagnosed as having skeletal class III malocclusion at the Orthodontic Department of King Saud University. The criteria for selection included:

- Adults of Saudi ethnicity
- Class III skeletal relationship (ANB > -1°)
- Cross bite of anterior teeth (Overjet > -1 mm)
- No anterior mandibular shift
- No previous orthodontic treatment
- No trauma or jaw fracture
- No cleft palate or craniofacial syndrome

The published data for adult Japanese females with class III malocclusion by Ishii et al. (27) was used as the reference sample for comparison with adult Saudi females.

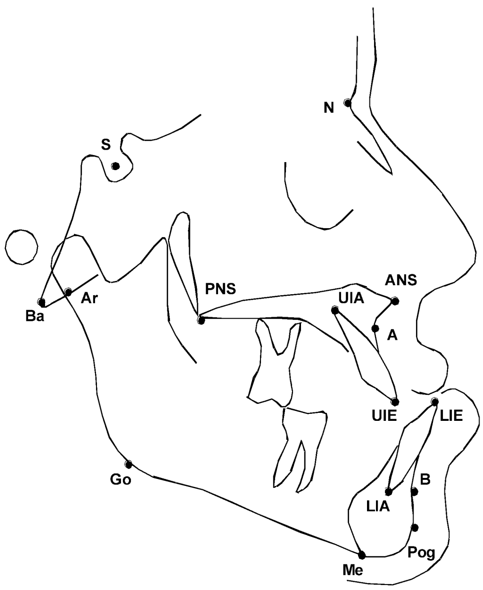

Fig. 1 Anatomical landmarks.

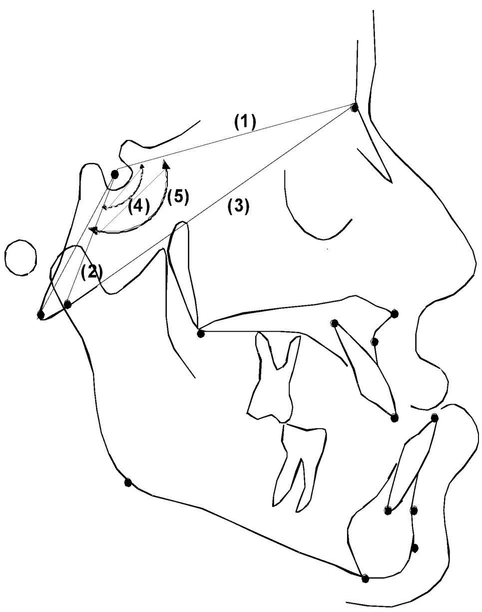

Fig. 2 Cranial base measurements. See Table 1.

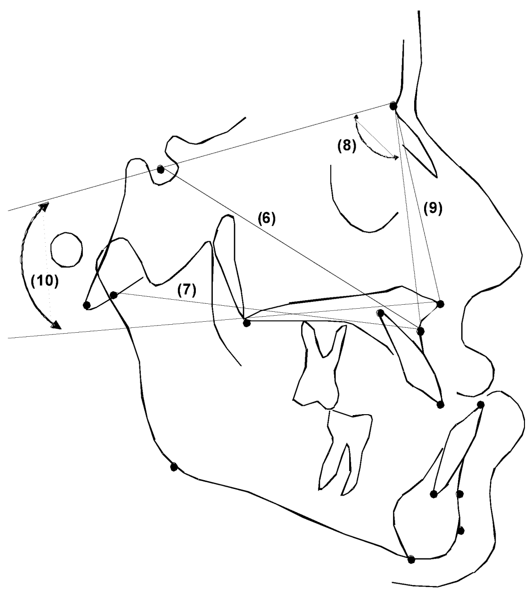

Fig. 3 Maxillary skeletal measurements. See Table 1.

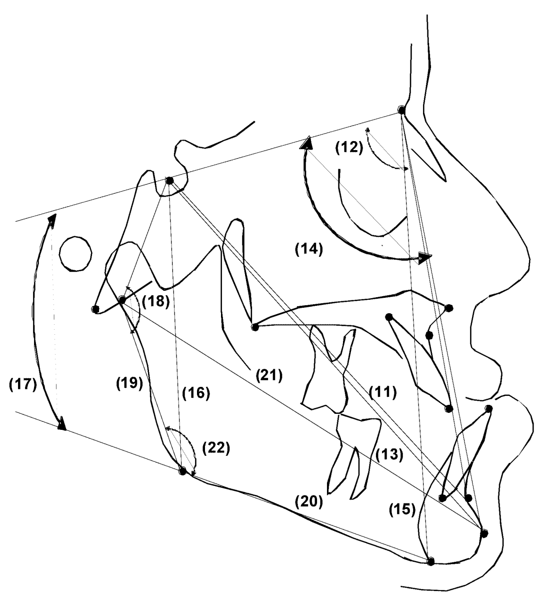

Fig. 4 Mandibular skeletal measurements. See Table 1.

Cephalometric radiographs

Cephalometric lateral skull radiographs were taken as follows: each subject stood with the head in a natural position. The head was fixed by fitting the ear rods of the cephalostat in the external auditory meatus. Teeth were held in centric occlusion. The lips were in rest position. Trained technicians took all radiographs. Each cephalometric radiograph was hand traced using a hard pencil (4H) on acetate paper. From each tracing, 15 landmarks were allocated and digitized on a light back-up digitizer linked to a computer.

Landmarks

The following landmarks were identified on each cephalogram (Fig. 1). Sella turcica (S), nasion (N), basion (Ba), articulare (Ar), anterior nasal spine (ANS), posterior nasal spine (PNS), upper incisal edge (UIE), upper incisal apex (UIA), point A (A), lower incisal edge (LIE), lower incisal apex (LIA), point B (B), pogonion (Pog), menton (Me), gonion (Go).

Cephalometric measurements

Cranial base measurements (Fig. 2), maxillary skeletal measurements (Fig. 3), mandibular skeletal measurements (Fig. 4), and intermaxillary and dentoalveolar measurements (Fig. 5) were obtained from the above anatomical landmarks (see Table 1).

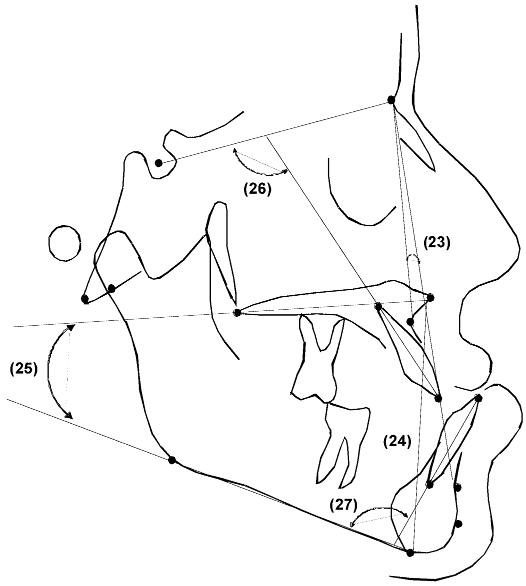

Fig. 5 Intermaxillary and dentoalveolar measurements. See Table 1.

Table 1 Statistical comparison between adult Saudi and Japanese females with class III malocclusion

Components	No	Variables	Saudi n = 30		Japanese n = 28		M-diff.	*t*-value	*P*-value	Sig. Level
			Mean	SD	Mean	SD				
Cranial base	1	S-N(mm)	65.78	3.15	62.5	3.10	3.28	5.72	0.000	***
	2	S-Ar(mm)	30.15	3.32	31.4	2.60	-1.25	-2.07	0.048	*
	3	N-Ar(mm)	85.09	5.47	84.1	4.00	0.99	1.01	0.321	NS
	4	N-S-Ar(dg)	119.69	7.67	123.8	5.60	-4.11	-2.93	0.006	*
	5	N-S-Ba(dg)	126.39	4.46	131.6	5.50	-5.21	-4.79	0.000	***
Maxillary	6	S-A(mm)	77.09	3.80	76.8	3.50	0.29	1.02	0.316	NS
	7	Ar-A(mm)	75.88	4.24	76.3	3.70	-0.42	-1.33	0.077	NS
	8	S-N-A(dg)	79.32	4.47	80.1	4.30	-0.78	-0.96	0.354	NS
	9	N-ANS(mm)	50.38	2.58	51.4	3.90	-1.02	-2.17	0.030	*
	10	PP/S-N(dg)	11.63	4.09	10.0	3.50	1.63	2.18	0.037	*
Mandibular	11	S-B(mm)	110.34	5.77	112.2	5.30	-1.86	-1.76	0.088	NS
	12	S-N-B(dg)	83.58	3.8	84.3	4.70	-0.72	-1.04	0.308	NS
	13	S-Pog(mm)	120.94	7.58	125.8	6.40	-4.86	-3.51	0.001	**
	14	S-N-Pog(dg)	84.93	3.64	84.3	4.80	0.63	0.94	0.354	NS
	15	N-Me(mm)	116.02	5.77	120.3	7.50	-4.28	-4.08	0.000	***
	16	S-Go(mm)	69.49	6.52	72.3	4.80	-2.87	-2.42	0.022	*
	17	S-N/Go-Me(dg)	38.85	5.46	40.9	6.10	-2.04	-2.05	0.050	*
	18	S-Ar-Go(dg)	143.61	8.09	139.2	7.30	4.41	2.98	0.006	*
	19	Ar-Go(mm)	44.01	3.86	45.7	4.10	-1.69	-2.40	0.023	*
	20	Go-Pog(mm)	74.27	4.61	76.8	4.80	-2.53	-3.18	0.000	***
	21	Ar-Pog(mm)	107.76	6.23	112.4	5.60	-4.64	-4.07	0.000	***
	22	Ar-Go-Me(dg)	137.28	6.66	137.9	7.10	0.38	0.31	0.755	NS
Intermaxillary	23	A-N-B(dg)	-3.99	3.09	-4.2	2.40	-0.20	-0.36	0.722	NS
	24	ANS-Me(mm)	65.87	5.32	69.2	6.50	-3.33	-3.41	0.002	**
	25	PP/Go-Me(dg)	28.78	6.51	30.8	6.40	-2.02	-1.70	0.082	NS
Dentoalveolar	26	UI/S-N(dg)	108.12	6.26	110.3	6.60	-2.18	-1.91	0.066	NS
	27	LI/Go-Me(dg)	80.06	9.06	75.0	7.40	5.06	3.06	0.005	**

Method errors

The magnification factor of the radiographic image was calculated as follows:

Magnification factor = true measurement ÷ image measurement.

A magnification factor of 0.91 was calculated and entered in the computer to compensate for the magnification of the linear measurements.

Method errors of the study in identifying and locating the anatomical landmarks during tracing and measurements were assessed by Dahlberg's method error (41) and the coefficient of reliability (42), calculated as follows:

$$\text{Dahlberg's method error} = \sqrt{\sum d^2/2n},$$

where d was the difference between repeated measurements and n was the number of measurements.

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_ is the total variance of the measurements.

The Dahlberg error was small and acceptable, the values being less than 1 mm for the linear measurement and less than 1 degree for the angular measurements. The coefficient of reliability indicated that the measured variables were highly correlated and the observed values ranged between 0.98 and 0.85.

Statistical analysis of data

The statistical analysis was performed with Statistical Package for the Social Sciences, version 10 (SPSS 10). The significance of differences in mean values between Saudi and Japanese adult females was tested by Student's *t*-test. One asterisk (*) indicates a 5% level of confidence with a p value of ≤ 0.05. Two asterisks (**) indicate a highly significant difference at the 1% level of confidence with a *P* value of ≤ 0.01. Three asterisks (***) indicate a very highly significant difference at the 0.1% level of confidence with a *P* value of ≤ 0.001. A significance level of 5% was used for rejection of the null hypothesis.

Results

The results of the comparisons between the means of the measurements for Saudi and Japanese adult females with class III malocclusion (Table 1) showed that out of 27 variables, 16 comparisons had significant differences.

Cranial base relationships

The anterior cranial base (S-N) was much larger in Saudi adult females than in the Japanese ($P < 0.001$), whereas the posterior cranial base (S-Ar) was notably smaller in Saudi adult females ($P < 0.05$). No major difference was observed in the total cranial base (N-Ar). The cranial base angles (S-N-Ar) and (S-N-Ba) were considerably smaller in the Saudi group compared with the Japanese group ($P < 0.05$ and $P < 0.001$ respectively).

Maxillary skeletal relationships

No significant difference was found in the anteroposterior position of the maxilla between Saudi and Japanese adult females with class III malocclusion evaluated by measuring the S-A, Ar-A, and S-N-A angle. On the other hand, the vertical position of the maxilla measured by the N-ANS and PP/S-N angle was notably different; the Saudi adult females had smaller upper facial height and a larger angle between the palatal plane and the S-N plane ($P < 0.05$).

Mandibular skeletal relationships

No significant difference was observed between the two groups in the anteroposterior position of the mandible measured by S-B and the S-N-B angle. The anteroposterior position of the chin was evaluated by S-Pog and the S-N-Pog angle. However, a considerable difference in the linear parameter ($P < 0.001$) was observed as well as the vertical position of the mandible evaluated by N-Me, S-Go, the S-N/Go-Me angle, and the S-Ar-Go angle. The total anterior facial height (N-Me), the posterior facial height (S- Go) and the mandibular plane angle (S-N/Go-Me angle) in Saudi females were reduced compared to the Japanese ($P < 0.001$, $P < 0.05$ and $P < 0.05$ respectively). Increased joint angle (S-Ar-Go angle) was detected in Saudi females compared with Japanese ($P < 0.05$). The form of the mandible as evaluated by Ar-Go, Go-Pog, and Ar-Pog was smaller in Saudi adult females ($P < 0.05$, $P < 0.001$, and $P < 0.001$, respectively). The gonial angle (Ar-Go-Me angle) did not show any major distinction between Saudi and Japanese adult females with class III malocclusion.

Intermaxillary relationships

The differences in the anteroposterior relationship of the maxilla and the mandible as evaluated by the A-N-B angle between the two groups was not significant, although substantial distinction was observed in the vertical distance between the palatal and mandibular planes as evaluated by ANS-Me and the PP/Go-Me angle. The lower anterior facial height (ANS-Me) and the angle between the palatal plane and mandibular plane (S-N/Go-Me angle) were reduced in Saudi females compared to Japanese ($P < 0.005$ and $P < 0.005$, respectively).

Dentoalveolar relationships

The Saudi females had less retroclined lower incisors than the Japanese ($P < 0.01$).

Discussion

The present study shows that of the 16 significant differences, 12 were small measurements in Saudi adult females with class III malocclusion compared to Japanese. To determine whether these results represent true difference between the two groups, we tested the proposed hypothesis by equally evaluating all comparisons, significant and non-significant.

The Saudi adult females with class III malocclusion had larger anterior cranial base than the Japanese. This is consistent with previous reports (26,27) of reduced anterior cranial base in Japanese females with class III malocclusion compared to Caucasian females with class III malocclusion. Similarly, Far East populations such as the Chinese, Taiwanese and Koreans had reduced anterior cranial bases compared with Caucasians (3,6,30-32). Smaller cranial bases were also found in Saudi adult females with class III malocclusion compared to Saudis with normal occlusion (23). As Arabs are Caucasian (43), the findings of the studies referring to Caucasians can be applied to the Saudi group in our study. Our findings are consistent with Ishii et al. (27) and Kishi (26) who found that Japanese have shorter anterior cranial bases than Caucasians. On the other hand, we found that the posterior cranial base was much smaller in the Saudi group compared to the Japanese group. These findings are in agreement with Masaki (24) who reported that the posterior cranial base was larger in Japanese with class III malocclusion compared to Japanese with normal occlusion. Ngan et al. (30) also found large posterior cranial bases in Chinese with class III malocclusion compared to Caucasians. However, our study differs from Ishii et al. (27) who found no difference between Japanese and Caucasians with class III malocclusion, and contradicted the findings of Baik (31) who reported that the posterior cranial base in Koreans with class III malocclusion is short. The total cranial base was similar in the Saudi and Japanese groups, in agreement with Ishii et al. (27) who found no difference between Japanese and Caucasians with class III malocclusion. The similarity in the length of the total cranial base might result from the different angle between the anterior and posterior cranial base or from differences in the lengths of the anterior and posterior cranial bases. The anterior cranial base was long and the posterior cranial base was short for the Saudi group whereas the opposite was true for the Japanese group. The cranial base angle was noticeably smaller in Saudis compared to Japanese. Singh et al. (3) and Ngan et al. (30) also found that Chinese and Koreans with class III malocclusion were associated with reduced cranial base angle compared to Caucasians. Nevertheless, as mentioned above, these findings disagree with Ishii et al. (27). It is possible that these features represent racial differences in cranial base morphology between Saudis and Japanese.

The anteroposterior position and relationship of the maxilla was similar in both groups. Saudi females with class III malocclusion have a retrognathic maxilla when compared to normal females (23). Far East Asians, including Japanese, have a more retrusive midfacial structure compared with Caucasians (3,25-29). Thus both Saudi and Japanese adult females with class III malocclusion have a similar degree of maxillary retrusiveness. The vertical relationship of the maxilla was significantly different between the groups. Saudi adult females had smaller upper facial height. Other investigators (24,28,29) agree that the Japanese have excessive vertical maxillary growth compared to Caucasians, and hence, Saudis. The angle between the palatal plane and the anterior cranial base in Saudi females indicates a downward tilting of the maxilla. This conflicts with Ishii et al. (27) who found a similar degree of tilting between Japanese and Caucasians. These differences between Saudis and Japanese could indicate ethnic differences between the two groups.

There was no significant difference in the anteroposterior relationship of the mandible between Saudi and Japanese. Several investigators (26-28) found that the Japanese had a small cranial base and a retruded maxilla with large mandible compared to Caucasians. Our study confirmed the similarity in the prognathism of the mandible, and that the Saudi group had smaller sized mandibles than the Japanese. Ishii et al (27) reported a similar finding when comparing Caucasians to Japanese. The vertical relationship of the mandible showed no significant difference. Saudis had smaller lower anterior face height and posterior total face height than the Japanese. This indicates a higher vertical position of the anatomical points Me and Go in relation to the maxilla and sella turcica in the Saudi group. The findings of the present study agree with the previous investigators (24,28,29); the Japanese have excessive vertical growth resulting in lower vertical positions of points Me and Go than Caucasians, including Saudis. The form of the mandible revealed great differences between the Saudi and Japanese groups. The joint angle was large, while the ramus and body of the mandible, and total mandibular length were all small in the Saudi group compared to the Japanese. The disparity our study found in joint angles between the two groups was in conflict with Ishii et al. (27) who found similar joint angles in both Japanese and Caucasians. Ngan et al. (30), however, agreed that there were significant differences in joint angles between Chinese and Caucasians. It is possible that the joint angle may be affected by the difference in cranial base length and the angle described earlier. This angle is formed by the points S-Ar-Go, whereas the cranial base angle is formed by the points N-S-Ar. With a small cranial base and point S fixed, the Ar point is positioned slightly forward resulting in a larger joint angle. The larger anterior cranial base, the smaller cranial base angle and the similar mandibular prognathism described earlier clarified the reason for the smaller sized mandible of the Saudi group compared to the Japanese. With the articulation of the mandible to the posterior cranial base, the small mandible attached to small posterior cranial base, large anterior cranial base and small cranial base angle should come to the same anteroposterior relation to large mandible attached to large posterior cranial base, small anterior cranial base and large cranial base angle (3,27). The gonial angle was similar in both groups, although it was larger in Saudi females with class III malocclusion than in normal Saudi females (23). Japanese and Far East Asians have a larger gonial angle than Caucasians (27). Thus, both Saudi and Japanese adult females with class III malocclusion have a similar degree of obtuseness of the gonial angle. The vertical relation and position of the maxilla and the mandible were appreciably different. The Saudi group had smaller anterior face height and less steep mandibles. Japanese have more vertical growth than Caucasians and the findings of the present study agree with the results of previous investigations (3,24,27,30,31).

The dentoalveolar comparisons indicated that the Saudi group had similar protrusion of upper incisors and less retrusion of mandibular incisors when compared with the Japanese. The inclination of the upper incisors to the cranial base was the only available variable for comparisons. The maxilla had the same degree of prognathism in relation to the cranial base in both groups. It was hypothesized that the soft tissue matrices, particularly labial pressure from circum-oral musculature, influences the angulation of the incisors; lower incisors are affected more than the upper incisors (3,15). With identical maxillary and mandibular prognathism, the angulation of the upper incisors was expected to be parallel in both groups and not affected by the soft tissue. An increased projection of the chin point resulted in more retroclination of the lower incisors in the Japanese group. Nojima et al. (28) also found significant lingual inclination of the lower incisors and chin protrusion.

In conclusion, the craniofacial differences were as follows. Saudi adult females with class III malocclusion compared to Japanese females have: (1) increased anterior cranial base length, (2) decreased posterior cranial base length, (3) smaller cranial base angle, (4) smaller upper, lower, and total anterior and posterior facial heights (5) downward tipping of the maxilla (6) retruded chin, (7) less steep mandibular plane, (8) increased joint angle, (9) smaller ramus, body and total mandibular length, and (10) less retroclined mandibular incisors. Taking these features into account, the null hypothesis “There is no difference between Saudi and Japanese adult females with class III malocclusion” was rejected. Nevertheless, these differences could represent true differences in craniofacial morphology between Saudi and Japanese who are from two different racial groups, or could simply reflect the nature of the samples. Further investigation into this area is required.

Recommendations

Although the present study achieved its aim, there were several shortcomings. Further detailed studies are necessary to evaluate the differences in facial and dental features between Saudi and Japanese adult females using two- and three-dimensional techniques and technology.

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