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Evaluation of anterior and overall tooth size ratios by Bolton's analysis in North Eastern Indian population

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ARTICLE INFO

Article history:
Available online 14 October 2017

Keywords:
Anterior ratio
Malocclusion
Overall ratio
Study model

ABSTRACT

Objective: To evaluate the norms using Bolton's analysis in North Eastern Indian population and to compare the gender difference.

Methods: The cross-sectional study comprised of 120 dental students aged 18–25 years with Angle's class I occlusion, normal overjet–overbite, normal growth and development, normal maxillary and mandibular arches with all teeth; excluding third molars, history of previous orthodontic or surgical treatment, restoration, prosthesis, tooth anomalies in form, structure and development, significant medical history and history of trauma. The mesio-distal diameter of each tooth was measured. Measurements were used to evaluate Bolton's overall and anterior ratios. Descriptive statistics like mean and standard deviation (SD) were used. The *p*-values less than 0.05 were treated as significant. Unpaired ''*t*'' test was used for comparison between male and female subjects.

Results: The mean anterior ratio was 79.16 ± 2.19 and overall ratio was 90.64 ± 2.00. The mean overall ratios were almost same in both males (90.51 ± 2.23) and females (90.78 ± 1.74) with no significant gender difference ($p = 0.471$). Similarly, the mean anterior ratios showed almost same in both males (79.30 ± 2.34) and females (79.02 ± 2.03) with no significant gender difference ($p = 0.486$).

Conclusion: It would be useful in diagnosis and treatment planning for the subjects with malocclusion in this reason. It would also aid in comparing with the standard Bolton's values. Also, both the ratios derived from the sample can be applied irrespective of gender.

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1. Introduction

One cannot ignore the abundant empirical evidence that is obtained from dental study casts. Occlusion or the relationship of the teeth to each other is of utmost importance since an orthodontist involves in positioning of teeth and adapting one arch to the other.

Model analysis helps to assess the possibilities of tooth movement in treatment planning and also aids in the

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http://dx.doi.org/10.1016/j.jpfa.2017.07.002

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prognosis of stability. Wayne A. Bolton in 1958 anticipated that tooth size ratios would be helpful in treatment planning of orthodontic cases and also in determining the functional and esthetic outcome. Since then, tooth size ratios have been applied to many clinical orthodontic cases.[1]

Bolton's original study was done in a specific population and the ratios obtained may not be applicable to other population groups. Many investigators have found that variations exist in tooth size ratio among different populations of different regions, sex, and malocclusion groups.[2–5]

The norms attained from the studies in Caucasians have found widespread acceptance and have been used arbitrarily all over irrespective of race.[1] There are ethnic variations of the profile in different parts of India like the people from North, South, and North-East are of different ethnic stock and therefore, exhibit significant variations in face form. So, it is felt that we cannot use the norms from Caucasians for several reasons, which can affect the norms in populations of different races as well as ethnicity.[8]

Till date, no study has been carried out to develop a set of normal data on tooth size ratio for the Mongoloid population. Therefore, the present study is undertaken to develop norms for the population and compare with Bolton's values.

The aim of this study was to establish the anterior and overall tooth-size ratios according to Bolton's analysis in Angle Class I normal occlusion in the Mongoloid population.

2. Methods

The study population comprised of dental students aged between 18 and 25 years studying in the Dental College, Regional Institute of Medical Sciences, Imphal. 120 subjects (60 males and 60 females) satisfying the selection criteria were taken for the study. The study population was stratified according to their state of origin and gender.

The inclusion criteria included:

a. Mongoloid population.
b. Angle's class I occlusion with normal overjet–overbite relationship with minor no crowding, normal growth and development, well-aligned maxillary and mandibular arches and all teeth present except third molars. All are having an excellent occlusion which follow the six keys to normal occlusion.
c. Good facial symmetry, determined clinically.

The following criteria are excluded from the study:

a. History of previous orthodontic or surgical treatment.
b. Caries or class II restoration.
c. Prosthesis.
d. Tooth anomalies such as in form, structure, and development.
e. Significant medical history.
f. History of trauma.

It was a cross-sectional study. Upper and lower impressions of the dental arches were made with alginate impression material and poured immediately to avoid distortion with dental stone – type III.

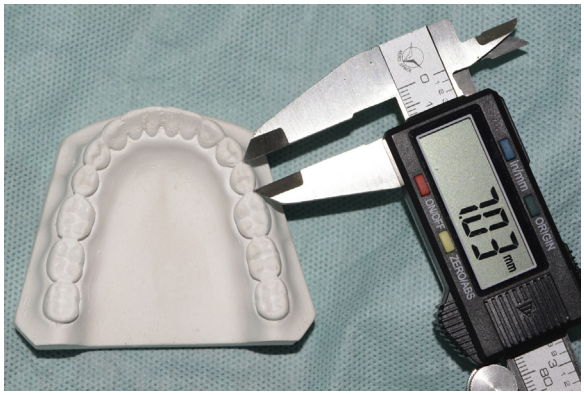


Fig. 1 – Measurement of mesiodistal width of the tooth.

Measurements for Bolton's index

A digital caliper accurate to 0.01 mm was used to make all measurements (Fig. 1).

1. Tooth size (Maxillary)
   The following teeth were measured at the largest mesiodistal dimension using a digital caliper accurate to 0.01 mm. The caliper was placed from the buccal surface keeping it parallel to the occlusal plane. The reading was recorded at the 0.1 mm level and measurements were done for the following teeth:
   a. Maxillary central incisors (right and left)
   b. Maxillary lateral incisors (right and left)
   c. Maxillary canines (right and left)
   d. Maxillary 1st premolars (right and left)
   e. Maxillary 2nd premolars (right and left)
   f. Maxillary 1st molars (right and left)
2. Tooth size (Mandibular)
   The following teeth were measured at the largest mesiodistal dimension using a digital caliper accurate to 0.01 mm. The reading was recorded at the 0.1-mm level and measurements were done for the following teeth:
   a. Mandibular central incisors (right and left)
   b. Mandibular lateral incisors (right and left)
   c. Mandibular canines (right and left)
   d. Mandibular 1st premolars (right and left)
   e. Mandibular 2nd premolars (right and left)
   f. Mandibular 1st molars (right and left)

2.1. *Anterior ratio*

The anterior tooth size ratio was determined for each subject as described by Bolton. The mesio-distal width of six maxillary and six mandibular teeth, from the right permanent canine to the left permanent canine was measured. The ratio between the two is the percentage relationship of mandibular anterior width to maxillary anterior width. This is referred to as ''anterior ratio''. It is denoted as:

$$\frac{\text{sum of mesiodistal width of mandibular 6 teeth} \times 100}{\text{sum of mesiodistal width of maxillary 6 teeth}}$$

Mean = 77.2%

2.2. Overall ratio

The overall tooth size ratio was determined for each subject as described by Bolton. The mesio-distal width of 12 maxillary and 12 mandibular teeth, from the right permanent 1st molar to the left permanent 1st molar was measured. The ratio between the two is the percentage relationship of mandibular overall width to maxillary overall width. This is referred to as ''overall ratio''. It is denoted as:

$$\frac{\text{sum of mesiodistal width of mandibular 12 teeth} \times 100}{\text{sum of mesiodistal width of maxillary 12 teeth}}$$

Mean = 91.3%

The result was statistically analyzed. Data entry and analyses of results were done using the Statistical Package for Social Sciences for Windows software version 21.0 (SPSS version 21). Descriptive statistics such as mean and standard deviation (SD) were used. The p-values less than 0.05 were treated as significant. Unpaired 't' test was done for comparison between male and female subjects.

3. Results

The observed mean tooth ratios i.e. overall ratio and anterior ratio for male subjects were 90.51 ± 2.23 and 79.30 ± 2.34 respectively (Table 1). The observed mean tooth ratios i.e. overall ratio and anterior ratio for females were 90.78 ± 1.74 and 79.02 ± 2.03 respectively (Table 1).

The combined mean anterior ratio was 79.16 ± 2.19 and the combined mean overall ratio was 90.64 ± 2.00.

The measured overall ratios were almost same in both males (90.51 ± 2.23) and females (90.78 ± 1.74) with no significant gender difference ($p = 0.471$) between them (Table 2). Similarly, the measured anterior ratios showed almost same in both males (79.30 ± 2.34) and females (79.02 ± 2.03) with no significant gender difference ($p = 0.486$) between them (Table 2).

Fig. 2 represents the chart for comparison of overall ratio and anterior ratio between male and female subjects.

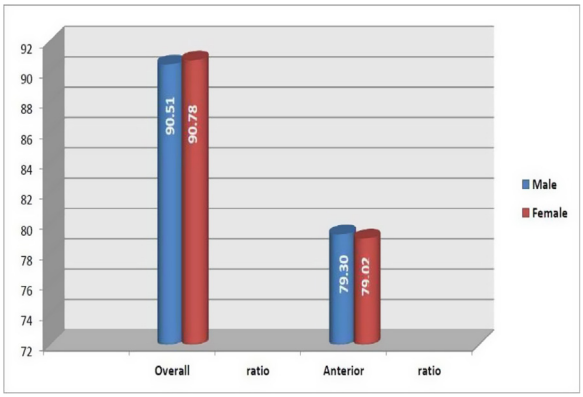


Fig. 2 – Comparison between male and female subjects using unpaired t test (* not significant).

4. Discussion

One of the goals in comprehensive orthodontic treatment is to obtain an optimal final occlusion, overbite and overjet. Bolton[1] in 1958 developed a tooth size analysis which is still widely used today. This analysis consists mainly of two components, the ''overall ratio'' and ''anterior ratio''. In his study, Bolton found the overall ratio of 91.3 ± 1.91 and the anterior ratio of 77.2 ± 1.65. In the present study, the mean overall ratio was 90.64 ± 2.00 which is lower than that of Bolton's value and the mean anterior ratio was 79.16 ± 2.19 which is higher than that of Bolton's value.

In Lavelle's[2] study among untreated population of 40 Caucasoid, 40 Negroid, and 40 Mongoloid, the mean overall ratio and anterior ratio showed gender difference as well as racial difference. The anterior ratios of Caucasoid male and female were respectively 76.8 and 77.5 and the overall ratios were 91.7 for male and 90.8 for females. For Negroid population, the anterior ratios were 79.4 for male and 78.6 for females and the overall ratios were 93.5 for males and 92.9 for females. For Mongoloid population, the anterior ratios were 78.7 for males and 78.2 for females and the overall ratios were 92.6 for males and 92.1 for females. In the present study, there was no gender difference. The anterior

Table 1 – Bolton's overall ratio and anterior ratio for North Eastern Indian population.

Bolton's ratio	Gender	N	Mean	Std. deviation	Std. error mean
Overall ratio	Male	60	90.5165	2.23877	.28902
	Female	60	90.7812	1.74179	.22486
Anterior ratio	Male	60	79.3080	2.34671	.30296
	Female	60	79.0280	2.03465	.26267

Table 2 – Comparison between male and female subjects using unpaired 't' test.

Bolton's ratio	Male	Female	p-Value	Significance
Overall ratio	90.5165 ± 2.23877	90.7812 ± 1.74179	0.471	*
Anterior ratio	79.3080 ± 2.34671	79.0280 ± 2.03465	0.486	*

* Not significant.

ratios for males and females were 79.3 and 79.0 respectively and the overall ratios were 90.5 for males and 90.7 for females. It shows that there is mandibular tooth material excess in both Negroid and Mongoloid population, whereas there is anterior mandibular tooth material excess and maxillary tooth material excess for the North Eastern Indian population.

Crosby[3] selected his sample which fell into one of the four malocclusion groups. The sample totaled 109 treated patients with the following distribution: Class I – 30, Class II Div I – 30, Class II Div II – 29 and Class II surgery – 20. When comparing each of these groups with Bolton's study, it was seen that the means of the tooth size ratios were very close to that of Bolton's. When all 109 samples were combined, the mean of the overall ratio was 91.4 and anterior ratio was 77.4 which compares with Bolton's mean of 91.3 and 77.2 respectively. The standard deviation in Crosby's study was 2.4 and 3.4 for the overall and anterior ratios respectively which was significantly higher than in Bolton's (1.91 for overall ratio and 1.65 for anterior ratio). In the present study, the mean overall ratio was 90.64 ± 2.00 which is lower than that of Crosby's value and the mean anterior ratio was 79.16 ± 2.19 which is higher than that of Crosby's value.

In the present study, the overall ratios and the anterior ratios found no statistically significant difference between male and female subjects ($p = 0.471$ and $p = 0.486$ respectively). In the study of Nie and Lin's,[4] sample consisted of 60 subjects belonging to the normal occlusion group and were of Han Chinese nationality. In this study, no differences in tooth size ratios between males and females were found. Both the overall ratio (93.27 ± 2.48) and anterior ratio (81.52 ± 2.82) were higher in the Han Chinese than the present study and Bolton's standards.

Some authors like Arya et al.[5] and Uysal et al.[6] also found no differences in gender or type of malocclusion supporting the present study.

Szulc et al.[7] found the mean overall ratio of 91.8 and the mean anterior ratio of 78.8 which were significantly higher than those of Bolton's standard values for all malocclusion groups and for both genders. However, the mean overall ratio of the present study was 90.64 which was smaller than their finding, whereas the mean anterior ratio of the present study (79.16) was higher than their finding.

5. Conclusions

In orthodontics, occlusion or the relationship of the teeth to each other is of utmost importance. As the study was carried out in a population with Angle's class I occlusion with normal overjet–overbite relationship, normal growth and development, well-aligned maxillary and mandibular arches with all teeth except third molars, within the age group of 18–25 years, it would be useful in diagnosis and treatment planning for the subjects with malocclusion. It would also aid in comparing with the standard Bolton's values in this population.

The mean overall ratio found is less than the standard Bolton's value suggesting maxillary tooth material excess, whereas the mean anterior ratio found is more than the standard Bolton's value suggesting mandibular tooth material excess. Hence it can be concluded that all upper second premolar extraction or proximal stripping may be useful for the correction of maxillary crowding. Likewise, single tooth extraction (lower central incisor) may be useful for correction of crowding in lower anterior segment.

From this study, it can also be concluded that both the ratios derived from the sample can be applied irrespective of the gender.

Conflicts of interest

The authors have none to declare.

Acknowledgment

I would like to express my deepest gratitude to Dr. O. Brajachand Singh who gave the opportunity to work in the Department of Orthodontics and Dentofacial Orthopedics, Dental College RIMS, Imphal. I would like to appreciate the work contributed by BDS student, Miss Jayabati Laiphangbam. I would also like to extend my profound gratefulness to the Institutional Ethics Committee, Regional Institute of Medical Sciences, Imphal, India for giving me the clearance to perform this study.

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