Original Article

Intermaxillary Bolton Tooth Size Discrepancies Among Different Malocclusion Groups

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Abstract: The orthodontic ''finishing'' phase is recognized for the many details necessary to accomplish an excellent result. A high percentage of finishing-phase difficulties arise because of tooth size imbalances that could have been discovered and considered during the initial diagnosis and treatment planning. The aim of our study was to determine whether there is a prevalent tendency for intermaxillary tooth size discrepancies among different malocclusion groups. This study involved 60 subjects who served as the normal occlusion group and 300 patients divided into five malocclusion groups (ie, Class I, Class II, Class II division 1, Class II division 2, and Class III). Tooth size measurements were performed on the models of the normal occlusion group and the pretreatment models of the patients. The tooth size ratios and the one-way analysis of variance test showed no sexual dimorphism for these ratios in each of five groups, so the sexes were combined for each group. Then, these ratios were compared among different malocclusion groups. The results showed no significant difference between subcategories of malocclusion, so these groups were combined as Class I, Class II, and Class III. No significant difference was found for all the ratios between the groups. (*Angle Orthod* 2006;76:26–30.)

Key Words: Bolton; Malocclusion

INTRODUCTION

The dental literature has many studies comparing tooth size discrepancies and malocclusion in different ethnic groups. However, there is a lack of sex and Angle classification specificity in these studies, and additional data are necessary to understand this association. Discrepancies in tooth size should be known at the initial diagnosis and treatment planning stages if perfect results in orthodontic finishing are to be achieved. Tooth size discrepancies are considered an important variable, especially in the anterior segment.

Most studies have been carried out on a mixture of treated and untreated subjects with good or excellent occlusion. However, especially for the comparison of intermaxillary tooth size relationship among different malocclusions, few studies are available and the results have been controversial.

Bolton[1] developed a method of analyzing the mesiodistal tooth size ratio between maxillary and mandibular teeth. He concluded that it would be difficult for proper occlusal interdigitation or coordination of arches in the finishing stage of orthodontic treatment without a proper mesiodistal tooth size ratio between the maxillary and the mandibular teeth. The genetic effects are considered important for determination of tooth dimensions, and the first reports were of clinical observations within families. Research on twins helped in understanding the genetic contribution of tooth size because a greater tooth size correlation was found in monozygotic twins.[2,3] Some researchers have de-emphasized the genetic contribution and described the determination of tooth size as multifactorial, involving environmental teratogenic and nutritional factors. Space limitations and nutrition have been described as important in the development of a healthy tooth germ and have been related to alterations in the number, shape, and form of permanent teeth.[4] Although it is widely accepted that both genetic and environmental variables affect tooth development, at the present time, it is virtually impossible to identify and describe the role each of these variables plays in the determination of tooth size.[5]

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Tooth size variations exist among various ethnic groups, and it is reported that individuals of black ethnic backgrounds have larger teeth than Caucasians.[1,6–12] Studies including Hispanic populations reported significant tooth size differences in relation to Caucasians but tooth size similarities to African Americans.[13] The Brazilian population, similar to the Hispanic population, is composed of a mixture of African and European descendents.

Arya et al[12] showed differences in tooth size between sexes, as has been reported by a number of other authors. They attempted to show differences in tooth size between Class I and Class II malocclusions but failed to do so. In their study, the mean size of each tooth for the different groups (ie, Class I and Class II, boys and girls) was compared. Differences for individuals between different arches were not analyzed.

Lavelle[14] showed that there was sexual dimorphism in tooth dimensions and in the ratio of upper to lower arch tooth size. In addition, there was racial dimorphism between blacks, Mongoloids, and Caucasians. Lavelle also measured the ratio of upper to lower arch tooth size in different malocclusion types. The difference was in the method of analysis. Rather than tooth sizes being compared for individuals, the mean size of each tooth of male patients for each malocclusion type was stated. A pattern of contrast was found, which differed for the maxillary values as compared with the mandibular values for different malocclusion categories.

The Sperry et al[15] study analyzed the Bolton ratios for groups of Class I, Class II, and Class III cases. The skeletal patterns were not mentioned, although some of the Class III cases were treated surgically. Male and female subjects were not differentiated. The overall ratios showed a mandibular tooth size excess for the Class III patients. Crosby and Alexander[13] analyzed the Bolton ratios for different occlusal categories. They did not differentiate between sexes, and they did not include Class III patients. The relationship of malocclusion to skeletal pattern was not mentioned. They did not find a statistically significant difference in the prevalence of tooth size discrepancies among the different malocclusion groups.

The objectives of this study were to determine (1) whether sexual dimorphism exists for tooth size ratios and (2) whether there is a difference for intermaxillary tooth size discrepancies represented by anterior ratio and overall and posterior ratio of Bolton for Class I, Class II, Class II division 1, Class II division 2, and Class III cases. All cases were gathered in three main groups as Class I, Class II, and Class III malocclusion.

MATERIALS AND METHODS

The samples for this study consisted of 300 patients with varying malocclusions. Patients were selected from the clinical practice of the Department of Orthodontics at Dicle University. All cases were born and living in southeastern Turkey and were between 13 and 19 years of age. The Angle classification of the occlusion coincided with the skeletal classification in all cases. The skeletal pattern was assessed using the Steiner cephalometric analyses and the ANB angle. After dental classification, each group comprised 60 individuals with the following distribution: Class I, 30 male and 30 female; Class II, 28 male and 32 female; Class II division 1, 25 male and 35 female; Class II division 2, 27 male and 33 female; Class III, 27 male and 33 female.

The following inclusion selection criteria were used:

- Good quality models of normal occlusion and pretreatment models of patients;
- All permanent teeth had erupted and were present from right first molar through left first molar;
- No severe mesiodistal and occlusal tooth abrasion;
- No residual crown or crown-bridge restoration;
- No tooth deformity (eg, conic-form lateral incisal teeth);
- No record of restoration or stripping of incisor and canine teeth.

All the teeth were measured at the largest mesiodistal dimension, using a digital caliper accurate to 0.01 mm. The reading was recorded at the 0.1 mm level, and the same examiner made all measurements. An analysis of error was performed by remeasuring the study casts of 30 randomly selected individuals and submitting the data to nonparametric Wilcoxon statistical testing. The anterior tooth size ratio was computed for each subject as described by Bolton.[1]

Analysis of variance (one-way ANOVA) was used to compare the mean Bolton anterior and total tooth size ratios as a function of Angle classification as well as sex. No statistical differences were found at the 95% confidence level ($P > .05$).

RESULTS

Analysis of error

The same researcher performed all measurements, and the reproducibility of the method was tested. A total of 30 individuals were randomly selected from the original sample, and measurements were repeated two times with a one-week interval. No significant differences between the two sets of measurements ($P > .05$) (Table 1) were found on testing using the Wilcoxon nonparametric test.

TABLE 1. Comparison of First and Second Measurements of Tooth Size Discrepancies. None of the Differences Were Significant at $P > .05$ Using a Wilcoxon Nonparametric Test[a]

Group	Measurement	n	Minimum	Maximum	Mean	SD	*P*
Class I	1	10	76.0	84	80.2	2.6	.760 (NS)
	2	10	77.2	83.5	80.0	2.6	
Class II	1	10	75.8	80.0	78.2	1.4	.833 (NS)
	2	10	75.9	80.2	78.2	1.3	
Class III	1	10	74.5	84.9	79.0	2.8	.155 (NS)
	2	10	75.5	84.9	79.9	2.9	

[a] NS indicates nonsignificant.

TABLE 2. Comparison of Anterior Six Teeth and Total 12 Teeth Sizes as a Function of Sex. None of the Above Differences Were Significant at $P > .05$ Using One-Way ANOVA Test[a]

		Male Patient				Female Patient			
	Group	Mean	SD	SE	*P*	X	SD	SE	*P*
Anterior six teeth	Class I	79.17	3.069	0.551	.535 (NS)	77.58	5.016	0.931	.289 (NS)
	Class II	78.28	3.840	0.668		78.17	3.466	0.667	
	Class II div I	78.00	3.124	0.528		76.83	2.518	0.503	
	Class II div. II	77.71	3.321	0.628		77.17	1.119	0.934	
	Class III	78.75	3.898	0.736		78.29	5.447	0.978	
Total 12 teeth	Class I	87.51	5.55	0.997	.178 (NS)	87.24	6.199	1.151	.164 (NS)
	Class II	89.65	3.183	0.5534		88.22	3.105	0.597	
	Class II div I	89.58	3.562	0.602		88.35	4.163	0.832	
	Class II div. II	91.55	2.574	0.486		98.19	3.41	0.299	
	Class III	91.22	3.417	0.645		90.54	3.432	0.616	

[a] NS indicates nonsignificant; div., division; ANOVA, analyis of variance.

Individual tooth analysis

To accurately collect the data, each tooth was measured at the largest mesiodistal dimension using a digital caliper accurate to 0.01 mm. Mean individual tooth sizes were then compared using ANOVA to determine whether tooth size was related to sex, malocclusion classification, or both. No significant differences were found among the five groups in both the six anterior and the total 12 teeth when individual tooth size was compared as a function of Angle classification. No statistically significant differences ($P > .05$) were found when individual tooth size was compared as a function of sex (Table 2). This shows that there was no significant sexual dimorphism for all ratios of all groups. There was no prevalent trend regarding the absolute value of tooth size ratios of the different sexes. Because there was no significant sexual dimorphism for tooth size ratios, the sexes were combined for each group. One-way ANOVA test was then performed between these groups, and no statistical differences were found (Table 3). It was obvious that, for the tooth size ratios, there were no significant differences between the Class I, Class II, Class II division 1, Class II division 2, and Class III groups. Because there is no significant difference between subcategories of malocclusion, these groups were combined. This produced 60 individuals in Class I, 180 in Class II, and 60 in the Class III groups. The one-way ANOVA test was performed between the three new groups and the statistical results were summarized (Table 4). No statistically significant differences ($P > .05$) were found

TABLE 3. Prevelance of Bolton Tooth Size Discrepancy Among Angle's Classification Groups. None of the Above Differences Were Significant at $P > .05$ Using One-Way ANOVA Test[a]

Group	Mean	SD	SE	*P*
Class I	78.40	4.167	0.358	.671 (NS)
Class II	78.32	3.646	0.470	
Class II div. I	72.51	2.923	0.337	
Class II div. II	77.42	8.442	1.078	
Class III	78.50	4.741	0.617	

[a] NS indicates nonsignificant; div., division; ANOVA, analysis of variance.

TABLE 4. Prevelance of Bolton Tooth Size Discrepancy Among Angle's Classification Groups After Subgroups Were Transfered. None of the Above Differences Were Significant at $P > .05$ Using One-Way ANOVA Test[a]

Group	Mean	SD	SE	*P*
Class I	78.40	4.167	0.538	.481 (NS)
Class II	77.72	5.562	0.413	
Class III	78.50	4.471	0.617	

[a] NS indicates nonsignificant; ANOVA, analysis of variance.

when individual tooth size was compared as a function of sex (Table 4).

DISCUSSION

The importance of tooth size discrepancies in orthodontic diagnosis has been widely reported in the literature and accepted by the orthodontic community because the relationship between the upper and the lower anterior dentitions is related to orthodontic finishing excellence.

Xia and Wu[16] also found no significant difference for tooth size ratios between the malocclusion group and the normal occlusion group after measuring mesiodistal tooth sizes of 1173 Han nationality cases on their models. Thus, the law of nature can be observed only after comparing tooth size ratios among different classified malocclusion groups.

Qiong and Jiuxiang[17] compared five different malocclusion groups and reported that there were no statistical differences between these groups. However, they reported that there was a tendency toward a Bolton discrepancy in the Class II and Class III malocclusion groups.

The skeletal categories were not mentioned in Crosby and Alexander's[13] study, although some of Class II cases were treated surgically. This may have an important effect on the selection of sample. For example, some skeletal Class II malocclusions can be converted to dental Class I malocclusions by forward movement of the permanent first molar associated with the premature loss of a deciduous second molar, so the Class I group may contain skeletal Class I and Class II patients. In this study, skeletal categories were taken into account and the cases were selected by the criteria of occlusal categories coinciding with skeletal categories.

Crosby and Alexander[13] also compared the tooth size ratios among different malocclusion groups, as in this study. They found that there were no significant differences among Class I, Class II division 1, Class II division 2, and Class II surgery groups. This study also found no significant difference between these groups.

The sample of the Class I group in the Crosby and Alexander[13] study was composed of Class I malocclusion in which no prevalent clinical presentations were mentioned, but this study was made up of normal occlusion and Class I malocclusion with bimaxillary protrusion.

Crosby and Alexander[13] did not differentiate between sexes and did not mention the ratio of sexes in each group. In their study, it was not clear whether there was sexual dimorphism for tooth size ratios. This study separated sexes and demonstrated no sexual dimorphism for tooth size ratios, and, thus, the sexes were combined in the ratio of 1:1 for each group.

Sperry et al[15] studied 130 cases and concluded that a tooth size discrepancy should be included as one part of the diagnostic records for mandibular prognathism. Our data show that tooth size discrepancies are independent of Angle classification. In addition, there was no prevalent trend regarding the absolute value of tooth size ratios of the different sexes.

CONCLUSIONS

- The results showed significant sexual dimorphism did not exist for the six and 12 tooth size ratios among the five groups.
- When tooth size ratios were compared as a function of sex, there were no significant differences between each group.
- There were no significant differences between the subgroups of malocclusion.
- After combination of these subgroups, there were no significant differences between the three groups when individual tooth size was compared as a function of sex and Angle classification.

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