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Comparison of tooth-size discrepancy among different malocclusion groups

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Introduction: This study was designed to compare the tooth size discrepancy as a factor of skeletal malocclusion in orthodontic patient population of Shiraz.
Materials and Methods: The study employed the pretreatment models of 200 patients, which were selected through a random available sampling method. The mesiodistal dimensions of teeth were measured by digital electron calipers (accurate to 0.01 mm) and the Bolton indices were determined. The study population was divided into four malocclusion groups according to Angle classification (Class I, Class II Div 1, Class II Div 2 and Class III). The data were analyzed using ANOVA and Duncan tests by SPSS software and the level of significance was $p<0.05$.
Results: The mean anterior ratio (79.01) of the total malocclusion group had a statistically significant difference with that of Bolton (77.2) but no significant difference was found for the overall ratio. The posterior and overall ratios of Class III malocclusion group were statistically greater than the other malocclusion groups. However, regarding the anterior ratio, the Class III group had a greater mean than Class II with no difference with Class I malocclusion group.
Conclusion: Comparing the two types of Class II malocclusion for ratios, no significant differences were observed.
Key words: Bolton analysis, Malocclusion groups, Tooth-size discrepancy
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A correct proportion between the mesiodistal dimensions of upper and lower teeth is critical to achieve a good intercuspation. Presence of a tooth- size discrepancy prevents the clinician from achieving a proper occlusion. The size mismatch between the maxillary and mandibular dentition can lead to generalized spacing, crowding or deviations from Class I occlusion. In the posterior region, a high percentage of the finishing phase difficulties arise because of tooth size imbalance that could have been detected and considered during initial diagnosis and treatment planning. Sometimes, abnormal tooth size is misdiagnosed during routine clinical observation and if not diagnosed properly before initiation of the treatment, tooth relation at the end of the treatment would not be so satisfactory.

Bolton analysis based on the ratios between the mesiodistal width of mandibular and maxillary teeth, is the most popular and known method for determining tooth size abnormality and also very useful in guiding orthodontists in patients with severe tooth size discrepancy.[1,2]

As in many other human attributes, there is variation in tooth size between males and females. Male teeth are generally recognized to be larger than female teeth.[3-7]

Gender differences have been reported to be great between the upper canines and upper central incisors in the primary and permanent dentitions [8], whereas the upper lateral incisors and lower incisors are the most homogenous [9]. Although, studies have reported significant differences in tooth size between males and females but there is no evidence of a significant difference in upper to lower anterior

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tooth size proportions[10,11].

The importance of a correct tooth size proportion between the upper and lower arches has been designed in several studies. Neff[12] developed anterior coefficient, which was a proportion for the width dimension of the teeth. A ratio of 1.20 to 1.22 when maxillary mesiodistal sum divided by mandibular mesiodistal sum would result in an optimal overbite. Lundstrom studied the relationship between the mandibular and the maxillary anterior sum and named it as the Anterior Index. The optimal ratio was found to be from 73% to 85% with a mean of 79% for an ideal overbite.

Gilpatric[14] showed that the total mesiodistal tooth diameters in the maxillary arch exceeded that in the mandibular arch by 8 to 12 mm and a value greater than 8 to 12 mm had resulted in an excessive overbite.

Introduction of Bolton's analysis in 1958[1,2] included comparisons of total mesiodistal widths of dental arches up to the distal surfaces of the first molars, as well as segments of the arches. He established an ideal anterior and an overall ratio with a mean value of 77.2% and 91.3% respectively.

Although in recent studies variables such as incisor inclinations,[15] upper incisor thickness[16,17] and arch form[16,18] have been described as important factors to be considered in achieving an optimal occlusal relationship and efforts have also been made to adapt the Bolton analysis to these variations, however, the Bolton analysis prevalence is still an effective clinical tool for apprising various relationships of upper to lower dentitions.

Few studies are available regarding a correlation among tooth size discrepancies and malocclusion groups. Lavella[19] studied 160 subjects for anterior tooth sizes and showed that Bolton discrepancy would be greater in Class III cases than other malocclusion groups.

The Sperry[20] study analyzed the Bolton ratios for groups of Class I, Class II and Class III cases. The overall ratios showed that there was excess mandibular tooth size for the Class III patients.

Crosby and Alexander[21] analyzed the Bolton ratios for different malocclusions. They did not differentiate between sexes, and they did not include Cl III patients. The results of their study showed no difference in the incidence of tooth size discrepancy among the different malocclusion groups.

Nie and Lin[10] found significant differences in the Bolton ratio among several occlusion categories and concluded that Bolton anterior ratio was greater in Class III cases than in Class II and Class I subjects.

Aroujo and Souki[22] in their study determined the correlation between anterior tooth size discrepancies and Angle's Class I, II and III malocclusion in Brazilian population, and showed that individuals with angle Class I and III malocclusions had significantly greater prevalence of tooth size discrepancies than the individuals with Class II malocclusion and the mean anterior tooth size discrepancy for Angle Class III subjects was significantly greater than Class I and Class II subjects.

In a recent study[23], conducted to investigate the correlation between the prevalence of tooth-size discrepancies and skeletal malocclusion to find out linear correlation between the posterior, the anterior, and the total Bolton indices, there was no evidence of any predisposition for a tooth-size discrepancy in any of the malocclusion groups.

The objectives of the current study were to determine whether sexual dimorphism exists for tooth size ratios to clarify any difference for intermaxillary tooth size discrepancies represented by anterior, overall and posterior ratios when comparing, Class I, Class II Division 1, Class II Division 2 and Class III cases in an Iranian population and finally to compare the tooth size ratios of the patients under study with those of Bolton's study.

Materials and Methods

Two hundreds of patients who lived in Shiraz, with varying malocclusions entered our study. The subjects were selected randomly from clinical practice of Orthodontic Department, School of Dentistry, Shiraz University of Medical Sciences in 2003. All cases were between 14 and 20 years old and occlusion categories of all subjects, which were classified by the Angle classification, coincided with skeletal categories. The subjects were divided into four malocclusion groups according to Angle classification Classes I, II Div 1, II Div 2 and III.

Each group comprised 50 individuals (25 males and 25 females). The skeletal pattern was assessed by ANB angle from cephalometric analysis, which meant in skeletal Class I, ANB angle was from 0° to 4°, ANB angle> 4° for skeletal class II and ANB angle <0° for skeletal Class III.

The selection criteria were as equivalent skeletal and dental classification, good- quality study cast, all permanent teeth (except wisdom teeth) to be erupted in the upper and lower arches, absence of any tooth deformity and severe mesiodistal and occlusal tooth abrasion no record of restoration or stripping of incisor and canine teeth.

The teeth on each cast, except for the second and third molars, were measured at the largest mesiodistal dimension using a digital caliper accurate to 0.01 mm. The results were recorded at 0.1 mm level, and the same examiner made all measurements. In order to determine the measurement error, the study casts of 30 randomly selected individuals were measured again one week later and an analysis of error was performed, submitting the data to non-parametric Wilcoxon statistical testing. The result showed no significant difference between the 2 measurements. The anterior, posterior, and overall tooth size ratios were computed for each subject as described by Bolton:

$$\frac{\text{Sum mandibular 3-3}}{\text{Sum maxillary 3-3}} \times 100 = \text{anterior ratio (AR)}$$

$$\frac{\text{Sum mandibular 654-456}}{\text{Sum maxillary 654-456}} \times 100 = \text{posterior ratio (PR)}$$

$$\frac{\text{Sum mandibular 6-6}}{\text{Sum maxillary 6-6}} \times 100 = \text{Overall ratio (OR)}$$

To compare the prevalence of tooth size discrepancies among the four malocclusion groups and two genders; a Chi Square test was performed. Moreover, in order to compare the mean Bolton tooth size ratios as a function of Angle classification as well as gender, analysis of variance (ANOVA) was performed.

Results

Fig 1. Mean, standard deviation and range of ratios within each malocclusion group

Ratios / Groups	Anterior Ratio $\bar{X} \pm$ SD (range)	Posterior Ratio $\bar{X} \pm$ SD (range)	Overall ratio $\bar{X} \pm$ SD (range)
CL I	79.44±3.14 (14.99)	104±3.48 (18.93)	91.85±2.21 (11.48)
CL II Div1	77.73±2.17 (7.77)	103.21±3.42 (16.31)	90.65±1.78 (6.37)
CL II Div2	78.72±2.38 (10.62)	103.45±3.21 (14.76)	91.09±2.05 (9.11)
CL III	80.16±2.88 (13.27)	105.82±2.94 (14.91)	93.14±1.86 (8.25)
Total groups	79.01±2.8 (17.75)	104.12±3.4 (20.66)	91.68±2.18 (11.95)
Bolton Study	77.2±1.65 (5.9)		91.3±1.91 (7.3)

The mean, standard deviation, and standard error of the tooth size ratios were obtained for each group (Table 1).

Anterior dental proportion

The mean anterior ratio of male subjects (79.57+2.7) was significantly larger than that of female subjects (78.45+2.81). The ANOVA demonstrated that there were significant differences between all groups (Table 2).

Using Duncan analysis, it was found that the differences were visible between subjects with Class II Div I and Class I and between Class III and Class II malocclusions. The mean ratio of Class III was significantly greater than that of Class II sample ($p<0.05$) but the Class I and Class III samples showed no significant differences when compared with each other (Table 3).

Fig 3. Significance of ratios between different malocclusion groups

Groups	Cl II Div 1	Cl III
CL I	AR OR	PR OR
CLII Div 1		AR PR OR
CLII Div 2		AR PR OR

Fig 2. Mean, standard deviation and standard error of ratios in males and females

	Male Patients			Female Patients			
	X	SE	SD	X	SE	SD	P value
CL I Malocclusion							
AR	80.12	0.45	2.27	78.76	0.75	3.75	0.127
PR	103.61	0.67	3.34	104.39	0.73	3.63	0.433
OR	92.17	0.36	1.78	91.54	0.51	2.57	0.318
CL II Division 1							
AR	78.51	0.47	2.37	76.94	0.33	1.65	0.009
PR	102.22	0.64	3.78	104.10	0.69	3.47	0.089
OR	90.47	0.35	1.74	90.56	0.37	1.84	0.72
CL II Division 2							
AR	79.04	0.47	2.36	78.40	0.48	2.41	0.34
PR	102.82	0.67	3.35	104.08	0.60	3.01	0.16
OR	90.98	0.40	2.02	91.20	0.42	2.12	0.7
CL III Malocclusion							
AR	80.61	0.66	3.28	79.72	0.48	2.40	0.27
PR	106.42	0.68	3.40	105.23	0.46	2.30	0.15
OR	93.61	0.39	1.96	92.67	0.33	1.66	0.07
Malocclusion groups (total)							
AR	79.57	0.27	2.70	78.45	0.28	2.81	0.004
PR	103.80	0.36	3.64	104.45	0.31	3.13	0.177
OR	91.87	0.22	2.18	91.49	0.22	2.19	0.22

AR: Anterior Ratio
PR: Posterior Ratio
OR: Overall Ratio

Posterior Dental Proportions

The mean for the posterior ratio in this study for different malocclusions as a single group was found to be 104.12 with a standard deviation of 3.40. Although the absolute value of tooth size ratio of male patients (103.8+3.64) was smaller than that of the female patients (104.45+3.13), the difference was not statistically significant (P=0.177).

Comparing the different groups of malocclusion, Class III group showed a statistically larger posterior ratio ($p<0.05$).

Overall dental proportions

As for posterior ratio, the overall ratio was significantly larger for Class III malocclusion than the other groups with no significance for both sexes. Regarding absolute values, the mean for the overall ratio for different groups was in an order of Class III>Class I>Class II Div 2> Class II Div 1. Besides, there was a statistically significant difference between Class I and Class II Div1 groups for the overall ratio.

Discussion

The present study demonstrated that statistically significant differences were in the incidence of anterior ratio between males and females among malocclusion groups, while that was not the case for overall and posterior ratios. When comparing the mean to interpret the overall ratio, the results of the present study were similar to that of Bolton[12] and Stifter[24]. For anterior ratio, which was measured, to be 79.01+2.8 when the whole malocclusion samples (i.e. 200 patients) were combined into one group, no similarity was found. This difference for the anterior ratio might be explained by differences in the samples involved, grouping criteria and statement as how many samples were treated or untreated. In the present study, the sample size was 200 untreated patients, which had malocclusions to be severe enough to warrant treatment, and it is possible that this is contributed to the larger percentage of tooth size discrepancies especially in the anterior region. This could be explained by the fact that anterior teeth, especially incisors, have a much greater incidence of tooth size deviations, that is, the greatest variables in mesial-distal tooth width occurring in the anterior region.

The findings that individuals with Class III malocclusion significantly present greater mean for the anterior ratio than the other groups may confirm the findings of Lavella[19] that Class III individuals had smaller maxillary teeth than Class I and Class II, but the small size of the maxillary teeth was not found in the present study. Therefore, the Bolton discrepancy in the Class III sample must be either attributed to anterior mandibular teeth width increase or to the accumulation of minor discrepancies of individual teeth.

The results obtained by Nie and Lin using Angle classification as a variable in analyzing 360 Chinese individuals for tooth size discrepancies[10] are in agreement with our findings that Class III patients demonstrated greater tooth size discrepancy when compared with patients of Classes II and I. These findings also confirm the initial investigations by Sperry et al.[20]

Crosby and Alexander[21] tried to verify the presence of any tooth- size discrepancy in a sample of 104 patients divided into four groups of malocclusion not including Class III malocclusion. They compared the averages of anterior and overall Bolton indices of the groups without finding any statistically difference in the incidence of the tooth-size discrepancy among the groups (Classes I, II Div1 and 2, and surgical Class II). Part of the results of our study was similar with theirs in respect to absence of statistical significant differences when comparing Class I and Class II malocclusion groups. Since they did not include subjects with Class III malocclusion in their study, they could not find any difference between normal occlusion and malocclusion groups considering the Bolton indices, while in the present study, a large part of the differences of Bolton indices were attributed to the presence of Class III malocclusions included in this study.

Regarding the studies reporting that the mesiodistal dimensions of lower teeth to be larger in Class III malocclusion when compared to Classes I and II (Div 1 and 2), it seems that the greater mean of Bolton ratio in the group of malocclusion might be due to etiologic factors that lead to mandibular prognathism. Further studies are needed to clarify if there would be any correlation between increased mandibular growth (as in Class III malocclusion) with increased mesiodistal dimension of lower anterior teeth. In other word, future researches may reveal that the genetic factors would determine the mandibular size while affecting the mesiodistal dimensions of lower mandiublar teeth in the same way.

Conclusion

Our results showed that subjects with Angle Class III had significantly greater prevalence of tooth size discrepancies than subjects with Class I and Class II. The mean anterior tooth size discrepancy for Angle Class III individuals was significantly greater than for Class II with no statistical difference with Class I. No Statistically significant difference was found to exist between the two types of Class II malocclusion for anterior, posterior, and overall ratios.

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