

Applicability of Bolton's Analysis: A Study on Tibetan Community

Abstract

Aim: This study aimed to evaluate the anterior and overall ratios of Tibetan population residing at Mundgod and to compare the obtained ratios to the ratios available from Bolton's study. **Materials and Methods:** The study consists of randomly selected 120 samples of Tibetan population ranging in age from 15 to 25 years, residing at Mundgod, Karnataka (60 males and 60 females). After measuring the width of each tooth, overall and anterior ratios were measured using formula proposed by Bolton. **Statistical Analysis:** Anterior and overall tooth ratios obtained from the study were compared to standard Bolton's ratio by one-sample *t*-test. The differences between males and females were compared by independent samples *t*-test. **Results:** The overall ratio was significantly lower for both males ($P = 0.03$) and females ($P = 0.001$) at 90.20 and 88.93, respectively, when compared to the Bolton's value of 91.3, whereas anterior ratio for males ($P = 0.001$) was significantly higher at 77.9 when compared to Bolton's value of 77.2. The combined values of males and females when compared to Bolton's value, i.e., the combined overall ratio ($P = 0.001$) was significantly lower at 89.5 and the combined anterior ratio ($P = 0.016$) was significantly higher at 78.7. **Conclusion:** In the present study, significant difference was observed between the overall and anterior ratios in Tibetan population as compared to the Bolton's value. Therefore, Bolton's original data cannot be applied for Tibetan population.

Keywords: Bolton's ratio, interarch discrepancy, Tibetan

Introduction

The intermaxillary tooth size ratio plays a pivotal role in orthodontic diagnosis and treatment planning. A discrepancy in this ratio can dictate treatment plan as to whether extractions are required or reproximation could be sufficient.^[1] It could also suggest whether to include compensating esthetic procedures such as composite bonding, prosthetic reconstructing, or crown recontouring.^[2] Acceptable intermaxillary tooth size ratio is a key to establish ideal interdigitation, overjet, and overbite at completion of orthodontic treatment.^[1-3]

Initial investigations on tooth size were given by Black^[4] and Neff.^[5] A classic work and most popular method for determining tooth size abnormality was given by Bolton,^[6,7] who quantified the maxillary-to-mandibular tooth size and gave his overall and anterior ratios based on 55 patients with excellent Class I occlusion.

Although Bolton's analysis is extremely useful in clinical settings and provides

insight into functional and esthetic outcomes of a case, obliterating the need for a diagnostic setup,^[8] it has certain limitations, first the size of the tooth is believed to be determined by genetic factors.^[9,10] As Bolton's study included only cases with excellent occlusion that were treated orthodontically without extractions,^[11] its applicability in different malocclusions was questionable. Furthermore, the gender composition of Bolton's study was not specified. Factors such as ethnic background also affect the tooth sizes.

Yonezu *et al.*^[12] showed that differences in tooth size have been associated with different ethnic backgrounds. Literature is replete with studies comparing tooth size discrepancy and malocclusion^[13] in different ethnic groups, but very few odontometric norms are available for many of the oriental populations. Only one such study was available for Tibetan population which was done by Karanth and Jayade^[14] but with the limitation of a smaller sample size consisting of thirty patients. Hence, the purpose of this study was to establish norms for Tibetans residing at Mundgod using a large sample size.

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When Tibet became an autonomous region of China in 1959, a large number of Tibetans migrated to India and numerous resettlement colonies were formed for them across various parts of the country. Mundgod is one among them which is located 65 km southeast of Dharwad, Karnataka.^[14]

Therefore, the purpose of this study was:

1. To evaluate the anterior and overall ratios of Tibetan population residing at Mundgod
2. To compare the obtained anterior and overall ratios between males and females of the same population
3. To compare both anterior and overall tooth size ratios of Tibetan population to the ratios available from Bolton's study.

Materials and Methods

The study consisted of randomly selected 120 samples of Tibetan population ranging in age from 15 to 25 years residing at Mundgod, Karnataka (60 males and 60 females). The study models were prepared after making alginate impression of maxillary and mandibular arches and pouring them immediately with dental stone.

Inclusion criteria

- All the permanent teeth present in each quadrant from central incisor to first molar
- Good quality study casts
- Absences of any decay, interproximal restoration, attrition, abrasion, and erosion
- Absence of any fractured tooth, abnormality affecting the shape, and position of tooth
- No previous or ongoing orthodontic treatment.

A digital caliper Figure 1 (Aerospace, Delhi) with a resolution of 0.2 mm/0.0005", accuracy of 0.02 mm/0.001", and repeatability of 0.01 mm/0.0005" was used to measure the mesiodistal crown dimension of each tooth. The width of each tooth was measured from the mesial contact point to distal contact point at its greatest interproximal distance.

A single investigator measured each tooth twice, from the right first molar to the left first molar in each arch [Figure 2]. If the difference was <0.2 mm, the first measurement was taken. If the second measurement differed by >0.2 mm from the first, the tooth was measured again and only new measurement was registered. Only ten pairs of models were measured each day to prevent visual fatigue.

Bolton's anterior (canine to canine) and overall (first molar to first molar) ratios were calculated with the following formula:

$$\left(\frac{\text{Sum of mandibular 12}}{\text{sum of maxillary 12}} \right) \times 100 = \text{overall ratio (\%)}$$

$$\left(\frac{\text{Sum of mandibular 6}}{\text{sum of maxillary 6}} \right) \times 100 = \text{anterior ratio (\%)}$$

Statistical analysis

The data were analyzed using Statistical Package for the Social Sciences (SPSS for Windows, Version 10.0., SPSS Inc., Chicago, USA). Anterior and overall tooth ratios obtained from the study were compared to standard Bolton's ratio by one-sample *t*-test. The differences between males and females were compared by independent samples *t*-test. $P < 0.05$ was considered statistically significant for all the comparisons.

Results

Table 1 shows the gender comparison of anterior and overall ratios of Tibetan population. Even though both the values were slightly more in males than in females, no significant difference was observed between them. Figure 3 shows the graphical comparison of the same result.

Table 2 & Figure 4 shows the comparison of anterior and overall ratios of males and females separately with that of Bolton's standard ratios. The males ($P = 0.03$) as well as females ($P = 0.001$) in the study population had significantly lower overall ratio compared to that of Bolton's values. The males in the study population had significantly higher ($P = 0.001$) anterior ratio compared to Bolton's values. However, for females, there was no significant difference ($P = 0.70$) between the study population and Bolton's values.

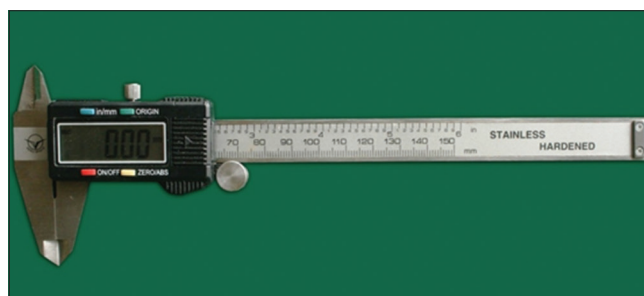


Figure 1: The digital caliper used in the study

Table 1: Comparison of anterior and overall ratios between males and females

Ratio	n	Mean	SD	t	df	P	Mean difference	95% CI-upper bound	95% CI-lower bound
Overall ratio									
Males	60	90.26	2.41	1.67	56	0.10, NS	1.32	-0.26	2.90
Females	60	88.93	3.50						
Anterior ratio									
Males	60	79.89	4.22	1.94	56	0.06, NS	2.33	-0.08	4.74
Females	60	77.56	4.92						

$P < 0.05$. n – Number; SD – Standard deviation; df – Degrees of freedom; CI – Confidence interval; NS – Not significant; S – Significant



Figure 2: Measurements on the mesiodistal width of the tooth on the dental cast

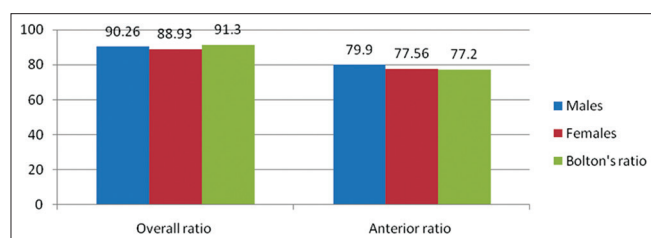


Figure 4: Overall and anterior ratios of males and females of study group compared to the Bolton's values

As there was no significant difference observed in both males and females, the mean value was taken to represent the whole sample. Table 3 & Figure 5 shows the comparison of anterior and overall ratios of Tibetan population with the values obtained from Bolton's study. Overall ratio of Tibetan population showed significantly lower values, i.e., 89.59 ($P = 0.001$) when compared to standard Bolton's values (91.30). Anterior ratio of Tibetan population showed significantly higher value, i.e., 78.73 ($P = 0.016$) when compared to standard Bolton's values (77.20).

Discussion

Among the various diagnostics tools used, Bolton's tooth size analysis is the most common and reliable method for detecting interarch discrepancy. Bolton's analysis is critically important and should be taken into consideration in order to achieve perfect occlusion with optimal overjet and overbite.^[1] Various studies^[13,15] have suggested that Bolton's ratio cannot be universally applied across the populations due to ethnic and gender variations. In addition, Bolton's ratio can differ in patients with different malocclusions.^[16]

As the mesiodistal diameter of the tooth is susceptible to dimensional changes due to attrition and interproximal caries, here, we selected a young group of students residing in a hostel of higher secondary school to minimize these variations associated with mesiodistal crown dimension.

The original Bolton's norms were calculated using 55 models with excellent occlusion, of which 44 were orthodontically

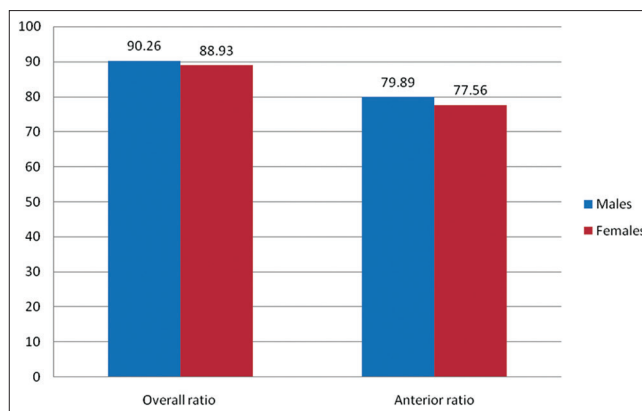


Figure 3: Gender-wise comparison of the overall and anterior ratios

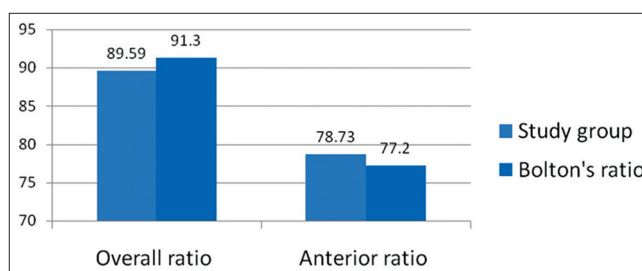


Figure 5: Overall and anterior ratios of study group compared to the Bolton's values

Table 2: Comparison of anterior and overall ratios of males and females separately with that of Bolton's standard ratios

Ratios	Tibetan population	Bolton's value	P	Significance	
Overall ratio	Males	90.20	91.3	0.03	S
	Females	88.93	91.3	0.001	S
Anterior ratio	Males	77.9	77.2	0.001	S
	Females	77.5	77.2	0.70	NS

$P < 0.05$. S – Significant; NS – Not significant

Table 3: Comparison of anterior and overall ratios of Tibetan population with Bolton's values

Ratio	Tibetan population	Bolton's value	P	Significance
Overall ratio	89.5	91.3	0.001	S
Anterior ratio	78.7	77.2	0.016	S

$P < 0.05$. S – Significant

treated.^[6,7] Bolton's estimates of variation were underestimated because his samples were derived from perfect Class I occlusion. In our study, we derived Bolton's ratio using randomly selected 120 samples of different malocclusion residing in a hostel of higher secondary school. The findings of our study were in conjunction with that of Crosby and Alexander^[17] and Araujo and Souki,^[13] where the mean anterior tooth size ratios exhibited no statistically significant difference among the different malocclusion groups.

In our study, the anterior and overall ratios were compared between two genders and it was observed that there was

no statistically significant difference in either of them. This could be attributed to similar distribution of the mesiodistal width of teeth in males and females. This was similar to the studies done by Ta *et al.*^[18] in Southern Chinese population. Alam *et al.*^[8] in different malocclusions also concluded that there is no gender difference in the anterior and overall ratios. Richardson and Malhotra^[19] reported no differences in upper and lower anterior tooth size ratios; there is a constant 77% ratio for both genders.

As there was no significant difference in anterior and overall ratios between two genders, the ratios were obtained for the sample as a whole. The ratios were then compared with the ratio derived from Bolton's study. The overall ratio of the Tibetan population was significantly lower than the Bolton's value, whereas the anterior ratio was significantly higher than the Bolton's value. Karanth and Jayade^[14] also conducted studies in the same population with a sample size of 30 to determine norms for various model analyses. According to them, no significant differences were seen in both anterior and overall ratios, but the range and standard deviation were larger for both the ratios. This could be due to the small sample size selection with normal occlusion. Studies conducted by Jaiswal and Paudel^[20] in Nepalese population and Subbarao *et al.*^[21] in Indian population revealed significantly higher values for both anterior and overall ratios upon comparison with Bolton's standard values.

Numerous factors such as heredity, growth of the bone, eruption and inclination of the teeth, external influences, function, and ethnic background probably affect the size and shape of the dental arches and could be responsible factors contributing to difference in the interarch ratio. In this study, the evaluations from the Tibetan sample are quite discrete to Bolton's original data from the American population. The mean overall and anterior ratios of Tibetan and Bolton's sample were incompatible, indicating that the Bolton analysis for Caucasian samples cannot be applied in general to the Tibetan population.

Conclusion

1. Significant differences were observed for the overall and anterior ratios as compared to Bolton's ratio
2. There was no statistically significant difference in overall ratio and anterior ratios observed between males and females
3. Hence, Bolton's original data cannot be applied for Tibetan population.

In summary, the results of this study showed some significant changes from values obtained from Bolton's study. Our study indicated that population-specific standards are necessary for clinical assessment.

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Conflicts of interest

There are no conflicts of interest.

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