EVALUATION OF TOOTH SIZE DISCREPANCY IN DIFFERENT MALOCCLUSION GROUPS

Iffat Batool, Assad Abbas*, S. Ausaf Ali Rizvi, Irum Abbas**

Department of Orthodontics, *Maxillofacial Surgery, Armed Forces Institute of Dentistry, Rawalpindi, **Department of Maxillofacial Surgery, Ayub Medical College, Abbottabad, Pakistan

Background: Orthodontic diagnosis and treatment planning requires the patient's thorough history, extra and intra oral examination, analysis of diagnostic records comprising of orthodontic photographs, necessary radiographs and properly trimmed study casts. Tooth-size is the sum of mesio distal widths of the maxillary and mandibular teeth. For ideal occlusion, teeth in both arches should be proportional in size. If larger teeth in one jaw are occluded with smaller teeth in the other jaw, ideal occlusion is not achieved. Tooth size analysis was presented by Bolton in 1958. The ratio for anterior segment was derived to be 77.2±0.22% and 91.3±0.26% for the whole arch. **Methods:** A quantitative study was carried out at the Armed Forces Institute of Dentistry (AFID), Rawalpindi, Pakistan, a tertiary care facility. Cross sectional data was gathered from the study casts of patients undergoing orthodontic treatment at AFID, after obtaining informed written consent from them. 135 out of 200 study casts were filtered based upon the inclusion and exclusion criteria. ANB angle and witt's appraisal were traced on corresponding lateral cephalograms. The mesio distal widths of all maxillary and mandibular teeth from right first molar to left first molar were calibrated with the use of a manual caliper. The readings were then used to compute the anterior and total Bolton ratios. **Results:** Significantly higher mean anterior tooth ratios were found for Class II ($p<0.01$) patients. All other ratios were within close range of Bolton's norms. **Conclusions:** Skeletal Class II patients showed a tendency towards higher mesiodistal widths of teeth in the mandibular anterior region.

Keywords: Interarch tooth size discrepancy, Bolton's norms, Skeletal Class I, II and III

INTRODUCTION

Every orthodontist's goal is to successfully treat patients of malocclusion ensuring that treatment plan and orthodontic techniques are properly carried out. Orthodontic diagnosis and treatment planning requires the patients thorough history, extra and intra oral examination, analysis of diagnostic records comprising of orthodontic photographs, necessary radiographs and properly trimmed study casts. A great advantage of study cast analysis is that the degree of malocclusion can be diagnosed in three dimensions.[1]

Tooth size means the mesio distal widths of the maxillary and mandibular teeth.[2] Specific dimension relationships must exist between the maxillary and mandibular teeth to ensure proper interdigitation, overbite and overjet. Amongst orthodontists, opinions vary widely concerning the frequency of significant tooth size discrepancy and the need to measure it in clinical practice.[3] Although the natural teeth match very well in most individuals, approximately 5% of the population has some degree of disproportion among the sizes of individual teeth.[4] Disproportion in the sizes of teeth between the maxillary and mandibular arches is not uncommon.[5–8] Tooth size discrepancy is usually limited to a single tooth such as a peg lateral. A thorough evaluation of the amount of space to be created for the final restoration of such a tooth is essential. The presence of an abnormally large tooth in any arch may effect extraction decisions.

Tooth size analysis was presented by Bolton in 1958.[2] He computed the specific ratios of the mesio distal widths that must exist between the maxillary and mandibular anterior segments as well as for the whole arch from right 1st molar to left 1st molar for proper coordination of maxillary and mandibular teeth. The ratio for anterior segment was derived to be 77.2±0.22 and 91.3±0.26 for the whole arch. The analysis is carried out by measuring the mesio distal width of each permanent tooth. Then the ratios of the summed width of the maxillary to the mandibular anterior teeth and the total mesio-distal width of all maxillary to mandibular teeth are compared with Bolton's given ratios. A variation greater than 2 SD of the normal ratios is considered clinically significant.[6, 9,10]

Only a few studies on inter arch tooth size discrepancy have been conducted in Pakistan.[11,12] The purpose of this study was to evaluate in orthodontic patients reporting at AFID, the relationship between tooth size discrepancy and malocclusion groups based on cephalometric analysis. This is the first study to be conducted in Pakistan in which tooth size discrepancies have been studied in different skeletal malocclusion groups.

MATERIAL AND METHODS

A cross sectional study was carried out at AFID, Rawalpindi, Pakistan, a tertiary care facility. The commandant AFID granted the permission after ethical committee's approval. Cross sectional data was gathered from the study casts of patients

undergoing orthodontic treatment at AFID, after obtaining informed written consent from them.

The inclusion criteria:

1. Permanent dentition
2. Presence of all permanent teeth from first molar to first molar in both arches
3. No caries or extensive restorations on any of the teeth

The exclusion criteria:

1. Presence of any deciduous tooth/teeth
2. Presence of any morphologic dental anomaly *viz* mesiodens, taurodontism, etc.
3. History of orthodontic treatment.

A thorough examination of all the study casts was done. All impressions of orthodontic patients were taken with fast setting alginate. Impressions were poured with orthodontic plaster, having a net expansion of 0.2%, after which they were trimmed. 135 out of 200 study casts were filtered based upon the inclusion and exclusion criteria. ANB angle[13] and Witt's appraisal[14] were traced on corresponding lateral cephalograms on acetate sheet using 0.1mm tracing pen to assess the skeletal class of the patients.

The mesio distal widths of all maxillary and mandibular teeth from right first molar to left first molar were calibrated with the use of a manual calliper. The readings were then used to compute the anterior and total Bolton ratios.

All data was analyzed using SPSS-14. Mean and standard deviation were calculated for anterior and total Bolton ratios for the whole sample and also for all three skeletal groups individually. ANOVA was used to compare the three skeletal groups with each other and also with Bolton's proposed norms for total and anterior Bolton ratios. Tukey's test was used for post HOC analysis.

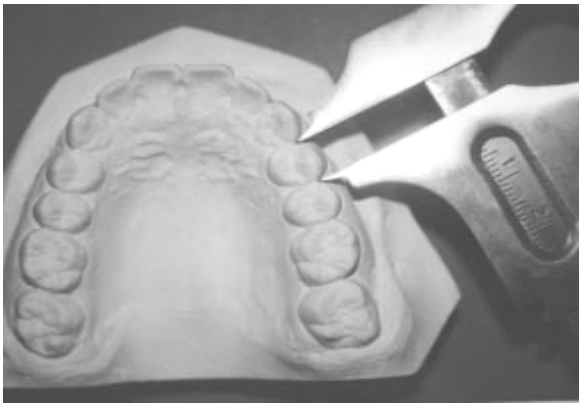

Figure-1: Calibration of the mesio distal widths of teeth from study cast.

RESULTS

Out of a total of 200 casts studied, 135 were filtered based on the above mentioned criteria. Of these, 37 were of Class I patients, 68 were of Class II patients and 30 were of Class III patients based on the corresponding cephalometric evaluations. A mean total Bolton ratio of 91.10±2.93 and a mean anterior Bolton ratio of 79.34±5.19 was found for the complete sample. The mean ratios for the different malocclusion groups are shown in Table-1.

Table-1: Mean values for total and anterior Bolton ratios for different malocclusion groups

Group	Mean total ratio	Mean anterior ratio
Complete sample (n=135)	91.10 ±2.93	79.34 ±5.19
Skeletal Class I (n=37)	91.64 ±3.34	77.67 ±4.12
Skeletal Class II (n=68)	90.79 ±2.97	80.14 ±5.20
Skeletal Class III (n=30)	91.13 ±2.20	79.58 ±5.97

The minimum total Bolton ratio calculated in the sample was 84.21 of a skeletal Class II patient while the highest ratio calculated was 98.90 of a skeletal Class I patient. ANOVA and Tukey's test failed to show any significant difference in the total Bolton ratios of different skeletal groups (p>0.05).

Table-2: Results for ANOVA and Tukey's test for total Bolton ratios

Class		*p*-Value
	Total Bolton	0.481
Class I	Bolton's	0.953
	Class II	0.418
	Class III	0.860
Class II	Bolton's	0.821
	Class I	0.418
	Class III	0.940
Class III	Bolton's	0.994
	Class I	0.860
	Class II	0.940

* p-value<0.05 is significant

The minimum anterior Bolton ratio calculated in the sample was 66.00 of a skeletal Class I patient while the highest ratio calculated was 97.30 of a skeletal Class II patient. ANNOVA and Tukey's test showed significant difference for anterior Bolton ratios between Bolton's proposed norms and Class II patients and also between Class I and Class II patients. (p<0.01)

Table-3: Results for ANOVA and Tukey's test for anterior Bolton ratios

Class		*p*- Value
	Total ANOVA	0.008*
Class I	Bolton's	0.976
	Class II	0.043*
	Class III	0.331
Class II	Bolton's	0.019*
	Class I	0.043*
	Class III	0.945
Class III	Bolton's	0.189
	Class I	0.331
	Class II	0.945

* p-value < 0.05 is significant

DISCUSSION

The importance of tooth size discrepancy in treatment planning has been the subject of various discussions in orthodontic literature. In our study, a comparison was made between tooth size discrepancy in skeletal Class I, II and III patients based on cephalometric findings. This is the first study to be conducted in Pakistan in which tooth size discrepancies have been studied in different skeletal malocclusion groups.

The mean total ratio for the whole sample was 91.10% which is very close to Bolton's proposed ideal ratio. However the anterior ratio for the whole sample was found to be 79.34%, which is much higher than Bolton's proposed ideal ratio, thus reflecting a tendency towards greater mesiodistal widths in the mandibular anterior segment in our population sample.

In skeletal Class I patients, the mean total ratio calculated was 91.64% and the mean anterior ratio calculated was 77.67%, both of which are close to Bolton's proposed ideal ratios. Similarly the total mean ratio calculated for skeletal Class II (90.79%) and Class III (91.13%) patients and the anterior mean ratio for skeletal Class III patients (79.58%) was in close agreement with Bolton's proposed ideal ratios. A peculiarity was the finding of significantly higher (p<0.05) mean anterior ratio (80.14%) for skeletal class II patients. This reflects a tendency towards wider mesiodistal dimensions in the mandibular anterior segment in our population sample. Usually the opposite of this is *assumed* to be true. There was a significant difference in the anterior tooth ratios between Class I and Class II patients. However, no significant difference between Class I and Class III or Class II and Class III patients was observed.

No correlation between angle's classification of malocclusion and Bolton discrepancy was shown by Crossby and Alexander in 1989.[9] Their study included 109 pretreatment models of orthodontic patients of Class I, Class II Div 1 and Class II Div 2 malocclusion.

Nie and Lin in 1999[15] studied 60 cases of normal occlusion and 300 cases of various malocclusion groups for interarch tooth size discrepancy. They found no significant difference between various malocclusion subgroups. However, Class III cases showed the greatest discrepancy in both anterior and overall ratios, followed by Class I and then Class II.

In 2001 Ta *et al*[16] studied Bolton's ratios in Southern Chinese children. Their sample included 50 Class I cases, 30 Class II cases and 30 Class III cases that were randomly selected from 1247 children. No significant gender difference was found. A significant difference ($p < 0.05$) was found between Class III groups and Bolton's norms for anterior ratio. For overall ratio, a significant difference (p<0.05) was found between class II cases and Bolton norms and also between Class II and Class III cases (p<0.05).

In 2002 Alkofide and Hashim [17] studied the intermaxillary tooth size discrepancy in Saudi population. The sample consisted of 240 subjects, 60 cases in each malocclusion group. A significant difference was observed only for anterior ratios in class III groups. However, a significant difference was found in all malocclusion cases as compared to Bolton's norms.

Hashim in 2002[18] did not find any difference in Bolton's raios between different malocclusion groups. His sample comprised of 55 orthodontic patients of different malocclusion groups.

Laino *et al*[19] found no relation between inter and intra arch tooth size discrepancy and malocclusion groups. Their sample comprised of 94 pre treatment models of orthodontic patients.

Araujo and Souki in 2003[20] studied 300 subjects who were allocated to three malocclusion groups with each group containing 100 individuals. The classification was done on the basis of ANB angle and Sassouni analysis. Significantly higher anterior mean ratios were found in Class III groups as compared to Class I and Class II groups. Tooth size discrepancy was found to be more prevalent in Class I and Class III groups.

Afzal *et al* in 2005[12] studied Bolton's ratios in 3 malocclusion groups in 55 Pakistani patients. While Class III group had the largest ratio followed by Class II and then by Class I, their differences were not statistically significant.

In 2005 Uysal *et al*[21] compared interarch tooth size discrepancy in 150 untreated, normal occlusion subjects and 560 patients of four different malocclusion groups. A gender dimorphism was found in the normal subjects. All malocclusion groups showed significantly higher overall ratios than normal occlusion groups (p<0.001). However no statistically significant difference was found between the malocclusion groups.

Basaran *et al* in 2006[22] failed to show any gender dimorphism or statistically significant difference of Bolton's tooth size discrepancy among different malocclusion groups. The sample was of 60 normal occlusion groups and 300 patients divided into various malocclusion groups on the basis of dental and skeletal pattern. The study was conducted in a Turkish population.

Fattahi *et al* in 2006[23] assessed interarch tooth size discrepancy among different malocclusion groups. The study was conducted using pre treatment models of 200 patients with equal gender distribution and from four malocclusion groups. The models were selected form the records of the Orthodontic

department, Shiraz Dental School, Iran. The mean overall ratios in order were Class III >Class I >Class II Div 2 >Class II Div 1. The mean anterior ratio for the Class III sample was significantly greater than that for Class II subjects but showed no significant difference from the Class I subjects. The posterior and overall ratio of the Class III malocclusion group was statistically significantly greater than the other malocclusion groups ($p<0.05$).

Al Khateeb and Abu Alhaija[24] in 2006 found no statistically significant differences in Bolton's ratios between the different malocclusions. Their sample consisted of 140 orthodontic models of school children aged between 13–15 years of Jordanian origin.

The results of this study are in partial agreement with some of the above studies in the fact that no significant difference was found between Bolton's norms and tooth size ratios in Class I patients. However, unlike other studies, Class III patients did not show a significantly higher anterior tooth ratio as compared to Class I patients. The observation that Class II subjects showed a significantly higher anterior ratio, indicating a tendency towards wider mandibular teeth has not been reported before. Perhaps the reason for this is that all except one previous study[20] classified patients into different malocclusion groups based on study cast relations, whereas this study used corresponding cephalometric tracings to classify the patients into different groups.

CONCLUSIONS

- Skeletal Class I and Class III patients showed mean interarch tooth size ratios within close range of Bolton's norms.
- Skeletal Class II patients showed significantly higher mean anterior tooth ratios as compared to Bolton's norms. The mean total tooth ratios were within close range of Bolton's norms.
- Although AFID caters for all army personnel belonging to various regions of the country, a larger study at the national level is required to verify the applicability of these results to our population.

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Address for Correspondence:

Col. Iffat Batool, Armed Forces Institute of Dentistry, Rawalpindi, Pakistan. Tel: +92-51-561-34080.
Email: assad14@hotmail.com