Dental Crowding in Primary Dentition and Its Relationship to Arch and Crown Dimensions Among Preschool Children of Davangere

A.R. Prabhakar, MDS G.R. Ravi, BDS Ameet J. Kurthukoti, MDS A.B. Shubha, MDS

ABSTRACT

The purpose of the present study was to evaluate dental crowding in the deciduous dentition and its relationship to the crown and the arch dimensions among preschool children of Davangere. Stratified randomized selection of one hundred, 3-4 year old healthy children with all primary teeth erupted was done and divided into two groups. One group had children with anterior crowding in both the arches while the other had spacing. Alginate impressions of the upper and lower arches were made and the study casts were obtained. The tooth and arch dimensions were determined. Mesiodistal dimensions of all the teeth were significantly larger in the crowded arch group. However, the buccolingual dimensions of the maxillary right central incisor, mandibular lateral incisors and the maxillary molars and the crown shape ratio of maxillary lateral incisors, mandibular canines and mandibular right second molar was statistically different. No significant correlation was found between the arch width and the presence of crowding of deciduous dentition. The arch depth of the spaced dentition was greater when compared to the crowded ones. The arch perimeter of the crowded arches was significantly less than the spaced arches. **(J Dent Child 2008;75:168-76)**

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Radznic described dental crowding as the difference between the space needed and the space available in the dental arch.[1] Three conditions which may predispose the dental arches to crowding are: (1) excessively large teeth; (2) excessively small bony bases of the jaws; and (3) a combination of these 2 factors.[2] Thus, crowding or spacing can be described as an expression of an altered tooth-to-tissue ratio or as a dentoalveolar disproportion.[1]

Primary teeth usually fit in the arches from the very moment they erupt. This is due to the fact that, in the early stages, the arches are already wide enough to accommodate all the teeth.[3] The primate spaces in primary dentition are widely documented as an important working phase in the development of occlusion.[4] On the contrary, crowding in primary dentition, although a rare finding, may still be present. The concept of an evolutionary trend towards a reduced facial skeletal size, without a corresponding decrease in the tooth size, has been proposed by various authors.[1,2,5,6]

The tooth size and arch dimensions definitely share a harmonious relationship and go a long way toward directly influencing the establishment of a correct occlusion.[3] Sanin and coworkers showed that the measurement of the primary dental arches and tooth size can be used to predict the occurrence of malocclusion in 82% of the cases. Thus, a study of this nature is warranted.[7-9]

Arrays of studies have been conducted concerning crowding of the permanent dentition. There is, however, paucity of the available data on crowding in the primary dentition. Various indicators of crowding have been found in the primary dentition, which may lead to the future manifestation of crowding in the early mixed dentition.

Dr. Prabhakar is professor and head, Dr. Ravi is postgraduate student, Dr. Kurthukoti is reader and Dr. Shubha is assistant professor, all in the Department of Pedodontics and Preventive Dentistry, Bapuji Dental College and Hospital, Davangere, Karnataka, India.

Correspond with Dr. Prabhakar at attiguppeprabhakar@yahoo.com

Of these, larger primary tooth size is the chief indicator. The maxillary and mandibular arch lengths and the posterior cranial base in the primary dentition, however, should be also considered as indicators when predicting the crowding in early mixed dentition.[10] Most of these studies have been undertaken in the western countries. Anthropometrical studies have proved that the constitution of teeth and arch dimensions are specific to each ethnic population.[11-13] A recent study evaluated the role of the sex dimorphism and compared the arch dimensions between 2 groups of 3- to 5-year-old children residing at Chennai and Hyderabad—2 cities in Southern India. This study concluded that the primary arch dimensions are known to be larger in boys than girls.[14] The scarcity of studies undertaken related especially to crowded primary dentition, in a culturally diverse and magnanimous Indian society prompted us to embark on a study of this nature.

The purposes of the present study were to:

1. estimate the mesiodistal and buccolingual crown dimensions and the crown shape ratio among children with spacing and crowding in anterior teeth of both arches;
2. estimate the arch width/breadth, depth, and perimeter among children with spacing and crowding in anterior teeth of both arches;
3. correlate the tooth and arch dimensions to crowding.

METHODS

The present study was conducted in the city of Davangere, Karnataka, located in the southern part of India, with a population of approximately 400,000. A stratified, randomized selection of 100 healthy 3- to 4-year-old children was taken from 8 different nursery schools situated in 4 different zones of Davangere. The children were divided into 2 groups of 50 each. The first group had all the primary teeth with anterior crowding in both the maxillary and mandibular arches, while the second group had spacing in both arches. As spacing in the primary dentition was considered normal,[5] children with spacing were included in the control group. The oral examination was performed under natural daylight conditions using a mouth mirror and explorer.

Subjects were selected if they were 3 to 4 years old, born to parents who were Davangere natives and had all their primary teeth completely erupted.

Subjects were excluded if they had large coronal restorations that might have altered coronal shape or size, proximal caries, a previous history of extraction, abnormal oral habits, acquired/developmental dental deformities, including anomalies related to the size, shape, or number of teeth and teeth that have been restored/reconstructed following trauma

After these criteria were met, a written consent was obtained from each child's parents/legal guardians. Full depth alginate impressions of both the maxillary and mandibular arches were made following the selection of properly sized, custom-made, perforated special tray. Later, the impressions were washed under running tap water disinfected with antiseptic solution and casts were prepared immediately using dental stone. The tooth dimensions, arch width, and arch perimeter were measured using Vernier calipers, and the arch depth was measured using a transparent grid on these casts.

MEASUREMENT REGISTRATION: TOOTH DIMENSIONS

The greatest mesiodistal width was measured at the contact points by holding the caliper tips oriented parallel to the crown's occlusal surface and perpendicular to the tooth's long axis. The greatest buccolingual width was measured at the tooth's gingival margin with the caliper tips oriented parallel to the crown's vestibular surface.[15,16] Crown shape ratio was determined using the following formula: buccolingual width ÷ mesiodistal crown width.[15, 16]

MEASUREMENT REGISTRATION: DENTAL ARCH DIMENSIONS

Dental arch dimensions included arch breadth/width, arch depth, and arch perimeter.

Arch breadth was measured at 3 levels[3] (Figure 1). Diameter between both canines (BC) was defined as the distance between both primary canines' cusp tips or between the canines' estimated midpoints. Diameter between both first molars (BM1) was measured between the first primary molars' mesiobuccal cusps. Diameter between both second molars (BM2) was measured between the second molars' mesiobuccal cusps.

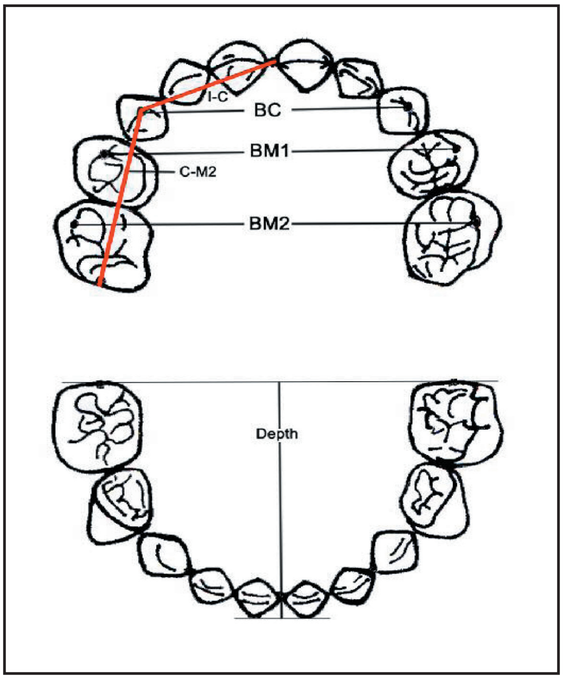

*Figure 1. Dental arch dimensions in primary dentition.**
** BC=diameter between canines; BM1=diameter between first molars; BM2=diameter between second molars; IC=distance between central incisors and canine (anterior segment); C–M2=distance between canine and second molar (posterior segment); Depth=total arch depth*

Arch depth was determined by measuring the total arch depth and 2 segments only on the left side (Figure 1). Total arch depth (depth) was measured using a transparent calibrated grid with 2 axes perpendicular to each other. The grid was placed on the cast. The distance between the central incisors' labial surfaces to the point of the tangent that passes through the primary second molars' distal surfaces was expressed as the arch depth.[17]

Anterior segment (I-C) was the distance between the primary central incisors' contact points and the primary canine cusp. If diastema exists, then the distance was from the center point of the diastema to the primary canine cusp.[3]

Posterior segment (C-M2) was the distance between the canine cusp and the primary second molar's distal surface.[3]

The arch perimeter in crowded arches was determined by the difference between the total mesiodistal width of all the teeth and the total overlaps in anterior teeth. Likewise, in the spaced arches, it was determined as the sum of the total mesiodistal width of all the teeth and the total spaces between them[18,19] (Figure 2).

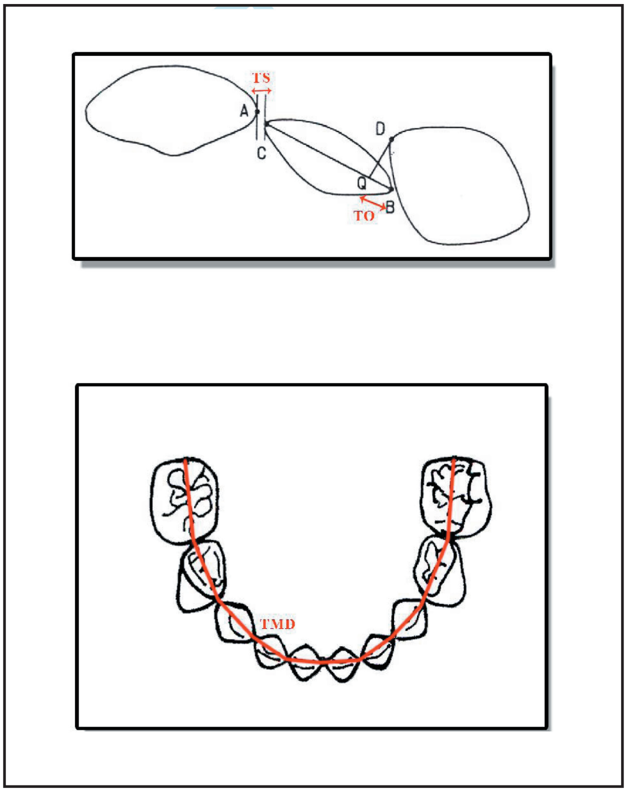

*Figure 2. Arch perimeter calculation.**
** TS=total space; TO=total overlap; TMD=total mesiodistal dimension.*

STATISTICAL ANALYSIS

The results were tabulated and subjected to statistical analysis using an unpaired *t* test. To overcome the intrapersonal variation, 10% of the study models were re-examined and the reliability was found to be between 0.97% and 0.99%. The level of significance was set at $P<.05$.

RESULTS

TABLE 1 OBSERVATIONS

When the mesiodistal and buccolingual dimensions of both groups' primary maxillary teeth were compared, the teeth size in the crowded arch group was larger than those in the spaced arch group. The differences were statistically significant ($P<.05$) for all the teeth when mesiodistal dimension was considered. The buccolingual dimension of only the primary maxillary right central incisor and the maxillary primary right and left molars, however, were statistically significant ($P<.05$).

When the crown shapes ratio of the primary maxillary teeth of both groups was measured, the spaced arch group showed larger crown shape than those in the crowded arch group. The crown shape of only primary maxillary lateral incisors, however, was statistically significant ($P<.05$).

TABLE 2 OBSERVATIONS

When comparing the mesiodistal and buccolingual dimensions of primary mandibular teeth between both groups, the teeth size in the crowded arch group was found to be larger than those in the spaced arch group. The differences were statistically significant ($P<.05$) for all the teeth when mesiodistal dimension was considered. The buccolingual dimension of only the primary mandibular lateral incisors, however, was statistically significant ($P<.05$).

When the crown shape ratio of the primary mandibular teeth in both the groups was compared, the spaced arch group showed larger crown shape than those in the crowded arch group. The crown shape of only the primary mandibular canines and right second molar, however, was statistically significant ($P<.05$).

TABLE 3 OBSERVATIONS

The maxillary arch was wider between the canines and the second molars in the spaced arch group compared to the crowded arch group. These values, however, showed no statistical significance ($P>.05$).

The arch depth in the spaced arch group was found to be more in all segments when compared with the crowded arch group, except in the C-M2 (ie, between the canine and second molar). I-C, however, was statistically significant ($P<.05$), while the C-M2 and total arch depth were not significant ($P>.05$).

Although the total mesiodistal dimension of the crowded arch group was larger than the spaced arch group, arch perimeter in the former was smaller than the latter. All these differences were statistically significant ($P<.05$).

TABLE 4 OBSERVATIONS

The mandibular arch was wider between the canines and between the first molars in the spaced arch group when compared to the crowded arch group. All these differences, however, showed no statistical significance ($P>.05$).

The arch depth in the spaced arch group was found to be more in all segments when compared with the crowded arch group, except in the posterior segment (ie, between canine and second molar). I-C was statistically significant

Table 1. Comparison of Tooth Dimensions in the Maxilla Among Spaced and Crowded Arch Groups

Tooth no.	Dimensions	Spaced arch group	Crowded arch group	Unpaired *t* test value	*P*-value*
		Mean±(SD)	Mean±(SD)		
51	MD	6.428±0.537	6.766±0.427	-3.481	NS†
	BL	5.138±0.398	5.306±0.425	-2.038	.044
	CS	0.795±0.064	0.777±0.080	1.269	.208
52	MD	5.270±0.289	5.494±0.332	-3.602	.001
	BL	4.634±0.341	4.676±0.414	-0.554	.581
	CS	0.877±0.080	0.841±0.076	2.320	.022
53	MD	6.576±0.501	6.918±0.454	-3.576	.001
	BL	6.062±0.480	6.098±0.441	-0.391	.697
	CS	1.080±1.145	0.874±0.054	1.273	.206
54	MD	7.358±0.410	7.714±0.422	-4.279	NS
	BL	8.418±0.560	8.860±0.640	-3.677	NS
	CS	1.140±0.081	1.138±0.100	0.088	.930
55	MD	9.014±0.527	9.406±0.509	-3.783	NS
	BL	9.632±0.512	10.096±0.480	-4.639	NS
	CS	1.068±0.050	1.065±0.050	0.319	.750
61	MD	6.418±0.544	6.754±0.413	-3.480	.001
	BL	5.146±0.400	5.306±0.417	-1.958	.053
	CS	0.796±0.064	0.777±0.076	1.314	.192
62	MD	5.270±0.285	5.476±0.346	-3.251	.002
	BL	4.656±0.351	4.694±0.412	-0.497	.621
	CS	0.882±0.083	0.846±0.077	2.241	.027
63	MD	6.582±0.489	6.932±0.447	-3.738	NS
	BL	6.018±0.345	6.078±0.456	-0.726	.469
	CS	1.071±1.146	0.869±0.056	1.250	.214
64	MD	7.348±0.491	7.768±0.422	-4.586	NS
	BL	8.476±0.472	8.862±0.639	-3.437	.001
	CS	1.151±0.072	1.135±0.098	0.964	.337
65	MD	8.970±0.541	9.382±0.551	-3.775	NS
	BL	9.656±0.495	10.080±0.521	-4.171	NS
	CS	1.074±0.052	1.061±0.058	1.175	.243

** MD=mesiodistal; BL=buccolingual; CS=crown shape ratio; † NS=nonsignificant.*

Table 2. Comparison of Tooth Dimensions in the Maxilla Among Spaced and Crowded Arch Groups

Tooth no.	Variable*	Spaced arch group	Crowded arch group	Unpaired *t* test value	*P*-value†
		Mean±(SD)	Mean±(SD)		
71	MD	4.154±0.251	4.342±0.371	-2.969	.004
	BL	3.862±0.256	3.940±0.249	-1.543	.126
	CS	0.921±0.068	0.900±0.075	1.484	.141
72	MD	4.680±0.374	4.896±0.374	-2.889	.005
	BL	4.254±0.317	4.446±0.298	-3.118	.002
	CS	0.904±0.057	0.903±0.070	0.063	.950
73	MD	5.716±0.443	6.052±0.386	-4.047	NS†
	BL	5.372±0.505	5.496±0.494	-1.242	.217
	CS	0.938±0.060	0.899±0.075	2.831	.006
74	MD	7.878±1.208	8.266±0.623	-2.019	.046
	BL	7.374±0.659	7.544±0.478	-1.477	.143
	CS	0.925±0.078	0.903±0.076	1.439	.153
75	MD	10.014±0.579	10.248±0.541	-2.088	.039
	BL	8.724±0.646	8.930±0.509	-1.771	.080
	CS	0.871±0.072	0.866±0.056	0.390	.697
81	MD	4.188±0.251	4.354±0.372	-2.617	.010
	BL	3.9480.712	3.938±0.247	0.094	.925
	CS	0.913±0.068	0.900±0.072	0.944	.348
82	MD	4.672±0.354	4.904±0.368	-3.215	.002
	BL	4.260±0.298	4.446±0.298	-3.121	.002
	CS	0.909±0.057	0.902±0.069	0.554	.581
83	MD	5.690±0.433	6.030±0.390	-4.127	NS
	BL	5.390±0.505	5.544±0.446	-1.616	.109
	CS	0.9450.066	0.908±0.073	2.690	.008
84	MD	8.010±0.515	8.272±0.624	-2.290	.024
	BL	7.394±0.623	7.546±0.477	-1.370	.174
	CS	0.925±0.080	0.906±0.074	1.230	.222
85	MD	10.000±0.583	10.258±0.530	-2.315	.023
	BL	8.744±0.624	8.904±0.548	-1.366	.175
	CS	4.154±0.251	4.342±0.371	-2.969	.004

** MD=mesiodistal; BL=buccolingual; CS=crown shape ratio;*
† NS=nonsignificant.

Table 3. Comparison of Arch Dimensions in the Maxilla Among Spaced and Crowded Arch Groups

Dimensions	Parameter*	Spaced arch group	Crowded arch group	Unpaired *t* test value	*P*-value†
		Mean±(SD)(mm)	Mean±(SD)(mm)		
Arch breadth	BC	28.848±2.345	28.428±2.074	0.949	.345
	BM1	37.436±1.882	36.786±1.850	1.741	.085
	BM2	43.332±2.340	43.156±1.937	0.410	.683
Arch depth	IC	16.336±1.213	15.460±1.451	3.275	.002
	CM2	20.280±1.174	20.670±1.403	-1.508	.135
	Total	**27.086±1.597**	**26.740±1.899**	**0.986**	**.327**
Arch perimeter	TMD	69.230±3.512	72.654±3.191	-5.104	NS
	TS/TO	2.884±1.095	2.196±0.719	3.713	NS
	Total	**72.066±3.664**	**70.500±2.948**	**2.355**	**.021**

* BC=diameter between canines; BM1=diameter between first molars; BM2=diameter between second molars; IC=distance between central incisors and canine (anterior segment); CM2=distance between canine and second molar (posterior segment); TMD=total mesiodistal dimensions; TS=total spaces; TO=total overlaps. † NS=nonsignificant.

(*P*<.05), however, while the C-M2 and total arch depth were statistically not significant (*P*>.05).

Although the total mesiodistal dimension of the crowded arch group was larger than the spaced arch group, arch perimeter in the former was smaller than the latter. All of these values were statistically significant (*P*<.05).

DISCUSSION

Pediatric dentistry encompasses the overall well-being of a child's oral health from birth through adolescence. The development of a child is known to change dynamically through this period. Spacing between the primary teeth has been widely documented in the dental literature[4,5,20, 21]and is considered an essential feature for normal growth and development. In the same league, crowding of the primary teeth has also been reported.[22-25] The relationship it shares with the crown and the arch dimensions, however, has yet to be elucidated, especially in India. This paucity in the available dental literature, particularly about the primary dentition, inspired us to conduct a study of this nature.

The best specimens for a study of crown morphology could be found in the mouth of a 2- to 6-year-old child who was willing to open his or her mouth wide, long, and often enough to permit the examination.[26] Usually all the primary teeth are known to erupt completely by 3 years of age, and even the arch dimensions are known to remain stable during this period.[3] Prediction of the development of crowding has been successfully attempted during mixed and permanent dentitions.[28-32] Richardson et al reviewed various causes for the late lower arch crowding and concluded that tooth structure played only a very minor role in the cause of late lower arch crowding. Particular type of skeletal morphology or a specific pattern of growth was not associated with an increase in lower arch crowding.[30-32] Hence, with this background, only 3- to 4-year-old children were selected as subjects for the present study.

Metrical studies of the tooth provide a valuable data needed both in anthropology and dentistry.[15] Many researchers basically used similar techniques in recording the mesiodistal tooth dimensions. A Vernier calipers was used in the study as it was known to be one of the most acceptable methods of assessing the crown dimensions.[15,16,18,19,27] A transparent grid,[17] which is routinely employed for the measurement of arch dimensions in orthodontic diagnosis and treatment planning, was used in our study for the measurement of arch depth. The degree of crowding or spacing was determined by the overlap method which is known to be easy, quick, and reliable.[13,14] Furthermore, the crowding was calculated directly in contrast to the other techniques, where tooth size and arch perimeter was recorded and then the crowding was derived subsequently.[18,19]

The mesiodistal dimensions of teeth have a definite contribution to crowding in permanent dentition.[33] When the mesiodistal dimensions of all the teeth were measured, the teeth size in the crowded arch group was significantly larger than those in the spaced arch group. Although not many studies have been done in this aspect of the primary dentition, our findings were concurrent with a previous study

Table 4. Comparison of Arch Dimensions in the Mandible Among Spaced and Crowded Arch Groups

Dimensions	Parameter*	Spaced arch	Crowded arch	Unpaired *t* test value	*P*-value†
		Mean±(SD)(mm)	Mean±(SD)(mm)		
Arch breadth	BC	22.366±1.373	22.086±1.274	1.057	.293
	BM1	28.866±1.890	28.466±2.033	1.019	.311
	BM2	35.744±2.236	36.202±1.990	-1.082	.282
Arch depth	IC	11.978±0.945	11.662±0.981	1.641	.104
	CM2	21.558±1.114	21.924±1.070	-1.676	.097
	Total	**23.668±1.720**	**23.422±1.453**	**0.773**	**.442**
Arch perimeter	TMD	65.150±3.234	67.536±3.450	-3.568	NS
	TS/TO	1.934±0.642	1.762±0.758	1.224	.224
	Total	**67.042±3.027**	**65.774±3.261**	**2.015**	**.047**

** BC=diameter between canines; BM1=diameter between first molars; BM2=diameter between second molars; IC=distance between central incisors and canine (anterior segment); CM2=distance between canine and second molar (posterior segment); TMD=total mesiodistal dimensions; TS=total spaces; TO=total overlaps. † NS=nonsignificant.*

conducted by Sanin, Savara, Clarkson, and Thomas, who found that the spaced primary dentition, having acceptable occlusion, was more likely to have smaller primary teeth.[7] In previous studies, however, they observed no significant correlation between mesiodistal dimensions of the teeth and dental crowding.[3,15]

Although the buccolingual dimension of all the teeth was larger in the crowded arch group, only the primary maxillary right central incisor, mandibular lateral incisors, and the primary maxillary right and left molars were significantly larger. Hitherto, only the primary maxillary right and left second molars were found to be larger in the crowded arch group in a previous study.[15] When the crown shape ratio of the all the primary teeth were evaluated, only maxillary lateral incisors, mandibular canines, and mandibular right second molar were statistically significant. These results were in contrast to the earlier study, which showed no correlation between crown shape and crowding.[15]

Arch width was determined at 3 different levels in our study. The differences in arch width, however, showed no statistical significance between the two groups. These observations of our study were in contradiction to previous studies,[3,13,14,16] which concluded that the arch width was significantly larger in the spaced arches. When the total arch depth, I-C, and the C-M2 were evaluated, the spaced arch group was found to be longer in all except in the posterior segment. Only the anterior segment in the spaced arch group, however, was significantly larger. Similar findings were found in the mandibular arch. These findings agreed with studies done by Facal-Garcia, de Nova-Garcia[3] and Moorrees and Chadha,[9] who found a significant correlation to exist between the diastemas and the arch dimensions. Furthermore, in the present study it was noticed that the arch perimeter was significantly associated with crowding. Although the total mesiodistal dimension of both the maxillary and mandibular teeth in the crowded arch group was larger than the spaced arch group, arch perimeter in the former was smaller than the latter. Tsai HH[15] reported similar findings, but they were not statistically significant among the Taiwanese children studied.

Both the tooth and the arch dimensions are known to be under the influence of genetic, environmental, racial, ethnic, and other factors.[3,14,22,34-38] Furthermore, teeth derivatives of the neural crest cells develop in close association with the mandible. It is highly likely, therefore, that dental changes are present in developmental disorders such as hemifacial microsomia.[37] Harris and Lease conducted a worldwide survey on the mesiodistal tooth crown dimensions of the primary dentition and made a distinction between Europeans, Africans, and Asians.[39] Europeans have small teeth with comparatively large anterior dimensions. Asian and sub-Saharan African samples, however, share features of average crown size but large cheek teeth. Hence, all the variations of tooth and arch dimensions observed and their relation to crowding was bound to occur, as all the previous studies quoted in the literature were conducted on different populations.

The present study attempted to provide baseline data regarding the dental crowding of primary teeth and its correlation to the tooth and arch dimensions among preschool children of Davangere, Karnataka, India. The observations of this study, by providing an insight about this correlation, have definitely opened up an avenue for further research. Additionally, a longitudinal study on a larger population is needed, considering the magnitude and severity of crowding in the primary dentition, to further enhance the understanding of the observations drawn from the present study.

CONCLUSIONS

Based on this study's results, the following conclusions can be made:

1. The crowding of primary dentition has a definite correlation to the dental crowns' mesiodistal width.
2. Although the buccolingual dimension of all the teeth were larger in the crowded arch group, only the dimensions of the primary maxillary right central incisor, mandibular lateral incisors, and mandibular right second molar were significantly larger compared to the spaced arch group.
3. The crown shape ratio of only primary maxillary lateral incisors, mandibular canines, and mandibular right second molars had a significant correlation to crowding.
4. Arch width did not contribute significantly to crowding.
5. The arch depth of the spaced dentition was broader, whereas the arch perimeter of the crowded arches was smaller.

A detailed study on a larger population, considering the magnitude of the crowding and its relation to tooth and arch dimensions, could further enhance understanding the observations made from the present study.

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