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Original Research Article

Tooth size discrepancy in different malocclusion groups in Libya: a pilot study.

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ABSTRACT:

Background: Orthodontists need to evaluate intermaxillary tooth size discrepancy (TSD) prior to initiating treatment in order to achieve a stable treatment. Thus, the aim of the present study was to determine the prevalence of TSD in Libyan subjects among different malocclusion groups.

Methods: A sample of 60 dental casts of Libyan subjects with different types of malocclusions (Class I, Class II div 1 and Class III) were included in the study. Each malocclusion group (20 dental casts) included equal numbers of males and females, 12-17 years of age. Mesio-Distal tooth measurements were extracted to compute the anterior and overall TSD ratios. Paired Student t-test was used to detect significant discrepancies between the paired teeth measurements. Analysis of Variance (ANOVA) and Tukey Honestly tests were undertaken to detect significant discrepancies among the malocclusion groups.

Results: Paired t-test revealed that there were no significant discrepancies between the paired tooth widths except for the upper first molars, upper first premolars, lower lateral incisors and lower canines ($P < 0.010$). ANOVA found no significant differences in the mean anterior TSD ratio in regard to malocclusion groups. However, a significant disparity was noticed in the mean overall TSD ratio among the different malocclusion categories ($P < 0.04$).

Conclusion: Statistically significant TSD between the examined malocclusion groups were observed only in the mean overall TSD ratio.

Keywords: Libyan, malocclusion, orthodontics, tooth size discrepancy

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INTRODUCTION

The attainment of a normal occlusion with proper inter-arch relationship, acceptable overbite and overjet and with proper interdigitation requires the presence of a maxillary and mandibular teeth proportional in size [1]. This conclusion was based on Bolton's [1] evaluation of 55 American participants with normal occlusion. Conducted research in this area has noticed a correlation between the Mesio-Distal [MD] tooth width of the maxillary and mandibular teeth [1-3].

Firstly, Bolton [1] found that in a normal occlusion, the overall ratio attained by dividing the sum of the MD tooth width of all mandibular permanent teeth except the 2nd and 3rd molars by the sum of the MD tooth width of the corresponding 12 maxillary teeth was $91.3\pm 0.26\%$, and the anterior ratio obtained by dividing the sum of the mandibular six anterior teeth by the corresponding maxillary teeth was $77.2\pm 0.22\%$. Bolton [1] concluded that these ratios are assessment aids that have to be employed in orthodontic diagnosis to provide the orthodontists with insight into the functional and aesthetic prognosis of the examined cases without using a diagnostic setup procedure. Consequently, Bolton [4] proposed that a ratio greater than 1 standard deviation [SD] from the described average values would require a diagnostic assessment. Crosby and Alexander [2] and Freeman et al. [3] have defined a significant difference as a value of greater than 2SD from Bolton's mean. The occurrence of a significant Tooth Size Discrepancy (TSD) in the overall population has been cited to be about 5% [5]. Bolton [4] observed that normal occlusion could be achieved by a wide range of MD tooth width as long as the intermaxillary tooth size ratio is within the normal range.

Subsequent studies observed that Bolton ratio varies among different populations and ethnicities. Therefore, many studies were undertaken to determine the Bolton ratio for each population [6-10]. Bolton's ratio was computed

for white Americans [2,8], black Americans [8], Turkish [11,12], Spanish [13] South Americans [7,14,15], Chinese [16], Jordanians [17] Saudi's [18] and Libyans [10]. Most of the research used study casts of orthodontic patients to determine the ratio [2,3,7,8,11,14,16,19,20]. A limited number of studies derived their examined samples from a community selected from schoolchildren [10,17,21]. Bugaighis et al. [10] derived their data from a random stratified sample of Libyan subjects; 12-17 years old, attending schools in Benghazi city, Libya. They concluded that there was no sexual dimorphism in both the overall and anterior Bolton ratios. Furthermore, the overall tooth size ratio in the examined subject was similar to that reported by Bolton [1]. However, their anterior tooth size ratio was significantly greater than the corresponding Bolton ratio [10]. A discrepancy of 2SD or more in the overall ratio was observed in 4.2% (anterior ratio) and in 3% (overall ratio) of the Libyan cohort which are among the lowest reported in the literature. However, the association between each malocclusion category and TSD could not be investigated in Bugaighis et al. study [10] due to the insufficient number of the recruited individuals with Class II division 2 and Class III malocclusions for undertaking reasonable comparative analysis.

A number of researchers have evaluated the relationship of TSD and malocclusion categories in different populations [6,8,11,14,16,17,22]. Mandibular tooth size excess in class III malocclusion has been previously reported [6,19]. While, no significant differences in the inter-arch MD tooth width in class II malocclusions was noted by Crosby and Alexander [2].

There appeared to be no published study on the prevalence of TSD among the different malocclusion groups in Libyan subjects. Therefore, the aim of the present cross sectional study was to determine the overall and anterior TSD ratio for class I, II division 1 and III malocclusion in a group of Libyan subjects.



METHODS AND MATERIALS

This retrospective cross-sectional observational study was undertaken at the Department of Orthodontics, Faculty of Dentistry, Benghazi-Libya. Ethical approval was secured from the Faculty of Dentistry, University of Benghazi. The assessment tool consisted of dental casts of patients seeking orthodontic treatment, selected from the archives of the Orthodontic Department, Faculty of Dentistry, University of Benghazi and from the Specialized Libyan Orthodontic and Dental Center, Benghazi, Libya.

The following inclusion criteria were identified; dental casts of individuals of Libyan descent with no craniofacial anomaly, hypodontia, or retained primary teeth. All permanent teeth were fully erupted up to the second molars without significant attrition, tooth caries, or restorations that might interfere with precise tooth measurement.

The examined sample comprised 60 dental casts; 20 sets of the following malocclusion categories; Class I, Class II division 1, and Class III. Each malocclusion group included dental casts of equal number of males and females, 12-17 years of age. MD tooth measurements were extracted directly following the method reported by Moorrees and Gron [23] where the distance between the mesial and distal points of contact of each tooth was computed. The position of the caliper had to be perpendicular to the occlusal surface of the measured tooth. The measuring tool was an electronic digital veneer caliper (Figure 1) of an accuracy of 0.01mm (0-150 mm Digital Calliper/ Lin 48772). The measurements were undertaken by one operator (F.E). An Excel spreadsheet file was prepared including all the recorded tooth measurements. The anterior and overall TSD ratios were computed according to Bolton's equation.

METHOD ERROR

To determine the reliability of the method, thirty randomly selected dental casts were re-

examined at a two-week interval by one examiner (F. E) to assess intra-operator measurement reproducibility. Paired *t-test* revealed no significant differences between both measurements at $P>0.05$. Intra-class Correlation Coefficient (ICC) was found to be greater than 0.90 indicating an excellent level of reproducibility between both trials.



Figure 1: electronic digital veneer caliper used for the measurement of the MD width of teeth

STATISTICAL ANALYSIS

The data were analyzed using the Social Package of Statistical Science software [SPSS] version 17 (Chicago, IL, USA). Shapiro-Wilk test revealed that the data was normally distributed. Paired *t-test* was undertaken to detect significant differences between paired tooth measurements. Analysis of Variance (ANOVA) and Tukey Honestly tests were undertaken to detect significant discrepancies among the malocclusion categories. The level of significance was set at $P<0.05$.

RESULTS

The mean age of the cohort was 14.2 years (SD= 1.3). Paired *t-test* revealed that there were no significant discrepancies between the paired MD tooth widths except for the upper first molars, upper first premolars, lower lateral incisors and lower canines at $P<0.012$ (Table 1). ANOVA demonstrated that there were no significant differences in the anterior TSD ratio in regard to malocclusion groups (Table 2). However, a significant disparity was noticed in the mean overall TSD ratio among the different malocclusion categories ($P<0.04$).

Table 1: Mean and SD for upper and lower MD tooth width (mm) in males and females and p value for statistical significant differences at $P < 0.05$

Arch	Tooth	Right		Left		P value
		Mean	SD	Mean	SD	
Maxillary	Central incisor	8.46	0.65	8.42	0.62	<0.375
	Lateral incisor	6.62	0.51	6.52	0.60	0.070
	Canine	7.59	0.50	7.60	0.44	0.683
	First premolar	6.44	0.59	6.64	0.46	0.003
	Second premolar	6.23	0.55	6.30	0.51	0.285
	First molar	10.27	0.74	10.12	0.63	0.001
	Cumulative tooth width	45.61		45.60		
Mandibular	Central incisor	5.03	0.74	5.08	0.63	0.325
	Lateral incisor	6.41	0.52	5.98	0.44	0.009
	Canine	6.48	0.52	6.62	0.48	0.012
	First premolar	6.65	0.57	6.49	0.49	0.459
	Second premolar	6.97	0.52	6.93	0.53	0.402
	First molar	10.82	0.73	10.79	0.71	0.500
	Cumulative tooth width	42.36		41.89		

Table 2: Mean (mm), SD, SEE and statistical significance ($P < 0.05$) for the anterior and overall tooth size discrepancy ratios for the different occlusal categories

TSD ratio	Occlusion	Mean	SD	SEE	P
Anterior Ratio	Class I	74.42	2.06	0.46	NS
	Class 2 div1	76.29	3.02	0.88	NS
	Class III	76.65	4.09	0.92	NS
Overall Ratio	Class I	89.91	1.79	0.40	S
	Class 2 div1	91.38	3.06	0.68	S
	Class III	92.05	2.96	0.66	S

The lowest anterior and overall TSD ratios were observed among class I malocclusion group at 74.42% (SD=±2.06) and 89.91% (SD= ±1.79) respectively, followed by class II division 1 malocclusion with greater variations at 76.29% (SD=3.02) and 91.3% (SD=3.06) correspondingly. Class III TSD ratios were 92.05% (SD=2.96) and 76.65 (SD=4.09) in this order.

Table 3 compares the frequency of TSD of >1SD and >2SD from the Bolton's mean anterior and overall tooth ratios among the examined

malocclusion groups. The percentage of subjects with clinically significant deviations (>2SD) from the anterior mean Bolton discrepancy was found to be at 15%, 10% and 20% respectively for class I, class II and class III malocclusions correspondingly. Whereas, the occurrence of TSD of >2SD from the Bolton means in the overall, all ratio was 10%, 10% and 15% in this order in each of class I, class II division 1 and class III malocclusion groups respectively.



Table 3: The distribution of subjects with anterior and overall tooth size discrepancy in the examined class I, class II division 1, and class III malocclusion groups (%)

	Class I		Class II division 1		Class II division 1	
	Anterior Ratio %	Overall Ratio %	Anterior Ratio %	Overall Ratio %	Anterior Ratio %	Overall Ratio %
	Class I	Class I	Class II div 1	Class II div 1	Class III	Class III
Bolton $\pm 1SD$	65	60	80	70	55	65
Bolton $\pm 2SD$	20	30	10	20	25	20
Bolton $> \pm 1SD$	15	10	10	10	20	15

DISCUSSION

The present research is a retrospective cross-sectional observational study exploring TSD between different categories of malocclusions. Orthodontists need to diagnose the location and amount of TSD prior to initiating treatment. This assists in determining whether to reduce tooth size (interdental stripping) or to add (composite building or veneers) to the tooth structure, either to open or close spaces in opposite arch during treatment planning to achieve an acceptable and stable treatment outcome [17].

The age range in the present study [12-17 year old] was chosen to be relatively young to minimize the impact of tooth wear and attrition on tooth width measurements. Furthermore, tooth size was extracted from study casts which enhances accuracy and permits re-measurement when desired [24].

There is a lack of consensus among the published studies regarding the existence of male/female tooth size discrepancy (TSD). Whilst, the presence of sexual dimorphism in TSD was noted in a number of studies [6,8,25], others did not observe such discrepancies [11–14,16,20]. In their literature review, Othman and Harradine [26] concluded that there were no male/female apparent discrepancies in Bolton’s ratios,

although, some of the revised studies described smaller females tooth dimension compared to males. Bugaighis et al. [10] noticed that there were no significant differences in anterior and overall Bolton ratios between males and females Libyan subjects. Therefore, in the present study, Bolton ratio was computed for each group with an equal number of both males and females study casts.

Significant differences were noted between the paired MD tooth widths of the upper first molars, upper first premolars, lower lateral incisors and lower canines. However, those differences were not clinically significant and considered to be within the range of measurement errors. Similar findings with clinically non significant discrepancies in the paired MD tooth width were noticed in Libyan subjects examined by Bugaighis et al. [10]. On the other hand, definite differences in paired MD tooth width were reported in Jordanian students [27]. Also, similar paired MD tooth measurements were observed in Yemeni’s population [22] and in Saudi subjects [18] from Arabic societies, in addition to subjects from other ethnicities [28].

In the present study, a class II division 2 malocclusion group was not included in the



analysis. This is because of the small number of subjects with such type of malocclusion. Bugaighis et al. [29] found that a mere of 3.5% of Libyans are presented with class II division 2 malocclusion leading to difficulties in collecting sufficient numbers of cases to undertake a meaningful comparative statistical analysis. This is considered to be a limitation in the present study. However, it is our aim to continue data collection to undertake a similar study with greater sample size representing all the malocclusion categories including class II division 2 malocclusion group.

This study found no statistically significant difference in the mean anterior TSD ratios among the examined malocclusion groups. However, a significant discrepancy was observed in the mean overall TSD ratio. The frequency of relative mandibular tooth width excess (for the anterior and overall ratios) was greater in class III cases. Similar findings were reported in previous studies undertaken on Americans [19], Iranians [30] and Chinese [16]. Those researchers suggested that this finding was most probably due to the accumulation of a relatively small size increase of the lower teeth which was not sufficient to be statistically significant. On the other hand, a number of studies had failed to demonstrate significant discrepancies in TSD among different malocclusion cohorts from Jordan [27], Yemen [22], America [2], Saudi Arabia [18] and Turkey [11].

The SEE entitles errors elaborated in the use of the employed equations. As the value of SEE declines, usefulness of the prediction equation improves. The SEE in the present study ranged from 0.46 to 0.92 mm. The values were higher for class II division 1 and class III malocclusions compared to class I malocclusion. For instance, nearly 92% of all potential class III cases would have an estimated anterior TSD ratio accurate to within 1 SEE (0.92 mm) of their actual size. The SEE values in the current study (ranging between 0.92 mm and 0.46 mm) are similar to those reported for the Iranians [30] and Turkish subjects [12].

The occurrence of TSD outside 2SD from Bolton ratio was employed as the index of the clinical significance of tooth size discrepancy of our cohort. The occurrence of a significant TSD (>2SD) from the Bolton's mean for a random sample of Libyan school children was observed in 4.2% (anterior ratio) and in 3% (overall ratio) which is among the lowest reported in the literature [10]. In the present study, TSD of >2SD from the Bolton's mean in the anterior ratio of class I, class II division 1 and class III malocclusion was found to be at 15%, 10% and 20% respectively. Whereas, the occurrence of TSD of >2SD from the Bolton means in overall, all ratio was 10%; 10% and 15% in this order in each of class I, class II division 1 and class III malocclusion groups correspondingly. The examined sample in the current study was collected from subjects presented with malocclusions and who were seeking orthodontic treatment; thus it is expected that they will have a greater TSD compared to the former study where the sample was random and was collected from school children.

The findings of the present study are considered as preliminary results that could not be generalized to represent Libyan subjects seeking orthodontic treatment. More studies are recommended with a larger sample size including all the categories of malocclusions across the whole country

CONCLUSION

- Statistically significant differences were noted between the paired MD tooth widths of the upper first molars, upper first premolars, lower lateral incisors and lower canines. However, these differences were not clinically significant
- A significant discrepancy among the examined malocclusion groups was observed in the mean overall TSD ratio, but not in the mean anterior TSD ratios
- Class I malocclusion had the lowest anterior and overall TSD ratios followed by



Class II division 1 followed by Class III malocclusion.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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الفروقات في متوسط حجم الأسنان بين مجموعات مختلفة من سوء الإطباق: دراسة تجريبية

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ملخص البحث

الخلفية: يحتاج أطباء تقويم الأسنان إلى تقييم الفروقات في حجم الأسنان بين الفكين العلوي والسفلي قبل البدء في العلاج لغرض الحصول على نتيجة مستقرة. لهذا فالهدف من هذه الدراسة هو إستكشاف الفروقات في نسبة حجم الأسنان العلوية والسفلية بين مجموعات سوء إطباق مختلفة

الطرق: تضمنت العينة 60 نموذج أسنان لمرضى لبيبيين يعانون من أنواع مختلفة لسوء الإطباق [صنف أول، صنف ثاني جزء أول وصنف ثالث]. تحتوي كل مجموعة على 20 نموذج أسنان. عشرة نماذج أسنان لذكور وعشر لإناث تتراوح أعمارهم ما بين الثانية عشر والسابع عشر عاماً. تم قياس عرض كل سن لحساب النسبة الأمامية والكاملة للفروقات في عرض الأسنان العلوية والسفلية. وقد استخدمت عمليات إحصائية وصفية لاستكشاف ترددات المتغيرات التي تم فحصها. كما تم حساب معامل الفروقات بين المجموعات المذكورة عند مستوى دلالة $P < 0.05$

النتائج: أثبتت التحاليل الإحصائية عدم وجود فروقات مهمة إحصائياً بين متوسط مجموع حجم الأسنان المتماثلة في الجانب الأيمن والأيسر ماعدا متوسط حجم أسنان الرحي الأولى العلوية وأسنان الضاحك الأول العلوية والأسنان الرباعية السفلى. كذلك أثبتت التحاليل الإحصائية أنه ليس هناك فروقات إحصائية مهمة في متوسط نسبة حجم الأسنان الأمامية السفلية والعلوية بين مجموعات سوء الإطباق المختلفة. ولكن لوحظ وجود فروقات مهمة إحصائياً في نسبة متوسط مجموع حجم الأسنان السفلية والعلوية بين مجموعات سوء الإطباق التي تمت دراستها.

الاستنتاج: هناك فروق إحصائية مهمة بين متوسط نسبة مجموع حجم الأسنان السفلية والعلوية بين مجموعات سوء الإطباق التي تمت دراستها.

الكلمات المفتاحية: ليبيا، سوء إطباق الأسنان، تقويم الأسنان، فروق حجم الأسنان.