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Comparison of Anterior Tooth Size Discrepancies Among Different Malocclusion Groups

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ABSTRACT

Background: Discrepancies between tooth sizes can cause orthodontic problems such as crowding and improper occlusion. By identifying these problems, better orthodontic treatment outcome can be achieved. The aim of this study is to identify anterior tooth size discrepancies among 4 different types of malocclusion i.e. Class I; Class II division 1 (II/1); Class II division 2 (II/2); and Class III. **Methods:** A retrospective study was carried out using 200 orthodontic study models where 50 study models were taken for each of the 4 malocclusion groups. The samples were selected using random sampling technique based on the orthodontic waiting list in the Orthodontic Department, Dental Faculty, UKM. All anterior teeth were measured by the same examiner at the largest mesio-distal dimension, using a digital caliper recorded up to 0.01 mm. Comparison between the 4 groups of malocclusion were made intra-arch using individual tooth size measurement and inter-arch using Anterior Bolton Index (ABI). **Results:** For the intra-arch assessment, Class II/1 had significantly the largest upper and lower anterior tooth size except for its upper canine and lower central incisor. Class III group had insignificantly the smallest mandibular anterior teeth compared to other malocclusion groups. For inter-arch assessment, Anterior Bolton Index (ABI) of all samples was 79.2 ± 3.94%. The highest ABI was noted in Class II / 2 of 80.3 ± 4.71%. However, no significant differences were found among the 4 malocclusion groups ($p>0.05$). **Conclusion:** Most of the anterior teeth in Class II division 1 were the largest of all. No significant difference in the inter-arch tooth size discrepancies were detected among all malocclusion groups.

Keywords: Tooth size discrepancy, malocclusion, Bolton discrepancy

INTRODUCTION

Discrepancies of the tooth sizes can be a local aetiological factor for malocclusion. Any deviation in the tooth size within the arch can cause malaligment such as crowding or spacing [1, 2]. Moreover, inter-arch tooth size discrepancy can cause poor interdigitation of the presenting occlusion [3].

Sometimes, these discrepancies are not noticeable til the end of the orthodontic treatment [4, 5]. Because of these discrepancies, at the end of an orthodontic treatment, good occlusion and interdigitation may not be achievable. When the anterior maxillary anterior teeth are too large in relation to the mandibular teeth, abnormal overbite or overjet can be the clinical manifestations [3]. On the other hand, if the mandibular anterior teeth are too large in relation to the maxillary teeth, end to end relationship of teeth, spacing in the maxillary anterior segment and improper occlusion of posterior teeth can be seen [6]. By identifying which type of malocclusion has the most tooth-size discrepancies, treatment can be modified and appropriate measures can be implemented to gain a good post-treatment interdigitation. Measures such as the removal or addition of tooth structure could be included in the initial treatment plan.

Inter-arch tooth size discrepancies are assessed by an index called Bolton Index [13]. Bolton introduced two indices, the Anterior Bolton Index (ABI) that involves the measurements of the six front teeth and the Overall Bolton Index (OBI) which incorporates the total mesio-distal size of 12 teeth from incisors to the first permanent molar. In order to compare tooth size discrepancies between different types of malocclusion which uses the incisor's relationship as its reference, thus the Anterior Bolton Index (ABI) is more suitable than the overall Bolton index. By comparing the ABI norms value, the applicability of the ABI to all the different types of malocclusion in Malaysia can be determined.

Many studies have been done to compare the inter-maxillary tooth size relationship among different malocclusions, and had controversial results. Some studies have noted that there were no significant differences among the malocclusion groups [4, 7, 8]. However, there are a number of studies with contradictory results. These studies found that Class III individuals had greater tooth size discrepancies when compared to Class I and Class II malocclusions [3, 9, 10, 11, 12].

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Therefore, the aim of this research is to compare the mesio-distal tooth width (intra-arch) and anterior tooth size discrepancies (inter-arch) among different types of malocclusion i.e. Class I, Class II division I, Class II division 2 and Class III in orthodontic patients attending UKM's dental clinic.

METHODOLOGY

Samples' selection

This was a retrospective study of orthodontic study models taken from Orthodontic department, Universiti Kebangsaan Malaysia from the year 2005-2008. Orthodontic study models were selected using stratified random sampling technique based on the orthodontic waiting list. A total of 200 study models with equal number of sample in each type of malocclusion were retrieved. The inclusion criteria for selecting the samples are shown in Table 1.

Table 1. Inclusion criteria

Inclusion Criteria
• Good quality of pretreatment models
• Presence of all 6 anterior teeth from incisors to canine for each quadrant
• Absence of dental prosthesis
• Absence of partially erupted teeth
• No tooth deformity (eg, conical shaped lateral incisor)
• No record of restoration or stripping of incisor and canine teeth.

Tooth width measurement

All the six front teeth were measured at the largest mesio-distal dimension, perpendicular to its long axis using a digital caliper accurate to 0.01 mm (ABSOLUTE Digimatic, Mitutoyo USA). The readings were recorded at the 0.01 mm level and were calculated manually. All the measurements were triplicated and done by single examiner to avoid bias. The measurements of all 200 study models were done within the 3-month period of data collection with an average of 4 study models per day. The anterior tooth size discrepancies were calculated based on the formula described by Bolton as shown below:

$$\frac{\text{sum mandibular “3-3”}}{\text{sum maxillary “3-3”}} \times 100 = \text{Anterior Bolton Index \%}$$

All statistical analyses were performed using the SPSS software package (Statistical Package for Social Sciences, version 19.0). All data collected were analyzed descriptively using percentages and frequencies. Comparison tests were performed using independent T-test since the data were normally distributed as shown by Kolmogorov-Smirnov analysis ($p>0.05$).

RESULTS

Analysis of error

Intra-examiner reliability test was performed by randomly re-measuring 10% of the samples (n=20) after a one-week interval. The re-measurements involved the individual reading of the mesio-distal width dimension of the six front teeth. Reliability testing was performed using Pearson correlation coefficient test. Result showed that both readings were strongly related with Pearson's r values of 0.9.

Intra-arch assessment

There were a total of 200 orthodontic study models that were used in this study which comprises of 50 study models for each malocclusion groups i.e. Class I, Class II division 1, Class II division 2 and Class III.

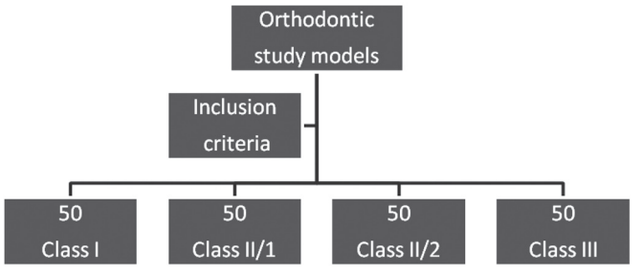

Figure 1. Selection of study models

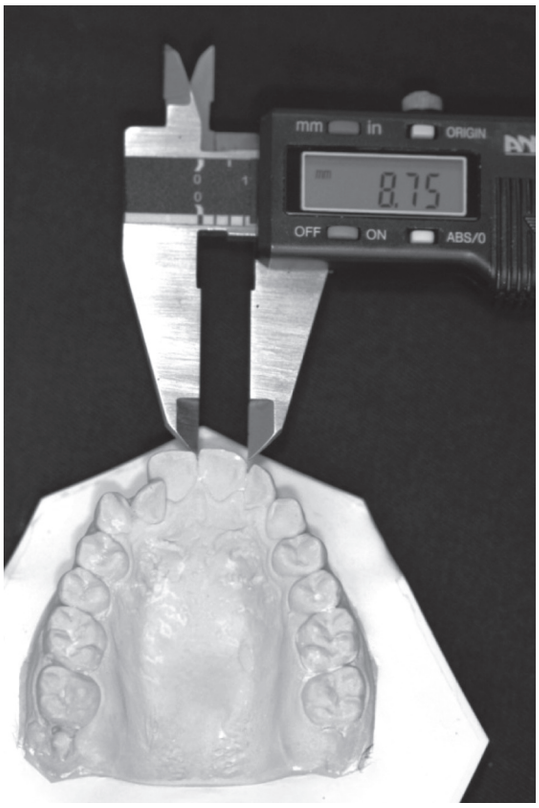

Figure 2. Mesio-distal width of a tooth measured using a digital caliper

Table 2. Total number of samples (N), mean ± standard deviation of each upper and lower anterior teeth.

	Upper			Lower		
	Central Incisor	Lateral Incisor	Canine	Central Incisor	Lateral Incisor	Canine
N	400	400	400	400	400	400
Mean	8.63± 0.56	7.09± 0.74	7.84 ± 0.64	5.48 ± 0.43	6.12 ± 0.53	6.92 ± 0.52

Table 2 shows overall number of teeth, mean and standard deviation of each tooth. In the upper arch, central incisor was 8.63± 0.56mm, lateral incisor was 7.09± 0.74mm and canine was 7.84 ± 0.64mm. While in the lower arch, average size of central incisor was 5.48 ± 0.43mm, 6.12 ± 0.53mm for lateral incisor and 6.92 ± 0.52mm for canine.

Figure 3 shows comparison of each tooth to the 4 different types of malocclusions groups i.e. Class I, Class II division 1 (Cl II/1), Class II division 2 (Cl II/2) and Class III. Upper central incisor of Class II/1 was the largest among other types of malocclusion of 8.74 ±0.05mm with significant differences ($p<0.05$) were detected when compared to Class II/2 and Class III. Among all upper lateral incisors, Class II/1 was the largest of 7.33±0.51mm with significant differences were detected when compared to other 3 malocclusion groups. Upper canine had almost similar size in all 4 malocclusion groups ranging from 7.75mm to 7.94mm with no significant differences detected in between the groups ($p>0.05$). No significant differences were detected in size of the lower central ($p>0.05$). As for the lower lateral incisor, Class II/1 showed the largest of all with measurement of 6.23± 0.56mm and significant differences ($p<0.05$) were noted when compared to Class I and Class III. Similarly, Class II/1's lower canine was the largest of all but only significant difference was found when compared to Class III ($p<0.05$). Overall, it was shown that the Class II/1's teeth had the largest tooth size in each of the tooth type except for the lower central incisor as shown in Figure 3.

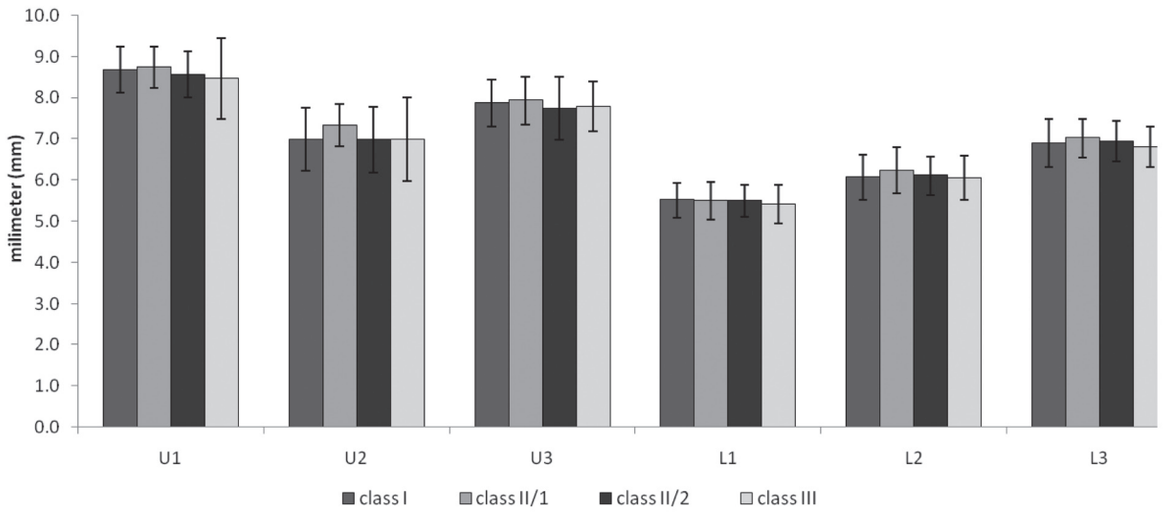

Figure 3. Mean and s.d. of mesio-distal width of each tooth in different types of malocclusion i.e. Class I, Class II/1, Class II/2 and Class III; U1-upper central incisor, U2- upper lateral incisor, U3-upper canine, L1-lower central incisor, L2- lower lateral incisor, L3-lower canine

Inter-arch assessment using Anterior Bolton Index (ABI)

The ABI for overall samples was 79.3 ±3.94%. Mean percentage and standard deviation of each malocclusion groups presented in Anterior Bolton Index (ABI) are shown in Table 3. ABI in Class II/2 was the highest of 80.3 ± 4.71%. Class III malocclusion had ABI 1.24 lesser than the Class II division 2 malocclusion. Both Class I and Class II/1 has almost similar ABI of 79%. No significant differences were detected in between each of 4 malocclusion groups ($p>0.05$).

Table 3. Mean and standard deviation of Anterior Bolton Index (ABI) in 4 different types of malocclusion groups

Types of malocclusion	Anterior Bolton Index (%)	
	Mean	s.d.
Class I	78.83	4.06
Class II /1	78.75	3.85
Class II/ 2	80.33	4.71
Class III	79.09	2.82

DISCUSSION

Assessment of tooth size discrepancies can be an important factor to determine orthodontic treatment outcome. In our study, we wanted to determine whether there is a difference in anterior tooth size among different malocclusion groups in orthodontic patients attending UKM's dental clinic. No discrimination of gender and side i.e. left/right were made as previous studies showed no statistical difference in tooth size when comparing between gender or between sides [14, 15, 16].

Intra-arch assessment

In a study by Fattahi *et al*. (2006), they found that Class III individuals had smaller maxillary teeth compared to Class I and Class II subjects [12]. The result does correlate with our study where we found that Class IIIs' maxillary anterior teeth were in fact the smallest for upper central incisors and the second smallest for upper lateral incisors and upper canines. We also found that Class III subjects had the smallest mandibular anterior teeth compared to other malocclusion groups which were not in agreement to the study by Lavelle (1972) and Sperry *et al*. (1977) that reported the mesio-distal width of lower teeth in Class III malocclusion subjects is larger when compared with Classes I and II (divisions 1 and 2) [9, 17]. We also found that Class II/1 had the largest mesio-distal width of anterior tooth size for both maxillary and mandibular teeth except for the lower central incisor.

Inter-arch assessment

Intermaxillary tooth size discrepancies can be assessed using ABI. For a correct anterior occlusion, Bolton has recommended the ABI of 77.2 ± 1.65%. In our study, the ABI for the whole samples was 79.3 ±3.94% in which is slightly higher than in the Bolton's sample. There are studies which found that their ABI were different from the Bolton's norms [18, 19, 20]. Paredes *et al* (2006) suggested a different norm for their Spanish population as their result showed significant differences between the Spanish's and Bolton's values [18]. Result from this study is in agreement with a study done in Iran by Fattahi *et al*. (2006) which had similar number of samples (n=200) [12]. Their ABI was 79.01%. Another study done in Pakistan by Batool *et al*. (2008) also found that their ABI was 79.3% [20]. Recently, a Malaysian study reported that their Malaysian ABI's value was similar to the Bolton's value. This contradiction in our finding may be due to the smaller number of samples compared to those recruited by the previous study.[21] However, when looking at the individual ethnic ABI values as presented in the Malaysian study, our ABI was closely related to the Malay ABI of 78.93 ± 2.68 as compared to the Malaysian Chinese and Indian values.[21] This similar findings could be reflected by the fact that the majority of people who attended our clinic in UKM were malay.

The difference of ABI in the 4 types of malocclusion are shown in these few studies. Class III has been shown to have greater anterior tooth discrepancies than the other 3 malocclusion groups [3, 9, 10]. In Brazil, Araujo and Souki (2003) also found that the mean anterior tooth size discrepancy for Class III subjects was significantly greater than that for Class I and Class II malocclusion [11]. However in our study, by using Anterior Bolton Index (ABI), we found that Class II division 2 had the highest ABI with a percentage of 80.33 ±4.06. However, no statistically significant differences were found when compared to the other 3 malocclusions ($p>0.05$). Our findings different from the Brazilian's study maybe because of the differences in the classification used. They classified their subjects based on skeletal pattern. This study used incisor's classification instead of the skeletal pattern's classification thus making the number of samples for Class II doubled.

Similarly, Crosby and Alexander (1989) compared the tooth size ratios among different malocclusion groups, as in our study [4]. They found that there were no significant differences among Class I, Class II division 1, Class II division 2, and Class III groups. In Japanese orthodontic population as studied by Endo 2008, no significant inter-arch tooth size discrepancies were noted between the malocclusion groups [8]. Akyalc *et al*. (2006) identified only the skeletal Class I and measured the tooth size discrepancies in all malocclusion groups. The result showed no significant difference in Class I, II or III malocclusions [22]. Results from these two studies also support this finding [7, 23].

CONCLUSION

This study found that Class II division 1 malocclusion had the largest anterior mesio-distal tooth size for both maxillary and mandibular teeth except for the lower central incisor. Class III individuals had the smallest mandibular anterior teeth compared to other malocclusion groups. The Anterior Bolton Index (ABI) for Class II division 2 was the highest among all malocclusion groups. However, there were no significant differences of Anterior Bolton Index among the 4 different types of malocclusion group.

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