

Original Article

Bolton's Tooth Size Discrepancy in Skeletal and Dental Class I, II and III Malocclusion Patients, Seeking Orthodontic Treatment at Liaquat University Hospital Jamshoro/ Hyderabad

Bolton's Ratio in Class I, II and III Malocclusion Patients

Tariq Aziz¹, Abdul Jabbar², Syed Rizwan Shah³, Abdul Bari Memon⁴, Ramesh Lal² and Maryam Mushtaq⁵

ABSTRACT

Objective: To evaluate Bolton's tooth size discrepancy in skeletal and dental Class I, II and III malocclusion.

Study Design: Analytic study

Place and Duration of Study: This study was conducted at the Department of Orthodontics, Institute of dentistry, LUMHS Jamshoro/Hyderabad from 01-07-2019 to 31-12-2019.

Materials and Methods: This study consisted of 73 patients. The patients were grouped into three classes of malocclusions based on Angle's molar classification on study cast and Steiner's ANB angle on lateral cephalometric radiograph. The Bolton analysis was performed on study cast. The researcher took all the measurements with the help of digital calipers, from right first molar to left first molar in both upper and lower arches. The data were analyzed by SPSS version 23.0 (Armonk, NY: IBM Corp.). Analysis of variance (ANOVA) was applied to statistically compare the overall and anterior ratios among the different malocclusions. To assess gender dimorphism independent student t-test was performed and level of significance was set at p- value < 0.05.

Results: Out of 73 patients included in this study 22 were female (30.13%) and 51 male (69.86%); with female to male ratio of 1:2.3. The mean age was 21±2.41 years. Of 73 patients, 14 (19.17%) were of Class I, 46 (63.01) Class II and 13 (17.8%) were of Class III patients. A mean Overall Bolton ratio of 92.30 ±2.93 and a mean anterior Bolton ratio of 79.17 ±5.19 was obtained for the complete sample. The one-way analysis of variance revealed insignificant relationship with p – value of 0.186 and 0.572 for overall ratio and anterior ratio respectively in different malocclusion groups. Regarding gender dimorphism, Independent sample t-test showed no significant relationship with P-value of 0.483 and 0.426 for overall ratio and anterior ratio respectively.

Conclusion: This study's result revealed no statistically significant difference between overall Bolton's ratio and anterior ratio in all malocclusion groups. Though higher anterior ratio was observed in Class I and III than the Bolton's standard values. Also, statistically insignificant relationship was observed between gender & Bolton's ratio.

Key Words: Tooth Size Discrepancy, Bolton ratio, Malocclusion

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INTRODUCTION

¹. Muhammad Dental College, Mirpurkhas.

². Department of Orthodontics, Institute of Dentistry, Liaquat University of Medical and Health Sciences, Jamshoro.

³. Department of Orthodontics, Women Medical and Dental College, Abbottabad.

⁴. Bibi Aseefa Dental College @ SMBBMU Larkana Sindh.

⁵. Department of Orthodontics, CIMS, Multan.

Correspondence: Dr. Abdul Jabbar, Associate Professor of Orthodontics, Institute of Dentistry, LUMHS, Jamshoro.

Contact No: 0333-2608489

Email: a_jabbar_lumhs@hotmail.com

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Orthodontic treatment comprises of different stages which has their own particular requirements and peculiar complications. Challenges and problems are encountered throughout the orthodontic treatment and especially the finishing stage. An excellent orthodontic finishing is essential to achieve a desired and optimum occlusion¹. In time diagnosis of tooth-size imbalances prior to commencement of orthodontic treatment will result in minimum problems during finishing stages². The ideal end result of perfect overjet, overbite and intermaxillary occlusion can be achieved by the early detection of intermaxillary tooth size discrepancy³. The definition of Tooth Size Discrepancy (TSD) is the asynchronous size of particular tooth or group of teeth as compared to the teeth in the same arch or opposing arch⁴. In order for maxillary teeth to align properly with the mandibular teeth, for esthetics, occlusal stability

and functional harmony there must be a definite proportionality of tooth size⁵. The exact location of tooth size discrepancy in a particular segment of arch can be detected by assessing the Bolton's anterior ratio. During orthodontic treatment the choice for extraction of particular tooth can be made by assessing Bolton's size ratio⁶. The mathematical formula developed by Bolton¹ after studying 55 cases with perfect occlusion, which defined the anterior Bolton index (ABI) of 77.2±1.65%. However, this index gives us a rough estimate of tooth sizes of different races and ethnicities and not the exact discrepancy.^{3,7-12}

Jury is still out on whether tooth size discrepancy is gender related or not. Proponents of this hypothesis had observed statistically significant differences between tooth sizes of males and females^{13,14} while the opponents didn't find any difference¹⁵⁻¹⁷ like literature review of Othman and Harradine¹⁸. According to estimate, 5% of general population has Significant Tooth size discrepancy⁶. There is scarce data available in Pakistan regarding tooth size discrepancies among different malocclusions groups. Hence this study is designed to collect the data from local population to determine the incidence of tooth size discrepancy among different types of skeletal and dental malocclusion.

MATERIALS AND METHODS

This study was carried out at Department of Orthodontics, Institute of dentistry, LUMHS Jamshoro/Hyderabad after approval from ethical review committee. Nonprobability consecutive sampling technique was employed. The Included samples consisted of Pretreatment lateral cephalometric radiograph and study cast from both male and female patients (age range 12-25 years). The inclusion criterion was; Good quality study cast, fully erupted permanent teeth except third molars, No inter-proximal or occlusal surface abrasion on teeth, absence of inter-proximal caries, restoration, as well as crown and bridge and absence of dental malformations or extra teeth.

The sample size of 73 patients was divided into three groups based on Angles Classification of Malocclusion and ANB angle. Class I malocclusion was diagnosed on Class I molar relationship and ANB angle between 0-4 degree. Class II Malocclusion with Class II molar relationship and ANB angle > than 4 degrees. Class III malocclusion was diagnosed based on class III molar relationship accompanied by ANB angle < 0 degree.

All the study casts were thoroughly examined. The mesio-distal width of each tooth was measured till permanent first molar in both arches. Second and third molars were excluded. The values obtained were used to calculate overall and anterior Bolton's ratio using the following formulas. The overall and anterior ratios were calculated by the following formula:

$$\frac{\text{Sum of lower 12 teeth}}{\text{Sum of upper 12 teeth}} \times 100 = \text{Overall Ratio}$$

$$\frac{\text{Sum of lower 6 teeth}}{\text{Sum of upper 6 teeth}} \times 100 = \text{Anterior ratio}$$

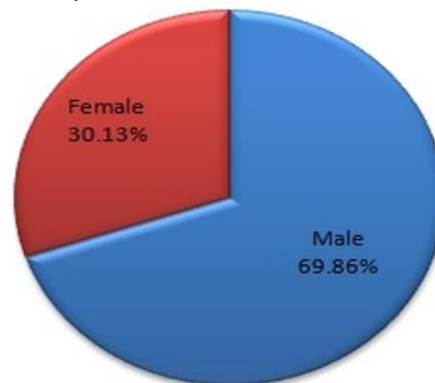
The data were analyzed by SPSS version 23.0 (Armonk, NY: IBM Corp.). To assess the normality of data Kolmogorov-smirnov test was applied. The test result showed normal distribution of the data hence parametric tests were used. Analysis of variance (ANOVA) was applied to statistically compare the overall and anterior ratios among the different malocclusions. To assess gender dimorphism independent student t-test was performed and level of significance was set at p- value < 0.05.

RESULTS

The study results are based on the analysis of 73 patients. Out of 73 patients, 22 were females (30.13%) and 51 were males (69.86%). Female to male ratio of 1:2.3 as shown in Figure No: 1, the patient's age ranges between 12 to 25 years. The mean age was 21±2.41 years.

Based on Angles Classification and cephalometric analysis, out of 73 patients, 14 (19.17%) were of Class I, 46 (63.01) Class II and 13 (17.8%) were of Class III patients. Detailed descriptive statistics of variable is shown in Table No: 1. A mean Overall Bolton ratio of 92.30 ±2.93 and a mean anterior Bolton's ratio of 79.17 ±5.19 was obtained for the complete sample. The mean Bolton's ratios for the different malocclusion groups are shown in Table No: 1. The one way analysis of variance was performed to determine the relationship among different malocclusion and Bolton ratio. The test results revealed insignificant relationship with p – value of 0.186 and 0.572 for overall ratio and anterior ratio respectively.

Independent sample t-test was applied to determine association between the Bolton ratio and gender. The test result shows there is no significant relationship between Bolton's ratio and gender with P-value = 0.483 and 0.426 for overall ratio and anterior ratio respectively.



N=73, Male: 51, Female: 22

Figure No. 1: Gender Distribution of Study Participants

Table No:1 Relationship between different Malocclusion and Bolton Ratio

Types of Malocclusion	N	Overall Ratio	Anterior Ratio
	73	92.30	79.17
Class I	14	92.7	79.6
Mean		±2.97	±3.52
Std. Deviation			
Class II	46	91.43	78.15
Mean		±3.10	±4.81
Std. Deviation			
Class III	13	92.79	79.78
Mean		±3.4	±3.89
Std. Deviation			
P-Value	0.186		0.572
F- Value	2.10		0.874

(One-way Analysis of Variance - ANOVA Significant level = > 0.05)

Table No.2: Relationship between Overall and Anterior Bolton Ratio and Gender

Bolton Ratio	Gender	N	Mean	Std. Deviation	F- Value	P- Value
Overall Ratio	Male	51	91.78	3.42	0.271	0.483
	Female	22	91.93	3.81		
Anterior Ratio	Male	51	78.93	2.79	0.719	0.426
	Female	22	78.26	3.16		

DISCUSSION

The presence of disproportionate tooth material in upper or lower arch can disturb the occlusal harmony. Bolton's ratio, which is the seventh key of occlusion, helps in analyzing the proportionality of upper and lower teeth. This analysis helps in proper diagnosis, and treatment of a case into a harmony that will result into structural and functional stability of maxillary and mandibular arch.

This study was designed to evaluate Bolton ratio in Class I, II and III malocclusions, in the Pakistani population. This study recruited relatively smaller sample size owing to restricting the selection upon a younger age group, in order to minimize the possibility of confounding factors like attrition, proximal restoration and caries in older age. The results of this study revealed that overall and anterior Bolton's ratio is statistically insignificant in Class I, II and Class III malocclusion which is in agreement to most of the studies done by the other authors. Though higher anterior ratio was observed in Class I and III than the Bolton's standard values.

Khateeb and Abu Alhajja¹⁹ conducted a study on 140 orthodontics models of school children of Jordanian origin between the age of 13-15 years and found no statistically significant difference in Boltions ratios in different malocclusions. In another study, Crossby and Alexander found no correlation between malocclusion classification according to Angle and Bolton's Ratio in 109 pretreatment study models of orthodontic

patients¹². In contrast to our results, a study conducted by Ta et al, in 2001 in southern Chinese children, found significant difference between anterior Bolton ratio in Class III and Bolton's norms for anterior ratio. Significant difference was observed between Class II and Bolton's norms and between Class II and Class III cases in overall ratio¹⁰.

Hashim in 2002 studied the difference in Bolton's ratio between different malocclusion and find no association²⁰. In another study conducted by Laino et al on sample of 94 patients found no relationship between Bolton's discrepancies in different malocclusion groups⁵.

In 2003 Araujo and Souki conducted a study to evaluate relationship between different malocclusion group and Bolton's ratio. There results were not in agreement with the results of the present study. They establish significantly higher anterior ratio in class III as compared to Class I and II malocclusion groups². In another study performed in 2005 by Afzal et al calculated Bolton's ratio in different malocclusion groups and results showed insignificant relationship. Statistically higher ratios were observed in class III than Class I and Class II malocclusion groups. These findings are comparable to the results of present study²¹.

Mujahid et al, in 2017 compared the mean anterior tooth size discrepancy in Class I and Class II malocclusion patients and find insignificant difference between two groups of malocclusions²².

Batool et al, conducted a study to find tooth size discrepancy in different malocclusion group and selected patients based on ANB angle. They found that tooth size discrepancy in mandibular anterior segment in skeletal Class II group was higher that partially contradicts the results of present study²³.

This current study revealed that, the overall and anterior ratio (92.30 and 79.17 respectively) were slightly higher than the Bolton's original norms in our population. The results are in agreement with the study conducted by Oktay and Ulukaya in 2010 who calculated the Bolton's ratio in normal occlusion with different malocclusion groups in Turkish population. The results showed that overall and anterior ratios of Turkish population were larger in comparison to the original values of Bolton²⁴. Another study conducted by V Mollabashi, M Karim Soltani et al, in Iranian population demonstrated the higher total Bolton and anterior ratio than the Boltions original norms²⁵.

With regard to gender, the present study found no statistically significant relationship between overall ratio and anterior ratio with p -value 0.483 and 0.426 respectively, which is in agreement with most of the studies conducted by other others. A study by Nourallah et al and Bernabe et al, found insignificant difference in tooth size discrepancy between male and female patients²⁶. Also, Basaran et al studied gender

dimorphism and tooth size discrepancy in Turkish population, which failed to find any association between these two variables²⁷. A study by Muhammad Tayyab et al, conducted on 90 Pakistani patients in 2014, demonstrated no sex predilection for overall ratio and anterior ratio. However, there are numerous studies that contradicts with current study in term of gender dimorphism and Bolton discrepancy.

A study conducted by Fattahi et al found that male patients had higher overall and anterior ratio than female patients²⁸. Similar results were also found in a study conducted by Uysal et al, who found tooth size discrepancy and gender dimorphism³. Also Lavelle observed sexual dimorphism in Bolton's ratio which is not in agreement with the results of current study¹⁴.

CONCLUSION

Following conclusion was deduced based on the results of this study,

There was no statistically significant difference between Overall Bolton's ratio and anterior Bolton's ratio in all three classes of malocclusion. Although higher Anterior Bolton's ratio was seen in Class I and III compared to Bolton's standard norms.

Though there was no statistically significant relationship between Gender and Bolton's Overall and anterior ratio, yet the male dentition showed tendency for slightly larger mesio-distal size than female counterparts.

Author's Contribution:

Concept & Design of Study: Abdul Jabbar
 Drafting: Tariq Aziz, Syed Rizwan Shah
 Data Analysis: Abdul Bari Memon, Ramesh Lal, Maryam Mushtaq
 Revisiting Critically: Abdul Jabbar, Tariq Aziz
 Final Approval of version: Abdul Jabbar

Conflict of Interest: The study has no conflict of interest to declare by any author.

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