Bolton's Ratios for Patients with Different Angle's Malocclusions Seeking Orthodontic Treatment in Kurdistan Region

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الخلاصة

الاهداف:تهدف الدراسه الى تقييم تأثير اختلاف المعدل الكلي والمعدل الجزئي لحجم الاسنان بين الذكور والاناث في اقليم كوردستان ومقارنتها مع النسب الثابته لبولتون . **المواد وطريقة العمل**: تشمل هذه الدراسه ١٦٠ زوجا من القوالب السنيه (٨٠ ذكور , ٨٠ اناث) حيث تم اختيارها عشوائيا من سكان اقليم كوردستان العراق و لمرضى يعانون من اختلافات في الاطباق السنيه , تتراوح اعمارهم مـابين (١٦ و ٣٤), بعد تقييـم البعد الانسي الوحشي لكل سن باستخدام فرجار رقمي , المعدل الكلي والمعدل الجزئي للبعد الانسي الوحشي تـم قياسـها باسـتخدام نسـب بولتـون. **النتائج**: المعدل الكلي للبعد الانسي الوحشي اعلى عند الذكور والاناث (٩٢.٥٤ و٩١.٧٣) عندما تمت مقارنتها بالنسب الثابته لبولتون (٩١.٣) , والمعدل الجزئي للبعد الانسي الوحشي ايضا كان اعلى عند كل من الـذكور والانـاث (٧٩.٩٧ و ٧٩.٢٢) عندما تمـت مقارنتها بقيم بولتون الثابته (٧٧.٢). فروقات معنويه كبيره لوحظت بين الدراسه الحاليه ونسب بولتون الثابته, في حين لـم يتم ملاحظت اي فروقـات معنويه بـين اختلاف الاجناس واختلاف الاطباق السنيه. **الاستنتاجات**:اختلاف الاجناس لايؤثر على قيم بولتون, بين اختلافات الاطباق السنية.

ABSTRACT

Aims: The study aimed to evaluate the overall and anterior Bolton's ratio between females and males of the Kurdistan population, and then compare it to Bolton's original ratio. **Materials and methods**: This cross-sectional study consisted of 160 orthodontic models (80 males, 80 females) that randomly selected from the Kurdistan Iraq population for patients seeking orthodontic treatment, ranging in age from 16 to 34 years. After evaluating the width of each tooth separately using digital caliper, anterior and total ratios were calculated by a formula presented by Bolton. **Results**: The study's overall Bolton's ratio was significantly higher for both females and males at 92.54 and 91.73, respectively, when compared to that of Bolton's original value of 91.3; the anterior Bolton's ratio was also significantly higher at 79.97 for males & 79.22 for females, when compared to that of Bolton's original value of 77.2. The high significant difference was observed between the current study and Bolton's ratios, with p-value of 0.01, whereas no significant gender differences in any malocclusion group have been found. **Conclusions**: No gender effect on Bolton's ratios among all Angle's classification types.

Keywords: Bolton ratios, Tooth size discrepancy, Kurdistan

INTRODUCTION

Delivering an attractive natural smile is a key element in orthodontic patient satisfaction, as teeth master the beauty of the face (esthetic) in addition to speech (phonation) and mastication [1, 2, 3].

The early prospectors of orthodontics realized the importance of the relation of the teeth in the same and opposite arches should be harmonized in addition to other structures in the face and the mouth, including the tongue, muscles of mastication, and the bones of maxilla and mandible. Spacing and crowding represent the most functional and esthetic problems for patients who attend orthodontic clinics [3, 4]. Since the fundamental goal of the orthodontic procedure is to correct alignment of teeth, the accurate evaluation and analysis of dental crowding and the space required to minimize it is important for the successful prognosis of orthodontic treatment, knowing the amount of crowding would be advantageous in other respects too like public health programs and epidemiological studies. By subtracting the required space from the available space, the degree and amount of spacing and crowding can be calculated [5].

Every orthodontist needs to have an idea about the normal growth of dentition and all changes within the arches with age [6] and having good knowledge about teeth sizes for good treatment planning and good post-treatment occlusion between maxilla and mandible.

A discrepancy in this ratio can instruct treatment plan as if the re approximation is enough or extraction of specific teeth is required, it could also offer whether to include esthetic procedures such as composite bonding, prosthetic reconstruction, or crown recontouring [7].

Variations in tooth size and width are correlated to ethnic groups [8, 9], as in many other attributes, the size of teeth differs from male to female, female teeth usually smaller than male teeth [9].

This study is designed to calculate the overall and anterior Bolton ratios in Angle Class I, II, and III malocclusions, and to look over the correlation between tooth size discrepancies in both males and females in Iraq specifically in Kurdistan.

Therefore, the aim of the study was:

1. To evaluate the anterior and overall Bolton's ratios in Angle Class I, II, and III malocclusions in Kurdistan region

2. To differentiate the obtained anterior and overall Bolton's ratios in Angle Class I, II, and III malocclusions between females and males of the same population

3. To compare the obtained anterior and overall Bolton's ratios in Angle Class I, II, and III malocclusions of the Kurdistan population to Bolton's original ratio.

MATERIALS AND METHODS

The present study started by selecting 500 orthodontic models of patients seeking orthodontic treatment at private and governmental clinics in Kurdistan, Specifically in Sulaymaniyah and Erbil cities.

Kurdistan, which is an autonomous region in northern Iraq, is bordered by Iran from the east, Syria from the west, and Turkey from north and Iraq from the south. Erbil is the regional capital of Kurdistan (known as Hewlêr in Kurdish).Sulaymaniyah is another City in Kurdistan which is located in the east not far from the Iran-Iraq border.

Different ethnic groups live in Kurdistan including Kurds, Arabs, and Turkmans, with an estimated population of 5.123 million, the population shows an overall gender-balance, revealing an index of 100 males per 100 females [10].

Data collection started at the same time in both cities from 24th of August till 19th of October, afterward the 500 casts has undergone examination and sorting to meet the inclusion criteria, at which 200 casts didn't match and had been excluded.

Eventually, 160 pre-treatment casts which consisted of **(80 males and 80 females)** have been randomly selected from the remained 300 casts to have an equal comparison between the two genders. The study group consisted of 23 Class I patients (12 males and 11 females), 107 Class II patients (52 males and 55 females), and 30 Class III (16 males and 14 females) as shown in (Table 1).

Table (1): Sample distribution

Gender		Class I	Class II	Class III	Total
	Male	12	52	16	80
	Female	11	55	14	80
Total		23	107	30	160

The inclusion criteria were:

1. Age ranges from 16 to 34 years.

2. Class I, II, III molar and canine relationship.

3. No large interproximal restoration

4. No previous orthodontic treatment.

5. All permanent teeth fully erupted in both jaws from central incisor to the first molar

6. Good quality cast models

7. Absences of attrition, abrasion, and erosion [3]

Two examiners performed the measurements starting from the first molar, the greatest interproximal width (from mesial to distal contact point) has been measured by using sliding stainless digital calipers (Markenlos, china) having an accuracy of 0.01mm as shown in Figure 1 [11, 12].

Figure (1): Measurement of mesio-distal width

Next, the calculations of the summations were performed by measurement of the width of the teeth of the maxillary and mandibular arches for total and anterior ratios [13, 14].

Then Bolton's overall ratio (first molar to first molar) and anterior ratio (canine to canine) was calculated by using the following formula:

Overall ratio (%) = Sum of mandibular 12/sum of maxillary 12) × 100

Anterior ratio (%) = Sum of mandibular anterior teeth/sum of maxillary anterior teeth× 100 [4, 7, 14].

Calibration

Intra examiner and inter examiner calibration were performed to reduce the possibility of mistakes by randomly selecting 10 cases with different malocclusion types as samples from the 160 casts, the inter examiner made analyses of these cases twice with an interval of 2 weeks. Afterwards, the same samples had been evaluated by intra examiner separately with a period of one week between the two examina-

tions. The paired t-test was performed to find the variations between the two results, the readings showed a *p*-value of 0.99 no significant difference.

Statistical analysis

After the collection and coding of the data, the results were analyzed by windows based SPSS program using t-independent test and ANOVA test with a level of significance at $p \leq 0.05$.

RESULTS

The statistical t-test analysis in Table 2 shows a gender comparison of overall and anterior ratios of Kurdistan population, the mean value of anterior ratio for males was 79.97 whereas for females was 79.22. The mean value of overall ratio for males was 92.54 whereas for females were 91.73, even though both the values were somewhat more in males than in females, no significant variation was observed between them. Figure 2 shows the graphical comparison of the same result.

Table (2): Comparison overall and anterior ratios between males and females

	Gender	N	Mean ± SD	P-value
Overall Bolton	Male	80	92.54 ± 5.74	0.30
	Female	80	91.73 ± 3.98	
Anterior Bolton	Male	80	79.97 ± 4.85	0.32
	Female	80	79.22 ± 4.59	

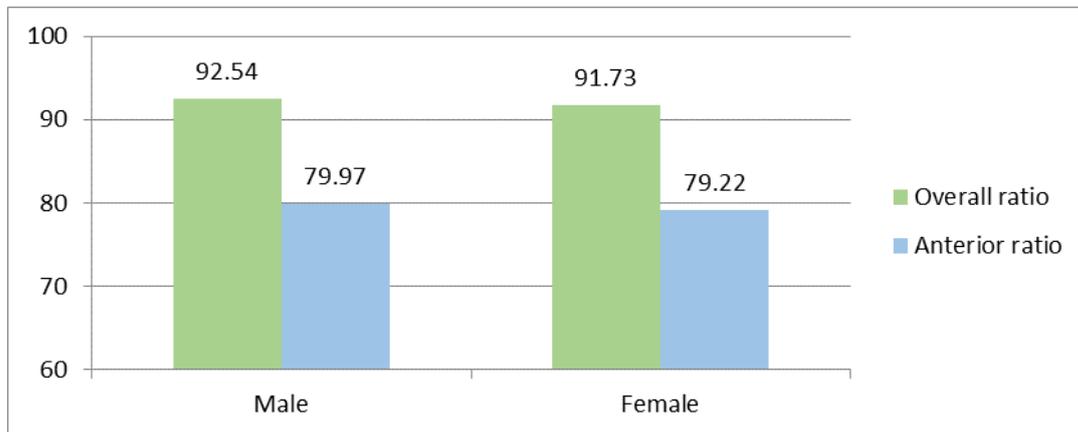$P > 0.05$. N= Number; SD=Standard deviation

Figure (2): Gender-wise differentiation of the anterior and overall ratios of the study

Table 3 and 4, shows the number of taken cases from each class of malocclusion separately, and the com parison of anterior & overall ratio in addition to *p*-value using one way ANOVA test.

Table (3): Comparison of Anterior Bolton's ratio among different malocclusion types

	N	Mean	P-value	Mini - Maxi
Class I	23	91.7857	0.84	85.70 - 112.10
Class II	107	92.3000		84.20 - 111.50
Class III	30	91.8200		79.60 - 109.10
Total	**160**	**92.1361**		**79.60 - 112.10**

Table (4): Comparison of overall Bolton's ratio among different malocclusion types

	N	Mean	P-value	Mini - Maxi
Class I	23	79.17	2.95	71.20 - 89.23
Class II	107	79.98		66.00 - 96.14
Class III	30	78.52		66.80 - 90.00
Total	**160**	**79.59**		**66.00 - 96.14**

The statistical t-test analysis in table 5 & figure 3 show the comparison of anterior and overall ratios of females and males separately with that of Bolton's standard ratios. The males as well as fe-

males ($p \leq 0.01$) in the study population had significantly higher overall ratio compared to that of Bolton's values. Significant difference ($p \leq 0.01$) was detected for both genders and among all groups of malocclusion when comparison has been performed between anterior ratio of the study to Bolton's standard ratio.

Table (5): Comparison of Bolton's standard ratio to study population

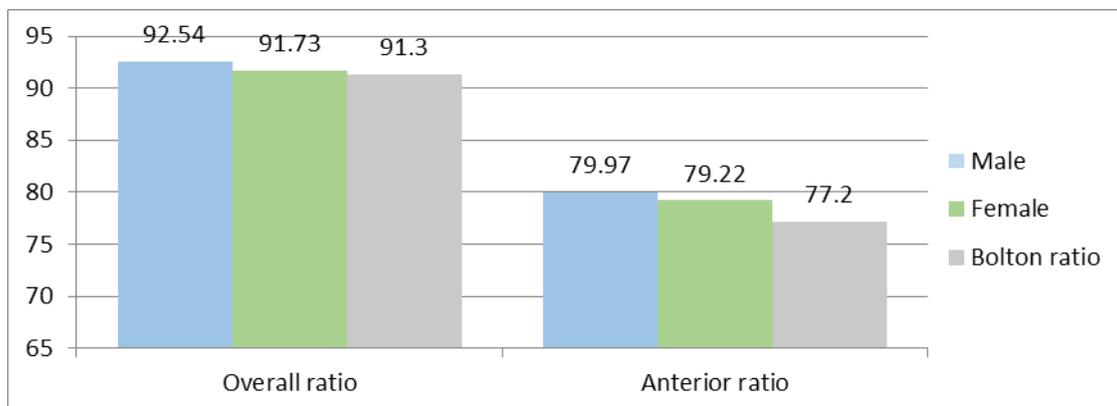| Ratios	Gender	Population	Bolton's value	P-value
Overall Bolton	Male	92.5	91.3	≤ 0.01
	Female	91.7	91.3	≤ 0.01
Anterior Bolton	Male	79.9	77.2	≤ 0.01
	Female	79.2	77.2	≤ 0.01

Figure (3): Overall and anterior ratios of females and males of study group compared to Bolton's standard values

Since a non-significant difference was observed in both females and males, the mean value was taken to represent the whole sample. Table 6 shows the comparison using t-test of overall and anterior ratios of Kurdistan population (both male & female) with the values obtained from Bolton's study. Overall ratio of Kurdistan population showed highly significant at $p \leq 0.01$, i.e., 92.2 ($p \leq 0.01$) when compared to standard Bolton's values (91.30). Furthermore, the anterior ratio of Kurdistan population also showed highly significant at $p \leq 0.01$, i.e., 79.6 ($p \leq 0.01$) when compared to standard Bolton's values (77.20).

Table(6): Comparison of total population to Bolton's value

Ratios	Population	Bolton's value	P-value
Overall Bolton	92.2	91.3	≤ 0.01
Anterior Bolton	**79.6**	**77.2**	**≤ 0.01**

DISCUSSION

The perception of aesthetics differs from one to another person and is impressed by social environment and personal experiences [15].

Among the various diagnostics tools used in order to achieve perfect occlusion with optimal overbite and overjet, Bolton's tooth size analysis is critically important, and it's considered to be the most reliable and common method for detecting interarch discrepancy [7].

Due to ethnic and gender variations, various studies suggest that Bolton's ratio cannot be universally applied across the populations. In addition, Bolton's ratio can differ in patients with different malocclusions; the original Bolton study was acquired from 55 samples with ideal occlusion, 11untreated orthodontically & 44 orthodontically treated [8,7,16].

The Relationship between mandibular and maxillary teeth drew the attention of the examiners over decades due to its importance [2], Initial investigations on tooth size were given by Black (1897) [17] and Neff (1949) [18].Then Bolton presented his anterior and overall ratios by studying 55 model patients having perfect class I occlusions [7, 19].

Bolton's analysis studies the interrelation of the mesio-distal width of the maxillary teeth to that of the mandibular teeth, according to Bolton the anterior ratio should be 77.2 ± 0.22 per cent and that's obtained by adding the widths of the six anterior lower teeth divided by the sum of the six anterior upper teeth, while overall ratio should be 91.3 ± 0.26 per cent calculated by adding the widths of the 12 lower teeth divided by the sum of the widths of the 12 upper teeth [13].

That's why it's very helpful in clinical settings and provides perception into functional and esthetic result of orthodontically treated cases, obliterating the need for a diagnostic set-up [7, 20].

In the present study, Bolton's ratio derived by using randomly selected 160 samples of different malocclusions. the data were collected from samples of untreated individuals seeking orthodontic treatment, then the anterior and overall ratios were contrast between two genders, it showed no significant difference in either of them, it might be due to close distribution of the mesiodistal width of teeth in females and males; the result of the present study support the findings done by Jamal.[21] in Tikrit city one of the Iraq cities & Ta. et al.,[22] in Southern Chinese population. Alam *et al*., [20] conducted their study in different malocclusions also stated that there is no gender variation in the overall and anterior ratios. Nourallah et al., [4] also obtained the same results concerning the gender difference when he applied the Bolton standards upon the Syrian population, Fattahi et al., [23] studied the Iranian population, although his overall ratio didn't show a significant difference, the anterior ratio showed significant gender variation among classes of malocclusion, therefore its concluded that gender varia-

tion in tooth size ratios can be population specific and it's not applied to our study population.

The result of the study shows the anterior and overall Bolton ratio through class I, II and III too, where no significant difference had been observed, this result was similar to study done by and Al-Khateeb & Abu Alhaija [24], Jabri et al., [25] in Nanjing, China, Endo et al., [26] among a Japanese peoples and Basaran et al., [27] observed no considerable difference for both ratios between the groups of malocclusion, which are in disagreement with the results of Wędrychowska-Szulc et al., [13] that revealed significant differences of anterior and overall Bolton ratio among malocclusion classes for males and females, Othman and Harradine [28] and Nie and lin [29] showed the same result.

As there was no considerable difference in overall and anterior ratios between two genders, the ratios were counted as a whole in order to compare it with that of Bolton [7].

The result of anterior and overall ratios in this study was significantly higher than Bolton's value. Studies conducted by Hashim et al., [3] in Qatar, Jaiswal and Paudel [30] in Nepalese population and Subbarao et al., [31] in Indian population also revealed highly significant at $p \leq 0.01$ for both overall and anterior ratios upon comparison with Bolton's standard values.

In disagreement, Trehan and Sharma [9] ratios were similar to Bolton's values with no significant variance.

Bolton has designed his calculations following the observation that tooth size was important for ideal occlusion; the measurements were based on 55 model patients with perfect malocclusion decades ago (1958) and it consisted of only Caucasian population, after many years of revolutions and changes in life style of people among divergent populations.

New studies indicate that modern postindustrial human populations are more susceptible to dental crowding due to narrowing of the dental arches because of increasing in processing of food, most of these investigations showed that the recent inclination in the rate of malocclusions among populations must be assigned to the availability of a more processed diet that needs less masticatory action, moreover dental crowding can be seen in lower frequencies in some populations which might be an outcome of a homogenous genetic background revealed in a small population [32].

All these factors in addition to different methods of measuring, Bolton's anterior and overall ratio cannot represent samples from other population and races, after applying Bolton analysis on any sample, high discrepancy will be noticed compared to Bolton ratios which could be the reason for diverse findings.

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