ORIGINAL RESEARCH

Assessment of Dental Crowding Occurring in Mixed Dentition in Maxillary and Mandibular Arches Based on Tooth Size–Arch Length Relationships and Certain Cephalometric Parameters

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Abstract

Aim: The aim of the study is to find indicators of crowding in primary and mixed dentition that may lead to occurrence of dental crowding in future dentition using dental measurements.

Materials and methods: A sample of 300 children was selected and divided into two groups based on their age primary dentition and mixed dentition. Dental arch impressions were made and casts were poured. The study was then divided into two phases for assessment of degree of crowding by Little's irregularity index (LII) and by measurement of tooth size-arch length discrepancies. Appropriate statistical analysis was used to assess the correlation of measurements in crowded and noncrowded groups.

Results: It was found that Little's index is less dependable as an indicator of anterior crowding. In the primary dentition, there is significant difference in inter-canine width between lower noncrowded and crowded dentition. In the mixed dentition, there is significant difference in Intermolar width between upper noncrowded and crowded dentition and in sum of incisors between noncrowded and crowded dentition in both the arches.

Conclusion: Little's index is not a reliable indicator of crowding in both primary and mixed dentition. Inter-canine width of lower arch can be considered as an indicator of crowding in primary dentition. The intermolar width of upper arch, sum of incisors in upper and lower arch and the intercanine width of upper and lower arch can be considered indicators of crowding in the mixed dentition.

Keywords: Arch width, Crowding, Little's index, Primary dentition.

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Introduction

One of the most common malocclusions found in children is dental crowding, especially in the anterior region, which is frequently observed in the mixed dentition period. Nance described dental crowding as the difference between the space needed in the dental arch and the space available in that arch, that is, the space discrepancy. Any form of crowding affects occlusion, esthetics, and proper maintenance of oral hygiene.

Occlusal harmony, normal function, and dentofacial esthetics can be achieved by early diagnosis, expediting successful treatment of developing malocclusions, hereby contributing to both short- and long-term benefits to the patient.[1]

Clinicians, according to their knowledge and experience, are accountable for recognizing, diagnosing, and managing abnormalities in developing dentition taking into consideration the complexity of associated problem.[2] Studies have proven that crowding has a direct correlation with arch dimension, and authors have also evaluated its relationship with cephalometric measurements.[3] With an early prediction of crowding, taking into consideration of evident indicators, a proper diagnosis and treatment with orthodontics or myofunctional therapies can be provided. Prompt treatment of unfavorable features in a developing occlusion result in reducing overall treatment time and providing better stability as well as esthetic results. The present study is designed to assess the possibility of early prediction of crowding through an initial evaluation of the mixed dentition system based on teeth size and arch measurements. The objective is to find indicators of crowding, which would be found in primary and mixed dentition and may lead to occurrence of dental crowding in future dentition, using dental measurements and to determine the factors that might be associated with mandibular anterior crowding.

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Materials and Methods

The present study was conducted on 300 children aged 3–5 and 8–11 years (150 each) in Bengaluru. Healthy subjects 3–5 years (primary dentition) and 8–11 years (mixed dentition with four incisors completely erupted) of age of Indian descent who are

healthy physically and mentally, with correct records for their age, no congenitally missing primary or permanent teeth, no previous Orthodontics treatment and minimal loss of tooth dimension by caries or attrition were included in the study. Prior to the field study, appropriate consent was taken from the respective parents. The selected sample was divided into two groups based on their age as 3–5 and 8–10 years.

Results

The following characteristics were seen in the primary dentition (Table 1); the mean Little's index value is 0.2640; the mean anterior crowding upper is 6.8467; the mean anterior crowding lower is 4.7000. The following characteristics were seen in the mixed dentition (Table 1); the mean Little's index value is 2.7213; the mean anterior crowding upper is 5.9047; the mean anterior crowding lower is 3.4020. It was found that the correlation coefficient of Little's index compared to anterior crowding in primary dentition was found to be -0.17786 and mixed dentition was found to be –0.28105; showing there is a significant negative correlation between D1 and D2. Little's index making very less dependable as the indicator of anterior crowding (Table 2). It was found that there is significant difference in inter-canine width between lower noncrowded and crowded dentition, while the other values did not show any significant difference (Table 3). It was found that there is significant difference in Intermolar width between upper noncrowded and crowded dentition and in sum of incisors between noncrowded and crowded dentition in both the arches; while the other values did not show any significant difference (Table 4).

Discussion

In dentistry, routinely in orthodontics, dental crowding is one of the most obscure terms used. It has been present since ancient times, as documented by Mockers and his co-workers; even in recent times, patients looking about for orthodontic correction visit dentists, with crowding being the most common complaint.[4] Within a dental arch, the alignment of teeth is mainly dependent upon the relationship between tooth size and jaw size. Any imbalance in jaw dimension and tooth size could result in crowding or spacing. Due to disproportionately large-sized teeth, or due to a decrease in arch length or arch width or a combination of these factors, lack of space in dental arch can be a manifestation. Hence, only when an optimum relationship between these two factors exists a perfect alignment of the teeth is possible.

The relationship between arch dimensions and tooth dimensions with dental crowding has been examined by many investigators. Quite disputable observations were made in these studies. On the one hand, Lundstrom[5] and Fastlicht[6] found commendable relationship between tooth size parameters and dental crowding. In contrary, Mills[7] and Howe et al.,[8] found a more significant association of crowding with arch dimensions Thus, if the role of these factors in dental crowding is understood more clearly, it may immensely help in the treatment of such conditions (Flowchart 1).

Dental crowding, as described by Nance is the difference between the space needed in the arch and the space available in that arch that is the space discrepancy.[9] Ergo, whenever there is an imbalance in tooth dimension and jaw dimension, it manifests as spacing or crowding in the arches. Proper guidance of eruption is the foundation of blanket oral care which contributes to the development of a stable, permanent dentition with functional harmony and esthetic acceptability. Prompt orthodontic treatment should be initiated in early mixed dentition period, thus cutting down advancement to full-scale malocclusion later. This also excludes elements interfering with normal growth and development of arches.[10] Nevertheless, this is controversial in study researches claiming that this could be expeditious, while some other researches discourse the benefits of early treatment.[11] Dentists' knowledge and experience should be applied for diagnosing and managing malocclusion in developing dentition (Figs 1 to 5).

Little's Index

In order to aid epidemiological studies by giving a guide to assess mandibular anterior crowding, LII was initially developed as a method of quantitatively grading mandibular incisor alignment.[12] The sum of the five displacements, which represent the relative degree of anterior irregularity, is used to assess the horizontal linear displacement of each mandibular incisor's anatomical contact point from the next tooth anatomic point in the traditional application of LII. The occlusal plane is projected vertically with the contact sites, but there is no attempt to assess vertical displacement.

Table 1: Mean Little's index and anterior crowding

Primary dentition		*Minimum*	*Maximum*	*Average*	*Standard deviation*
Little's index (D1)		0.00	2.00	0.2640	0.5645
Degree of anterior crowding (D2)	D2 (U)	–3.3	17.3	6.8467	3.8386
	D2 (L)	–12	13.5	4.7000	3.1979
Mixed dentition		*Minimum*	*Maximum*	*Mean*	*Standard deviation*
Little's index (D1)		0	20.3	2.7213	2.9395
Degree of anterior crowding (D2)	D2 (U)	–7	16.9	5.9047	4.0856
	D2 (L)	–6	33	3.4020	4.3300

Table 2: Correlation coefficient of Little's index and degree of anterior crowding

Variable	*Correlation coefficient*	*p-value*	*Inference*
Primary dentition			
D1 vs D2	–0.17786	0.0302	There is a significant negative correlation between D1 and D2
Mixed dentition			
D1 vs D2	–0.28105	0.00049547	There is a significant negative correlation between D1 and D2

Table 3: Student *t*-test comparison of primary dentition noncrowded and crowded arches

	Primary upper noncrowded			*Primary upper crowded*			*Comparison*		
	Sample Size	*Average*	*Standard deviation*	*Sample size*	*Average*	*Standard deviation*	*t-statistic*	*p-value*	*Inference*
Intermolar width	123	27.9016	1.4649	27	28.1222	1.2702	0.7939	0.4285	No significant difference
Intercanine width	123	22.1512	1.3569	27	22.1333	1.3613	0.0619	0.9508	No significant difference
Arch length	123	27.7691	1.2319	27	27.6222	1.3718	0.5128	0.6088	No significant difference
Available arch length	123	82.5285	63.0270	27	75.8519	5.0208	1.1582	0.2486	No significant difference
Sum of incisors	123	24.0683	20.1254	27	22.5222	1.1676	0.8455	0.3992	No significant difference
Intermolar width	123	25.4228	2.1875	27	24.6111	2.8887	1.3759	0.1709	No significant difference
Intercanine width	123	18.2179	2.2825	27	17.0741	1.9158	2.7088	0.0075	Significant difference
Arch length	123	24.6797	1.7895	27	24.2741	1.3099	1.3551	0.1774	No significant difference
Available arch length	123	70.3496	4.2925	27	70.3704	5.0088	0.0200	0.9841	No significant difference
Sum of incisors	123	16.5350	1.9149	27	16.2815	1.2616	0.8508	0.3962	No significant difference

Table 4: Student *t*-test comparison of mixed dentition noncrowded and crowded arches

	Mixed upper noncrowded			*Mixed upper crowded*			*Comparison*		
	Sample size	*Average*	*Standard deviation*	*Sample size*	*Average*	*Standard deviation*	*t-value*	*p-value*	*Inference*
Intermolar width	111	30.9033	2.2322	39	29.4231	2.2359	3.5581	0.0005	Significant difference
Intercanine width	111	24.9892	2.0978	39	20.5974	3.0115	0.7509	0. 007	Significant difference
Arch length	111	28.7351	2.0396	39	29.1769	2.0447	1.1615	0.2473	No significant difference
Available arch length	111	79.5405	5.1958	39	79.8205	4.6503	0.3135	0.7544	No significant difference
Sum of incisors	111	28.8477	2.1810	39	30.6641	2.6520	3.8447	0.0002	Significant difference
	Sample size	*Average*	*Standard deviation*	*Sample size*	*Average*	*Standard deviation*	*t-statistic*	*p-value*	*Inference*
Intermolar width	80	28.0938	2.1804	70	27.5314	2.0063	1.6444	0.1022	No significant difference
Intercanine width	80	19.5650	1.7353	70	16.4371	1.9941	0.4160	0.0005	Significant difference
Arch length	80	24.8100	1.5799	70	25.1086	1.7303	1.0978	0.2741	No significant difference
Available arch length	80	71.8125	3.8651	70	71.8429	4.9917	0.0412	0.9672	No significant difference
Sum of incisors	80	21.0288	1.6212	70	22.6300	1.7711	5.7456	0.0000	Significant difference

The anterior arch length was overlooked since it was believed that the vertical displacement of the contact points had little to no effect on it.

Moreover, LII has been used to analyze typical maturational changes in the dentition or occlusal and dentoalveolar alterations in persons over 40 years old, as well as to assess arch length disparity for epidemiological application.[13]

The maxillary and mandibular arches are now included in the usage of LII by the orthodontics community in order to evaluate the efficiency of various orthodontics brackets, retainers, and treatment methods.

As the reproducibility of the individual contact point displacement measurements, used to calculate the LII score, has not been examined in the dental literature, confidence in the results of these articles may be restricted, and the increased usage of LII is concerning.[14] Macauley et al., came to the conclusion that utilizing LII to evaluate the effectiveness of orthodontics brackets, retainers, or treatment methods must be strongly discouraged due to the low reproducibility of individual contact point displacement measurements. Due to the low accuracy and precision of the procedure, it is not recommended to use LII to predictably determine the outcome of Orthodontics treatment.[15]

The estimation of change in the arch perimeter or in arch length segments during the transition from mixed to permanent dentition is what is lacking in all of the mixed dentition analysis methods that are currently available. It is quite challenging to forecast how the arch's length and perimeter will evolve over time.[16] In the mixed dentition, it is challenging to tell the patients with crowding of 3–5 mm apart from the noncrowded patients. To help with crowding diagnosis, physicians would wish to be able to identify this group of crowded patients in mixed dentition. All approaches for analyzing mixed dentition rely on measurement variables that forecast the combined mesiodistal widths of the non-erupted canines and premolars in each of the dentition's four quadrants. Any effort to design a mixed dentition prediction technique is complicated by crowding.

To determine the amount of space in the arch that will be available for incoming permanent teeth and the necessary occlusal adjustments, mixed dentition studies were developed.

These investigations are finished by looking at the change in arch perimeter and the size of the permanent teeth that come before the first permanent molar. An approach to creating a mixed dentition forecast is available. The size of the permanent teeth that have already erupted in the mouth and measurements taken from their radiological images are used by all methods to estimate the size of the canines and premolars that have not yet fully developed.

Similarly, no prediction methods have been developed for primary dentition stage, wherein we can correct the developing

Flowchart 1: Phases of the study

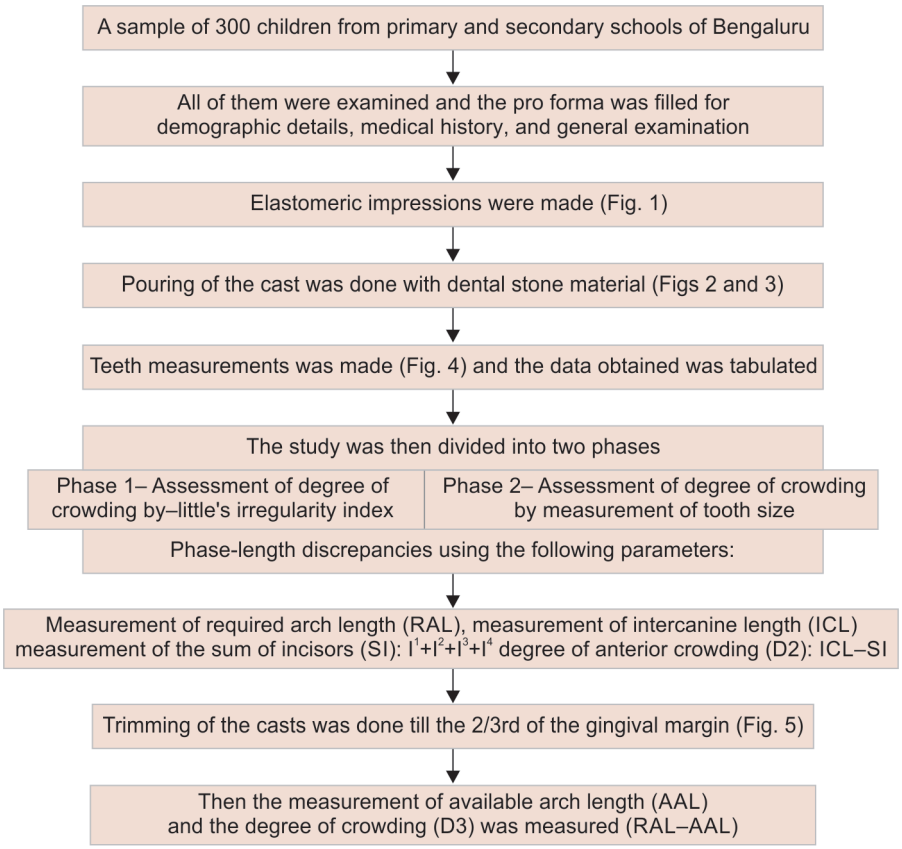

Fig. 1: Impression making

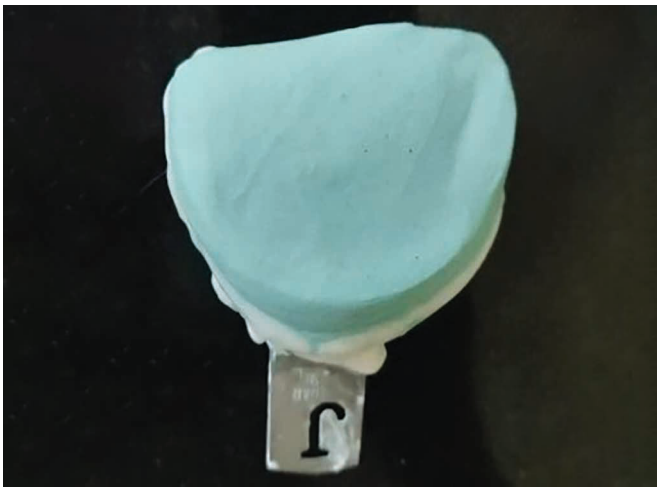

Fig. 2: Cast pouring completed

malocclusion right from that stage. The incapacity of the prediction methods to foresee the loss of arch length or perimeter that takes place during the change from primary and mixed to permanent dentitions is what makes them difficult to use. Using a preliminary assessment of the mixed dentition system based on the size of anterior teeth and arch length, this study seeks to determine whether it is possible to forecast crowding in the early stages.

The objective of the present study is to find indicators of crowding, which would be found in primary and mixed dentition and may lead to occurrence of dental crowding in the future dentition, using dental measurements and to determine the factors that might be associated with mandibular anterior crowding. In comparison, in primary dentition, it was found that the correlation coefficient of Little's index compared to anterior crowding was found to be −0.17786, showing there is a significant negative correlation between D1 and D2, making Little's index very less dependable as the indicator of anterior crowding.

In mixed dentition, it was found that the correlation coefficient of Little's index compared to anterior crowding was found to be −0.28105, showing there is a significant negative correlation between D1 and D2, making Little's index very less dependable as the indicator of anterior crowding as given in Tables 1 and 2.

Fig. 3: Maxillary and mandibular casts

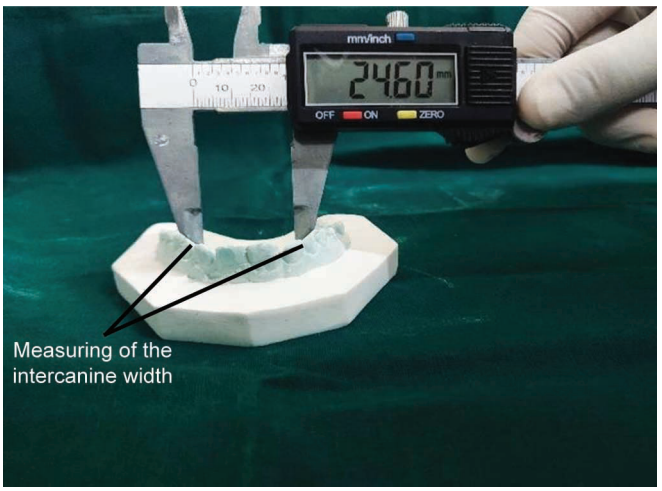

Fig. 4: Measurement of individual tooth

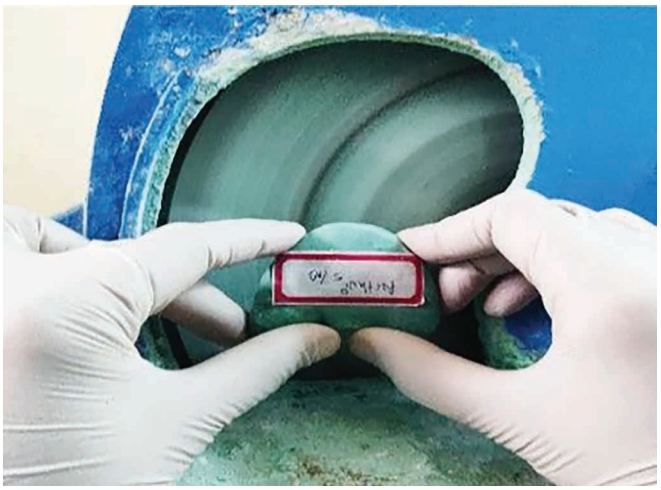

Fig. 5: Trimming of the cast

Primary Dentition

On student *t*-test comparison of primary dentition noncrowded and crowded arches, it was found that there is significant difference in inter-canine width between lower noncrowded (mean 18.21 mm) and crowded dentition (mean 17.07 mm) (*p-value* of 0.0075), while the other values did not show any significant difference, making inter-canine width of lower arch a reliable measurement for the prediction of future crowding (Table 3).

Mixed Dentition

On student t-test comparison of mixed dentition noncrowded and crowded arches, it was found that there is significant difference in Intermolar width between upper noncrowded (mean 30.9 mm) and crowded (mean 29.42 mm) dentition (*p-value* of 0.0005), and in sum of incisors between non- crowded and crowded dentition in both the arches (upper arch *p-value*: < 0.01 and lower arch *p-value*: < 0.01); while the other values did not show any significant difference, making Intermolar width of upper arch and sum of incisors in both the arches reliable measurements for the prediction of future crowding (Table 4). Tsai[17] studied two groups of children in 2003, one with anterior crowding in both dental arches and the other with anterior spacing in both dental arches, to compare dental arch size, mesiodistal and buccolingual crown widths, and crown morphologies. Statistics showed that crowded arches had statistically considerably smaller arch widths than the spaced arches for both lower and upper arches.

In accordance with this study, our study also showed that there is significant difference in Intermolar width of upper arch in crowded and noncrowded mixed dentition and in inter-canine width of lower arch in crowded and noncrowded primary dentition. In order to evaluate the association between arch length and incisor tooth size in the prediction of crowding or spacing, Nakhjavani[18] conducted a cross-sectional study in 2014.

The ratio of the arch length to the total of the incisors' mesiodistal widths significantly increased, and this movement from crowding to spacing was observed. Contrary to this, in our study, there was no significant importance noticed in arch length for the prediction of crowding, while there was a significant difference in sum of incisors between noncrowded and crowded dentition in both the arches in mixed dentition, making it a reliable measurement for the prediction of dental crowding. A study was conducted in 2015 by Selmani and Gjorgova[19] to compare the relationships between the length, width, and perimeter of crowded and uncrowded arches.

This study found that lower arch crowding was not influenced by the length or perimeter of the arches.

Because the discrepancies between the two groups were so great, they could discuss the width of the arch in relation to contributing variables to the lower arch crowding.

This study's findings were supported by our research, which demonstrated that the length and perimeter of an arch did not determine crowding. Whereas inter-canine width in lower arch of primary dentition, Intermolar width of upper arch in mixed dentition and sum of incisors in both upper and lower arches in mixed dentition were shown to be associating factors for determination of crowding.

Conclusion

Within the parameters of the Little's index: Little's index is not a reliable indicator of crowding in both primary and mixed dentition.

- Primary dentition: Inter-canine width of lower arch can be considered as an indicator of crowding in primary dentition. Inter-canine width of 18.21 mm is considered as the average value.
- Mixed dentition: Intermolar width of upper arch can be considered as an indicator of crowding. Intermolar width

of 30.9 mm is considered as the average value. Sum of incisors can be considered as an indicator of crowding in bs where any value greater than 28.84 mm in upper arch and any value greater than 21.02 mm in lower arch might increase the possibility of crowding in mixed dentition; inter-canine width of upper and lower arch can be considered as an indicator of crowding. Upper of inter-canine width of 24.98 mm and lower inter-canine width of 19.5 mm in this age group is considered as the average value.

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