To Evaluate the Tooth Size Discrepancies and Arch Parameters Among Different Malocclusions in A Central India Population

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ABSTRACT

Aim: To evaluate and compare tooth size discrepancies and arch parameters among Class I, Class II Div I, Class II Div II and Class III malocclusion groups in the Central India population.

Materials and Methods: The study included 160 subjects (aged 13–15 years) evenly divided among Class I, Class II Division I, Class II Division II, and Class III malocclusion groups. Mesiodistal tooth width, Bolton's ratios, arch length, and arch width were measured using standardized orthodontic methods.

Results: Statistically significant differences were observed across malocclusion groups in certain parameters, highlighting the need for population-specific diagnostic norms.

Conclusion: These findings provide valuable insight into tooth-arch relationships within the Central India population and underscore the importance of individual diagnostic assessment in orthodontic planning.

Keywords: Tooth size discrepancy, Bolton's ratio, Arch length, Arch width, Malocclusion, Central India population.

1. INTRODUCTION

Accurate diagnosis in orthodontics hinges on an understanding of tooth size, arch dimensions, and their role in achieving occlusal harmony. As described by Bolton in 1958, disproportion between mesiodistal widths of maxillary and mandibular teeth can compromise interarch relationships, leading to unsatisfactory results if not properly addressed during treatment planning [1]. This concept led to the formulation of Bolton's anterior and overall tooth size ratios, which are widely used for diagnostic purposes [1,2].

Differences in arch form and dimension are often observed across malocclusion types, genders, and populations [4–6]. Ethnic and regional differences have been widely reported, with studies from populations such as African American, Hispanic, Asian, and Middle Eastern showing variability in tooth size ratios and arch dimensions [5–9].Despite a large body of literature on this topic from various countries, there is a lack of data specific to the Central India. Thus, this study aims to evaluate the mesiodistal tooth size discrepancies, Bolton's ratios, and dental arch dimensions in individuals with different classes of malocclusion within this region.

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2. Aims and objectives: To evaluate and compare tooth size discrepancies and arch parameters among Class I, Class II Div I, Class II Div II and Class III malocclusion groups in the Central India population.

3. Materials and Methods

Sample: 160 school children (13–15 years), native to Central India, equally divided into four malocclusion groups.

Inclusion/Exclusion Criteria: Subjects with fully erupted teeth and no history of orthodontic treatment or dental anomalies were included.

Measurements: Impressions were taken and casts were made. Tooth widths were measured using digital calipers. Bolton's ratios, arch lengths (measured with brass wire), and arch widths at various dental landmarks were recorded.

Analysis: Data were statistically analyzed using independent t-tests and standard deviation calculations.

MATERIALS AND METHOD (FIGURES)

Figure 1 : Armamentarium for impression taking and study model preparation

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Figure 2 : Vernier gauge calibrated with digital micrometer

Figure 3 :Measurement of mesio-distal tooth width

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Figure 4 : Measurement of arch length with brass wire

Figure 5 : Measurement of arch width of canine

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Measurement of arch width at three points :

Figure 6 : The distance between the buccal cusp on the right side to the buccal cusp on the left side

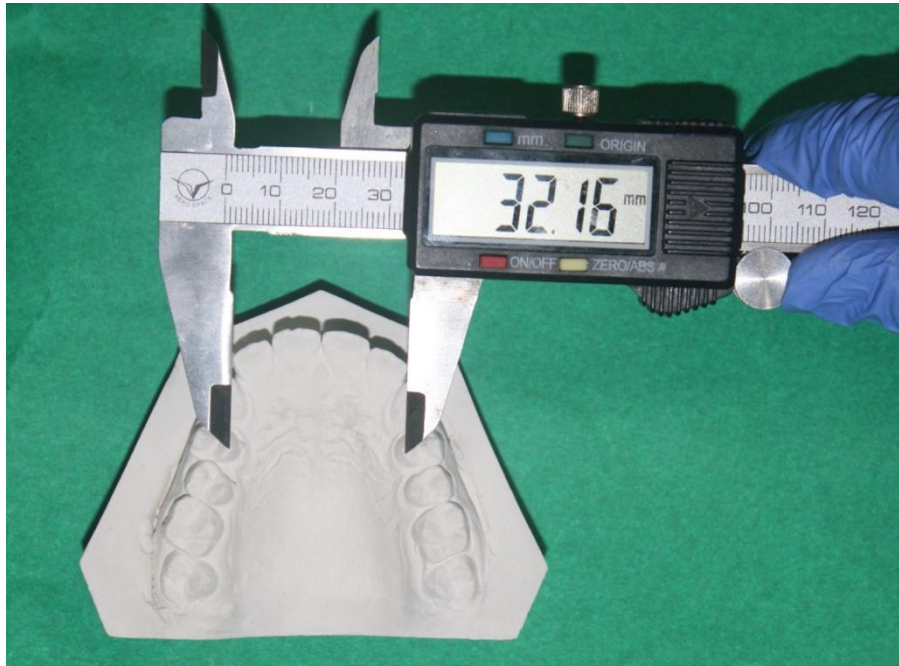**Figure 7: Distance between the central fossa to central fossa**

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Figure 8 : The distance between the lingual cusp to the lingual cusp

2. RESULTS

Table 1 describes the central incisors showed a gradual decrease in width from Class I (9.17±0.71) to Class III (7.67±0.90). Lateral incisors and canines followed a similar pattern, indicating that Class III malocclusions had generally smaller tooth dimensions. Molars had the most noticeable difference, with Class I being the widest (10.80±0.53) and Class III the narrowest (9.72±0.59). Table 1.A describes that in maxillary teeth significant reductions in tooth width were found when comparing Class III with Class I and Class II. The largest differences were observed in central incisors, lateral incisors, canines, and molars. In mandibular teeth Class III cases showed smaller lateral incisors and first premolars compared to Class I and Class II. However, some mandibular teeth (e.g., central incisors) were not significantly different.

Table 2 describes that arch length and width parameters significantly differed in select comparisons, notably between Class I and Class III, and between Class II div II and Class III.Class III often had reduced values, particularly in the maxillary molars (DBC and DLC dimensions).Class I and Class II divisions showed relatively stable dimensions with fewer significant differences. Table 2.A describes that no major differences were noted in intercanine width, suggesting relatively stable lower anterior dental relationships. However, arch length showed notable changes, with Class III cases generally having a longer mandibular arch.

Table 3 describes that in **Anterior Bolton's Ratio:** Class III had the highest value (90.96±24.65), indicating a tendency for larger mandibular anterior teeth relative to the maxillary.**Overall Bolton's Ratio:** Class III (91.85±5.67) showed a balanced but slightly higher mean than Class I (91.20±4.4), suggesting proportionate tooth size discrepancies.

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Table 1: Mean and SD of mesiodistal tooth width among various malocclusions in maxillay and mandibular arch

Arch	Tooth	Class I		Class II div I		Class II div II		Class III		Total	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Maxillary arch	Central incisor	9.17±.71		8.99±.89		8.84±.86		7.67±.90		8.66±1.03	
	Lateral incisor	7.60±.89		7.42±.76		7.27±.77		6.74±.78		7.25±.86	
	Canine	8.40±.60		8.26±.77		8.18±.63		7.38±.66		8.05±.77	
	1st premolar	7.72±.60		7.41±.96		7.39±.60		6.91±.46		7.36±.74	
	2nd premolar	7.25±.84		7.08±.92		6.68±.82		6.56±.50		6.89±.83	
	Molar	10.80±.53		10.72±.79		10.22±.92		9.72±.59		10.36±.84	
Mandibular arch	Central incisor	5.77±.53		5.70±.69		5.58±.74		5.88±.81		5.73±.71	
	Lateral incisor	6.45±.63		6.10±.54		5.74±.80		5.86±.61		6.04±.70	
	Canine	7.50±.73		7.06±.84		7.26±.48		6.65±.66		7.11±.75	
	1st premolar	7.70±.78		7.47±.93		7.38±.53		6.58±.52		7.28±.82	
	2nd premolar	7.67±.62		7.34±.76		7.18±.78		6.35±.43		7.13±.82	
	Molar	11.36±.75		11.15±.98		10.93±1.28		10.09±.88		10.88±1.10	

Table 1.A : Differences in mesio-distal tooth width in different malocclusion groups of maxillary and mandibular arch

Arch	Tooth	Class I with Class II div I	Class I with Class II div II	Class I with Class III	Class II div 1 with class II div 2	Class II div 1 with class 3	Class II div 2 with class 3
Maxillary arch	Central Incisor	0.18175	0.33500*	1.51125*	0.15325	1.32950*	1.17625*
	Lateral Incisor	0.17775	0.32500*	0.86000*	0.14725	0.68225*	0.53500*
	Canine	0.13300	0.22000*	1.01325*	0.08700	0.88025*	0.79325*
	First Premolar	0.3150*	0.33500*	0.80737*	0.02000	0.49237*	0.47237*
	Second Premolar	0.16875	0.56500*	0.68075*	0.3962*	0.51200*	0.11575
	Molar	0.08000	0.57500*	1.07500*	0.4950*	0.99500*	0.50000*
Mandibular arch	Central Incisor	0.07350	0.19000	-0.11175	0.11650	-0.18525	-0.3017*
	Lateral Incisor	0.3415*	0.70500*	0.58500*	0.3635*	0.24350*	-0.12000
	Canine	0.4375*	0.23500*	0.84875*	-0.2025	0.41125*	0.61375*
	First Premolar	0.22500	0.31500*	1.11500*	0.09000	0.89000*	0.80000*
	Second Premolar	0.3325*	0.49000*	1.32375*	0.15750	0.99125*	0.83375*

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Molar		0.20650	0.43000*	1.26375*	0.22350	1.05725*	0.83375*

Table 2: Difference in arch length and arch width among various malocclusion in maxillary arch

Arch	Tooth		Class I with Class II div I	Class I with Class II div II	Class I with Class III	Class II div 1 with class II div 2	Class II div 1 with class 3	Class II div 2 with class 3
Maxillary arch	Inter canine width		0.3625	0.857	0.5125	-1.219*	0.150	1.3695*
	1st premolar	DBC	0.6535	-0.1435	-0.0073	-0.797	-0.66075	0.13625
		DCF	0.542	-0.4455	-0.4488	-0.9875	-0.9907	-0.0032
		DLC	0.85425	-0.0925	-1.035	-0.94675	-1.88925*	-0.9425
	2nd premolar	DBC	0.2785	1.096	0.8965	0.81750	0.618	-0.1995
		DCF	-0.0693	-0.414	-0.6293	-0.34475	-0.56	-0.21525
		DLC	0.7547	0.7990	-.52225	0.04425	-1.277*	-1.321*
	1st Molar	DBC	1.716*	1.0185	-0.3625	-0.69750	-2.07850*	-1.381
		DCF	0.85475	0.5525	-0.9958	-0.30225	-1.8505*	-1.5483*
		DLC	0.8515	1.3115	-39.91*	0.46	-39.974*	-40.434*
	Arch length		-0.2832	1.514	3.4887*	1.7973	3.772*	1.9747

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Table 2.A: Difference in arch length and arch width among various malocclusion in mandibular arch

Arch	Tooth		Class I with Class II div I	Class I with Class II div II	Class I with Class III	Class II div 1 with class II div 2	Class II div 1 with class 3	Class II div 2 with class 3
Mandibular arch	Inter canine width		-0.2786	-0.146	-0.2832	0.1313	-0.0045	-0.1356
	1st premolar	DBC	-0.59775	0.4415	-1.661	1.0392	-1.0635	-2.1028
		DCF	-15.853	0.6085	-1.8065	15.914	15.6725	-2.415
		DLC	-0.83325	0.8890	-1.8995	1.7223	-1.0663	-2.7885
	2nd premolar	DBC	-0.3980	1.4895	0.89125	1.8875	1.28925	-0.5982
		DCF	-0.31125	0.9985	0.04375	1.3098	0.355	-0.9545
		DLC	-0.011	0.9625	-0.3395	0.9735	-.32850	-1.302
	1st molar	DBC	1.49275	-0.117	-0.3655	-1.610	-1.8583	-0.248
		DCF	-0.17275	-0.237	-1.4595	-0.064	-1.2868	-1.2225
		DLC	-.21025	-0.029	-1.936	0.1813	-1.7258	-1.907
	Arch length		-0.6820	-0.143	-1.1280	0.5395	-0.4460	-0.9855

Table 3: Mean and SD of anterior and overall Bolton's ratio in different malocclusion group

Variable	Class I	Class II div I	Class II div II	Class III	Total
Anterior Bolton's ratio	79.34±13.39	76.32±5.5	77.17±5.87	90.96±24.65	80.95±15.62
Overall Bolton's ratio	91.20±4.4	88.41±5.4	82.42±27.87	91.85±5.67	88.47±14.97

3. DISCUSSION

The present study found statistically significant differences in mesiodistal tooth widths and Bolton's ratios among different malocclusion classes. These findings are consistent with several previous studies that report a greater frequency of anterior tooth size discrepancy in Class III malocclusions and lower frequency in Class I malocclusions [7,8,17,20]. Our findings also support the conclusions by Araujo and Souki and Uysal et al., who reported increased anterior ratios in patients with Class III malocclusion [7,8].

Gender differences observed in arch width and length, with males exhibiting larger values, align with established findings from Bishara et al., Moyers and McLaughlin et al. [11–13]. Additionally, arch form differences observed in Class II subjects,

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such as narrower arches and reduced arch length, have been reported in prior studies [13,24].Population-based studies like those by Smith et al., Lavelle, and Endo et al. emphasize that Bolton's ratios show ethnic variability, reinforcing the need to establish population-specific standards [4,5,22]. The findings from the present study in the Central India population provide important normative data to support individualized orthodontic treatment planning in central Indian demographics.A study by Othman and Harradine highlights the diagnostic importance of tooth size discrepancies, noting that failure to identify these may lead to compromised occlusal outcomes [10,19]. The literature also suggests that digital methods for tooth-size analysis are increasingly accurate and may complement traditional manual techniques [25].

Interestingly, although Bolton suggested standard values of 77.2% for anterior and 91.3% for overall ratios, many studies, including those by Al-Tamimi, Alkofide, and Akyalcin, show variation outside these limits in different populations and malocclusion groups [15,27,27]. The findings in the Central India population are consistent with this trend and suggest the need for adjusted diagnostic cutoffs for improved clinical accuracy.Overall, the study validates the clinical importance of evaluating Bolton's ratios and arch dimensions, and supports the existing literature advocating customized diagnostic approaches based on demographic and skeletal variation [10,14].

4. CONCLUSION

Across all classes of malocclusion, Class I consistently showed the highest mesiodistal tooth widths in both maxillary and mandibular arches.Class III demonstrated the lowest values for most teeth, indicating a generalized reduction in tooth size.

In the **maxillary arch**, the intercanine width and arch length were generally greatest in Class II div II and least in Class III. Significant differences were observed, particularly in DLC and DCF measurements of the first and second molars.The **mandibular arch** showed relatively consistent intercanine width across all classes, but differences in other transverse dimensions and arch length were less pronounced.

Class III malocclusion exhibited the highest anterior and overall Bolton's ratios, suggesting a relative excess of mandibular tooth material.Class II divisions showed the lowest anterior and overall Bolton's ratios, possibly indicating maxillary tooth material excess or mandibular deficiency.

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