Bolton ratio in a North Indian population with different malocclusions

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ABSTRACT

Objective: The objective was to evaluate the Bolton ratio in a North Indian population in Lucknow with different malocclusion.

Materials and Methods: Totally, 110 study cast (Age: Female (14.2 ± 1.5 years, Male (13.9 ± 2.3 years)) were taken from the patients undergoing orthodontic treatment and Subjects were divided into three groups: Group I (Angle’s Class I, n = 40), Group II (Angle’s Class II, n = 50) and Group III (Angle’s Class III, n = 20) according Angle’s classification of malocclusion. The mesiodistal widths of all maxillary and mandibular teeth from right first molar to left first molar were measured with a digital caliper to calculate the Bolton ratio. The readings were then used to compute the anterior and total Bolton ratios. ANOVA and Tukey’s test were used for the statistical analysis.

Results: A mean total Bolton ratio of 91.36 ± 2.13 and a mean anterior Bolton ratio of 78.14 ± 4.09 were found for the sample, Significantly higher mean anterior tooth ratios were found for Group II (Angle’s Class II) patients (P < 0.01). All other ratios were within close range of Bolton’s norms.

Conclusions: Angle’s Class II patients showed a tendency toward wider mesiodistal widths of teeth in the mandibular anterior region or smaller tooth sizes in the maxillary anterior region.

Key words: Angle’s Class I, II and III, Bolton’s ratio, tooth size discrepancy

INTRODUCTION

Tooth size discrepancy (TSD) is different among the sizes of the individual teeth.[1] For ideal occlusion, teeth in both arches should be proportional in size, significant TSDs prevent an ideal occlusion being produced at the end of orthodontic treatment. Tooth size analysis was presented by Bolton in 1958, and the anterior segment ratio was derived to be 77.2 ± 0.22% and 91.3 ± 0.26% for the total arch ratio. Bolton’s ratio has been suggested as the seventh “key” for an ideal occlusion, as it plays an important role for ideal occlusion.[2] Overall, TSDs relate to all teeth excluding permanent second and third molars, whereas anterior TSDs involve the six anterior teeth from left side canine to the right side. Prevalence of an overall TSD has varied from 4% to 11%[3,4] among the patients undergoing orthodontic treatment. Anterior TSDs, have a prevalence between 17% and 31% among orthodontic patients,[5] that is similar to the prevalence of 20.5% in non-orthodontic patients.[6] The prevalence of TSDs are more common in Class II division 1 malocclusions[7] and in Class III malocclusions.[8] Studies have found smaller tooth size ratios in women than in men, but the differences at 0.6–1.0% that were not significant. Smith et al.[9] found that Black people had the highest overall tooth size ratios (93.4%), followed by Hispanics (92.3%) and whites (91.2%). There are various methods to measure the mesiodistal width of teeth such as conventional fine–pointed caliper or digital caliper, measuring photocopies of casts with a caliper, divider, etc.[10,11] The purpose of this study was to evaluate the Bolton ratio in a North Indian population with different malocclusion groups.

How to cite this article: Shastri D, Singh A, Tandon P. Bolton ratio in a North Indian population with different malocclusions. J Orthodont Sci 2015;4:83-5.
MATERIALS AND METHODS

This cross-sectional study was carried out at various dental clinics at Lucknow in North India. Orthodontic diagnosis and treatment planning requires the patient’s history, extra and intra-oral examination, analysis of diagnostic records comprising of orthodontic photographs, radiographs and study casts. Tooth size is the sum of the mesiodistal widths of the maxillary and mandibular teeth that is measured in this study over the study casts. A thorough examination of all the study casts was done. All impressions of orthodontic patients were taken with a fast setting alginate. Impressions were poured with an orthodontic plaster, after which they were trimmed. 110 out of 150 study casts [Age: Female (14.2 ± 1.5 years, Male (13.9 ± 2.3 years)] were filtered based upon the inclusion and exclusion criteria [Table 1]. Study casts were further divided into three groups: Group I (Angle’s Class I, n = 40), Group II (Angle’s Class II, n = 50) and Group III (Angle’s Class III, n = 20) according to Angle’s classification of malocclusion. The mesiodistal widths of all maxillary and mandibular teeth from right permanent first molar to left permanent first molar were calibrated with the use of a digital caliper. The readings were used to calculate the anterior and total Bolton ratios and the data were analyzed using SPSS-14. Mean and standard deviation (SD) were calculated for anterior and total Bolton ratios for the whole sample and for all the three groups individually. The ANOVA test was used to compare the three groups with each other and with the Bolton’s proposed norms for total and anterior Bolton ratios. Tukey’s test was also used for post hoc analysis.

RESULTS

A mean total Bolton ratio of 91.36 ± 2.13 and a mean anterior Bolton ratio of 78.14 ± 4.09 were found for the complete sample [Table 2]. The minimum total Bolton ratio calculated for Group II patients while the highest ratio was calculated for Group I patients. ANOVA and Tukey’s test failed to show any significant difference in the total Bolton ratios of different sample groups (P > 0.05) [Table 3]. The minimum anterior Bolton ratio calculated for Group I patient while the highest ratio was calculated was for Group II patient [Table 2]. ANOVA and Tukey’s test showed a significant difference for anterior Bolton ratios between Bolton’s proposed norms and Group II patients and also between Group I and Group II patients (P < 0.01) [Table 4].

DISCUSSION

In order to achieve excellence in orthodontic finishing, clinician should be familiar to the discrepancies in tooth size at the initial diagnosis and treatment planning stages. Tooth size discrepancies are considered an important factor especially in the anterior segment. A good occlusion depends on a correct ratio between the dental masses in the maxillary and mandibular arches. By measuring the greatest mesiodistal width of each permanent tooth, including all the teeth since the 1st left to the 1st right permanent molar a ratio of 91.3% ±1.91 was found. When only the six anterior teeth of the arch were evaluated, the ratio was 77.2%±1.65). For Bolton patients with means of anterior and total tooth size ratio above or below 2% of the values established in his research, should be classified as having TSD. The mean ± SD for overall and anterior TSD ratios in the present sample were 91.36 ± 2.13 and 78.14 ± 4.09, respectively, similar to the recent study in the Lybia.

Table 1: Inclusion and exclusion criteria of subjects

| Inclusion criteria                              | Exclusion criteria                           |
|------------------------------------------------|----------------------------------------------|
| Permanent dentition                            | Presence of any deciduous tooth/teeth        |
| Presence of all permanent teeth from first molar to first molar in both arches | Presence of any morphologic dental anomaly namely mesiodens, taurodontism, etc. |
| North Indian population                        | Prior history of orthodontic treatment       |
| No caries or extensive restorations on any of the teeth |                                             |

Table 2: Mean (SD) of tooth size ratios for different malocclusion groups

| Groups          | Total sample (n=110) | Group I, (n=40) | Group II, (n=50) | Group III, (n=20) |
|-----------------|----------------------|-----------------|------------------|-------------------|
| Mean total ratio | 91.36 (2.13)         | 91.73 (3.60)    | 90.77 (2.13)     | 91.33 (2.32)      |
| Mean anterior ratio | 78.14 (4.09) | 76.89 (4.16)    | 81.10 (5.01)     | 77.51 (5.64)      |

Table 3: ANOVA and Tukey’s test for total Bolton’s ratios

| Groups | Comparison | P   |
|--------|------------|-----|
| Group I| Total Bolton | 0.433 |
|        | Bolton’s    | 0.933 |
|        | Group II    | 0.435 |
|        | Group III   | 0.865 |
| Group II| Bolton’s    | 0.825 |
|         | Group I     | 0.437 |
|         | Group III   | 0.921 |
| Group III| Bolton’s   | 0.950 |
|          | Group I     | 0.872 |
|          | Group II    | 0.929 |

P<0.05 is significant

Table 4: ANOVA and Tukey’s test for anterior Bolton’s ratios

| Groups | Comparison | P   |
|--------|------------|-----|
| Group I| Total Bolton | 0.005* |
|        | Bolton’s    | 0.932 |
|        | Group II    | 0.043* |
|        | Group III   | 0.065 |
| Group II| Bolton’s    | 0.006 |
|         | Group I     | 0.043* |
|         | Group III   | 0.926 |
| Group III| Bolton’s   | 0.135 |
|          | Group I     | 0.372 |
|          | Group II    | 0.931 |

*P<0.05 is significant
In our study, a comparison was made between TSD in Class I, II and III patients on study cast based on Angle’s classification of malocclusion. The mean total ratio for the whole sample was 91.36 ± 2.13 which is very close to Bolton’s proposed ideal ratio. However, the anterior ratio for the whole sample was found to be 78.14 ± 4.09, which is higher than Bolton’s proposed ideal ratio, which reflected a greater mesiodistal widths in the mandibular anterior segment in our population sample. In Group I patients, the mean total ratio calculated was 91.73 ± 3.60 and the mean anterior ratio calculated was 76.89 ± 4.16, both of which are close to Bolton’s proposed ideal ratios. Similarly, the total mean ratio calculated for Group II (90.77 ± 2.13) and Group III (91.33 ± 2.32) patients and the anterior mean ratio for Group III patients (77.51 ± 5.64) was in close agreement with Bolton’s proposed ideal ratios. A significantly higher (P < 0.05) mean anterior ratio (81.10 ± 5.01) for Group II patients was found and this reflects a tendency toward wider mesiodistal dimensions in the mandibular anterior segment in our study sample. There was a significant difference in the anterior tooth ratios between Group I and Group II patients. No significant difference was found between Group I and Group III or Group II and Group III patients. No correlation was found between Angle’s classification of malocclusion and Bolton discrepancy as shown by Crosby and Alexander. Hashim did not find any difference in Bolton’s ratios between different malocclusion groups. Uysal and Sari compared interarch TSD in 150 untreated, normal occlusion subjects and 560 patients of four different malocclusion groups. A gender dimorphism was found in the normal subjects. All malocclusion groups showed significantly higher overall ratios than normal occlusion groups. However, no statistically significant difference was found between the malocclusion groups. Al-Khateeb and Abu Alhaija found no statistically significant differences in Bolton’s ratios between the different malocclusions. Their sample consisted of 140 orthodontic models of school children aged between 13 and 15 years of Jordanian origin. In this study found that Group II patients had higher mesiodistal width in mandibular anterior region and Group II includes Angle’s Class II malocclusion patients, but the study did by Neamah, they found that excess mesiodistal width in maxillary anterior region in skeletal Class II subjects. Ahir and Shah studied a Gujarati population and found mandibular excess in Angle’s Class I and Class III malocclusion. The results of the present study are in partial agreement with some of the above studies considering the fact that no significant difference was found between Bolton’s norms and tooth size ratios in Group I and Group III patients. However, unlike other studies, Group III did not show a significantly higher anterior tooth ratio as compared to Group I patients. The observation of this study was that in Group II that includes Angle’s Class II malocclusion subjects showed a significantly higher anterior ratio, indicating wider mandibular teeth in Angle’s Class II malocclusion or smaller teeth in maxillary arch.

CONCLUSION

- Mean anterior TSD for Angle Class II subjects was significantly greater compared to Bolton’s mean anterior ratio

- There was relatively more tooth size excess in the mandibular anterior or smaller teeth in the anterior maxillary arch in selected samples of malocclusions (North Indian population) as compared to Bolton’s original sample of excellent occlusions.

Source of funding
Nil.

Conflicts of interest
There are no conflicts of interest.

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