

Literature Review

Bolton Analysis on Class I, II, and III Malocclusion Cases

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ABSTRACT

Background: Tooth size discrepancy is defined as an imbalance in size between each tooth. To obtain good occlusion with overbite and overjet, the maxillary and mandibular teeth must be of the appropriate size. One of the causes of malocclusion is the mismatch of the mesiodistal size of the teeth to the arch of the jaw. The relation of teeth with a large maxillary mesiodistal size while the mandibular mesiodistal size is small, it is impossible to get an ideal occlusion. This condition is known as tooth size discrepancy and can be a problem when determining the orthodontic treatment plan and when achieving the final orthodontic treatment outcome. **Purpose:** this study aimed to describe Bolton's analysis in cases of Class I, II, and III malocclusions. **Review(s):** The literature sources used in preparing the review were through databases PubMed and Google Scholar with the keywords tooth size discrepancy, Bolton analysis, and Class I, II, and III malocclusions. From the results of the researchers' measurements on malocclusions in the Angle Classification Class I and II, The anterior ratio was different in several cases, while in Class III the results were greater than the Bolton ratio, where the size of the lower jaw teeth was larger than the maxillary teeth, especially in the anterior ratio. **Conclusion:** Bolton's analysis can be applied to all cases regardless of the type of malocclusion, gender, or race, and remains an important investigation before starting treatment for post-treatment arch stability.

Keywords: Tooth size discrepancy; Bolton analysis; Malocclusion; Orthodontics; Medicine

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INTRODUCTION

The term "tooth size disparity" refers to an imbalance in the size of individual teeth. The maxillary and mandibular teeth must be of the proper size to achieve excellent occlusion with *overbite* and *overjet*. Black presented the mesiodistal breadth of the tooth for the first time in 1902. Black made measurements of human teeth and made a table of average dimensions, and the results of these measurements are still used today. Every clinician must know about tooth size discrepancies in order to make a diagnosis and develop a treatment plan.¹

A form of deviation of occlusion as a normal biological variation will result in malocclusion. These deviations are in the form of characteristics of malocclusion, the number and types of which vary greatly in both individuals and groups of populations. One of the causes of malocclusion is the misalignment of the teeth's mesiodistal size with the arch of the jaw. This condition is known as tooth size discrepancy and can be a problem when determining the orthodontic treatment plan and when achieving the final orthodontic treatment.²

Orthodontic treatment is an aesthetic purpose and is intended to achieve a good functional balance. This

goal is to pay attention to the occlusal tooth relationships that affect the final treatment outcome, such as maxillary anterior protrusion, *overjet*, dental arch suitability, and tooth tilt between the maxilla and mandible can be achieved. Occlusion is a regular arrangement of teeth in the jaw arch, between the upper and lower teeth, between the teeth and the jawbone, the skull, the surrounding muscles, and the mesial buccal cups of the maxillary first molar's curvature and contact occlusion. The buccal cusp of the maxillary first molar is located in the buccal groove of the mandibular first molar and is located in the tooth gap between the mandibular first molar and the second molar.²

Arch length and tooth size discrepancy is important to plan the orthodontic treatment to obtain the optimal treatment outcome. Thus, this study aimed to describe Bolton's analysis in cases of Class I, II, and III malocclusions.

REVIEW(S)

The literature review result in this study regarding the topic can be seen in Table 1. The literature sources used in preparing the review were through databases PubMed and

Google Scholar with the keywords tooth size discrepancy, Bolton analysis, and Class I, II, and III malocclusions. From the results of the researchers' measurements on malocclusions in the Angle Classification Class I and II, the

anterior ratio was different in several cases, while in Class III the results were greater than the Bolton ratio, where the size of the lower jaw teeth was larger than the maxillary teeth, especially in the anterior ratio.

Table 1. Literature review result

Citation	Research Methods	Results
Mustafa & Abuaffan, (2021) ³	Dental casts of 104 students from the University of Sudan made into a pattern with proper occlusion (52 women, 52 men), aged 16-26 years, who were chosen at random.	<ul style="list-style-type: none"> Females total Bolton and anterior were $91.67 \pm 3.3\%$ and 78.29 ± 2.6, while Male were 93.901 ± 9.8 and 78.43 ± 2.44, respectively. There has been no statistically significant difference between males and females in frontal and entire proportions ($P > 0.05$). Bolton's anterior and whole proportions were 78.37 ± 2.54 and 92.79 ± 7.43 percent, respectively, among Sudanese University students. In the anterior to overall ratio found ($P \leq 0.05$), Between this study and Bolton's research there are statistically significant differences.
Hasija et.al. (2014) ⁴	A Bolton analysis was done after all 100 patients' teeth were measured. The results are compared to Bolton's mean and standard deviation.	<ul style="list-style-type: none"> The average intermaxillary tooth size ratio was similar in different groups of malocclusions than in the ideal occlusion.
Elyes (2021) ⁵	On a total of 120 3D orthodontic models of Tunisian patients aged 18-37 years with varying occlusal relationships, the arch width and mesiodistal tooth width were measured. The overall and anterior ratio between the maxilla and mandible teeth were evaluated using the Bolton method.	<ul style="list-style-type: none"> This study demonstrated the presence of sexual dimorphism related to tooth size. Women exhibit smaller teeth than men, which are mainly related to the maxillary first molars, canines, second premolars, and mandibular first molars. Our comparison of the TSD results with those recorded by Bolton, shows a slightly higher anterior to overall ratio than the standard value. No difference in the overall and anterior ratio of the difference in tooth size was found between the Angle malocclusion group and gender.
Mahmoud, et.al. (2017) ⁶	The study casts were randomly selected from orthodontic patient records and the sample consisted of 107 pretreatment study castings with entire permanent teeth erupted from first molar to first molar. The near-centrifugal diameter of the tooth was measured at the point of contact with the digital caliper of stainless steel, and Bolton analysis was performed.	<ul style="list-style-type: none"> When compared to the Bolton anterior ratio, there was a statistically and clinically significant anterior TSD ($p = 0.002$). In terms of overall, there were no differences in significant and anterior TSD measurements among malocclusion groups ($p = 0.572$ and $p = 0.976$, respectively). Gender did not make a significant difference in the overall TSD data ($p = 0.102$). The average overall ratio in Class II Division 1 was lower than Bolton's, but the overall ratio and forward ratio in Class II Division 2 were greater than Bolton's (91.3%, $SD \pm 2$) and (77.2, $SD \pm 2$).
Machado (2018) ⁷	168 pretreated dental casts of Portuguese orthodontic subjects (fifty-nine men and 109 females) with one-of-a-kind occlusions have been used, which were chosen at random from 541 orthodontic patients who were treated in a row.	<ul style="list-style-type: none"> The consequences confirmed that the mean, wide deviation, and variety within the regular occlusion group were higher than Bolton's ($78.3 \pm 3.5\%$ within the anterior ratio and $92.1 \pm 2.2\%$ within the common ratio) and there has been no distinction among the sexes ($p > 0.05$). Anterior and common ratio, $p = 0.001$ and $p < 0.001$ Class II/2 (anterior ratio, $p = 0.032$) and (common ratio, $p = 0.041$) considerably exceptional from the statistics Bolton reference.
Hanivo (2018) ²	Types of descriptive research, carried out on 40 samples of patient study models who have class I angle occlusion. There are 3 groups of tooth size variations seen from the total Bolton ratio	<ul style="list-style-type: none"> The group of tooth size variations in Angle class I malocclusion patients with a total normal Bolton ratio at the end of treatment describes the overbite with mostly reaching the ideal, the smallest average overjet with mostly reaching the ideal, and the molar relation class I Angle relationship with very little mesiocclusion deviation.

<p>Trehan et.al. (2012)⁸</p>	<p>A study model of 100 orthodontic patients was used for a sample, aged 15 to 21 years which was randomly selected from the Department of Orthodontics at Mahatma Gandhi Dental College in Jaipur.</p>	<ul style="list-style-type: none"> • The mesio-distal width of the teeth was not statistically significant, men had a little bigger mesio-distal width than females. • Females show greater variation in tooth size than males. • Males and females had similar average width ratios of the anterior teeth to total teeth, and there was no significant difference between the two.
<p>Ramadhan et al., (2020)⁹</p>	<p>This analytical observational study began sampling using a targeted sampling technique, took a sample of 50 dental faculty members in 2016, performed a Bolton anterior ratio analysis on the study model, and performed an extraoral profile. I interpreted the result of the photo.</p>	<ul style="list-style-type: none"> • The average anterior tooth ratio was $79.53\% \pm 2.61$, the facial profile was 33 (66%), the facial profile was 17 (34%), and the average convexity was 172.11° in 50 samples. • Between the differences in tooth size and facial contours, there was no significant relationship between the two.
<p>Ayu & Paramitha (2021)¹⁰</p>	<p>This descriptive study used a purposive sampling technique, using 40 male and female study samples from Balinese patients at RSGM FKG Unmas that matched the inclusion criteria.</p>	<p>The results of the study of the anterior ratio of Balinese tribes for men and women were $79.55\% \pm 3.40$ and $61.57\% \pm 5.32$, respectively. The overall ratio of Balinese ethnicity to males and females was $91.66\% \pm 2.57$ and $102.50\% \pm 5.26$, respectively.</p>
<p>Muqbil (2010)¹¹</p>	<p>For each race, 30 cast sets were rated from each malocclusion group. There were 360 dental casts utilized in all.</p>	<ul style="list-style-type: none"> • Gender: Only the Afro Caribbean Class II/I group had significant disparities in the overall ratios between men and women. The anterior ratios was significantly different for all racial groups with Class III malocclusion, as well as for Afro Caribbean Class I Asian and Class II / II. • Malocclusion group: For the combined overall and anterior ratio, the malocclusion group's mean differed significantly. The gap between Class III patients and the remaining malocclusion group caused the difference. The difference between the Class I and Class III groups also resulted in a significant difference in anterior ratio among Asian respondents. • Race: Anterior ratio of Class I groups was only significantly different between Asian and Caucasian groups. The overall combined ratio and the front combined ratio did not differ significantly.

DISCUSSION

A malocclusion is a form of the maxillary-mandibular relationship that differs from the acknowledged conventional shape as the normal form. An imbalance in the dentate face might result in malocclusion.¹² A normal anteroposterior connection between the maxillary and mandibular first molars, with the mesial buccal cusp of the maxillary first molar staying in the buccal fissure of the mandibular first molar, is known as an Angle Class I malocclusion (neutral occlusion). Molars while the maxillary canines are in the space between the distal ends of the canines. Mandibular first premolar mandibular and mesial margin. Malocclusion is a very large dental and oral health problem in Indonesia, its prevalence is still very high, about 80% of the population, and ranked third after tooth decay and periodontitis. According to Bolton, achieving proper occlusion requires a tooth size analysis that shows the ideal ratio of upper and lower teeth.¹³ According to Bolton, this proportion is given by the sum of the widths of the mesiodistal diameter of the lower tooth relative to the upper tooth. For optimal occlusion, Bolton specifically computed the ratio of the existing mesiodistal width between the maxillary and

mandibular teeth, from canine to canine and first molar to first molar. This was done in the study model, not in the patient's mouth.¹⁴

Orthodontic treatment is closely related to a person's face because the mouth (especially soft tissue parts such as lips and hard tissues such as teeth and jawbone) is one of the factors that play a role in shaping a person's facial characteristics.¹⁵

Size discrepancy is the lack of harmony between the sizes of a tooth or a group of teeth when communicating between one arch or opposing arches. The discrepancy of tooth size and arch size serves to diagnose orthodontics. The difference in tooth size between the maxilla and the mandible is a key component in accomplishing treatment goals.⁷

The results of the measurements showed that the overall ratio of tooth size discrepancies in the male study model was 92.15 ± 2.15 , and the overall ratio of 33 tooth size discrepancies in the female study model was 92.33 ± 3.57 . Obtained the value of $p = 0.84$ ($p > 0.05$) in the Independent T-Test indicates that there is no significant difference between male and female sexes from the average value of the overall ratio of tooth size discrepancies in the research

model. The results of this study are comparable with those of Mahmoud et al. (2017), who looked at tooth size differences in Sudanese persons with various malocclusion groups and found that the overall ratio for men was 91.82 and females was 90.87. With $p=0.1$ ($p>0.05$), there was no significant difference in the overall ratio of tooth size disparities between females and males.⁶

In a study conducted by Mustafa & Abuaffan (2021), Bolton's anterior and total ratios were 78.43 ± 2.44 and 93.901 ± 9.8 for men and 78.29 ± 2 and 6 for men, or $91.67 \pm 3.3\%$. In the anterior and overall proportions, there were no statistically significant differences between males and females ($p > 0.05$). Bolton's anterior and total proportions were 78.37 2.54 and 92.79 7.43 percent, respectively, among Sudanese University students. However, the anterior to overall ratio ($p 0.05$) showed significant differences between this study with Bolton's in statistically.³

In a study conducted by Elyes (2021) showed sexual dimorphism related to tooth size. In fact, women exhibit smaller teeth than men, which are mainly related to the maxillary first molars, canines, second premolars, and mandibular first molars. On the other hand, this distinction is not systematic and does not appeal to all teeth. Our comparison of the TSD results with those recorded by Bolton, shows a slightly higher anterior to overall ratio than the standard value.⁵

In a study by Mahmoud et al. (2017), for the sample, 107 pretreatment study casts of completely erupted permanent dentition from first to first molar were employed, which was randomly selected from orthodontic patient records. When compared to Bolton's anterior ratio, the results revealed a clinically and statistically significant difference in anterior size ($p = 0.002$). While on Measurements of total TSD and anterior TSD among malocclusion groups there was no significant difference ($p = 0.572$ and $p = 0.976$, respectively). Gender did not make a significant difference in the total TSD data ($p = 0.102$). The average overall ratio in Class II and Division 1 was lower than Bolton's, while the Class II overall ratio (91.3% , $SD \pm 2$) and forward ratio (77.2 , $SD \pm 2$) were higher.⁷

Results of 11 studies that have been carried out show that the analysis of permanent teeth that can be used for tooth size discrepancies is Bolton's analysis. Bolton analysis may be used in any situation, regardless of the kind of malocclusion, gender, or race, and it's still a important investigation to do it before commencing therapy to ensure post-treatment arch stability.

CONCLUSION

From the results, there were variances in the anterior ratio based on the researchers' measurements in Angle's classification malocclusion Classes I and II, whereas the findings in Class III were bigger than the Bolton ratio, where the lower teeth were larger than the maxillary teeth, notably in the anterior ratio.

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