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ANALYSIS OF TOOTH SIZE DISCREPANCIES AMONG 5 DIFFERENT MALOCCLUSION GROUPS.

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ABSTRACT

INTRODUCTION: Bolton's analysis is the most popular and best known method for determining tooth size abnormality. Bolton's original study was carried out on a group of Caucasian females with excellent occlusions, and so its application to males, non Caucasian populations, and different malocclusion groups has been questioned.

OBJECTIVES: To compare Bolton's tooth size ratio with normal occlusion; to determine whether there is a difference in the tooth size discrepancies when comparing various malocclusion groups and between males and females; to determine the prevalance of tooth size discrepancies in the overall sample of the study.

METHODS: The study was carried out using a total of 150 dental casts and was grouped based on malocclusion. Bolton's anterior and overall ratios were calculated for each malocclusion. Tooth size ratios of normal occlusion was compared to Bolton's ratio. Tooth size discrepancies was then compared between various malocclusions and between males and females. Also the incidence of significant discrepancies from the Bolton's mean was assessed in each malocclusion group.

RESULTS: Class II div 1 had least anterior and overall ratio and Class III and Class II div 2 have highest anterior and overall ratio. 12 % of tooth size discrepancy was found in the present sample. No significant difference was found between genders.

CONCLUSION: 1.A statistically significant increase in the anterior and overall ratios of Class III and Class II div 2 malocclusion indicating mandibular tooth material excess.
2. A statistically significant decrease in the anterior and overall ratios of Class II div 1 malocclusion groups indicating maxillary tooth material excess.

KEYWORDS :

INTRODUCTION

Identifying the tooth size discrepancies between the maxillary and mandibular arches is an important component of correct orthodontic diagnosis and treatment. The presence of such discrepancies at the beginning of the treatment influences orthodontic planning by demanding reduction (proximal stripping), increase (crowns and resins), or elimination (extractions) of dental mass prior to treatment finalization. Bennett and McLaughlin added the seventh key to Andrew's six keys of occlusion which was correct tooth size proportion. The presence of a tooth size discrepancy prevents the achievement of an ideal overjet, overbite, and occlusion.[1]

Bolton's analysis has proven extremely useful in the clinical setting to guide the orthodontist in cases with extreme tooth size discrepancies and it is not without limitations. Firstly, as Bolton's study included only cases with excellent occlusion, its feasibility in different malocclusions is questionable. Secondly, the gender composition of Bolton's sample was not specified, it implies potential selection bias.[2] Also, most of the cases taken up in his study were orthodontically treated (nonextraction) but the methods of gaining space have not been specified.[3] Because different tooth sizes have been associated with ethnic groups, it is logical to expect that differences in tooth widths can directly affect tooth-widths ratios.[4]

As tooth size discrepancies tend to be population specific, this study was taken up in South Indian population to determine whether gender dimorphism exists for tooth size ratios and to clarify any differences in intermaxillary tooth size discrepancies represented by anterior and overall ratios when comparing normal occlusion, Angle's Class I, Class II div 1, Class II div 2 and Class III cases; and finally to compare the tooth size ratios of these patients with those of Bolton's study.

MATERIALS AND METHODOLOGY

he study was conducted on the study models of patients who reported to the Department of Orthodontics and Dentofacial Orthopaedics, D.A.P.M.R.V. Dental College and Hospital, Bengaluru. The study was carried out using a total of 150 dental casts and corresponding lateral cephalograms of patients aged between 12-25 years selected and grouped into normal occlusion, Class I, Class II div 1, Class II div 2 and Class III malocclusion based on the ANB values with equal number of males and females (30 samples in each group).
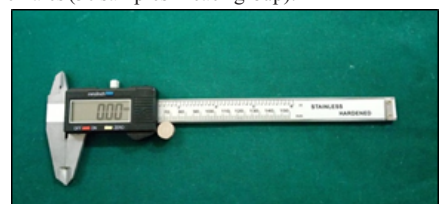

Fig 1: Digital vernier caliper

Fig 2 : Measurement of mesiodistal width of tooth on dental cast

Fig 2 : Measurement of mesiodistal width of tooth on dental castA digital caliper was used to measure the casts to the nearest 0.01 mm and lateral cephalograms were traced in an acetate matte tracing paper (0.003 inches thick, 8 X 10 inches) with a sharp 3H drawing pencil. The mesiodistal tooth dimensions were measured from the right first molar to the left first molar of the maxillary and mandibular arches. The width of each tooth was measured from its mesial contact point to the distal contact point at its greatest interproximal distance. Bolton's anterior and overall ratios were then calculated (Fig 1 and 2).

Tooth size ratios of normal occlusion were compared to Bolton's ratio. Tooth size discrepancies were then compared between normal occlusion, Angle's Class I, Class II div 1, Class II div 2 and Class III malocclusions and between males and females. Also, the incidence of significant discrepancies from the Bolton's mean was assessed in each malocclusion group. According to Bolton's analysis, a significant discrepancy was defined as one whose value was outside of 2 SD from Bolton's mean.[5] Therefore, for the overall ratio, a significant discrepancy was defined as a ratio below 87.5 or above 95.1. Similarly, any ratio below 73.9 or above 80.5 was considered to be a significant discrepancy for the anterior ratio.

Statistical analysis:
The mean & SD was derived for the scores testing for Tooth size discrepancy and also for Anterior & Over-all Bolton's Ratio. ANOVA test followed by Tukey's HSD Post hoc Analysis was done to compare the mean differences between study groups. Student Unpaired t test was used to compare the mean differences in Tooth size discrepancy and also for Anterior & Over-all Bolton's Ratio between the genders. The level of significance was set at $P < 0.05$

RESULTS
The sample consisted of 150 orthodontic models which were divided into 5 groups: normal occlusion, Class I, Class II div 1, Class II div 2 and Class III malocclusion, evenly distributed with equal numbers of males and females in each group. The average overall ratio for all classes combined was 91.94 and for the anterior ratio 77.71.

Table 1 shows that the mean anterior and overall ratio for the Class II div 1 malocclusion group was least among all malocclusion groups, while it was greatest for Class III and Class II div 2 malocclusion groups when both sexes were combined. The mean anterior and overall ratio for the Class II div 1 malocclusion group was 75.01% and 90.6% respectively indicating of anterior and overall maxillary excess. The mean anterior and overall ratio for the Class III malocclusion group was 79.02% and 92.42% respectively indicating anterior and overall mandibular excess.

The mean anterior and overall ratio for the Class II div 2 malocclusion group was 78.93% and 92.59% (maximum seen upto 82.05% and 95.46%) respectively, indicating of anterior and overall mandibular excess (Table 1 and 2). The mean anterior and overall mandibular excess was estimated as 0.85 mm (maximum of 2.3 mm) and 1.35 mm(maximum of 4.2 mm) respectively.

TABLE 1: Comparison of Mean Anterior and Overall Ratio between different types of Malocclusion using one-way ANOVA test

Malocclusion	Normal	Class I	Class II Div 1	Class II Div 2	Class III	P-Value
Total Ant	77.29	77.29	77.29	77.29	77.29	<0.001*
Total Overall	91.60	91.60	91.60	91.60	91.60	0.004*
Males Anterior	76.87	76.87	76.87	76.87	76.87	<0.001
Males Overall	91.08	91.08	91.08	91.08	91.08	0.07
Females Anterior	77.71	77.71	77.71	77.71	77.71	<0.001*
Females Overall	92.12	92.12	92.12	92.12	92.12	0.08

The one-way analysis of variance indicates there was a significant difference between anterior ratios in the different malocclusion classes, whereas there was no significant difference between the overall ratios. When the overall and anterior ratio was compared between males and females, no significant difference was detected between either sex. Comparisons of the overall and anterior ratios between normal occlusion and other malocclusion classes (with no sex

difference) indicate that there was no statistically significant difference between them.

When the results of the present study were compared to Bolton's results, no statistically significant difference was noted for both, overall and anterior ratios in normal occlusion but statistically significant differences were noted for all the other malocclusion classes (Table 2).

TABLE 2: Comparison of Anterior and Overall Ratio between the present & Bolton study in different malocclusions using Independent Student t Test

	Study Type	Normal	Class I	Class II Div 1	Class II Div 2	Class III
Anterior Ratio	Bolton	77.20	77.20	77.20	77.20	77.20
	Present study	77.29	77.29	77.29	77.29	77.29
	P-Value	0.82	0.004*	<0.001*	<0.001*	<0.001*
Overall Ratio	Bolton	91.30	91.30	91.30	91.30	91.30
	Present study	91.60	92.50	91.60	92.59	92.42
	P-Value	0.40	0.03*	0.17	0.002*	0.02*

Tooth size discrepancies greater than ±2 SD were considered to be clinically significant. In the present study, clinically significant discrepancies were found in 12% of the sample. When analyzed by Angle classification, there were significantly greater numbers of Class II div 1 and Class III subjects with ±2 SD tooth size discrepancy than of other malocclusions. However, no significant difference was observed between genders.

DISCUSSION
The importance of obtaining an adequate relationship between the maxillary and mandibular teeth has drawn the attention of many investigators over the years. One of the causative factors leading to an inadequate relationship between maxillary and mandibular dentition has been attributed to a discrepancy in tooth size.[6]

The majority of studies comparing Bolton's ratios have tried to establish whether or not differences existed between males and females. The results of these studies have varied. Bishara et al[7] looked at three groups of children from the United States, Egypt, and Mexico and found that there were gender differences within each racial group, with males showing large mesiodistal tooth widths for different teeth. This supported the work of Richardson et al[8] who showed that tooth size dimensions were greater in a group of Negro males than females. Lavelle[9] reported relatively larger overall and anterior ratios in males compared with white, black, and mongoloid female populations. Smith *et al.*[2] found larger overall and posterior ratios in black, Hispanic, and white males. Santoro *et al*, Ta *et al*, Endo *et al*, and Al-Omari *et al*, on the other hand, observed no sexual dimorphism in overall and anterior ratios.[10-13] Nie and Lin[14] found no difference between the genders for the tooth size ratios. The results of the present study showed no sexual dimorphism in overall and anterior ratios among various malocclusion groups (Table 9) and both the genders were combined for subsequent comparisons. These results are corroborating with previous studies that have identified minor (statistically insignificant) differences between men and women.[10-14] The anterior and overall ratios of the normal occlusion group of the present study were similar to those of Bolton's study when comparing means for interpreting tooth size ratios. This indicates that Bolton's ratios can be successfully applied to the current study population for diagnosis and treatment planning.

Studies that have focussed on the prevalence of a Bolton's discrepancy in orthodontic patients have looked at different malocclusions with varying results. Some studies have found relative mandibular tooth excess in Class III malocclusions[11,14-17], relative maxillary excess in Class II malocclusions[14], whilst other studies found no significant differences[18-20]. In the present study when the anterior and overall ratios of normal occlusion were compared to Angle's Class I malocclusion there was no significant difference between them (P = 0.09). Whereas, there was a statistically significant difference between the ratios when Normal occlusion was compared to Angle's Class II div 1, Class II div 2 and Class III malocclusions (P < 0.001). The results showed a mean anterior and overall maxillary excess in Angle's Class II div 1 malocclusion, whereas, it was a mandibular tooth material excess in

both Class II div 2 and Class III malocclusions.

Sperry et al[15] showed that the Class III group with mandibular prognathism had more patients with mandibular tooth-size excess for the overall ratio than the Class I and Class II groups ($P < .05$). This conclusion was similar to a result of the present study. Lavelle[9] showed that tooth sizes of Class III were the smallest among the 3 malocclusion categories (ie, Class I, Class II and Class III) for maxillary teeth; they were the greatest for mandibular teeth. This possibly indicated that tooth size ratios of mandibular teeth divided by maxillary teeth in Class III may be the greatest among different malocclusion types.

The increase in the anterior and overall ratios of Class II div 2 malocclusion may be due to the generalized decrease in tooth size in them as shown by Peck et al[21]. He showed that the mesiodistal diameters for the maxillary and mandibular incisors of the Class II div 2 samples were significantly smaller than those of the reference sample (p<0.002), pointing to a systematically reduced tooth size as a trait associated with Class II div 2 malocclusions. The higher prevalence of mean anterior and overall tooth size ratios in the Class II division 2 malocclusion group of the present study population may have restorative implications.

In the present sample, the frequency of tooth size discrepancy outside 2 SD from Bolton's mean values was used to determine the clinical significance of tooth size imbalance. 12 percent of the subjects had a discrepancy greater than 2 SDs from Bolton's means for the overall and anterior ratio. The present results are compatible with those in the literature and indicates the need for the assessment of Bolton's ratios during diagnosis and treatment planning in the sample population. [10,13,22,23]

In clinical practice, clinicians often note the discrepancy of individual tooth size and skeletal size but seldom pay attention to tooth size discrepancy between maxillary and mandibular teeth. The present study showed the tendency of mandibular tooth size excess in Angle Class III and Class II div 2 malocclusion and the tendency of maxillary tooth size excess in Angle Class II div 1 malocclusion. This indicates that it might be reasonable for orthodontists to do interproximal stripping or tooth extraction in the mandibular dentition for Class III and Class II div 2 malocclusion and in the maxillary dentition for Class II div 1 malocclusion. These results suggested that the Bolton analysis is important and should be considered when diagnosing, planning, and predicting prognosis in clinical orthodontics.

CONCLUSION

The conclusions drawn from this study are:-
1. The prevalence of tooth size discrepancy in the sample population was 12% in the overall ratio and for the anterior ratio.
2. When tooth size ratios of normal occlusion was compared to Boltons original sample, no statistically significant difference was found, indicating Bolton's anterior and overall ratios can be successfully used in the present population.
3. No significant sexual dimorphism existed in any of the malocclusion groups.
4. The means for anterior and overall ratios for the normal occlusion and other malocclusion classes in the present study were statistically significant compared to those of Bolton.
5. When tooth size ratios were compared, there was a statistically significant increase in the anterior and overall ratios of Class III and Class II div 2 malocclusion groups indicating mandibular tooth material excess.

When tooth size ratios were compared, there was a statistically significant decrease in the anterior and overall ratios of Class II div 1 malocclusion groups indicating maxillary tooth material excess.

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