Research Article

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Journal of Orthodontics & Endodontics
ISSN 2469-2980

2017
Vol. 3 No. 3: 10

DOI: 10.21767/2469-2980.100044

Tooth Size Discrepancy among Different Malocclusion Groups in a Sudanese Sample

Mahmoud NM[1], Eltahir HE[1] and Mageet AO[2*]

1 Orthodontic Resident at Mageet Orthodontic Training Center, University of Gezira, Sudan
2 Mohammed Bin Rashid University, Dubai, United Arab Emirates

***Corresponding author:** Mageet AO

amageet2000@yahoo.co.uk

Associate Professor of Orthodontics, Mohammed Bin Rashid University, Dubai, United Arab Emirates.

Tel: +971-5533-78730

Citation: Mahmoud NM, Eltahir HE, Mageet AO (2017) Tooth Size Discrepancy among Different Malocclusion Groups in a Sudanese Sample. J Orthod Endod. Vol. 3 No. 2:10

Abstract

Introduction: The standard model of orthodontic treatment can be divided into three different stages as stated by Proffit, namely leveling and alignment, working and finishing phases. Each of these presents different challenges. In particular the final, or "finishing" phase, constitutes the most complicated for the complexity of the various factors that need to be taken into account if an optimum result is to be achieved at the end of treatment. One of these factors, often a primary cause of difficulty, is Tooth Size Discrepancy (TSD). Problems arising from this can be alleviated if the existence of TSD forms part of the initial diagnosis and is considered when formulating a treatment plan for the individual patient.

Objectives: The present research aimed at determining the extent and prevalence in a representative orthodontic population in Sudan and to investigate the dimensions of TSD in this population that comprised a clinically significant factor.

Materials and methods: The sample comprised 107 pretreatment study casts with fully erupted and complete permanent dentitions from first molar to first molar, which were selected randomly from records of the orthodontic patients. The mesiodistal diameters of the teeth were measured at contact points using a stainless steel digital caliper and Bolton analysis was carried out on them.

Results: A clinically and statistically significant anterior TSD (p=0.002) existed in comparison to Bolton's anterior tooth ratio. Measurements of the overall and anterior TSD between malocclusion groups showed no significant differences (P=0.572, P=0.976 respectively). In terms of gender, no significant differences were observed for the overall TSD data (P=0.102). In Class II division 1 mean overall ratio was lower than Bolton's, and Class II division 2 mean overall ratio higher than Bolton's [overall ratio (91.3%, SD ± 2), anterior ratio (77.2, SD ± 2)].

Conclusion: Class II division 1 patients showed a tendency towards excessive maxillary tooth material and Class II division 2 patients showed a tendency towards excessive mandibular tooth material.

Keywords: Tooth size discrepancy; Bolton analysis; Bolton ratio, Crowding of teeth

Received: June 28, 2017; **Accepted:** July 17, 2017; **Published:** July 25, 2017

Introduction

TSD is defined as the lack of harmony of size of individual tooth or groups of teeth when related to those within the same arch or the opposing arch [1]. It can also be defined as a relative excess of tooth structure in one arch in relation to the other arch [2]. Ideal orthodontic treatment results with optimal occlusion and ideal intercuspation (Class I incisors, canine and molar relationship). Over jet and overbite is jeopardized by tooth size discrepancy [2]. For good occlusion, the upper and lower teeth must be proportional in size. If large upper teeth are combined with small lower teeth, as in a denture setup with mismatched sizes, there is no way to achieve ideal occlusion. Although the natural teeth match very well right and left in most

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individuals, approximately 5% of the population shows some degree of disproportionately among the sizes of individual teeth [3] e.g. the upper lateral incisors (Peg lateral in one side).

Many clinicians have realized the importance of TSD. G.V. Black was the first to formally investigate the mesio-distal widths of teeth [4]. He measured a large number of human teeth and set up tables of mean dimensions, which are still used today as reference.

Comparison between the mesio-distal widths of teeth with the opposing corresponding tooth on the other side of the dental arch carried out by Ballard [5]. His results indicated that 90% of his sample showed a right left discrepancy in mesio-distal width equal to or exceeding 0.25 mm. His suggested solution was the stripping of proximal surfaces when a lack of balance existed.

Bolton's [6,7] method in diagnosing TSDs by analyzing the mesio-distal tooth width ratio between the maxillary and mandibular teeth has been widely used since its publication.

Various studies have studied sex differences in relation to TSD. Bishara [8] found that males have larger teeth than females. Despite the difference most studies have found that there is little impact of gender on interarch ratios [8-13]. Smith et al. found that males had a larger ratio than females but the differences were small and much less than one SD from Bolton norms [14].

Lavelle [15] showed interest in determining if patients with differing malocclusion groups have different norms of Interarch Tooth Size Discrepancy (ITSD). He found that patients with Angle Class III malocclusions tend to have higher ITSD than Class I or II patients. Araujo and Souki [9] studied 100 patients in each malocclusion and found that Class I and III patients had greater ITSD than Class II patients. They also found that Class III patients had more anterior ITSD than Class I and II patients. However many studies have found no differences in ITSD between malocclusion groups [13,14,16,17].

Aim of the Study

The present study aimed to investigate the extent of TSD in a representative Sudanese orthodontic population and to attempt to determine the size of the discrepancy in millimeters that constituted a clinically significant difference.

Materials and Methods

From 107 pretreatment sets of orthodontic study models at Mageet specialized dental clinic in Khartoum, Sudan, models were identified that fulfilled the following criteria:

- All permanent teeth have erupted.
- Subjects from Sudanese ethnic background determined from case records.
- No retained primary teeth.
- No abnormal tooth morphology.
- No previous orthodontic treatment.
- No factors which prevented accurate measurement of mesiodistal tooth widths including tooth restorations, fractured teeth, or broken teeth on models.
- The measurement is repeated one month after the initial measurements for 30 models to assure accuracy (the margin of error was 0.05 mm)-digital caliber **(Figures 1 and 2)**.
- The mesiodistal widths of 12 maxillary teeth and 12 mandibular teeth from right first molar to left first molar are totaled and compared. These mesio-distal crown measurements were taken from mesial and distal contact areas, respectively **(Figure 3)**. The dividend of two is the percentage relationship of mandibular to maxillary tooth size, which is called "overall ratio".

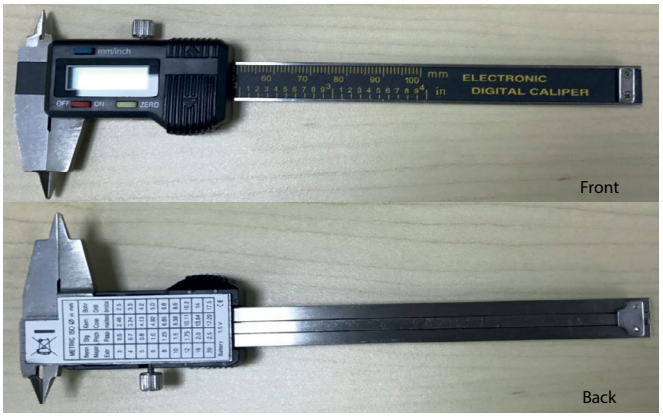

Figure 1 Digital caliper.

Figure 2 Measuring the mesiodistal width of teeth.

Results

There are more of females in the Orthodontic patients' sample in Sudan than the males as shown in **Figure 4**. **Figure 5** shows increase percentage of Class I and Class III malocclusions while the percentage is decreased in Class II/1 and Class II/2 malocclusions in the sample.

Descriptive statistics of mesiodistal tooth width compared to with the different malocclusion groups. ANOVA demonstrated that there were significant differences in upper right lateral incisor, upper right canine, upper left second premolar and lower right central incisor mesiodistal widths in the different malocclusion groups.

Table 1 compares the mean and standard deviation of the width of the maxillary and mandibular teeth in the right and left sides. Statistically significant differences were found in maxillary central and lateral incisors and mandibular central incisors and canines. **Table 2** reports the mean and standard deviation of the width of the maxillary and mandibular teeth in the male and female groups. Both male and female measurements follow a similar pattern distribution with the males having slightly larger dental dimensions except upper left first premolar. There were statistically significant differences in mesiodistal tooth width in upper right and left canine, lower right central incisor and lower right canine.

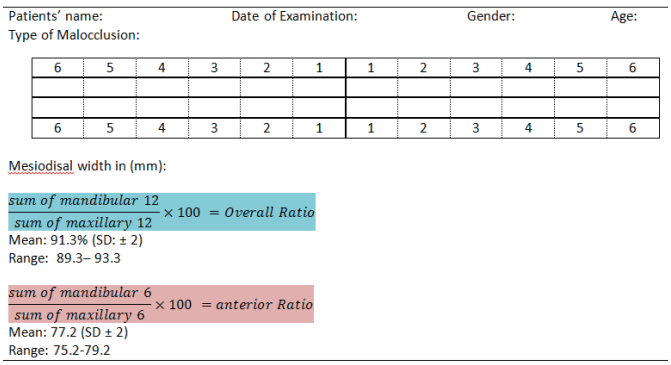

Figure 3 The form of calculating the tooth size discrepancy.

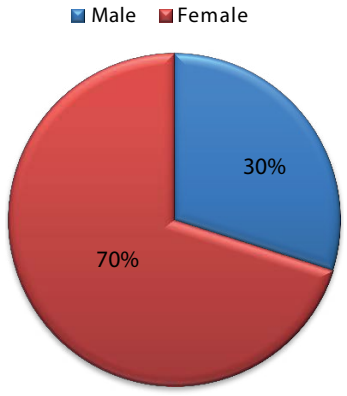

Figure 4 Percentage of males and females in the study.

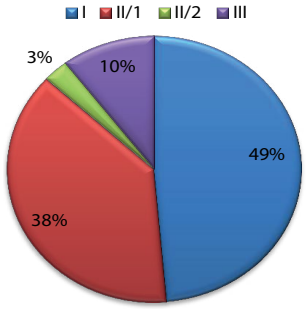

Figure 5 Percentage of different malocclusions in the subjects of the study.

Table 1 Comparison between right and left mesiodistal tooth width in the sample.

Arches	Tooth	Right		Left		*P-value*
		Mean	SD	Mean	SD	
Maxillary	1	9.10	0.68	90.00	0.68	0.002
	2	7.32	0.65	70.23	0.65	0.004
	3	8.13	0.46	80.09	0.48	0.107
	4	7.45	0.57	70.50	0.59	0.230
	5	7.21	0.54	70.20	0.60	0.795
	6	10.72	1.10	10.84	0.63	0.226
Mandibular	1	5.75	0.51	5.69	0.52	0.012
	2	6.23	0.48	6.29	0.46	0.061
	3	7.15	0.57	7.06	0.57	0.034
	4	7.50	0.59	7.51	0.59	0.874
	5	7.65	0.56	7.60	0.57	0.324
	6	11.27	0.74	11.32	0.75	0.222

Table 2 Difference in tooth size and tooth size discrepancy in the sample.

Quadrants	Tooth	Male		Female		P-value
		Mean	SD	Mean	SD	
Maxillary right	11	9.29	0.65	9.02	0.67	0.821
	12	7.43	0.54	7.27	0.68	0.224
	13	8.33	0.49	8.05	0.42	0.014
	14	7.68	0.50	7.35	0.57	0.441
	15	7.40	0.60	7.13	0.49	0.107
	16	11.00	0.56	10.61	1.25	0.246
Maxillary left	21	9.26	0.67	8.90	0.66	0.892
	22	7.32	0.60	7.19	0.67	0.443
	23	8.26	0.53	8.01	0.44	0.011
	24	7.68	0.54	8.49	9.32	0.292
	25	7.37	0.55	7.12	0.61	0.611
	26	11.12	0.67	10.72	0.58	0.572
Mandibular left	31	5.84	0.46	5.62	0.53	0.112
	32	6.40	0.48	6.24	0.44	0.214
	33	7.25	0.55	6.98	0.56	0.126
	34	7.85	0.48	7.37	0.58	0.139
	35	7.60	0.61	7.60	0.55	0.590
	36	11.80	0.62	11.12	0.71	0.577
Mandibular right	41	5.92	0.42	5.68	0.53	0.005
	42	6.34	0.51	6.19	0.46	0.061
	43	7.33	0.62	7.08	0.53	0.021
	44	7.78	0.49	7.38	0.59	0.309
	45	7.76	0.60	7.60	0.53	0.940
	46	11.67	0.66	11.10	0.72	0.814

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Table 3 Anterior ratio and overall ratio of tooth size discrepancy of males and females.

Tooth size discrepancy	Males		Females		*P-value*
	Mean	SD	Mean	SD	
Anterior Ratio	78.34	2.76	78.30	3.87	0.949
Overall Ratio	91.82	2.50	90.87	2.81	0.102

Table 4 Anterior ratio and overall ratio of tooth size discrepancy of different malocclusion groups.

Tooth size discrepancy	Class I		Class II/1		Class II/2		Class III		*P-value*
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Anterior Ratio	78.44	2.91	78.11	4.49	78.57	1.53	78.37	3.16	0.976
Overall Ratio	91.37	2.98	90.73	2.63	92.42	2.17	91.38	2.04	0.572

Table 5 Comparison of mesiodistal tooth width in the different malocclusion groups.

Quadrants	Tooth No.	Class I		Class II/1		Class II/2		Class III		*P-value*
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Maxillary right	11	9.03	0.72	9.18	0.59	8.83	0.76	9.18	0.78	0.619
	12	7.08	0.62	7.49	0.59	7.75	0.66	7.68	0.64	0.002
	13	8.00	0.44	8.20	0.41	8.33	0.28	8.45	0.56	0.011
	14	7.36	0.63	7.54	0.51	7.33	0.57	7.59	0.43	0.369
	15	7.08	0.54	7.35	0.51	7.00	0.50	7.31	0.51	0.078
	16	10.78	0.59	10.81	0.53	11.00	0.00	10.09	3.07	0.241
Maxillary left	21	8.89	0.72	9.10	0.59	8.83	0.76	9.22	0.71	0.301
	22	7.10	0.59	7.32	0.69	7.25	1.14	7.45	0.56	0.297
	23	7.97	0.45	8.17	0.45	8.00	0.86	8.36	0.50	0.051
	24	7.43	0.62	7.60	0.50	7.66	0.57	7.45	0.78	0.841
	25	7.06	0.57	7.31	0.56	6.83	0.76	7.54	0.68	0.030
	26	10.74	0.65	10.89	0.59	11.00	0.50	11.04	0.72	0.429
Mandibular left	31	5.62	0.51	5.70	0.48	5.66	0.57	5.95	0.65	0.300
	32	6.24	0.44	6.30	0.47	6.50	0.50	6.40	0.49	0.578
	33	6.95	0.52	7.15	0.56	7.00	1.00	7.31	0.64	0.157
	34	7.48	0.64	7.56	0.53	7.75	0.66	7.45	0.56	0.789
	35	7.55	0.56	7.58	0.54	7.50	0.50	7.93	0.67	0.252
	36	11.22	0.80	11.39	0.65	11.41	0.52	11.56	0.86	0.482
Mandibular right	41	5.63	0.53	5.80	0.43	5.66	0.57	6.13	0.50	0.021
	42	6.20	0.51	6.23	0.44	6.16	0.28	6.40	0.49	0.648
	43	7.06	0.51	7.22	0.54	7.50	0.86	7.22	0.81	0.375
	44	7.38	0.59	7.59	0.54	8.16	1.04	7.59	0.49	0.070
	45	7.57	0.62	7.73	0.50	7.50	0.50	7.75	0.43	0.515
	46	11.07	0.82	11.43	0.58	11.41	0.14	11.59	0.83	0.051

Table 3 shows the mean, standard deviations of the anterior and overall tooth size ratios in males and females. ANOVA demonstrated no significance in the male/female comparison.

Table 4 summarizes the mean values and standard deviations of the anterior and overall tooth size ratios in the malocclusion groups. ANOVA demonstrated that there were no significant differences in anterior and overall tooth size ratios among the malocclusion groups.

Discussion

The clinical importance of TSD in treatment planning has been the subject of various discussions in orthodontic literature. In our study, a comparison was made between TSD in different malocclusion groups. This is one of the few studies to be conducted in Sudan in which TSD have been studied in different malocclusion groups.

Our sample was construed of 70% females and 30% males which may indicate that females seek orthodontic treatment more than males. From this sample 49% had class I malocclusion, 38% class II div1 and the remaining divided between class II div2 and class III as shown in **Figure 4**.

The mean overall ratio for the whole sample was 91.16% which is very close to Bolton's proposed ideal ratio. However the anterior ratio for the whole sample was found to be 78.31%, which is higher than Bolton's proposed ideal ratio, thus reflecting a tendency towards greater mesiodistal widths in the mandibular anterior segment in our population sample.

In class I and class III patients, the mean overall ratios calculated

was 91.37% and 91.38% respectively, which is closely similar to Bolton's ideal ratio and the mean anterior ratios calculated was 78.44% and 78.37% which is higher than Bolton's ideal ratio **(Table 5)**.

There was a significant difference from the ideal for Class II division 1 and Class II division 2 patients whose corresponding overall ratios were calculated at 90.73% and 92.42% respectively. Here, the relevant anterior ratios were 78.11% and 78.57% respectively; again, markedly greater than Bolton's ideal ratio.

These indicate a tendency of maxillary tooth excess in Class II division 1 malocclusions. This is somewhat in accordance with Strujic et al. [18]; he found there was a tendency for mandibular tooth excess in subjects with Class III malocclusions and for maxillary tooth excess in subjects with Class II malocclusions in an orthodontic population.

The higher prevalence of anterior TSDs in this Sudanese orthodontic population suggests that a tooth size analysis should be conducted at the treatment planning stage. Where significant TSDs are detected, this is normally accommodated by the reduction or augmentation of tooth tissue [19].

We were unable to find any statistically significant differences in the mean overall and anterior tooth size ratios between the different malocclusion groups. This is in accordance to Uysal and Sari [17] who identified no differences in tooth size ratios between malocclusion groups in a Turkish population, also in accordance to O'Mahony and Millett [11] who identified no statistical difference in tooth size ratios between malocclusion groups in an Irish population, but contrasts with Nie and Lin [12] who identified a higher prevalence of increased overall tooth size ratios in Class III malocclusions compared to Class I and Class II malocclusions in a Chinese population.

In this study the mean anterior tooth size ratios exhibited no statistically significant differences between genders and among the malocclusion groups. This is similar in findings to Crosby and Alexander [16], and Araujo and Souki [9].

Also in this study a comparison was made between the left and right segments of both maxillary and mandibular arches. There was a significant difference found between left and right maxillary central and lateral incisors in the mesiodistal width, but no significant difference between the rests of the maxillary teeth.

In the mandibular arch a significant difference was found in the mesiodistal width between the left and right central incisors and canines.

Conclusion

- Class I, class II, and class III patients showed mean anterior tooth size ratio slightly higher than Bolton's anterior ratio.
- Class II division 1 patients showed mean overall ratio slightly lower to Bolton's overall ratio and Class division 2 patients showed mean overall ratio slightly higher than Bolton's overall ratio.
- There were no statistically significant differences of overall and anterior TSD with regard to gender or malocclusion.
- The results help in treatment planning, putting in consideration tooth size discrepancy and decision for extraction.

Recommendation

Although Mageet Orthodontic Training Centre caters for all personnel belonging to various regions of the country, a larger study at the national level is required to verify the applicability of these results to our population and also to compare between tooth size and arch length.

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