

Dental and Alveolar Arch Widths in Normal Occlusion, Class II division 1 and Class II division 2

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Abstract: The aim of this study was to compare the transverse dimensions of the dental arches and alveolar arches in the canine, premolar, and molar regions of Class II division 1 and Class II division 2 malocclusion groups with normal occlusion subjects. This study was performed using measurements on dental casts of 150 normal occlusion (mean age: 21.6 ± 2.6 years), 106 Class II division 1 (mean age: 17.2 ± 2.4 years), and 108 Class II division 2 (mean age: 18.5 ± 2.9 years) malocclusion subjects. Independent-samples *t*-test was applied for comparisons of the groups. These findings indicate that the maxillary interpremolar width, maxillary canine, premolar and molar alveolar widths, and mandibular premolar and molar alveolar widths were significantly narrower in subjects with Class II division 1 malocclusion than in the normal occlusion sample. The maxillary interpremolar width, canine and premolar alveolar widths, and all mandibular alveolar widths were significantly narrower in the Class II division 2 group than in the normal occlusion sample. The mandibular intercanine and interpremolar widths were narrower and the maxillary intermolar width measurement was larger in the Class II division 2 subjects when compared with the Class II division 1 subjects. Maxillary molar teeth in subjects with Class II division 1 malocclusions tend to incline to the buccal to compensate the insufficient alveolar base. For that reason, rapid maxillary expansion rather than slow expansion may be considered before or during the treatment of Class II division 1 patients. (*Angle Orthod* 2005;75:941–947.)

Key Words: Dental width; Alveolar width; Class II division 1; Class II division 2

INTRODUCTION

The size and shape of the arches have considerable implications in orthodontic diagnosis and treatment planning, affecting the space available, dental esthetics, and stability of the dentition.¹ Investigators have studied the growth of arch widths in persons with normal occlusion, arch widths in adults with normal occlusion, and compared these values with those of different malocclusion samples.^{2–10} However, there is con-

siderable controversy among the results presented in the literature.

Fröhlich⁴ compared intercanine and intermolar widths of both arches from 51 children with Class II malocclusion with normal occlusion. He found that the absolute arch widths of the Class II children did not differ appreciably from those of children with normal occlusion. Sayin and Turkkahraman⁵ compared the arch and alveolar widths of patients with Class II division 1 malocclusion and subjects with Class I ideal occlusion in the permanent dentition. They indicated that mandibular intercanine widths were significantly larger in the Class II division 1 group, although maxillary intermolar widths were larger in the normal occlusion sample. Staley et al⁶ stated that patients with Class II division 1 malocclusion had narrower maxillary intercanine, intermolar, and alveolar widths. Their findings revealed a posterior crossbite tendency in the Class II group. Enlow and Hans⁷ discussed generic Class II skeletodental features and facial growth without differentiating Class II division 2 from Class II division 1 and reported that Class II patients have long, narrow anterior cranial bases that affect the nasomaxillary complex and result in long, narrow palates and maxillary arches.

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TABLE 1. The Distribution of Age in Different Malocclusion Groups^a

		Mean Age, y	SD, y	Min, y	Max, y
Normal occlusion	Male	22.1	3.1	18.1	35.1
	Female	21.1	2.1	18.0	30.0
Class II division 1	Male	17.8	1.8	15.9	23.0
	Female	16.5	2.9	13.1	20.8
Class II division 2	Male	19.4	2.7	15.9	23.0
	Female	17.6	3.0	12.8	22.0

^a SD indicates standard deviation; Min, minimum; and Max, maximum.

In a cross-sectional study of 386 white women, Buschang et al⁸ found that Class II division 2 patients had greater maxillary intercanine and intermolar distances than did Class II division 1 patients. However, the Class II division 2 patients showed less mandibular intercanine and intermolar width than the Class I and II division 1 patients. Moorrees et al⁹ used serial dental casts of untreated Class II malocclusions to compare arch dimensions of Class II division 1 and Class II division 2 subgroups. Compared with dental cast measurements from a control reference population, Class II division 2 dental casts had maxillary and mandibular intercanine distances greater than average and normally distributed intermolar distances.

Most of these studies presented a limited sample size resulting in questionable validity. Therefore, the aim of this study was to compare the transverse dimensions of the dental arches and alveolar widths of Class II division 1 and Class II division 2 malocclusion groups with the transverse measurements of untreated normal occlusion subjects. The null hypothesis to be tested states that there is no difference in the mean maxillary and mandibular dental arch and alveolar width dimensions among Class II division 1, Class II division 2, and a normal occlusion sample.

MATERIALS AND METHODS

This study was performed using the dental casts of 150 normal occlusion, 106 Class II division 1, and 108 Class II division 2 malocclusion subjects from the archives of the Selcuk University, Faculty of Dentistry, Department of Orthodontics. The distribution of age in different malocclusion groups for all subjects is shown in Table 1.

Normal occlusion sample

Dental casts of 150 adult subjects (72 men and 78 women) with normal occlusion that met the following criteria were¹¹ (1) Class I canine and molar relationship with minor or no crowding; (2) normal growth and development, (3) well-aligned upper and lower dental arches; (4) all teeth present except third molars; (5) good facial symmetry determined clinically; (6) no sig-

nificant medical history; and (7) no history of trauma, and no previous orthodontic, prosthodontic treatment, maxillofacial or plastic surgery.

Malocclusion sample

A sample of 106 subjects (45 men and 61 women) with Class II division 1 malocclusion and a sample of 108 subjects (45 men and 63 women) with Class II division 2 malocclusion were selected from patient records.

The inclusion criteria used to select Class II division 1 samples were⁶ (1) bilateral Class II molar relationship in centric occlusion with the distobuccal cusp tip of the maxillary first molar within one mm (anterior or posterior) from the buccal groove of the mandibular first molar and protrusive maxillary incisors; (2) all teeth present except third molars; (3) no significant medical history; and (4) no history of trauma, and no previous orthodontic, prosthodontic treatment, maxillofacial or plastic surgery.

The criteria used to select Class II division 2 samples were¹⁰ (1) Class II molar relationship on at least one side in centric occlusion; (2) Class II permanent canine relationship and retroclination of two or more maxillary incisors; (3) all teeth present except third molars, and no significant medical history; and (4) no history of trauma, and no previous orthodontic, prosthodontic treatment, maxillofacial or plastic surgery.

Twelve arch width measurements were recorded from each subject's dental casts by one examiner (Dr Memili) using a dial caliper and recording the data to the nearest 0.1 mm. These measurements are shown in Table 2.

Independent-samples *t*-test was applied for comparison of the groups. All statistical analyses were performed using the Statistical Package for Social Sciences for Windows (SPSS) software package (version 10.1, SPSS Inc, Chicago, Ill).

RESULTS

Four weeks after the first measurements, 25 randomly selected dental casts were remeasured. A paired-samples *t*-test was applied to the measure-

TABLE 2. Maxillary and Mandibular Dental and Alveolar Width Measurements Used in the Study

1. Maxillary intercanine width (UC-C): the distance between the cusp tips of the right and left canines or the center of the wear facets in cases of attrition.
2. Maxillary interpremolar width (UP-P): the distance between the cusp tips of the right and left first premolars.
3. Maxillary intermolar width (UM-M): the distance between the mesiobuccal cusp tips of the right and left first molars.
4. Mandibular intercanine width (LC-C): the distance between the cusp tips of the right and left mandibular canines.
5. Mandibular interpremolar width (LP-P): the distance between the cusp tips of the right and left mandibular first premolars.
6. Mandibular intermolar width (LM-M): between the most gingival extensions of the buccal grooves on the first molars or, when the grooves had no distinct terminus on the buccal surface, between points on the grooves located at the middle of the buccal surfaces.
7. Maxillary canine alveolar width (UAC-C): the distance between two points at the mucogingival junctions above the cusp tips of the maxillary right and left canines.
8. Maxillary premolar alveolar width (UAP-P): the distance between two points at the mucogingival junctions above the interdental contact point of the maxillary first and second premolars.
9. Maxillary molar alveolar width (UAM-M): the distance between two points at the mucogingival junctions above the mesiobuccal cusp tips of the maxillary first molars
10. Mandibular canine alveolar width (LAC-C): the projection of UAC-C point in the lower jaw
11. Mandibular premolar alveolar width (LAP-P): the projection of UAP-P point in the lower jaw
12. Mandibular molar alveolar width (LAM-M): the projection of UAM-M point in the lower jaw

TABLE 3. Error of the Method

Transverse Measurement	Dahlberg's Calculation	Reliability Coefficient
UC-C	0.944	0.994
UP-P	0.881	0.978
UM-M	0.494	0.987
AC-C	0.729	0.990
AP-P	0.441	0.980
AM-M	0.646	0.956
UAC-C	0.470	0.945
UAP-P	0.620	0.934
UAM-M	0.474	0.939
LAC-C	0.441	0.943
LAP-P	0.360	0.954
LAM-M	0.357	0.931

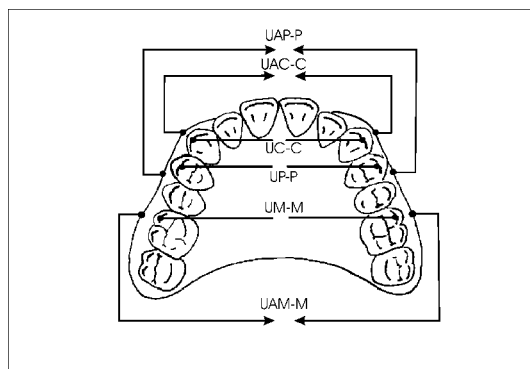


FIGURE 1. Maxillary dental cast measurements (modified from Sayin and Turkkahraman⁵).

ments. The difference between the first and second measurements of the 25 casts was insignificant. The method error was calculated by using Dahlberg's formula. Values varied from 0.357 to 0.944 and were within acceptable limits (Table 3).

Correlation analysis yielded the highest *r* value, 0.994, for the maxillary intercanine width, UC-C, and

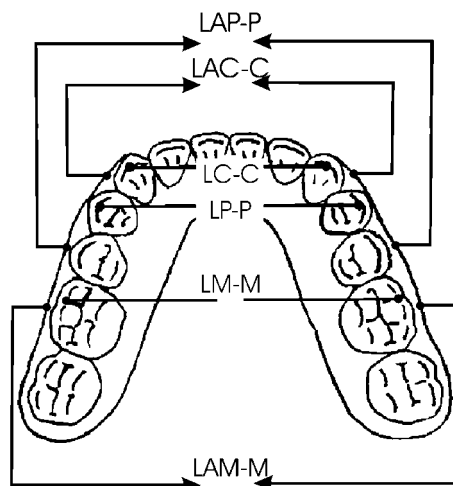


FIGURE 2. Mandibular dental cast measurements (modified from Sayin and Turkkahraman⁵).

the lowest *r* value, 0.931, for mandibular molar alveolar width, LAM-M, measurements.

Descriptive statistics (mean, standard deviation, minimum and maximum) and statistical comparisons of dental and alveolar width measurements for dental casts in the three groups (normal occlusion, Class II division 1, and Class II division 2) are shown in Table 4. According to the independent-samples *t*-test, statistically significant differences were found in maxillary and mandibular dental arch and alveolar width dimensions among Class II division 1, Class II division 2, and normal occlusion samples. The null hypothesis was thus rejected.

Normal occlusion and Class II division 1 malocclusion samples

Statistically significant differences were found in nine of the 12 measurements. The maxillary interpre-

TABLE 4. Descriptive Statistics and Statistical Comparisons of Dental and Alveolar Widths of Normal Occlusion and Class II Division 1 and Class II Division 2 Malocclusion Samples^a

	Normal Occlusion				Class II Division 2		
	Mean	SD	Min	Max	Mean	SD	Min
UC-C	34.4	2.1	29.8	40.3	34.0	2.6	29.2
UP-P	42.1	2.5	34.5	52.8	39.9	2.7	32.5
UM-M	50.7	3.7	45.2	59.4	52.1	2.8	37.8
AC-C	25.9	1.7	20.7	33.1	27.9	1.8	23.5
AP-P	34.6	1.9	29.4	40.3	34.8	2.4	29.0
AM-M	45.7	2.8	38.3	51.8	46.8	3.1	35.5
UAC-C	38.6	2.4	33.4	45.3	36.7	2.3	32.4
UAP-P	49.8	2.6	41.5	58.1	45.1	2.7	40.7
UAM-M	58.1	5.3	56.0	67.5	56.6	3.0	50.1
LAC-C	35.7	2.3	29.5	41.5	34.3	2.8	22.7
LAP-P	48.5	2.7	41.2	54.5	40.7	2.4	28.8
LAM-M	58.0	2.8	50.1	64.4	56.3	3.7	32.9

^a SD indicates standard deviation; Min, minimum; Max, maximum; NS, not significant.

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.

molar width ($P < .001$); maxillary canine ($P < .001$), premolar ($P < .001$), and molar ($P < .05$) alveolar widths; and mandibular premolar ($P < .001$) and molar ($P < .05$) alveolar widths were significantly narrower in the Class II division 1 group when compared with the normal occlusion sample. The upper ($P < .01$) and lower ($P < .01$) intermolar and lower intercanine ($P < .001$) widths were statistically significantly larger in the Class II division 1 group (Table 4).

Normal occlusion and Class II division 2 malocclusion samples

Table 4 shows the statistical comparisons of the normal occlusion and Class II division 2 malocclusion samples. Normal occlusion subjects had statistically significant narrower lower intercanine and intermolar widths ($P < .001$) than did the subjects with Class II division 2 malocclusion. Both groups had similar values in maxillary intercanine, intermolar, mandibular interpremolar widths and maxillary molar alveolar width measurement. Except for these, all measurements were larger in the normal occlusion samples when compared with the Class II division 2 group.

Class II division 1 and Class II division 2 malocclusion samples

Statistically significant differences were found only in three of the 12 transverse measurements ($P < .05$) (Table 4). The mandibular intercanine and interpremolar width measurements were narrower and the maxillary intermolar width measurement was larger in the Class II division 2 subjects when compared with the Class II division 1 subjects.

DISCUSSION

This study was carried out to compare the dental arch and alveolar base widths of Class II division 1 and Class II division 2 malocclusion groups with an untreated normal occlusion sample. Width measurements described in this article will help clinicians diagnose and plan the treatment of patients with Class II division 1 and Class II division 2 malocclusions.

The large sample size in this study might have increased its power. An increased sample size leads to a greater probability of establishing statistical significance for the observed trends in all dental and alveolar width measurements.

Investigators who studied growth changes in the transverse arch width found that molar and canine arch widths did not change after age 13 in female subjects and age 16 in male subjects.¹²⁻¹⁶ The minimum ages of the subjects measured in this study were chosen on the basis of these previous studies. Therefore, we assumed that the arch widths of the subjects studied were fully developed.

In the normal occlusion sample only subjects with minor or no crowding were included, whereas the absence of crowding was not a criterion in the Class II groups. If a Class I group with crowding would be compared with a Class I group without crowding, most probably narrower arches would be found in the Class I group with crowding. For that reason, group differences in this study may be the result of differences concerning crowding as well and our results must be interpreted carefully.

Clinicians have speculated that nasal obstruction, finger habits, tongue thrusting, low tongue position,

TABLE 4. Extended

Class II Division 1		Class II Division 2			Test		
Max	Mean	SD	Min	Max	Normal Occlusion vs Class II Division 1	Normal Occlusion vs Class II Division 1	Class II Division 1 vs Class II Division 2
43.2	34.2	2.4	29.5	40.0	NS	NS	NS
49.5	39.3	3.1	27.5	47.5	***	***	NS
57.9	50.0	2.6	43.0	56.0	**	NS	*
32.3	27.4	1.8	21.6	32.6	***	***	*
40.7	34.1	2.2	29.2	39.6	NS	NS	*
55.5	47.1	3.2	28.8	53.7	**	***	NS
44.8	37.2	2.2	30.2	41.3	***	***	NS
53.3	45.3	3.2	26.5	51.0	***	***	NS
65.3	57.0	2.8	49.0	65.0	*	NS	NS
32.1	31.1	1.7	27.3	37.0	NS	***	NS
47.2	40.3	2.4	32.3	46.2	***	***	NS
64.3	56.8	3.1	37.7	62.3	***	**	NS

and abnormal swallowing and sucking behaviors were reasons for narrower maxillary dental arch widths in Class II division 1 malocclusions compared with a normal occlusion sample. Staley et al⁶ stated that the maxillary dental arch as a whole is narrower in adults with Class II division 1 malocclusion than it is in adults with normal occlusion. When we compare the dental and alveolar arch widths of Class II division 1 malocclusion samples with the normal occlusion samples, statistically significant lower values were found in most of the upper arch widths in Class II division 1 patients. All upper alveolar width and interpremolar width measurements were greater in the normal occlusion sample. However, the intermolar dental arch width was larger in the Class II division 1 sample.

Staley et al⁶ reported that subjects with normal occlusion had larger maxillary canine widths than the malocclusion subjects, but no differences were found in mandibular canine widths. Bishara et al¹⁷ studied the growth trends in maxillary and mandibular dental arch widths and lengths in persons with Class II division 1 malocclusions and normal subjects and reported no differences in maxillary and mandibular canine width measurements between the groups. In contrast with the others, Sayin and Turkkahraman⁵ found that mandibular intercanine widths were significantly larger in the Class II division 1 group than in the Class I group, whereas no significant differences were found among maxillary intercanine width measurements. In accordance with Sayin and Turkkahraman,⁵ the results of this study showed that the maxillary intercanine width difference was similar in Class I and Class II division 1 groups, and the mandibular intercanine width was significantly larger in the Class II division 1 sample.

Both these investigations were carried out on the same population and it could be the specific peculiarity of this population (Figures 1 and 2).

In this study, molar reference points were taken from Staley et al,⁶ who measured the widths between the mesiobuccal cusp tips of the maxillary first molars and the buccal grooves of the lower first molars. Because, in normal centric occlusion, the mesiobuccal cusp tips of the maxillary molars are positioned near the buccal grooves of the mandibular molars. Staley et al⁶ and Sayin and Turkkahraman⁵ suggested that the narrow widths of the dental arch in Class II division 1 patients appeared to be caused by palatally tipped teeth and also by narrower bony bases of the dental arch. Their results showed that transverse discrepancy in Class II division 1 patients originated from upper posterior teeth and not from the maxillary alveolar base.

However, in contrast with previous studies, these findings indicated that the upper alveolar intermolar width was narrower and upper and lower intermolar widths were larger in patients with Class II division 1 malocclusion when compared with the normal occlusion sample. Therefore, we concluded that subjects with Class II division 1 malocclusions tend to have the maxillary molar teeth inclined to the buccal to compensate for the insufficient alveolar base. For that reason, rapid maxillary expansion rather than slow expansion may be considered before or during the treatment of a Class II division 1 patient.

Of the four main categories in Angle's classifications of malocclusions, the Class II division 2 type of discrepancy occurs the least often.¹⁰ Obtaining data on Class II division 2 patients has always been challenging because of the low prevalence rates. For that rea-

son, little data was found in the literature related to the alveolar widths of this malocclusion. In one of them, Walkow and Peck¹⁰ indicated that mandibular canine width was significantly less in Class II division 2 deep-bite patients and suggested that the extreme deep bite may inhibit anterior development of the mandibular dentoalveolar segment.

In a cross-sectional study, Buschang et al⁸ found that Class II division 2 patients showed smaller mandibular intercanine and intermolar widths than the Class I and II division 1 patients. In this study overbite was not calculated specifically, but a deep bite was observed in most subjects. Surprisingly the mandibular intercanine width was significantly larger in patients with Class II division 2. Current findings indicated that subjects with Class II division 2 malocclusion had statistically significant larger lower intercanine and intermolar widths ($P < .001$) than did subjects with normal occlusion. Both normal occlusion and Class II division 2 subjects had similar values in maxillary intercanine, intermolar, mandibular interpremolar widths and maxillary molar alveolar width measurement. Maxillary and mandibular alveolar widths in the canine and premolar regions and upper interpremolar and lower alveolar intermolar widths showed significant larger measurements in normal occlusion samples when compared with the Class II division 2 group.

Buschang et al⁸ reported that in an adult female sample, the maxillary intermolar width of Class II cases was smaller than in the Class I subjects. Within the Class II malocclusion group, the maxillary width was smaller in the Class II division 1 group than in the Class II division 2 subjects. Lux et al¹⁸ found that dental arch widths of Class II division 2 cases took a position between the Class II division 1 cases and the Class I control groups. Moorrees et al⁹ used serial dental casts of untreated Class II malocclusions to compare arch dimensions of Class II division 1 and Class II division 2 subgroups. Compared with dental cast measurements from a control reference population, the Class II division 2 dental casts had greater than average maxillary and mandibular intercanine distances with the intermolar distances normally distributed.

CONCLUSIONS

- Maxillary interpremolar width, all maxillary alveolar widths, and mandibular premolar and molar alveolar widths were significantly narrower in the Class II division 1 group when compared with the normal occlusion sample.
- Maxillary interpremolar width, canine and premolar alveolar widths, and all mandibular alveolar widths were significantly narrower in the Class II division 2

group when compared with the normal occlusion sample.

- Mandibular intercanine and interpremolar width measurements were narrower and maxillary intermolar width measurements were larger in Class II division 2 subjects when compared with the Class II division 1 subjects.
- Upper alveolar intermolar width was narrower, and upper and lower intermolar width was greater in patients with Class II division 1 malocclusion when compared with the normal occlusion sample.
- Maxillary molar teeth in subjects with Class II division 1 malocclusions tend to incline buccally to compensate for the insufficient alveolar base.
- For that reason, rapid maxillary expansion rather than slow expansion may be considered before or during the treatment of a Class II division 1 patient.

REFERENCES

1. Lee RT. Arch width and form: a review. *Am J Orthod Dentofacial Orthop.* 1999;115:305–313.
2. Solow B. The pattern of craniofacial associations. *Acta Odontol Scand.* 1966;24:46.
3. Slagvold O. Associations in width dimensions of the upper and lower jaws. *Trans Eur Orthod Soc.* 1971;43:465–471.
4. Fröhlich FJ. A longitudinal study of untreated Class II type malocclusion. *Trans Eur Orthod Soc.* 1961;37:137–159.
5. 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.
6. 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.
7. Enlow DH, Hans MG. *Essentials of Facial Growth.* Philadelphia, Pa: WB Saunders; 1996:1–280.
8. 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.
9. Moorrees CFA, Gron AM, Le Bret LML, Yen PKJ, Fröhlich FJ. Growth studies of the dentition: a review. *Am J Orthod.* 1969;55:600–616.
10. Walkow TM, Peck S. Dental arch width in Class II division 2 deep-bite malocclusion. *Am J Orthod Dentofacial Orthop.* 2002;122:608–613.
11. Uysal T. *Erişkin Türk toplumunda dentofasiyal yapıların ideal transversal boyutlarının model ve posteroanterior sefalometrik filmler aracılığıyla değerlendirilmesi* [PhD thesis]. Konya, Turkey: Selcuk University, Health Science Institute; 2003.
12. 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.
13. Knott VB. Longitudinal study of dental arch widths at four stages of dentition. *Angle Orthod.* 1972;42:387–394.

14. DeKock WH. Dental arch depth and width studied longitudinally from 12 years of age to adulthood. *Am J Orthod.* 1972;62:56–66.
15. Sillman JH. Dimensional changes of the dental arches: longitudinal study from birth to 25 years. *Am J Orthod.* 1964; 50:824–842.
16. Moorrees CFA. *The Dentition of the Growing Child.* Cambridge, Mass: Harvard University Press; 1959:87–110.
17. 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;110:483–489.
18. 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.