

## Comparision of maxillomandibular tooth size discrepancy among different malocclusion groups in Saurashtra population.

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### Abstract

**Aim:** The purpose of this study was to determine the mean mesiodistal tooth width of the teeth, Bolton anterior and overall ratios, arch perimeter, and arch width in the three different malocclusions groups in Saurashtra population.

**Material & Method:** All four parameters were measured on a total of 105 pre-treatment orthodontic study models, aged 18-25 years of three different occlusal relationships (Class I, Class II division 1, Class II division 2 malocclusions). The mean and standard deviation for each measurement of each tooth in the different groups of malocclusions were calculated. Analysis of variance and Posthoc tukey test was used to determine whether significant differences existed between the different malocclusion groups.

**Results:** The results show that (1) Class II Division 2 malocclusion showed larger teeth than the rest of the otherocclusal categories; (2) Statistically significant differences were found in Bolton ratios between the different malocclusions particularly in Class II Division 2; (3) Maxillary intercanine width was found significantly smaller in Class II Division 2 malocclusion, maxillary interpremolar widths in Class II division 1 and 2 were significantly smaller, mandibular interpremolar width was significantly smaller in class II Division 1 (4) The maxillary arch perimeter was significantly longer in Class II division 1 than in Class II division 2; and the mandibular arch of both Class II categories was significantly shorter.

**Conclusion:** Tooth size discrepancies, differences in Arch perimeter and Arch width were found between different malocclusions. Hence it is important to evaluate maxillomandibular tooth size harmony which forms the basis of healthy optimal occlusal interdigitation of teeth

**Key Words:** Tooth size; Arch width; Arch Perimeter; Anterior ratio; Overall ratio

## Introduction

An intermaxillary tooth-size relationship, dental arch dimensions, including dental arch width, perimeter, and form, are an essential orthodontic diagnostic aid. A correct maxillary and mandibular mesiodistal tooth size relationship is mandatory for the achievement of correct occlusal interdigitation and proper coordination of arches in final stages of orthodontic treatment plan.<sup>1,2</sup>

Lawrence F Andrews in 1972 evaluated the dental casts of 120 non orthodontic individuals with normal occlusion and concluded that to achieve normal occlusion, six crucial 'keys' are required. Later on, McLaughlin et al in 2001 elucidated that tooth size should be considered as 'seventh key' for optimal occlusion and an ideal orthodontic treatment sequela is dependent on the relative sizes of maxillary and mandibular teeth to each other. The lack of harmony of size of each tooth or group of teeth when related to those within the same arch or the opposing arch is called as Tooth Size Discrepancy.<sup>3</sup>

The evolutions of the tooth-size analysis ratios which are to be the substratum of orthodontic investigation, without difficulty, be made a diagnostic avail which sanctions the orthodontist to gain insight into the functional and

aesthetic outcome of any case without the utilization of a diagnostic setup.<sup>4</sup>

Variations with different ethnic backgrounds and malocclusions often exhibits different tooth size, dental arch measurements and its characteristics. On a clinical level, mesiodistal width of tooth coordinates to alignment of the arch and large teeth are associated with crowded dental arches. An individual with tooth-size discrepancies requires either removal or addition of tooth structure to regain or approximate the spaces in the arch.

Various methods have been delineated to assess interarch tooth size relationship such as Kesling's diagnostic setup, Neff's anterior coefficient, and Bolton's ratios for the six anterior teeth, and an overall ratio for the 12 teeth<sup>4</sup>, among all these Bolton's anterior and overall ratio is most widely accepted method, which states that the ideal anterior and overall ratios with mean values of 77.2% and 91.3%, respectively are required for proper ratio of upper and lower teeth<sup>5-6</sup>. Several methods for calculating the dental arch perimeter have been adopted by various authors. One of these methods involves direct measurement of these parameters by extending a brass wire, or steel wire along the distances that need to be measured and then straightening and measuring the length of the wire. Numerous factors such as heredity, maturation of the bone,

eruptive pathway and angulation of the teeth, external influences, and ethnic background can influence the size and shape of the dental arches.

Various studies were carried out on arch width and transverse craniofacial development to evaluate changes due to growth, treatment,

and relapse. Some studies investigated the transverse morphology and growth of Class II division 1 and Class II division 2 compared with Class I.<sup>7</sup>

The aim of this study is to determine: the mesiodistal width of tooth, the anterior and overall Bolton ratios, the arch perimeter, and arch width in the different malocclusions group.

## Materials and methods

### Study Design

A total of 105 sets of pre-treatment study models were obtained of patients (age range 18- 25 years) with different malocclusions (Class I, Class II division 1, Class II division 2,

malocclusions) who have visited to the Department of Orthodontics and Dentofacial Orthopaedics, College of Dental Science, Amargadh, Bhavnagar, Gujarat. The distribution of subjects according malocclusion group is shown in

**Table 1**

TABLE 1. Distribution of Subjects According to Malocclusion Group

Classification of Malocclusion	Number of Subjects
Angle's Class I	35
Angle's Class II Division 1	35
Angle's Class II Division 2	35

Total Subjects	105
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**Selection Criteria****Inclusion Criteria:**

1. Presence of all permanent teeth except third molar with no caries, restorations, or any other dental anomalies.
2. All teeth completely erupted to the occlusal plane.
3. No previous or ongoing orthodontic treatment

**Method of collection of data:**

The mesiodistal width of each tooth from first molar to first molar of contralateral side was measured by Digital Vernier caliper. It was measured at the greatest distance between the contact points on the mesiodistal surfaces from orthodontic pretreatment study model as shown in Figure 1. All the measurements were done by one investigator to avoid bias. Bolton's anterior and overall ratios were calculated for each dental cast using the formula given by Bolton. Arch Perimeter was measured anterior to first molar using soft brass wire touching

**Exclusion Criteria:**

1. No abnormal tooth morphology
2. Partially erupted or missing teeth
3. Fractured or broken tooth on studymodel
4. No tooth agenesis or extractions

mesial surface of first molar of one side and passed over buccal cusps of first premolar and along anteriors continued to opposite side of arch. Arch width between canines, premolars, and first molars were measured in both the arches at three different points: the distance between the buccal cusp on the right side to the buccal cusp on the left side, distance between the central fossa to central fossa, and the distance between the lingual cusp to the lingual cusp as shown in Figure 2 (A, B, C)



Figure A Measuring mesiodistal width with vernier caliper



Figure 2 (A) Measuring Arch width from Buccal cusps with vernier caliper



Figure 2 (A) Measuring Arch width from Central fossa with vernier caliper



Figure 2 (A) Measuring Arch width from lingual cusps with vernier caliper

### Statistical analysis

The mean and standard deviation for each measurement of each tooth in the different groups of malocclusions were calculated. Analysis of variance and Posthoc tukey test was used to determine whether significant differences existed between the different malocclusion groups. The compared variables were mesiodistal tooth widths, the Bolton's anterior and overall ratios, the arch Perimeter, the intercanine width, interpremolars, and intermolar widths from all the measured points. Least significant

difference was used to identify which of the groups is different.

### Results

The mean and standard deviations of the mesiodistal widths of teeth in maxillary and mandibular arches within different malocclusion groups are shown in **Table 2**. **Table 3** shows the mean and standard deviations of anterior and overall Bolton ratios in the different malocclusion groups. The maxillary and mandibular arch width shown in **Table 4**. and arch perimeter for the three occlusal patterns are shown in **Table 5**.

**Table 2** Mean and Standard Deviation of Mesiodistal Tooth Width in the Different Malocclusion Groups (measurements are in mm)

Arch	Tooth	Class 1	Class II Division 1	Class II Division 2
Maxillary Arch	Central Incisor	9.53±0.92	9.59±0.86	9.45±1.12
	Lateral incisor	8.12±0.97	7.57±0.76	8.18±0.82
	Canine	8.46±0.98	8.36±0.57	8.61±0.73
	First Premolar	7.62±0.71	7.56±0.82	7.85±0.79
	Second Premolar	7.23±0.75	7.43±0.78	7.64±0.79
	First Molar	10.95±0.79	11.07±0.97	11.02±0.94
Mandibular Arch	Central Incisor	6.71±0.85	6.45±0.62	7.05±0.91
	Lateral incisor	6.94±0.76	6.84±0.75	7.06±0.64
	Canine	7.79±0.7	7.36±0.72	7.67±0.84
	First Premolar	7.72±0.8	7.53±0.5	7.62±0.79
	Second Premolar	7.58±0.68	7.9±0.76	7.32±0.69
	First Molar	11.5±0.91	11.79±0.76	11.41±0.9

**Table 3** Mean and Standard Deviation of Anterior and Overall Bolton Ratios in the Different Malocclusion Groups in Percent (%)

	Class I (n=35)	Class II div 1 (n=35)	Class II div 2 (n=35)
Anterior ratio	78.4±3.34	80.82±3.06	79.91±2.51
Overall ratio	91.76±2.76	92.79±1.87	90.62±4.57



**Table 4** Mean and Standard Deviation of Arch Width in the Different Malocclusion Groups. Measurements are in mm

Arch	Tooth	Class I	Class II Division 1	Class II Division 2
Maxillary Arch	Inter canine width	27.29±4.66	27.3±4.71	23.61±4.55
	First Premolar			
	DBC	34.6±5.68	32.7±4.96	31.79±4.9
	DCF	28.38±6.13	28.1±5.55	24.76±4.82
	DLC	24.52±6.33	23.81±5.69	20.76±4.9
	Second Premolar			
	DBC	39.38±6.21	36.83±4.03	35.68±4.76
	DCF	39.38±6.21	36.83±4.03	35.68±4.76
	DLC	29±6.42	28.05±5.71	24.5±4.95
	First molar			
	DBC	43.05±1.86	43.11±4.8	42.09±2.75
	DCF	37.63±3.06	38.1±5.54	37.15±4.08
	DLC	33.73±5.79	33.85±6.66	33.32±4.53
Mandibular Arch	Inter canine width	19.23±6.71	19.23±5.9	16.83±5.38
	First Premolar			
	DBC	27.59±6.49	27.49±5.42	24.43±4.37
	DCF	22.91±6.6	22.85±5.88	21.02±3.1
	DLC	20.43±6.45	20.04±5.46	20.33±3.04
	Second Premolar			
	DBC	32.29±5.93	33.76±4.93	29.34±5.6
	DCF	27.52±5.46	28.22±5.69	24.12±5.46
	DLC	24.23±5.48	24.9±6.08	20.13±4.86
	First molar			
	DBC	37.98±2.42	39.9±4.79	38.69±3.4
	DCF	33.05±4.94	35.07±5.94	33±3.9
	DLC	28.85±5.61	31.29±6.04	28.7±4.05

**Table 5** Mean and Standard Deviation of Arch Perimeter in the Different Malocclusion Groups. (measurements are in mm)

	Class I (n=35)	Class II Division 1 (n=35)	Class II Division 2 (n=35)
Maxillary Arch Length	78.47±6.3	82.17±8.47	70.8±8.27
Mandibular Arch Length	69.01±9.47	72.73±8.47	59.94±5.69

### Comparisons between the different malocclusion groups

1. **Mesiodistal tooth width:** The differences in mesiodistal tooth widths between the different malocclusion groups are shown in **Table 6**. The mandibular central incisor and maxillary lateral incisor is significantly larger in Class II division 2 compared to class I and Class II division 1. ( $p < .01$ ). In class I malocclusion group, mandibular second Premolar is significantly larger than mandibular second premolar in Class II Division 2. ( $p < .05$ ). no statistical difference was found in any other tooth size.
2. **Bolton Ratios:** The differences in Bolton Ratios between the different malocclusion groups are shown in **Table 7**. In Class II Division I malocclusion, anterior and overall Bolton ratio is significantly greater than Class II Division II and Class I malocclusion. ( $p < .01$ ).
3. **Arch Width:** The maxillary intercanine width is significantly

smaller in Class II Division 2 ( $p < .01$ ). The maxillary interpremolar widths in Class II division 2 malocclusions were significantly smaller than those in the other malocclusion groups from all the measured points, i.e., between buccal cusps, between central fossae, and between the palatal cusps. No differences were found in the maxillary intermolar width. In mandibular arch, interpremolar width was significantly smaller in both Class II div 1 and Class II div 2 malocclusions than Class 1 group. No differences were found in measurements of arch width of inter canine and intermolar width. The differences in arch widths between the different malocclusion groups are shown in **Table 8**

4. **Arch Perimeter:** The maxillary arch length in Class II division 2 malocclusion was significantly shorter than that of Class II division 1 ( $P < .01$ ). In the mandible, Class II division 1 malocclusions showed a significantly greater arch length than the Class 1 malocclusion group. The differences in arch length between the different malocclusion groups are shown in **Table 9**.

TABLE 6. Differences in the Mesiodistal Tooth Width in the Different Malocclusion Groups. Measurements are in mm

Arch	Tooth	One-way Anova		Posthoc Tukey Test		
		F value (*=welch test)	P VALUE	Class I vs Class II Division I difference (p value)	Class I vs ClassII Division II difference (p value)	Class II Division I vs Class II Division II difference (p value)
Maxillary Arch	Central Incisor	0.183	0.833	-0.06 (0.964)	0.08 (0.937)	0.14 (0.819)
	Lateral incisor	5.368	<b>0.006 *</b>	0.55 (0.023)	-0.06 (0.954)	-0.61 (0.01)
	Canine	1.25*	0.293	0.1 (0.861)	-0.15 (0.695)	-0.25 (0.379)
	First Premolar	1.301	0.277	0.06 (0.939)	-0.22 (0.457)	-0.29 (0.279)
	Second Premolar	2.424	0.094	-0.2 (0.52)	-0.41 (0.076)	-0.21 (0.511)
	First Molar	0.156	0.856	-0.12 (0.844)	-0.07 (0.942)	0.05 (0.973)
Mandibular Arch	Central Incisor	4.846	<b>0.01</b>	0.26 (0.378)	-0.34 (0.186)	-0.6 (0.007)
	Lateral incisor	0.839	0.435	0.1 (0.831)	-0.12 (0.757)	-0.22 (0.402)
	Canine	3.014	0.054	0.43 (0.05)	0.12 (0.784)	-0.31 (0.205)
	First Premolar	0.792*	0.457	0.2 (0.479)	0.11 (0.808)	-0.09 (0.852)
	Second Premolar	5.802	<b>0.004</b>	-0.32 (0.144)	0.25 (0.296)	0.58 (0.003)
	First Molar	1.902	0.155	-0.29 (0.334)	0.09 (0.896)	0.38 (0.154)

Table 7. The differences between arch widths at different teeth in the different malocclusion groups. Measurements are in mm

Arch	Tooth	One-way Anova		Posthoc Tukey Test		
		F value (* = welch test)	P VALUE	Class I vs Class II Division I difference (p value)	Class I vs Class II Division II difference (p value)	Class II Division I vs Class II Division II difference (p value)
Maxillary Arch	Inter canine width	7.349	<b>0.001</b>	-0.01 (1)	3.68 (0.004)	3.69 (0.003)
	First Premolar					
	DBC	2.681	0.073	1.9 (0.279)	2.81 (0.065)	0.91 (0.743)
	DCF	4.659	<b>0.012</b>	0.28 (0.976)	3.62 (0.02)	3.35 (0.034)
	DLC	4.358	<b>0.015</b>	0.71 (0.858)	3.77 (0.018)	3.05 (0.067)
	Second Premolar					
	DBC	4.862	<b>0.01</b>	2.55 (0.095)	3.7 (0.008)	1.15 (0.613)
	DCF	4.815	<b>0.01</b>	1.21 (0.633)	4.01 (0.009)	2.8 (0.092)
	DLC	6.003	<b>0.003</b>	0.95 (0.766)	4.5 (0.004)	3.55 (0.029)
	First molar					
	DBC	1.526*	0.225	-0.07 (0.996)	0.95 (0.465)	1.02 (0.417)
	DCF	0.421	0.657	-0.47 (0.893)	0.48 (0.888)	0.95 (0.63)
	DLC	0.081	0.922	-0.12 (0.996)	0.41 (0.952)	0.53 (0.922)
Mandibular Arch	Inter canine width	1.85	0.163	0 (1)	2.4 (0.223)	2.4 (0.224)
	First Premolar					
	DBC	3.748	<b>0.027</b>	0.1 (0.997)	3.16 (0.047)	3.07 (0.056)
	DCF	2.074*	0.135	0.06 (0.999)	1.89 (0.313)	1.83 (0.335)
	DLC	0.049*	0.953	0.39 (0.946)	0.1 (0.996)	-0.29 (0.969)
	Second Premolar					
	DBC	5.855	<b>0.004</b>	-1.47 (0.506)	2.95 (0.069)	4.42 (0.003)
	DCF	5.486	<b>0.005</b>	-0.7 (0.856)	3.4 (0.031)	4.1 (0.007)
	DLC	7.73	<b>0.001</b>	-0.67 (0.865)	4.1 (0.007)	4.77 (0.001)
	First molar					
	DBC	2.448	0.092	-1.92 (0.078)	-0.71 (0.695)	1.21 (0.358)
	DCF	1.959	0.146	-2.02 (0.213)	0.05 (0.999)	2.07 (0.198)
	DLC	2.628	0.077	-2.43 (0.138)	0.16 (0.992)	2.59 (0.107)

Table 8: The differences between Bolton ratio in the different malocclusion groups. Measurements are in mm

	One-way Anova		Posthoc Tukey Test		
	F value (* = welch test)	P VALUE	Class I vs Class II Division I difference (p value)	Class I vs Class II Division II difference (p value)	Class II Division I vs Class II Division II difference (p value)
Anterior ratio	5.011*	<u>0.009</u>	-2.42 (0.003)	-1.52 (0.091)	0.91 (0.417)
Overall ratio	4.158*	<u>0.02</u>	-1.02 (0.392)	1.14 (0.313)	2.17 (0.018)

Table 9: The differences between Arch Perimeter in the different malocclusion groups. Measurements are in mm

	One-way Anova		Posthoc Tukey Test		
	F value (* = welch test)	P VALUE	Class I vs Class II Division I difference (p value)	Class I vs Class II Division II difference (p value)	Class II Division I vs Class II Division II difference (p value)
Maxillary Arch Length	19.64	<u>&lt;0.001</u>	-3.7 (0.118)	7.67 (<0.001)	11.37 (<0.001)
Mandibular Arch Length	31.227*	<u>&lt;0.001</u>	-3.71 (0.135)	9.07 (<0.001)	12.79 (<0.001)

## Discussion

The clinical significance of Tooth size Discrepancy in treatment planning has been the subject of various discussions in orthodontic literature. In our study, the mesiodistal tooth size, Bolton ratio, arch width, and arch length were compared in Class I, Class II division 1, Class II division 2 malocclusion groups.

The significant difference in tooth size was demonstrated in the incisors, premolars, and the sum of the tooth widths in both maxillary and mandibular arches. The Bolton anterior and overall ratio between different malocclusions also showed significant differences particularly in Class II Division 2 malocclusion group. The two significant clinical features which may alter the anterior tooth-size ratio were presented, (1) greater labial inclination of incisor teeth with the resultant acute interincisal angle and (2) the incisors with greater labiolingual thickness. However, other studies showed no significant differences between different malocclusion groups. The difference in the results between this study and the other investigations might be attributed to the sample size, method of analysis, sample size, and large standard deviation found in this study. The increase in both upper and lower tooth dimensions might have

compensated for any significant increase in Bolton ratio.<sup>7</sup>

In this study, maxillary intercanine width was found significantly smaller in Class II Division 2 malocclusion than Class 1 malocclusion group, which might indicate a restricted growth in this region in Class II malocclusion. The maxillary interpremolar widths in Class II division 1 and 2 were significantly smaller than that in the other malocclusion groups. However, Frhlich found no significant difference in the arch width of Class I and Class II. The Class I malocclusions, however, were wider than the Class II division 1 malocclusions mainly at the first premolar region. The studies conducted by Nojima et al and Kook et al compared Class I, Class II, and Class III malocclusions in different populations. However, no differences were made between the different occlusal categories within the same population.<sup>8-10</sup>

The maxillary arch length in Class II division 2 was significantly shorter than Class II division 1, which is an expected result, considering the retroclination of the maxillary central incisors in Class II division 2 compared with Class II division 1. In the mandible, Class II division 1 malocclusions showed a significantly

greater arch length than the Class 1 malocclusion group.

## Conclusion

The results of this study seem to justify the validity of the mesiodistal tooth width, classic Bolton tooth analysis, arch length, arch width which emphasizes that excellent occlusion depends on a harmonious maxillomandibular tooth-size relationship. The orthodontist who is cognizant and aware of these possible discrepancies will be better prepared to diagnose and plan treatment with a more accurate certainty for patients of varied population mix. These conclusions could greatly influence clinical decision-making, and further studies should be undertaken in this field.

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