Original Article

Factors Contributing to Mandibular Anterior Crowding in the Early Mixed Dentition

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Abstract: The aim of this study was to uncover the possible factors contributing to mandibular anterior crowding in the early mixed dentition. Mandibular dental casts of 60 children in the early mixed dentition were divided into two groups according to the severity of mandibular anterior crowding. The space available for the mandibular permanent incisors, total incisor width, deciduous intercanine width, deciduous intermolar widths, permanent intermolar width, interalveolar width, and total arch length were compared between the crowded group (CG) and noncrowded group (NCG), and correlations with crowding were investigated. The mandibular deciduous intercanine width, mandibular deciduous intermolar widths, mandibular permanent intermolar width, mandibular interalveolar width, space available for the mandibular permanent incisors, and total arch length were significantly larger in the NCG. The total width of the four mandibular incisors did not differ significantly between CG and NCG. Significant inverse correlations were found between crowding and available space, deciduous intercanine width, deciduous intermolar widths, permanent intermolar width, and interalveolar width. Total incisor width was directly correlated with crowding. No significant correlation was found between crowding and total arch length. The results of this study suggested that individual variations play an important role in treatment planning. However, one must not overlook arch length discrepancies and transverse discrepancies in patients with mandibular anterior crowding. (*Angle Orthod* 2004;74:754–758.)

Key Words: Anterior crowding; Arch width; Mixed dentition

INTRODUCTION

Although crowding is considered as the most prevalent form of malocclusion,[1–5] a period of slightly crowded mandibular incisors has been accepted as a normal developmental stage.[6,7] When the permanent mandibular lateral incisors erupt, an average 1.6 mm of additional space was required for the perfect alignment of the four mandibular incisors.[6–8] This slight crowding was reported to be solved by a slight increase in intercanine width, labial positioning of the permanent incisors relative to the primary incisors, and slight backward movement of the canines into the primate space.[6,7]

However, crowding of more than 1.6 mm may not be solved by these mechanisms. In a longitudinal study, Sanin and Savara[9] evaluated 150 children and reported that 89% of the subjects with crowding in the early mixed dentition also had crowding in the permanent dentition, and only 11% showed complete correction. They also found that, except for two cases, the other self-correcting cases had no more than 0.5 mm crowding in the early mixed dentition. In another study, Lundy and Richardson[10] reported that the mean crowding of the lower incisors had decreased 0.9 mm from the initial eruption of the lower permanent incisors to the initial eruption of the permanent canines.

The determination of the factors contributing to mandibular anterior crowding, especially in the early mixed dentition stage, is of great importance for treatment planning. Some authors correlated arch dimensions with crowding. Mills[11] found that dental arches of individuals without crowding were about 4 mm wider than the crowded arches. Sanin and Savara[9] reported larger anterior and posterior widths of the mandibular dental arch in children who did not have crowding in the permanent dentition. McKeown[12] found a greater correlation between dental arch size and crowding than between tooth size and crowding. Howe et al[13] evaluated dental crowding in the permanent dentition and reported significant differences in arch dimensions between crowded group (CG) and noncrowded group (NCG). Radnzic[14] reported significant correlations between arch dimensions and the degree of crowding. Hagberg[15] reported that a mandibular intercanine distance of less than 26 mm

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TABLE 1. Mean Chronological Ages of the Groups

	Noncrowded (n = 30)				Crowded (n = 30)				
	Mean	SD	Min	Max	Mean	SD	Min	Max	*P*
Chronological age	9.14	0.96	7.47	11.17	8.84	0.72	7.2	10.19	.177 NS[a]

[a] NS indicates nonsignificant.

was associated with crowding in seven-, nine-, and 10-year-old children. Melo et al[16] reported that mandibular dental arch length in the primary dentition was an effective discriminator in separating normal and crowded cases.

On the other hand, some authors correlated tooth size with crowding. Fastlicht[17] reported significant correlation between dental crowding and mesiodistal dimensions of mandibular permanent incisors. Norderval et al[18] reported that the mesiodistal diameter of four mandibular incisor teeth was significantly larger in adults with slight crowding in the mandibular anterior segment.

A review of the literature indicated conflicting results about the factors contributing to crowding. These differences may be due to variables such as the developmental period of the study sample, differences in sample sizes, and the methods used for measurements. Few studies have evaluated mandibular anterior crowding in the early mixed dentition. The aim of this study was to find possible factors contributing to mandibular anterior crowding in the early mixed dentition.

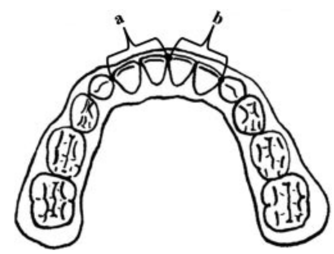

FIGURE 1. The space available for the mandibular permanent incisors.

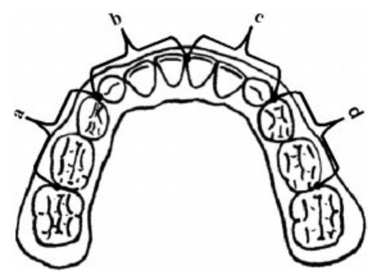

FIGURE 2. Total mandibular arch length.

MATERIALS AND METHODS

Mandibular dental casts of 60 children (29 boys, 31 girls) referred to the Department of Orthodontics, Suleyman Demirel University were evaluated in this study. These subjects were selected according to the following criteria:

- Class I skeletal pattern;
- Early mixed dentition stage (fully erupted four permanent mandibular incisors, deciduous canines, deciduous molars, and permanent first molars);
- No congenitally missing permanent teeth or premature loss of deciduous or permanent teeth;
- Minimal loss of tooth dimension by caries or attrition.

None of the subjects had undergone previous orthodontic treatment. Two groups were formed according to the severity of mandibular anterior crowding. Because 1.6 mm of mandibular anterior crowding was reported as normal at this stage,[6–8] subjects who had anterior crowding $\leq$1.6 mm were included in the noncrowded group (NCG) and those who had anterior crowding $>$1.6 mm were included in the crowded group (CG). Each group was composed of 30 subjects. Mean chronological ages of the groups are shown in Table 1.

The following measurements were performed on each mandibular plaster model. Available space: the space available for the mandibular permanent incisors was measured between the mesial surfaces of deciduous canines by dividing the dental arch into two straight line segments, the length of these segments was summed to give available space[9] (Figure 1); total incisor width: the width of each incisor was measured and summed to give total incisor width; crowding: total incisor width was subtracted from available incisor space to calculate the severity of crowding; total arch length: total mandibular arch length was measured as segments on the right and left sides, as defined by Warren and Bishara.[19] For the anterior segment, measurements were performed from the contact point of the permanent central incisors to the contact point between the deciduous canine and the first deciduous molar. For the posterior segment, measurements were performed from the contact point between the canine and first deciduous molar to the most distal point of the second deciduous molar. The segment lengths for the right and left sides were summed to determine total arch length (Figure 2); intercanine width: distance between the cusp tips of mandibular deciduous canines (Figure 3); intermolar width I: distance between mesiolingual cusp tips of mandibular first deciduous molars (Figure 3); intermolar width II: distance between mesiobuccal cusp tips of mandibular second deciduous molars (Figure 3); permanent intermolar width: distance between mesiobuccal cusp tips of mandibular first permanent molars

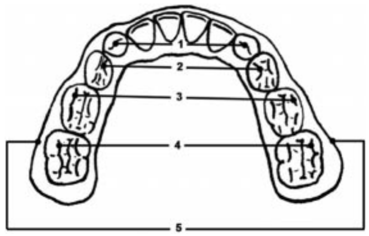

FIGURE 3. Arch and alveolar width measurements.

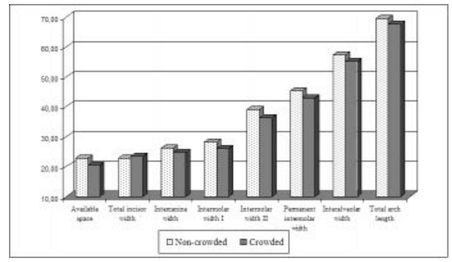

FIGURE 4. Bar graphs of the measurements.

TABLE 2. Reliability Coefficients of the Measurements

	r
Available space	0.9803
Total incisor width	0.9646
Intercanine width	0.9646
Intermolar width I	0.9922
Intermolar width II	0.9795
Permanent intermolar width	0.9971
Interalveolar width	0.9934
Total arch length	0.9930

(Figure 3); interalveolar width: distance between mucogingival junctions below the buccal grooves of the right and left mandibular first permanent molars (Figure 3).

All the measurements were performed on plaster models with dial caliper to the nearest 0.01 mm. All measurements of 20 subjects were repeated two weeks later to determine measurement error. The repeatability coefficients of the measurements were shown in Table 2. Statistical comparison of the two groups was performed with independent samples *t*-test. Pearson correlations were examined for interrelationships between crowding and all other measurements.

RESULTS

Statistical comparison of the groups

Statistical comparison of the groups is shown in Table 3. All the parameters except total incisor width were significantly different. Bar graphs of the measurements are shown in Figure 4.

Available space. The space available for the mandibular permanent incisors was significantly larger in NCG ($P < .001$).

Total incisor width. Total width of the four mandibular incisors did not differ significantly between the groups.

Intercanine width. Mandibular deciduous intercanine width was significantly larger in NCG ($P < .01$).

Intermolar widths I and II. Mandibular deciduous intermolar widths I and II were significantly larger in NCG ($P < .001$).

Permanent intermolar width. Mandibular permanent intermolar width was significantly larger in NCG ($P < .001$).

Interalveolar width. Mandibular interalveolar width was significantly larger in NCG ($P < .01$).

Total arch length. Total arch length was significantly larger in NCG ($P < .01$).

Measurement correlations. Correlations of the measurements are shown in Table 4. Significant inverse correlations were found between crowding and available space ($r = 0.63$; $P < .001$), intercanine width ($r = 0.37$; $P < .01$), intermolar width I ($r = 0.58$; $P < .001$), intermolar width II ($r = 0.52$; $P < .001$), permanent intermolar width ($r = 0.34$; $P < .01$), and interalveolar width ($r = 0.28$; $P < .05$). Total incisor width was directly correlated with crowding ($r = 0.43$; $P < .01$). No significant correlation was found between crowding and total arch length.

TABLE 3. *t*-Test Comparison of the Measurements

	Noncrowded (n = 30)		Crowded (n = 30)		
	Mean	SD	Mean	SD	*P*
Available space	22.81	1.59	20.46	1.38	.000***
Total incisor width	22.91	1.72	23.47	1.52	.181 NS[a]
Intercanine width	26.27	1.73	24.74	1.73	.001**
Intermolar width I	28.29	1.56	26.12	1.59	.000***
Intermolar width II	39.02	1.88	36.28	2.01	.000***
Permanent intermolar width	45.52	2.24	42.98	2.59	.000***
Interalveolar width	57.27	2.34	55.16	2.19	.001**
Total arch length	69.72	2.98	67.63	2.64	.006**

[a] NS indicates nonsignificant.
** $P < .01$.
*** $P < .001$.

TABLE 4. Pearson Correlation Coefficients of the Measurements

	Crowding	
	r	*P*
Available space	−0.63	.000***
Total incisor width	0.43	.001**
Intercanine width	−0.37	.004**
Intermolar width I	−0.58	.000***
Intermolar width II	−0.52	.000***
Permanent intermolar width	−0.34	.008**
Interalveolar width	−0.28	.033*
Total arch length	−0.17	.203 NS[a]

[a] NS indicates nonsignificant.
* $P < .05$.
** $P < .01$.
*** $P < .001$.

DISCUSSION

The term ''incisor liability'' was defined as the difference between the amount of space needed for the incisors and the amount available.[6] In the mandible, because of incisor liability with a mild irregularity of the mandibular incisors, a mean of 1.6 mm was accepted as normal when the permanent incisors and first molars had erupted but the primary canines and molars were retained.[6–8] For this reason, patients whose mandibular anterior crowding was ≤1.6 mm were included in the NCG. Patients whose mandibular anterior crowding was >1.6 mm were included in the CG.

Patients with minimal loss of tooth dimension were selected so as not to affect arch length measurements. A Class I skeletal pattern was also taken into consideration for all patients so as not to affect arch dimensions. The mean ages of the patients in each group did not differ significantly. This was important because of continuing growth and development. Finding the possible factors contributing to mandibular anterior crowding in the early mixed dentition is of great importance for further treatment planning.

Some of the reports in the literature found differences in arch widths between patients with and without crowding. Howe et al[13] compared 50 subjects with severe crowding with 54 subjects with mild or no crowding and found that mandibular arch widths were significantly larger in the NCG. They concluded that consideration might be given to those treatment techniques that increase dental arch length rather than reduce tooth mass. Radnzic[14] evaluated 120 boys (age 13 years to 15 years 11 months) and reported that crowded arches had smaller arch widths than noncrowded or spaced arches. He suggested that expansion might occasionally be beneficial in carefully selected young patients and in the majority of cases, carefully planned extractions would continue to be an important part of treatment in the relief of primary dental crowding.

Sanin and Savara[9] evaluated 150 children and reported that children without crowding in the permanent dentition had larger anterior and posterior widths of the mandibular dental arch. Norderval et al[18] compared 27 adults with ideal occlusion with 39 adults with slight mandibular crowding and reported no differences in intercanine widths between the groups. Hagberg[15] examined dental casts longitudinally of 54 Swedish children aged seven, nine, 10, and 13 years and associated an intercanine distance less than 26 mm with crowding. He also reported that a distance of 28 mm or more had no risk for crowding. According to our findings, mandibular deciduous intercanine width, mandibular deciduous intermolar widths I and II, mandibular permanent intermolar width, and mandibular interalveolar width were significantly larger in NCG. These findings indicated that a mandibular transverse discrepancy existed in CG. In accordance with Hagberg,[15] the mean intercanine width was 26.3 in the NCG and 24.7 in the CG. Although we examined patients in the early mixed dentition, our findings were in accordance with those of Howe et al,[13] Radnzic,[14] and Sanin and Savara,[9] who evaluated permanent dentitions. This suggests that arch width differences between CG and NCG can be determined even in the early mixed dentition.

Some researchers investigated contributions of arch length to crowding. Sanin and Savara[9] reported that children without crowding in the permanent dentition had more available space for the emergence of the canines than children with crowding. Radnzic[14] reported that crowded arches had smaller arch lengths than noncrowded or spaced arches. Melo et al[16] evaluated 12 normal and 11 crowded cases at the primary dentition stage and reported that mandibular dental arch length was an effective discriminator in separating the two groups. Our results indicated that the space available for the mandibular permanent incisors and total arch length was significantly larger in NCG. Although the methods used to measure arch length and dentitional stages of the subjects were different, our results were in accordance with those of Sanin and Savara,[9] Radnzic,[14] and Melo et al.[16]

Some authors found differences in tooth dimensions between subjects with and without crowding. Norderval et al[18] reported that the four mandibular incisor teeth had significantly larger mesiodistal diameters in the CG. Doris et al[20] evaluated 80 subjects (between 11 and 18 years of age) and reported that mesiodistal tooth size was uniformly larger in the group with crowded arches. Howe et al[13] reported that CG and NCG could not be distinguished from each other on the basis of mesiodistal tooth diameters. Radnzic[14] did not find a difference in cumulative crown widths between crowded and noncrowded arches but reported that cumulative mesiodistal crown widths contributed significantly to dental crowding. Mills[11] evaluated 230 male subjects and reported little variations between crown diameters of persons with and without malalignment. In accordance with Howe et al,[13] our results indicated that the total width of four mandibular incisors did not differ significantly between CG and NCG.

Several investigators studied associations between crowding and arch dimensions and tooth size using correlation analysis. Mills[11] reported a significant association between crowding and arch width. McKeown[12] evaluated 65 children and found a greater correlation between dental arch size and crowding than between tooth size and crowding. Radnzic[14] reported significant correlations between arch dimensions and the degree of crowding but no significant correlation between cumulative mesiodistal crown widths and dental crowding. Hagberg[15] reported that Pearson correlation coefficient between intercanine distance and crowding was significant with the exception of seven-year-old girls and 13-year-old boys.

Sampson and Richards[21] investigated 47 longitudinal cases and reported that crowding at the early mixed and permanent dentition stages was related directly to tooth size and inversely to molar arch width and canine arch width. Fastlicht[17] reported significant correlation between dental crowding and mesiodistal dimensions of mandibular permanent incisors. In our study, the results of correlation analysis indicated significant inverse correlations between crowding and available space, intercanine width, intermolar width I, intermolar width II, permanent intermolar width, and interalveolar width. Total incisor width was directly correlated with crowding. No significant correlation was found between crowding and total arch length.

Although mean values of tooth size did not exhibit a significant difference between patients with and without crowding, the results of the correlation analysis indicated significant direct correlations between crowding and total incisor width. These results may indicate that arch dimensions play a more important role than tooth size in the development of crowding. No significant correlation was found between crowding and total arch length, although total arch length was significantly larger in NCG. This may indicate that when considered in isolation, arch length and crowding was not correlated, but arch length may significantly contribute toward crowding when evaluated together with other factors.

CONCLUSIONS

Mandibular deciduous intercanine width, mandibular deciduous intermolar widths I and II, mandibular permanent intermolar width, and mandibular interalveolar width were significantly larger in NCG.

The space available for the mandibular permanent incisors and total arch length were significantly larger in NCG.

The results of the correlation analysis indicated significant correlations between crowding and total incisor width, available space, intercanine width, intermolar width I, intermolar width II, permanent intermolar width, and interalveolar width. No significant correlation was found between crowding and total arch length.

The results of this study also suggested that individual variations play an important role in treatment planning. However, one must not overlook arch length discrepancy and transverse discrepancy in patients with mandibular anterior crowding. For this reason, the application of a lingual arch or lip bumper in patients with anterior mandibular crowding may be of value in the early mixed dentition.

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