Extrapolation of Bolton's tooth size ratio on Nepalese Orthodontic Patients

[1]Rajiv Yadav, [2]Anil K Yadav, [3]Tekendra Chaulagain, [4]Neelam Yadav

[1]**Associate Professor and Head, Department of Orthodontics and Dentofacial Orthopedics, Tribhuvan University Dental teaching hospital, Institute of medicine, Maharajgunj Medical Campus, Kathmandu, Nepal**

[2]**Consultant orthodontist/Dental Surgeon, Narayani Hospital, Birgunj, Nepal**

[3]**Orthodontic PG Resident, Department of Orthodontics and Dentofacial Orthopedics, Tribhuvan University Dental teaching hospital, Institute of medicine, Maharajgunj Medical Campus, Kathmandu, Nepal**

[4]**Consultant Prosthodontist, MSDH -Multi-Specialist Dental Hospital Pvt Ltd, Kathmandu, Nepal.**

ABSTRACT

Introduction: Tooth size discrepancy is not uncommon in orthodontic patients and varies between ethnic groups. *Objective*was to determine overall and anterior Bolton's tooth size ratio among Class I normal occlusion of Nepalese adults and to compare the present study ratio among gender and with Bolton's standard ratio.*Materials and Methods:* The study was conducted on eightytwo study casts with equal male and female samples. The mesiodistal widths of all maxillary and mandibular twelve teeth from right first molar to left first molar were measured with a digital caliper. The data obtained were used to calculate the anterior and overall Bolton ratios. Student's *t*-test was used to compare tooth size ratios between males and females, and between the present study and Bolton's standard. P values < 0.05 will be considered to be significant. *Results:* The mean of overall and anterior ratios were 76.83± 2.37 and 88.98± 2.41 respectively. The overall and anterior ratio was insignificant among genders. *Conclusion:* The overall and anterior Bolton's ratio showed significant difference with Bolton's standard ratio. Hence,extrapolation of Bolton's tooth size ratio on Nepalese orthodontic patients cannot be done. Population specific standards are necessary to be used for clinical assessment.

Keywords: Anterior Ratio; Bolton's ratio; Nepalese Adults; Overall Ratio;Tooth size discrepancy.

INTRODUCTION

The maxillary and mandibular teeth must be proportional in size to each other to achieve functional occlusion with the normaloverjet, overbite, interdigitation with the best possible esthetic and function. Black in 1902 first measured the mesiodistal widths of teeth.[1] The proportional relation between the size of maxillary and mandibular teeth guidean orthodontist to forecast the final functional and aesthetic occlusion.[2] Tooth size discrepancy of less than 1.5 mm is rarely significant, but larger discrepancies create treatment problems and must be included in the orthodontic problem list.[3]To correct this discrepancy, patients with interarch tooth size discrepancies typically require special finishing steps, interproximal reduction or composite buildups or porcelain veneers, so that the teeth occlude harmoniously. Good occlusion needs proportional tooth size relationships between dental arches.Bolton was the first to publish his analysis of mesiodistal tooth size dimensions and their effect on occlusion. He proposed that the overall ratio of the sum of mesiodistal widths of the twelve mandibular teeth divided by the sum of the twelve maxillary teeth was 91.3±1.91 and the anterior ratio for the six upper and lower anterior teeth was

77.2±1.65.[4]Lavelle concluded overall and anterior ratios were greater among blacks than Caucasoids, whereas the Mongoloids were intermediate.[5]Lew and Keng[6]in Chinese and Hashim and Murshid[7] in Saudi population found that anterior ratio were similar to Bolton standards.Bolton's ratio study in Nepalese students by Hong Qu et al.[8] found mean ratio comparable with Bolton's standard whereas Mishra et al.[9] in their study in Nepalese subjects found statistically significant differences for anterior tooth size ratio when the study groups were compared with Bolton's standards.

Studies by Lavelle,[5] Mishra et al.[9] Smith et al.,[10] Santoro et al.,[11] Bernabé et al.,[12] Paredes et al.,[13] Endo et al.,[14] and Ta et al.,[15]in their studies found that tooth size discrepancies vary with different sample populations and recommends population specific standards to achieve optimal orthodontic results.As Bolton ratio values vary with ethnic and racial differences, the need for a comprehensive investigation to compare Bolton ratio in Nepalese population has been felt. Also only few studies have been conducted on Nepalese population. Thus the present study was proposed to investigate the anterior and overall Bolton ratios on Nepalese population. The aim of the study was to determine overall and anterior Bolton's tooth size ratio among Class I

normal occlusion of Nepalese adults and to compare the present study ratio among gender and with Bolton's standard ratio.

MATERIALS AND METHODS

A cross sectional, quantitative, analytical study was designed. At 80% power of study and 5% level of significance eighty samples were required. Eighty twosamples were included in the study with equal male and female distribution. The ethical approval for the study was obtained from Institutional Review Committee,Institute of Medicine Tribhuvan University Maharajgunj, Kathmandu, Nepal. (Ref: 368(6-11)E^2/077/078. *Inclusion criteria* were Class I molar and canine relationship, normal overjet and overbite, with no crowding/spacing and/or rotation, well-aligned dental arches, fully erupted permanent dentition from first molar to first molar in both arches. *Exclusion criteria:*no previous orthodontic treatment, no shape anomalies, agenesis or

caliper touched the distal contact point. The Bolton's ratio was calculated as follows:

Overall ratio=

$$\frac{\text{sum of mesio-distal width of mandibular 12 teeth}}{\text{Sum of mesio-distal width of mandibular 12 teeth}} \times 100$$

Anterior ratio=

$$\frac{\text{sum of mesio-distal width of mandibular 6 teeth}}{\text{Sum of mesio-distal width of mandibular 6 teeth}} \times 100$$

The mesio-distal width of all twelve maxillary and mandibular teeth were taken and entered manually in excel. The statistical analyses were done with SPSS (Statistical Package for Social Science for Windows Version 23.0, SPSS Inc., Chicago, Illinois, USA). Interclass correlation coefficient was calculated

Table: 1 Descriptive statistical data for anterior and overall Bolton's Ratio							
	N	Range	Minimum	Maximum	Mean	SD	SE
Anterior ratio	82	19	62	81	76.83	2.373	.262
Overall ratio	82	21	71	93	88.98	2.418	.267
SD= standard deviation, SE= standard error							

extractions, no interproximal reduction or addition (restorations) with all subjects of Nepalese citizen and above 18 years of age. The impressions of upper and lower jaw

to assess the intra examiner reliability by observing 13 samples twice at an interval of 2 weeks which showed good reliability (ICC=.98). Student's t-test was used to compare overall and

Table: 2 Anterior and Overall Bolton' Ratio for male and female								
	Sex	Mean	SD	Minimum	Maximum	Range	P value	P
Anterior Ratio	Female	76.50	2.967	62	80	19	0.22	NS
	Male	77.17	1.562	73	81	07		
Overall Ratio	Female	88.37	3.034	71	92	20	0.26	NS
	Male	89.60	1.383	86	93	07		
SD= standard deviation, NS= not significant at p<0.05								

were made with alginate (Zelgan, Dentsply) and poured with dental stone type III (Orthokal, Kalabhai Karson) immediately. The casts were trimmed after one hour and numbered for identification. The mesio-distal tooth dimension was measured by one investigator with Digital caliper-Precise (PRECISE ECO Series No. 03148927 South, India) with accuracy at 0.01 mm. The mesio-distal width was measured from buccal contact point with caliper inserted from mesial contact point and the caliper was parallel to long axis of tooth and closed slowly till the other beak of the

anterior ratios between males and females, and between the present study and Bolton's study result. A P value < 0.05 was considered to be significant.

RESULT

The Kolmogorov-Smirnov test showed normally distributed data for all the teeth measurements. The Table: 1 summarizes the descriptive statistical data for anterior and overall Bolton's ratio. The anterior ratio and overall ratio were found to be 76.83± 2.373 and 88.98 ± 2.418 respectively.

Table: 2 summarizes the anterior and overall Bolton's ratio for male and female with in significant difference between male and female samples. The anterior ratio in male and female was 76.50 ± 2.967 and 77.17 ± 1.562. Male had slightly more anterior ratio but was not significant at p<0.05. The overall ratio was 89.60 ± 1.383 and 88.37 ± 3.034 respectively in male and female and was statistically not significant at p<0.05.

Table: 3 comparison between mean of present study overall and anterior ratio with Bolton's Standard means				
	N	Mean	SD	p Value
Overall ratio Present study	82	88.98	2.418	0.00*
Overall Bolton Ratio	55	91.30	1.91	
Anterior ratio present study	82	76.83	2.373	**0.00***
Anterior Bolton Ratio	55	77.20	1.65	
SD= standard deviation, *= significant at p<0.001				

Table: 3 summarizes the comparison between mean of present study overall and anterior ratio with Bolton's. In this study there was significant difference between present ratio and Bolton's standard showing population specific variation at p<0.001

DISCUSSION

Mesio-distal tooth size of the maxillary and mandibular arches must relate to each other to obtain an optimal occlusion. Crosby and Alexander reported that a large percentage of orthodontic patients possess significant tooth-size discrepancies.[16] In patients with significant tooth size discrepancy, alignment into optimal occlusion may not be possible.[4,17]Therefore, orthodontists should be aware of these discrepancies before beginning an orthodontic treatment. The treatment alternatives for tooth-size discrepancies include restoration of relatively small teeth, interproximal stripping of relatively large teeth, modification of crown angulation or inclination, and extraction.[18]

In the present study, an analysis of tooth size discrepancies was carried out to assess the extent of discrepancy from the original Bolton's norms and its relationship to gender. The orthodontically untreated samples were used to collect the data and results showed means of overall and anterior ratio were lower but were statistically significant from Bolton's means.The combined mean value of anterior and overall ratio as well as the mean for male and female were lower than those of Bolton's mean. The overall and anterior ratio were statistically insignificant between male and female with male having greater means than female similar to Lavelle,[5]Mishra

et al.,[9]Nie and Lin,[19]Jaiswal et al[20] and Hashim et al.,[21]. The mean anterior ratio was 76.83±2.37 which was smaller than Bolton's norm, Hong Q et al.[8] and Mishra et al.[9], and Jaiswal et al[20]. but similar to Trehan et al., [22] Rahman AN et al.,[23]and Hashim et al. [21]. The mean overall ratio was 88.89±2.41 in the present study which is smaller than Bolton's norm, Mishra et al.[9] and Jaiswal et al. [20]. The overall ratio of the present study for gender was smaller than Mishra et al.[9] and Jaiswal et al. [20] and similar to Ta et al.,[15]Bernabé et al.,[12]Rahman et al.,[23]Hashim et al.,[21] Kumar et al. [24]and Mohammad et al.[25]

When tooth size was related to gender, both the anterior and the overall ratio revealed no significant differences suggesting that no sexual dimorphism existed in the present study population. Similar findings were reported by Hong Q et al.[8] and Mishra et al.[9]Bishara et al among Iowa, Egypt and Mexico populations,[26]Kumar et al.,[27]Murmu et al[28] Araujo and Souki,[29]Akyalçin et al.,[30]Sameshima,[31]Nie and Lin,[19]andJohe et al.[32]

Several authors have suggested that it is important to measure individual tooth sizes before initiating orthodontic treatment. Bolton, in his study, suggested that discrepancies >1 SD can cause problems in clinical situations. However, in Bolton's study, casts of patients with ideal occlusion were used, and hence it might be difficult to determine the level of discrepancies which can have clinical implications. Santoro et al.,[33] Araujo and Souki,[29] Freeman et al.,[34] Othman and Harradine,[35] Crosby and Alexaner,[16] and several other investigators have stated that a tooth size discrepancy of >2 SD or 1.5 mm of the Bolton norm can cause difficulties in tooth alignment and final occlusion. Proffit et al.[3] stated that a discrepancy >1.5 mm can create problems and should be considered during the treatment planning process.

The findings of the present study indicate that the mean anterior and overall ratios were significantly higher for the population studied when compared with the Bolton's standard ratios which are being currently used to assess the prevalence of tooth size discrepancies. Hence, it is important to take into consideration

the present values specific for Nepalese population during diagnosis and treatment planning of orthodontic patients as treating them to the already existing values might not provide the ideal occlusion sought at the end of treatment.

CONCLUSION

The meananterior ratio and overall ratio was 76.83± 2.37 and 88.98± 2.41, respectively. The anterior and overall ratio were not statistically significant different among genders. The mean anterior and overall ratio showed statistically significant difference when compared to Bolton's standard ratio. Hence, extrapolation of Bolton's tooth size standard ratio on Nepalese orthodontic patients cannot be performed. Population specific standards are necessary to be used for clinical diagnosis and treatment planning.

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