Factors for crowding in the early mixed dentition stage

ABSTRACT :

Objective: To find out the factors responsible for crowding in the early mixed dentition.

Materials and methods: 60 dental casts of children in their early mixed dentition (30 boys and 30 girls) were divided into crowded and noncrowded groups. Comparison were made between the two groups according to following criterion: -(1) space available for permanent lower incisors, (2) total incisor width, (3) deciduous intermolar width, (5) permanent intermolar width, (6) interalveolar width, (7) total arch length. Correlation of the measurements with crowding was also evaluated.

Statistical analysis used: Data was analysed using STATA-12.0 (STATA SE, StataCorp., Texas, USA). Means, standard deviation, and medians were calculated for describing the data. Data was tested for normality using Shapiro-Wilks test. Since all variables were found to be non-normally distributed, therefore comparison of all measurements between the crowded and non-crowded groups was done using Wilcoxon ranksum test (Mann-Whitney test). All values were considered statistically significant for a value of $p<0.05$.

Results: Mandibular deciduous intercanine width was significantly larger in Noncrowded Group. The space available for the mandibular permanent incisors and total arch length were significantly larger in Noncrowded Group. The correlation analysis indicated significant correlations between crowding and available space, intercanine width, intermolar width I. No significant correlation was found between crowding and intermolar width II, permanent intermolar width, and interalveolar width.

Conclusion: Procedures which preserve the arch length such as timely restoration of proximal caries, prevention of premature loss of deciduous teeth and use of space maintainers such as lingual arch may prove useful in alleviating crowding.

Key Message: Dental crowding is associated with small dental arches rather than with large teeth, greater consideration may be given to those treatment techniques which increase dental arch length. This may be especially relevant in younger patients whose dentitions are in the mixed stages of development.

Keywords: crowding, arch length, early mixed dentition

Introduction:

Dental crowding is defined as a discrepancy between tooth size and jaw size that results in a misalignment of the tooth row[1]. For esthetic reasons, patients with lower anterior crowding comprise a significant portion of visits to a dental office[2].

Arnold 3reported crowding in 85% of mandibular models examined with an average of 4.5mm of crowding in the mixed dentition. Al-Sehbaug4 in their study of Saudi population found that 62.3 % of children (7-9 years) and 49.5 % of children (>9-11 years) had crowding in mandible. Keski Nisula5 in their study found that anterior crowding was detected in the maxillary arch in 11.6% and in mandibular arch 38.9% of children in early mixed dentition. Sanin & Savara6 in a study of 150 children in the mixed dentition, 89 % of patients who had crowding in the mixed dentition had crowding in the permanent dentition.

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[1]SHARMA, K., [2]KOHLI, A., [3]KATIYAR, A., [4]PANDA, S., [5]KATYAYAN, R.

[1,2,3,5]Department of Paedodontics and Preventive Dentistry, Rama Dental College, Hospital and Research Centre, Kanpur.

[4]Department of Orthodontics and Dentofacial Orthopaedics Rama Dental College, Hospital and Research Centre, Kanpur.

Address for Corresponding : Dr. Karuna Sharma Department of Paedodontics and Preventive Dentistry, Rama Dental College, Hospital and Research Centre, Kanpur.
Email : drkarunasharma999@gmail.com

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Correction of Dental crowding can be accomplished by various Orthodontic procedures. Brennan & Gianneley (2000) placed lingual arch to preserve arch length and make the leeway space available to in 107 patients in mixed dentition.[7] They found that there was adequate space in 60% of the cases to resolve crowding. Thus the importance of treating crowding in mixed dentition. Other treatment modalities include extraction[8], expansion[9], proximal stripping[9], molar distalization[10]. Selection of appropriate treatment approach may depend upon which factors influence the observed crowding.

Review of literature has shown that very few studies have evaluated the factors affecting crowding in mixed dentition and also they have shown conflicting results. Hence the need for the present study.

Materials and Methods:

Ethical approval was sought and granted for the study by the institutional ethical committee. Mandibular dental casts of 60 children (30 boys, 30 girls) referred to the Department of Paedodontics and Preventive Dentistry, Rama Dental College, Hospital and Research Centre, Lakhanpur, Kanpur were evaluated in this study. The children were selected following an oral examination performed under standard light source using a mirror with a good reflecting surface and stainless steel explorer. These subjects were selected according to the following criteria:

Inclusion criteria:

1. Class I occlusion (bilateral Class I molars in centric occlusion relationship)
2. Early mixed dentition stage (fully erupted first permanent molars and four permanent lower incisors along with deciduous canines, deciduous molars).

Exclusion criteria:

1. Children with loss of tooth dimension by proximal dental caries or trauma.
2. Children with congenitally missing primary or permanent teeth.
3. Children having deleterious oral habits.
4. Children with any previous history of extraction.
5. Children with acquired/developmental dental deformities

Two groups were formed according to the severity of mandibular anterior crowding as suggested by Sayin & Türkkahraman. 11

1. Noncrowded group- subjects who had anterior crowding =1.6 mm
2. Crowded group-subjects who had anterior crowding >1.6 mm.

This slight crowding of 1.6mm has been reported to be solved by a slight increase in intercanine width and labial positioning of the permanent incisors relative to the primary incisors.[12,13] Each group comprised of 30 subjects. Because sex distribution of the samples showed little difference between the groups (noncrowded group: 16 boys, 14 girls; crowded group 14 boys, 16 girls), the measurements for males and females were pooled in the statistical procedures. Mean chronological ages of the subjects were 9.23 years (range 7-11 years).

Once the above requirements were met, dental examination was carried out in the department. A full depth alginate impression of mandibular arch of each child was made using stainless steel stock impression trays. The impression was washed under running tap water and was disinfected using glutaraldehyde. Later cast was prepared using dental stone. Study model cast were made. The models were trimmed using model trimmer and B.P. knife. The following measurements were performed on each mandibular plaster model as suggested by Sayin & Türkkahraman.[11]

1. Available space: The space available for the mandibular permanent incisors was measured between the mesial surfaces of the deciduous canines by dividing the dental arch into two straight line segments, the length of these segments was summed to give available space.

2. Total incisor width: The width of each incisor was measured from one contact point to the other and summed to give total incisor width;

3. Crowding: Total incisor width was subtracted from available incisor space to calculate the severity of crowding;

4. Total arch length: Total mandibular arch length was measured as segments. Posterior segment (right and left). Distance from the contact point between first

permanent molar and second deciduous molar and contact between deciduous canine and first deciduous molar. 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. The segment lengths for the right and left sides were summed to determine total arch length.

5. Intercanine width: Distance between the cusp tips of right and left of mandibular deciduous canines.

6. Intermolar width I: Distance between mesiolingual cusp tips of right and left mandibular first deciduous molars;

7. Intermolar width II: Distance between mesiobuccal cusp tips of right and left of mandibular second deciduous molars;

8. Permanent intermolar width: Distance between right and left mesiobuccal cusp tips of mandibular first permanent molars;

9. Interalveolar width: Distance between mucogingival junctions below the buccal grooves of the right and left mandibular first permanent molars.

All the measurements were performed on plaster models with a digital caliper (Rocky mountain inc., Denver, Co, USA) to the nearest 0.01 mm. The measurements of 20 randomly selected subjects were repeated two weeks later to determine measurement error.

Results:

The study group comprised of 60 subjects, divided into two groups- mandibular anterior crowding group and non-crowded group, including 30 subjects each. Mean age of the subjects was 9.23 years (S.D= 1.36), and the study group included equal proportions of males and females (30 each).

Table 1: Shows mean age (in years) of study subjects, according to gender. In males the mean age was 9.3 ± 1.23 years and in females it was 9.16 ± 1.51.

Table 2: shows the Mean Chronological Ages of the Groups. The difference in ages between the groups was insignificant.

TABLES

Table 1: Showing mean age (in years) of study subjects, according to gender

Gender	No. of subjects	Age in years Mean ± SD
Males	30	9.3 ± 1.23
Females	30	9.16 ± 1.51
Total	60	9.23 ± 1.36

Table 2: Mean Chronological Ages of the Groups

Chronological age	Crowded (n=30)				Non crowded (n=30)				z-statistic	p-value[I]
	Mean	S.D.	Min	Max	Mean	S.D.	Min	Max		
	9.0	1.38	7	11	9.46	1.33	7	11	-1.330	0.1834[NS]

IMann-Whitney test, NS: Non significant

Table 3: Shows comparison of all measurements between crowded and non-crowded groups.p values were found to be significant with respect to total arch length, were found to be highly statistically significant with respect to available space and intercanine width and p value for remaining measures were found to be non-significant.

Table 3: Showing comparison of all measurements between crowded and non-crowded groups:

Measurements (in mm)	Crowded (n= 30) Mean ± SD Median (min, max)	Non crowded (n= 30) Mean ± SD Median (min, max)	z-statistic	p-value[I]
Available space	19.76 ± 1.18 20.24 (17.55, 21.71)	23.39 ± 2.19 22.58 (20.69, 28.54)	-6.299	<0.0001**
Total incisor width	23.04 ± 1.16 22.94 (21.06, 25.06)	22.77 ± 0.99 22.86 (21.04, 24.34)	0.525	0.5996[NS]
Crowding	-3.28 ± 1.16 -2.82 (-5.87, -1.91)	0.62 ± 1.87 -0.1 (-1.49, 5.64)	-6.653	< 0.0001**
Total arch length	66.29 ± 2.74 65.43 (62.15, 70.82)	68.71 ± 4.03 67.29 (61.05, 77.48)	-2.499	0.0125*
Intercanine width	23.90 ± 1.17 23.89 (21.14, 25.58)	26.05 ± 2.34 25.42 (22.51, 32.15)	-4.118	<0.0001**
Intermolar width I	26.33 ± 1.18 26.40 (24.16, 28.85)	27.38 ± 2.49 26.98 (23.2, 33.79)	-1.649	0.0992[NS]
Intermolar width II	37.74 ± 1.65 37.68 (34.68, 42.22)	38.83 ± 2.82 38.58 (34.59, 45.69)	-1.626	0.1039[NS]
Permanent intermolar width	44.75 ± 1.45 44.65 (42.09, 48.78)	45.50 ± 2.59 45.43 (41.3, 51.49)	-1.390	0.1646[NS]
Interalveolar width	58.27 ± 1.72 58.21 (55.39, 62.79)	59.34 ± 3.96 58.93 (54.6, 71.18)	-0.724	0.4688[NS]

IMann-Whitney test; *statistically significant (p<0.05), **highly statistically significant (p<0.001),NS- not significant (p>0.05)

Significant inverse correlations were found between crowding and available space (r= -0.795; p < 0.001),

total arch length (r = -0.345, p < 0.001), intercanine width (r= -0.556; p < .0001), intermolar width I (r = -0.289; p < .05). No significant correlation was found between crowding and total incisor width, intermolar width II, permanent intermolar width and interalveolar width. (Table 4)

Intraclass correlation coefficients for reliability assessment were found to be excellent.(Table 5).

Table 4: Showing correlation of measurements with crowding:

Measurement	Crowding	
	Rho (r_s)[I]	p-value
Available space	-0.795	<0.0001**
Total incisor width	0.149	0.256[NS]
Total arch length	-0.345	0.0068**
Inter canine width	-0.556	<0.0001**
Intermolar width I	-0.289	0.025*
Intermolar width II	-0.203	0.118[NS]
Permanent intermolar width	-0.239	0.065[NS]
Interalveolar width	-0.130	0.320[NS]

I Spearman's rank correlation coefficient;
** Highly statistically significant (p<0.001);
*statistically significant (p<0.05);
NS: Non Significant (p> 0.05)

Table 5: Reliability Coefficients of the Measurements

Variable	ICC	95% CI of ICC		P value	Interpretation
		Lower bound	Upper bound		
Space available	0.998	0.994	0.999	<0.001	Excellent
Total incisor width	0.996	0.989	0.998	<0.001	Excellent
Crowding	0.998	0.995	0.999	<0.001	Excellent
Total arch length	1.000	0.999	1.000	<0.001	Excellent
Intercanine width	0.998	0.995	0.999	<0.001	Excellent
Intermolar width I	0.994	0.984	0.998	<0.001	Excellent
Intermolar width II	0.998	0.996	0.999	<0.001	Excellent
Permanent intermolar width	0.998	0.995	0.999	<0.001	Excellent
Interalveolar width	0.999	0.998	1.000	<0.001	Excellent

ICC - Intraclass correlation coefficients for reliability assessment.

Measurement Correlations:

Significant inverse correlations were found between crowding and available space (r = -0.795; p < 0.001), total arch length (r = -0.345, p < 0.001), intercanine width (r= -0.556; p < .0001), intermolar width I (r = -0.289; p < .05). No significant correlation was found between crowding and total incisor width, intermolar width II, permanent intermolar width and interalveolar width.(table 4).

Discussion:

The philosophy of early preventive and interceptive orthodontic treatment is advocated to avoid full-fledged orthodontic treatment at a later stage. India is a developing country has a high poverty level and therefore preventive orthodontic treatment deserves its importance, as orthodontic treatment is expensive and not within the affordable range of a majority of the population. So the assessment of malocclusion at an early age is important.

Crowding is very common among children and its early recognition and intervention is of utmost importance. Also, studies have shown that with timely and proper interceptive methods certain extraction cases can be turned into non extraction[12].

Various methods have been proposed to assess crowding in the dental arch[13,14]. A digital vernier caliper was used in this study as it is known to be one of the most acceptable methods of assessing crown dimensions and arch dimensions[15].

In our study the space available for permanent incisor and total arch length was significantly larger in noncrowded group. This finding was in accordance with the findings of Sayin & turkaraman[11], Sanin & Savara[6], Radnzic16 and Melo et al[17].However,the study by Radnzic16 was based on permanent dentition and that of Melo et al[17] was on primary dentition.

In our study tooth width of the mandibular incisors didn't vary significantly between the groups. This was in accordance with the study of Sayin & Türkkahraman 11, Howe et al8, Radnzic16, Mills18. However, studies by Nordeval et al[19], Doris20 showed opposite results.
Deciduous intercanine width was found to be significantly different between the groups. This finding was in accordance to the finding of Sayin & Türkkahraman [11]. This was also similar the to the findings of Howe et al8,Radnzic16, Sanin and savara6

who conducted their study on permanent dentition. Hagberg21 in his longitudinal study showed that intercanine width less than 26mm was associated with crowding and 28mm or more had no risk for crowding

In our study the deciduous inter molar widths I & II, permanent itnermolar width a and interalveolar width were not significantly different between the crowded and non crowded groups. This finding didn't agree with the finding of sayin & Türkkahraman[11] who showed a significant difference in the above mentioned measurements between the groups.

In our study space available for mandibular incisors & total arch length was significantly larger in the NCG. This finding was in accordance with the finding of sayin & Türkkahraman[11], Savin &savara6, Radznic[16] &Melo et al[17]. The findings of Melo et al[17] were based on primary dentition stage.

Significant inverse correlations were found between crowding and available space, total arch length, intercanine width, intermolar width I. No significant correlation

was found between crowding and total incisor width, intermolar width II, permanent intermolar width and interalveolar width. Sayin & Türkkahraman 11 in their study found significant inverse correlations 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.

Sardarian&Ghaferi[2] in their study showed that significant inverse correlation was found between initial intercanine width & incisor crowding in girls. Sampson & Richards[22] showed that crowding in the early mixed and permanent dentition was related directly to tooth size and inversely to molar arch width and canine arch width. Prabhakar et al[23] their study reported no significant correlation between the arch width and the presence of crowding in deciduous dentition.

Conclusion:

Following conclusions were drawn from the present study-

1. Mandibular deciduous intercanine width was significantly larger in Noncrowded Group. The space available for the mandibular permanent incisors and total arch length were significantly larger in Noncrowded Group.
2. The results of the correlation analysis indicated significant correlations between crowding and available space, intercanine width, intermolar width I. No significant correlation was found between crowding and intermolar width II, permanent intermolar width, and interalveolar width.

Procedures which preserve the arch length such as timely restoration of proximal caries, prevention of premature loss of deciduous teeth and use of space maintainers such as lingual arch may prove useful in alleviating crowding.

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