# Bolton Ratio in Different Groups of Malocclusions in Iraqi Population

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**Abstract**

It is important clinically to evaluate Bolton ratio and it influences the organizing of orthodontic management. The objective of the present study was to relate anterior and overall Bolton ratios in dissimilar Angle's malocclusion classes of Iraqi sample with Bolton's standards, and also to find if there is any gender difference. This study involved dental casts from one hundred twenty subjects 14-25 years old divided into three main malocclusion groups Class I, Class II and Class III from Saladin city. Statistically no significant differences in anterior and overall Bolton's ratios were recorded in malocclusion classes and no significant gender difference in any malocclusion group.

## Introduction:

One of the most common methods to determine abnormality of tooth size in clinical orthodontics studies is Bolton's analysis. It is useful aids in diagnosis and treatment planning, during assessing the coincidence amongst upper and lower mesiodistal measurement of teeth. Bolton realized the importance of the harmonious relationship between the teeth in the dental arches. The anterior Bolton ratio is percentage of summing the (6) lower anterior teeth widths divided by the total of the (6) upper anterior teeth widths, it equal to $(77.2 \pm 0.22)$ %, while the overall Bolton ratio is the percentage obtained by summing of the twelve lower teeth widths divided by the sum of the twelve upper teeth widths and it equal to $(91.3 \pm 0.26)$ % [1,2]. An anterior coefficient a proportion for the teeth width dimension was established by Neff and an ideal overbite was characterized when upper mesiodistal summation divided by the lower mesiodistal summation forming a ratio of $(1.20--1.22)$ [3]. Anterior index for the incisors and canine for ideal overbite was stated by Lundström, the optimal ratio was found to be with a mean of 79% [4].

Many researchers indicated that tooth size ratios exhibits racial, ethnic and gender differences. Smith et al. [5] stated that Bolton's ratios should not be requested to Hispanic or black and white males, and were only applied to white females. They also reported that the total Bolton ratio significantly larger in males than females. Lavell [6] concluded that Negroids had greater anterior and overall Bolton ratios than Mongoloids and Caucasoids, regardless of racial origin, the overall Bolton ratio was consistently greater in males than in females. Other studies shown a statistically significant correlations between malocclusion groups and tooth size ratios [7-11]. Ta et al [7] found that the total Bolton ratio were significantly larger in Class three than Class two malocclusion group and no significant differences of anterior Bolton ratio in Class one, Class two and Class three malocclusion groups in southern Chinese children, Nie and Lin [9] registered significant differences of the total and anterior Bolton ratios between the malocclusion classes in Chinese population. Araujo and Souki [8] found that discrepancy of anterior tooth size was significantly greater for Angle Class three groups than Class one and Class two groups of a Brazilian sample. Fattahi et

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al[10] observed that the anterior and total Bolton ratio was significantly greater in Class III group compared with Class II (division one and division two) groups of Iranian populace. Barbara et al observed statistically significant differences of total and anterior Bolton ratio of all malocclusion classes for both genders[11].However, other reports have stated no statistically significant differences of tooth size ratios in dissimilar malocclusion groups of various populations[12-15].Toshiya *et al* [12] reported no significant differences in anterior or overall Bolton ratio in Class one, Class two, and Class three malocclusion groups among a Japanese peoples, no statistically significant sex differences were noticed in the malocclusion groups. Norderval et al 16 found that Bolton anterior ratio was significantly higher in the lower incisal crowding group compared with good alignment group. Nourallah e al.,17 applied Bolton's analysis on Syrian samples and reported similar values to the original data of an American population. They concluded that Bolton analysis can also be used on an Arabian or at least a Syrian population. The objectives of the present study were to find possible gender differences in overall and anterior Bolton tooth size ratios and to determine whether any differences exist of tooth size discrepancies in Class one, Class two and Class three malocclusion groups of Iraqi sample.

## Materials and method:

The present study was implemented on (120) pre-treatment study casts of differing malocclusion who were attending Tikrit University, College of Dentistry , Department of Orthodontics and different healthy centers in Saladin city. The type of malocclusion was evaluated depending on Angle's classification by clinical examination. Class one – the mesio buccal cusp of upper 1st permanent molar occluded in the lower 1st permanent molar buccal groove; Class two – the mesio buccal cusp of the upper 1st permanent molar is located anterior to the lower 1st permanent molar buccal groove; Class three – the mesio buccal cusp of the upper

1st permanent molar is located posterior to the lower 1st permanent molar buccal groove [18,19].

**Sample specification**

Dental casts were taken met the following standards:

1) completely erupted permanent incisors, canines, premolars and first molars 2) no obvious loss of crown width mesiodistally caused by pathological wear, dental caries, trauma, or congenital anomalies; 3)good property models 4) no history of orthodontic treatment; 4) the patient had no bridge or crown prostheses and 5) no anomalies in tooth number ,size and shape[18,19].

The age ranged 14-25 years and the sample distributed as follows:

Group I: Angle's Class one (16 males & 24 females)

Group II: Angle's Class two, (22 females & 18 males); and

Group III: Angle's Class three (17 males & 23 females).

The mesiodistal width of permanent upper and lower incisors, canines, bicuspids and 1st molars was calculated in parallel with the occlusal plane between anatomical mesial and distal contact points. The measurements were recorded using vernier calipers, (±0.1 mm accuracy). The readings were utilized to calculate both the anterior and overall Bolton ratios. The anterior ratio (The total of mesiodistal width of six lower permanent anterior teeth / The summation of mesiodistal width of six upper permanent anterior teeth X 100) while the total ratio (The total of mesiodistal width of lower permanent twelve teeth/ The total of mesiodistal width of upper permanent twelve teeth X 100)[1,2].

The measurements were recorded from each subject's dental casts by one examiner Three weeks after the first measurements, twenty dental casts were selected randomly and re measured. A paired samples t-test was employed. The difference between the two measurements was statistically insignificant.

All measurements was evaluated using the Statistical Package of Social Sciences for Windows (SPSS) software package. Means and standard deviations were analyzed for anterior and overall Bolton

ratios for all three malocclusion groups separately and also for the whole sample. ANOVA test was used to compare with Bolton's suggested standards for overall and anterior Bolton ratios, and also between groups with each other.

## Results:

Descriptive statistics and statistical comparisons of dental casts (means, standard deviations, maximum and minimum) are shown in Table 1, the results showed no statistically significant differences between males and females in anterior ratio were found in each malocclusion group, Table 2 showed no statistically significant differences between males and females in the overall ratios in all malocclusion groups Therefore, the values for males and females were combined for all other analyses.

Table 3 revealed a non-statistically significant difference from Bolton standards of anterior ratios for each malocclusion group and between malocclusion groups while Table 4 showed a non-statistically significant differences from Bolton standards of the total ratios for each malocclusion group and between malocclusion groups.

The anterior Bolton ratio ranged between (69.1 - 88.4 %), mean value (78.1). The highest mean value was in Class three groups, while the lowest mean in Class two groups, these differences were statistically a non-significant Table 3. The assessment of the total Bolton ratio in Table 4 presented that the range was (82.8 - 98.1%), mean value (92.2). The highest mean values of the anterior Bolton ratio were in Class three, while the lowest means in Class two, these differences were statistically a non-significant.

The subjects were distributed into three groups according to the normal overall Bolton ratio (91.3 ± 2%): 1. Normal overall Bolton ratio (89.3 - 93.3 %) was found in 47 subjects. 2. Low overall Bolton ratio (< 89.3%) was found in 16 subjects with wider upper teeth. 3. High overall Bolton ratio (>93.3%) was found in 57 subjects with wider lower teeth Table 5.

## Discussion:

Discrepancy of tooth size is very important element in orthodontic diagnosis and widely reported in dental literature. Many investigators [8,19-22] found that discrepancy of mesiodistal tooth-size should be measured for each subject before starting of orthodontic treatment because the correlation between the maxillary and mandibular anterior and posterior teeth is associated to excellence of orthodontic finish off. Conversely, Heusdens et al.[23] stated that the influence of generalized tooth size discrepancy on occlusion is limited because disagreeing results were existing in the literature.

The results of the present analysis regarding the prevalence of tooth size discrepancies demonstrated a non-statistically significant gender differences in both anterior and total Bolton ratios. These findings are in coincidence with those of other studies on different populations[7,9,13,14,22]. However, the findings are inconsistent with tooth size statistics stated by Uysal and Sari[20] and Moorees et al.[24], who found significant sex difference in the total Bolton ratio.

Other investigators suggested that sex difference of the total Bolton ratio attributed to populace particular [20-22,25]. However, Nuer et al.[21] found in the normal occlusion group significant statistical differences in the anterior ratio between genders, whereas, a non-significant difference were found between sexes in malocclusion groups. Fattahi et al,[26] demonstrated significant sex difference of the anterior ratio between the malocclusion classes, but not the overall ratio of an Iranian population. It is, therefore, concluded that gender differences in tooth size ratios may be population specific.

Our results for the non significant difference of the total and anterior ratio between Class one, Class two and Class three malocclusion groups with Bolton subjects suggested that the Bolton overall and anterior ratio was applicable to the Iraqi patients with different classes of malocclusion. The results of the present study supported the findings of Toshiya et al[12] , Al-Khateeb and Abu Al- haija[13] ,

Akyalcin et al[14], Uysal et al,[22] and Crosby and Alexander[27] , who also observed anon statistically significant difference in anterior or overall Bolton ratios in the malocclusion classes, as confirmed by the present study. They concluded that there is no predisposition of discrepancy of tooth size on malocclusion. While Ta et al,[7] reported in a study on Honk Kong population a significant differences of the total Bolton ratio concerning Class two and Class three malocclusion groups and anon significant differences in the anterior Bolton ratio in Angle Class one, Class two and Class three malocclusion groups, and Our results are in disagreement with Araujo and Souki,[8], Nie and Lin,[9] and Fattahi et al,[10]. They found a greater tooth size ratio in Class three malocclusion subjects compared with other classes of malocclusion and reported a statistically significant differences in tooth size ratio in various Angle malocclusion classes. The probable cause for the different results attributed to population and malocclusion type. In the present study, the ratios outside two standard deviations from Bolton's mean considered clinically significant tooth size discrepancy, Our results suggesting anon significant difference in the distribution of total and anterior tooth size discrepancy are consistent with those reported by other investigators [8,9,14,27].

Table (1): Percentage of anterior tooth size ratios  by malocclusion form and sex

| Males | | | | | | Females | | | | T test |
|---|---|---|---|---|---|---|---|---|---|---|
| Group | n | Mean | SD | Min | Max | Mean | SD | Min | Max | |
| Class I | 40 | 78.2 | 2.5 | 74.3 | 86.5 | 76.4 | 2.4 | 69.1 | 88.4 | ns |
| Class II | 40 | 76.7 | 2.7 | 72.2 | 87.4 | 77.6 | 2.6 | 71.4 | 87.3 | ns |
| Class III | 40 | 79.3 | 1.6 | 73.1 | 85.8 | 80.1 | 1.9 | 75.6 | 86.5 | ns |
| Total | 120 | 78.1 | 2.8 | 72.2 | 87.4 | 78.03 | 2.9 | 69.1 | 88.4 | ns |

SD ; Standard Deviation; ns, non-significant; Max, Maximum; Min, Minimum; n, number.

Table (2): Percentage of overall tooth size ratio by malocclusion form and sex

| Males | | | | | | Females | | | | T test |
|---|---|---|---|---|---|---|---|---|---|---|
| Group | n | Mean | SD | Min | Max | Mean | SD | Min | Max | |
| Class I | 40 | 91.9 | 2.5 | 85.8 | 95.7 | 92.1 | 2.4 | 85.4 | 96.2 | ns |
| Class II | 40 | 90.8 | 1.7 | 83.4 | 97.2 | 90.6 | 2.6 | 82.8 | 98.1 | ns |
| Class III | 40 | 94.1 | 1.6 | 86.4 | 96.4 | 93.7 | 1.9 | 87.7 | 96.6 | ns |
| Total | 120 | 92.2 | 2.7 | 83.4 | 97.2 | 92.1 | 3.1 | 82.8 | 98.1 | ns |

SD ; Standard Deviation; ns, non-significant; Max, maximum; Min, minimum; n, number.

Table (3): Percentage of anterior tooth size ratio  matched with Bolton ratio

| Group | n | Mean | SD | Min | Max | SE | ANOVA |
|---|---|---|---|---|---|---|---|
| Bolton | 55 | 77.2 | 1.66 | 74.5 | 80.4 | 0.22 | ns |
| Class I | 40 | 77.3 | 1.7 | 69.1 | 88.4 | 0.26 | ns |
| Class II | 40 | 77.15 | 2.6 | 71.4 | 87.4 | 0.28 | ns |
| Class III | 40 | 79.7 | 1.7 | 73.1 | 86.5 | 0.29 | ns |
| Total | 120 | 78.1 | 1.8 | 69.1 | 88.4 | 0.27 | ns |

SD ; Standard Deviation; ns, non-significant; Max, maximum; Min, minimum; n, number

Table (4): Percentage of total tooth size ratio matched with Bolton ratio

| Group | n | Mean | SD | Min | Max | SE | ANOVA |
|-------|---|------|----|----|-----|----|-------|
| Bolton | 55 | 91.3 | 1.91 | 87.5 | 94.8 | 0.26 | ns |
| Class I | 40 | 92 | 2.7 | 85.4 | 96.2 | 0.29 | ns |
| Class II | 40 | 90.7 | 2.4 | 82.8 | 98.1 | 0.24 | ns |
| Class III | 40 | 93.9 | 2.6 | 86.4 | 96.6 | 0.20 | ns |
| Total | 120 | 92.2 | 1.9 | 82.8 | 98.1 | 0.28 | ns |

SD; Standard Deviation; ns, non-significant; Max, maximum; Min, minimum; n, number.

Table (5): Overall Bolton ratio distribution according to malocclusion

| Group | Low Bolton ratio | | Normal Bolton ratio | | High Bolton ratio | | Total |
|-------|-----|-----|-----|-----|-----|-----|-----|
| | n | % | n | % | n | % | n |
| Class I | 5 | 12.5 | 17 | 42.5 | 18 | 45 | 40 |
| Class II | 7 | 17.5 | 18 | 45 | 15 | 37.5 | 40 |
| Class III | 4 | 10 | 12 | 30 | 24 | 60 | 40 |
| Total | 16 | 13.3 | 47 | 39.2 | 57 | 47..5 | 120 |

n, number.

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