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Investigation of the Relationship between Mesiodistal Crown Diameters and Tooth Extraction Decisions in Orthodontic Patients

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ABSTRACT

Aim: This study aimed to evaluate whether there is a relationship between extraction decisions and the mesiodistal sizes of the teeth in class I cases.

Materials and Methods: 140 patients were allocated into two groups according to the orthodontic treatment plan (the four-premolar-extraction protocol/non-extraction protocol). Their mesiodistal tooth widths were measured using dental casts and a digital calliper. The measurements were taken for all the permanent teeth, except the second and third molars. The data were evaluated using the Student's t-test to determine whether there were any differences between the groups. The analysis was performed separately for the different genders.

Results: In female subjects, it was detected that the teeth numbered 15, 14, 13, 21, 23, 24, and 25 in the extraction group were significantly larger than the same teeth in the nonextraction group (p<0.05). Additionally, the sum of maxillary teeth in the extraction group was more than that for the non-extraction group. In male subjects as well, the teeth numbered 43, 41, and 32 in the extraction group were significantly larger than the same teeth in the nonextraction group (p<0.05).

Conclusion: The present study helps to clarify the effect of odontometric measurements on extraction decisions.

Key words: Extraction protocol, Nonextraction protocol, Odontometry, Treatment decision

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INTRODUCTION

The purpose of an acceptable orthodontic treatment is to provide aesthetic and functional outcomes for the patient and stability of the results. To achieve these goals, a proper patient- specific treatment plan should be implemented. Since orthodontics has become a speciality, clinicians have been debating about the choices to make in various treatment modalities. In these discussions, the decision about whether tooth extractions should be carried out has been one of the issues that have priority. Angle, who was a pioneer of modern orthodontics, and his followers were conservative advocates of the nonextraction treatment [1]. On the other hand, Case and his proponents opposed Angle's idea of nonextraction therapy for every patient and argued that tooth extraction should be used where appropriate [2,3]. With regard to this debate, which took place in the early 1900s, both sides were far from providing solid scientific facts to support their claims. The debate was not carried out on a scientific basis; in fact, it seemed to be a clash of egos [4]. In the middle of the 1930s, some clinicians were not satisfied with the results of the nonextraction treatment, especially in terms of relapses, and they began to prefer extraction treatment in some cases [5].

Even though its popularity has changed in the historical process, tooth extraction is one of the indispensable elements of clinical practice in some cases. The main factors that affect the decision to extract a tooth are as follows: the severity of the discrepancy between the tooth size and arch length, inclination of the incisors, soft tissue profile, periodontal considerations, and stability of the outcomes obtained [6]. The training of the clinician is another factor affecting extraction decisions.

Dental crowding defined by Nance is as the difference between the space needed in the dental arch and the space available in that arch [7]. The amount of crowding is particularly useful when making extraction decisions. Proffit et al. stated that 5 mm crowding on the dental arch was a cutoff point in terms of extraction [8]. Cases with 5 mm-9 mm dental crowding were evaluated as being borderline. In cases with over 9 mm crowding, extraction was almost inevitably recommended. There are two reasons why dental crowding occurs. Either sufficient space for the proper alignment of the teeth is lost for various reasons, such as the premature loss of primary teeth, or there is a dimensional discrepancy between the mesiodistal diameters of the teeth and the dental arch.

In the literature, there are many publications that examine the relationship between tooth diameters and crowding [9-12]. The amount of dental crowding has been associated indirectly with the decision of tooth extraction. However, there is a scarcity of studies on tooth dimensions and extraction decisions to make a direct relationship. The aim of this study was to evaluate whether there is a relationship between extraction decisions and the mesiodistal size of the teeth in class I cases.

MATERIALS AND METHODS

This study was carried out using the records of the Department of Orthodontics at the Gaziosmanpasa University. It was reviewed and approved by the clinical research ethics committee. According to the treatment plan as to whether to extract four premolars or not, two study groups were established. In extraction group, upper and lower first or second premolars were extracted. Minimum 1 week later after the extractions, fixed orthodontic treatments was started by placing brackets and archwire.

The case selection for both the groups was based on the following criteria.

- Being at the stage of adolescence,
- Being Turkish descent,
- Having a class I skeletal pattern (0° ≤ ANB° ≤ 5°),
- Having a normal vertical skeletal pattern (26° ≤ SnGo° ≤ 38°),
- Not having any impacted or congenitally missing teeth,
- Not having tooth extraction anamnesis.

60 patients (40 females and 20 males) treated according to the four-premolar-extraction protocol were included in the extraction group. 80 patients (40 females and 40 males) treated according to the nonextraction protocol were included in the nonextraction group. In both groups, mesiodistal crown diameters of the all twelve teeth-from the left first molar to the right first molar-were measured in such a way that the tips of the calliper would be parallel to the occlusal plane. A digital calliper with a measurement accuracy of 0.01 mm was used (Rolson, Berkshire, United Kingdom). Since it is thought that the measurements could be achieved more easily and precisely, plaster models were utilised. The measurements were taken for both the maxillary and mandibular dental arches. To test the reliability of the measurements, 20 sets of dental casts were re-measured after two weeks by the same investigator. The mean difference between them was 0.12 mm, and this was not statistically significant. The plan was that an equal number of males and females would to be used when the groups were set up, but it was not possible to obtain a sufficient number of male subjects for the extraction group.

Statistical analysis

The data for each tooth and each patient were collected on an Excel sheet. Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS Statistics for Windows, Version 19.0, IBM Corp., Armonk, NY). p-values of less than 0.05 were considered to be statistically significant. The means, standard deviations, and ranges were calculated for all the teeth. Since the data set was distributed normally, the Student's t-test, a parametric test, was utilised for the statistical analysis.

RESULTS

The mean mesiodistal widths, standard deviations, and ranges for each tooth are shown in Table 1. When the mesiodistal crown diameters of the subjects who had extractions and those who did not have were compared, statistically significant differences were detected for some teeth. The teeth numbered 15, 14, 13, 21, 23, 24, and 25 in the female extraction group were significantly larger than the same teeth in the female nonextraction group. In the male extraction group as well, the teeth numbered 43, 41, and 32 were significantly larger than the same teeth in the male nonextraction group. In addition, the sum of the mesiodistal crown diameters of the maxillary teeth in the female extraction group was more than that of the nonextraction group (Table 2).

When the tooth sizes of the females and males in the extraction group were compared, statistically significant differences were found in the teeth numbered 11 and 43. In the nonextraction group as well, statistically significant differences were detected in the teeth numbered 14, 13, 12, 11, 21, 22, and 23. There was also a statistically significant difference in the total mesiodistal width of the twelve maxillary teeth between the male and female subjects. In all of these statistical differences, the mesiodistal crown diameters of the males were larger than those of the female subjects (Table 3).

Table 1: Descriptive data of the investigated subjects

Tooth Number	Mean	Standard Deviation	Range
16	10.47	0.56	3.3
15	6.8	0.51	2.7
14	7.09	0.47	2.2
13	7.87	0.52	2.7
12	6.86	0.63	4.5
11	8.89	0.57	3.1

21	8.9	0.57	3.2
22	6.84	0.6	3.3
23	7.84	0.49	2.4
24	7.11	0.46	2.3
25	6.79	0.5	2.4
26	10.33	0.55	3.5
Sum of the maxillary 12 teeth	95.8	4.82	22.9
46	11.03	0.69	4.5
45	7.2	0.51	2.8
44	7.15	0.49	2.3
43	6.82	0.44	2.3
42	6.09	0.41	2.2
41	5.56	0.37	1.7
31	5.55	0.39	1.8
32	6.1	0.42	2
33	6.84	0.44	2.3
34	7.19	0.51	2.3
35	7.25	0.49	2.7
36	11.07	0.61	3.5
Sum of the mandibular 12 teeth	87.85	4.38	22.5

Table 2: Statistical analysis of the mesiodistal crown diameters according to the treatment protocol

Tooth Number	Female						p	Male						p
	Extraction			Nonextraction				Extraction			Nonextraction			
	Mean	SD	Range	Mean	SD	Range		Mean	SD	Range	Mean	SD	Range	
16	10.42	0.53	2.7	10.43	0.66	2.6	0.926	10.58	0.57	2.2	10.51	0.47	2.1	0.601
15	6.97	0.49	2.2	6.63	0.46	1.7	0.002*	6.74	0.54	1.9	6.83	0.52	2.3	0.522
14	7.2	0.44	2.2	6.91	0.44	1.9	0.004*	7.19	0.52	2	7.11	0.46	1.6	0.56
13	7.9	0.45	2.3	7.59	0.41	1.8	0.002*	8.05	0.68	2.5	8.02	0.5	2.3	0.859
12	6.88	0.59	2.8	6.62	0.7	4	0.076	7.1	0.5	2.3	6.97	0.6	2.4	0.414
11	8.86	0.45	1.8	8.64	0.61	2.3	0.071	9.17	0.46	1.8	9.03	0.58	2.7	0.352
21	8.91	0.47	2.2	8.61	0.61	2.4	0.015*	9.17	0.49	2.1	9.07	0.56	2.5	0.511
22	6.83	0.57	2.5	6.67	0.72	3.3	0.265	6.93	0.43	1.7	6.98	0.54	2.2	0.721
23	7.86	0.37	1.7	7.58	0.45	1.7	0.003*	8.02	0.58	2.1	7.99	0.5	2.2	0.809
24	7.18	0.4	1.8	6.98	0.47	2.3	0.038*	7.22	0.51	1.7	7.13	0.46	1.8	0.494
25	6.92	0.45	1.6	6.6	0.45	1.7	0.003*	6.85	0.49	1.7	6.83	0.57	2.3	0.893
26	10.26	0.51	2.4	10.23	0.58	2.2	0.822	10.5	0.66	2.6	10.4	0.49	2	0.542
Sum of the maxillary 12 teeth	96.2	4.24	21.9	93.5	5	18.9	0.011*	97.48	4.38	14.6	96.86	4.7	16.6	0.623
46	11.06	0.81	4.5	10.95	0.66	3	0.506	11.11	0.7	2.2	11.03	0.59	2.4	0.653
45	7.31	0.49	2.5	7.25	0.51	2.7	0.641	7.1	0.53	1.9	7.07	0.48	2.2	0.841
44	7.27	0.48	2.2	7.11	0.5	2.2	0.13	7.17	0.54	2	7.08	0.46	1.7	0.5

43	6.82	0.42	2	6.75	0.45	2	0.493	7.07	0.38	1.4	6.78	0.45	1.5	0.015*
42	6.15	0.43	2	6.08	0.42	1.8	0.477	6.14	0.43	1.8	6.02	0.38	1.5	0.275
41	5.59	0.35	1.4	5.53	0.37	1.6	0.46	5.73	0.4	1.3	5.47	0.36	1.3	0.015*
31	5.61	0.39	1.7	5.55	0.38	1.8	0.469	5.63	0.34	1.3	5.45	0.4	1.6	0.086
32	6.17	0.42	1.9	6.1	0.44	2	0.522	6.21	0.39	1.5	5.98	0.39	1.4	0.042*
33	6.83	0.39	1.6	6.72	0.47	2.3	0.261	7.03	0.43	1.6	6.86	0.43	1.6	0.144
34	7.33	0.49	2.3	7.13	0.52	2.1	0.075	7.19	0.55	2.2	7.13	0.5	2.1	0.674
35	7.31	0.5	2.5	7.23	0.49	2.5	0.461	7.25	0.49	1.8	7.2	0.49	1.8	0.684
36	11.03	0.54	2.3	11.04	0.73	3.5	0.972	11.24	0.61	2.1	11.07	0.55	2.3	0.294
Sum of the mandibular 12 teeth	88.48	4.33	22.5	87.44	4.76	21.1	0.308	88.86	3.93	14.6	87.13	4.22	16.6	0.132

*Significant at p<0.05 by Student's t-test

Table 3: Statistical analysis of the mesiodistal crown diameters according to the gender

Tooth Number	Female						p	Male						p
	Extraction			Nonextraction				Extraction			Nonextraction			
	Mean	SD	Range	Mean	SD	Range		Mean	SD	Range	Mean	SD	Range	
16	10.42	0.53	2.7	10.58	0.57	2.2	0.286	10.43	0.66	2.6	10.51	0.47	2.1	0.561
15	6.97	0.49	2.2	6.74	0.54	1.9	0.098	6.63	0.46	1.7	6.83	0.52	2.3	0.077
14	7.2	0.44	2.2	7.19	0.52	2	0.908	6.91	0.44	1.9	7.11	0.46	1.6	0.048*
13	7.9	0.45	2.3	8.05	0.68	2.5	0.32	7.59	0.41	1.8	8.02	0.5	2.3	<0.001*
12	6.88	0.59	2.8	7.1	0.5	2.3	0.17	6.62	0.7	4	6.97	0.6	2.4	0.019*
11	8.86	0.45	1.8	9.17	0.46	1.8	0.016*	8.64	0.61	2.3	9.03	0.58	2.7	0.004*
21	8.91	0.47	2.2	9.17	0.49	2.1	0.054	8.61	0.61	2.4	9.07	0.56	2.5	0.001*
22	6.83	0.57	2.5	6.93	0.43	1.7	0.491	6.67	0.72	3.3	6.98	0.54	2.2	0.031*
23	7.86	0.37	1.7	8.02	0.58	2.1	0.207	7.58	0.45	1.7	7.99	0.5	2.2	<0.001*
24	7.18	0.4	1.8	7.22	0.51	1.7	0.757	6.98	0.47	2.3	7.13	0.46	1.8	0.145
25	6.92	0.45	1.6	6.85	0.49	1.7	0.568	6.6	0.45	1.7	6.83	0.57	2.3	0.059
26	10.26	0.51	2.4	10.5	0.66	2.6	0.132	10.23	0.58	2.2	10.4	0.49	2	0.16
Sum of the maxillary 12 teeth	96.2	4.24	21.9	97.48	4.38	14.6	0.279	93.5	5	18.9	96.86	4.7	16.6	0.003*
46	11.06	0.81	4.5	11.11	0.7	2.2	0.814	10.95	0.66	3	11.03	0.59	2.4	0.556
45	7.31	0.49	2.5	7.1	0.53	1.9	0.139	7.25	0.51	2.7	7.07	0.48	2.2	0.105
44	7.27	0.48	2.2	7.17	0.54	2	0.436	7.11	0.5	2.2	7.08	0.46	1.7	0.78
43	6.82	0.42	2	7.07	0.38	1.4	0.029*	6.75	0.45	2	6.78	0.45	1.5	0.785
42	6.15	0.43	2	6.14	0.43	1.8	0.949	6.08	0.42	1.8	6.02	0.38	1.5	0.504
41	5.59	0.35	1.4	5.73	0.4	1.3	0.178	5.53	0.37	1.6	5.47	0.36	1.3	0.465
31	5.61	0.39	1.7	5.63	0.34	1.3	0.883	5.55	0.38	1.8	5.45	0.4	1.6	0.234
32	6.17	0.42	1.9	6.21	0.39	1.5	0.726	6.1	0.44	2	5.98	0.39	1.4	0.196
33	6.83	0.39	1.6	7.03	0.43	1.6	0.072	6.72	0.47	2.3	6.86	0.43	1.6	0.18
34	7.33	0.49	2.3	7.19	0.55	2.2	0.324	7.13	0.52	2.1	7.13	0.5	2.1	0.965
35	7.31	0.5	2.5	7.25	0.49	1.8	0.637	7.23	0.49	2.5	7.2	0.49	1.8	0.734
36	11.03	0.54	2.3	11.24	0.61	2.1	0.192	11.04	0.73	3.5	11.07	0.55	2.3	0.809

Sum of the mandibular 12 teeth	88.48	4.33	22.5	88.86	3.93	14.6	0.747	87.44	4.76	21.1	87.13	4.22	16.6	0.759

*Significant at p<0.05 by Student's t-test

DISCUSSION

The relationship between the size of the teeth and dental crowding has been previously investigated by various researchers [9-12]. Although some of these studies have suggested that there is a significant correlation between them [9,10]. Other studies have presented uncorrelated results [11,12]. We believe that the reason for these contradictory results is that the researchers neglected to take account of the incisor inclinations while creating the research groups. Because the protrusion of the incisors is another masked expression of crowding, subjects who had protruded incisors, therefore, should not have been included in the group with noncrowding, while subjects who had retruded incisors should not have been included in the group with crowding. However, in these studies, the groups were set up according to the amount of crowding without considering the inclination of the incisors. In this respect, we think that the results of these studies should be interpreted with caution.

In the present study, we investigated the relationship between the mesiodistal crown diameters of the teeth and treatment protocols (extraction versus nonextraction). Thus, we surmised that the incisor inclinations would not affect the results of the study, because the protrusion of the incisors is another expression of crowding and the extraction treatment may be planned not only to eliminate the apparent crowding, but also to correct the improper incisor inclinations. Furthermore, we included subjects who had skeletal class I (0° ≤ ANB° ≤ 5°) and normal vertical (26° ≤ SnGo° ≤ 38°) patterns in the study. Clinicians sometimes prefer to mask sagittal and vertical skeletal problems by moving the dentoalveolar structures and correcting the occlusion. This method, known as camouflage treatment, often requires tooth extractions [13]. Since it was thought that the results would be affected, subjects with sagittal and vertical skeletal anomalies were not included in the study.

Statistical differences in some teeth in terms of treatment protocol and gender were detected in this study. The differences were in favor of extraction protocol and males. In addition, the mesiodistal sum of the twelve maxillary teeth in the female extraction group was statistically more than that in the female nonextraction group (Table 3). In the literature, although there are studies examining the relationship between tooth dimensions and dental crowding [9-12,14-16]. We could not find any study that compared the mesiodistal crown diameters of the teeth in four-premolar extraction and nonextraction cases. This study seems to be the first trial to examine the relationship between extraction decisions and tooth size. Therefore, there is no previous literature allowing us to compare and evaluate the data we have obtained. Despite their shortcomings, we still think that the best studies with which we can compare our data are those investigating the relationship between dental crowding and tooth dimensions.

Doris et al. stated that the total mesiodistal teeth size for patients with more than 4 mm of dental crowding was larger than that for patients with noncrowded arch [9]. In addition, they detected that five teeth in particular (the maxillary lateral incisor, maxillary second premolars, mandibular canines, and mandibular first and second premolars) in the crowded group were larger mesiodistally than the teeth in the uncrowded group. Doris et al. [9] did not include the first molar tooth in the study. Bernabé et al. compared the mesiodistal, buccolingual tooth sizes and crown proportions in three groups (those with moderate, mild, and noncrowded arches) [14]. They concluded that differences between the groups for the mesiodistal tooth sizes existed in all the upper teeth and in the lower central incisor and first and second premolars. Similarly, Chang et al. also showed that the mesiodistal tooth diameters of the crowded group were significantly larger than those of the noncrowded group [10]. In opposition to these studies, there are also researchers who have not been able to find a relationship between the mesiodistal tooth dimension and amount of crowding. Howe et al. could find no differences between the crowded and noncrowded groups [11]. They claimed that crowded and noncrowded groups could not be distinguished from each other in terms of mesiodistal tooth size. However, we think that contradictory outcomes should be expected, since incisor inclinations were not taken into account in any of these studies while creating the groups. As mentioned above, incisor protrusion is often the masked form of crowding and creating groups without considering incisor inclinations would be a methodological error.

Another finding of the present study is that some of the teeth of males were statistically larger than the same teeth in females (Table 3). For two teeth in the extraction group (11 and 43) and seven teeth in the nonextraction group (14, 13, 12, 11, 21, 22, and 23), there were statistically differences between the genders. In particular, in the nonextraction group, the differences with regard to the maxillary canines were found to be quite strong (p<0.001). These findings are consistent with the majority of the publications in the literature [17-20]. Filipovic et al. stated that males have larger teeth than females and canines show the greatest sexual dimorphism [17]. Similarly, other researchers have also reported that males have larger teeth than females and this difference is evident in canine teeth [18,19]. Moreover, these teeth have been presented as a diagnostic tool in sex identification in the field of forensic science due to sexual dimorphism [20].

As a limitation of this study, we could not create the groups by using equal number of subjects. Actually, we intended to use equal number of subjects (80 cases in the extraction group and 80 cases in the nonextraction group) at the beginning of the study. However, we had trouble finding extracted male subjects. Therefore, the groups were not equal in terms of subject numbers.

CONCLUSION

The results of this study show that subjects for whom the four-premolar-extraction protocol had been used had a larger mesiodistal tooth width for some teeth compared with those subjects for whom the nonextraction plan had been adopted. This suggests that mesiodistal tooth diameter may be a determining factor in treatment decisions, although this is not clearly recognised in case planning. Additionally, males have larger teeth than females, and this difference is particularly evident in the upper canine teeth.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this manuscript.

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