A tooth-Size discrepancy of Normal Occlusion and Class II Division 1 Malocclusion in North Indian Population

Abhay Kumar Jain[1]. Tina Chugh[2], Nishita Garg[3], Rajiv Ahluwalia[2], Parvinder Kaur Bindra[2]

[1]Orthodontics and Dentofacial Orthopedics, Hazaribag College of Dental Science, Hazaribag, Jharkhand, India.

[2]Orthodontics and Dentofacial Orthopedics, Santosh Dental College, Santosh deemed to be University, Ghaziabad, Uttar Pradesh, India.

[3]Pedodontics and preventive dentistry, Dental institute, RIMS, Ranchi, Jharkhand, India.

Corresponding author: Dr. Tina Chugh

ABSTRACT:

Objective: The aims of this study were to compare the tooth size ratios of a North Indian population to the Bolton ratios, determine sex differences in tooth-size ratios, and determine whether there is a difference in intermaxillary tooth-size discrepancies for malocclusion subjects. **Subjects and Methods:** 40 samples with normal occlusion and 40 patients with Class II division 1 malocclusion were randomly selected with the age range of 13 to 25 years equally divided among males and females. The mesiodistal crown dimension was measured using a digital caliper accurate to 0.01 mm. For statistical evaluation, descriptive statistics and Student's t-test were performed. **Results:** No statistical significant differences were obtained between the mean values of the anterior ratio and overall ratio of the present study and the mean values reported by Bolton. The overall ratio among the normal occlusion and Class II division 1 malocclusion groups showed statistically significant differences ($p < 0.05$). The tooth most closely related to the overall ratio in the Class II division 1 malocclusion group was the mandibular second premolar. **Conclusion:** The results of this study show that the overall and anterior Bolton ratios can be applied with confidence to an Indian population. There is a tendency for maxillary tooth size excess in the Class II division 1 malocclusion patients of the same population. It can be concluded that Bolton tooth size analysis is an important diagnostic tool and should be taken into consideration before the initiation of orthodontic treatment.

KEYWORDS: Anterior ratio, Overall ratio, Tooth size discrepancy, Malocclusion, North Indian population

INTRODUCTION

Tooth size ratios represent a valid diagnostic tool that allows for an educated prediction of treatment outcomes and may also limit the necessity for diagnostic setups for complex cases. A proper relationship of the total mesiodistal width of the maxillary dentition to the mesiodistal width of the mandibular dentition will favor an optimal post-treatment occlusion. Treatment planning should always take into consideration a discrepancy in the tooth size ratios and should include compensating esthetic procedures such as composite bonding, prosthetic reconstruction, stripping, and crown recontouring. A lack of information about tooth size could also compromise the final results in extraction cases if the chosen extraction pattern leads to a clinically significant maxillo-mandibular tooth size discrepancy. Pioneer investigations on tooth sizes were conducted by Black in 1902[1] and Neff in 1949.[2] These studies were followed by the classic work of Bolton [3,4] who quantified

the maxillary-to-mandibular tooth size relationship and provided the accepted normative data. Bolton selected 55 cases with optimal occlusions and compared the sums of the mesiodistal widths of the maxillary and mandibular teeth, including the first molars. An overall ratio of 91.3 was obtained, with a standard deviation of 1.91. He also calculated that the ratio for the anterior teeth from canine to canine was 77.2, with a standard deviation of 1.65. Stifer[5] repeated Bolton's study in Class I dentitions and arrived at similar results. More recently the accuracy and dependability of Bolton's analysis have been challenged.[6,7] The dental literature is replete with studies comparing tooth size discrepancy and malocclusion in different ethnic groups. However, only a few of them were interested in sex and Angle classification specificity, and additional data are necessary to understand this relationship.[8-15] Since differences in tooth sizes are not systematic, different interarch relationships might be expected between genders and different populations. Several authors have obtained the normal values of Bolton's analysis of different races.[16-20] These studies suggest that race and ethnicity should be taken into consideration where Bolton's analysis is concerned. Uysal and Sari[19] analyzed dental casts of 150 Turkish subjects with normal occlusion and obtained an overall ratio of 89.88% + 2.29% and an anterior ratio of 78.26% + 2.61%. A significant sex difference in the overall ratio was reported in their study. Nur et al.[20] however, reported significant sex differences in the anterior ratio whereas no difference was found between genders in the overall ratio. Furthermore, the values for anterior and overall ratios were higher for both genders than the values reported by Uysal and Sari[19] and Bolton[4]. Lavelle[11] stated that tooth size and proportion have an important role in malocclusion, the relationship between tooth-size discrepancy and Angle classification has been studied as well. Nur et al[20] analyzed dental casts of 600 Turkish subjects divided into 5 groups including all malocclusions and reported significant differences in overall ratios between normal occlusion and Class II division 1 and 2 malocclusions. However, differences in the anterior ratio between Class III and Class II division 1 malocclusions were reported only in females. Crosby and Alexander[21] studied 109 Caucasian orthodontic patients with varying malocclusions (Class I; Class II, division 1; Class II, division 2; Class II surgery) and found no statistically significant difference in the incidence of tooth size discrepancies among these groups. However, Nie and Lin[22] and Smith et al[6] found significant differences in Bolton's ratio among several occlusal categories and concluded that the anterior ratio was greater in Class III than in Class II and Class I subjects. Araujo and Souki[23] determined the correlation between anterior tooth size discrepancies and Angle Class I, II, and III malocclusions in a Brazilian population, and showed that subjects with Class I and III malocclusions had a significantly greater prevalence of tooth size discrepancies than individuals with a Class II malocclusion; the mean anterior tooth size discrepancy for Class III subjects was significantly greater than that for Class I and Class II subjects. Uysal et al.[24] also found that all malocclusion groups had higher overall ratios than the normal occlusion group. However no significant differences among malocclusion groups were reported. Although many studies have compared the Bolton ratio among malocclusion groups, there is only one

study in literature that investigated the individual teeth which affect interarch relationships[6]. In order to predict the final occlusion after comprehensive orthodontic treatment, it is necessary to know which teeth are responsible from the intermaxillary tooth-size discrepancy. The aims of this study were:1) to determine if there is a difference between the tooth size ratios of a North Indian population and the ratios available from the Bolton analysis, 2) to compare the tooth size ratios of males and females, 3) to determine whether there is a difference for intermaxillary tooth-size discrepancies represented by anterior and overall ratios of Bolton for Class II division 1 malocclusion subjects.

MATERIAL AND METHODS

Forty subjects with normal occlusion and forty patients with Class II division 1 malocclusion were randomly selected from different private clinics in Delhi, NCR. In the normal occlusion group, dental casts of forty North Indian subjects (20 males, 20 females) with ideal occlusion were analysed. The following selection criteria were used:

1. Must be of North Indian origin and inhabitant of the same
2. Male or female with ages ranging from 13-25 years
3. All permanent teeth from the first molar to the first molar should be fully erupted
4. Ideal overjet and overbite
5. Angle Class I molar occlusion
6. Well-aligned upper and lower dental arches
7. Good quality study casts.

The malocclusion group consisted of 40 patients (20 males, 20 females). Steiner cephalometric analysis was used to assess the skeletal pattern and the following selection criteria of malocclusion group:

1. Good quality pretreatment study casts
2. All permanent teeth from the first molar to the first molar should be fully erupted
3. Increased overjet
4. Angle Class II molar occlusion
5. Skeletal Class II division 1 malocclusion (ANB >5°)

Exclusion criteria included

1. Any restoration or crown that affects the tooth's mesiodistal diameter;
2. Congenital defects or deformed teeth;
3. Any sign of occlusal or interproximal wear of teeth.

Measurements were made directly on the dental casts by a single examiner to eliminate inter-operator error. All the teeth from the right first molar to the left first molar in the upper and lower arches were measured at the largest mesiodistal crown dimension, using an electronic digital caliper accurate to 0.01 mm. *(Mitutoyo Digital Caliper, Japan*) (fig.1). The procedure for measuring the mesiodistal tooth width was performed as described by **Hunter and Priest[25]**, wherein the measurements were done by placing caliper beaks from perpendicular to the long axis of the tooth from the facial aspect of the teeth. The measurements included the mesiodistal width of all the twelve maxillary and mandibular teeth from the right first permanent molar to the left first permanent molar on 80 pairs of casts (fig. 2). Bolton's analysis[4]

was then performed on each set of casts. The mesiodistal widths of the maxillary teeth from the right first permanent molar through the left first permanent molar were calculated and compared with the sum of mesiodistal width derived the mandibular twelve teeth. The ratio between the two is the percentage relationship of the mandibular arch length to the maxillary arch length which is called as "overall ratio".

$$\text{Overall ratio} = \frac{\text{Sum of the mandibular 12 teeth}}{\text{Sum of the maxillary 12 teeth}} \times 100$$

Similarly, a ratio between the maxillary and mandibular anterior teeth was calculated. The mesiodistal widths of the six maxillary and mandibular teeth and the right permanent canine to the left permanent canine were measured. The ratio between the two is the percentage relationship of the mandibular anterior width to the maxillary anterior width and this is referred to as "anterior ratio".[17]

$$\text{Anterior ratio} = \frac{\text{Sum of mandibular 6 anterior teeth}}{\text{Sum of maxillary 6 anterior teeth}} \times 100$$

All the records were subjected to statistical analysis. The mean and standard deviation were calculated for the measurements made. A T-test was used to evaluate gender differences. Independent samples t-test was used to compare the prevalence of anterior and overall tooth-size discrepancies among the normal occlusion and malocclusion groups. Statistical differences were determined at the 95% confidence level (p <.05).

RESULTS

The results are summarized in Tables 1 to 5. Table 1 shows the mean, range, and standard deviation of the width of the maxillary and mandibular teeth in the male and female subgroups of normal occlusion and Class II division 1 malocclusion groups. Table 2 and 3 shows the descriptive statistics of the tooth-size ratios observed in the normal occlusion and Class II division 1 malocclusion groups. The mean values for the anterior and overall ratios for male and female subjects did not differ significantly (p >.05, Tables 2 and 3). Table 2 shows the anterior ratio of males and females for the normal occlusion group (76.61 ± 1.70 and 76.92 ± 1.83 respectively). The overall ratio for male group was 91.06 ± 1.79 whereas for female group, it was 90.61 ± 1.71. When the comparison between male and female for anterior ratio and overall ratio (Table 3) was done, no statistically significant difference was found. Since no sexual dimorphism was noted for overall ratio and anterior ratio, both the genders were combined for normal group and then compared with Bolton's study. The Bolton's analysis in Indian population (Table 4) showed anterior ratio of 76.76±1.75 and an overall ratio of 90.84±1.75. In Bolton's study done in Caucasian population anterior ratio was found to be 77.2 with a standard deviation of 1.65, and the overall ratio was 91.3 with a standard deviation of 1.91. When the t-test was done to compare the results of the present

study with Bolton's study, no statistically significant difference was found between the two. However, when compared with the Caucasian population, the Indian population showed a large range of values indicating the variability in tooth size. Since the mean anterior and overall tooth size ratio of the present study were not significantly different from the Caucasian means, therefore Bolton's analysis can safely be used and applied to the Indian population. Independent samples t-test demonstrated that there was no statistically significant difference between the normal and malocclusion groups for anterior ratios. Statistically significant differences were seen only in the overall ratio (p <.05) (Table 5). The tooth most closely related to the overall ratio was the lower second premolar. The upper first molar was the second most important tooth explaining variation in the overall arch ratio, followed by the lower first molars and upper second premolars respectively. Lower central incisors and canines were least likely to explain individual differences in the overall ratio.

DISCUSSION

The tooth size discrepancies have a direct impact on excellence in orthodontic finishing.[23] Heusdens et al.[7] have suggested that the effect of generalized tooth-size discrepancy on occlusion is limited. Keeping in mind the conflicting results present in the literature, the present study was planned to determine if there is a difference in intermaxillary tooth-size discrepancies in subjects with Class II division 1 malocclusion subjects. The present study did not find any significant gender-based differences in tooth-size ratios. The tooth size data reported by Uysal and Sari[19] and Moorrees et al.[26] imply gender differences in the overall ratio. These gender differences in the overall ratio may be population specific. A conflicting result was reported by Nur et al[20], who found no gender-based differences in mesiodistal tooth ratios in malocclusion cases, whereas significant statistical differences were found in the anterior ratio in the normal occlusion group. Our results are consistent with those of other researchers and do not support the need for sex-specific criteria.[18,19,24,25].

It has been suggested that the generalized use of the Bolton analysis might not be valid for other populations. On the other hand, studies prove the acceptability of Bolton's analysis to other populations as well.[19] In our normal occlusion group, the anterior ratio was found to be 76.76 ± 1.76, and the overall ratio was found to be 90.83±1.75. Other investigators who studied the same population reported different findings and concluded that it is appropriate to use Indian norms in orthodontic practice for Indian patients. However, the values of the present study fell within one standard deviation confidence interval of Bolton. Since the data from this North Indian sample are similar to Bolton's original data, the generalized application of the Bolton analysis to a North Indian population seems possible.

A number of studies examined the tooth-size ratios in patients with malocclusions requiring orthodontic treatment and reported different findings. In any of the malocclusion groups, some studies found no evidence of a tendency for a tooth-size difference.[22,23] Ta et al[17] reported statistically significant variations in the ratio between the Class II occlusion group and the Bolton Standard. Uysal et al[24] reported higher overall ratios in all malocclusion groups compared to the normal occlusion group. However, they did not find any significant differences among different malocclusion groups. In the present study, a statistically significant difference was observed only for the overall ratio between the Class II division 1 malocclusion and the

normal occlusion groups. The overall ratio was 89.88 ± 2.2 in the Class II division 1 malocclusion group and this value were significantly lower than the overall ratio in the normal occlusion group. Nie and Lin[22] also found that maxillary dentition showed a tendency for maxillary tooth size excess in Class II malocclusion. In order to establish an ideal occlusion in Class II division 1 malocclusion in cases with clinically significant tooth-size discrepancy, proximal stripping or extraction may be necessary for the maxillary arch.

The current study's findings also indicated that changes in the overall tooth-size ratios may be caused by particular teeth. The mandibular second premolars, maxillary first molars, mandibular first molars, and maxillary second premolars were followed in order of explaining the observed differences in the interarch tooth size discrepancy. The maxillary lateral incisors, maxillary second premolars, mandibular second premolars, and mandibular canines were the most variable and showed the most obvious group differences, according to research by Doris et al[10] whereas Santoro et al.[15] showed that the maxillary first molars, followed by maxillary central incisors and maxillary lateral incisors were the most variable teeth. Crosby and Alexander[21] suggested that the greatest variability in mesiodistal tooth width occurs in the anterior region. Our findings suggest that posterior teeth are mostly responsible for incongruity in the overall ratio in the Class II division 1 malocclusion group and, should be examined clinically to detect any major size and shape variation at the initiation of orthodontic treatment. It is not uncommon for a clinician to correct the skeletal Class II malocclusion successfully but still see a Class II canine occlusion and increased overjet. In such cases, if stripping is the treatment of choice, it should be carried out in the posterior section of the maxillary arch according to the results of the present study.

Conclusion

On the basis of the results of this investigation, the following conclusions can be drawn:

- The results from the present study are similar to Bolton's original data for an American (Caucasian) population. These values and the degree of variation were similar to the original data by Bolton's indicating that Bolton's analysis for Caucasian samples can be applied with confidence to the North Indian population.
- It also confirms no relevant gender-based differences exist, and so these values can be applied to both males and females.
- The overall ratio in the Class II division 1 malocclusion group was significantly lower than the overall ratio in the normal occlusion group. There is a tendency for maxillary tooth size excess in Class II division 1 malocclusion patients and that should be examined clinically at the beginning of treatment.

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Tables: Table1: Mean, Range, and Standard Deviation of Permanent Tooth Widths for a North Indian Sample

	NORMAL OCCLUSION						CLASS II DIV 1 MALOCCLUSION					
	MALE			FEMALE			MALE			FEMALE		
TOOTH	MEAN	SD	RANGE	MEAN	SD	RANGE	MEAN	SD	RANGE	MEAN	SD	RANGE
UI1	8.6690	0.5033	7.99-9.97	8.2905	0.4066	7.54-9.48	8.7930	0.6777	7.68-9.74	8.6465	0.6293	7.9-9.89
UI2	7.0490	0.3537	6.56-7.89	6.6285	0.3557	6.19-7.42	7.0670	0.6522	5.83-7.86	6.6810	0.5032	5.92-7.27
UC	7.9130	0.3587	6.9-8.81	7.4770	0.5876	6.71-9.46	8.0075	0.4490	6.9-8.48	7.6540	0.4354	6.99-8.95
UP1	7.1455	0.4907	6.29-7.98	6.8055	0.3335	6.22-7.32	7.2100	0.4702	6.54-7.72	6.8720	0.4125	6.2-7.98
UP2	6.6780	0.5370	5.78-7.8	6.5495	0.4146	5.85-7.5	6.8645	0.5239	5.61-7.76	6.6420	0.4230	6.15-7.19

U indicates maxillary arch , L indicates mandibular arch I1 indicates central incisor; I2, lateral incisor; C, canine; P1, first premolar; P2, second premolar; and M1, first molar

Table 2: Tooth-Size Ratios of Male and Female subjects in Normal Occlusion group.

UM1	10.4675	0.3891	9.83-11.41	10.1260	0.3789	9.56-11.06	10.5780	0.5628	9.52-11.41	10.3585	0.4661	9.7-11.24
LI1	5.2130	0.2435	4.71-5.58	5.1040	0.3189	4.65-5.84	5.3510	0.4279	4.56-5.81	5.3480	0.3520	4.86-6.23
LI2	5.7370	0.2919	5.16-6.16	5.6540	0.3738	5.06-6.69	6.0135	0.4077	5.06-6.45	5.8280	0.3623	5.35-6.72
LC	6.9285	0.2509	6.63-7.48	6.5380	0.3180	6.18-7.3	7.0145	0.4680	6.01-7.48	6.6580	0.3955	6.33-8.11
LP1	7.1575	0.3859	6.46-7.48	6.8130	0.3709	6.12-7.63	7.0755	0.5579	5.94-7.89	6.8805	0.4122	6.15-7.88
LP2	7.1950	0.4619	6.47-8.53	6.8210	0.4179	6.27-7.78	7.1840	0.5357	6.09-7.84	6.9320	0.3736	6.43-7.84
LM1	11.2340	0.5524	10.26-12.01	10.7975	0.4174	10.28-11.56	11.1685	0.6437	9.5-11.98	10.7180	0.4436	9.86-11.45

Ratio	Gender	n	Mean	SD	p-value
Anterior ratio	Male	20	76.60	1.70	0.5863
	Female	20	76.92	1.83	
Overall ratio	Male	20	91.06	1.79	0.4238
	Female	20	90.62	1.72	

Table 3: Tooth-Size Ratios of Male and Female subjects in Class II Division 1 Malocclusion Group

Ratio	Gender	n	Mean	SD	p-value
Anterior ratio	Male	20	77.52	2.20	0.5529
	Female	20	77.13	1.86	

Overall ratio	Male	20	90.12	2.33	0.4959
	Female	20	89.63	2.16	

Table 4: Comparison of present study and Bolton's study with respect to anterior and overall ratio in normal occlusion group

Ratio	Study	n	Mean	SD	Range	p-value
Anterior ratio	Present	40	76.76	1.75	73.78-81.2	> 0.05
	Bolton's	55	77.20	1.65	74.5-80.4	
Overall ratio	Present	40	90.84	1.75	88.06-95.4	> 0.05
	Bolton's	55	91.30	1.91	87.5-94.8	

Table 5: Comparison of Anterior and Overall Tooth-Size Ratios among Normal Occlusion and Class II Division 1 Malocclusion Groups

Groups	Anterior ratio %				Overall ratio %			
	Means	**SD**	**SE**	**Range**	**Means**	**SD**	**SE**	**Range**
Normal	76.76	1.75	0.28	73.78-81.2	90.84	1.75	0.28	88.06-95.4
Class-II	77.32	2.02	0.32	74.69-81.38	89.88	2.20	0.36	85.02-93.68
P value	0.2565				0.0355*			

SD, Standard deviation; SE, Standard error * P <.05.

FIGURE LEGENDS

Fig.1: Electronic digital caliper accurate to 0.01 mm. *(Mitutoyo Digital Caliper, Japan).*

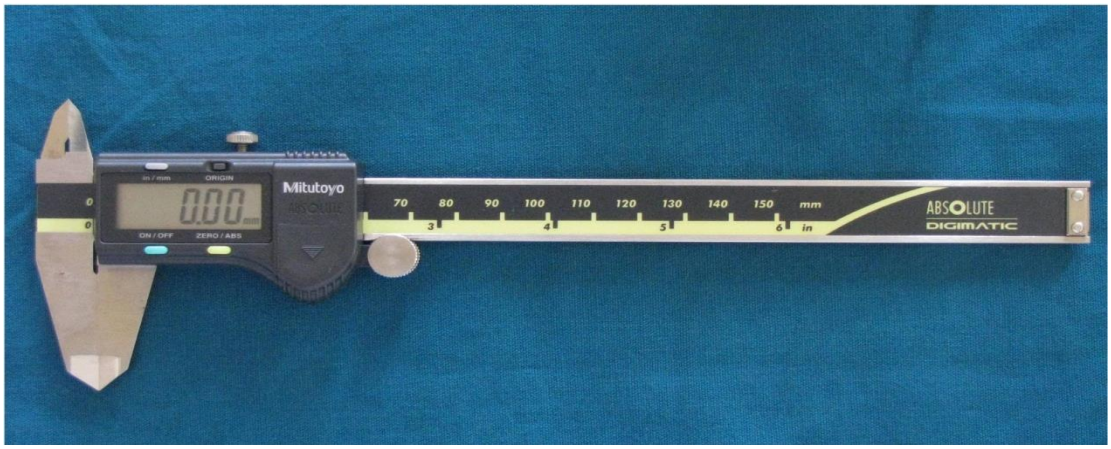

Fig.2: Measurement of mesiodistal crown dimension