

Bolton Anterior Tooth Size Discrepancy Among Different Malocclusion Groups

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ABSTRACT

Aim: To evaluate differences of Bolton's anterior tooth size proportions in Class I, II and III malocclusion groups.

Materials and methods: The study was done on 45 patients in the age range of 15 – 30 years who were randomly selected and were sub-divided in three groups of 15 patients each as: Group A (Angle's Class I malocclusion), Group B (Angle's Class II malocclusion) and Group C (Angle's Class III malocclusion). Good quality study casts were prepared and mesiodistal widths of teeth were measured using a caliper and Bolton's analysis was done.

Statistical analysis: KRUSKAL-WALIS test was done to compare the prevalence of anterior tooth size discrepancies and analysis of individual tooth size discrepancy was done by MANN WHITNEY 'U' test.

Results: It was found that the mean anterior tooth ratio of class III malocclusion groups was greater than class I and class II groups. The mean excess tooth size of class II malocclusion groups was greater than class I and class III groups. These findings were not statistically significant. Inter-group comparisons of anterior ratio and mean excess tooth size were statistically insignificant.

Conclusion: No co-relation was found between anterior tooth ratio and different malocclusion groups and also between tooth size discrepancy and different malocclusion groups.

Keywords: Malocclusion, orthodontics, tooth size discrepancy.

INTRODUCTION

Successful orthodontic treatment is based on comprehensive diagnosis and treatment planning. Selection of an appropriate treatment approach may involve recognizing the extent of discrepancy^{1,2,3}. Several factors can contribute to such discrepancies: 1) variations in tooth size 2) variations in tooth morphology 3) variations in tooth 4) combination of large teeth in small jaws and vice versa. These in turn can lead to crowding,

spacing, dental midline variations, resulting in changes in molar relationships and canine relationships⁶. Bolton, in 1958 developed a method of analyzing mesio-distal tooth size ratio between maxillary and mandibular teeth. He concluded that without the proper mesiodistal tooth size ratio between the maxillary and mandibular teeth it would be difficult to achieve proper occlusal interdigitation of arches in the finishing stages of orthodontic treatment.¹

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The parameters in the analysis are subject to variation in different ethnicities/populations and thus having a database of the population being treated goes a long way in individualizing treatment plan according to the specific group.⁶ Since the arches do not function independent of each other, the relationships must be considered with their antagonist, taking Angle's Class I, II and III malocclusions.⁶

AIM OF THE STUDY

To evaluate differences of Bolton's anterior tooth size proportions in Class I, II and III malocclusion groups⁵

MATERIALS AND METHODS

A total of 45 patients visiting the Department of Orthodontics, A.B. Shetty Memorial Institute of Dental Sciences, Mangalore were included in the study. They were selected based on the following criteria: 1) Presence of all anterior permanent teeth, fully erupted in the upper and lower arches, 2) Good quality study casts, 3) Absence of tooth deformity and 4) No record of restoration or stripping of incisor and canine teeth. The patients were in the age range of 15 – 30 years and were randomly selected for the study and were further sub-divided as follows:

- Group A – 15 patients exhibiting Angle's Class I malocclusion
- Group B – 15 patients exhibiting Angle's Class II malocclusion
- Group C – 15 patients exhibiting Angle's Class III malocclusion

The materials required to conduct the study were good study casts with no record of restoration or stripping of incisor and canine teeth and Calipers (ODIN) for the measurement of mesiodistal dimension. Each canine and incisor tooth was measured at the mesiodistal dimension using a caliper accurate to 0.1 mm. The reading was recorded at the 0.1mm level⁶. The anterior tooth size ratio was computed for each subject as described by Bolton^{1,6}:

Sum of mandibular 3-3

Sum of maxillary 3-3

The anterior tooth discrepancies were computed as follows:

$$\text{Sum of mandibular 3-3} \times 100 = 77.2\%$$

Sum maxillary 3-3

If value exceeds 77.2%, then mandibular excess, which is calculated by

$$\frac{\text{Sum of mandibular 3-3} - \text{Sum of maxillary 3-3} \times 77.2}{100}$$

If value is less than 77.2%, then maxillary excess, which is calculated by

$$\frac{\text{Sum of maxillary 3-3} - \text{Sum of mandibular 3-3} \times 100}{77.2}$$

To statistically compare the prevalence of anterior tooth size discrepancies among the three-malocclusion groups using KRUSKAL-WALIS test. Analysis of individual tooth size discrepancy was done by using MANN WHITNEY 'U' test.

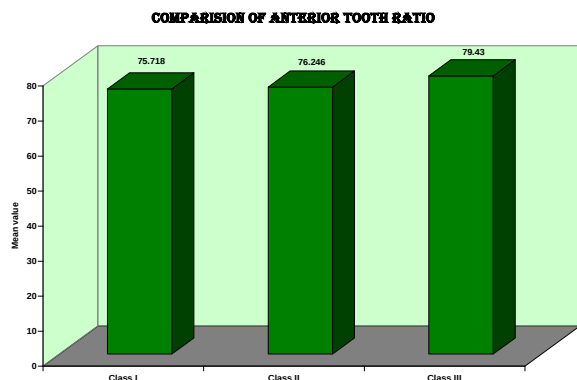
RESULTS

Comparisons of anterior tooth ratios between class I, class II and class III malocclusion groups were made using KRUSKAL-WALIS test (Table I). It was observed that the mean anterior tooth ratio of class III malocclusion groups (79.43) was greater than class I (75.71) and class II (76.24) groups and it was found that no statically significant difference occurs among the three different malocclusion groups ($p > 0.05$).

Table I: Anterior Tooth Ratio

COMPARISON	SAMPLES	MEAN	STANDARD DEVIATION	H	P
CLASS I	15	75.7180	3.31772		
CLASS II	15	76.2460	4.91241		
CLASS III	15	79.4346	6.19599	3.47	0.179

H = KRUSKAL-WALIS TEST



Graph 1: Comparison of anterior tooth ratio.

Inter-comparison of the anterior tooth ratio between class I, class II and class III revealed no statistically significant difference among the groups ($p > 0.05$).

Table II: Intercomparison - Anterior Tooth Ratio

COMPARISON	Z value	P
CLASS I and CLASS II	0.145	0.884
CLASS I and CLASS III	1.661	0.097
CLASS II and CLASS III	1.566	0.117

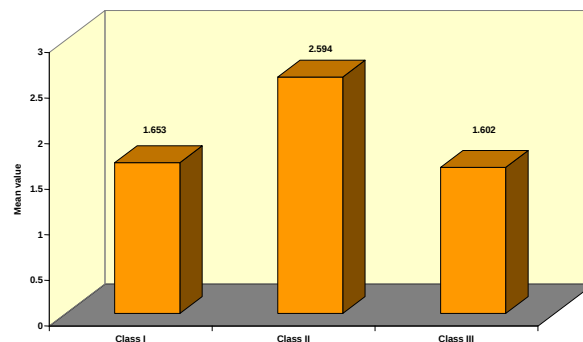
Z = MANN-WHITNEY 'U' TEST

Comparisons of the mean excess tooth size between class I, class II and class III malocclusion groups were made using KRUSKAL-WALIS test (Table III). It was observed that the mean excess tooth size of class II malocclusion groups (2.59) was greater than class I (1.65) and class III (1.60) groups and it was found that no statically significant difference occurs among the three different malocclusion groups ($p > 0.05$).

Table III: Tooth Size Discrepancy

COMPARISON	SAMPLE S	MEAN	STANDAR D DEVIATION	H	P
CLASS I	15	1.6527	1.08528		
CLASS II	15	2.5940	1.47109		
CLASS III	15	1.6015	0.92974	4.25	0.119

H = KRUSKAL-WALIS TEST



Graph 2: Comparison of Mean Tooth Size Discrepancy

Inter-comparisons of the mean excess tooth size between class I, class II and class III revealed no statistically significant difference between the groups.

Table IV: Intercomparison - Tooth Size Discrepancy.

COMPARISON	Z value	P
CLASS I and CLASS II	1.743	0.081
CLASS I and CLASS III	0.691	0.489
CLASS II and CLASS III	1.705	0.088

Z = MANN-WHITNEY 'U' TEST

DISCUSSION

Tooth size ratios represent a valid diagnostic tool that allow for an educated prediction of treatment outcomes and may also limit the necessity for the diagnostic setups for the complex cases. A proper relationship of the total mesiodistal width of the maxillary dentition to the mesiodistal width of the mandibular dentition will favour an optimal post treatment occlusion. If a patient has significant tooth size discrepancy, orthodontic alignment into optimal occlusion may not be possible^{4,7,8} reported that the large percentage of orthodontic patients possess significant tooth size discrepancies, therefore, the orthodontist should be aware of these discrepancies before beginning orthodontic treatment.

Bolton and Tuverson indicated that overbite, overjet and interincisal angle might influence ideal tooth size relationship. However, no

definite conclusions have been drawn as to effect these factors have on the accuracy of the tooth size analysis.

Tooth size discrepancies in different classes of malocclusion

The results of this study showed that the mean anterior tooth ratio of class III was greater than class I and class II malocclusion. This result though not statistically significant, was found to be partially in agreement to the study conducted by Eustaquio Araujo and Marcelo Souki⁶, which states that the mean anterior tooth ratio of class I and class III malocclusions was greater than class II malocclusion. Also, in the present study with respect to mean anterior tooth size discrepancy for Angles class II subjects was found to be greater than class I and class III, again in agreement with the study conducted by Eustaquio Araujo and Marcelo Souki⁶

Crosby and Alexander⁴ and Al Tamimi and Hashim⁹ performed their studies in orthodontically treated patients with varying malocclusions (class I, class II div I, class II div II, class II surgical) and found no significant difference in the incidence of tooth size discrepancies among the malocclusion groups, which is in agreement with the results of the present study.

Sperry et al² showed that class III malocclusion group with mandibular prognathism had more patients with mandibular tooth size excess for the overall ratio compared to class I and class II groups. While in the present study all class III groups had a greater frequency of mandibular tooth size excess. While studying tooth size discrepancy Nie and Lin⁵ found similar conclusion but significant difference between the malocclusion groups, unlike the current study which shows statistically insignificant values.

Margherita Santoro¹⁰ conducted a study on the mesiodistal crown dimensions of Americans of Dominican background. On comparing with Bolton's ratios, the overall ratio was found same, whereas the anterior ratio was 78.1 which is >77.2% as in Bolton's. The mean anterior ratio in the present study was found to be larger (79.43%) in class III group. Fattahi HR¹¹ conducted a study on different malocclusions and found the mean anterior ratio of

the class III (79.01) group significantly larger compared to Bolton's. A study on Chinese children by Tu An Ta et al¹² showed a significant difference between Bolton standard and the class III malocclusion group.

A study conducted by Vanessa Paredes¹³ on Spanish population to determine Bolton's ratio showed a significant difference and concluded that a specific standard for Spanish population might be needed. Similarly, in the present study, differences were present in values of anterior tooth ratio compared to Bolton's, indicating a need for standard values for South Indian population. The study on the overall ratio has not been included in this study. Further studies are required on the overall ratio of different malocclusion groups.

Tooth size discrepancies and ethnic/racial groups

Most studies have found no differences in the mean Bolton's ratio between the sexes. Studies in which the results are positive shows the difference to be less with slightly higher ratios found in males. Lavelle¹⁴ studied tooth -size ratios in Caucasoids, Negroids and Mongoloids and found both the overall and anterior average ratios were greater in Negroids than in Caucasoids, those for Mongoloids being intermediate. Smith¹⁵ found Whites displayed lowest overall ratio followed by Hispanics and Blacks. The anterior ratio was significant in Hispanics and a trend towards larger overall ratios in the Black population.

Santoro¹⁰ found the values obtained by performing Bolton's analysis on Dominican Americans closely resembled previous data available of the African American population. Bishara¹⁶ studied the mesiodistal and buccolingual crown dimensions in three populations: From Iowa city, Iowa; from Alexandria, Egypt; and from Chihuahua, Mexico. He concluded that there was a greater variation in the buccolingual than in the mesiodistal dimensions among the three populations. The study on the racial group has not been included in the present study. Certainly, further research is needed on the tooth size discrepancy among different racial groups.

Tooth size discrepancies and gender

Lavella¹⁴ reported that the overall and anterior ratios were greater in males than females, without indicating whether or not the difference was significant. Al-Tamimi and Hashim⁹ investigated the difference in tooth size ratio between genders. Results of their study showed no sexual dichotomy in Bolton ratios in the relatively small samples of Saudi subjects. In contrast Smith found that males had larger tooth ratios than females. Bishara¹⁶ showed canines and molars are significantly larger in boys than girls and also showed that there is a greater similarity in tooth dimensions among the boys from the three populations than among the girls, but the magnitude of these differences is of little clinical significance.

Doris¹⁷ conducted a study to determine if gender had any significance in malocclusion and concluded that teeth in males were uniformly larger than in females, but not to a statistically significant level. Both the sexes had simile distribution of crowding versus non-crowding. A study conducted by Baydas B¹⁸ to determine the possible effect of genetic factors on Bolton tooth-size discrepancy. Statistical analysis showed that heritability was effective on Bolton tooth size discrepancy in all groups except the male-female group. Siblings of the same gender showed high heritability for anterior and overall ratios, but no statistically significant difference was observed in the siblings of different gender.

As studies conducted by Lavella¹⁴, Al-Tamimi and Hashim⁹, Doris¹⁷ and Baydas B¹⁸ showed no statistically significant difference among genders. Hence, the study on genders had not been included in the present study.

CLINICAL SIGNIFICANCE

Smith¹⁵ stated that specific dimensional relationships must exist between maxillary and mandibular teeth to ensure proper interdigitation, overbite and overjet at the end of the orthodontic treatment. This is acceptable. But the important question is what size of discrepancy is clinically significant in making an acceptable occlusion unachievable unless tooth size is altered by interdental stripping or restorative addition. Bernabe¹⁹ in his study chose 1.5mm as limit of acceptable discrepancy.

According to the study conducted by Doris¹⁷ crowded arches were defined as those with more than 4mm of space deficiency. The hypothesis tested was whether the arches with more than 4mm of crowding consistently had larger teeth than the ones with lesser or no crowding. He concluded that the total mesiodistal tooth size was uniformly larger in the crowded arches and certain teeth (maxillary lateral incisors and second premolars, mandibular canines and premolars) were larger in the crowded arches group.

Tooth thickness is an additional aspect of tooth size, which can influence occlusal fit. Bolton pointed out that the ratio permitting ideal occlusion would be influenced by the labiolingual thickness. Rudolph²⁰ investigated this and showed that Bolton's mean ratios were better indicators of potential ideal occlusion if the maxillary incisors were thinner. Measurement of tooth thickness would be an additional complexity in any measurement of Bolton's ratio. This factor may explain part of the range of ratio which can permit a good occlusion.

CONCLUSION

On completion of the study the following conclusion can be drawn from the findings of the present study.

1. The mean anterior tooth ratio of class III malocclusion groups was greater than class I and class II groups among the three different malocclusion groups. It was found that no statically significant difference occurred among the three different malocclusion groups.
2. Comparison of anterior tooth ratio between class I and class II, class I and class III; class II and class III were made. It was found that no statistically significant difference occurs among the three different malocclusion groups.
3. The mean excess tooth size of class II malocclusion groups was greater than class I and class III groups. It was found that no statically significant difference occurred among the three different malocclusion groups.
4. Comparison of anterior tooth size discrepancy between class I and class II, class I and class III; class II and class III were made. It was found

that no statistically significant difference occurs among the three different malocclusion groups.

Thus, to conclude there is no co-relation between anterior tooth ratio and different malocclusion groups and also between tooth size discrepancy and different malocclusion groups.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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