Original Article

Comparison of Spaced and Non-spaced Dentitions among the Children of Vadodara City

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Abstract

Aim: To compare dental arch size, mesiodistal (MD) and buccolingual crown widths between spaced and non-spaced dental arches. **Materials and Methods:** A total of 80 children were included in the study, of which 40 children had spaced dentition and 40 had non-spaced dentition. The selection was done on the basis of selection criteria. Alginate impressions were taken, and models were prepared. The tooth measurements for MD, buccolingual and clinical crown height along with arch dimensions were measured with the help of digital Vernier callipers. The measurements were entered into the prepared pro forma sheets and analysed. Statistical tests applied were independent sample *t*-test and Pearson's correlation test. **Results:** The MD dimension of the teeth was more in the spaced dentition than the non-spaced dentition. The buccolingual dimensions of the teeth were more in the non-spaced dentition than the spaced dentition. However, the difference was not statistically significant ($P \geq 0.05$). There was no statistically significant difference in the crown size ratio between spaced and non-spaced dentition, except for mandibular left second molar ($P \leq 0.05$). The arch dimensions were also more both in the maxilla and mandible in spaced dentition when compared to non-spaced dentition. The correlation was statistically significant. **Conclusion:** The tooth and arch dimensions of spaced and non-spaced dentitions among the Gujarati children were evaluated. The crowding of primary dentition has a definite correlation to the dental crowns' MD width.

Keywords: Deciduous dentition, dental arch, mandible, maxilla

Introduction

Tooth dimensions define the characteristics of the tooth, measure of spatial extent; length, width and height or size and shape of the crown. A well-aligned set of teeth ascertains aesthetics and stability. Furthermore, a perfect tooth position offers best conditions for good health and optimal care of teeth. However, the dental arch continuity and integrity are a result of harmony between tooth and arch dimensions. Any disproportion between these elements predisposes to dental crowding and spacing, which are considered detrimental to dental health and function.[1]

Radznic described dental crowding as the difference between the space needed and the space available in the dental arch. 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 two factors.[2] Lundstrom stated that as tooth size increases, crowding increases. He also stated that arch perimeter decreases as crowding increases in an examination of the variation of tooth size as the aetiology of malocclusion.[3] He also stated that persons with large teeth are likely to have crowding than those with small teeth.[4]

Brash said that crowding was hereditary and may result from continued inter-breeding between physically dissimilar ethnic groups. He stressed environmental factors reasoning that the modern, refined diet must have played a role in reducing muscular stimulation, hence the full expression of facial growth.[5] Harris concluded that arch size, arch shape and occlusal relations indicate a dominance of environmental over genetic factors.[6] Barber speculated that dental crowding might

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result from abnormal muscle forces, abnormal paths of tooth eruption, occlusal forces resulting in mesial migration of the teeth and loss of arch length through dental caries.[7]

Primary teeth usually fit in the arches from the very moment they erupt as the arches are wide enough due to the presence of primate spaces. The primate spaces in primary dentition are widely documented as an important working phase in the development of occlusion. On the contrary, crowding in primary dentition that is a rare finding may still be present. Thus, crowding or spacing can be described as an expression of an altered tooth-to-tissue ratio or as a dentoalveolar disproportion.[8]

The tooth size and arch dimensions definitely share a harmonious relationship and go a long way towards directly influencing the establishment of a correct occlusion.[9] Arrays of studies have been conducted concerning crowding of the permanent dentition.[1] There is, however, a paucity of the available data on correlation of tooth dimension and crowding in the primary dentition. Larger primary tooth size is the chief indicator of the various indicators of crowding, which may lead to the future manifestation of crowding in the early mixed dentition.[8]

Prabhakaran *et al*. in a study evaluated the role of the sexual dimorphism and compared the arch dimensions among 3–5-year-old children.[10] Various studies have been conducted to correlate tooth dimensions with spacing or crowding in permanent dentition. A scarcity of such studies undertaken related to primary dentition, in a culturally diverse Indian society, encouraged to get on with a study of this nature. The study focuses on the evaluation of the tooth dimensions in spaced and non-spaced primary dentition of 3–6-year-old children of Vadodara city.

Materials and Methods

The descriptive study was conducted among the pre-school children of Gujarati ethnicity from Vadodara city. Prior permission was taken from the dean of the college and the principals of the various schools to conduct the study. Ethical approval was obtained. Gujarati children between 3 and 6 years with fully erupted complete set of deciduous teeth were selected. Children with medical history and dental implications were excluded. In addition, the children with any restoration, loss of tooth structure due to caries, hypoplasia and fracture were excluded from the study.

A sample size of 80 children of age group 3–6 years was selected from primary schools by stratified randomised sampling technique. These children were screened under natural light as per the inclusion criteria using sterilised diagnostic instruments. Maxillary and mandibular tray selections were done. An alginate impression for both upper and lower jaws was taken with suitable impression trays. To ensure disinfection and dimensional stability and to prevent inaccuracies, the impressions were disinfected in 2% glutaraldehyde and then covered with damp gauze during the short interval between impression making and pouring of dental stone. Proper study models were made using base formers. Dental casts with porosities were excluded. All the tooth measurements were carried out using electronic digital Vernier callipers. Only 5 models/day were measured to avoid any visual fatigue. Parameters that were measured are mesiodistal (MD), buccolingual and crown height dimensions as per the following criteria:

- The MD dimension was obtained by measuring the maximum distance between the mesial and distal contact points of the tooth on a line parallel to the occlusal plane [Figure 1]
- The buccolingual dimension was obtained by measuring the greatest distance between the buccal and lingual surface of the tooth at a right angle to the MD measurement [Figure 2]
- The crown shape ratio was determined using the formula: Buccolingual width ÷ mesiodistal crown width.

The width of primate and physiological spaces will also be measured with the help of Vernier callipers, holding the end's parallel to the occlusal plane and cervical to the contact points. Dental arch dimensions included arch breadth/width, arch depth and arch perimeter.

- Arch width was measured at three levels. Diameter between both canines (IC) [Figure 3], diameter between both second molars (IM2) [Figure 4] and diameter between both first molars (IM1) were measured [Figure 5]
- Total arch depth was measured using stainless steel scales and Vernier callipers, with 2 axes perpendicular to each other. It was measured at two levels:
  - Anterior segment (I-C) was the distance between the primary central incisors' contact points and the primary canine cusp [Figure 6]
  - Posterior segment (C-M2) was the distance between the canine cusp and the primary second molar's distal surface [Figure 7].
- The arch perimeter in crowded arches was determined by the difference between the total MD width of all the teeth and the total overlaps (TOs) in anterior teeth. Likewise,

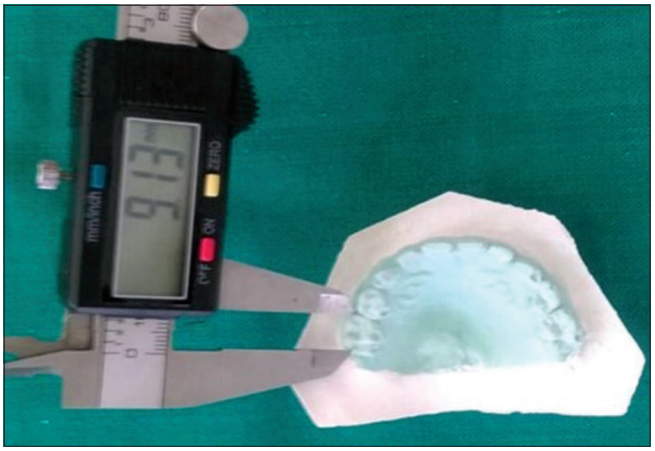

Figure 1: Measurement of mesiodistal dimension.

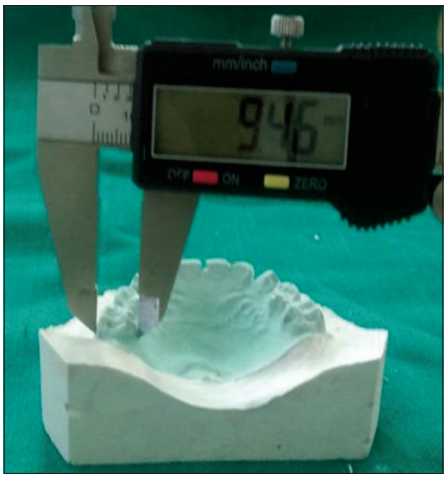

Figure 2: Measurement of buccolingual dimension.

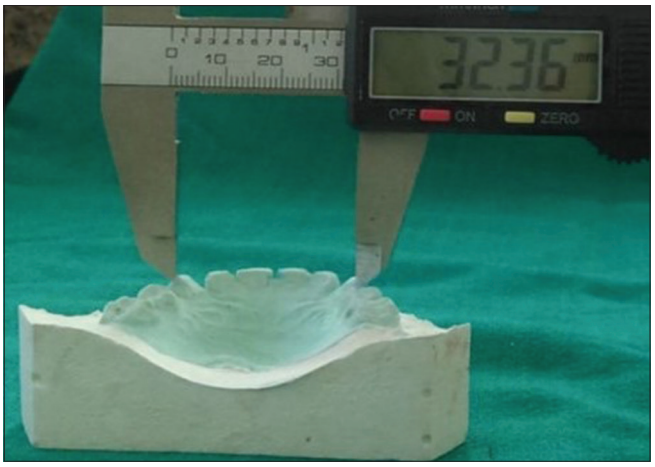

Figure 3: Measurement of intercanine width.

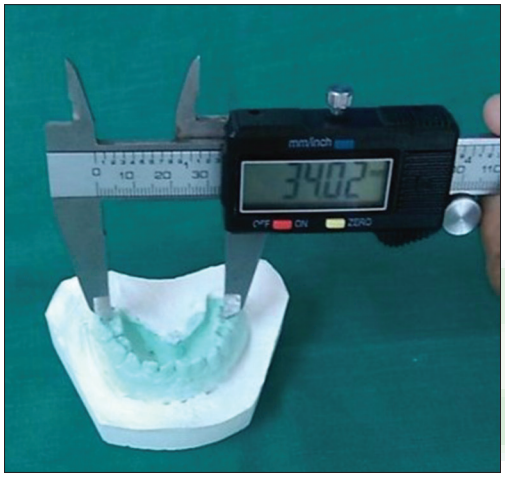

Figure 4: Measurement of 2nd intermolar width.

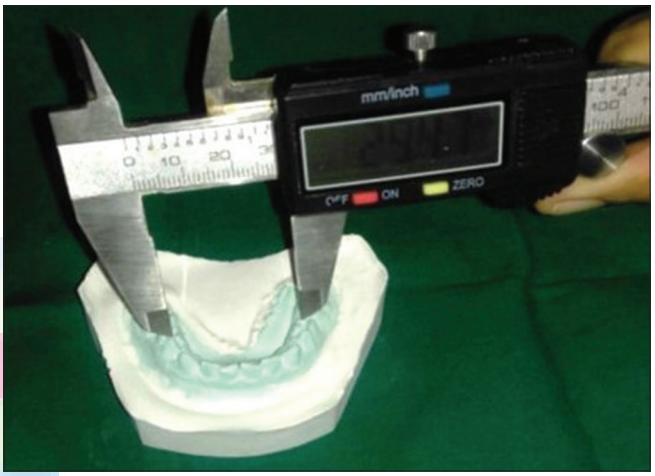

Figure 5: Measurement of 1st intermolar width.

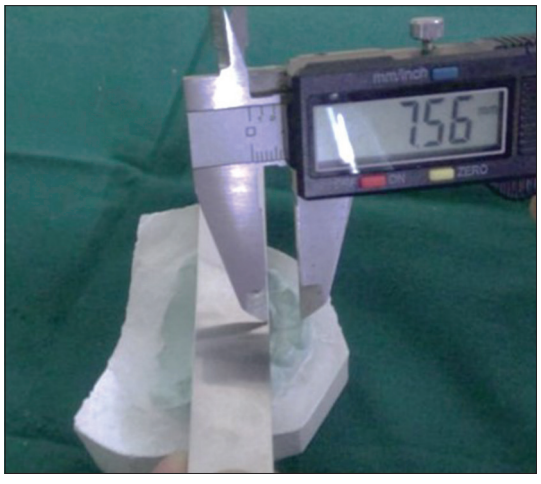

Figure 6: Measurement of anterior segment for arch depth (I-C).

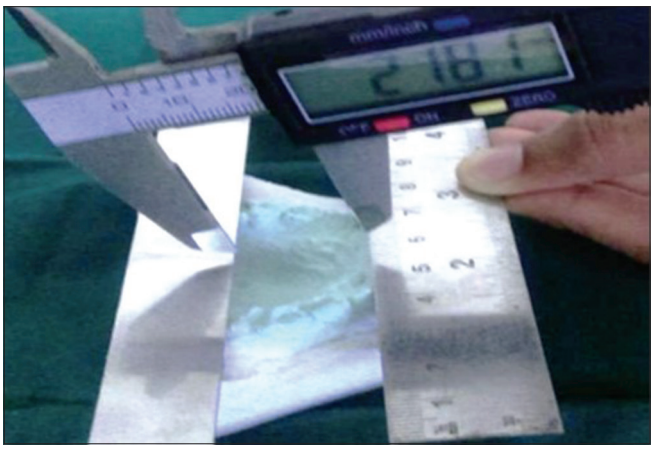

Figure 7: Measurement of posterior segment for arch depth (C-M2).

in the spaced arches, it was determined as the sum of the total MD width of all the teeth and the total spaces between them.

To minimise any error, the teeth were measured twice. If the difference between the two readings varied by 0.2 mm, then the mean of the two readings was considered. Repeatability test was done by randomly selecting ten dental casts, to check

the examiner's reliability. Statistical test applied were (a) descriptive statistics and (b) two-tailed independent sample *t*-test.

Results

A total of 80 students were included in the study. The children were equally divided into the two groups –40 children with spaced dentition and 40 children with non-spaced dentition. All the children selected were within the age group of 3–6 years and of Gujarati ethnic background.

Tooth dimensions

The tooth dimensions – MD, buccolingual and clinical crown ratio dimensions – were measured for all the teeth of both maxillary and mandibular arches. These measurements were achieved from casts of all the participants. As there was no difference in the tooth dimensions between the right and left quadrants in both the arches, only right quadrant was considered.

Table 1 shows the mean MD values for maxillary and mandibular teeth in both spaced and non-spaced dentitions. There was a difference in the mean MD values for all the teeth in both spaced and non-spaced dentitions, but the difference was not statistically significant.

Table 2 shows the mean buccolingual values for maxillary teeth in both spaced and non-spaced dentitions. There was a difference in the mean buccolingual values for all the teeth in both spaced and non-spaced dentitions. The buccolingual dimensions of maxillary primary second molar and primary canine only showed statistical significance ($P \leq 0.05$). There was a difference in the mean buccolingual values in the mandibular arch for all the teeth in both spaced and non-spaced dentitions, but the difference was not statistically significant.

Table 3 shows the mean values of clinical crown size of maxillary and mandibular teeth in spaced and non-spaced dentition. The mean crown size ratio in maxillary arch was greater for primary incisors and canine in spaced dentition than in non-spaced dentition. The mean crown size ratio was 0.9 mm, 0.85 mm and 1.07 mm for central incisor, lateral incisor and canine, respectively. The mean crown size ratio in mandibular teeth was greater for all the mandibular primary teeth in non-spaced dentition than in spaced dentition, except for the second molar. However, none of the teeth showed any statistically significant difference.

Arch dimensions

The arch dimensions – arch width, arch depth and arch perimeter – were measured for all the teeth of both maxillary and mandibular arches. The mean difference between the parameters among the spaced and non-spaced dentition was calculated using two-tailed independent sample *t*-test.

Table 4 shows the mean values for arch width in both maxillary and mandibular arches. In the maxillary arch, the inter-canine width (IC) was greater in the spaced dentition (30.3 ± 1.68) than the non-spaced dentition (29.8 ± 1.86). However, in the mandible, the inter-canine width was greater in non-spaced dentition (23.0 ± 1.54) than the spaced dentition (22.9 ± 1.49). The inter-molar width of the first molar in maxillary arch

Table 1: Mean value of mesiodistal dimension of maxillary and mandibular primary teeth in spaced and non-spaced dentition

Tooth number	Dentition	Mean±SD	*P*
55	Non-spaced	8.59±0.86	0.51
	Spaced	8.69±0.50	
54	Non-spaced	7.21±0.63	0.53
	Spaced	7.10±0.91	
53	Non-spaced	6.47±0.50	0.95
	Spaced	6.46±0.46	
52	Non-spaced	5.39±0.38	0.18
	Spaced	5.26±0.48	
51	Non-spaced	6.34±0.68	0.35
	Spaced	6.20±0.67	
85	Non-spaced	9.72±0.74	0.35
	Spaced	9.54±0.95	
84	Non-spaced	7.74±0.86	0.21
	Spaced	7.49±0.87	
83	Non-spaced	5.77±0.55	0.06
	Spaced	5.54±0.53	
82	Non-spaced	4.80±0.61	0.66
	Spaced	4.73±0.70	
81	Non-spaced	4.13±0.41	0.14
	Spaced	5.22±0.47	

SD: Standard deviation

Table 2: Mean value of buccolingual dimension of maxillary and mandibular primary teeth in spaced and non-spaced dentition

Tooth number	Dentition	Mean±SD	*P*
55	Non-spaced	9.86±0.41	0.04*
	Spaced	9.62±0.63	
54	Non-spaced	8.72±0.40	0.13
	Spaced	8.38±0.75	
53	Non-spaced	6.31±0.52	0.03*
	Spaced	6.07±0.47	
52	Non-spaced	4.94±0.45	0.95
	Spaced	4.95±1.18	
51	Non-spaced	5.03±0.37	0.41
	Spaced	4.96±0.43	
85	Non-spaced	9.16±0.75	0.35
	Spaced	9.18±0.59	
84	Non-spaced	7.52±0.78	0.21
	Spaced	7.45±0.77	
83	Non-spaced	5.54±0.49	0.44
	Spaced	5.45±0.51	
82	Non-spaced	4.40±0.46	0.08
	Spaced	4.58±0.47	
81	Non-spaced	4.01±0.51	0.08
	Spaced	4.19±0.40	

*Statistically significant. SD: Standard deviation

was greater in the spaced dentition (33.8 ± 1.88) than the non-spaced dentition (33.3 ± 1.98). The similar result was seen in the mandibular arch as well. In the maxillary arch and the mandibular arch, the inter-molar width of the second molar was greater in the spaced dentition than the non-spaced dentition. However, the difference for the arch width at different levels was not statistically significant.

Table 5 shows the mean values for arch depth in the maxillary and mandibular arches. The incisor-canine depth (InC) was greater in the spaced dentition in both the arches. The difference was highly significant ($P = 0.00$). The canine second molar depth (CM2) was also more in the spaced dentition than the non-spaced dentition in both maxilla and mandible. The difference was not statistically significant.

Table 6 shows the mean values for arch perimeter in the maxillary and mandibular arches. The arch perimeter in spaced dentition was calculated as the sum of total mesiodistal dimension (TMD) and total spacing. The arch perimeter in non-spaced dentition was calculated as the difference in the TMD and TO. The arch perimeter of the maxillary arch in the spaced dentition was more than the non-spaced dentition. The difference was statistically significant ($P = 0.00$). The arch perimeter of the mandibular arch in the spaced dentition was more than non-spaced dentition. The difference was statistically significant ($P = 0.00$).

Table 3: Mean value of clinical crown size of maxillary and mandibular primary teeth in spaced and non-spaced dentition

Tooth number	Dentition	Mean±SD	*P*
55	Non-spaced	0.87±0.09	0.12
	Spaced	0.90±0.05	
54	Non-spaced	0.82±0.07	0.09
	Spaced	0.85±0.12	
53	Non-spaced	1.04±0.09	0.38
	Spaced	1.07±0.09	
52	Non-spaced	1.11±0.10	0.73
	Spaced	1.09±0.14	
51	Non-spaced	1.28±0.17	0.66
	Spaced	1.25±0.16	
85	Non-spaced	1.04±0.17	0.59
	Spaced	1.24±1.08	
84	Non-spaced	1.10±0.17	0.60
	Spaced	1.04±0.16	
83	Non-spaced	1.04±0.12	0.55
	Spaced	1.02±0.12	
82	Non-spaced	1.03±0.14	0.18
	Spaced	1.01±0.13	
81	Non-spaced	1.06±0.09	0.07
	Spaced	1.04±0.11	

SD: Standard deviation

Table 4: Mean values for arch width in maxillary and mandibular arches

Group	Dentition	Mean±SD	Mean difference	*t*	*P*
IC maxilla	Non-spaced	29.8±1.86	−0.50	−1.27	0.20
	Spaced	30.3±1.68			
IC mandible	Non-spaced	23.0±1.54	0.14	0.43	0.66
	Spaced	22.9±1.49			
IM1 maxilla	Non-spaced	33.3±1.98	−0.42	−0.98	0.33
	Spaced	33.8±1.88			
IM1 mandible	Non-spaced	28.1±1.59	−1.40	−1.40	0.16
	Spaced	28.8±2.76			
IM2 maxilla	Non-spaced	39.6±1.98	−0.05	−0.05	0.95
	Spaced	39.7±1.88			
IM2 mandible	Non-spaced	34.4±1.59	−0.61	−0.61	0.54
	Spaced	34.7±2.74			

IC: Inter-canine width, IM1: Inter-molar width of first molar, IM2: Inter-molar width of second molar, SD: Standard deviation

Discussion

Dental crowding can be defined as a disparity in the relationship between tooth size and jaw size, which results in imbrication and rotation of teeth. Initially, Siepel in his study showed that

Table 5: Mean values for arch depth in maxillary and mandibular arches

Group	Dentition	Mean±SD	Mean difference	*t*	*P*
InC maxilla	Non-spaced	14.56±1.51	−2.24	−6.10	0.00**
	Spaced	16.80±1.75			
InC mandible	Non-spaced	13.12±1.51	−2.49	−6.78	0.00**
	Spaced	15.61±1.75			
CM2 maxilla	Non-spaced	18.09±2.08	0.29	0.65	0.51
	Spaced	17.79±1.94			
CM2 mandible	Non-spaced	16.14±2.13	−1.06	−1.06	0.29
	Spaced	16.62±1.94			

**Statistically significant. InC: Incisor-canine depth, CM2: Canine second molar depth, SD: Standard deviation

Table 6: Mean values for arch perimeter in maxillary and mandibular arches

Group	Dentition	Mean±SD	Mean difference	*t*	*P*
TMD maxilla	Non-spaced	68.25±3.88	1.39	1.51	0.13
	Spaced	66.85±4.36			
TS/TO maxilla	Non-spaced	2.19±0.62	−1.44	−6.27	0.00**
	Spaced	3.61±1.31			
Maxilla perimeter	Non-spaced	66.08±4.04	−4.38	−4.45	0.00**
	Spaced	70.46±4.73			
TMD mandible	Non-spaced	64.20±4.74	−0.27	−0.22	0.82
	Spaced	64.48±6.37			
TS/TO mandible	Non-spaced	1.60±0.48	−1.81	−6.61	0.00**
	Spaced	3.42±1.66			
Mandible perimeter	Non-spaced	62.59±4.82	−5.30	−4.02	0.00**
	Spaced	67.90±6.80			

**Statistically significant. TMD: Total mesiodistal dimension, TS: Total spacing, TO: Total overlap, SD: Standard deviation

the positions of teeth in the dental arch could be determined by considering the size of the teeth and the amount of space available for them in the dental arch.[11] This was followed by a study by Lundstrom, where he reported two factors accountable for dental crowding, i.e., the increase in MD dimensions of teeth and the decrease in dental arch dimensions.[3]

Moderate-to-high correlations between tooth sizes within a dental arch have been previously published by Tanaka and Johnston and Bernabé and Flores-Mir for prediction of tooth sizes in treatment planning.[12,13] This supports the multivariate character of each tooth in its respective dental arch.[14] Arrays of studies have been conducted concerning crowding of the permanent dentition. There is, however, a 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.[8] The maxillary and mandibular arch lengths and the posterior cranial base in the primary dentition also play as an important indicator while predicting the crowding in early mixed dentition.[15] Various anthropometrical studies have proved that the constitution of teeth and arch dimensions are specific to each ethnic population.[16-18] Thus, this study was conducted among the Gujarati children to evaluate the tooth and arch dimensions and the correlation between the two dimensions.

The tooth dimensions measured in the study were MD dimension, buccolingual dimension and crown size ratio. The dimensions were measured from the spaced as well as non-spaced dental models that were prepared. The mean MD dimensions were greater in the non-spaced dentition than the spaced dentition. The difference was not statistically significant in spaced and non-spaced dentitions in both the arches. There was a wide variation in the mean MD dimensions in both the dentitions. Similar results were reported by Sanin *et al*.[19] and Prabhakar *et al*.,[8] who found that the spaced primary dentition, having acceptable occlusion, was more likely to have smaller primary teeth.

The mean buccolingual dimension of the teeth was larger in the non-spaced dentition than the spaced dentition. Similarly, in the study conducted by Prabhakar *et al*.[8] and Tsai,[20] the buccolingual dimensions of the primary maxillary right central incisor, mandibular lateral incisors, and the primary maxillary right and left molars were significantly larger in the non-spaced dentition. The difference in the mean buccolingual dimensions was statistically significant for maxillary second molar and canine ($P \leq 0.05$). In the mandibular arch, none of the primary teeth showed any statistically significant difference though the teeth showed difference in the mean buccolingual dimensions in both the dentitions.

The crown size ratio was calculated as buccolingual dimension/MD dimension. The mean value was greater for primary incisors and canine in spaced dentition than the non-spaced dentition in the maxillary arch. In the mandibular arch, mean crown size ratio was greater for all the mandibular primary teeth in non-spaced dentition than the spaced dentition, except for the second molar. The results were similar to the results of the study conducted by Prabhakar *et al*.[8] However, there was no correlation between the crown shape and crowding in the study conducted by Tsai.[20]

The arch width was measured at three different levels – inter-canine width, inter-molar width of first molar and inter-molar width of second molar. The difference for the arch width at different levels was not statistically significant. This was also seen in the study conducted by Prabhakar *et al*.,[8] but studies conducted by Merz *et al*.,[18] Prabhakaran *et al*.[10] and Tsai[21] contradicted the results of this study and concluded that the arch width was significantly larger in the spaced arches.

The arch depth was calculated at two levels – incisor-canine (IC) and canine second molar (CM2). The incisor-canine depth (InC) was greater in the spaced dentition in both the arches and the difference was highly significant. The canine second molar depth (CM2) was also more in the spaced dentition than the non-spaced dentition in both maxilla and mandible. The difference was not statistically significant. Similarly, in the study conducted by Prabhakar *et al*.,[8] Facal-García *et al*.,[22] Moorrees and Chadha,[23] they concluded that there is a significant correlation existing between the spaced dentition and arch dimensions.

The TMD was greater than in the non-spaced dentition in the maxillary arch, but the total arch perimeter was lesser in non-spaced dentition. In the mandibular arch, the TMD was similar in both the spaced and non-spaced dentitions. The total arch perimeter was lesser in the non-spaced dentition than the spaced dentition. The difference was not statistically significant. Prabhakar *et al*.[8] and Tsai[21] reported similar findings, except that the arch perimeter was lesser in non-spaced dentition than spaced dentition in both the arches.

Conclusion

- The mean MD dimensions were greater in the non-spaced dentition
- The mean buccolingual dimension of the teeth was larger in the non-spaced dentition
- The mean crown size ratio was greater for primary incisors and canine in spaced dentition than the non-spaced dentition in the maxillary arch. In the mandibular arch, mean crown size ratio was greater for all the mandibular primary teeth in non-spaced dentition
- Arch width did not contribute significantly to crowding of the dental arches
- The arch depth of the spaced dentition was more than the arch depth recorded in the non-spaced dentition.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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