ORIGINAL RESEARCH

Effect of Bi-jaw Premolar Extractions on Tooth Size Discrepancy in an Indian Population having Class I Malocclusion: An *in vitro* Study

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ABSTRACT

Aim: To evaluate the effect of bi-jaw premolar extractions on Bolton tooth size discrepancy in patients of Indian origin, all of which exhibited a bilateral Angle's class I molar relationship.

Materials and methods: Ninety sets of pretreatment study casts, which constituted the sample for the study, were divided into three groups, namely, Bolton small (BS), Bolton normal (BN), and Bolton big (BB). Simulated bi-jaw extraction of premolars was carried out in four different combinations for each set of study cast. The four values of Bolton's overall ratio (BOR) thus obtained were compared with the original BOR value.

Results: The BOR value reduced when subjected to any of the four combinations of bi-jaw premolar extractions.

Conclusion: Premolar extraction in any combination inevitably changes the BOR value, which potentially affects the settling of occlusion toward the finishing stages of orthodontic treatment.

Clinical significance: The present study provides an insight into the choice of bi-jaw premolar extraction combination for each of the three groups in patients exhibiting class I malocclusion in the Indian population.

Keywords: Bi-jaw premolar extraction, Bilateral angle's class I malocclusion, Tooth size discrepancy.

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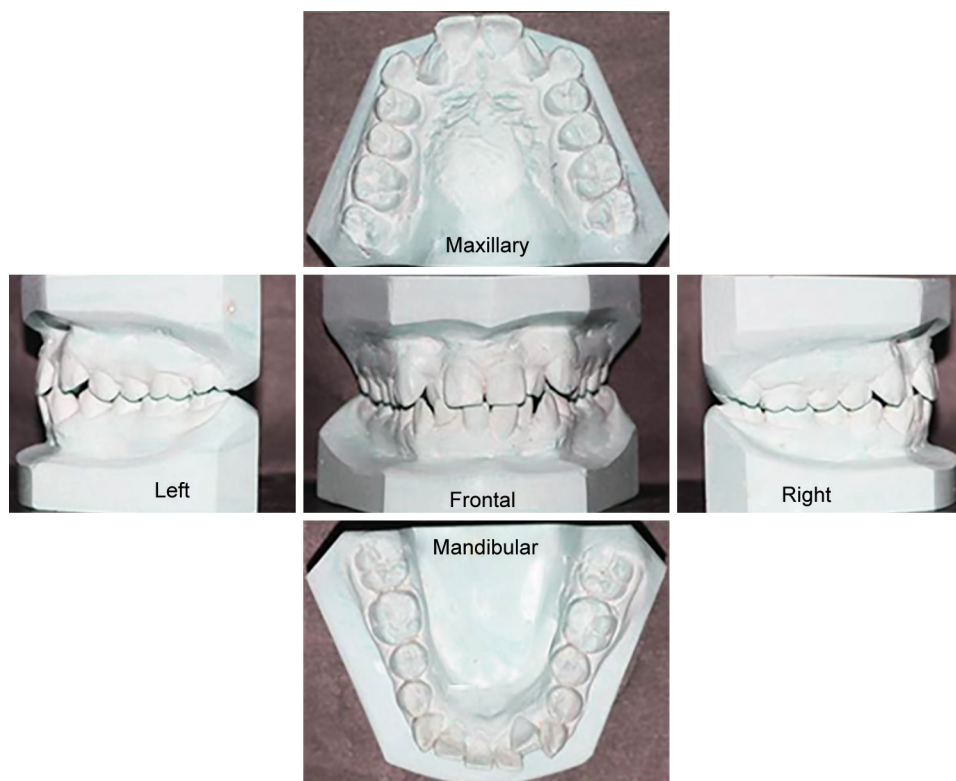
INTRODUCTION

Orthodontic treatment aims at establishing propriety of interproximal contact between adjacent teeth; occlusion between antagonists; incisal and cuspal guidance; harmony and symmetry between dentition and the soft tissue drape while setting up a stable; and a good functional occlusion.[1] A harmonious relationship between mesiodistal width of maxillary and mandibular teeth is an important factor to help achieve proper interarch posterior interdigitation and settling of teeth in centric occlusion. This makes the correct ratio between tooth sizes absolutely necessary.

Bolton[2] analysis is still the most widely used for measuring such discrepancies before initiating orthodontic treatment. Bolton ratio, being an essential parameter to achieve normal occlusion, is now considered as the 7th Key after the 6 Keys were established by Lawrence Andrews.

When using the extraction modality, extraction of premolars, often from both the jaws, is the most common elective option used.[3] Tooth extraction implies subtraction of tooth material from one or both the arches. This means that the ratio between the tooth material of the maxillary and mandibular arches is deemed to change following the extraction of premolars in any combination.[4] Thus, BOR is expected to change after the bi-jaw premolar extraction therapy, and it could arguably be influenced by different extraction combinations.[5]

The decision of extraction as well as selection of the teeth to be extracted will determine to a large extent the final outcome of the orthodontic treatment, especially in terms of settling of the occlusion toward the finishing stages of orthodontic treatment.[6,7] Tooth extraction is an irreversible procedure, which implies that the decision of therapeutic extraction of any tooth or teeth needs to be backed up by a high degree of caution and clinical judgment.[8,9]

Thus, a pretreatment guide to the choice of a particular extraction combination of premolars is essential to help in predicting the final outcome of the treatment as well as avoiding undesirable treatment effects. The present study is carried out to ascertain the effect of four combinations of bi-jaw premolar extractions on the BOR value in a Navi Mumbai population and is expected to serve as a useful pretreatment guide to choose that combination of bi-jaw premolar extractions that will aid

Fig. 1: Study casts showing bilateral angle's class I molar relationship

in getting the BOR as close to the ideal value of 91.3 ± 1.91% as possible.

MATERIALS AND METHODS

A total of 90 sets of study casts, each set showing a bilateral Angle's Class I molar relationship (Fig. 1), were examined as per the following criteria:

- All patients residing in the city of Navi Mumbai.
- The study casts were of good quality, which implied that they were not damaged in any way that would lead to loss of mesiodistal or occlusal dimensions of the teeth.
- All permanent teeth were present from left first molar through right first molar in both arches.
- No proximal tooth decay, proximal restorations, mesiodistal or occlusal abrasion were present.

A digital Vernier caliper having an accuracy of 0.1 mm was used to carry out the process of measuring width of teeth (Fig. 2).

The greatest mesiodistal width between the anatomic mesial and distal contact points of each tooth from the left first molar to the right first molar was measured (Fig. 3). The BOR was calculated for each cast using the formula reported by Bolton[1]:

$$BOR = \frac{\text{Sum of mesiodistal width of mandibular 12}}{\text{Sum of mesiodistal with of maxillary 12}} \times 100$$

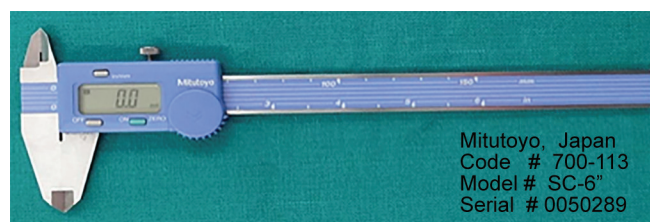To determine the measurement error, 10 sets of casts were randomly selected from the aforementioned sample

Fig. 2: Digital Vernier caliper used for measurement of mesiodistal width of teeth
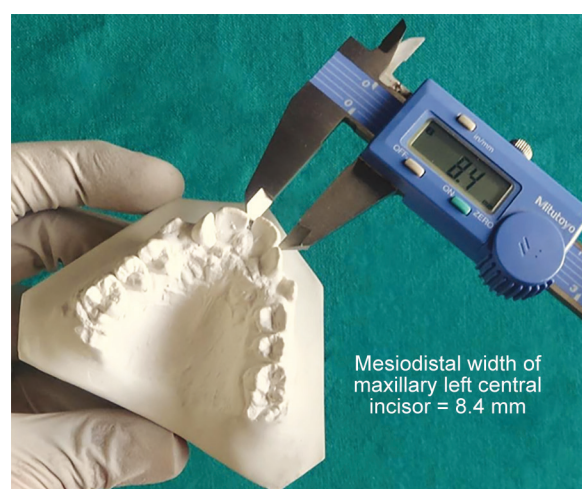

Fig. 3: Measurement of mesiodistal width of teeth

of 90 sets of casts. The aforementioned 10 sets of casts were subjected to the identical process of measurements on two separate occasions. The second set of measurement was made 2 weeks after the first set; all measurements were

made by the same operator. The paired t-test was used to determine the measurement error.

Bolton,[1] in his landmark study, had calculated the overall ratio, which had a mean of 91.3% with a standard deviation (SD) of 1.91%. Using the above value as a benchmark for the present study, the sets of casts included in the present study were divided into three groups:
1. *BS*: This included casts of patients with BOR value less than 89.39% (mean – 1 SD = 91.3 – 1.91%).
2. *BN*: This included casts of patients with BOR values between 89.39 and 93.21% (mean ± 1 SD = 91.3 ± 1.91%).
3. *BB*: This included casts of patients with BOR value greater than 93.21% (mean + 1 SD = 91.3 + 1.91%).

The next step in the study was to hypothetically extract four premolars for each of the 90 sets of casts in the following four combinations:
1. Extraction of maxillary and mandibular first premolars (first)
2. Extraction of maxillary and mandibular second premolars (second)
3. Extraction of maxillary first premolars and mandibular second premolars (third)
4. Extraction of maxillary second premolars and mandibular first premolars (fourth)

The aforementioned hypothetical extractions were accomplished by simply substituting zero in place of the measured mesiodistal width of all the four deemed-to-be-extracted premolars. After subjecting each of the 90 sets of casts to the four different combinations of "extraction," the BOR was again determined for each of the aforementioned individual extraction combination. Thus, in addition to the original value of BOR, four different BOR values for each set of the 90 casts were obtained, each value corresponding to the premolar extraction combination it is subjected to.

Statistical analysis included one-way analysis of variance test for determination of the change in the BOR for each of the four extraction combinations.

RESULTS

Descriptive statistics for measurements performed for each of the 10 sets of casts is presented in Table 1, which showed the mean and SD for two measurements of A and B. The difference between the two sets of measurements was statistically insignificant (p = 0.064 > 0.05).

The box-and-whisker plot for BOR (Graph 1) indicated that the BOR value was seen to decrease following extraction of premolars in any of the four combinations. The values of BOR were seen to decrease from the highest to lowest in the following order of chronology: Third, first, second, and fourth.

Graph 2 and Table 2 illustrate the estimated means of BOR for the four combinations of premolar extraction.

Table 1: Descriptive statistics for measurements performed twice for each of the 10 sets of casts

| Arch	Value	Mean	n	SD	Standard error of mean
Mandibular (A)	A1	89.79	10	4.391	1.388
	A2	89.77	10	4.389	1.388
Maxillary (B)	B1	99.73	10	4.159	1.315
	B2	99.72	10	4.161	1.316

A1: First measurement for mandibular arch; A2: Second measurement for mandibular arch; B1: First measurement for maxillary arch; B2: Second measurement for maxillary arch

Table 2: Estimated means and standard error of BOR for premolar extraction combinations

Bolton's overall ratio	Mean	Standard error	95% confidence interval	
			Lower bound	Upper bound
Original	91.635	0.344	90.951	92.32
First	89.883	0.358	89.172	90.594
Second	89.657	0.358	88.946	90.368
Third	90.098	0.368	89.366	90.83
Fourth	89.445	0.352	88.747	90.144
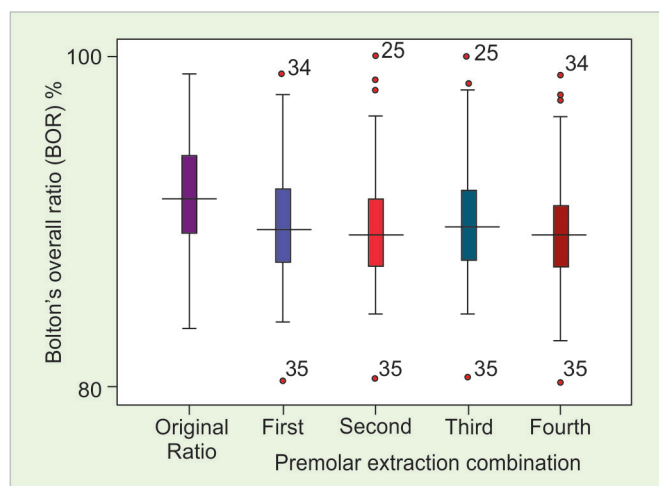
Graph 1: Box-and-whisker plot for BOR
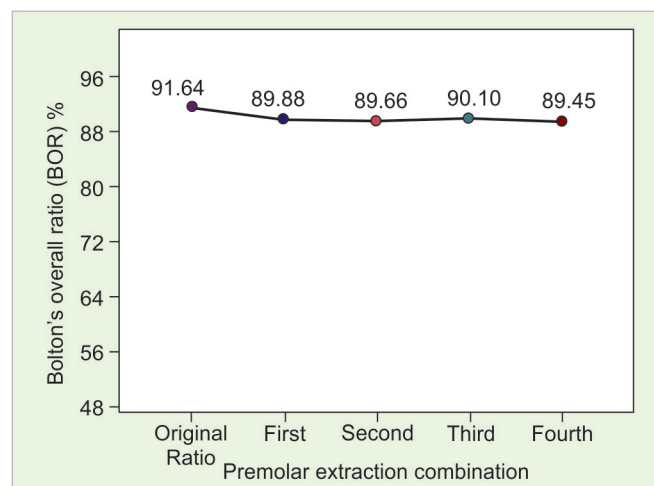
Graph 2: Estimated means of BOR for premolar extraction combinations

DISCUSSION

In addition to the landmark study by Bolton,[2] the effect of premolar extraction on the BOR has been collaborated by studies conducted by Nie and Lin[10] and Garn et al.[11] The conclusion from the aforementioned studies was that the BOR decreased after extraction of four premolars in any combination. They also found BOR to decrease after extraction of premolars in any of the four combinations used in the present study. Saatci and Yukay[12] found the BOR to increase after the extraction of all four first premolars or extraction of both upper first premolars with both lower second premolars; but noted the BOR to decrease following the extraction of all four second premolars or extraction of both upper second premolars with both lower first premolars.

The BOR value decreased, as seen in the present study, following extraction of premolars in any of the four combinations. The aforementioned result compares favorably with the findings of Bolton,[2] Nie and Lin,[10] and Garn et al.[11]

The present study indicated that the BOR decreased from the highest to the lowest in the following order of chronology: Extraction combination of both upper second premolars with both lower first premolars; extraction of all four first premolars; extraction of all four second premolars; extraction of both upper first premolars with both lower second premolars. This is in variance with findings of Tong et al,[3] who found significant reduction in BOR after extraction combination of all four second premolars. They also found extraction combination of both upper second premolars with both lower first premolars to lead to a smaller change in the BOR value.

CONCLUSION

The results of the present study indicated that the BOR reduced when subjected to any of the four combinations of bi-jaw premolar extractions. Greatest amount of reduction was seen with an extraction combination of maxillary second premolars and mandibular first premolars. Thus, this combination of bi-jaw premolar extraction could be considered as the most appropriate in patients classified under the BB group.

The extraction combination involving maxillary first premolars with mandibular second premolars showed the least reduction in the BOR value. Thus, the aforementioned extraction combination is best suited for patients classified under BN group.

The extraction combination of maxillary first premolars with mandibular second premolars would be the most appropriate in patients classified under the BS group as this combination led to the lowest reduction of BOR value.

CLINICAL SIGNIFICANCE

The present study could prove to be a valuable pretreatment guide in terms of treatment planning and aiding the clinician to choose the best possible combination of bi-jaw premolar extraction.

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