ORIGINAL RESEARCH

Interarch Tooth Size Relationship of Indian Population: Does Bolton's Analysis Apply?

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ABSTRACT

Background: Orthodontists have several methods to detect inter arch-tooth size discrepancies in patients presenting for orthodontic treatment. Many methods such as Pont's analysis, Nance and Carey's analysis, Peck and Peck ratio, Bolton's analysis are commonly used methods. A thorough search of literature reveals a paucity of reliable data on the mesiodistal dimensions of the crowns of the permanent dentition of Indian population. Without information about the size of individual tooth and groups of teeth for Indian population, it is difficult for the clinician to make an adequate diagnosis and treatment plan and to carry out a plan of therapy.

Aim: To determine the size of individual permanent tooth and the sex differences, with tooth size ratios according to Bolton's formula and to evaluate the reliability of Bolton's norms (Anterior/Posterior) in Indian population.

Materials and methods: One hundred and twenty cases in which an excellent occlusion was naturally existent with the mean age of 22 years (18-27 years) were selected in the study. The casts were prepared after taking alginate impression of maxillary and mandibular arches and pouring them immediately with dental stone. A sliding Digital Vernier calliper used to measure the teeth. The ratios of the mean of mesiodistal dimensions of types of teeth were computed.

Results: The mean overall ratio for the Indian population is found to be 92.11 with a standard deviation of 2.12. The values ranged from 86.50-97.13 and the median is 92.16. The mean anterior ratio for the Indian population is found to be 78.14 with a standard deviation of 2.59.

Conclusion: Bolton's original data does not represent Indian population. In our study Greater size variability was found in maxillary teeth as compared with mandibular teeth except mandibular first molar. Our study indicated that population-specific standards are necessary for clinical assessments. Significant differences were shown for the overall ratio and anterior ratio for both sexes as compared to Bolton's ratio.

Keywords: Bolton's ratio, Interarch tooth size discrepancy, Indian Bolton's norms, Bolton's analysis.

INTRODUCTION

In comprehensive orthodontic treatment, the utmost important goal is to obtain optimum occlusion with ideal overbite and overjet. There are many factors that will influence the attainability of this goal, one of which is the relation of intermaxillary tooth size discrepancy. To measure this discrepancy the study models are routinely used. Orthodontists have several methods to detect inter arch-tooth size discrepancies in patients presenting for orthodontic treatment. Many methods such as Pont's analysis, Nance and Carey's analysis, Peck and Peck ratio, Bolton's analysis are commonly used methods.

'Bolton's tooth size analysis'[1-3] is the most common diagnostic tool used in the field of orthodontics. From over the last century a discussion is continued on the intermaxillary tooth size discrepancy. A tooth size discrepancy (TSD) is defined as a disproportion among the size of individual teeth.[4] Bolton's analysis[1,2] based on the ratios between the mesiodistal tooth diameter and sums of the maxillary and mandibular dentition, remains the most recognized method for detecting interarch tooth size discrepancies. Bolton developed his overall and anterior ratios based on 55 patients with excellent class I malocclusions. There is good evidence that population differs with respect to interarch tooth size relationships because differences in tooth sizes are not systematic.[5]

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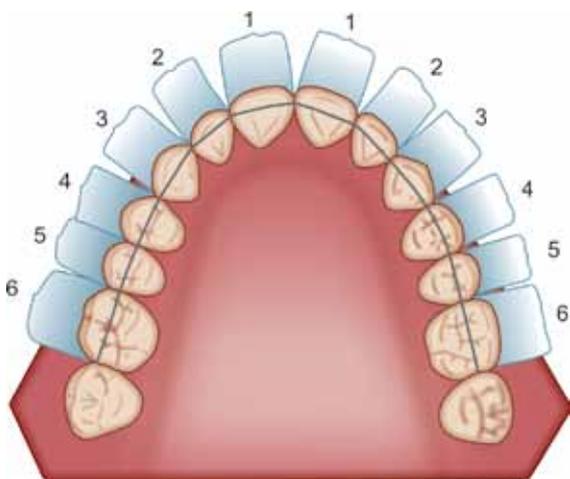
Fig. 1: Mesiodistal widths of the maxillary teeth from right first permanent molar through the left first permanent molar
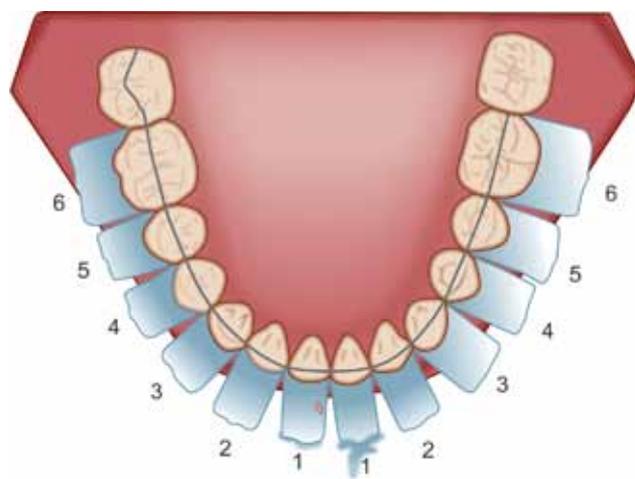
Fig. 2: Mesiodistal widths of the mandibular teeth from right first permanent molar through the left first permanent molar

Because the population and gender differences in maxillary tooth size are not the same as the differences in mandibular tooth size, different interarch relations might be expected. A thorough search of literature reveals a paucity of reliable data on the mesiodistal dimensions of the crowns of the permanent dentition of Indian population. Without information about the size of individual tooth and groups of teeth for Indian population, it is difficult for the clinician to make an adequate diagnosis and treatment plan and to carry out a plan of therapy. In order to improve the quality of dental care available, there is a great need for data on the sizes of the individual teeth of Indian population. Very few studies were performed[6,7] on such an important diagnostic analysis in India. So the purpose of this study is to establish normative odontometric data on the mesiodistal crown dimension of the permanent teeth and also to establish the ratio of tooth size between maxillary and mandibular teeth from canine to canine and first molar to first molar. The study also finds the sex difference for those variables and compares these figures with those of Bolton's norms in Indian population.

Aims

The purpose of this study is to establish normative data to determine the size of individual permanent tooth, tooth size ratios for maxillary and mandibular dentition and sex differences in those variables in the Indian population and to compare the figures obtained with those of the Bolton's analysis.

MATERIALS

The study was conducted in the Department of Orthodontics and Dentofacial Orthopedics. The samples selected for the study were taken from one hundred twenty cases in which an excellent occlusion was naturally existent with the mean age of 22 years (18-27 years). The casts were prepared after taking alginate impression of maxillary and mandibular arches and pouring them immediately in dental stone.

METHODS

A sliding Digital vernier caliper was used to measure the teeth. The width of each tooth is measured from its mesial contact point to distal contact points at its greatest interproximal distance. The data for this study was obtained from the records obtained from 120 casts with normal occlusion with class I molar as well as class I canine relationship also with overjet and overbite of around 3 mm.

Procedure for Bolton's Index

The ratios of the mean of mesiodistal dimensions of teeth were computed. These included the ratio of tooth sizes within the arch and as well as inter arch. Mesiodistal crown diameter is defined as the greatest distance between contact points or the points where the contact would normally occur was measured for all teeth anterior to and including the first molar (Figs 1 and 2). The mesiodistal widths of the maxillary teeth from right first permanent molar through the left first permanent molar were calculated and compared with the sum derived by the same procedure carried out on the mandibular twelve teeth. The ratio between the two is the percentage relationship of mandibular arch length to maxillary arch length is called as 'Overall ratio'.

The same method was used in setting up a ratio between the maxillary and mandibular anterior teeth. The mesiodistal width of six maxillary and mandibular teeth, the right permanent canine to left permanent canine was measured. The ratio between the two is the percentage relationship of mandibular anterior width to maxillary anterior width and this is referred to as 'anterior ratio'.

According to the Bolton's analysis, a significant difference was defined as one whose value was outside 2 SD

from Bolton's mean because approximately 95% of Bolton's subjects were within this range. For the overall '12' ratio a significant difference is therefore defined as a ratio below 87.5 or above 95.1 with ratios in between falling within 2 SD of Bolton's mean likewise, any ratio below 73.9 or above 80.5 was considered to be a significant discrepancy for the anterior '6' ratio.

RESULTS

The mean overall ratio for the Indian population is found to be 92.11 with a standard deviation of 2.12. The values ranged from 86.50-97.13 and the median is 92.16 (Tables 1 and 2). The mean anterior ratio for the Indian population is found to be 78.14 with a standard deviation of 2.59. The values ranged from 70.82-83.97 and the median is 78.58. A statistically significant sex difference is found in overall ratio (p < 0.001) and anterior ratio in both male and female subgroups respectively. The overall ratios were 92.70 for men and 91.51 for women. The anterior ratios for men is 78.55 and for women 77.73. The values for females in both overall ratio and anterior ratio were statistically insignificant while values for males are statistically significant when it was compared with the original Bolton's values.

DISCUSSION

Many methods are commonly used as a diagnostic tool but 'Bolton's tooth size analysis' is the most common and reliable

method. Bolton's analysis,[1,2] based on the ratios between the mesiodistal tooth diameter and sums of the maxillary and mandibular dentition, remains the most recognized method for detecting interarch tooth size discrepancies. There is good evidence that population differs with respect to interarch tooth size relationships because differences in tooth sizes are not systematic. The population and gender differences in maxillary tooth size are not the same as the differences in mandibular tooth size, different interarch relations might be expected. The genotype in India is different from the one in USA where Bolton did his basic study. So the purpose of this study is to determine the size of individual permanent tooth and the sex differences in those variables in the Indian population, to determine the intermaxillary tooth size discrepancy ratios according to Bolton's formula in normal occlusion with the sex differences in those variables and also to evaluate the reliability of Bolton's norms (Anterior/Posterior) in Indian population having optimum occlusion with ideal overjet and overbite.

Most of the samples selected for the study are the students from different states of India learning together in university. In this study, mesiodistal diameter of the crown has been utilized the most frequently in tooth size studies in spite of the fact that this diameter is susceptible to dimensional changes due to caries and interproximal caries.[8] That's why in this study, a young group was chosen to minimize the alteration of the mesiodistal tooth dimensions because of factors such as attrition, restoration or caries.

Table 1: The mean and standard deviation of the mesiodistal width of the maxillary teeth in the male and female subgroups

Maxillary	Sex						Total		
	Male			Female					
	n	Mean	Std. deviation	n	Mean	Std. deviation	n	Mean	Std. deviation
CI	120	8.454	0.553	120	8.327	0.532	120	8.390	0.544
LI	120	6.690	0.4564	120	6.605	0.512	120	6.648	0.485
C	120	7.743	0.506	120	7.469	0.452	120	7.606	0.497
IPM	120	6.957	0.479	120	6.852	0.428	120	6.904	0.456
IIPM	120	6.6552	0.523	120	6.445	0.384	120	6.498	0.460
IM	120	9.814	0.540	120	9.663	0.569	120	9.738	0.558

Table 2: The mean and standard deviation of the mesiodistal width of the mandibular teeth in the male and female subgroups

Mandibular	Sex						Total		
	Male			Female					
	n	Mean	Std. deviation	n	Mean	Std. deviation	n	Mean	Std. deviation
CI	120	5.347	0.363	120	5.219	0.346	120	5.283	0.359
LI	120	5.868	0.369	120	5.772	0.377	120	5.820	0.375
C	120	6.778	0.402	120	6.444	0.457	120	6.611	0.460
IPM	120	6.931	0.532	120	6.739	0.373	120	6.835	0.468
IIPM	120	6.807	0.551	120	6.687	0.395	120	6.747	0.481
IM	120	11.070	0.643	120	10.679	0.645	120	10.875	0.671

The mean overall '12' ratios from first molar to first molar of the normal Indian occlusion group was found to be 92.11 with standard deviation of ± 2.12843. But the overall ratio calculated in India[10] (Manipal) of Chinese population was 90.84 ± 0.179. This suggests that the values coordinate with the values obtained by the study TA et al.[9] The values obtained by the previous Indian studies were 93.46 ± 1.549[6] (Manipal) and 91.54 ± 2.65[7] (North India). The value obtained by the present study was moreover coordinates with whites[11] and not to the any previous Indian study.

The mean anterior '6' ratios from canine to canine of the normal Indian occlusion group was found to be 78.14 with standard deviation of ±2.59. The values obtained by the previous Indian studies were 78.39 ± 2.76[6] (Manipal) and 77.41 ± 2.51[7] (North India). The value obtained by the present study was moreover coordinates with Dominican Americans[12] and Peruvian population and not to any previous study in India.

Tooth Size Discrepancies and Gender

The present study showed that almost all the teeth both maxillary and mandibular teeth in males were larger in size than females. But mandibular first premolars are found almost to be of same size that of maxillary one and mandibular second premolars are larger than maxillary first premolars this is in accordance with Bishara et al.[13] In the present study the males are having higher ratios than females. But males significantly differ from the original Bolton's ratio and females slightly differ but difference was not statistically significant.

Clinical Significance of Tooth Size Discrepancy

In the present study, significant differences were observed for the mean value of total tooth material and anterior tooth material both in maxilla and mandible between the two sexes. The mean values observed for females were lesser than those of males. The mesiodistal dimensions of the maxillary teeth showed greater variability than the mandibular teeth except mandibular first molar with the dimensions having the greatest variability. The size of the maxillary lateral incisor was also highly variable. In addition, the individual tooth size data reported by Santoro et al[12] imply high variability for the maxillary first molar and lateral incisor; this agrees with our findings except mandibular first molar. The previous studies suggests that mandibular premolars are larger in size that of maxillary but the present study suggests that the first premolar of both maxillary and mandibular is of almost similar in size but mandibular second premolar is larger than maxillary first premolar. This suggests that these teeth could be responsible for incongruity in the anterior ratio and should be examined clinically at the beginning of treatment to detect any major size and shape variations.

The values obtained in this study resemble very closely the data available for Dominican American,[12] Dominican, and North American groups.[14] The individual tooth size values of the present study are matches mostly with the values of Turkish population.[15]

There was a significant difference between men and women. The statistically significant differences were due to both the anterior and posterior arch-segment relationships, even though only the posterior ratio showed a significant difference. Both men's and women's anterior ratio measurements had similar distribution patterns.

CONCLUSION

From our study we conclude that Bolton's original data does not represent Indian population with following general conclusions:

1. Greater size variability was found in maxillary teeth as compared with mandibular teeth except mandibular first molar. The mandibular first molars and the maxillary lateral incisors had significant variability and these teeth shall be examined clinically to exclude any major size and shape discrepancies.
2. The relationships between the sizes of the mandibular and maxillary teeth depend on population and sex. Our study indicated that population-specific standards are necessary for clinical assessments.
3. Significant differences were shown for the overall ratio and anterior ratio for both sexes as compared to Bolton's ratio.
4. A discrepancy in the overall ratio was found in 5% of Indian subjects with normal occlusions and anterior ratios outside 2 standard deviations from the Bolton mean were found in 3.33% of our sample. Even if the values are not significantly higher than previous ones available in the literature for orthodontic patient populations, a careful analysis of interarch relationships should be included in the diagnostic procedures.

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