

Incidence of Tooth Size Discrepancy in Different Groups of Malocclusion and its Relation to Extraction

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Abstract:

Background: For proper intercuspation, the teeth must be proportional in size. If teeth are mismatched, with unusually large teeth in one arch compared to the other, then an ideal occlusion cannot be attained. This study has been done to determine the prevalence of tooth size discrepancies among orthodontic patients in general and also between different malocclusion groups, sex, and to analyze the change in the degree of severity in Bolton discrepancy before and after the hypothetical premolar extraction.

Methods: The study was carried out on randomly collected 100 pre-treatment dental casts. Tooth size analyses were performed on these pre-treatment models and Mesio distal tooth size ratios were measured as described by Bolton before and after various patterns of hypothetical extraction.

Result: The results were statistically evaluated using ANOVA and paired samples *t*-test. 5 out of 100 patients are seen with severe Bolton discrepancy with Bolton values (BV) ranging above and below 2 standard deviation. Statistically insignificant difference is seen between males and females and also between various groups of malocclusion. The difference between the pre-treatment and post extraction BV was found statistically significant for the first premolar extraction and insignificant for others.

Conclusion: The results of this study indicate a new point of view to the question of which teeth to extract when evaluated for tooth size aspect only.

Key Words: Anterior ratio, Bolton analysis, Bolton values, overall ratio, tooth size discrepancies

Introduction

Harmony among the skeletal, dental, and soft-tissue structures is a prerequisite for good occlusion. Disharmony in these structures results in malocclusion.¹

For proper intercuspation, the teeth must be proportional in size. If teeth are mismatched, with unusually large teeth in one arch compared to the other, then an ideal occlusion cannot be attained, which is not uncommon and defined as tooth size discrepancy (TSD).¹ A significant variation in this harmony will lead to malocclusion and difficulties in obtaining an occlusion with optimal overjet, overbite, and Class I canine and molar relationships.

Dental casts are still considered as a vital diagnostic tool in orthodontic practice. The dental cast facilitates the analysis of tooth size and shape, alignment and rotations of the teeth, presence or absence of teeth, arch width, length, form and symmetry; and the occlusal relationship.

TSD can be assessed using diagnostic setup or using a mathematical formula like the Bolton analysis.¹

Before treatment, it is necessary to identify total Bolton index (TBI) because teeth removal has a direct influence on upper and lower TSD, also on upper and lower incisors position.² Bolton stated that after four premolars are removed, normal TBI value was between 87% and 89% when upper teeth sizes suited lower teeth sizes. When teeth are too wide in the upper jaw - TBI is lower than 87% (low TBI) and when teeth are too wide in the lower jaw - TBI value is higher than 89% (high TBI).³

When malocclusion requires extraction, tooth size differences and spaces are often seen at the end of treatment.⁴ Many investigators have expressed the opinion that premolar extraction is responsible for TSD in some cases but none of them have reported on the percentage of cases in which this occurs.

The purpose of this study was to determine the prevalence of tooth size discrepancies among orthodontic patients in general and also between different malocclusion groups, to analyze the change in the degree of severity in Bolton discrepancy before and after the hypothetical extraction and to identify any incidence in Bolton discrepancy taking place after hypothetical extractions in normal or control groups without any Bolton discrepancy.

Methods

This study was conducted on 100 pre-treatment diagnostic casts collected on randomized clinical trials from the Department of Orthodontics in Bapuji Dental College, Davangere.

Inclusion criteria

1. Sufficiently erupted permanent teeth to allow measurement of their widest mesiodistal dimensions
2. Study models without any mutilated teeth.

The teeth were measured with a fine point Mitutoyo Dial Calipers (made in Japan, model no. -505 -633 -50 D15) to the nearest of 0.02 mm (Figures 1 and 2).

The mesiodistal widths of 12 maxillary teeth and 12 mandibular teeth from right to left first permanent molar are totaled and compared. These mesio-distal crown measurements were taken from mesial and distal contact areas, respectively (Figure 3). The dividend of two is the percentage relationship of mandibular tooth size to maxillary which is called as to “over-all ratio.”

$$\frac{\text{Sum of mandibular 12}}{\text{Sum maxillary 12}} \times 100 = \text{Over - all ratio}$$

Subsequent to calculated pre-treatment Bolton’s value (BV), hypothetical extraction of four premolars was accomplished by substituting “zero” to the place of the corresponding premolars that were removed.

Four premolars removed were in four different combinations for each case. These combinations were: (1) Removal of all first premolars, (2) removal of all second premolars, (3) removal of upper first and lower second premolars, (4) removal of upper second and lower first premolars.

The resultant measurements were again subjected to Bolton’s analysis to see whether a tooth size discrepancy had been created.

Finally, the pre-treatment and postextraction tooth size ratios and BV were evaluated statistically by the use of paired Student’s *t*-test.

Proforma

Incidence of tooth discrepancy in different groups of malocclusion and its relation to extraction

Patients name: _____ Date: _____

Sex : _____

Type of malocclusion : _____

Mesiodistal tooth sizes (mm)

6	5	4	3	2	1	1	2	3	4	5	6*
10.0	7.0	7.0	7.5	6.5	8.5	8.5	6.5	7.5	7.0	7.0	10.0
11.0	7.0	7.0	7.0	5.5	5.0	5.0	5.5	7.0	7.0	7.0	11.0
6	5	4	3	2	1	1	2	3	4	5	6
R											L

$$\frac{\text{Sum of mandibular 12}}{\text{Sum maxillary 12}} \times 100 = \dots \dots \dots \% \text{ overall ratio}$$

Mean: 91.3%

SD: ± 1.91

Range: 87.5-97.8

$$\frac{\text{Sum mandibular 6 mm}}{\text{Sum maxillary 6 mm}} \times 100 = \dots \dots \dots \% \text{ anterior ratio}$$

Mean: 77.2%

SD: ± 1.65

Range: 87.5-97.8

1. If overall ratio exceeds 91.3%

a) $\frac{\text{Actual maxillary 12}}{\text{Correct mandibular 12}} \times 0.913 = \dots$

b) $\frac{\text{Actual maxillary 12}}{\text{Correct mandibular 12}} \times 0.913 - \dots = \dots$

Excess mandibular 12

2. If overall ratio is <91.3%

a) $\frac{\text{Actual maxillary 12}}{\text{Correct maxillary 12}} \times 0.913 \times 1.0953 = \dots$

b) $\frac{\text{Actual maxillary 12}}{\text{Correct maxillary 12}} \times 0.913 - \dots = \dots$

Excess maxillary 12

Similar proforma was followed for different extraction patterns as mentioned earlier.



Figure 1: Armamentarium used in this study.

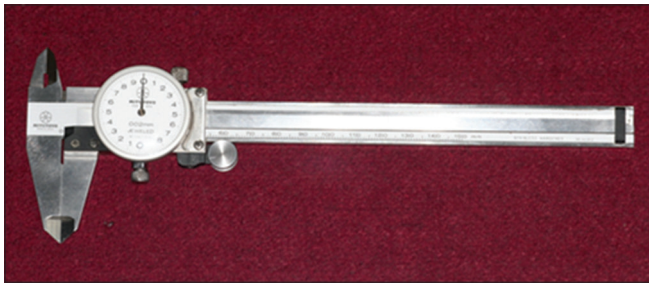


Figure 2: Mitutoyo dial calipers.

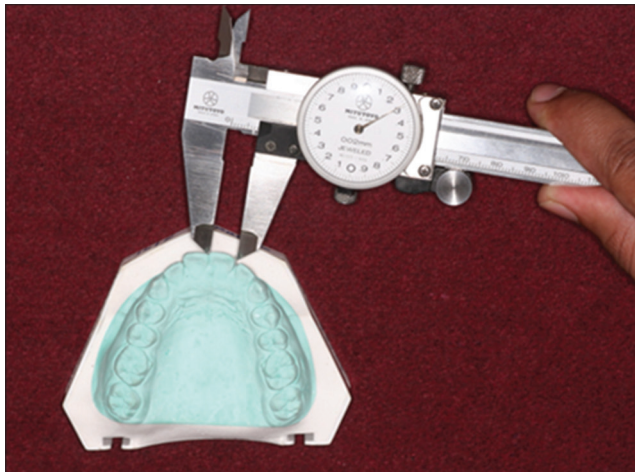


Figure 3: Mitutoyo dial caliper using in measuring mesiodistal width.

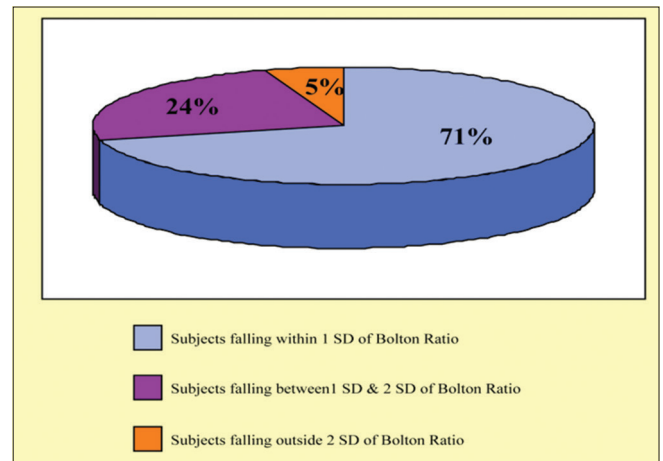
Results

In this study, 100 pre-treatment casts were randomly collected, of these samples 71 were falling within BV of $91.3\% \pm 1$ standard deviation (SD), 24 were falling within BV of $91.3\% \pm 2$ SD, and 5 were above $BV \pm 2$ SD (Table 1 and Graph 1).

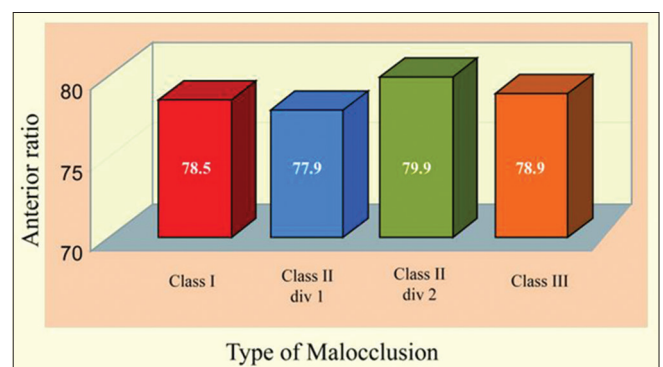
In this present study, there was an anterior discrepancy with a mean value of 78.5% with a SD of 2.9 mm, showing no statistical significance (Table 2). Furthermore, in the overall discrepancy with a value of 91.9% with a SD of 2.1 mm, showed no statistical significance (Table 3).

The “*f*” value obtained from ANOVA test was 1.33 for the anterior ratio for different malocclusion groups, Class I, Class II division 1, Class II division 2, and Class III malocclusion. The *P* value was 0.27 (>0.05) suggesting that it is clinically insignificant (Table 4). The mean values for Class I, Class II division 1, Class II division 2, and Class III malocclusions for anterior ratio are indicated in Graph 2.

The overall ratio for different malocclusion groups showed an “*f*” value of 3.34 and a *P* value 0.05 indicating statistically significant but clinically insignificant (Table 5). The mean value for Class I, Class II division 1, Class II division 2, and Class III malocclusion for the overall ratio are shown in Graph 3.



Graph 1: Frequency of Bolton discrepancy in the present study sample.



Graph 2: Comparison of mean anterior ratio between various groups of malocclusion.

Size of the sample	Subjects falling within 1 SD of Bolton ratio	Subjects falling between 1 SD and 2 SD of Bolton ratio	Subjects falling outside 2 SD of Bolton ratio
100	71	24	5

SD: Standard deviation

Parameters	Bolton study	Present study
Number of subjects	55	100
Mean	77.5	78.5
SD	1.65	2.9
Range	74.5-80.4	72.7-84.3

SD: Standard deviation

On these samples, hypothetical extractions were conducted for different combinations and the values are subjected again to Bolton’s analysis.

All first premolar extraction exhibits the maximum “*t*” value of 7.45 with a *P* < 0.001 suggesting a maximum statistical significance. All second premolar extraction exhibits the minimum *t* value of 2.96 and a *P* value of 0.01 suggesting

that it is statistically significant but clinically insignificant (Tables 6a-d). The Graph 4 shows a comparison of mean BV before and after various patterns of extraction for Bolton group.

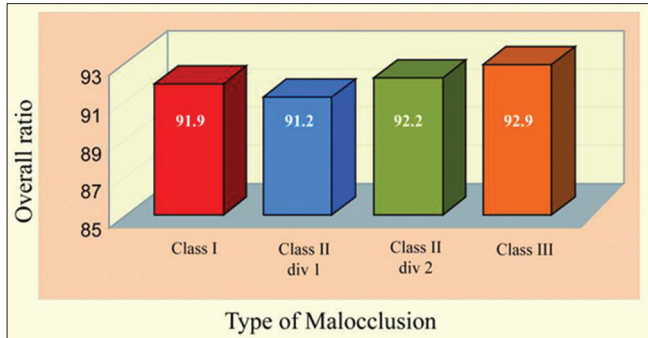
Discussion

For an orthodontist, the most gratifying realization of balance in the denture is a treated case, which remains unaltered for a long period after removal of retaining appliance. If the teeth are mismatched with unusually large teeth in one arch compared with the other, then an ideal occlusion cannot be attained then a TSD develops.

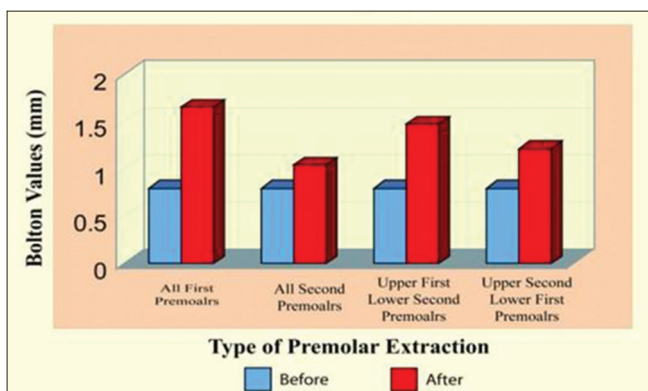
Many investigators have expressed the opinion that removal of premolars is responsible for creating a TSD in some cases but none of them have reported on the percentage of cases in which this occurs.⁵

The present study conducted demonstrates the prevalence of tooth size discrepancies among orthodontic patients in various malocclusions.

Bolton’s analysis in 1958 included comparisons of total mesiodistal widths of dental arches up to the distal surfaces of the first molars and gave the ideal anterior and overall ratio. From Bolton’s results, it can be seen that there is a relatively



Graph 3: Comparison of mean overall ratio between various groups of malocclusion.



Graph 4: Comparison of mean Bolton value between before and after various premolar extractions in Bolton group.

Table 3: Comparison of overall ratio between Bolton study and present study.

Parameters	Bolton study	Present study
Number of subjects	55	100
Mean	91.3	91.9
SD	1.91	2.1
Range	87.5-95.8	87.8-96

SD: Standard deviation

Table 4: Comparison of anterior ratio between various groups of malocclusion.

Group of malocclusion	Anterior ratio (mean±SD)	F value	P value	Significance
Class I	78.5±2.6	1.33	0.27 (>0.05)	NS
Class II division 1	77.9±2.6			
Class II division 2	79.9±2.6			
Class III	78.9±4			

SD: Standard deviation

Table 5: Comparison of overall ratio between various groups of malocclusion.

Group of malocclusion	Overall ratio (mean±SD)	F value	P value	Significance
Class I	91.9±1.6	3.34	<0.05	S
Class II division 1	91.2±1.9			
Class II division 2	92.2±1.7			
Class III	92.9±2.7			

SD: Standard deviation

Table 6a: Comparison of mean Bolton value between before and after all first premolar extraction pattern in Bolton group.

First premolar extractions	Mean	SD	Min	Max	t value	P value	Significance
Before	0.79	0.5	0.02	1.85	7.45	<0.001	HS
After	1.65	0.82	0.00	3.25			

SD: Standard deviation

Table 6b: Comparison of mean Bolton value between before and after all second premolar extraction pattern in Bolton group.

Second premolar extraction	Mean	SD	Min	Max	t value	P value	Significance
Before	0.79	0.5	0.02	1.85	2.96	<0.01	S
After	1.04	0.66	0.02	2.79			

SD: Standard deviation

Table 6c: Comparison of mean Bolton value between before and after upper 4 first premolar lower second premolar extraction patterns in Bolton group.

Upper 4 first premolar lower second premolar extraction	Mean	SD	Min	Max	t value	P value	Significance
Before	0.79	0.5	0.02	1.85	5.54	<0.001	HS
After	1.47	0.92	0.01	3.23			

SD: Standard deviation

Table 6d: Comparison of mean Bolton value between before and after upper second premolar lower first premolar extraction pattern in Bolton group.

Upper second premolar lower first premolar extraction	Mean	SD	Min	Max	t value	P value	Significance
Before	0.79	0.5	0.02	1.85	4.14	<0.001	HS
After	1.21	0.77	0.06	3.16			

SD: Standard deviation

small range in which tooth size ratios should fall, to achieve optimal occlusal relationship.

Neff developed an “anterior coefficient” to be used as a guide to the finished relationship of the anterior segments.⁶ Comparison of anterior discrepancy and overall discrepancy of the present study sample (local population) and Bolton’s sample was done which showed that overall ratio was almost matching but the Anterior ratio was slightly higher than the anterior ratio of Bolton sample. This difference could be because the present study was done on local population sample which is randomly collected and the Bolton’s study was on the Caucasian population sample selected with a criterion of good occlusion.⁷

The mean, SD, and range for Class I, Class II division 1, Class II division 2, and Class III malocclusion⁸ were calculated for both anterior ratio and overall ratio. In the present study, no statistical significant difference is seen between findings indicating that the tooth discrepancy is not related to jaw relationship. This is in confirmation with study done by Alkofide and Hashim⁹ who found that there is no statistical significant difference between the different classes of malocclusion.

The mean, SD, and range were calculated for all the three groups. There was a maximum increase in the mean BV following all first premolar extraction and minimum increase was noticed in all second premolar extraction indicating that again following all first premolar premolar extractions mandibular discrepancy is increasing significantly and this is in confirmation with the with study done by Saatci and Yukay,¹⁰ showing that all second premolar extraction is favorable compared to other patterns of premolar extraction especially with all first premolar extraction in this group.

In this study the same procedure has been followed for mesiodistal measurements as suggested by Bolton³ in 1958. It was found that the difference between the pre-treatment BV and the values after removal of first premolars was statistically significant and not significant after second premolar removal. The extraction of all first premolars created more severe discrepancies. Conversely, the extraction of all second premolars did not increase discrepancies that had existed before treatment and instead it reduced in some subjects. It was also noted in the study that, if we extract premolars of

equal mesiodistal dimension from upper and lower dental arches, more severe tooth-size discrepancies were created when compared with the removal of greater mandibular premolars.

It appeared that, because most discrepancies created by extraction occurred as a mandibular excess, removal of the mandibular second premolars, which usually has wider mesiodistal dimensions, was likely to result in discrepancies of a smaller size than the mandibular first premolars.¹¹ Therefore this result is in agreement with the opinion expressed by Bolton that the removal of mandibular second premolars often crates the potential for a better occlusion than the removal of the first premolars, as the mandibular molars are allowed more mesial movement. However, Bolton also cautioned, as we do, that this statement should not be interpreted as a broad recommendation for extraction of mandibular second premolars.

The results obtained in this study suggest a new point of view to the question of which teeth to extract when evaluated from a tooth - size discrepancy¹² standpoint only. The question of the reduction of tooth structure as a treatment procedure in orthodontics has always been a controversial one. Controversy centers on how far we should go and what the dividing line between extraction and non-extraction is. The decision to extract must be preceded by a great deal of thought and study.

Conclusion

1. There was a significant difference in the anterior ratio between the present study and Bolton’s sample and the overall ratio did not show any significant difference
2. A specific malocclusion group was not shown to contain a larger percentage of tooth size discrepancies
3. The results obtained in the present study are in agreement with the removal of all second premolars in mandibular discrepancy cases and removal of all first premolars in maxillary discrepancy cases.

The inference of this study suggests a new point of view of the question of which teeth to extract when evaluated from a TSD standpoint only.

The present study accordingly concludes that clinicians should always remember to look on each patient individually and be aware of other factors in determining what teeth, if any? Should be removed and use these findings only as one factor to be considered together with many others.

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