

Evaluation of the Elongation Amount in Prepared Molar Teeth With the Aid of an Intraoral Scanner

Prepare Edilmiş Molar Dişlerdeki Uzama Miktarının Dijital Sistem ile Değerlendirilmesi

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ABSTRACT

INTRODUCTION: To evaluate the amount of displacement of endodontically treated molar teeth after tooth preparation for crown restoration in short term.

MATERIAL and METHODS: Eighteen endodontically treated molar teeth were scanned using digital intra-oral scanner on the day of tooth preparation and a week later. The data of the first and last scans were compared to evaluate the possible tooth displacement with color maps. For each tooth, measurements from 5 different reference points were performed to qualitatively determine the amount of displacement. Statistical analysis was done with the Wilcoxon test. Statistical significance was set at $p < 0.05$.

RESULTS: No difference was determined in the bucco-lingual and cervico-incisal directions, but there was a difference in the mesio-distal direction according to color maps. But the difference was not statistically significant ($p > 0.05$)

CONCLUSION: According to the findings of this study the amount of mesio-distal displacement that observed in root canal-treated molars in adults found to be neither statistically nor clinically significant.

Keywords: Color map, digital intra-oral scanner, tooth movement

ÖZ

GİRİŞ: Bu çalışmanın amacı; kron restorasyonu için diş preperasyonu yapılmış endodontik tedavili azı dişlerinin, kısa sürede yer değiştirip değiştirmediğinin değerlendirilmesidir.

YÖNTEM ve GEREÇLER: Endodontik tedavi görmüş 18 azı dişi, dişin prepare edildiği gün ve bir hafta sonrası dijital ağız içi tarayıcı kullanılarak tarandı. Olası diş yer değiştirmesini renkli haritalarla değerlendirmek için ilk ve son taramaların verileri karşılaştırıldı. Yer değiştirme miktarının niteliksel olarak belirlenmesi amacıyla her diş için 5 farklı referans noktasından ölçümler yapıldı. İstatistiksel analiz Wilcoxon testi ile yapıldı. İstatistiksel anlamlılık $p < 0.05$ olarak belirlendi.

BULGULAR: Renk haritalara göre bucco-lingual ve serviko-insizal yönlerde farklılık saptanmazken mesio-distal yönde farklılık tespit edildi. Ancak fark istatistiksel olarak anlamlı değildi ($p > 0,05$)

SONUÇ: Bu çalışmanın bulgularına göre erişkinlerde kanal tedavili azı dişlerinde gözlenen mezio-distal yer değiştirme miktarının ne istatistiksel ne de klinik olarak anlamlı olmadığıdır.

Anahtar Kelimeler: Renk haritası, dijital ağız içi tarayıcı, diş hareketi

INTRODUCTION

Restoration with a full crown is recommended for molar teeth with root canal treatment as these teeth are subjected to heavier occlusal forces compared with anterior teeth.^{1,2} A crucial amount of hard tissue is lost during the removal of carious tissues and preparation of the access cavity. Brittleness of teeth increases as a result of moisture loss and change in the collagen microstructure of the dentin after removing pulp tissues.^{1,2} Temporary crowns are preferred to prevent tooth sensitivity and tooth displacement. Sensitivity is not a problem for endodontically treated teeth and temporary restoration of these teeth may potentially lead to allergic reactions, plaque buildup, or gingival irritation.^{3,4} Because of these reasons, temporary crown restorations may not be necessary for these teeth if contact losses in the prepared tooth do not result in possible occlusal, mesio-distal, or bucco-lingual tooth movement.⁵ Tooth movement of prepared teeth even if in the short term may affect the fit of the final restoration or aesthetics.

In the light of the literature, scarce information existed regarding the amount of displacement of teeth for prosthetic purposes.⁶ To the best of our knowledge, this is the first study aimed to digitally evaluate the three-dimensional (3D) displacement of the prepared endodontically treated teeth for crown restoration in short term.

The null hypothesis is “there is no difference in the position of endodontically treated before and one week after preparation”

MATERIAL and METHODS

The present study was executed with the approval of Nuh Naci Yazgan University Scientific Research and Publication Ethics Committee Presidency, numbered 2022/8112. All patients were informed about the study and who were willing to participate signed an informed consent.

The required minimum sample size was determined using the G*Power v.3.1.9.4 program (Heinrich Heine, University of Duesseldorf, Duesseldorf) according to the data from Zhang et al.⁶ The effect size calculated using the data of the mentioned study is 1,386. An alpha-type error of 0.05 and a beta power of 0.95 was specified, and each group's minimal estimated sample size was computed as 9 to determine the displacement of prepared teeth. A total of 18 samples were included to increase the statistical power of this study and consider potential sample loss. The study was carried out retrospectively with the data of the patients who applied to Aydın Adnan Menderes University Faculty of Dentistry, Prosthetic Dentistry clinic between 01.01.2020 and 01.01.2021. The data from the intraoral scanning of patients who underwent prosthetic treatment after root-canal treatment without temporary restoration due to patient-related

reasons were used in the present study.

The following inclusion and exclusion criteria were considered in the selection of patients to be treated;

The inclusion criterias were as follows:

- 1) endodontically treated molars which are to be further treated with single crown,
- 2) first and the second molars which has approximal contacts and occlusal antagonists,
- 3) adults,
- 4) completion of prosthetic treatment no more than one week.

The exclusion criteria were as follows:

- 1) history of systemic and periodontal disease,
- 2) history of orthodontic treatment.

After tooth preparation, the impressions were taken by an intraoral scanner (Trios 3 Scanner, 3Shape, Copenhagen, Denmark). After one week, a second scan (final scan) was performed during the final appointment and recorded in the digital archive of the scanner system. After color map superimpositions, measurements were performed on initial and final intraoral scanings to determine whether the color difference was due to the displacement of the tooth in any direction.

Reference points were determined for linear measurements as; the central fossa, mesial and distal marginal ridges, and buccal and lingual cusp of the tooth located mesial to the prepared tooth.⁷

Linear measurements were as follows (Figure 3);

- 1- The distance between the palatal midpoint of the prepared tooth and the palatal surface of the reference tooth,
- 2- The distance between the buccal midpoint of the prepared tooth and the buccal surface of the reference tooth,
- 3- The distance between the mesial transverse ridge of the prepared tooth and distal transverse ridge of the reference tooth,
- 4- The distance between the midpoint of the central fossa of the prepared tooth and the midpoint of the central fossa of the reference tooth,
- 5- The distal transverse ridge of the prepared tooth and the mesial transverse ridge of the reference tooth .

The data of the initial and the final scans were compared, and possible tooth displacements were analyzed with three-dimensional color maps and linear measurements.

Statistical Analysis

Statistical data analysis was performed using the IBM SPSS Statistics V25 (Armonk, NY: IBM Corp)

program. The normal distribution of the data was examined with the Shapiro-Wilk test. Descriptive statistics were presented as mean and standard deviation. Statistical analyzes were performed with the Wilcoxon Test. The significance level was 0.05 in all analyzes.

RESULTS

Eighteen teeth (six maxillary, twelve mandibular teeth) of twelve patients who met the inclusion criteria were included in the study.

The initial and the final scans were superimposed

in 3D using Ortho Analyzer™ (3Shape, Copenhagen, Denmark) software. After registration, no color difference was observed in the bucco-lingual and cervico-incisal directions (Figure 1), but there was a difference in the mesio-distal direction (Figure 2). Measurements were made using the initial and the final scan to determine whether the color difference in the mesiodistal direction was due to any movement in the tooth. These measurements were by calculating the distance among reference points. The difference between the measured values was analyzed statistically. There is no statistically significant difference when five different data from the scale are evaluated over the initial and final screening data (Table 1).

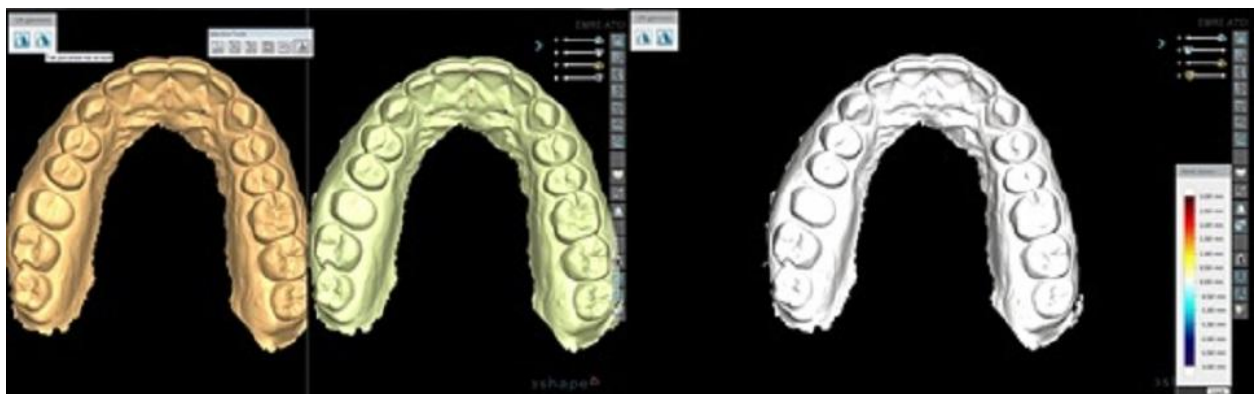


Figure 1. A 3D registration and colormap image of a sample.

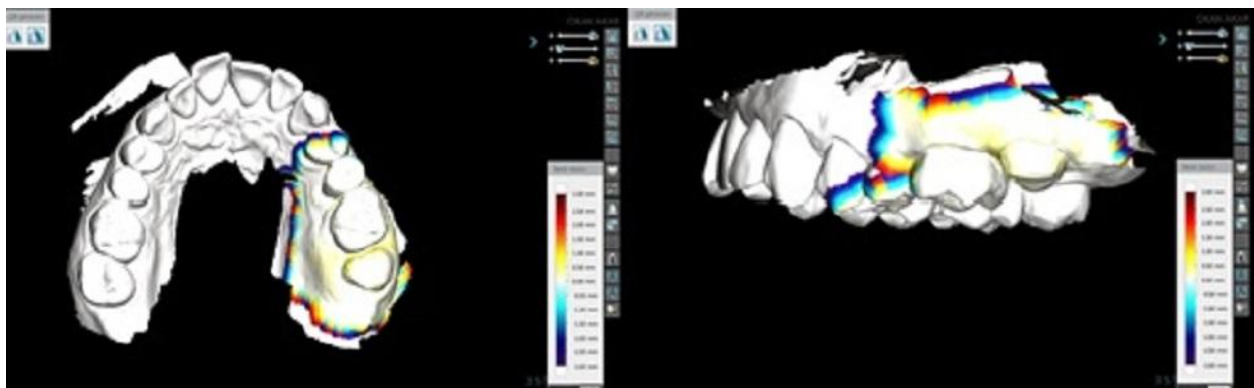


Figure 2. A 3D registration and colormap image of a sample.



Figure 3. Measurements made by taking reference points in the mesio-distal direction

Table 1. Wilcoxon analysis results

Obtained from 1 st and 2 nd Scan Data	P
Between 1. Measurements	0,372
Between 2. Measurements	0,616
Between 3. Measurements	0,349
Between 4. Measurements	0,647
Between 5. Measurements	0,931

*p<0,05

DISCUSSION

There has been a general belief that permanent teeth without contact or antagonists over-erupt, rotate, or tip. Displacement of teeth is a complex issue to study as the relevant mechanisms affected and the slow development of the movement have not been fully understood.

Most of the literature examining displacement has investigated movements in periods of a long time after tooth loss or orthodontic treatment.^{7,8} According to literature, there is only one study that investigates the tooth movement from a prosthodontic perspective.⁶

To the best of our knowledge, this is the first study in the literature that evaluate the amount of displacement of prepared teeth for crown restoration in short term.

Despite the rapid development in technologies, the delivery of a metal-ceramic restoration expected to take at least a week. The study was planned over a short term (1 week) to reflect typical clinical practice. The findings of this study is believed to be helpful to guide clinicians in terms of time and material planning.

In prosthodontic literature, tooth movement has been evaluated using panoramic radiographs⁹, confocal laser scanning microscopy (CLSM) [10], dental casts⁸⁻¹¹, and the use of colormaps obtained by superimposition.⁶ In this study color maps and superimposition technique was adopted from the study of Liu et al.⁶

Continuous eruption, hyper eruption, over-eruption, super-eruption, and supra-eruption terms have been used to describe continued tooth movement in the occlusal direction even during adulthood.⁹ It has been shown that the dentoalveolar height increases throughout adulthood, and the teeth continue to move during this small but stable growth, and this movement has been shown for both opposite and non-opposite teeth.^{9,12} There have been conflicting reports on the degree and severity of posterior tooth movements that occur when there are no opposing or neighboring teeth.^{11,13,14} Craddock et al. found that 92% of non-opposite posterior teeth excessively erupted in study of 100 individuals over the age of 18, and prevalence of whom with missing teeth for more than five years of with more than 2 mm eruption was 27%.¹³ The authors also reported that excessive movement of the maxillary teeth was significantly more than the mandibular teeth. Shugars et al. in their retrospective study with 111 adults, unopposed posterior teeth over a median period of 7 years revealed excessive eruption of >1 mm in only 1% of cases studied.¹⁵ Although the amount is not certain, the results in these studies which belong to long-term tooth movements have shown that there is an over eruption. While, in this present study short term tooth movements were examined.

Christou and Kiliaridis examined the changes in the position of maxillary molars without antagonists in adults.⁷ The results of their 10-year evaluation demonstrated that displacement of unopposed teeth occurs in three dimensions, however in patients with healthy periodontal tissues, this is clinically insignificant. Also, healthy teeth are likely to show uniform vertical displacement over time due to the continued activity of the periodontal ligament.⁷ However, irregular vertical movement of periodontally affected teeth is very likely due to the nature of the disease.⁷ Another result was the significant palatal displacement of the molars, which did not have an antagonist. This can be attributed to the constant strength of the soft tissues adjacent to the tooth and the perioral muscle system, particularly the buccinator muscle, which is a significant environmental determinant of the tooth position.¹⁶ Another factor for the compensation of teeth may be occlusal forces. They play an essential role in maintaining the transverse dimension of dental arches but there are no occlusal forces on teeth without antagonists.¹⁷

Compagnon and Woda examined the unrelated upper first molars in both healthy mouths and mouths with some periodontal pathologies.¹⁸ Their study showed that most overeruption occurs in the first years following losing the opposing tooth.¹⁸ They reported that the gingival margin remained at its original level during this occlusal tooth movement in healthy individuals. In these studies vertical tooth movement is frequently evaluated.^{7,13,15,18} Since developments in digital technologies shorten the treatment time, the reason why vertical tooth movement was not observed in the present study may be that a shorter treatment time was determined compared to the treatment time in other studies.

Moreover, in the present study, unlike other studies, teeth that endodontically treated were evaluated.^{7,13,15,18} Further studies are needed to investigate whether there is a difference between overeruption of vital and endodontically treated teeth.

A 12-year study conducted by Lindskog-Stokland et al. in women over 50 years of age showed that the risk of excessive eruption of unopposed molars increased significantly.⁹ In contrast, the risk of molars facing a mesial edentulous space showed a low risk for mesial tipping as a result of tooth extraction was low. However, there was a significant interaction between overeruption and tipping; in both conditions, an increase in overeruption was associated with molar tipping. In the present study, Contrary to the results of this study, in the current study, mesial movement of the teeth was observed, although the working time was much shorter. The change that occurs during one week span may not be clinically important and may be compensated by the cement space.

Studies examining tooth movements are often

orthodontic, and only one study is in prosthodontics is performed by Liu et al. ⁶ They prepared molars to make post-core and reported that the most tooth movement is in the mesiodistal direction, followed by bucco-lingual and occluso-gingival. In our study, the most displacement was in the mesiodistal direction however, the displacement was not statistically significant. The absence of movement in the buccolingual direction may be attributed to the distribution of periodontal ligaments. Teeth generally exhibit a tendency for mesial migration, and to control this movement, the mesial ligaments are more densely organized.¹⁹

One of the limitations of this study was that this study is the small sample size. Another limitation may be the exclusion of teeth with decreased periodontal support, as those teeth may be more prone to displacement. Future research may focus on the displacement of prepared teeth, taking into account the periodontal factors in larger sample.

In this study, mesialization was observed in endodontically treated and prepared teeth but it was not considered clinically significant. The study presents a

scientific evidence for the determination to make a temporary restoration from the time of the preparation to the delivery of the crown restoration. Within the limitations of this study, temporary crowns may not be necessary in cases of allergies or in cases where occlusal force is not desired during recovery of endodontically treated teeth. Moreover, this will reduce both the chair time and the cost.

CONCLUSION

Within the limitations of this study;

The decision to place a temporary crown during the prosthetic process for an endodontically treated tooth should be made by the clinician after carefully evaluating the advantages and disadvantages of the procedure.

Only mesio-distal displacement was observed in endodontically treated molars after tooth preparation.

Mesiodistal tooth displacement was neither statistically nor clinically significant.

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