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Comparison of Intermaxillary Tooth Size Discrepancy Among Different Malocclusion Groups

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ABSTRACT

Background: A correct maxillary to mandibular tooth size relationship is critical to achieve a good intercuspation. Any deviation from this harmony can lead to malocclusion and prevent the attainability of optimal occlusion. The purpose of this study was to determine whether there was a difference in the incidence of tooth size discrepancies among different malocclusion groups and whether there was any prevalent trend in the gender differences for tooth size discrepancy.

Materials and methods: This study consisted of 80 subjects; 39 males (mean age 25.9years), 41 females (mean age 22.3 years) divided into three malocclusion groups; Class I, II and III based on Angles classification and Steiner cephalometric analysis. The mesiodistal diameters of teeth were measured by digital electronic calipers and Bolton indices were calculated.

Results: There was no statistically significant difference among different malocclusion groups for intermaxillary tooth size ratios and no prevalent gender trends. The means of anterior, posterior and overall tooth size ratios showed that a large percentage of patients had mesial-distal tooth size discrepancies at pre-treatment analysis.

Conclusions: Depending on the results of the study it seems prudent for orthodontists to routinely include a tooth size analysis in the initial diagnosis. Identifying such a discrepancy would prove beneficial by allowing more efficient diagnosis of problems, more specificity in treatment planning, and a higher success rate in achieving optimal occlusions, overbite, and overjet.

Keywords: Bolton ratio; Intermaxillary tooth size ratio; Optimal occlusion.

INTRODUCTION

One of the goals in comprehensive orthodontic treatment is to obtain an optimal final occlusion, overbite, and overjet. There are many factors that will influence the attainability of this goal, one of which is the relationship of the total mesiodistal width of the maxillary teeth to that of the mandibular teeth. A certain maxillary-to-mandibular tooth size relationship is important for proper occlusal relationships. It would be difficult for proper occlusal interdigitation or coordination of arches in the finishing stage of orthodontic treatment without proper mesiodistal tooth size ratio between maxillary and mandibular teeth. A significant variation in this relationship should be compensated for in the treatment planning by considering esthetic bonding, prosthetic recontouring, stripping of enamel, extraction, leaving spaces, or changing the desired anterior overjet or overbite. The alternative to not doing any

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of these may result in compromising the occlusion in the buccal segments, an undesirable result.[1]

Over the years many investigators have attempted to quantify this relationship. In 1923 Gilpatric calculated that the total mesiodistal tooth diameters in the maxillary arch exceeded that in the mandibular arch by 8 to 12 mm. Ballard, in 1944, evaluated 500 sets of models of orthodontic patients and found that 90% possessed mesiodistal crown discrepancies of at least 0.25 mm between one or more pairs of teeth from opposite sides of the arch, whereas 80% revealed discrepancies of at least 0.5 mm. In 1949, Neff developed the "anterior coefficient," a method to compare the widths of the anterior teeth in opposing arches.[1] Wayne Bolton examined the casts of 55 patients with excellent occlusions to devise the tooth-size ratio. The resultant formula is an expression of the total sum of mesiodistal widths of upper and lower teeth as they relate to each other. The maxillary and mandibular size ratio is expressed in percentage. Bolton observed that there was a precise relationship between the two arches. The ideal ratio of mandibular and maxillary teeth was expressed as 77.2 for the six anterior teeth and 91.3 for all the teeth till permanent first molars. In time, the development of this concept has led to the formulation of posterior ratio, ideal value104.88, which considers the posterior teeth from first premolar to first molar bilaterally.[2]

A correct proportion between the mesiodistal dimensions of upper and lower teeth is critical to achieve a good intercuspation. Deviations from this harmony might be related to various kinds of malocclusions. There are only a handful of reports of studies of tooth-size discrepancy in different malocclusions; and the results are contentious. Thus, the present study was undertaken to determine the Bolton ratios and to check for any sexual dimorphism in the representative sample. Null hypothesis: there is no difference in the incidence of tooth size discrepancy as demonstrated by anterior,posterior and overall ratios and there is no sexual dimorphism for these ratios

AIMS AND OBJECTIVES

The objectives of the present study were to determine (i) whether there is a difference in the incidence of tooth size discrepancies as demonstrated by the anterior, posterior and the overall ratios when comparing (1) Class I, (2) Class II and (3) Class III cases.

(ii) Whether there is a difference in the incidence of tooth size discrepancy between male and female cases as shown by anterior, posterior and overall tooth size ratios.

MATERIALS AND METHODS

The sample for the study consisted of study models of patients in the Department of Orthodontics and Dentofacial Orthopedics. A total of 289 models were examined and 80 models of patients; 39 males (mean age 25.9years), 41 females (mean age 22.3 years) met the inclusion criteria. The following selection criteria were used:

1. North Indian population
2. Good quality pre-treatment models
3. Erupted permanent teeth from right first molar to left first molar
4. Absence of mesio-distal and occlusal abrasions
5. Absence of tooth deformities

For classifying the subjects as Class I, Class II and Class III; Angle's classification and skeletal classification based on Steiner's ANB angle was considered. (ANB- skeletal Class I: 0-4 degrees, skeletal Class II :> 4, skeletal Class III :< 0).

Bolton's analysis consisted of:

1. Measurement of mesiodistal diameters of teeth: With the aid of an electronic digital calliper every tooth from right first molar to left first molar was measured at the level of contact points to the nearest tenth of a millimeter.

2. Index calculation according to Bolton:

Overall Ratio (91.3%)

(Mandibular sum mesiodistal widths6-6/ maxillary sum mesiodistal widths6-6) X100

Anterior Ratio (77.2%)

(Mandibular sum mesiodistal widths 3-3/ maxillary sum mesiodistal widths 3-3) X 100

Posterior Ratio (104.88%)

(Mandibular sum mesiodistal widths 654-456/maxillary sum mesiodistal widths 654-456) X 100

STATISTICAL ANALYSIS

The statistical analysis was carried out using Statistical Package for Social Sciences (SPSS Inc., Chicago, IL, version 15.0 for Windows). All quantitative variables were estimated using mean, standard deviation and standard error. Normality of data was checked by measures of Kolmogorov Smirnov tests of normality. As our data for ratios was normally distributed means of two groups (genders) were compared using unpaired t-test. As we had three malocclusion classes we applied One Way ANOVA for comparison of these classes. All statistical tests were two-sided and performed at a significance level of α=.05

RESULTS

Distribution of subjects according to gender and malocclusion classes is demonstrated in Table 1 and Table 2.Table 3 summarizes the means, standard deviation, and minimum and maximum values of overall, anterior and posterior tooth size ratios in each group. ANOVA (Table 4) demonstrated that there were no significant differences for overall, anterior and posterior tooth size ratios when the level of significance was set at $p < 0.05$. As no statistically significant difference was seen by ANOVA, Post Hoc test for multiple comparisons was not applied.

Table 1: Tabulation of the sample based on the gender

		FREQUENCY	PERCENT	VALID PERCENT	CUMULATIVE PERCENT
VALID	MALE	39	48.8	48.8	48.8
	FEMALE	41	51.3	51.3	100
	TOTAL	80	100	100	

Table 2: Tabulation of the sample based on the malocclusion groups.

		FREQUENCY	PERCENT	VALID PERCENT	CUMULATIVE PERCENT
VALID	CLASS I	33	41.3	41.3	41.3
	CLASS II	40	50	50	91.3
	CLASS III	7	8.8	8.8	100
	TOTAL	80	100	100	

Table 3: Mean, Standard devation, Standard error based on malocclusion classes.

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Overall ratio	CLASS I	33	89.9694	3.59249	.62537	88.6956	91.2432	82.47	95.70
	CLASS II	40	90.8400	2.76292	.43686	89.9564	91.7236	87.25	98.60
	CLASS III	7	92.7400	1.37793	.52081	91.4656	94.0144	90.73	94.82
	TOTAL	80	90.6471	3.12079	.34891	89.9526	91.3416	82.47	98.60
Anterior ratio	CLASS I	33	80.5827	5.15022	.89654	78.7565	82.4089	73.73	97.53
	CLASS II	40	79.2925	4.36532	.69022	77.8964	80.6886	72.63	97.64
	CLASS III	7	78.8929	2.19920	.83122	76.8589	80.9268	76.61	83.15

	TOTAL	80	79.7898	4.58018	.51208	78.7705	80.8090	72.63	97.64
Posterior ratio	CLASS I	33	102.2421	3.04376	.52985	101.1629	103.3214	95.74	108.33
	CLASS II	40	102.3443	3.40497	.53837	101.2553	103.4332	95.37	112.62
	CLASS III	7	104.2371	1.55801	.58887	102.7962	105.6781	101.90	106.45
	TOTAL	80	102.4678	3.15705	.35297	101.7652	103.1703	95.37	112.62

Table 4: ANOVA showing no significant differences for overall, anterior and posterior tooth size ratios for different malocclusion groups when the level of significance was set at $p < 0.05$.

	F	Sig.
Overall ratio	2.522	.087
Anterior ratio	.861	.427
Posterior ratio	1.221	.301

The difference in the Bolton ratios for Class I, Class II and Class III were checked for males (Table 5) and females (Table 6) separately. ANOVA (Table 7) demonstrated no statistically significant gender differences. This was true for anterior, posterior and the overall ratios.

Table 5: Mean, Standard devation, Standard error based on gender for males.

Males		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Min.	Max.
						Lower Bound	Upper Bound		
Overall ratio	CLASS I	15	90.3053	3.24730	.83845	88.5070	92.1036	83.63	94.68
	CLASS II	20	91.2720	3.15034	.70444	89.7976	92.7464	87.38	98.60
	CLASS III	4	92.9325	1.75661	.87831	90.1373	95.7277	90.73	94.82
	TOTAL	39	91.0705	3.11582	.49893	90.0605	92.0805	83.63	98.60
Anterior ratio	CLASS I	15	79.8360	3.13242	.80879	78.1013	81.5707	73.73	84.69
	CLASS II	20	80.3165	5.59887	1.25195	77.6961	82.9369	72.72	97.64
	CLASS III	4	78.2975	1.58458	.79229	75.7761	80.8189	76.61	80.39
	TOTAL	39	79.9246	4.45528	.71342	78.4804	81.3688	72.72	97.64
Posterior ratio	CLASS I	15	102.7173	2.84441	.73442	101.1422	104.2925	98.11	108.33
	CLASS II	20	102.2945	3.91307	.87499	100.4631	104.1259	95.37	112.62
	CLASS III	4	104.4800	1.95003	.97501	101.3771	107.5829	101.90	106.45
	TOTAL	39	102.6813	3.36999	.53963	101.5889	103.7737	95.37	112.62

Table 6: Mean, Standard devation, Standard error based on gender for females.

Females		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Min.	Max.
						Lower Bound	Upper Bound		
Overall ratio	CLASS I	18	89.6894	3.92773	.92577	87.7362	91.6427	82.47	95.70
	CLASS II	20	90.4080	2.31336	.51728	89.3253	91.4907	87.25	94.68

	CLASS III	3	92.4833	.94585	.54609	90.1337	94.8330	91.43	93.26
	TOTAL	41	90.2444	3.10985	.48568	89.2628	91.2260	82.47	95.70
Anterior ratio	CLASS I	18	81.2050	6.39894	1.50824	78.0229	84.3871	74.00	97.53
	CLASS II	20	78.2685	2.35798	.52726	77.1649	79.3721	72.63	83.33
	CLASS III	3	79.6867	3.01480	1.74060	72.1975	87.1759	77.65	83.15
	TOTAL	41	79.6615	4.74764	.74146	78.1629	81.1600	72.63	97.53
Posterior ratio	CLASS I	18	101.8461	3.22658	.76051	100.2416	103.4507	95.74	105.94
	CLASS II	20	102.3940	2.91213	.65117	101.0311	103.7569	97.87	106.82
	CLASS III	3	103.9133	1.14150	.65905	101.0777	106.7490	102.90	105.15
	TOTAL	41	102.2646	2.96800	.46352	101.3278	103.2015	95.74	106.82

Table 7: ANOVA showing no statistically significant gender differences.

Gender		**F**	**Sig.**
Male	Overall ratio	1.223	.306
Male	Anterior ratio	.335	.718
Male	Posterior ratio	.691	.508
Female	Overall ratio	1.097	.344
Female	Anterior ratio	1.893	.165
Female	Posterior ratio	.649	.528

Pearson correlation (Table 8) showed that the overall Bolton Ratio is significantly correlated to both the Anterior (Correlation Coefficient 0.361) and Posterior (Correlation Coefficient 0.426) tooth size ratios.

Table 8: Correlations of Overall ratio, Anterior ratio and Posterior ratio.

		Overall ratio	Anterior ratio	Posterior ratio
Overall ratio	Pearson Correlation	1	.361(**)	.426(**)
	Sig. (2-tailed)		.001	.000
	N	80	80	80
Anterior ratio	Pearson Correlation	.361(**)	1	-.027
	Sig. (2-tailed)	.001		.810
	N	80	80	80
Posterior ratio	Pearson Correlation	.426(**)	-.027	1
	Sig. (2-tailed)	.000	.810	
	N	80	80	80
** Correlation is significant at the 0.01 level (2-tailed).				

DISCUSSION

The results from the present study demonstrated no statistically significant differences in the incidence of tooth size discrepancies among the different malocclusion groups. The means of anterior Bolton ratios show the ratios are highest in Class I followed by Class II and then Class III. The means of Posterior tooth size ratios show the values to be highest in Class III followed by Class II and then Class I. The present study showed no significant difference in the values of Bolton ratios of males and females.

A number of studies have been conducted to explore the tooth size discrepancies in various malocclusions. Crosby and Alexander[3] compared the tooth size ratios among different malocclusion groups and found no statistically significant difference among Class I, II and III malocclusion groups. Araujo E, Souki M[4] investigated the

correlation between anterior tooth size discrepancies and Angle's Class I, II, and III malocclusions, as well as their prevalence in the Brazilian population. They concluded that Individuals with Angle Class I and Class III malocclusions show significantly greater prevalence of tooth size discrepancies than do individuals with Class II malocclusions. They also found that mean anterior tooth size discrepancy for Angle Class III subjects was significantly greater than for Class I and Class II subjects.

In the present study, the means of Overall Bolton ratios in Class I, II and III again show no statistically significant differences in the values but the trends though statistically insignificant showed that the ratios are highest in Class III (higher than the ideal 91.3%), followed by Class II and then Class I (lower than ideal 91.3%). A higher Bolton ratio means greater mandibular tooth material thus indicating a trend towards higher total mandibular tooth material in Class III subjects. Similarly the Overall Bolton ratios for Class II malocclusion group show a tendency towards greater total maxillary tooth material. Sperry et al[5] showed that the Class III group with mandibular prognathism had more patients with mandibular tooth size excess for overall ratio than class I and Class II groups. Lavelle[6] showed that the tooth sizes of Class III were smallest among three malocclusion categories for maxillary teeth; they were the greatest for mandibular teeth. This indicated that the Bolton ratios may be the highest in Class III patients among different malocclusion groups but this was not compared in the study.

Freeman JE, Maskeroni AJ, and Lorton L[1] showed a high frequency of Bolton ratio discrepancies in patients in their study. Nie and Lin[7] compared Bolton ratios in normal occlusion, bimaxillary protrusion, Class II div 1 and 2, Class III and Class III surgery groups. They showed a tendency of mandibular tooth size excess in Angle's Class III malocclusion and tendency of maxillary tooth size excess in Angle Class II malocclusion. They also showed no prevalent trend in differences for ratios in two sexes. Laino A. et al[2] showed no evidence of any predisposition for a tooth size discrepancy in any of the malocclusion groups. Endo T, Abe R, Kuroki H, Oka K, Shimooka S[8] studied possible sex differences in anterior and overall tooth size ratios to evaluate any differences in tooth size ratios and distributions among Angle Class I, Class II, and Class III malocclusion groups in a Japanese population. They concluded that Bolton's values can be used for the typical Japanese orthodontic population.

Uysal T, Sari Z, Basciftci FA, Memili B[9] studied the sex differences in the overall and anterior ratios and also compared tooth size ratios of different malocclusion groups. They concluded that significant sex differences did not exist for the different malocclusion groups. They further concluded that no statistically significant differences for anterior and overall ratio were found between different malocclusion groups. Akyalcin S, Dogan S, Dincer B, Erdinc AM, Oncag G[10] showed the tooth size discrepancies to be highly prevalent in orthodontic population. Basaran G, Selek M, Hamamci O, Akkus Z[11] showed no sexual differences for intermaxillary tooth size ratios and no satistically significant differences between different malocclusion groups. Johe RS, Steinhart T, Sado N, Greenberg B, Jing S[12] studied the intermaxillary tooth size discrepancies in different malocclusion groups, ethnicities and both sexes. They concluded that 50% of the subjects had anterior Bolton tooth size discrepancy and 41% had overall Bolton tooth size discrepancy. The discrepancies were evenly distributed between the two sexes and among different malocclusion groups, ethnicity categories. Bernabé E, Major PW, Flores-Mir C[13] reported clinically significant tooth-size discrepancies in their study conducted on a Peruvian population.

Oktay H, Ulukaya E[14] also compared the intermaxillary tooth size discrepancies and found that there were no significant differences among different malocclusion groups for anterior ratio but overall and posterior ratios showed statistically significant differences. They concluded that the intermaxillary tooth size discrepancy may vary among different malocclusion groups and contribute to malocclusion. Wedrychowska-Szulc B, Janiszewska-Olszowska J, Stepien P[15] showed mean values to be highest for anterior ratio in males with class I and class III malocclusion. Bugaighis I, Karanth D, and Borzabadi-Farahani A[16] studied a Lybian population and found the anterior ratio to be varied as compared to Bolton ratio whereas the overall ratio was found to be similar to the Bolton's overall value; with no significant sex differences for

both variables. Al-Tamimi T, Hashim HA[17] reported no statistically significant differences for the mean values of the anterior ratio and the overall ratio or any gender differences. Smith SS, Buschang PH, Watanabe E[18] concluded that interarch tooth size relationships are population and gender specific. Bolton ratios should not be used indiscriminately to different population groups. O'Mahony G, Millett DT, Barry MK et al[19] concluded that there were no significant difference in the prevalence of mean overall ratio with regard to malocclusion or gender. Begum M, Goje SK, Karra A et al[20] showed no significant sex differences for Bolton' overall ratio and anterior ratio. Cancado RH et al[21] studied the difference in the anterior and overall Bolton ratios in patients with Angle's Class I, II and III malocclusions and concluded that there was no significant difference between the different malocclusions.

The present study further showed that the overall ratio is significantly correlated to both the anterior and the posterior ratio that is whenever there is variation in either anterior or posterior tooth size ratio the overall ratio tends to be affected. However, a variation in either anterior or posterior ratio is not necessarily related to a variation in the other.

Various studies [14,15,18] were in favour of the prsent study but there were other studies which showed tooth size discripencies and sexual dimorphism(sperry,lavelle,arya et al) ,so the results were contradictory and inconclusive

This study has shown that even though there was no significant difference in the incidence of tooth size discrepancies among malocclusion groups; a large percentage of patients had mesial-distal tooth size discrepancies at pre-treatment analysis. Therefore, it is suggested that Bolton's tooth size analysis be performed before initiation of orthodontic treatment. Bolton tooth size analysis is an important diagnostic tool and should be used for every orthodontic patient before initiation of treatment. Along with other diagnostic considerations, this should aid in the finishing of our orthodontic cases and increase the stability of results.

CONCLUSION

There was no significant difference in the overall, anterior and posterior tooth size ratios; among Class I, II and III malocclusion groups.

The comparison of the means of overall Bolton ratio showed a trend for mandibular tooth size excess in Class III group and maxillary tooth size excess in Class II group.

There was no prevalent trend in differences for Bolton ratios in two sexes in any of the malocclusion groups.

The overall Bolton ratio is significantly related to both anterior as well as posterior Bolton ratios.

CONFLICT OF INTEREST

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

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