Original Article

Arch Widths in Class II-2 Adults Compared to Adults with Class II-1 and Normal Occlusion

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ABSTRACT

Objective: To compare (1) arch widths in adults with Class II division 2 (II-2), Class II division 1 (II-1), and Class I normal occlusions, (2) genders, (3) gender dimorphism, (4) differences between maxillary and mandibular arch widths, and to (5) develop adult norms for arch widths.

Materials and Methods: Subjects were white Americans with no history of orthodontic treatment. Arch width dimensions measured were: intercanine, intermolar, and molar alveolar in both arches. Analysis of variance (ANOVA) and Duncan's test were used to compare groups.

Results: Comparison of pooled genders showed the II-2 group had maxillary arch widths significantly smaller than the normal occlusions and significantly larger than the II-1 group. All groups had similar mandibular intercanine and alveolar widths. The II-2 and II-1 groups had similar mandibular intermolar widths, both significantly smaller than normal occlusions. The II-2 group had a maxillary/mandibular intermolar difference significantly smaller than the normal occlusions, and significantly less negative than the II-1 group. Gender comparisons in two of six widths showed normal and II-2 male subjects were similar, and in six of six widths normal and II-2 female subjects were similar; in five of six widths II-2 and II-1 male and female subjects were similar. Gender dimorphism occurred in five of six widths in normal occlusions, four of six widths in II-2, and one of six widths in II-1.

Conclusions: Arch width dimensions of II-2 subjects were intermediate between normal and II-1 occlusions. In both Class II malocclusions, the process that narrows arch widths was more pronounced in male than in female subjects.

KEY WORDS: Arch widths; Adults; Class II-2; Class II-1; Class I normal

INTRODUCTION

Tables 1 and 2 summarize results of previous arch width studies; some studies pooled genders and others compared genders. Two gender pooled studies compared arch widths in Class II division 2 (II-2) and normal occlusion adults.[1,2] In the maxilla, both studies reported similar intercanine widths in II-2 and normal occlusions. The studies disagreed on maxillary intermolar widths with II-2 narrower than normal occlusions in one[1] and II-2 similar to normal occlusions in the other.[2] One study[2] reported similar molar alveolar widths in II-2 and normal occlusions. These studies differed in mandibular intercanine and intermolar widths. One found these widths similar in II-2 and normal occlusions[1] while the other found II-2 widths wider than normal occlusions.[2] One study reported II-2 mandibular molar alveolar widths narrower than those of normal occlusions.[2] Three studies reporting widths of II-2 adults did not have normal occlusion control groups for comparison.[3–5]

Four studies compared arch widths in II-2 and normal occlusions in children.[6–9] One study pooled genders[6] and three compared genders separately.[7–9] In the maxilla, two studies agreed that in male subjects normal occlusions had larger intermolar widths than II-2.[7–8] However, in female subjects two studies agreed that normal occlusions and II-2 had similar widths.[8,9] The gender pooled study reported similarity between

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Table 1. Comparison of Arch Width Studies[a]

Widths	Normal vs Class II-2	Class II-2 vs Class II-1	Normal vs Class II-1
Maxilla			
Intercanine	Huth I > II-2 P, ♂ Huth I = II-2 ♀ Herren I = II-2 P Uysal I = II-2 P Fröhlich I = II-2 P	Huth II-2 > II-1 P, ♂ Huth II-2 = II-1 ♀ Fröhlich II-2 > II-1 P Uysal II-2 = II-1 P Al-Khateeb II-2 = II-1 P	Huth I > II-1 P, ♂ Huth I = II-1 ♀ Staley I > II-1 ♂, ♀ Herren I > II-1 P Nie I > II-1 ♂, ♀ Sayin I = II-1 ♀ Uysal I = II-1 P Fröhlich I = II-1 P
Intermolar	Huth I > II-2 P, ♂ Huth I = II-2 ♀ Herren I > II-2 P Uysal I = II-2 P Young I > II-2 ♂, ♀ Fröhlich I = II-2 P Ingervall I > II-2 ♂ Ingervall I = II-2 ♀ Lux I = II-2 ♂, ♀ (13, 15)	Huth II-2 > II-1 P, ♂, ♀ Huth II-2 > II-1 P, ♂, ♀ Al-Khateeb II-2 > II-1 P Young II-2 = II-1 ♂, ♀ Fröhlich II-2 > II-1 P Lux II-2 > II-1 ♂, (13, 15) Lux II-2 = II-1 ♀, (13, 15)	Huth I > II-1 P, ♂, ♀ Herren I > II-1 P Staley I > II-1 ♂, ♀ Sayin I > II-1 ♀ Nie I > II-1 ♂, ♀ Uysal II-1 > I P Young I > II-1 ♂, ♀ Tollaro I > II-1 P Fröhlich I = II-1 P Lux I > II-1 ♂, ♀ (13, 15)
Molar-alveolar	Huth I > II-2 P, ♂ Huth I = II-2 ♀ Uysal I = II-2 P	Huth II-2 > II-1 P Huth II-2 = II-1 ♂, ♀ Uysal II-2 = II-1 P	Huth I > II-1 P, ♂, ♀ Staley I > II-1 ♂, ♀ Sayin I = II-1 ♀ Uysal II-1 > I P
Mandible			
Intercanine	Huth I = II-2 P, ♂, ♀ Herren I = II-2 P Uysal II-2 > I P Fröhlich I = II-2 P	Huth II-2 = II-1 P, ♂, ♀ Al-Khateeb II-2 = II-1 P Uysal II-1 > II-2 P Fröhlich II-2 = II-1 P	Huth I = II-1 P, ♂, ♀ Staley I = II-1 ♂, ♀ Herren I = II-1 P Sayin II-1 > I ♀ Uysal II-1 > I P Fröhlich I = II-1 P
Intermolar	Huth I > II-2 P, ♂, ♀ Herren I = II-2 P Uysal II-2 > I P Young I = II-2 ♂ Young I > II-2 ♀ Ingervall I = II-2 ♂, ♀ Fröhlich I = II-2 P Lux I = II-2 ♂, ♀ (13, 15)	Huth II-2 = II-1 P, ♂, ♀ Uysal II-2 = II-1 P Al-Khateeb II-2 = II-1 P Young II-2 = II-1 ♂, ♀ Lux II-2 = II-1 ♂, ♀ (13, 15) Fröhlich II-2 = II-1 P	Huth I > II-1P, ♂, ♀ Staley I > II-1 ♂ Staley I = II-1 ♀ Herren I > II-1 P Sayin I = II-1 ♀ Uysal II-1 > I P Nie I = II-1 ♂ Nie I > II-1 ♀ Young I > II-1 ♂ (9, 10, 11); ♀ Young I = II-1 ♂ (12, 13) Fröhlich I = II-1 P Tollaro I = II-1 P Lux I = II-1 ♂, ♀ (13, 15)
Molar-alveolar	Huth I = II-2 P, ♂, ♀ Uysal I > II-2 P	Huth II-2 = II-1 P, ♂, ♀ Uysal II-2 = II-1 P	Huth I = II-1 P, ♂, ♀ Staley I > II-1 ♂ Staley I = II-1 ♀ Sayin I = II-1 ♀ Uysal I > II-1 P

[a] P indicates genders pooled; ♂, male, ♀, female; age (years).

occlusion groups.[6] In the mandible, three studies agreed that intermolar widths were similar in the occlusion groups.[6,8,9] The fourth study agreed with the others with respect to male subjects, but not with female subjects.[7]

Two gender pooled studies compared arch widths in II-2 and Class II division 1 (II-1) adults.[2,5] In the maxilla, intercanine[2,5] and molar alveolar[2] widths were similar in the groups. In both studies, intermolar widths were larger in II-2 than in II-1.[2,5] In the mandible, intermolar[2,5] and molar alveolar[2] widths were similar in both malocclusions, but the studies differed in intercanine width comparisons (Table 1).

Three studies compared widths of II-2 and II-1 malocclusions in children, one pooled genders,[6] the others compared genders separately.[7,9] Intermolar comparisons differed in the maxilla, but agreed in the mandible (Table 1).

Table 2. Comparison of Arch Width Studies: Difference Obtained by Subtracting the Mandibular Arch Width From its Corresponding Maxillary Arch Width[a]

Arch Width Difference	Normal vs Class II-2	Class II-2 vs Class II-1	Normal vs Class II-1
Canine	Huth I > II-2 P, ♂ Huth I = II-2 ♀	Huth II-2 = II-1 P, ♂, ♀	Huth I > II-1 P, ♂, ♀ Staley I > II-1 ♂, ♀ Sayin I > II-1 ♀ Bishara I = II-1 ♂, ♀ cross-sectional Bishara I > II-1 ♂ magnitude of longitudinal curves Bishara I = II-1 ♀ magnitude of longitudinal curves
Molar	Huth I > II-2 P, ♂ Huth I = II-2 ♀ Lux I > II-2 ♂, ♀ (13, 15)	Huth II-2 > II-1P, ♂, ♀ Lux II-2 = II-1 ♂, ♀ (13, 15)	Huth I > II-1 P, ♂, ♀ Staley I > II-1 ♂, ♀ Sayin I > II-1 ♀ Bishara I = II-1 ♂, ♀ cross-sectional Bishara I > II-1 ♂ magnitude of longitudinal curves Longitudinal curves Bishara I = II-1 ♀ magnitude of longitudinal curves
Alveolar	Huth I > II-2 P, ♂,♀	Huth II-2 = II-1 P, ♂, ♀	Huth I > II-1 P, ♂, ♀ Staley I > II-1 ♂, ♀ Sayin I = II-1 ♀

[a] P indicates genders pooled; ♂, male; ♀, female; age (years).

One study reported the interarch difference between intermolar widths in II-2 children.[9] The difference in normal occlusions was larger than in II-2 boys and girls (Table 2). Boys and girls with II-2 and II-1 had similar differences.[9] No studies have reported intrarch differences in II-2 adults.

The main purpose of this study was to compare II-2 malocclusions with normal and II-1 occlusions. Because this study includes II-1 subjects, the results of past studies of II-1 malocclusions[1,2,6,7,9–14] are summarized in Tables 1 and 2. The results reported by Tollaro et al[13] were from II-1 children with posterior transverse interarch discrepancy. Bishara et al[14] compared interarch differences in intercanine and intermolar widths cross-sectionally in children and found similarity between II-1 and normal occlusions. In male patients only, longitudinal curves based on interarch differences had a greater magnitude in normal occlusions than in II-1.[14]

One adult study found that normal occlusion male patients had larger arch widths than female patients for five of six arch widths, whereas II-1 male patients had larger widths than female patients for only maxillary and mandibular alveolar widths.[10] No study has reported gender dimorphism in II-2 malocclusions. When comparing Class II and normal occlusions, gender differences appear to be important (Tables 1 and 2). Therefore, both gender and gender pooled comparisons were made in this study.

The objectives of this study were to test four null hypotheses: (1) that there are no differences in the arch widths in adult Class II division 2, Class II division 1, and Class I normal occlusions; (2) that there are no differences in the gender dimorphism in arch widths within the three occlusion groups; (3) that there are no differences in the arch widths between genders of the occlusion groups; and (4) that there are no differences in the interarch width between the maxilla and mandible in the occlusion groups. Another objective was to develop norms for adult arch widths using data from the Class I normal subjects.

MATERIALS AND METHODS

All subjects were white Americans with no history of orthodontic treatment. Records for 113 subjects included plaster casts with fully erupted permanent incisors, canines, premolars, and first molars. Lateral cephalograms were available for all but three Class II division 2 female subjects.

A sample of 41 Class II division 2 subjects, 19 male and 22 female, was selected from the records of patients who were treated in the Department of Orthodontics between 1960 and 1987. The following inclusion criteria were used to select this sample: (1) at least one maxillary central incisor lingually inclined, (2) overjet not more than 5 mm, (3) deep overbite, (4) first molars bilaterally full Class II in centric occlusion, and (5) no teeth in crossbite.

A sample of 38 Class II division 1 subjects, 19 male and 19 female, was selected from the records of patients who were treated in the Department of Orthodontics between 1960 and 1987. The following inclusion criteria were used to select this sample: (1) maxillary incisors labially inclined, (2) overjet greater than 7.5 mm, and (3) first molars bilaterally full Class II in centric occlusion. Four male and two female subjects had posterior crossbites.

Table 3. Ages of Subjects in Years

Occlusion Group	N	Mean	Minimum	Maximum
Class II-2 male	19	23.9	15.8	39.0
Class II-2 female	22	20.3	13.4	33.8
Class II-1 male	19	22.4	15.7	33.8
Class II-1 female	19	18.0	13.5	24.5
Class I normal male	18	20.9	15.9	26.8
Class II normal female	16	16.0	13.0	24.6

A sample of 34 subjects, 18 male and 16 female, with Class I normal occlusion was selected from the Iowa Facial Growth Study.[15] The following inclusion criteria were used to collect this sample: (1) teeth well aligned within the dental arches with less than 3 mm of crowding or spacing, (2) overjet not more than 4 mm (3) first molars bilaterally Class I in centric occlusion, and (4) no teeth in crossbite.

The minimum age of the subjects chosen for this study was based on earlier evidence reporting no significant change in first molar and canine arch widths after age 13 in girls and age 16 in boys.[16–20] Ages are listed in Table 3.

Six arch width measurements were taken with dial calipers on the dental casts of each subject: (1) maxillary intercanine width between the cusp tips, (2) maxillary intermolar width between the tips of the mesiobuccal cusps of the first molars, (3) maxillary alveolar width at the mucogingival junctions above the mesiobuccal cusp tips of the first molars, (4) mandibular alveolar width at the mucogingival junctions below the buccal grooves of the first molars, (5) mandibular intermolar width between points on the main buccal grooves located vertically at the middle of the buccal surfaces of the first molars, and (6) mandibular intercanine width between the cusp tips (Figure 1).

Arch widths were measured with a dial calipers to the nearest 0.05 mm (Helios, Germany). Two measurements were taken at separate times for each variable measured. The intra-examiner correlations between first and second measurements for the six variables ranged from $r = .96$ to $r = .99$. The average of the first and second measurements was used for data analysis. Interexaminer correlations averaged $r = .94$.

Descriptive statistics were computed. A general linear model procedure analysis of variance (ANOVA) was used to compare occlusion group and gender differences. Duncan's multiple range test was used to further compare occlusion and gender groups. Statistical significance was set at $\leq .05$.

RESULTS

Arch Widths in Maxilla

With genders pooled, the three occlusion groups fell into three significantly different (ANOVA $P \leq .0001$) groups for intercanine, intermolar, and molar alveolar widths (Table 4). For all widths, the II-2 group was between normal and II-1.

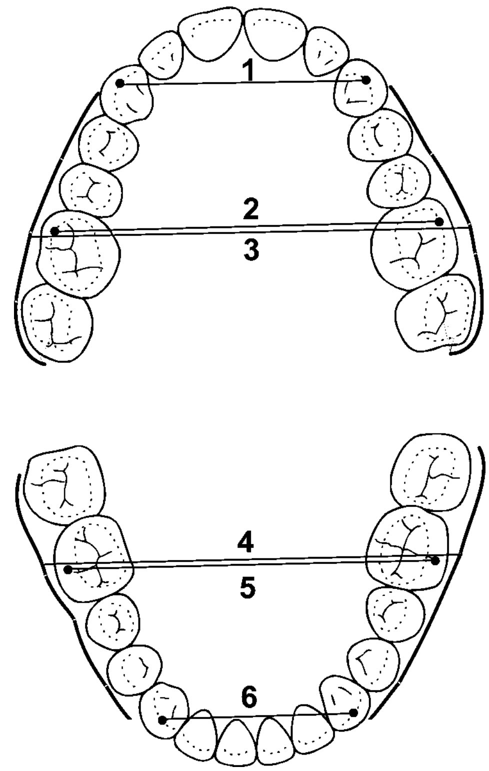

Figure 1. Measurement of arch widths: (1) maxillary intercanine, (2) maxillary intermolar, (3) maxillary alveolar, (4) mandibular alveolar, (5) mandibular intermolar, and (6) mandibular intercanine.

An ANOVA showed significant ($P \leq .0001$) gender dimorphism and gender differences between occlusion groups (Tables 4 and 5). Gender dimorphism occurred in normal occlusions in all three widths and in II-2 occlusions for intermolar and alveolar widths. Gender differences are summarized. In male subjects, intercanine and alveolar widths were: I > II-2, II-2 = II-1, I > II-1; and intermolar widths were: I > II-2, II-2 > II-1, I > II-1. In female subjects, intercanine widths were: I = II-2, II-2 = II-1, I = II-2; intermolar widths were: I = II-2, II-2 > II-1, I > II-1, and alveolar widths were: I = II-2, II-2 = II-1, I > II-1.

Arch Widths in Mandible

With genders pooled, the II-2 and II-1 groups had similar mean intermolar widths, both significantly (ANOVA $P \leq .04$) smaller than the normal occlusions (Table 4). No differences were observed between the occlusion groups for intercanine and alveolar widths (Table 5).

The ANOVA showed significant ($P \leq .0001$) gender dimorphism and gender differences between occlusion groups for intermolar and alveolar widths (Tables 4

Table 4. Comparison of Arch Widths in Class II-2 and Class II-1 Malocclusions and Normal Occlusions (Genders Pooled)

Variable	F Value	P < Fa	Duncan's[b] Letter	Mean ± SD, mm	N	Group	Gender[c] Dimorphism
Maxilla							
Intercanine width	11.91	.0001	A	34.7 ± 2.4	34	Normal occlusion	M > F
			B	32.9 ± 2.3	41	II-2	No
			C	32.1 ± 2.3	38	II-1	No
Intermolar width	34.43	.0001	A	52.4 ± 3.1	34	Normal occlusion	M > F
			B	49.2 ± 2.9	41	II-2	M > F
			C	46.8 ± 2.7	38	II-1	No
Alveolar width	21.37	.0001	A	59.2 ± 3.7	34	Normal occlusion	M > F
			B	55.8 ± 3.0	41	II-2	M > F
			C	54.4 ± 2.8	38	II-1	No
Mandible							
Intercanine width	0.44	.64	A	25.8 ± 1.7	34	Normal occlusion	No
			A	25.5 ± 1.8	41	II-2	No
			A	25.3 ± 2.0	38	II-1	No
Intermolar width	3.36	.0382	A	51.0 ± 2.7	34	Normal occlusion	M > F
			B	49.6 ± 2.8	41	II-2	M > F
			B	49.4 ± 2.9	38	II-1	No
Alveolar width	1.19	.31	A	56.1 ± 2.7	34	Normal occlusion	M > F
			A	55.5 ± 2.7	41	II-2	M > F
			A	55.2 ± 2.5	38	II-1	M > F

[a] Probability value F test, significance: $P \leq .05$.
[b] Significant differences: $P \leq .05$, groups with same letter do not differ.
[c] Significant differences: $P \leq .05$, Duncan's test.
N = 113

and 5). No gender dimorphism or gender differences occurred in intercanine width. Dimorphisms occurred in normal and II-2 occlusions in intermolar width and in all three occlusion groups in alveolar width. Gender differences are summarized. In male subjects, intermolar widths were: I > II-2, II-2 = II-1, I > II-1; and alveolar widths were: I = II-2, II-2 = II-1, I > II-1. Female subjects had no gender differences in intermolar and alveolar widths.

Maxillary Minus Mandibular Arch Width Differences

Mandibular arch widths were subtracted from corresponding maxillary arch widths to compare maxillary/mandibular arch width differences. With genders pooled, significant differences (ANOVA $P \leq .0001$) were observed between groups (Table 6). Normal occlusions had significantly larger mean differences than the Class II groups. The II-2 and II-1 groups had similar mean differences for intercanine and alveolar widths. The mean alveolar width difference was positive for the normal and II-2 groups, but negative for the II-1 group. The II-2 group had a negative mean intermolar difference significantly smaller than normal occlusions and significantly larger than II-1.

The ANOVA showed only one gender dimorphism in arch width differences: normal occlusion male subjects had a larger intercanine difference than normal female subjects ($P \leq .0001$).

DISCUSSION

The null hypotheses were rejected for arch widths except for mandibular intercanine and alveolar widths. The null hypotheses for gender comparisons were rejected except for mandibular intercanine width. The null hypotheses for gender dimorphism were rejected except for mandibular intercanine width, and intermolar and alveolar width differences. The null hypotheses for interarch differences were rejected.

Gender dimorphism influenced maxillary intercanine widths in all three comparisons with previous studies (Table 1). Female intercanine widths were similar in normal, II-2, and II-1 occlusions (Table 5). Gender influenced the intermolar width comparisons of normal and II-2, with female widths being similar. Gender also influenced maxillary molar alveolar width comparison between normal and II-1 and II-2 and II-1. In the II-2 and II-1 comparison, both genders had similar widths, but when pooled, widths were larger in II-2 than in II-1.

Maxillary intercanine width comparisons between II-2 and normal differed from previous studies.[1,2,6] However, the II-2 and II-1 comparisons were similar to one study[6] and dissimilar to two studies.[5,6] Maxillary intermolar comparisons between II-2 and normal were similar to four previous studies,[1,7–9] and differed from four studies.[2,6,7,9] Maxillary intermolar comparisons between II-2 and II-1 were similar to many previous stud-

Table 5. Gender Differences in Arch Widths Between Occlusion Groups (n = 113)

Width	F Value	PR < F[a]	Duncan's[b] Letter	Mean ± SD, mm	N	Occlusion Group
Maxilla						
Intercanine	9.01	.0001	A	36.1 ± 2.3	18	Normal males
			B	33.1 ± 1.3	16	Normal females
			B	33.0 ± 2.1	19	II-2 Males
			B	32.8 ± 2.5	22	II-2 Females
			B	32.5 ± 2.1	19	II-1 Males
			B	31.6 ± 2.5	19	II-1 Females
Intermolar	25.2	.0001	A	54.6 ± 2.1	18	Normal males
			B	50.2 ± 2.9	19	II-2 Males
			BC	49.9 ± 1.9	16	Normal females
			CD	48.4 ± 2.6	22	II-2 Females
			DE	47.3 ± 3.1	19	II-1 Males
			E	46.3 ± 2.1	19	II-1 Females
Alveolar	20.08	.0001	A	61.6 ± 3.0	18	Normal males
			B	57.1 ± 3.1	19	II-2 Males
			BC	56.5 ± 2.3	16	Normal females
			BCD	55.3 ± 2.9	19	II-1 Males
			CD	54.8 ± 2.4	22	II-2 Females
			D	53.5 ± 2.5	19	II-1 Females
Mandible						
Intercanine	1.01	.42	A	26.3 ± 1.9	18	Normal males
			A	25.6 ± 1.6	19	II-2 Males
			A	25.6 ± 2.1	19	II-1 Males
			A	25.4 ± 2.0	22	II-2 Females
			A	25.2 ± 2.2	16	Normal females
			A	25.1 ± 2.0	19	II-1 Females
Intermolar	9.88	.0001	A	53.0 ± 1.6	18	Normal males
			B	50.9 ± 2.7	19	II-2 Males
			BC	50.2 ± 3.2	19	II-1 Males
			C	48.8 ± 1.6	16	Normal females
			C	48.7 ± 2.5	19	II-1 Females
			C	48.5 ± 2.4	22	II-2 Females
Alveolar	13.22	.0001	A	58.3 ± 1.7	18	Normal males
			AB	57.0 ± 2.6	19	II-2 Males
			B	56.2 ± 2.5	19	II-1 Males
			C	54.3 ± 2.2	22	II-2 Females
			C	54.1 ± 2.2	19	II-1 Females
			C	53.8 ± 1.3	16	Normal females

[a] Probability value F test, significance $P \leq .05$.
[b] Significant differences: $P \leq .05$, groups with same letter do not differ.

Table 6. Comparison of Maxillary Minus Mandibular Arch Width Differences (Genders Pooled)

Variable	F Value	$P < F$[a]	Duncan's[b] Letter	Mean ± SD, mm	N	Group	Gender[c] Dimorphism
Intercanine difference	13.69	.0001	A	8.9 ± 1.7	34	Normal occlusion	M > F
			B	7.4 ± 1.9	41	II-2	No
			B	6.7 ± 1.9	38	II-1	No
Intermolar difference	34.82	.0001	A	1.3 ± 1.4	34	Normal occlusion	No
			B	−0.4 ± 1.4	41	II-2	No
			C	−2.6 ± 2.9	38	II-1	No
Alveolar difference	20.98	.0001	A	3.0 ± 2.4	34	Normal occlusion	No
			B	0.3 ± 1.9	41	II-2	No
			B	−0.8 ± 3.7	38	II-1	No

[a] Probability value F test, significance: $P \leq .05$.
[b] Significant differences: $P \leq .05$, groups with same letter do not differ.
[c] Significant differences: $P \leq .05$, Duncan's test.
N = 113

Table 7. Arch Widths (Mean, SD, Minimum, and Maximum) in Adult Class I Normal Occlusions (in mm)

Width	Males (n = 18)				Females (n = 16)			
	Mean	SD	Min	Max	Mean	SD	Min	Max
Maxilla								
Intercanine width	36.1	2.3	32.9	41.9	33.1	1.3	31.3	35.4
Intermolar width	54.6	2.1	51.4	58.0	49.9	1.8	46.6	53.1
Alveolar width (at first molars)	61.6	3.0	57.2	67.9	56.5	2.3	53.2	60.4
Mandible								
Intercanine width	26.3	1.9	23.3	31.0	25.2	2.2	22.6	27.6
Intermolar width	53.0	1.6	50.2	56.0	48.8	1.6	46.4	52.2
Alveolar width (at first molars)	58.3	1.7	55.3	61.6	53.8	1.3	51.5	56.2
Maxillary minus mandibular intermolar widths	1.5	1.5	−0.5	4.3	1.2	1.2	−1.3	4.3

ies,[2,5,6,9] but differed from one study.[7] Maxillary molar alveolar comparisons between II-1 and normal and II-1 occlusions differed from the previous study.[2]

Gender dimorphism did not influence mandibular width comparisons with previous studies (Table 1). Mandibular intercanine comparisons between II-2 and normal occlusions were similar to two studies[1,6] and differed from one,[2] and the II-2 and II-1 comparisons were similar to two studies[5,6] and differed from one.[2] Mandibular intermolar comparisons between II-2 and normal occlusions differed from previous studies, except for female subjects in one study.[7] Perhaps sample selection influenced this result. Intermolar comparisons between II-2 and II-1 were similar to previous studies.[2,5–7,9] Mandibular molar alveolar comparisons between II-2 and normal occlusions differed from one study[2]; however, molar alveolar comparisons between II-2 and II-1 agreed with this study.[2] Differences reported in one study[2] are perhaps explained by population differences.

Gender dimorphism in normal occlusions was more similar to II-2 than II-1 malocclusions. Male subjects with normal occlusion had significantly larger arch widths than female subjects in five of six widths, II-2 male subjects had significantly larger widths than female subjects in four of six widths, and II-1 male subjects had significantly larger arch widths than female subjects in one of six widths.

Gender comparisons of II-2 and normal occlusions showed male subjects similar in two of six, and female subjects similar in six of six widths; for II-1, male subjects were similar to normal occlusions in one of six, and female subjects were similar in four of six widths. In five of six widths, II-2 and II-1 male and female subjects were similar. The process that narrows Class II arches is more pronounced in male than in female subjects.

The findings of this study for differences between maxillary and mandibular arch widths are summarized in Table 2. One previous study of children had data for comparison of II-2 and normal occlusions[9] and the comparisons agreed only for male subjects. The study did not agree in the comparison of II-2 and II-1 differences.[9] Comparisons for II-1 and normal occlusions are in Table 2.

The results of this study show that the maxillary arch widths of II-2 subjects fall between the widths of normal occlusions and II-1 malocclusions. Arch widths in the mandible were similar in the occlusion groups except for intermolar width in which both malocclusion groups were equally narrower than the normal occlusion group. The lower intercanine width was similar in the three groups, supporting the view that this width should be maintained during treatment of most orthodontic patients.

Disagreement among studies of arch widths in Class II malocclusions may be explained by several factors: gender dimorphism, ethnic and racial differences, sample selection and size, and age of subjects.

The difference calculated in this study between the maxillary and mandibular intermolar widths assumes a Class I molar relationship as the goal of treatment. The mean difference between the maxillary and mandibular intermolar widths in Class II-2 adults was about −0.5 mm with a range of −3.4 mm to +4.3 mm. The negative differences suggest that some II-2 patients could benefit from maxillary arch expansion.

The values given in Table 7 for the Class I normal sample serve as norms to evaluate arch widths in patients of European heritage. For patients with posterior crossbites, the difference between maxillary and mandibular molar measurements is a guideline for the amount of maxillary expansion required. Lower arch width must be considered.

CONCLUSIONS

- The Class II division 2 group had mean maxillary arch widths significantly smaller than normal occlusions and significantly larger than Class II division 1.
- All groups had similar mandibular intercanine and alveolar widths.

- The Class II division 2 and Class II division 1 groups had similar mandibular intermolar widths, both smaller than normal occlusions.
- The Class II division 2 and Class II division 1 groups had similar maxillary/mandibular differences in intercanine and alveolar widths, both smaller than normal occlusions.
- The Class II division 2 group had a maxillary/mandibular intermolar difference smaller than normal occlusions, and less negative than Class II division 1.
- Gender comparisons showed Class II male subjects less normal than Class II female subjects.
- Gender dimorphism was observed in five of six widths in normal occlusions, four of six widths in Class II division 2, and one of six widths in Class II division 1.

REFERENCES

1. Herren P, Jordi-Guilloud T. Quantitative determination of the dental arch by polygon measurement in the ideal and anomalous arch [in German]. *SSO Schweiz Monatsschr Zahnheilkd.* 1973;83:682–709.
2. Uysal T, Memili B, Usumez S, Sari Z. Dental and alveolar arch widths in normal occlusion, Class II division 1 and Class II division 2. *Angle Orthod.* 2005;75:941–947.
3. Walkow TM, Peck S. Dental arch width in Class II Division 2 deep-bite malocclusion. *Am J Orthod Dentofacial Orthop.* 2002;122:608–613.
4. Buschang PH, Stroud J, Alexander RG. Differences in dental arch morphology among adult females with untreated Class I and Class II malocclusion. *Eur J Orthod.* 1994;16: 47–52.
5. Al-Khateeb SN, Abu Alhaija ESJ. Tooth size discrepancies and arch parameters among different malocclusions in a Jordanian sample. *Angle Orthod.* 2006;76:459–465.
6. Fröhlich FJ. A longitudinal study of untreated Class II type malocclusion. *Trans Eur Orthod Soc.* 1961;37:137–151.
7. Young M, Johnson E, Smyth C, Still M. Investigations into the nature and characteristic features of post-normal occlusion. *Med Res Council Special Rep Ser, London.* 1937;225: 1–93.
8. Ingervall B, Lennartson B. Cranial morphology and dental arch dimensions in children with Angle Class II, div. 2 malocclusion. *Odontol Revy.* 1973;24:149–160.
9. Lux CJ, Conradt C, Burden D, Komposch G. Dental arch widths and mandibular-maxillary base widths in Class II malocclusions between early mixed and permanent dentitions. *Angle Orthod.* 2003;73:674–685.
10. Staley RN, Stuntz WR, Peterson LC. A comparison of arch widths in adults with normal occlusion and adults with Class II division 1 malocclusion. *Am J Orthod.* 1985;88:163–169.
11. Nie Q, Lin J. A comparison of dental arch forms between Class II division 1 and normal occlusion assessed by Euclidean distance matrix analysis. *Am J Orthod Dentofacial Orthop.* 2006;129:528–535.
12. Sayin MO, Turkkahraman H. Comparison of dental arch and alveolar widths of patients with Class II division 1 malocclusion and subjects with Class I ideal occlusion. *Angle Orthod.* 2004;74:356–360.
13. Tollaro I, Baccetti T, Franchi L, Tanasescu CD. Role of posterior transverse interarch discrepancy in Class II, Division 1 malocclusion during the mixed dentition phase. *Am J Orthod Dentofacial Orthop.* 1996;110:417–422.
14. Bishara SE, Bayati P, Jakobsen JR. Longitudinal comparisons of dental arch changes in normal and untreated Class II Division 1 subjects and their clinical implications. *Am J Orthod Dentofacial Orthop.* 1996 Nov;110(5):483–489.
15. Meredith HV, Chadha JM. A roentgenographic study of change in head height during childhood and adolescence. *Hum Biol.* 1962;34:299–319.
16. Moorrees CFA. *The Dentition of the Growing Child.* Cambridge: Harvard University Press; 1959:87–110.
17. Knott VB. Size and form of the dental arches in children with good occlusion studied longitudinally from age 9 years to late adolescence. *Am J Phys Anthropol.* 1961;19:263–284.
18. Sillman JH. Dimensional changes of the dental arches: longitudinal study from birth to 25 years. *Am J Orthod.* 1964; 50:824–842.
19. Knott VB. Longitudinal study of dental arch widths at four stages of dentition. *Angle Orthod.* 1972;42:387–394.
20. DeKock WH. Dental arch depth and width studied longitudinally from 12 years of age to adulthood. *Am J Orthod.* 1972;62:56–66.