RESEARCH ARTICLE

Arch Measurements, Bigonial Width, Dental Caries, and Their Effect on Occurrence of Mandibular Incisors Crowding in Early Mixed Dentition Period

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Abstract

Aim and objective: To assess the effect of various arch parameters, bigonial angle, and caries occurrence on mandibular incisors crowding during the early mixed dentition period.

Materials and methods: Sixty children (mean age of 7.5 years) with mandibular anterior incisors crowding and class I molar relationship in early mixed dentition were selected. Bigonial width (BW) and caries occurrence were recorded during patient examination. The study casts were prepared divided into a normal group (NG) and crowded group (CG). Different vertical and transverse arch perimeters along with space available for the permanent mandibular incisors were measured manually. Statistical analysis was done to establish the association of all these variables with two crowding groups.

Results: The total incisor width or the tooth material was significantly more, and all arch parameters were less in measurements in CG than NG. The available space, BW, and caries occurrence did not differ significantly between NG and CG.

Conclusion: The amount of tooth material and individual variations in arch parameters significantly contribute to mandibular anterior crowding in the early mixed dentition period irrespective of the age and gender of the child.

Clinical significance: All cases of early mixed dentition mandibular incisors crowding should be individually assessed for arch length discrepancy, and transverse discrepancy results of this study help in the prediction of crowding before an establishment of a customized treatment plan with the use of lingual arch or lip bumper appliances in patients with anterior mandibular crowding may be valuable.

Keywords: Available space, Mandibular incisor crowding, Mixed dentition, Total incisor width.

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Introduction

Eruption of well-aligned permanent teeth contributes to the health of oral musculature, soft tissue along with the influence on the personality of a growing individual. Early malocclusion like mandibular incisor crowding compromises the normal development of a stomatognathic system and can lead to psychological and social problems.[1]

Crowding of the permanent mandibular incisors is one of the most prevalent forms of malocclusion associated with newly erupted teeth in children. The discrepancy between total mandibular permanent incisors width and the available space in the alveolar process may cause this.[2] Slight crowding may be managed with minor tooth movements like increasing intercanine width (ICW) by interproximal slicing of primary canines or their distal movement into the primate spaces.[3] Dental caries is the most common chronic disease of teeth in children. Attainment of close proximal contacts on the eruption of permanent teeth causes an increase in deposition of cariogenic plaque on the susceptible host (tooth).[4] Proximal carious lesions are frequently observed in association with irregular teeth. It is a challenge for children to maintain oral hygiene due to unfavorable contact areas and spillways, resulting in increased susceptibility to caries development.[5] It will be beneficial to study the etiology and factors associated with the development of crowding in newly erupted permanent mandibular incisors so that crowding can be predicted for timely intervention.[6] The present study aimed to assess the association of various arch parameters measured on study cast, bigonial angle, and caries occurrence with mandibular incisors crowing during the early mixed dentition period in Faridabad city.

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Materials and Methods

The present study was conducted in a unique group of 60 children between 6 and 9 who reported a complaint of crowding in relation to their mandibular incisors in the department of pediatric dentistry, Sudha Rustagi College of Dental Sciences and Research Faridabad.

Inclusion Criteria

(i) Class I skeletal malocclusion in early mixed dentition stage having erupted, in occlusion four permanent mandibular incisors and permanent first molars. (ii) No missing permanent teeth or premature loss of primary or permanent teeth should be there.

Exclusion Criteria

(i) Hypoplastic teeth and missing teeth. (ii) Partially erupted or impacted permanent mandibular incisors. (iii) Craniofacial syndromes.

Ethical clearance was obtained from the Institutional Ethical committee. Before the onset of the study, the purpose of the study was informed and explained. The consent was obtained from parents and volunteers to participate in the present study. Data were collected from clinical examination, and dental study casts of selected cases with completely erupted permanent mandibular incisors and first permanent molars with Angles class I molar relationship were prepared for analysis. Subjects were divided into two groups based on the severity of mandibular anterior crowding.

The most common type of malocclusion is crowding, although somewhat crowded mandibular incisors are considered a normal developmental stage. When the permanent mandibular lateral incisors erupted, the four mandibular incisors needed an extra 1.6 mm of space to align perfectly.[7] Subjects in the normal group (NG) (Fig. 1A) had incisor crowding of <1.6 mm, while those in the crowded group (CG) had incisor crowding of >1.6 mm (Fig. 1B).

Technique of Measuring Arch Parameters

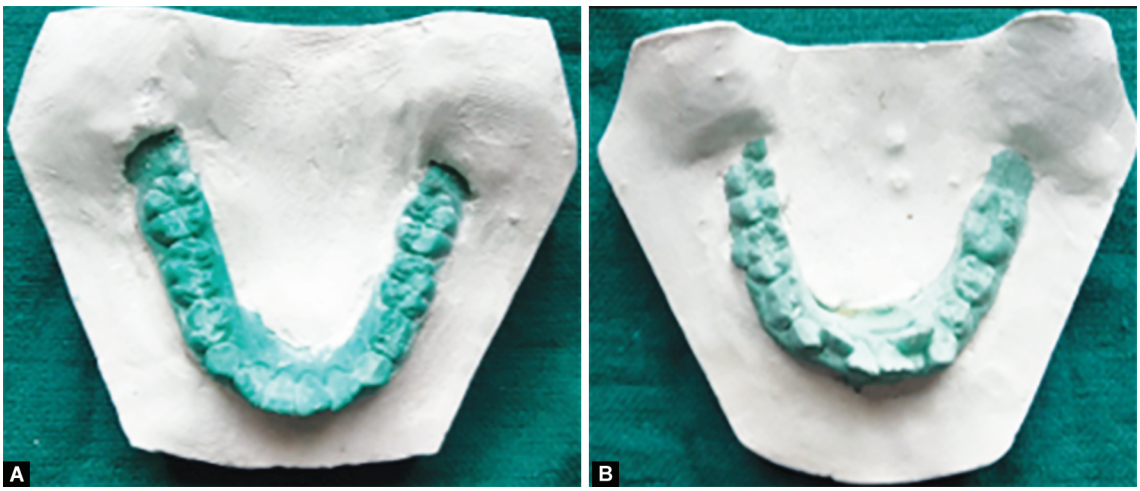
The space available for the permanent mandibular incisors was measured between the mesial surfaces of primary canines. Mandibular total incisor width was subtracted from available incisor space to calculate the severity of crowding. The total mandibular arch length was measured as segments on the right and left sides: ICW and the distance between mandibular primary canines' cusp tips. Distance between mesiobuccal cusp tips of mandibular second primary molars was recorded as intermolar width (IMW) and distance between mesiobuccal cusp tips of mandibular first permanent molars as permanent IMW. Distance between mucogingival junctions below the buccal grooves of the right and left mandibular first permanent molars was considered interalveolar width (IAW) and measurement from gonion to gonion on soft tissues bigonial width (BW).

Statistical Analysis

All measurements were taken with a dial caliper or divider on plaster models to the nearest 0.01 mm. To evaluate measurement error, all measures were repeated 2 weeks later. For age and gender distributions, the Chi-square test was used, and an independent samples *t*-test was used to compare the two groups statistically. Interrelationships between crowding and all other parameters were investigated using Pearson correlations. Intraoral photographs were taken to determine the molar relation. DMFT/deft index was recorded.

Results

There were 60 patients in total in the present study, inclusive of 23 females and 37 males. Males and females in the sample population were found to have mean ages of 7.490989 and 7.431121, respectively (Table 1). The space available for the permanent mandibular incisors in the CG (20.7787) was less than the non-crowded group (NCG) (20.8367) though the difference was not significant ($p = 0.932$). The difference of total incisor width of the four mandibular incisors of a CG (24.920) as compared to the NCG (21.617) was statistically significant ($p < 0.0001$). The total arch length of the CG (71.173) was significantly less as compared to the NCG (83.713) arch length ($p < 0.0001$). Mandibular primary ICW of the CG (25.273) was significantly less than NCG (29.787) ($p < 0.0001$). A significant difference ($p < 0.0001$) was found as mandibular primary IMW of the CG (36.520) was less than NCG (40.547). Mandibular permanent IMW of the CG (44.333) was significantly less than NCG (50.333) ($p < 0.0001$). Significance difference ($p < 0.0001$) was found as mandibular IAW of CG (54.777) was less than NCG (61.220). No apparent difference ($p = 0.358$) was found through the BW of the CG (80.303) was greater than that NCG (79.867). These results (Table 1) show that smaller arch parameters contributed to crowding in our CG of children except the BW and space available (Table 2) shows the effect of gender as a factor affecting crowding. The space available for the permanent mandibular incisors in males (20.669) was lesser than in females (21.030) though the difference was not significant ($p = 0.623$). The difference was not significant ($p = 0.384$) with a total width of the four mandibular incisors of males being (22.962) when compared with females (23.760). No significant difference ($p = 0.424$) was found though crowding of the four mandibular incisors of females (2.686) was slightly more when compared with males (2.320). The total arch



Figs 1A and B: (A) Non-crowded group; (B) Crowded group

Table 1: *t*-test comparison of the measurements according to the presence of crowding

	Crowding	*N*	*Mean*	*Std. deviation*	*p value*
Available space (AS)	Crowded	30	20.7787	2.92405	0.932, NS
	Non-crowded	30	20.8367	2.28360	
Total incisor width (TIW)	Crowded	30	24.920	2.6440	<0.0001, S
	Non-crowded	30	21.617	2.9854	
Crowding	Crowded	30	4.0533	0.79034	<0.0001, S
	Non-crowded	30	0.8687	0.30480	
Total arch length (TAL)	Crowded	30	71.173	4.6241	<0.0001, S
	Non-crowded	30	83.713	7.9478	
Intercanine width (ICW)	Crowded	30	25.273	1.6741	<0.0001, S
	Non-crowded	30	29.787	2.1318	
Intermolar width (IMW)	Crowded	30	36.520	1.7474	<0.0001, S
	Non-crowded	30	40.547	1.9652	
Permanent intermolar width (PIMW)	Crowded	30	44.333	1.8453	<0.0001, S
	Non-crowded	30	50.333	2.3999	
Interalveolar width (IAW)	Crowded	30	54.177	1.6425	<0.0001, S
	Non-crowded	30	61.220	2.6067	
Bigonial width (BW)	Crowded	30	80.303	1.9136	0.358, NS
	Non-crowded	30	79.867	1.7357	

Independent *t*-test; S, significant; NS, non-significant

Table 2: Comparison of measurements according to the gender

Parameters	*Sex*	*N*	*Mean*	*Std. deviation*	*p value*
AV. space	Male	37	20.669	2.392	0.623, NS
	Female	23	21.030	2.949	
Total IW	Male	37	22.962	2.981	0.384, NS
	Female	23	23.760	3.666	
Crowding	Male	37	2.3205	1.725	0.424, NS
	Female	23	2.686	1.703	
Total AL	Male	37	78.089	9.214	0.483, NS
	Female	23	76.404	8.825	
Inter-CW	Male	37	27.543	2.793	0.967, NS
	Female	23	27.508	3.286	
IM width	Male	37	39.083	2.809	<0.0001, S
	Female	23	37.647	2.434	
Perm. IMW	Male	37	47.295	3.681	0.920, NS
	Female	23	47.396	3.799	
IAL. width	Male	37	58.113	4.321	0.319, NS
	Female	23	57.030	3.875	
BW	Male	37	80.208	1.895	0.503, NS
	Female	23	79.886	1.726	

Student's *t*-test; S, significant; NS, non-significant

length of females (76.404) was less than males (78.089) which were not statistically significant ($p = 0.483$). Mandibular primary ICW of females (27.508) was slightly less than males (27.543) ($p = 0.967$).

A significant difference ($p < 0.0001$) was found as mandibular primary IMW of females (37.647) was less than males (40.547). This factor may contribute to more crowding in females in the early mixed dentition period. No significant difference ($p = 0.921$) was found through mandibular permanent IMW of males (47.295) was less than females (47.396). This difference may be because of late development in males than females in the early years of life. No apparent difference ($p = 0.319$) was found as mandibular IAW of females (57.030) was less than males (58.113). No significant difference ($p = 0.503$) was found as the BW of males (80.208) was more than females (79.886).

Table 3 shows significant inverse correlation between crowding and ICW ($r = 0.727, p < 0.0001$), IMW ($r = 0.717, p < 0.0001$), permanent IMW ($r = 0.729$, $p < 0.0001$), and IAW ($r = 0.803$, $p < 0.0001$). Total incisor width was directly correlated with crowding ($r = 0.613$, $p <$

Table 3: Pearson correlation coefficients of the measurements

	Crowding	
	R	*p value*
Available space	−0.064	0.628, NS
Total incisor width	0.613	<0.0001, S
Intercanine width	−0.727	<0.0001, S
Intermolar width	−0.717	<0.0001, S
Permanent intermolar width	−0.729	<0.0001, S
Interalveolar width	−0.803	<0.0001, S
Bigonial width	0.157	0.230, NS

Pearson correlation coefficient; S, significant; NS, non-significant

Table 4: Mean DMFT according to the presence of crowding

		DMFT		
Crowding	*N*	*Mean*	*Std. deviation*	*p value*
Crowded	30	2.43	1.406	0.031, S
Non-crowded	30	1.63	1.402	

Independent *t*-test

0.0001). No significant correlation was found between crowding and available space or BW.

Table 4 shows a significant difference ($p = 0.031$) as the mean (DMFT + deft) of the CG (2.43) was more than that of the NCG (1.63).

Discussion

The most common type of malocclusion is swarming, i.e., crowding of teeth.[8] Dental crowding is the discrepancy between jaw size and tooth size leading to rotation and overlapping of teeth, thus, in turn, causing a change in arch width, arch length, IMW, etc., which is also influenced by various environmental, genetic, and hereditary factors.[9,10] According to Das and Venkatsubramanian, in patients with class I malocclusion, crowded incisors were the most common finding, followed by protruded maxillary incisors, deep anterior overbite, anterior crossbite, posterior crossbite, and mesial drift of molars in that order.[1] Hwang stated that large tooth sizes and short arch widths led to class I dental crowding, according to a study of 164 Korean patients that included 82 crowded casts and 82 well-aligned castings.[11] Bugaighis and Ludstrom concluded that crowding is caused by large tooth size rather than short arch width, according to the reports.[12,13]

The present study elaborates on the factors affecting mandibular incisor crowding in early mixed dentition (6–8 years old) children. The results revealed that the total incisor width and crowding were found to be significantly higher among those subjects who were having crowded arches when compared with those who were having non-crowded arches. At the same time, total arch length (TAL), ICW, IMW, permanent intermolar width (PIMW), IAW, and BW were found to be significantly lower among those subjects who were having crowded arches when compared with those who were having non-crowded arches. Available space and BW did not show any difference. Also, the CG's mean (DMFT + deft) score was considerably higher than that of the non-crowded subgroup. Incisor liability with a slight irregularity of the mandibular incisors, a mean of 1.6 mm was accepted as expected when the permanent incisors and first molars had erupted, but the first canines and molars were retained.[7,14] 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. Class I skeletal pattern was also considered for all patients so as not to affect arch dimensions. The mean ages of the patients in each group did not differ significantly. Finding the possible factors contributing to mandibular anterior crowding in the early mixed dentition is vital for further treatment planning.

Gender Ratio

Mandibular crowding in females was slightly greater than males, although the difference was not significant.

Available Space and Crowding

Children without crowding in the permanent dentition had more space available for the erupting canines than children with crowding, according to the study.[15,16] The space available for permanent mandibular incisors in the CG was less than the NCG in the current study, although the difference was not significant.

Total Incisor Width and Crowding

Some authors found differences in tooth dimensions between subjects with and without crowding. Those with minor mandibular crowding had wider mesiodistal widths of the four lower incisor teeth than subjects without lower incisor crowding, according to Norderval et al.[17] Doris et al. discovered that the sum of mesiodistal tooth diameters was statistically significant in crowded casts.[18] Puri et al. when compared crowded to normal dental arches, the MD dimensions of individual teeth, the sum of the incisors, and the total of the canines were uniformly larger in crowded arches.[19] The total width of the four mandibular incisors in the CG was higher than in the NCG in the current study.

Total Arch Length

Forsberg discovered that the arch dimensions mattered more than the tooth dimensions when it came to crowding. Some scholars looked into the role of arch length in crowding.[20] According to Rahbar and Chaudhry, non-crowded arches had longer arch lengths than crowded arches, and the differences were statistically notable (p 0.05).[21] This finding is consistent with our findings, as the non-crowding group's lower arch length was considerably more than the crowding group's for only a few of the parameters studied. Mckeown found a strong link between arch size and crowding in his 65-cast analysis, with the two variables being inversely related.[22]

In the present analysis, the CG's total arch length was lower than the non-crowded lower arch group.

Intercanine Width

Norderval et al. compared 27 persons with perfect occlusion to 39 adults with minor mandibular crowding and found no variations in ICWs.[17] Hagberg found that an ICW of <26 mm is related to crowding in 7-, 9-, and 10-year-old children, while a width of 28 mm or more is projected to have no risk of crowding up to the age of 10.[23] Males had considerably larger mean inter-width in canine in both the maxilla and mandible than females (Daniel et al.). In this study, the CG's ICW was smaller than the NCG's in the mandibular arch.

Intermolar Width and Permanent Intermolar Width

Arch width and crowding were found to be substantially associated in a study of 65 dental casts obtained from people aged 18–25, with a narrow arch predisposing to tooth crowding (McKeown).[24]

Howe et al. compared 50 subjects with severe crowding with 54 subjects with mild or no crowding and located those mandibular arch widths were significantly more in the NCG. They concluded that consideration could be given to those treatment techniques that increase dental arch length rather than reduce tooth mass.[24] Kaundal in a research of 40 Indian patients, arch perimeter and IMWs were shown to be lower in individuals with crowding than in patients without crowding. Males had considerably wider IMWs in both the maxilla and mandible than females[25] (Daniel et al.). In the present study, the mandibular deciduous and PIMW of the CG was less than the NCG.

Interalveolar Width

According to Sayin and Turkkahraman, no apparent difference was noted among Angles Class I and Class II div1 malocclusion; mandibular IAW was significantly greater in the NCG.[26] The first ICW (*D*), first primary IMW (*E*), and alveolar arch width were identified to be predisposing factors of tooth crowding in the mixed dentition era by Indriyanti et al.[16] There was a significant difference (p 0.05) between male and female groups in all dimensions of the anterior and posterior alveolus in both maxilla and mandible, i.e., IAW is more in males than females (Alhadlaq et al.). In the present study, the CG's mandibular IAW was less than the NCG.

Bigonial Width

No research in the literature looked at the link between bigonial breadth and mandibular incisor crowding, however, in our study, the BW of the CG was slightly more than that of the NCG, but the difference was not significant. Also, the BW of males was slightly greater than that of the NCG, but the difference was again not significant.

(DMFT+deft) and Crowding

According to Disha et al., when the correlation of dental caries and malocclusion among the study subjects was studied, in the permanent dentition, 13.5% of the subjects who had malocclusion experienced dental caries, and in the primary dentition, the score was 60.9%, which was statistically insignificant.[26] In addition, in a study by Luzzi et al., in 2011, except for the association among midline deviation and the extraction of primary tooth element, there was no statistically significant link between caries and clinical orthodontic abnormalities ($p = 0.07$).[27] In a study by Buczkowska-Radlinska et al. in 2012, Polish children with crowded teeth in the primary and mixed dentition did not have more caries than children without crowding.[28] The lack of relationship between crowding and dental caries in the anterior teeth in primary and mixed dentition may be related to shorter exposure to caries-promoting conditions. The mean (DMFT + deft) score was found to be considerably higher in the crowded subgroup than in the non-crowded subgroup in the current study.

Conclusion

- Mandibular deciduous ICW, mandibular deciduous IMW, mandibular PIMW, total arch length, and mandibular IAW were significantly greater in the NCG, while total incisor width was significantly greater in the CG.
- The results of the correlation analysis indicated significant correlations between crowding and total incisor width, ICW, IMW, PIMW, and IAW. Total incisor width (TIW) showed a statistically significant positive correlation with crowding. While ICW, IMW, PIMW, and IAW showed a statistically significant negative correlation with crowding.
- Bigonial width and available space (AS) did not show any statistically significant correlation with crowding.
- The mean (DMFT + deft) score was found to be significantly more among the crowded subgroup than that among the non-crowded subgroup.

Clinical Significance

All cases of early mixed dentition mandibular incisors crowding should be individually assessed for arch length discrepancy, and transverse discrepancy results of this study help in the prediction of crowding before and establishment of a customized treatment plan with the use of lingual arch or lip bumper appliances in patients with anterior mandibular crowding may be valuable.

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