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Relationship of arch parameters with arch length-tooth material discrepancy

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Abstract
Dental crowding can be defined as a disparity in the relationship between tooth size and jaw size which resulting imbrications and rotation of teeth. Eight pairs of study models were used in this study. Each study model met the following criteria: all permanent teeth with the exception of the molars were present in both the maxillary and mandibular arches and these was no history of previous orthodontic treatment.

Keywords: skeletal, Vernier caliper, brass wire, arch Length

1. Introduction
Dental crowding can be defined as a disparity in the relationship between tooth size and jaw size which result in imbrications and rotation of teeth. Three condition which may predispose the dental arches to crowding are excessively large teeth, excessively small bones of the jaws and a combination of large teeth and small jaws [1].
A concept that large teeth are characteristic of modern, civilized man has been advanced by dental anthropologists, orthodontists and student of developing occlusion. It is a generally accepted theory that primitive civilizations exhibited a significant degree of wear or attrition, probably the result of more vigorous mastication of harder foodstuff than is commonly associated attritional occlusion theory given by Begg[2].

2. Aims and objectives
To determine the extent to which various dental arch parameters contribute to dental crowding.

3. Material and methods
Eight pairs of study were used in this study. Each study model met the following criteria: all permanent teeth with the exception of the third molars were present in both the maxillary and the mandibular arches. There was no history of previous orthodontic treatment.
These study models were divided into two groups.
Group 1 consisted of forty pairs (20 males and 20 females) of study models with angles class I normal occlusion having class I skeletal base and little or no crowding. These patients exhibited a straight profile, normal overjet and overbite and class I canine relationship. The mean age for this group was 21.28±2.85years (figure-1)
Group 2 consisted of forty pairs (20 males and 20 females) of study models with angles class I normal occlusion having class I skeletal base and more than 5 mm crowding. The mean age for this group was 18.25±3.24 years (figure-2)
The following Mearsurement were recorded
1. The largest mesiodistal width of each tooth (except the second and third molars) of each arch.
2. Buccal and lingual inter-canine width.
3. Buccal and lingual inter-molar width
4. Arch length
5. Arch perimeter of both arches
   Digital vernier caliper was used to recorded the measurements. It was calibrated to 0.1 mm (figure 3).

Measurement of mesiodistal width of tooth

The mesiodistal width of the teeth were measured in the widest area by caliper calibrated to 0.1 mm. The caliper was held perpendicular to the long axis of tooth (figure-4)

Measurement of arch diamension

Arch dimension in the canine and molar regions were buccally and lingually. The buccal arch dimension war measures 5 mm apical to the mesiodistal centre of the gingival margin of the canine tooth on one side to the same point on the contralateral side. On the lingual side, the distance between midpoint on the cervical region of the canine on one side was measured to the corresponding point on the contra-lateral side. The same procedure was preformed in the molar region. (figure 5).

Measurement of arch perimeter

The arch perimeter is a line drawn from the surface of the first perimeter molar around the arch over contact points and incisal edges in a smooth curve to the distal surface of the first permanent molars on the opposite side. The brass wire made into a arch, free kinds and in a simulated arch form. The wire is then straighten and measured with scale. (figure-6).

Measurement of arch length

To determine the arch length a line was drawn a point midway to the central incisors perpendicular to the tangent touching the distal surface of the first permanent molars. (figure-7)

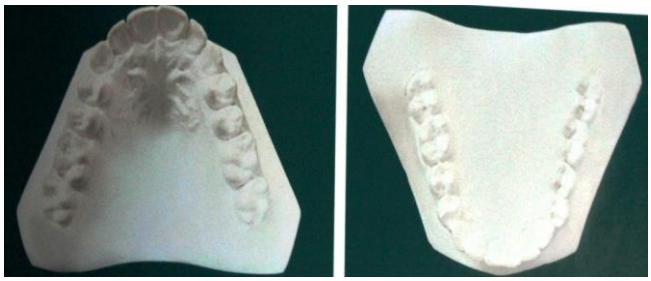


Fig 1: Normal dentition

Fig 2: Crowded dentition

Fig 3: Digital vernier caliper

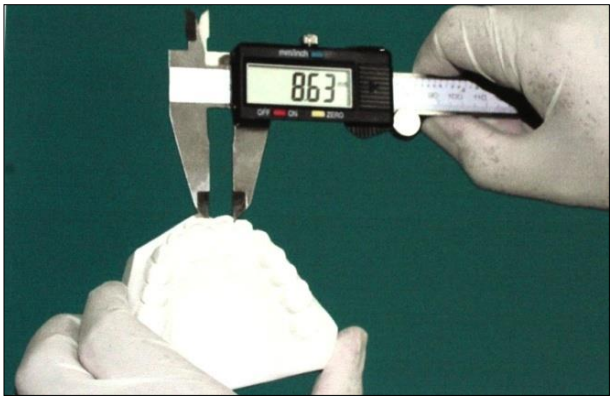


Fig 4: Measurement of tooth size using Digital vernier caliper

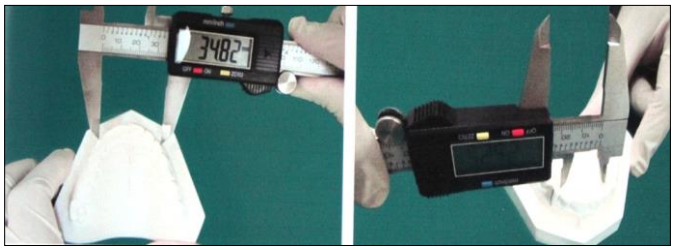


Fig 5: Measurement of Arch dimension

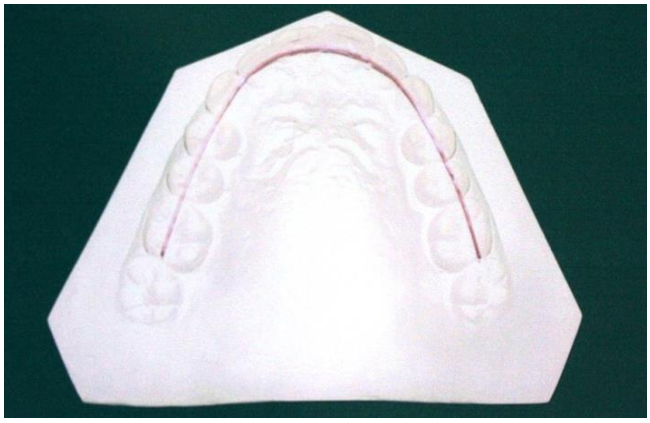


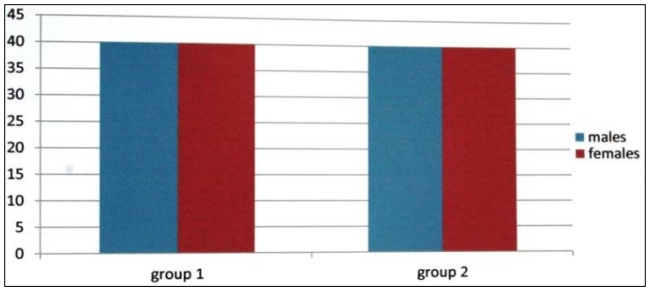
Fig 6: Measurement of Arch perimeter

Fig 7: Measurement of Arch length using brass wire

4. Result

Table 1: Demographic data

	Males	Females	Mean age
Group-1	20	20	21.82±2.85
Group -2	20	20	18.25±3.24



Graph 1: Demographic data

Table 1 and graph 1 shows

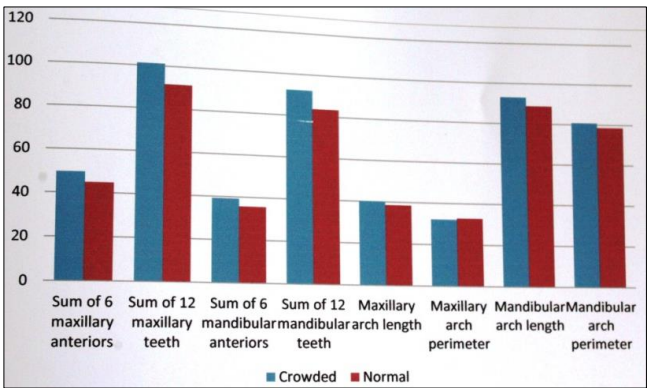
Group 1 consisted of 40 pairs (20 males and 20 females) of study models with Angles class I normal occlusion having class I skeletal base and little or no crowding.

Group 2 consisted of 40 pairs (20 males and 20 females) of study models with Angles class I normal occlusion having class I skeletal base and more than 5 mm of dental crowding.

Table 2: Collective mesiodistal tooth diameter, arc length and arch perimeter for males in crowded and uncrowded occlusions (mm)

Region	Males				
	Crowded		Normal		P-value
	Mean	SD	Mean	SD	
Sum of 6 maxillary anteriors	49.60	2.88	44.775	2.83	0.0000**
Sum of 12 maxillary teeth	101.175	6.29	91.53	4.82	0.0000**
Sum of 6 mandibular anteriors	39.35	3.13	35.74	2.03	0.0001**
Sum of 12 mandibular teeth	92.275	5.25	83.61	4.08	0.0000
Maxillary arch length	40.17	3.78	38.625	2.95	0.1587
Maxillary arch perimeter	93.125	8.33	88.9	5.57	0.0682
Mandibular arch length	32.17	2.34	32.895	2.05	0.3036
Mandibular arch perimeter	80.9	7.34	78.7	4.22	0.2542

p<0.05 significant *p<0.01 highly significant**

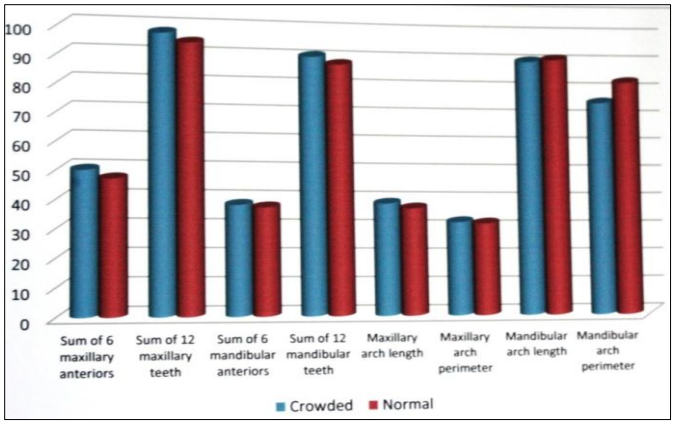


Graph 2: Collective mesiodistal tooth diameter, arch length and arch perimeter formal crowded and uncrowded occlusion (mm)

Table 3: Collective mesiodistal tooth diameter, arch length and arch perimeter for females in crowded and uncrowded occlusion (mm)

Region	Females				
	Crowded		Normal		P-value
	Mean	SD	Mean	SD	
Sum of 6 maxillary anteriors	50.25	2.96	47.37	2.42	0.0018*
Sum of 12 maxillary teeth	98.475	5.67	95.27	4.78	0.0610
Sum of 6 mandibular anteriors	38.7	2.40	37.89	2.62	0.3142
Sum of 12 mandibular teeth	91.425	4.97	88.85	4.36	0.0900
Maxillary arch length	39.575	3.16	37.945	3.03	0.1041
Maxillary arch perimeter	91.2	8.29	91.95	6.86	0.07571
Mandibular arch length	33.125	2.76	32.66	2.73	0.5951
Mandibular arch perimeter	76.425	10.10	83.95	6.51	0.0085*

p<0.05 significant* p<0.01 highly significant**



Graph 3: collective mesiodistal tooth diameter, arch length and arch perimeter for female's crowded and uncrowded occlusions (mm)

Table and graph 2,3 depict the comparison of the tooth size discrepancy in normal and crowded group among males females (n=80) respectively.

Tooth size: in males, the mean value of maxillary tooth size diameters of the six anterior teeth in group 1 (non crowded) was 44.77±2.82 and group 2(crowded) was found to be 49.60±2.88 and all 12 teeth in the maxillary arch in group 1 (non crowded) was 91.53±4.82 and group 2 (crowded) was found be 101.17±6.29. Highly significant difference was found.

In females, the mean values of maxillary tooth size diameter of six anterior teeth in group 1 was found to be 47.37±2.42 and in group 2 was 50.25±2.96. Significant difference was found in the tooth size of six anterior between group 1and group 2 in females but there was no significant difference in the mean values of maxillary tooth size diameter of 12 teeth. Their mean valve in group 1 was found to be 95.27±4.78 and group 2 was 98.47±5.67.

Arch length:- In males, the mean value of maxillary arch length in group 1 was to be 38.62±2.95 and group 2 was 40.17±3.78. No significant difference was found. Mean value of mandibular arch length in males of group 1 was found to be 32.89±2.05 and group 2 was 32.17±2.34 and no significant difference was found.

In females, the mean value of maxillary arch length in group 1 and group 2 was found to be 37.94±3.03 and group 2 was 39.57±3.16 and that of mandibular arch length were found to be 32.66±2.37(group 1) and33.12±2.76 (group 2). No significant difference was found in the arch length between group 1 and 2.

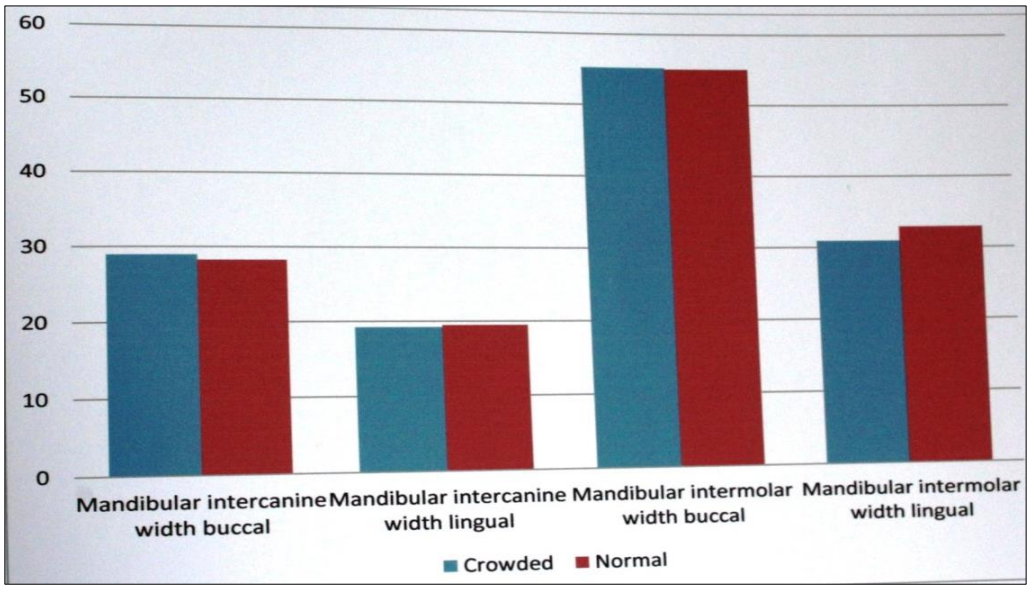
Arch perimeter: In males, the mean value of maxillary arch perimeter in group 1 was found to be 88.9±5.57 and group 2 was 93.12±8.33. No significant difference was found in the arch perimeter between group 1 and 2. The mean values of mandibular arch perimeter in group 1 was found to be 78.7±4.22 and group 2 was 80.9±7.34. No significant difference was found in the arch perimeter between group 1 and 2 in males.

In females, the mean values of maxillary arch perimeter in group 1 was found to be 91.95±6.86 and in group 2 was 91.2±8.29. No significant difference was found in the arch perimeter between group 1 and 2. I n mandibular arch perimeter significant difference was found between group 1 and 2.

Tables 4: Mandibular arch dimensions for males in crowded and uncrowded occlusions (mm)

Region	Males				
	Crowded		Normal		P value
	Mean	SD	Mean	SD	
Mandibular intercanine width buccal	28.935	2.23	28.23	1.98	0.2965
Mandibular intercanine width lingual	19.205	2.17	19.455	1.30	0.6619
Mandibular intermolar width buccal	55.2	2.07	55.055	2.67	0.8490
Mandibular intermolar width lingual	30.89	2.20	32.86	2.14	0.0067

P<0.05-significant * P<0.01= highly significant **

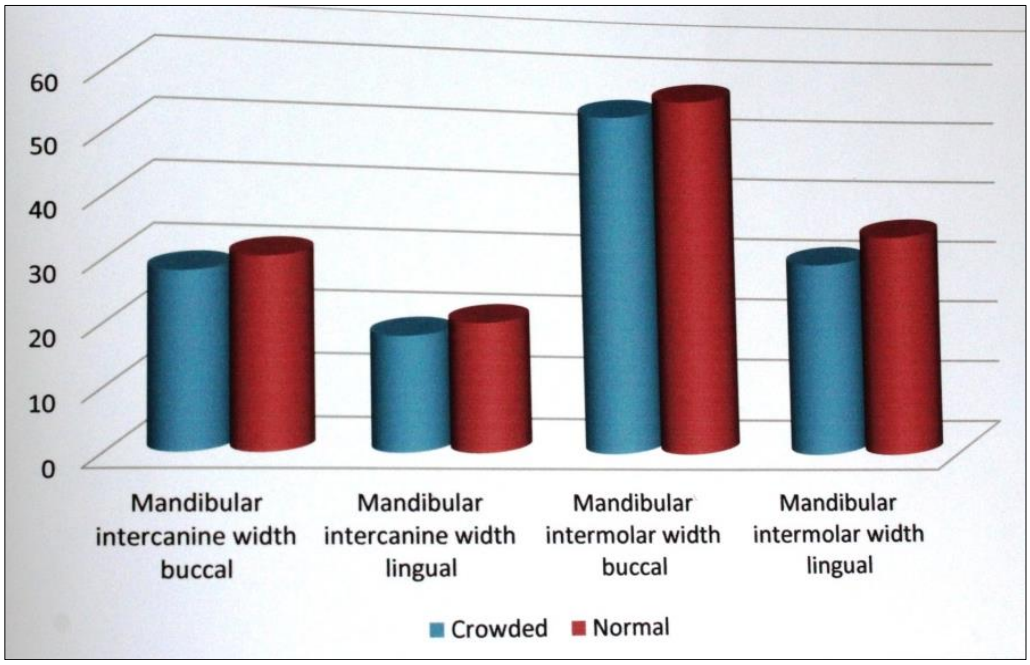


Graph 4: Mandibular arch dimension for males in crowded and uncrowded occlusion (mm)

Tables 5: Mandibular arch dimensions for females in crowded and uncrowded occlusions (mm)

Region	Males				
	Crowded		Normal		
	Mean	SD	Mean	SD	P value
Mandibular intercanine width buccal	28.25	2.65	30.82	2.25	0.0021*
Mandibular intercanine width lingual	18.525	3.19	20.835	0.89	0.0050*
Mandibular intermolar width buccal	55.225	2.71	58.22	2.22	0.0005**
Mandibular intermolar width lingual	31.375	2.93	36.125	2.42	0.0000**

P<0.05-significant * P<0.01= highly significant **



Graph 5: Mandibular arch dimensions for females in crowded and uncrowded occlusions (mm)

Arch dimensions

Mandibular intercanine and intermolar width

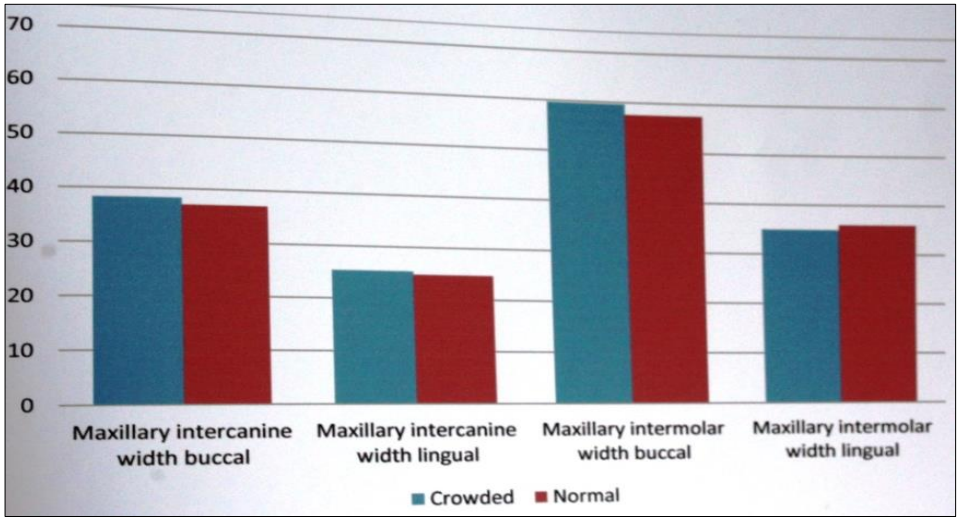
In males, the mean value of buccal mandibular intercanine width in group 1 was to be 28.23±1.98 and group 2 was 28.93±2.23. No significant difference was found between the two groups. And no significant difference was found of lingual mandibular intercanine width between group 1 and 2.No significant difference was found in the buccal mandibular intermolar width between group 1 and 2.But significant difference was found in lingual side.

In females, highly significant difference found in buccal and lingual mandibular intercanine width between group 1 and 2. (Table and graph 4,5)

Table 6: Maxillary arch dimension for males in crowded and uncrowded occlusion (mm)

Region	Males				
	Crowded		Normal		P value
	Mean	SD	Mean	SD	
Mandibular intercanine width buccal	38.32	2.67	37.1	2.68	0.1575
Mandibular intercanine width lingual	25.31	2.32	24.69	2.02	0.3724
Mandibular intermolar width buccal	59.67	2.39	57.55	2.70	0.0124*
Mandibular intermolar width lingual	34.975	2.08	36.02	2.33	0.1425

P<0.05-significant * P<0.01= highly significant **

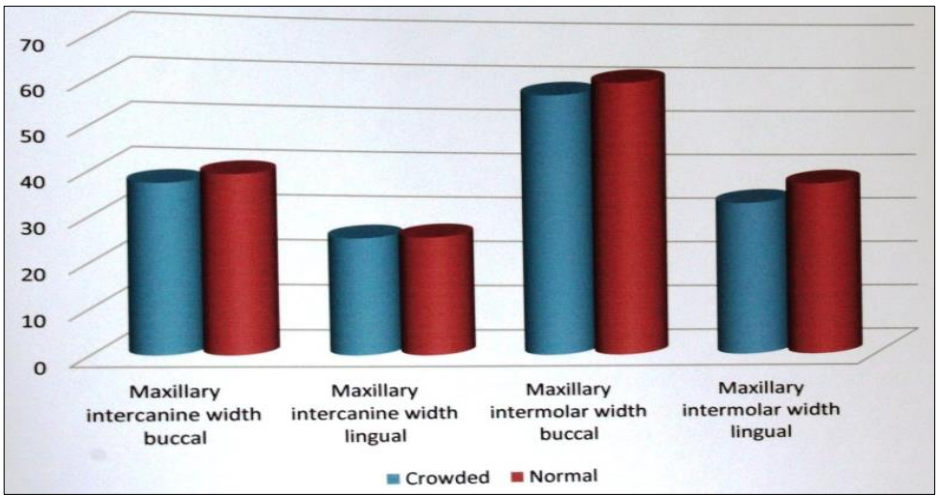


Graph 6: Maxillary arch dimension for males in crowded and uncrowded occlusion(mm)

Tables 7: Maxillary arch dimension for females in crowded and uncrowded occlusion(mm)

Region	Males				
	Crowded		Normal		P value
	Mean	SD	Mean	SD	
Mandibular intercanine width buccal	37.725	3.01	40.005	2.06	0.0085*
Mandibular intercanine width lingual	26.05	2.33	26.43	2.12	0.6694
Mandibular intermolar width buccal	59.025	2.40	62.02	2.94	0.0011**
Mandibular intermolar width lingual	34.55	2.55	39.015	2.54	0.0000**

P<0.05-significant * P<0.01= highly significant **



Graph 7: Maxillary arch dimension for females in crowded and uncrowded occlusion (mm)

Maxillary intercanine and intermolar width

In males, no significant difference was found in the maxillary buccal and lingual intercanine width between group 1 and 2. And no significant difference was found in the maxillary lingual inter molar width between group 1 and 2 but in buccal side significant difference are occur.

In females, no significant difference was found in the maxillary buccal and lingual intercanine width between group 1 and 2. But highly significant difference was found in the maxillary buccal and lingual intermolar width between group 1 and 2. (tables and graphs- 6,7)

5. Discussion

Malocclusion has been described as a "disease of civilization Comuecim and Kaul 1984)"because of its high prevalence in contemporary Industrialized countries as compared to historic populations and, even, isolated cultures that continue to subsist on less-processed diets (Corruccini 1984).

The causes of malocclusion could be classified in two major categories dental or skeletal. One way of distinguishing between the two is to compare tooth size and arch dimensions in Class I non crowded occlusions with Class I malocclusions exhibiting severe crowding. The results will reveal the dental or skeletal causes of crowding. This information will be helpful in treatment

planning prior to orthodontic treatment. Nance described dental crowding as the difference between the spaces needed in the dental arch and the space available in that arch that is, the space discrepancy. Thus, crowding or spacing can be described as an expression of an altered tooth/tissue ratio or as a dent alveolar disproportion. The causes of crowding or spacing are, however, still not fully understood.

In our study, the sample size was selected within an age group of 15-25 years that was equally distributed in crowded and non crowed groups (40 samples) and with equal sex ratio (20 males and 20 female).This was in accordance with the study done by Doris *et al*.' and Puri *et al*. [2]" This age range was chosen such that the subjects were beyond the active growth phase and therefore had stable arch width. Also, early adult dentitions have less mutilation and attrition in most subjects.

In the present study both group had class I skeletal relationship. However, in the previous studies done by Howe *et al*. the skeletal relationship was not included in factors considered for crowded group. The skeletal relationship may affect arch malocclusions.

In our study, there was a highly significant difference in tooth size diameter of all the teeth (maxillary and mandibular) between the crowded and non crowded groups, among males. However, in the maxillary arch, though there was tooth size significant discrepancy in the sum of maxillary six anterior teeth in diameter was significantly noted in the two groups, there was no correlation found between both the groups in the region of maxillary twelve teeth.

Furthermore, no statistically significant difference was observed in the mandibular tooth size diameter of six anterior teeth and twelve teeth between both the groups. This is in accordance to the studies conducted by Lundstrom, Doris *et al*., Chang *et al*., Fastlitcht and Lomardi1 was

found that crowding was greater in those individuals with larger teeth. However, in the studies conducted by Howe *et al* Randzie, Fsber, and Gilmore, no significant correlation was found between the mesiodistal tooth size crowding.

In the evaluation of arch dimension, the most significant difference was seen in the maxillary and mandibular intercanine and intermolar (buccal and lingual aspect) arch width in females and mandibular lingual intermolar and maxillary buccal intermolar width in males in the noncrowded and crowded groups. Similar results were found in the study done by Howe *et al*., where significant differences in lingual measurements of lower arch were noted in both crowded and noncrowded groups. But in the study done by Possi *et al*. mandibular arch dimensions, both in the transverse and longitudinal directions, did not differ significantly between the uncrowded and crowded groups, excerpt for the buccal intercanine width which was significantly greater in the uncrowded group. This may be due to prominent canine root areas in the uncrowded dentitions. In the majority of crowded mandibles, the canine toot rotated and does not show a root prominence in the oral mucosa.

In the present study there was no significant difference in cither arch or arch perimeter in both the groups in either maxilla and mandible. These results were in conformity with the results evaluated by Poosti M *et al*. However studies conducted by Howe *et al*. found significant difference in dental arch perimeter measurement for maxilla between the crowded and non crowded dentitions. Moreover they revealed that the non crowded arches tended to be wider and more broadly contoured than did the crowded arches.

Dental crowding associated with small dental arches rather than with large teeth, is an important consideration for treatment techniques which increase dental arch length. This may be especially relevant in younger patients whose dentitions are in the deciduous and mixed stages of development. If such a patient is diagnosed as having dental crowding and small dental arches, then treatment measures may include efforts to further jaw development in order to accommodate the existing tooth mass. This might be accomplished by early expansion procedures using such appliances as the rapid palatal expander, the quad helix appliance, or the Fränkel appliance", alone or in combination.

Observations made during the course of this study suggests further investigation. For example, the findings presented could be interpreted to suggest that compared to dental arch dimensions, tooth size may be significantly associated with dental crowding. However, associated differences

between the two groups may have been overlooked.

6. Conclusion

The correct tooth size-arch length relationship between the maxillary and mandibular teeth is an important factor for achieving proper interception during the final stages of orthodontic treatment

The following conclusions can be drawn from the present study

1. Mesiodistal tooth size was larger in crowded arches as compared to non-crowded arches in both males and females.
2. In females, maxillary arch width was found to be smaller in crowded arches as compared to non crowded arches.

3. In males, inter-canine width was not significantly different in the crowded and non-crowded arches but maxillary buccal and mandibular lingual inter-molar width was found to be significantly smaller in the crowded arches.

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