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Digital Analysis of Tooth Sizes Among Individuals with Classes I and II Malocclusions in the Kosovo Population - A Pilot Study

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Abstract

Background: This study aimed to evaluate the tooth size discrepancy in patients with different types of malocclusions and compare it with that in patients with normal occlusion, using the three-dimensional (3D) measurement program Maestro Studio.

Methods and Results: Patients of both sexes who were aged between 13 and 16 years and who had never received orthodontic treatment were randomly selected. The participants' mean age was 14.3±1.1 years; 62.0% of patients were girls. Fifty patients were divided into three groups. Group 1 included 16 patients with malocclusion Class I (controls), Group 2 included 19 patients with malocclusion Class II division 1 (II/1), and Group 3 included 15 patients with malocclusion Class II division 2 (II/2). The tooth measurements were made according to the Bolton analysis. Anterior ratio (AR) and overall ratio (OR) were calculated. There was no significant difference in the AR between the groups. However, we found a significant difference in the OR between the groups (P=0.0129). Patients with Class II/2 malocclusion had a significantly lower OR than patients with Class II/1 malocclusion (P=0.0155). However, there was no significant difference in the OR between Class 1 and Class II/1 or Class II/2 malocclusions.

Conclusion: Individuals with different malocclusions show different tooth sizes.(**International Journal of Biomedicine. 2022;12(3):433-437.**).

Keywords: tooth size • anterior ratio • overall ratio • digital analysis

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Introduction

Orthodontic diagnosis greatly depends on arch dimensions. Throughout development, genetic and environmental factors affect the form of the dental arch, which varies from person to person.(1) Orthodontic alignment of the teeth into normal occlusion may be impossible if a patient's arches have a considerable discrepancy in the tooth size.(2) When the maxillary and mandibular teeth are out of proportion, this is referred to as a tooth size discrepancy.(3) A previous study suggested that tooth size is the seventh key (fulfillment of Bolton's tooth size ratio) in achieving a normal occlusion.(4) The Bolton analysis, also known as the Bolton ratio, is used to calculate the size of teeth and the difference in size between the maxillary and mandibular teeth. This method assists in identifying the appropriate interarchal relationship, and it is useful in aiding the diagnosis and treatment planning.(5) The six front teeth are associated with anterior tooth size discrepancies, whereas all teeth, except for the second and third permanent molars, are associated with overall tooth size discrepancies.(6) Several reports have shown that tooth size varies among multiple nations, races, and sexes.(7-10) Tooth size discrepancies are more common in subjects with malocclusions.(11) The digitalization of orthodontic records is a current trend among many orthodontists to improve diagnosis and treatment planning (12,13) and can be considered the new gold standard in orthodontic practice.(14)

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Several potential advantages of using digital models include their accuracy and speed in collecting data for diagnosis, the ability to transfer information, the accessibility in orthodontic analysis, and the use of a single digital model to simulate several treatment modalities and generate the virtual configuration.[15,16]

This study aimed to evaluate the tooth size discrepancy in patients with malocclusion Class II and compare it with that in patients with normal occlusion, using the three-dimensional (3D) measurement program Maestro Studio.

Materials and Methods

This study was conducted in the Orthodontics Department at of the University Dentistry Clinical Center of Kosovo with prior approval from the Ethical Committee (Protocol # 4068, 07.17.2020) of this institution. Patients of both sexes who were aged between 13 and 16 years and who had never received orthodontic treatment were randomly selected. The participants' mean age was 14.3±1.1 years; 62.0% of patients were girls. Fifty patients were divided into three groups. Group 1 included 16 patients with malocclusion Class I (controls), Group 2 included 19 patients with malocclusion Class II division 1 (II/1), and Group 3 included 15 patients with malocclusion Class II division 2 (II/2).

The inclusion criteria were as follows: age 13–16 years, permanent dentition, presence of all teeth from the first molar on one side to the first molar on the other side, small restorations that could not change the mesiodistal diameter of the tooth, and no tooth extractions. The exclusion criteria were as follows: dental casts obtained from patients who had previously been treated orthodontically, patients who previously had surgery, dental changes in the size and number of teeth, and asymmetry of the arches.

This study comprised three phases. In Phase 1, after proceeding with alginate impressions, the patients were transferred to the dental laboratory for their teeth to be put into plaster to create plaster models. In Phase 2, all dental models for both jaws (maxillae and mandibula) were scanned using a 3D scanner (Deluxe model; Open Technology, Italy); Precision: 5 microns estimated according to ISO 12836 Certification. The project was automatically saved, and its design and scanning were completed at the same time (Fig.1).

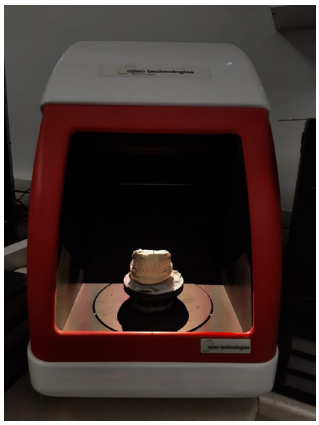

Fig. 1. *3D scanner (Deluxe model)*

Five axes and two color cameras were used in the scanning system, which has a 5-micron resolution. The dental arch was able to be scanned at a 1:1 ratio in approximately 20 seconds.

In Phase 3, the software program Maestro 3D Dental Studio was used for measuring the digital models. Through different movements of the digital models, this digitalized 3D software measured the dimensions of the dental arches and teeth. To evaluate the accuracy of the calculation, the digital measurements were performed by one orthodontist specialist who was trained precisely in the field of digitalization for measurements of the marked points. The measurements were made according to the Bolton analysis, using the mesiodistal width between the right first molar and the left first molar.[3]

The software automatically generated the mesiodistal size of each tooth in the digital models (Fig.2). The results for the sum of the 6 anterior teeth and the total of 12 teeth were calculated using the Bolton analysis formula for the size of the sixth tooth and the twelfth tooth as follows:

Anterior ratio (AR) = (Mesiodistal width of 6 anterior mandibular teeth / Mesiodistal width of 6 anterior maxillary teeth) × 100

Overall ratio (OR) = (Mesiodistal width of 12 mandibular teeth / Mesiodistal width of 12 maxillary teeth) × 100

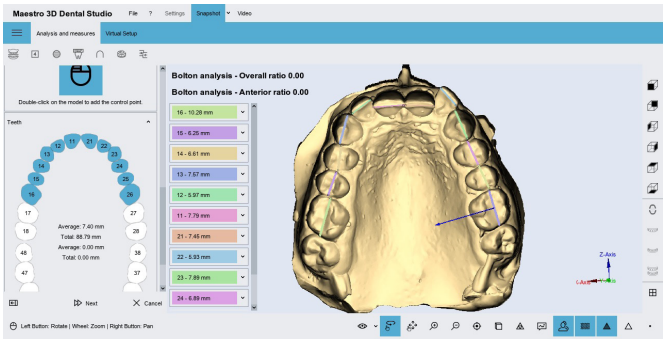

Fig. 2. *Maestro 3D Dental Studio software (digital model).*

Statistical analysis was performed using IBM SPSS Statistics for Windows, Version 22.0. (SPSS Inc, Armonk, NY: IBM Corp). Baseline characteristics were summarized as frequencies and percentages for categorical variables and as mean±SD for continuous variables. Multiple comparisons were performed with one-way ANOVA and Tukey's HSD Post-hoc Test. A probability value of $P<0.05$ was considered statistically significant.

Results

Table 1 presents the general characteristics of the patients. Evaluation of the mesiodistal dimensions of permanent teeth in the different malocclusion groups is shown in Table 2. When the mesiodistal dimensions of the upper teeth were evaluated between the different malocclusion groups, a significant difference was found in U14 (P=0.0147), U13 (P=0.0295), U12 (P=0.0324), U23 (P=0.017), U24 (P=0.0262), and U25 (P=0.0135). The highest values were observed in Group 3. Only L41 (P=0.0447) showed a significant difference in the mesiodistal dimensions of the lower teeth between the various malocclusion groups, with higher values in Group 3.

Table 1.
General characteristics of the patients.

	Group 1 (Class I)	Group 2 (Class II/1)	Group 3 (Class II/2)	Total
Sex, n (%)				
F	10 (62.5)	12 (63.2)	9 (60.0)	31 (62.0)
M	6 (37.5)	7 (36.8)	6 (40.0)	19 (38.0)
Age, years				
Mean±SD	14.1 ± 1.2	14.5 ± 1.1	14.3 ± 1.2	14.3 ± 1.1
Range	13–16	13–16	13–16	13–16

Table 2.
Evaluation of the mesiodistal dimensions of permanent teeth in the different malocclusion groups

Jaw	Tooth	Group 1	Group 2	Group 3	Statistics
Maxilla	U 16	9.96 ± 0.38	9.80 ± 0.53	9.87 ± 0.64	P=0.6703
	U 15	6.32 ± 0.41	6.15 ± 0.49	6.53 ± 0.43	P=0.0586
	U 14	6.60 ± 0.36	6.28 ± 0.47	6.91 ± 0.89	P=0.0147 P_{1-2}=0.2692 P_{1-3}=0.3321 P_{2-3}=0.0108
	U 13	7.02 ± 0.55	6.90 ± 0.47	7.39 ± 0.57	P=0.0295 P_{1-2}=0.7815 P_{1-3}=0.1354 P_{2-3}=0.0261
	U 12	6.24 ± 0.56	5.88 ± 0.60	6.43 ± 0.65	P=0.0324 P_{1-2}=0.1945 P_{1-3}=0.6576 P_{2-3}=0.0296
	U 11	7.84 ± 0.52	7.88 ± 0.49	8.02 ± 0.59	P=0.6150
	U 21	7.70 ± 0.51	7.82 ± 0.52	7.99 ± 0.50	P=0.2940
	U 22	5.89 ± 0.49	5.86 ± 0.60	6.27 ± 0.56	P=0.0783
	U 23	7.08 ± 0.47	6.80 ± 0.48	7.31 ± 0.55	P=0.017 P_{1-2}=0.2335 P_{1-3}=0.4118 P_{2-3}=0.0131
	U 24	6.72 ± 0.64	6.34 ± 0.43	6.76 ± 0.36	P=0.0262 P_{1-2}=0.0678 P_{1-3}=0.9720 P_{2-3}=0.0434
	U 25	6.43 ± 0.64	6.10 ± 0.44	6.63 ± 0.43	P=0.0135 P_{1-2}=0.1478 P_{1-3}=0.5240 P_{2-3}=0.0115
	U 26	10.0 ± 0.43	9.87 ± 0.55	9.91 ± 0.46	P=0.7300
Mandible	L 46	10.19 ± 0.53	10.13 ± 0.39	10.10 ± 0.63	P=0.8838
	L 45	6.63 ± 0.37	6.56 ± 0.52	6.71 ± 0.59	P=0.6886
	L 44	6.35 ± 0.61	6.35 ± 0.47	6.72 ± 0.47	P=0.0797
	L 43	6.02 ± 0.56	6.01 ± 0.50	6.10 ± 0.37	P=0.8494
	L 42	5.28 ± 0.21	5.21 ± 0.33	5.32 ± 0.40	P=0.6011
	L 41	4.65 ± 0.25	4.95 ± 0.78	5.16 ± 0.43	P=0.0447 P_{1-2}=0.2586 P_{1-3}=0.0363 P_{2-3}=0.5216
	L 31	4.66 ± 0.30	4.89 ± 0.69	5.03 ± 0.40	P=0.1329
	L 32	5.11 ± 0.49	5.19 ± 0.36	5.37 ± 0.52	P=0.2755
	L 33	5.97 ± 0.39	6.09 ± 0.43	6.16 ± 0.54	P=0.5016
	L 34	6.23 ± 0.55	6.31 ± 0.39	6.59 ± 0.41	P=0.0774
	L 35	6.30 ± 0.69	6.64 ± 0.50	6.50 ± 0.76	P=0.3105
	L 36	9.97 ± 0.55	10.18 ± 0.50	10.12 ± 0.68	P=0.5525

There was no significant difference in the AR between the groups. However, we found a significant difference in the OR between the groups (*P*=0.0129). Group 3 had a significantly lower OR than Group 2 (*P*=0.0155). However, there was no significant difference in the OR between Group 1 with Group 2 or Group 3 (Table 3).

Table 3.
Evaluation of the Bolton ratio in the different malocclusion groups.

	Group 1 (Class I)	Group 2 (Class II/1)	Group 3 (Class II/2)	Statistics
AR	76.6 ± 2.5	77.8 ± 3.9	75.2 ±3.3	P=0.0879
OR	89.4 ± 1.6	91.4 ± 3.2	88.8 ± 2.6	P=0.0129 P_{1-2}=0.0704 P_{1-3}=0.7975 P_{2-3}=0.0155

Discussion

The goal of the present study was to evaluate digital models of Class I and II malocclusion for tooth sizes using the Bolton analysis. We applied a 3D measurement program to evaluate these models.

This study showed that the highest values in tooth size were in Class II/2 malocclusion for U14,U13,U12, U23, U24, and U25 in the upper jaw. However, in the lower jaw, only L41 showed the highest values in Class II/2 malocclusion. Many orthodontists recommend that, before initiating orthodontic treatment, the size of the teeth should be assessed as one of the main diagnostic findings. This recommendation has been made because the relevance of a discrepancy in the size of the teeth has been highlighted in most of the scientific literature.[17] Patients with Class II/1 malocclusions have higher anterior and overall ratios than those with Class I or Class II/2 malocclusions. Compared to several other methods, Bolton's analysis is the most common calculation for defining interarch tooth size discrepancies. Previous studies have shown the ideal anterior and overall ratios, with mean values of 77.2±1.65% and 91.3±1.91%, respectively, for the proper harmony of maxillary and mandibular teeth.[18,19]

The mean AR in Class II/1 was slightly higher in our study than that mentioned above, and the mean AR in Class II/2 was lower than that mentioned above. The mean OR in Class II/1 was slightly higher in our study than that mentioned above, and the mean OR in Class II/2 was lower than that mentioned above.

The difference in the size of the upper and lower teeth can vary in different populations.[20] In a study conducted in India, Patil et al. showed no significant difference in the AR or OR between groups with malocclusion of Classes I, II/1, and II/2.[21] Additionally, Uysal and Sari did not find a significant variation in the mean overall or anterior tooth size ratio in patients with Class 1 malocclusion in the Turkish population.[22] In the Irish population, a study showed no significant difference in tooth size ratios across malocclusion groups.[23] These differences between studies might be attributed to varying sample sizes, ethnic variations, and levels of operator accuracy.

The current study investigated the discrepancy in tooth size in our community between the sexes. In this study, there was no association between sexual dimorphism of anterior and total tooth size discrepancies in Classes II/1 and II/2 malocclusion. This finding is consistent with the majority of the world's populations, such as the USA, Turkey, Japan, and Libya.[24-26] Therefore, the size of the teeth is not affected by sex. The diameters of the mesiodistal teeth typically decrease with age.[27] Massaro et al. reported that there were no changes in the mesiodistal tooth size between the ages of 13 and 17 years.[28] Digital evaluation of the tooth size and morphological traits is currently possible because of recent advancements in 3D imaging.[12,29] Notably, this is the first study conducted in Kosovo to evaluate the discrepancy in tooth size between Classes II/1 and II/2 and compare this discrepancy with Class I malocclusions using digital measurements performed with 3D scanned models. Limitations of our study include the limited number of patients and the limited number of study centers. Therefore, our findings may not be representative of the total Kosovo population.

In conclusion, individuals with different malocclusions show different tooth sizes. This study showed that the control group (Class I) had lower AR and OR values than those obtained by Bolton's analysis. We also found that the mean AR and OR in Class II were different in our study than those found by Bolton's analysis. Our findings suggest that treatment planning that takes into consideration the choice of which teeth to extract and the tooth size discrepancy should be performed. A larger study at the national level is required to verify the applicability of these results to the Kosovo population.

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Competing Interests

The authors declare that they have no competing interests.

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