

# Arch widths in Saudi subjects with Class II, Division 1 malocclusion

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## Abstract:

**Objectives:** To measure arch widths in Saudi subjects with Class II, Division 1 malocclusion and to compare arch widths between normal occlusion and Class II, Division 1 malocclusion in Saudi subjects. **Methods:** The current study consisted of study models of sixty subjects (30 males and 30 females), aged 13 to 20 years. All subjects had Class II, Division 1 malocclusion. An electronic digital caliper was used to measure the arch widths. **Results:** The result showed that the means of the maxillary intermolar width I, the maxillary intermolar width II, and the maxillary intercanine width were  $49.63 \pm 3.07$ ,  $44.85 \pm 2.84$ , and  $33.41 \pm 2.28$  respectively. The means of the mandibular intermolar width I, the mandibular intermolar width II, and the mandibular intercanine width were  $43.99 \pm 2.69$ ,  $40.41 \pm 2.53$ , and  $26.26 \pm 1.72$  respectively. The arch widths were larger in males than that of females. The results also showed that the arch widths were slightly smaller in Class II, Division 1 malocclusion compared to Class I normal occlusion. Significant difference was observed only in the maxillary intermolar width II. **Conclusion:** The arch widths were larger in males than that of females and smaller in Class II, Division 1 malocclusion compared to Class I normal occlusion.

**Key words:** Dental arch, class II malocclusion, arch width.

## Introduction:

Clinical examination of patients with Class II, Division 1 malocclusions often reveals a transverse discrepancy

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between the dental arches generally attributed to a reduction in maxillary arch width.<sup>[1]</sup> Several studies investigated the arch width and found the width of the dental arches in subjects with Class II, Division 1 malocclusions to be either normal or narrower than the corresponding widths of normal subjects.<sup>[2-5]</sup>

Knowledge of arch width and tooth size ratio that is associated with Class II, Division 1 malocclusion would be helpful in determining orthodontic treatment goals and likely post-treatment sequelae for this malocclusion. Review of the literature reveals that variations in arch widths exist between different racial and malocclusal groups. Therefore different diagnostic standards should be established for each group separately. The aims of the present study were to measure arch widths in Saudi subjects with Class II, Division 1 malocclusion and to compare arch widths between normal occlusion and Class II, Division 1 malocclusion in Saudi subjects.

#### **Materials and methods:**

Sixty pairs of pretreatment orthodontic study models with Class II, Division 1 malocclusion were selected from orthodontic records of subjects (30 males and 30 female) seeking orthodontic treatment at the College of Dentistry, King Saud University, Riyadh, SA.

#### **Criteria for sample selection:**

1. All subjects were Saudis.
2. Age ranged from 13 to 20 years.
3. Bilateral Class II molar relationship.
4. Protrusive maxillary incisors and overjet (Horizontal overlap) more than 5 mm.
5. Good quality study models
6. No restorative treatments other than Class I restorations.
7. Presence of fully erupted permanent teeth from the right first molar to the left first molar of the maxillary and mandibular arch.
8. Minimal crowding and absence of severely rotated tooth.

Measurements were made directly on the orthodontic study models. An electronic digital caliper with fine tips measuring within 0.01 mm (Mitutoyo,<sup>®</sup> U.K.) was used by one operator to

measure the following parameters on the maxillary and mandibular study models:

1. Maxillary intercanine width: Distance between the cusp tips of the maxillary right and left permanent canines.
2. Maxillary interpremolar width I: Distance between buccal cusp tips of the maxillary right and left permanent first premolars.
3. Maxillary interpremolar width II: Distance between buccal cusp tips of the maxillary right and left permanent second premolars.
4. Maxillary intermolar width I: Distance between the mesiobuccal cusp tips of the maxillary right and left permanent first molars.
5. Maxillary intermolar width II: Distance between the central fossae of the maxillary right and left permanent first molars.
6. Maxillary interalveolar width: Distance between the mucogingival junctions above the mesiobuccal cusp tips of the maxillary right and left permanent first molars.
7. Mandibular intercanine width: Distance between the cusp tips of the mandibular right and left permanent canines.
8. Mandibular interpremolar width I: Distance between buccal cusp tips of the mandibular right and left permanent first premolars.
9. Mandibular interpremolar width II: Distance between buccal cusp tips of the mandibular right and left permanent second premolars.
10. Mandibular intermolar width I: Distance between the mesiobuccal cusp tips of the mandibular right and left permanent first molars.
11. Mandibular intermolar width II: Distance between the central fossae of the mandibular right and left permanent first molars.
12. Mandibular interalveolar width: Distance between the mucogingival junctions below the buccal grooves of the mandibular right and left permanent first molars.
13. Overjet (horizontal overlap): The horizontal distance in millimeter from the labial surface of maxillary central incisor to labial surface of mandibular central incisor along a line parallel to the occlusal plane with teeth in centric occlusion.

**Table I- The errors of the method for arch widths by Dahlberg's method, Pearson's correlation coefficient and the Dependent paired t-test. All measurements are in millimeters (n = 20 models)**

**D.M = Dahlberg's method   r = Pearson's correlation coefficient   P = Level of significance.**

Pairs	D.M	r	t-value	P
Maxillary intermolar width I	0.2	0.98	1.40	>0.05
Maxillary intermolar width II	0.2	0.99	-1.50	>0.05
Maxillary intercanine width	0.14	0.99	1.29	>0.05
Maxillary interpremolar width I	0.15	0.98	0.53	>0.05
Maxillary interpremolar width II	0.14	0.99	0.88	>0.05
Maxillary interalveolar width	0.2	0.99	0.65	>0.05
Mandibular intermolar width I	0.2	0.99	2.02	>0.05
Mandibular intermolar width II	0.14	0.99	1.22	>0.05
Mandibular intercanine width	0.18	0.98	0.11	>0.05
Mandibular interpremolar width I	0.17	0.99	0.92	>0.05
Mandibular interpremolar width II	0.22	0.98	-0.21	>0.05
Mandibular interalveolar width	0.18	0.99	0.14	>0.05

**Table II Mean, standard deviation, standard error of the mean for maxillary arch widths (n = 60).**

Variable	Mean	SD	Standard error of the mean
Intermolar width I	49.63	3.07	0.39
Intermolar width II	44.85	2.84	0.36
Intercanine width	33.41	2.28	0.29
Interpremolar width I	40.08	2.69	0.34
Interpremolar width II	44.81	2.96	0.38
Interalveolar width	56.7	3.4	0.43

**Table III Mean, standard deviation, standard error of the mean for mandibular arch widths (n = 60).**

Variable	Mean	SD	Standard error of the mean
Intermolar width I	43.99	2.69	0.34
Intermolar width II	40.41	2.53	0.32
Intercanine width	26.26	1.72	0.22
Interpremolar width I	34.29	2.78	0.35
Interpremolar width II	39.45	2.54	0.32
Interalveolar width	55.82	2.63	0.34

**Table IV Degree of sexual dimorphism for maxillary arch widths (Male n = 30 and Female n = 30).**

Variable		Males	Females	t-value	P
Intermolar width I	Mean	50.32	48.94	1.777	0.81
	SD	3.44	2.52		NS
Intermolar width II	Mean	45.52	44.18	1.871	0.066
	SD	3.26	2.2		NS
Intercanine Width	Mean	34.18	32.64	2.763	0.008**
	SD	2.53	1.71		
Interpremolar width I	Mean	40.86	39.30	2.329	0.023*
	SD	2.99	2.12		
Interpremolar width II	Mean	45.41	44.22	1.576	0.120
	SD	3.16	2.66		NS
Interalveolar Width	Mean	57.79	55.60	2.618	0.011*
	SD	3.55	2.9		

NS = Not Significant, P<0.05, \*\* P<0.01.

**Table V Degree of sexual dimorphism for mandibular arch widths (Male n = 30 and Female n = 30).**

Variable		Males	Females	t-value	P
Intermolar width I	Mean	44.54	43.43	1.620	0.111
	SD	2.85	2.44		NS
Intermolar width II	Mean	41.05	39.78	1.995	0.051
	SD	2.62	2.3		NS
Intercanine Width	Mean	26.87	25.65	2.898	0.005**
	SD	1.89	1.31		
Interpremolar width I	Mean	34.59	33.98	0.841	0.404
	SD	2.62	2.94		NS
Interpremolar width II	Mean	39.76	39.13	0.952	0.345
	SD	2.69	2.39		NS
Interalveolar Width	Mean	56.71	54.93	2.762	0.008**
	SD	2.65	2.32		

\*\* P<0.01, NS = Not Significant.

**Table VI Comparison of arch widths between Saudis with Class II, Division 1 (present study) and Saudis with Class I normal occlusion.**

		Class I normal	Class II, Div I		
Sample size		65	60	t-value	P
Maxillary intermolar width II	Mean	46.4	44.85	3.174	0.0019**
	SD	2.62	2.84		
Maxillary intercanine width	Mean	33.8	33.41	0.9554	0.3412
	SD	2.28	2.28		NS
Mandibular intermolar width II	Mean	40.6	40.41	0.4068	0.6849
	SD	2.68	2.53		NS
Mandibular intercanine width	Mean	25.9	26.26	1.121	0.2646
	SD	1.86	1.72		NS

\*\*P<0.01, NS = Not Significant.

**Table VII - Comparison of arch widths between the Saudi females (present study) and the Turkish females with Class II, Division 1.**

		Saudi females	Turkish females	t-value	P
Sample size		30	30		
Maxillary intermolar width I	Mean	48.94	50	1.736	0.087 NS
	SD	2.52	2.2		
Maxillary intermolar width II	Mean	44.18	45.5	2.287	0.025*
	SD	2.2	2.27		
Maxillary intercanine width	Mean	32.64	33.56	1.564	0.123 NS
	SD	1.71	2.73		
Maxillary interpremolar width I	Mean	39.30	39.46	0.2667	0.790 NS
	SD	2.12	2.51		
Maxillary interpremolar width II	Mean	44.22	44.32	0.1563	0.876 NS
	S.D	2.66	2.28		
Maxillary interalveolar width	Mean	55.60	56.09	0.7680	0.445 NS
	SD	2.9	1.95		
Mandibular intermolar width I	Mean	43.43	43.7	0.4165	0.678 NS
	SD	2.44	2.58		
Mandibular intercanine width	Mean	25.65	26.8	2.419	0.018*
	SD	1.31	2.25		
Mandibular interpremolar width I	Mean	33.98	34.58	0.8345	0.407 NS
	SD	2.94	2.62		
Mandibular interpremolar width II	Mean	39.13	38.53	0.8854	0.379 NS
	SD	2.39	2.84		
Mandibular interalveolar Width	Mean	54.93	54.49	0.7361	0.464 NS
	SD	2.32	2.31		

\*P < 0.05, NS = Not Significant.

**Table VIII- Comparison between the arch widths of the Saudi males (present study) and the American males with Class II, Division 1.**

		Saudi males	American males	t-value	P
Sample size		30	20		
Maxillary intermolar width I	Mean	50.32	47.3	3.196	0.002**
	SD	3.44	3.0		
Maxillary intercanine Width	Mean	34.18	32.5	2.456	0.017*
	SD	2.53	2.1		
Maxillary interalveolar width	Mean	57.79	55.4	2.503	0.015*
	SD	3.55	2.9		
Mandibular intercanine width	Mean	26.87	25.5	2.454	0.017*
	SD	1.89	2.0		
Mandibular interalveolar width	Mean	56.71	56.3	0.5561	0.580 NS
	SD	2.65	2.4		

\*P < 0.05, \*\*P < 0.01, NS = Not Significant.

**Table IX Comparison between the arch widths of the Saudi females (present study) and the American females with Class II, Division 1.**

		Saudi female	American females	t-value	P
		30	19		
Maxillary intermolar width I	Mean	48.94	46.3	3.802	0.0004***
	SD	2.52	2.1		
Maxillary intercanine Width	Mean	32.64	31.6	1.731	0.09 NS
	SD	1.71	2.5		
Maxillary interalveolar width	Mean	55.60	53.5	2.601	0.0124*
	SD	2.9	2.5		
Mandibular intercanine Width	Mean	25.65	25.1	1.165	0.2497 NS
	SD	1.31	2.0		
Mandibular interalveolar width	Mean	54.93	54.1	1.244	0.2195 NS
	SD	2.32	2.2		

\*P < 0.05, \*\*\*P < 0.001, NS = Not Significant.

This variable was measured with the depth of gauge of the digital caliper.

#### **Statistical analysis:**

The data of the present study were subjected to statistical analysis using a computer program: Statistical Package for the Social Science (SPSS)<sup>®</sup> version 9.0.

The following tests were carried out:

#### **Descriptive statistics:**

The following statistics were calculated for each variable: mean, standard deviation, and standard error of the mean.

**Pearson's correlation coefficient:** used as a method of measuring the interdependence between two variables from the same sample.

**Independent t-test:** used for comparison between the groups.

#### **Assessment of measurement errors:**

Twenty pairs of study models were randomly selected and remeasured by the same examiner with one week interval and compared with the first measurements. Three statistical tests including Dahlberg's method<sup>[6]</sup>, Pearson's correlation coefficient and Dependent paired t-test were used for analyzing the error. Tables I shows

the error of the method for the arch widths measurements.

#### **Results:**

##### **Descriptive statistics:**

Table II and III show the descriptive statistics for the maxillary and the mandibular arch widths.

##### **Sexual dimorphism:**

Tables IV and V exhibit that the arch widths were slightly larger in males than in females. Significant differences were observed in the maxillary and mandibular intercanine widths (P < 0.01), mandibular interalveolar width (P < 0.01), maxillary interalveolar width (P < 0.05) and maxillary interpremolar width I (P < 0.05).

##### **Comparison between arch widths of the present study with Class I normal occlusion:**

Table VI indicates that the maxillary intermolar width II was significantly smaller in Saudi subjects with Class II, Division 1 than that of Class I normal occlusion in early study on Saudis.<sup>[7]</sup> Class I normal occlusion showed a slightly higher mean values for maxillary intercanine width and mandibular intermolar width II but no significant difference was reached (P >

0.05). On the other hand, the mandibular intercanine width exhibited higher mean value in Class II, Division 1 with no statistical significant difference ( $P > 0.05$ ).

#### **Comparison between arch widths of the present study and the Turkish females with Class II, Division 1:**

Table VII shows that the Saudi females had lower mean values in arch widths than those of Turkish females with Class II, Division 1 in the study done by Sayin and Turkkahraman<sup>[5]</sup>, except for the mandibular interalveolar width and the mandibular interpremolar width II. The Saudi females had significantly lower mean values for the maxillary intermolar width II and the mandibular intercanine width than the Turkish females ( $P < 0.05$ ).

#### **Comparison between arch width of Saudis (present study) and American Whites with Class II, Division 1:**

Table VIII reveals that all arch width measurements were greater in the Saudi males than that of the American males with Class II, Division 1 in the study done by Staley et al<sup>[3]</sup>. All variables showed statistical significant differences with the exception of the mandibular interalveolar width. Similarly, all arch width measurements were greater in the Saudi females than in the American females with Class II, Division 1. Significant differences were observed only in the maxillary intermolar width I and the maxillary interalveolar width (Table IX).

#### **Discussion:**

The age range of the subjects in the present study was between 13 to 20 years of age. Researchers, who studied growth changes in arch width, found that little or no change occurred in the intercanine and the intermolar widths after the age of thirteen years in females and sixteen years in males<sup>[8-10]</sup>. Bishara<sup>[11]</sup> also pointed out that limited changes in arch width occurs between 13 and 25 years of age. Therefore, it was assumed that the arch width of the subjects selected in the present study were stable.

The measurements in the present study were made directly on study models by one operator using an electronic digital caliper (Mitutoyo, U.K.) with fine tips measuring within 0.01 mm. However, other investigators used different methods and devices. Schirmer and Wiltshire<sup>[12]</sup> and Champagne<sup>[13]</sup> compared measurements made manually on casts with those made on digitized casts obtained from a photocopier. They concluded that, although photocopies are easy to handle, manually measuring teeth with a calibrated gauge produced the most accurate and reproducible measurements. On the other hand, Bhatia and Harrison<sup>[14]</sup> studied the performance of the traveling microscope; an apparatus modified to measure dental casts, and found that the method was more precise than some alternatives. Further, Martensson and Ryden<sup>[15]</sup> investigated a holographic system for measuring dental casts. The method was shown to be more precise than previous methods, and the authors believed that it would also save storage space. However, although the microscope and holographic systems had some advantages, they did not prove to be practical in clinical practice, and they never became popular.<sup>[16]</sup> The method used in the present study was found to be easy, precise, and more practical.

The results of the present study showed that the arch widths were slightly larger in the male subjects than that of the female subjects. This finding is in agreement with the results obtained by Staley et al<sup>[3]</sup>, Burris and Harris<sup>[17]</sup>, and Tamimi and Hashim<sup>[7]</sup>. On the basis of the present study, significant differences were observed only in the maxillary and the mandibular intercanine widths, the mandibular and the maxillary interalveolar widths, and the maxillary interpremolar width I.

The arch widths of the present study were compared with those of American White subjects<sup>[3]</sup> and Turkish subjects<sup>[5]</sup> with Class II, Division 1 malocclusion. Some arch width measurements could not be compared to arch width measurements published in these studies because they did not use the same reference points of the measurements. The mandibular intermolar width of American



White subjects<sup>[3]</sup> and the mandibular intermolar width II of Turkish subjects<sup>[5]</sup> were measured according to reference points differed from those used in the present study. Hence, meaningful comparisons are not always possible and firm conclusions are difficult to draw.

When comparing the results of the arch width in the Saudi females with those of the Turkish females, the arch width in the Saudi females were slightly smaller than those of the Turkish females, with the exception of mandibular interalveolar width and mandibular interpremolar width II (Table VII). Further, the results showed that all arch width measurements were greater in the Saudi males and females than those of the American males and females (Tables VIII & IX).

Several studies on the arch width in different racial groups with different occlusal categories reported racial difference in arch width measurements between British and Nigerian<sup>[18]</sup>, between Egyptian, Philippino, and Saudi<sup>[19]</sup>, and between American black and American white.<sup>[17,20]</sup> Comparison between these studies is difficult due to differences in criteria of sample selection, method, and measuring devices.

The arch widths of the present study were compared with those obtained in an early study on Saudis with Class I normal occlusion.<sup>[7]</sup> The results showed that the maxillary intermolar width II was significantly smaller in Class II, Division 1 than Class I normal occlusion (Table VI). This finding is in agreement with Staley et al<sup>[3]</sup>, Bishara et al<sup>[4]</sup>, and Sayin & Turkkaharaman<sup>[5]</sup>. On the other hand, this result was not in line with the results reported by Bishara et al<sup>[4]</sup> who found no significant difference in the female subjects when comparing the intermolar width, and also with the observation of Fröhlich<sup>[2]</sup> who found no significant difference in the intermolar width between normal and Class II subjects.

The present study also showed that the mean values for the maxillary intercanine width and the mandibular intermolar width were slightly greater in Class I normal occlusion subjects, but these differences were not significant (Table VI). The same was reported by Staley et al<sup>[3]</sup> and Sayin

& Turkkaharaman<sup>[5]</sup>. On the other hand, the mandibular intercanine width was slightly larger in Class II, Division 1 than that in Class I normal occlusion but not statistically significant (Table VI). This finding is in agreement with Sayin & Turkkaharaman<sup>[5]</sup>, but in disagreement with Staley et al<sup>[3]</sup> who reported that both Class II malocclusion subjects and normal occlusion subjects had similar mandibular intercanine widths.

### Conclusions:

The results of the present study led to the following conclusions:

- 1) The arch widths were larger in males than that of females. Statistically significant differences were observed only in maxillary and mandibular intercanine widths, mandibular and maxillary interalveolar width, and maxillary interpremolar width I.
- 2) The arch widths were slightly smaller in Class II, Division 1 malocclusion compared to Class I normal occlusion. Significant difference was observed only in the maxillary intermolar width II.

### Recommendations:

Although the objectives of the present study were achieved, further work is needed on a larger sample size from different parts of the kingdom in order to:

1. Determine whether the narrow maxillary arch width in Class II, Division I malocclusion is due to palatal movement of maxillary posterior teeth, narrow bony bases, or both.
2. Compare arch widths between different malocclusal categories.

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