Original Article

An odontometric study of arch dimensions among Qatari population sample with different malocclusions

ABSTRACT

Background: Arch dimensions are very important to clinicians in orthodontics, pedodontics, prosthodontics, as well as to anthropologist. The dimensions include arch widths, arch length, and intra-alveolar width which assist in establishing proper diagnosis and treatment planning.

Aims: This study aims to determine the arch dimensions in Qatari sample with different malocclusions, compare the results obtained with other previous studies and also compare the result between the different Angle's malocclusions classes.

Materials and Methods: The sample consisted of 90 pairs of pretreatment orthodontic study casts selected from patients attending the orthodontic clinic. The sample was classified into three groups according to Angle's Classification as follows: Class I, Class, II, and Class III malocclusion and each group consisted of 30 pairs. The age range was between 13 and 20 years old. The intercanine width, inter-premolar width, intermolar width, and intra-alveolar width measurements were made in each dental cast using an electronic digital caliper. Independent *t*-test was performed for comparative analysis.

Results: Descriptive statistics were presented for the three Angle's classifications. No significant difference was noted between the maxillary variables in Class I and Class III. Statistically significant difference was noticed in maxillary variables in Class II (intermolar II and inter-premolar I and II). Furthermore, significant differences were revealed in mandibular intermolar I and II, inter-premolar II, and inter-alveolar between Class III and Class I and also between Class III and Class II malocclusions. Class III malocclusion showed wider arch dimensions than that in Class I and Class II.

Conclusions: The result of the present study is important to the orthodontist, pedodontist, and also to the prosthodontist and anthropologist.

Keywords: Angle's classification, arch dimension, inter-alveolar width, intercanine width, intermolar width, inter-premolar width

INTRODUCTION AND REVIEW OF LITERATURE

Arch dimensions are very important to clinicians in orthodontics, prosthodontics, and oral and maxillofacial surgeons, as well as to anthropologist. These arch dimensions include arch widths, arch length, and inter-alveolar width which will be of great help in diagnosis and treatment plan.

Several studies were conducted with different results. AL-Taee[1] carried out study consisted of 56 pairs of study casts with Angle Class I and Class II division 1 malocclusions in AL-Ramadi city. She concluded that the arch widths were smaller in Class II division 1 malocclusion when compared to Class I normal occlusion. However, the mandibular intercanine width and the arch widths were larger in males compared to the females.

Frohlich[2] did study of arch dimensions in 51 children who presented with Angle Class II and normal occlusion. She

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mentioned that the data of her study were collected earlier by Moorrees.[3] The result of the intercanine and intermolar widths of maxillary and mandibular arches revealed no significant difference. However, Sayin and Turkkahraman[4] carried out an investigation of arch dimensions in patients presented with Angle Class II division 1 malocclusion and with Class I ideal occlusion. They found a significantly increased mandibular intercanine width in the Class II division 1 and reported that the maxillary intermolar widths were larger in the normal occlusion sample.

Ahmed *et al*.[5] stated that the maxillary intercanine width was significantly decreased in Class II division 1 and division 2. On the other hand, the maxillary and mandibular intercanine and intermolar widths were increased in Class II division 2 malocclusion.

Bishara *et al*.[6] conducted a study in the maxillary and mandibular dental arch widths and lengths including growth between Class II division 1 malocclusion and normal occlusion. They found no difference in the maxillary and mandibular intercanine width.

Uysal *et al*.[7] performed a study on dental casts of 150 normal occlusion, 106 Class II division 1, and 108 Class II division 2 malocclusions. They observed narrower maxillary inter-premolar width, maxillary canine, premolar and molar alveolar widths, and mandibular premolar and molar alveolar widths when comparing between Class II division 1 malocclusion and normal occlusion. They also observed significantly narrower maxillary inter-premolar width, canine and alveolar widths, and all mandibular alveolar widths were significantly narrower in the Class II division 2 group than in the normal occlusion. Furthermore, the mandibular intercanine and inter-premolar widths were narrower, and the maxillary intermolar width measurement was larger in the Class II division 2 when compared with the Class II division 1. They concluded that the maxillary molar teeth in Class II division 1 malocclusions tend to incline to the buccal to compensate the insufficient alveolar base.

Further, Staley *et al*.[8] conducted a comparative study in arch dimension in patients within a normal occlusion and Class II division 1 dentally and skeletally. They found that the maxillary intermolar width, intercanine width, and inter-alveolar width were significantly greater in the Class I than the Class II, division 1. In normal occlusion, males had significantly larger dimensions than females in five of the six arch width variables, whereas in Class II, division 1, the males had larger dimensions when compared with females; however, the difference was not significant only in the maxillary and mandibular inter-alveolar widths.

Diwan and Elahi[9] measured the intermolar width and intercanine width in 91 adults Filipinos. The results were compared to other reported studies of maxillary arch dimensions for adult Egyptians and Saudis. They found that the Filipinos had narrower intermolar width compared to that of the Egyptians and greater intercanine width than that of Saudis.

Buschang *et al*.[10] performed an investigation in dental arch morphology in untreated adult females had Class I, Class II division 1, and Class II division 2 malocclusions. They observed that females with Class II, division 1 malocclusion had the longest and narrowest arches when compared to the other malocclusion.

In 2002, Walkow and Peck[11] studied maxillary and mandibular dental arch widths of 23 dental casts of patients presented with Class II division 2 malocclusions and compared with control sample. They dental arch form of Class II division 2 was normal with the exception of reduced mandibular intercanine width. Further, they observed that the maxillary and mandibular posterior arch widths of Class II division 2 patients were similar to those of other orthodontic patients.

Varrela[12] reported that the cause of the typical Class II occlusion was due to the deficiency of the transversal growth of the maxilla and also due to the sagittal growth of the mandible. Further, McNamara[13] found that maxillary arch was narrower in patients with Class II division 1 malocclusion, and recommended that expansion was needed during or before orthodontic treatment.

Recently, Adil *et al*.[14] investigated the differences in inter-first premolar, molar width, and arch depth in different malocclusions in 112 dental cast of nonorthodontically treated Pakistani patients with age more than 14 years. Significant differences in inter-first premolar and intermolar width arch between Class I and Class II and in inter-first molar width in Class II and III were observed. They concluded that in Angle's Class III the palate was shallowest and the maxillary inter-first premolar and molar width is the largest in Angle's Class I and Class II, whereas the narrowest arch was in Class II.

Very recently Herzog *et al*.[15] conducted a study on patient presented with Angle's Class I. Thirty-one patients treated with extraction of four first premolars and 31 patient treated without extraction. The maxillary and mandibular intercanine and intermolar widths and perimeters were assessed by digital scanning of their dental cast. They concluded that patients treated with extraction had reduced maxillary and mandibular intermolar and arch perimeter measurements

compared to the nonextraction, and no significant difference was observed in intercanine width in both arches and between the extraction and nonextraction patients.

When searching the literature no research or data was published for the Qatari population. Therefore, the aim of the present investigation was to obtain arch in Angle's Class I, II and III malocclusion and compares the result obtained with previous reports as well as between the different malocclusion Classes.

MATERIALS AND METHODS

Materials

A total of 90pairs of pretreatment orthodontic study models with Angle's Class I, Class II division 1, and Class III malocclusion were selected from orthodontic records. Each malocclusion class consists of 30 study models of participants seeking orthodontic treatment.

Criteria for sample selection

1. All participants should be Qatari national
2. Age ranged from 13 to 20 years
3. Bilateral buccal segment, Class I, II, and III molar relationship
4. Good quality study models without severe crowding, rotations, or Class II restorations
5. Presence of all fully erupted permanent teeth in both arches.

Methods

Measurements were performed on the orthodontic study models using an electronic digital caliper measuring to the nearest 0.01 mm (Mitutoyo U. K.). One operator (Y. D) measured the following parameters on both jaws [Figures 1 and 2]:

1. Maxillary and mandibular intercanine width: Distance between the cusp tips of the right and left permanent canines
2. Maxillary and mandibular inter-premolar width I: Distance between buccal cusp tips of the right and left permanent first premolars
3. Maxillary and mandibular inter-premolar width II: Distance between buccal cusp tips of the right and left permanent second premolars
4. Maxillary and mandibular intermolar width I: Distance between the mesiobuccal cusp tips of the right and left permanent first molars
5. Maxillary and mandibular intermolar width II: Distance between the central fossa of the right and left permanent first molars
6. Maxillary and mandibular inter-alveolar width: Distance between the mucogingival junctions above the mesiobuccal cusp tips of the right and left permanent first molars.

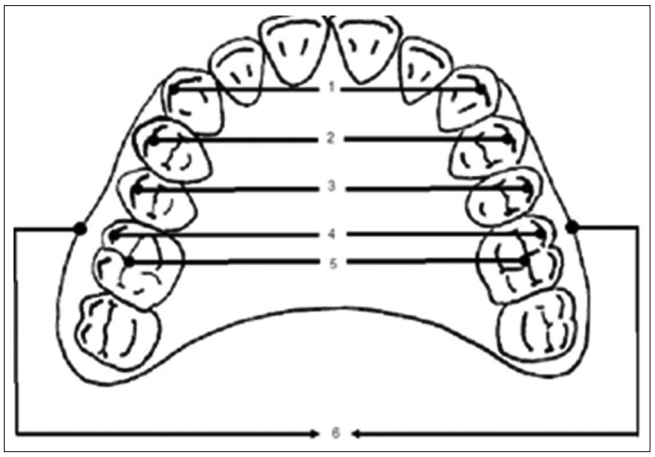

Figure 1: Reference points of maxillary arch width

Statistical analysis

The descriptive statistics were presented for each variable, and independent *t*-test was used for comparison between the different malocclusion classes and previous study results. The level of statistical significance was $P < 0.05$.

Error of the method

A total of 10 pairs of pretreatment study casts were randomly selected measured and remeasured by the same operator with 1-week interval. Independent *t*-test was used for analyzing the error of the method.

RESULTS

Table 1 shows the result of the error of the method. The independent *t*-test result showed no statistically significant differences were observed between the first and second readings for all variables.

Tables 2 and 3 exhibit the mean, standard deviation, standard error, and minimum and maximum values in the maxilla and the mandible for Angle's Class I, Class II, and Class III malocclusions groups.

Table 4 indicates that the maxillary inter-premolar width I and II was very statistically significant in Class I than that of Class II. Intermolar width I and II, intercanine width, and inter-alveolar width showed slightly higher mean values in Class I but no statistically significant difference was reached ($P > 1.000$).

No statistically significant difference was observed in the mandibular arch between Class I and Class II in all variables ($P > 0.05$).

Table 1: Error of the method

	Mean 1st week	Mean 2nd week	*P*	Significance
MAX I.C	33.74	33.725	0.98	N.S
MAX I.PM1	40.65	40.704	0.96	N.S
MAX I.PM2	45.55	45.452	0.94	N.S
MAX I.M1	50.45	50.502	0.96	N.S
MAX I.M2	45.49	45.535	0.96	N.S
MAX I.A	56.15	56.008	0.91	N.S
MAN I.C	27.03	26.976	0.97	N.S
MAN I.PM1	34.79	34.836	0.97	N.S
MAN I.PM2	39.89	39.745	0.93	N.S
MAN I.M1	44.47	44.388	0.94	N.S
MAN I.M2	39.89	40.082	0.77	N.S
MAN I.A	55.51	55.509	1	N.S

MAX: Maxillary, MAN: Mandibular. NS: Not Significant

Table 2: Mean, standard deviation, standard error, minimum value, and maximum value for maxillary arch widths in Class I, II, and III (*n*=30 in each malocclusion group)

Variable	Mean	SD	SE	Minimum value	Maximum value
Intermolar width I					
Class I	50.24	2.47	0.45	45.06	55.86
Class II	49.44	2.38	0.43	45.72	55.17
Class III	50.96	3.92	0.71	42.03	60.65
Intermolar width II					
Class I	45.05	2.14	0.39	40.66	49.43
Class II	44.32	2.36	0.43	40.7	49.69
Class III	45.96	3.36	0.61	39.25	54.68
Intercanine width					
Class I	34.10	3.25	0.59	26.05	39.34
Class II	33.60	2.20	0.40	28.74	37.32
Class III	34.38	2.93	0.53	27.57	39.58
Inter-premolar width I					
Class I	41.50	2.97	0.54	36.57	47.46
Class II	39.51	2.37	0.43	34.09	44.77
Class III	41.73	3.85	0.70	33.46	49.43
Inter-premolar width II					
Class I	45.25	3.17	0.57	40.08	52.5
Class II	43.78	2.10	0.38	39.2	48.2
Class III	46.84	4.07	0.74	37.27	55.19
Inter-alveolar width					
Class I	56.50	2.87	0.52	51.02	62.97
Class II	56.13	2.78	0.50	50	62.47
Class III	56.79	3.71	0.67	49	66.42

SD: Standard deviation, SE: Standard error

Table 5 demonstrates that no statistically significant difference was noticed in the maxillary arch between Class I and Class III in all variables ($P > 0.05$).

Statistically significant differences were observed in the mandibular intermolar width I and II and inter-premolar width II in Class III than that of Class I ($P < 0.05$) and no significant difference was reached in the other variables ($P > 0.05$).

Table 6 shows that there was a statistically significant difference at 5% level of maxillary intermolar width II in Class III than that of Class II. The extremely significant difference was found in inter-premolar width II in Class III, whereas very extremely significant difference was observed in inter-premolar width I in Class III than that of Class II.

The very statistically significant difference was noticed in the mandibular intermolar width I and inter-premolar width II in Class III than that of Class II. Inter-alveolar width was statistically significant at 1% level in Class III compared to Class II.

NB: Tables 7-9 comparison results were interpreted in the discussion section to help the reader, instead of looking for the article of Asiry and Hashim 2012 study in Saudis.

DISCUSSION

When searching the literature, it shows that different arch dimensions were observed between the different races. This leads to establishing diagnostic mean values for each race which will be of great value in diagnosis and treatment plan. Therefore, the aim of the present study was to establish arch dimensions in Qatari sample with Angle's Class I, Class II, and Class III malocclusion and to compare the results between the different Angle's Classes.

The age range of the participants in the present study was between 13 and 20 years of age. This is because it was reported by several investigators that little or no change occurred in the intercanine and intermolar widths after the age of 13 years in females and 16 years in males[3,16] The same observation was confirmed by Bishara *et al*.[17] Therefore, it was considered that the arch dimensions of the selected sample in the present study were stable.

The measurements in the present study were made directly on the study cast by one operator using an electronic digital caliper (Mitutoyo, U. K.). However, other investigators used different methods and devices; among those were Schirmer and Wiltshire[18] and Champagne[19] where the measurements were done manually on dental casts compared with those made on digitized casts obtained from a photocopier. They stated that the method and device produce the most accurate and reproducible measurements. Further, Bhatia and Harrison[20] used the traveling microscope and declaring that the method was more precise than some alternatives. Further, Mårtensson and Rydén[21] utilize a holographic system, and also consider it more precise than previous methods with the advantage of

saving storage space. However, the method used in the present study was simple, easy, precise, and more practical.

Table 3: Mean, standard deviation, standard error, minimum value, and maximum value for mandibular arch widths in Class I, II, and III ($n=30$ in each malocclusion group)

Variable	Mean	SD	SE	Minimum value	Maximum value
Intermolar width I					
Class I	44.64	2.59	0.47	37.65	50.74
Class II	44.20	2.74	0.50	39.87	51.55
Class III	46.68	4.16	0.76	37.71	57.61
Intermolar width II					
Class I	40.60	2.50	0.45	34.67	46.9
Class II	41.28	7.07	1.29	35.88	76.06
Class III	42.24	3.42	0.62	35.62	50.46
Intercanine width					
Class I	26.86	1.91	0.34	22.35	30.45
Class II	26.59	2.14	0.39	20.62	30.28
Class III	27.01	2.60	0.47	18.48	32.1
Inter-premolar width					
Class I	34.40	2.56	0.46	28.64	39.49
Class II	34.23	2.11	0.38	29.72	29.72
Class III	35.20	3.19	0.58	25.54	40.55
Inter-premolar width II					
Class I	39.38	2.69	0.49	32.79	44.46
Class II	38.79	2.61	0.47	34.75	45.29
Class III	35.20	3.19	0.58	25.54	40.55
Inter-alveolar width					
Class I	56.21	2.51	0.45	52.18	63.14
Class II	54.92	2.87	0.52	49.41	62.45
Class III	41.2	4.14	0.75	30.88	49.43

SD: Standard deviation, SE: Standard error

In the present study, very statistical significant differences were found between Class I and Class II and between Class II and Class III in inter-premolar width I in the maxillary arch and intermolar width I, inter-premolar II and inter-alveolar width in the mandibular arch. On the other hand, an extremely significant difference was observed in maxillary inter-premolar II when comparing Class II and Class III.

Further, in the present study, significant differences were observed between the Angle's malocclusion classes. The maxillary arch widths were narrower in Class II and wider in Class III. This finding in agreement with the result obtained by Ahmed *et al*.[5] Moreover, several studies on arch dimensions in different races reported differences in arch

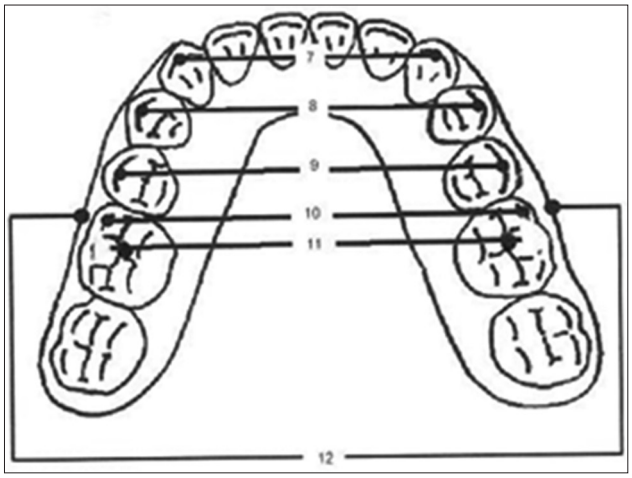

Figure 2: Reference points of mandibular arch width

Table 4: Comparison between Class I and Class II arch width of the present study

Variable	Class I		Class II		*P*	Comment
	Mean	SD	Mean	SD		
Intermolar width I						
Maxillary	50.24	2.47	49.44	2.38	0.210	NS
Mandible	44.64	2.59	44.20	2.74	0.527	NS
Intermolar width II						
Maxillary	45.05	2.14	44.32	2.36	0.212	NS
Mandible	40.60	2.50	41.28	7.07	0.620	NS
Intercanine width						
Maxillary	34.10	3.25	33.60	2.20	0.489	NS
Mandible	26.86	1.91	26.59	2.14	0.606	NS
Inter-premolar width I						
Maxillary	41.50	2.97	39.51	2.37	0.005	Very statistically significant
Mandible	34.40	2.56	34.23	2.11	0.785	NS
Inter-premolar width II						
Maxillary	45.25	3.17	43.78	2.10	0.039	Statistically significant
Mandible	39.38	2.69	38.79	2.61	0.397	NS
Inter-alveolar width						
Maxillary	56.50	2.87	56.13	2.78	0.617	NS
Mandible	56.21	2.51	54.92	2.87	0.069	Not quite statistically significant

SD: Standard deviation, NS: Not significant

Table 5: Comparison between Class I and Class III arch width of the present study

Variable	Class I		Class III		*P*	Comment
	Mean	SD	Mean	SD		
Intermolar width I						
Maxillary	50.24	2.47	50.96	3.92	0.398	NS
Mandible	44.64	2.59	46.68	4.16	0.026	Statistically significant
Intermolar width II						
Maxillary	45.05	2.14	45.96	3.36	0.218	NS
Mandible	40.60	2.50	42.24	3.42	0.038	Statistically significant
Intercanine width						
Maxillary	34.10	3.25	34.38	2.93	0.728	NS
Mandible	26.86	1.91	27.01	2.60	0.797	NS
Inter-premolar width I						
Maxillary	41.50	2.97	41.73	3.85	0.802	NS
Mandible	34.40	2.56	35.20	3.19	0.288	NS
Inter-premolar width II						
Maxillary	45.25	3.17	46.84	4.07	0.097	Not quite statistically significant
Mandible	39.38	2.69	41.2	4.14	0.045	Statistically significant
Inter-alveolar width						
Maxillary	56.50	2.87	56.79	3.71	0.733	NS
Mandible	56.21	2.51	57.08	3.39	0.266	NS

SD: Standard deviation, NS: Not significant

Table 6: Comparison between Class II and Class III malocclusion arch width of the present study

Variable	Class II		Class III		*P*	Comment
	Mean	SD	Mean	SD		
Intermolar width I						
Maxillary	49.44	2.38	50.96	3.92	0.077	Not quite statistically significant
Mandible	44.20	2.74	46.68	4.16	0.008	Very statistically significant
Intermolar width II						
Maxillary	44.32	2.36	45.96	3.36	0.033	Statistically significant
Mandible	41.28	7.07	42.24	3.42	0.505	NS
Intercanine width						
Maxillary	33.60	2.20	34.38	2.93	0.251	NS
Mandible	26.59	2.14	27.01	2.60	0.493	NS
Inter-premolar width I						
Maxillary	39.51	2.37	41.73	3.85	0.009	Very statistically significant
Mandible	34.23	2.11	35.20	3.19	0.172	NS
Inter-premolar width II						
Maxillary	43.78	2.10	46.84	4.07	0.0006	Extremely statistically significant
Mandible	38.79	2.61	41.2	4.14	0.008	Very statistically significant
Inter-alveolar width						
Maxillary	56.13	2.78	56.79	3.71	0.439	NS
Mandible	54.92	2.87	57.08	3.39	0.0102	Very statistically significant

SD: Standard deviation, NS: Not significant

dimensions between British and Nigerian[22] and between Egyptian and Filipino and Saudis,[9] between Negroid and Caucasian.[23,24] Comparison between these studies is difficult due to the fact that different reference points were used and also due to the differences in criteria of sample selection, methodology, and measuring tools.

Furthermore, the arch widths results of the present study were compared with those obtained in an early study conducted among Saudis with Class I occlusion[25] and Class II.[26] The results show that no significant difference was exhibited in the maxillary intermolar width II which was relatively smaller in Qatari than that of the Saudis with Class I malocclusion.[25] A similar result was noticed in mandibular intermolar width II, whereas the mandibular intercanine width was significantly greater in Qatari ($P < 0.05$) [Table 7]. The same observation was reported by Staley *et al*.[8]

Table 7: Comparison between Class I arch width of the present study result and Class I arch width of Moshabab and Hashim 2012 study among Saudis

Variable	Class I				*P*	Comment
	Present study mean	Present study SD	Saudis mean	Saudis SD		
Intermolar width II						
Maxillary	45.05	2.14	46.4	2.62	0.452	Not statistically significant
Mandible	40.60	2.50	40.6	2.68	1.000	Not statistically significant
Intercanine width						
Maxillary	34.10	3.25	33.8	2.28	0.605	Not statistically significant
Mandible	26.86	1.91	25.9	1.86	0.022	Statistically significant

SD: Standard deviation

Table 8: Comparison between arch width of the present study Class I and Class II arch width of Moshabab and Hashim 2012 study among Saudis

Variable	Class I		Class II		*P*	Comment
	Present study mean	Present study SD	Saudis mean	Saudis SD		
Intermolar width II						
Maxillary	45.05	2.14	44.85	2.84	0.734	NS
Mandible	40.60	2.50	40.41	3.53	0.792	NS
Intercanine width						
Maxillary	34.10	3.25	33.41	2.28	0.245	NS
Mandible	26.86	1.91	26.26	1.72	0.136	NS

SD: Standard deviation, NS: Not significant

Table 9: Comparison between Class II malocclusion of the present study and Moshabab and Hashim (2012) study among Saudis

Variable	Mean Qatari	SD	Mean Saudi	SD	*P*	Comment
Intermolar width I						
Maxillary	49.44	2.38	49.63	3.07	0.767	NS
Mandible	44.20	2.74	43.99	2.69	0.729	NS
Intermolar width II						
Maxillary	44.32	2.36	44.85	2.84	0.380	NS
Mandible	41.28	7.07	40.41	2.53	0.395	NS
Intercanine width						
Maxillary	33.60	2.20	33.41	2.28	0.707	NS
Mandible	26.59	2.14	26.26	1.72	0.431	NS
Inter-premolar width I						
Maxillary	39.51	2.37	40.08	2.69	0.327	NS
Mandible	34.23	2.11	34.29	2.78	0.917	NS
Inter-premolar width II						
Maxillary	43.78	2.10	44.81	2.96	0.092	NS
Mandible	38.79	2.61	39.45	2.54	0.252	NS
Inter-alveolar width in						
Maxillary	56.13	2.78	56.70	3.40	0.429	NS
Mandible	54.92	2.87	55.82	2.63	0.141	NS

SD: Standard deviation, NS: Not significant

Moreover, the comparison between Class I and Class II indicated that the maxillary intermolar width II and intercanine width in Qatari were relatively greater than that of the Saudis. On the other hand, the mandibular intermolar width II and the intercanine width were almost similar. Hence, no statistically significant was noticed in the maxilla and the mandible [Tables 8]. This finding was in line with the result of Frohlich.[2] On the other hand, Staley *et al*.[8] found both Class II malocclusion and Class I occlusion patients had similar mandibular intercanine widths. The same result was reported by Asiry and Hashim[26] and also by Adil *et al*.[14] However, the findings of Sayin and Turkkahraman[4] were in agreement with Adil *et al*.[14] in a study carried out among Pakistani patients and in disagreement with the present study results. When the result of Class II malocclusion of the present study were compared with the result of Class II malocclusion in a study carried out among Saudis by Asiry and Hashim;[26]

no statistically significant differences were found in all variables [Table 9].

The outcome of these arch dimensions studies let many manufacturers introduce ready-made stock impression trays and maxillary and mandibular archwires to maintain the mandibular and maxillary relationship and to avoid treatment relapse during the retention period. The result of the present study is invaluable to the orthodontist and pedodontist as well as to the prosthodontist and anthropologist. However, the large sample size is recommended to draw strong and firm conclusions.

CONCLUSION

The result of the present study is invaluable to the orthodontist and pedodontist as well as to the prosthodontist and anthropologist. However, large sample size is recommended in order to draw strong and firm conclusions.

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Nil.

Conflicts of interest
There are no conflicts of interest.

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