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KANİN BRAKET TORKUNUN DİŞ HAREKETİ ÜZERİNE ETKİLERİ: PROSPEKTİF KLİNİK ÇALIŞMA

THE EFFECTS OF CANINE BRACKET TORQUE ON TOOTH MOVEMENT: A PROSPECTIVE CLINICAL STUDY

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ÖZET

Bu çalışmanın amacı, premolar çekimli tedavilerde mandibular kanin (Mn3) braket torkunun Mn3 ve mandibular birinci molar (Mn6) diş hareketlerine etkilerini değerlendirmektir. Bu split-mouth çalışmaya 27 birey dahil edildi. -11° torka sahip Mn3 braketleri çalışma grubunu, 0° torka sahip Mn3 braketleri ise kontrol grubunu oluşturdu. Başlangıç (T0) ve 12. hafta (T1) alt ortodontik modeller hazırlandı ve üç boyutlu (3D) tarayıcı ile tarandıktan sonra, Orthoanalyzer analiz programı kullanılarak çakıştırıldı. Mn3 ve Mn6 hareketleri ölçüldü. Verilerin normal dağılım açısından test edilmesi için Shapiro Wilk testi kullanıldı. T0 ve T1 aşamaları arasındaki grup içi karşılaştırmalar ve T1-T0 fark değerleri için gruplar arası karşılaştırmalar, normal dağılım gösteren veriler için paired sample t- testi ve normal dağılım göstermeyen veriler için Wilcoxon signed rank testi kullanılarak yapıldı. Önem düzeyi $p < 0.05$ olarak alındı. Her iki grupta Mn3'ün distal açısal ve doğrusal, bukkal doğrusal hareketlerinde ve Mn6' nın oklüzal ve lingual doğrusal hareketlerinde önemli artışlar izlendi. Mn3 ve Mn6 hareketi gruplar arasında istatistiksel olarak anlamlı farklılık göstermedi. Artmış Mn3 braket torku, premolar çekimli tedavinin başlangıç hizalama aşamasında Mn3 ve Mn6 diş hareketlerinde önemli bir fark yaratmadı.

Anahtar Kelimeler: Kanin braketi, Tork, Diş hareketi

ABSTRACT

The aim of this study was to evaluate the effects of mandibular canine (Mn3) bracket torque on Mn3 and mandibular 1st molar (Mn6) tooth movements in treatments with premolar extraction. This split-mouth study included 27 individuals in a -11° Mn3 bracket torque study group and a 0° Mn3 bracket torque control group. The initial (T0) and 12th week (T1) lower orthodontic models were prepared and digitised with a 3D scanner and superimposed using the Orthoanalyzer analysis program. Mn3 and Mn6 movements were measured. A Shapiro Wilk test was used to test the data for normal distribution. Intragroup comparisons between the T0 and T1 stages and intergroup comparisons for T1–T0 difference values were made using a paired sample t-test for normally distributed data and the Wilcoxon signed rank test for data not showing normal distribution. The significance level was $p < 0.05$. Both groups showed significant increases in the distal angular and linear and the buccal linear movements of Mn3, as well as in the occlusal and the lingual linear movements of Mn6. Mn3 and Mn6 movements did not show statistically significant differences between the groups. The increased Mn3 bracket torque did not make a significant difference on Mn3 and Mn6 tooth movements during the initial alignment stage of treatment with premolar extraction.

Keywords: Canine bracket, Torque, Tooth movement

1. INTRODUCTION

Bracket prescription selection is an essential part of orthodontic treatment planning (Thickett *et al.*, 2007). Andrews introduced straight wire technique and preadjusted bracket prescription in 1972 (Andrews, 1972). The relationship between preadjusted brackets and the arch wire creates 3-dimensional tooth positioning and enables the achievement of six keys of occlusion at the end of treatment (Cash *et al.*, 2004). For this reason, previous studies have reported the effect of bracket design or arch wire properties on levelling movements (Pandis *et al.*, 2008) or changes in inclination of the teeth by the combination of rectangular arch wire and bracket torque for different prescriptions (Mittal *et al.*, 2015). These prescriptions have different values for the torque of the mandibular canine (Mn3) brackets. For example, Roth stated the required torque value for the Mn3 as -11º in his technique (Roth, 1976), in the MBT technique, Mn3 brackets with torque values of -6°, 0° or + 6° are recommended, depending on the case (McLaughlin *et al.*, 2001). However, the effects of the different Mn3 bracket torque values have not been reported regarding the movement of tooth in treatments involving 1st premolar extraction. Therefore, the present study evaluated the effects of Mn3 bracket torque of -11° on Mn3 and Mn6 tooth movements in treatments with a mandibular 1st premolar extraction.

2. MATERIALS AND METHODS

The study was approved by the clinical research ethics committee of the Ondokuz Mayıs University with number 2016/337. This was a single-center prospective clinical study, with a single operator (YÜ) participating in the orthodontic treatment of the patients. The patient informed form was obtained for all patients. Individuals included in the study had the following criteria:

- Indication of treatment with moderate anchorage in lower dental arch and extraction in the mandibular 1st premolars,
- In permanent dentition,
- No missing teeth.

The sample size was calculated 15 individuals for 95% confidence and 99.9% test power, using Jahanbakhshi et al.'s study (Jahanbakhshi *et al.*, 2016) as a reference. The average age of the 27 included individuals (22 females and 5 males) was 15, 4 years (11,8 years – 17, 9 years). The split-mouth design used here has been used in many studies (Huffman & Way, 1983; Ziegler & Ingervall, 1989; Daskalogiannakis & McLachlan, 1996) because the findings are more reliable than those obtained by comparing variables in different patients. All patients were bonded with Mn3 with a -11° torque in one half of the lower dental arch (study group) and a 0° torque in the other half of the lower dental arch (control group). The simple randomization was used include using a shuffled deck of bracket prescription cards. Prescription 1 with 0º in the left Mn3 bracket torque and -11° in the right Mn3 bracket torque, and prescription 2 with -11° in the left Mn3 bracket torque and 0º in the right Mn3 bracket torque were prepared.

Our bracket selection criteria were the same torque and angulation values for all symmetrical teeth, with only the Mn3 teeth having a different torque alternative. We prefer the 0.022-inch slot Level Arch Modern prescription Mini Diamond Twin ® (Ormco, Glendora, California, USA) metal brackets because they meet these criteria and Accent™ (Ormco, Glendora, California, USA) Mn6 tubes. The bracket prescriptions are shown in Table 1.

A .017" x .025" Turbo Wire (Ormco Corp., Orange, California, USA) was used as initial arch wire. This is a nine-strand, rectangular, braided NiTi (Nickel Titanium) with low stiffness and great flexibility (Ormco product catalog, 2017).

The brackets were bonded to the mandibular central incisor**,** Mn3, and Mn6 teeth as measurement references. The mandibular 2nd molars (Mn7) not included in the treatment were used for superimposition. The plaster model (T0) was then prepared. The lower teeth were bonded without the mandibular 1st premolars and Mn7. The anchorage was prepared moderate. After extraction of the premolars, lacebacks were tied and the arch wire inserted into the brackets. The frequency of control sessions were four weeks. At the 12th week, a 2nd lower plaster model (T1) was prepared. The lower plaster models were digitized with a 3D scanner (3Shape R-700 Desktop Orthodontic Scanner, Copenhagen, Denmark) and superimposed using the Orthoanalyzer (3Shape, Copenhagen, Denmark) analysis program**.** The distobuccal and mesiolingual cusp tips of Mn7 were used as reference of superimposition. Sagittal and horizontal planes were formed in this model. The sagittal planes were created using the mesial, central and distal points of the right-left Mn7 central fossaes. The horizontal plane was created perpendicular to the sagittal plane passing through the palatal midline projection.

2.1.Measurements

Mn3 degree (Mn3 dg): The distogingival angle between the line passing distoocclusal corner of the Mn3 bracket and the tip of the Mn3 with the line passing parallel to the occlusal edge of bracket base.

Mn6 degree (Mn6 dg): The distogingival angle between the the line passing distoocclusal corner of the Mn6 tube and the tip of the midbuccal cusp with the line passing paralel to the occlusal edge of tube base.

Mn3 X millimeter (Mn3 X mm), Mn6 X millimeter (Mn6 X mm), Mn3 Y millimetre (Mn3 Y mm), Mn6 Y millimetre (Mn6 y mm) measurements are shown in Figure 1 as mesiodistal and occlusogingival measurements.

Mn3 occlusal millimetre (Mn3 O mm), Mn6 occlusal millimetre (Mn6 O mm) measurements are shown in Figure 2 as faciolingual measurements.

The distances between the tips of the right and left Mn7' s disto-buccal and mesio-lingual cusps on the X axis of the horizontal plane are used Mn7 measurements.

2.2. Statistical Analysis

Data was analyzed with IBM SPSS V26, and a Shapiro Wilk test was used to test the data for a normal distribution. Intragroup and intergroup comparisons were made using a paired sample t test for normally distributed data and a Wilcoxon signed rank test for data not showing normal distribution. Results are presented as mean ± standard deviation, and the significance level was $p < 0.05$.

3. RESULTS

3.1.Intragroup Comparisons

The angular movements of the Mn3 in the distal direction significantly increased in both the study ($P < 0.001$) and control ($P < 0.01$) groups. The linear movements of the Mn3 in the distal and facial directions significantly increased in both the study ($P < 0.001$) and control ($P < 0.001$) groups. The linear movement of Mn6 in the lingual direction significantly increased in both the study ($P < 0.01$) and control ($P < 0.001$) groups. However, the angular and linear mesiodistal movement of the Mn6 teeth did not show a statistically significant difference in either the study or the control groups. The occlusogingival movement of Mn3 did not show statistically significant difference in both groups. The occlusal movement of Mn6 significantly increased in the control ($p < .05$) group.

The transverse distances of the tips of distobuccal and mesiolingual cusps of the right and left Mn7' s did not show statistically significant differences between T0 and T1 stages. Intragroup comparisons and Mn7's measurements are shown in Table 2.

3.2.Intergroup Comparisons

The movements of Mn3 and Mn6 did not show any statistically significant differences between the groups (P>.05). Intergroup comparisons are showen in Table 3.

4. DISCUSSION

This study evaluated the effects of -11° torque of Mn3 bracket on tooth movements in the first 12 weeks of an orthodontic treatment. During this period, a 0.017 × 0.025 Turbo Wire arch wire was used as the initial arch wire because of its rectangular cross-section. This section was chosen to reveal the torque of the bracket. The new lower-stiffness NiTi wires allow clinicians to use larger, rectangular-cross-section wires at the start of the treatment. In addition, by using fewer arch wires, they can simultaneously achieve movements, such as the correction of rotations, tipping, levelling and torqueing (Kapila & Sachdeva, 1989; Ibe & Segner, 1998). Therefore, this wire can also be used as an initial arch wire in severe malocclusions (Jyothikiran *et al.*, 2014).

The data set for the present study was obtained by measuring the amount of tooth movement on digital models. In previous studies, digital jaw models were used for the three-dimensional analysis of orthodontic tooth movement (Schmidt *et al.*, 2018), and the surface fit method is recommended for superimposition of these models. The safest areas for this method include the lingual alveolar surfaces of the anterior and posterior teeth, the bilateral lingual-buccal alveolar surfaces of the posterior teeth, the lingual surfaces of the bilateral alveolar protrusions of posterior teeth and the bilateral mandibular torus regions (An *et al.*, 2015). However, in our study, the buccal and lingual cusp tips of the Mn7s, which were not included in the treatment, were preferred as the superimposition area, given that soft tissue and alveolar protrusion surfaces may change during the treatment with premolar extraction. Comparison of the transverse distances between these cusp tips for the T0 and T1 stages did not reveal a statistically significant difference, thereby supporting their reliability as a superimposition area.

The results of present study indicated significant linear and angular movements of the Mn3 in the distal direction in both groups, and these movements did not differ between the two groups. The faciolingual evaluation results of our study revealed a significant amount of buccal movement of Mn3 in both groups, and again this movement did not differ between the groups. Hamdan et al. reported that intercanine distance was increased especially in the treatment with the extraction of the 1st premolars (Hamdan *et al.*, 2015). The results of our research show that the increase in facial movement in both groups can be evaluated as the total increase in the intercanine distance. Mittal et al. also reported that patients treated with skeletal class 1 and premolar extractions do not display a clinical difference in torque of the anterior teeth when treated with the MBT or Roth bracket prescriptions (Mittal *et al*., 2015).

The Mn6 moved significantly in both groups towards the lingual and occlusal directions, and these movements were similar between both groups. This result showed that the Mn3 bracket torque value did not have a significant effect on the movements of the Mn6 tooth.

In this study, the Mn3 and Mn6 tooth movements were same in the both groups. These results were attributed to the use of the combination of the 0.022″ slot brackets and the 0.017″ × 0.025″ initial arch wire because most of the bracket torque is lost due to play angle (Burstone, 1994). As the play angle increases, the torque loss also increases (Creekmore & Kunik, 1993). In our study, the 0.021″ × 0.025″ Turbo Wire could be used to reduce the play angle; however, this wire was not considered particularly suitable for use in an actual clinical setting in cases with crowding that requires extraction treatment. Mittal et al. stated that using a full size 0.021″ × 0.025″ arch wire for full torque expression, the difference between the two bracket prescriptions can be determined. However, they expressed that this use did not reflect their routine clinical practice (Mittal *et al*., 2015).

Another factor possibly affecting movement is the highly flexible NiTi wire structure of the Turbo wire, because low-modulus alloys like NiTi are more prone to torque loss (Gioka & Eliades, 2004). In support of this view, Al-Qabandi et al. found no difference between the 0.016″ × 0.022″ and round NiTi initial arch wires used with the 0.018″ × 0.025″ edgewise appliance (Al-Qabandi *et al.*, 1999). Perrey et al. also were unable to draw conclusions regarding which bracket-archwire combination might offer a significant advantage in terms of levelling outcomes (Perrey *et al.*, 2015). Similarly, in our study, we concluded that using the combination of a 0.022″ slot canine bracket with an increased torque and a 0.017″ × 0.025″ arch wire did not provide any significant advantage in terms of tooth movement at the initial stage of the treatment. In this respect, this study can serve as a reference for clinicians regarding the bracket prescription and arch wire combination that should be used in cases where torque control is planned from the beginning of the treatment.

The main limitation of the present study was that the data set was formed from measurements made on digital orthodontic models; therefore, tooth movements were measured only at the crown level. Future studies should examine the effects of different Mn3 bracket torque values and full size initial arch wire combinations on tooth movement.

5. CONCLUSION

The increased Mn3 bracket torque did not make a significant difference on Mn3 and Mn6 tooth movements during the initial orthodontic alignment stage of treatment with a mandibular 1st premolar extraction.

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Table 1. The bracket prescriptions of this study

	Groups			
	Study		Control	
Mandibular Brackets	Angulation	Torque	Angulation	Torque
Incisors	0°	-6°	0°	-6°
Canine	+6°	-11°	+6°	0°
2nd premolar	0°	-17°	0°	-17°
1st molar tube	5°(Distal offset)	-10°	5°(Distal offset)	-10°

Table 2. Intragroup comparisons

MEASUREMENT	GROUP	MEASUREMENT VALUE (mean ± standard deviation)		P
		Bonding (T0)	**12th week (T1)**	
Mn3dg (Angular)	Study	76.73 ± 15.19	87.39 ± 13.29	0.000***
	Control	82.76 ± 19.82	91.67 ± 12.38	0.004**
Mn3 x mm (Linear)	Study	34.51 ± 2.76	32.39 ± 2.85	0.000***
	Control	33.68 ± 3.79	31.52 ± 3.38	0.000***
Mn3 y mm (Linear)	Study	3.45 ± 1.86	3.47 ± 1.64	0.970
	Control	3.03 ± 1.10	3.07 ±1.18	0.857
Mn3 O mm (Linear)	Study	13.12 ± 3.24	14.49 ± 3.22	0.000***
	Control	12.14 ± 2.70	13.76 ± 2.59	0.000***
Mn6dg (Angular)	Study	110.81 ± 18.26	109.78 ± 15.23	0.686
	Control	107.96 ± 19.32	107.73 ± 21.67	0.865
Mn6 x mm (Linear)	Study	10.75 ± 3.72	10.54 ± 3.21	0.162
	Control	9.86 ± 1.89	9.79 ± 1.92	0.553
Mn6 y mm (Linear)	Study	2.75 ± 0.98	2.71 ± 1.04	0.199
	Control	3.02 ± 1.46	2.83 ± 1.49	0.018*
Mn6 O mm (Linear)	Study	22.05 ± 2.89	21.75 ± 2.73	0.007**
	Control	21.53 ± 1.53	21.18 ± 1.38	0.000***
Mn7DB		52.22 ± 3,54	52.20 ± 3.57	0.870
Mn7ML		41.21 ± 3.63	41.14 ± 3.66	0.404

Table 3. Intergroup comparisons

MEASUREMENT	GROUP	MEASUREMENT VALUE (mean ± standard deviation) (T1-T0)	P
Mn3dg (Angular)	Study	10.65 ± 13.36	0.537
	Control	8.90 ± 14.55	
Mn3 x mm (Linear)	Study	2.12 ± 0.97	0.882
	Control	2.16 ± 1.33	
Mn3 y mm (Linear)	Study	0.02 ± 1.39	0.899
	Control	0.04 ± 1.30	
Mn3 O mm (Linear)	Study	1.37 ± 1.05	0.489
	Control	1.62 ± 1.48	
Mn6 dg (Angular)	Study	-1.03 ± 13.17	0.755
	Control	-0.22 ± 6.71	
Mn6 x mm (Linear)	Study	-0.21 ± 0.74	0.243
	Control	-0.06 ± 0.36	
Mn6 y mm (Linear)	Study	-0.03 ± 0.80	0.249
	Control	-0.19 ± 0.37	
Mn6 O mm (Linear)	Study	0.30 ± 0.54	0.773
	Control	-0.35 ± 0.43	

Figure Legends

Figure 1. Mesiodistal and occlusogingival measurements.

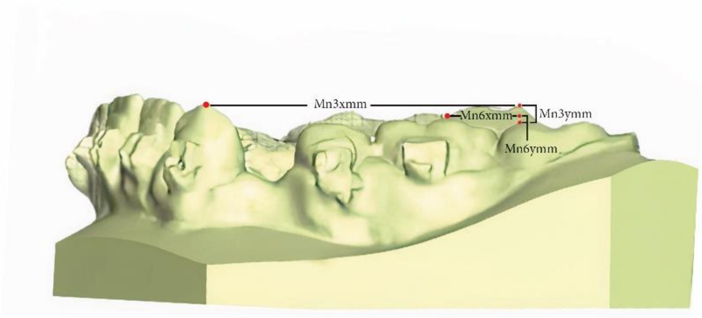
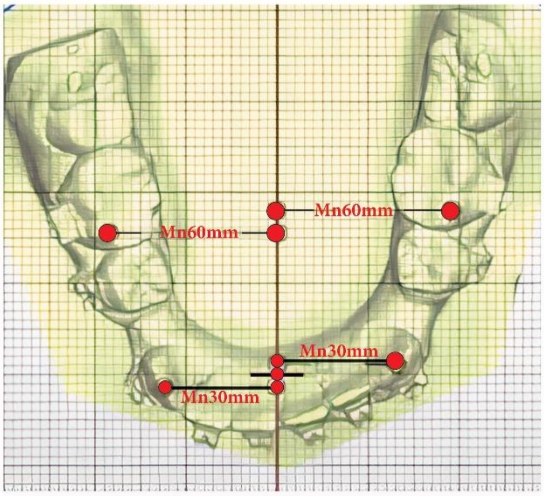


Figure 2. Faciolingual measurements.



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