

EFFECT OF THE TYPE OF THE ANESTHETIC SOLUTION ON THE INCIDENCE OF PULP NECROSIS FOLLOWING CROWN PREPARATION: A RANDOMIZED CLINICAL STUDY

KURON PREPARASYONUNU TAKİBEN GÖRÜLEN PULPA NEKROZUNA ANESTEZİ SOLÜSYONU TİPİNİN ETKİSİ: BİR RANDOMİZE KLİNİK ÇALIŞMA

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ABSTRACT

Aim: The objective of the present study was to evaluate the effect of the type of the anesthetic solution (with or without epinephrine) on the development of pulp necrosis after tooth preparation.

Methods: Seventy-two patients were randomly allocated into 2 groups according to the type of the anesthetic solution used. In the first group, 4% articaine with 1:100.000 epinephrine was used as local anesthesia and in the second group, 3% plain mepivacaine was used. Before administration of the anesthetic solution, electric pulp tester (EPT) and cold test were used to test the vitality of the teeth. The teeth were then prepared and provisional crowns were fabricated chairside. After 15 days, the provisional crowns were removed and then the EPT procedures and cold test were repeated. Postoperative pain level on days 1, 3, 5 and 15 were recorded. The EPT scores and pain levels were statistically analyzed.

Results: A statistically significant difference was observed between the groups in terms of percentage change in EPT scores.

Conclusion: The type of the anesthetic solution does not affect the vitality of the teeth after full-crown preparation.

Keywords: Anesthetic solution, Pulp necrosis, Articaine, Mepivacaine

ÖZ

Amaç: Bu çalışmanın amacı, diş preparasyonu sonrası gelişen pulpa nekrozu üzerine kullanılan anestezi solüsyonunun etkisini değerlendirmektir.

Metod: 72 hasta kullanılacak anestezi solüsyonu tipine göre rastgele olarak 2 gruba ayrıldı. Birinci grupta lokal anestezi olarak 1/100000 epinefrinli %4'lük articaine kullanıldı ve ikinci grupta %3 sade mepivacaine kullanıldı. Anestezi uygulamasından önce elektrikli pulpa testi (EPT) ve soğuk testi kullanılarak dişlerin vitalitesi test edildi. Daha sonra diş preparasyonu yapıldı ve geçici kuronlar uygulandı. 15 gün sonra geçici kuronlar söküldü ve EPT ve soğuk testi prosedürleri tekrarlandı. Tedaviden sonraki 1., 3., 5. ve 15. günlerde ki postoperatif ağrı değerleri kaydedildi. EPT değerleri ve ağrı skorları istatistiksel olarak analiz edildi.

Bulgular: Gruplar arasında EPT yüzdelik değişimleri açısından istatistiksel olarak anlamlı farklılık olduğu gözlemlendi.

Sonuç: Kullanılan anestezi solüsyonu tipi, tam kuron preparasyonu sonrası dişlerin canlılığını etkilememektedir.

Anahtar kelimeler: Anestezi solüsyonu, Pulpa nekrozu, Articaine, Mepivacaine

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INTRODUCTION

The ratio of teeth becomes necrotic after tooth preparation for full coverage crowns is between 15% and 25% ^{1, 2}. Several reasons have been asserted to clarify the necrosis of pulp after tooth preparation ³ such as heat generation during cutting procedures if the water-cooling is not adequate ⁴, the pressure performed to the dentin during cutting even when the water cooling of the tooth is adequate effective ⁵ and toxic influences of medicaments and materials performed on the freshly cut dentine surface ^{6, 7}.

Some pulp tests are subjective which involve electrical or thermal stimulation of a tooth to determine whether the pulpal nerves are functional. In the other hand, there are some objective pulp tests such as Laser Doppler Flowmetry (LDF) using devices to detect pulpal vascularity ⁸. It is well known that detection of the pulpal blood flow (PBF) is the true determinant of pulp vitality ⁹⁻¹². Previously, Kim et al ¹³ have evaluated the effect of drilling dentine on the amount of PBF using a radio-labelled injection technique and reported 13% and 34% reduction in PBF with or without water-cooling respectively. Moreover, one hour after drilling the reduction was around 89%. Decrease in PBF may result in vitality loss because the most accepted theory in pulp canal obliteration is that change in PBF results in uncontrolled reparative dentin formation and entire root canal becomes obliterated.

The most common forms of injectable local anesthetics used in dentistry are in amid class. Some of amid anesthetics are articaine, lidocaine, mepivacaine and bupivacaine which are commonly used in Endodontics. To increase anesthetic efficacy, local anesthetics including vasoconstrictor (epinephrine) are recommended ¹⁴. It has been stated that the vasoconstrictor presents in the local anesthesia may also change the amount of PBF ¹⁵. However, to date, no study has evaluated the effect of vasoconstrictor presents in local anesthetic on the vitality loss of tooth after full crown preparation. Therefore, the present study aimed to evaluate the effect of the type of the anesthetic solution (with or without epinephrine) on the development of pulp necrosis after tooth preparation. The null hypothesis was that the type of the anesthetic solution does not affect the ratio of the vitality loss of teeth and postoperative pain level after tooth preparation.

MATERIALS AND METHODS

The decision number of the ethical approval was 2016-58. A written consent was obtained from the participants before undergoing the treatment. Since a minimum sample size of 27 subjects for per group was calculated using the G*Power software (GPower; Franz Faul, University of Kiel, Germany) (a power of 0.8, an α of 0.05, an effect size of 0.5), the study included a total of 72 patients.

Healthy patients without any systemic diseases or allergic reactions (American Society of Anesthesiology [ASA] I) with healthy intact incisor, canine or premolar teeth that will form the abutments for fixed partial denture were included to the study. Exclusion criteria were as follows: molar teeth, patients who are younger than 18 or older than 65 years old, and taking analgesics or antibiotics within one month prior to the study.

A web program was used to randomly assign seventy-two participants into 2 groups using (www.randomizer.org) according to the anesthetic solutions (3% plain mepivacaine or 4% articaine with 1:100.000 epinephrine). A dental assistant put the anesthetic solution into the syringe before treatment to effectively blind the practitioner and patient to the local anesthetic solution. Before administration of the anesthetic solution, electric pulp tester (EPT) (Digitest, Parkell, Edgewood, NY, USA) and cold test (Roeko Endo Frost, Coltene, Langenau, Germany) were used to test the vitality of the teeth. After isolation of the related tooth with cotton rolls, the tooth was dried and EPT test which has readings range from 0 to 64 was performed. The buccal cusp tip of premolars and the incisal edge of anterior teeth was selected for the placement of the probe of EPT and selected area was coated with a small amount of toothpaste before testing. The mean value of three EPT readings was recorded. Additionally, the EPT test was performed on contralateral tooth (as control tooth) to re-evaluate the EPT readings. Before the teeth preparation, local infiltration anesthesia was performed for all teeth. The fixed partial dentures were of the porcelain fused to metal type. Approximately, 1 mm from the distal, mesial and lingual surfaces and 1.2 mm from the buccal and 2 mm from the occlusal surfaces was removed using high-speed diamond burs under water spray coolant. The finish line of the teeth preparation



was formed chamfer and subgingival (located approximately 0.5 mm below the gingival margin). After teeth preparations, provisional crowns were fabricated chairside for abutment teeth using autopolymerizing composite resin (Structur 2, Voco GmbH, Cuxhaven, Germany) and was cemented to the teeth using a provisional luting agent (Life Regular Set, Kerr, Salerno, Italy). After 15 days, the provisional crowns were removed and the EPT procedures were repeated. After the evaluation of marginal seating, occlusal interference and esthetic, the fixed partial dentures were cemented using a glass ionomer cement (Meron, Voco GmbH, Cuxhaven, Germany).

To compare postoperative pain level between the groups, the participants were given directions to record postoperative pain level on days 1, 3, 5 and 15 using a visual analog scale with a length of 10-cm (VAS). Gender, age and tooth number were also recorded.

The study data were analyzed using a program (IBM SPSS Inc., Chicago, IL, USA). Linear regression analysis was carried out to detect the most effective factor (group, tooth number, age and sex) related with the percentage change between preoperative and postoperative EPT scores. Only the data for age were normally distributed and homogenous and the rest of the data (EPT scores and pain levels) were not. For intra-group analysis, the Wilcoxon test was used to compare preoperative and postoperative EPT scores. For inter-group analysis, the Mann-Whitney U test was used to compare the percentage changes between preoperative and postoperative EPT scores, and postoperative pain level on days 1, 3, 5, and 15. To compare gender and tooth number between the groups the chi-square test and to compare age between the groups independent samples t-test was carried out. The significance level for all tests was set at 5% ($p = 0.05$).

RESULTS

Since 2 patients from 3% mepivacaine group were lost during follow-up, a total of 70 patients were included into the study (Figure 1). Demographic features according to the groups are shown in Table 1. The difference between the groups in terms of gender, tooth number, or age was not statistically significant ($P > 0.05$).

Table 1. Dispersion of participants according to age, gender and tooth number

	4% Articaine (1:100.000)	3% Mepivacaine	P value
<i>N</i>	36	34	
Mean Age	43.28 ± 11.60	44.38 ± 10.40	0.677
Gender			0.299
Female	20	23	
Male	16	11	
Tooth Number			0.227
#4	1	1	
#5	1	3	
#6	3	3	
#7	0	2	
#8	1	4	
#9	2	6	
#10	2	2	
#11	7	4	
#12	3	2	
#13	4	0	
#20	2	2	
#21	3	0	
#22	2	1	
#23	0	1	
#25	0	1	
#26	2	0	
#27	2	0	
#28	1	1	
#29	0	1	

Linear regression analysis revealed that the percentage change between the pre- and post-treatment EPT scores were not affected by the age, gender and tooth number ($P > 0.05$). However, the type of the anesthetic solution affected the percentage change between the preoperative and postoperative EPT scores ($P < 0.05$). Table 2 shows the linear regression analysis findings.

Table 2. Linear Regression findings for group, gender, age and tooth number on the dependent variable "percentage change between preoperative and postoperative EPT scores"

	B [*]	Standard Error	Beta	Pvalue
Group	-59.466	20.565	-0.332	0.005
Gender	32.097	26.056	0.174	0.222
Age	1.28	1.163	0.156	0.275
Tooth Number	-0.603	1.128	-0.065	0.595

According to the intragroup analyses, although the post-treatment EPT scores of 4% Articaine (1:100.000) group were significantly lower than the pre-treatment EPT scores ($P < 0.05$), in the 3% Mepivacaine group, the difference between the preoperative and postoperative EPT readings was not statistically significant ($P > 0.05$) (Table 3).

Table 3. EPT scores according to the groups

	4% Articaïne (1:100.000)	3% Mepivacaine
Preoperative	1.88 ± 1.17	1.44 ± 0.96
Postoperative (15th Day)	0.74 ± 0.31	1.06 ± 0.94
P value	p < 0.001	p = 0.77

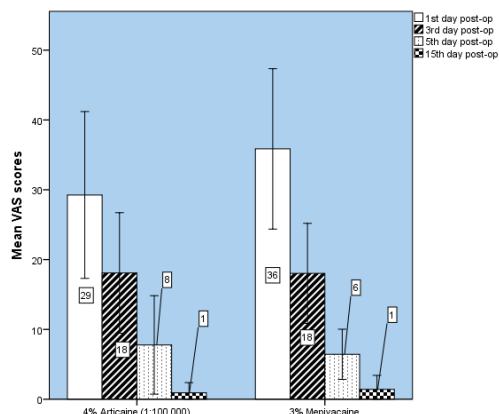


Figure 1. Flow diagram



CONSORT 2010 Flow Diagram

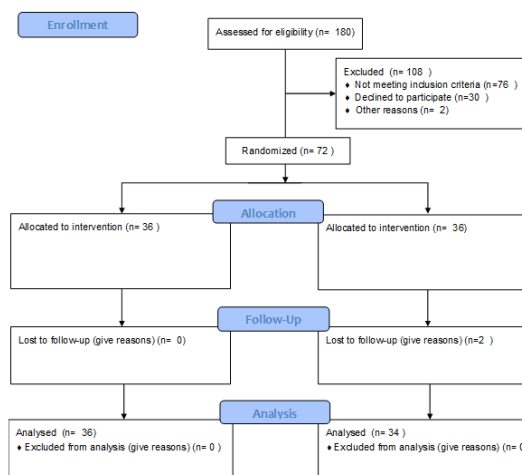


Figure 3. Postoperative mean VAS scores according to the groups

For intergroup analyzing, pre-preparation and post-preparation percentage change in EPT scores were compared and it has been revealed a statistically significant difference between the 4% Articaïne (1:100.000) and 3% Mepivacaine groups in terms of percentage change in EPT scores ($P < 0.05$). The percentage change was higher in the 4% Articaïne (1:100.000) group means that the 4% Articaïne (1:100.000) group lowered preoperative EPT scores more than the 3% Mepivacaine group did (Figure 2).

Postoperative pain levels between the groups were not statistically different at any time intervals (1st, 3rd, 5th, and 15th days) ($P > 0.05$) (Figure 3).

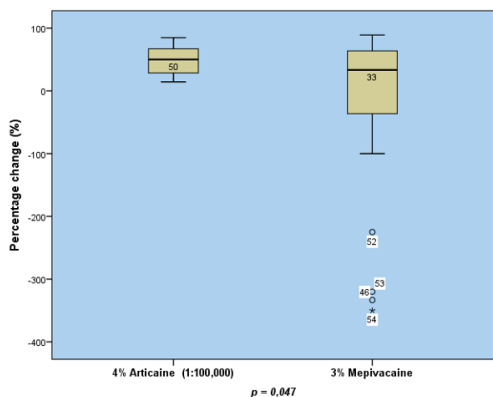


Figure 2. Box plots show preoperative-postoperative percentage change of EPT scores for the groups

DISCUSSION

This study has shown that the type of the anesthetic solution affects the post-treatment EPT score. However, both the ratio of the vitality loss of teeth after tooth preparation and post-operative pain level have not been effected by the type of the anesthetic solution. Thus, the null hypothesis was accepted.

Previously several studies have reported pulpal necrosis after crown preparation ^{2, 5, 16}. On the contrary, in the present experiment, none of the tooth has become necrotic. This was probably due to the difference in experimental design between the present study and the previous ones. Langeland et al. reported that crown preparation does not cause a pulpal reaction if the water cooling is sufficient. In addition, in the present study, intact teeth were included to the study and intact teeth have a significantly lower incidence of pulp necrosis (5%) ¹⁶. However, according to the result of the present study, in the 4% Articaïne (1:100.000) group post-treatment EPT scores were significantly lower than the preoperative EPT scores. In contrast, in the 3% Mepivacaine group, the difference between the pre-treatment and post-treatment EPT scores was not statistically significant. This is an important finding because it is well known



that vasoconstrictor present in local anesthesia causes a decrease in PBF¹⁷ and this situation would result in a restricted blood source in the pulp. It is more likely that the restricted blood source limits the pulpal blood flow and makes the pulp less capable of overcoming an irritant¹⁸. Consequently, pulp inflammation may develop. In the development of pulp inflammation, inflammatory mediators are synthesized that may excite nerve fibers in the pulp resulting in a hyperalgesia¹⁹. This may explain the post-operative sensitivity of the teeth to EPT in the 4% Articaine (1:100.000) group. Although, the degree of pulp inflammation does not need to be severe to result in pulpal necrosis¹⁸, none of the teeth has become necrotic in the present study. This may be explained by the fact that preparation procedures irritate the pulp and induce a slow, progressively developing tissue degeneration in the pulp resulting in broad secondary dentin accumulation within the pulp² as can be seen in a traumatized tooth in which the tooth may stay vital for a considerable period of time but late development of pulp necrosis can be occur suddenly several years after the trauma^{20,21}.

In the present study, the effect of the type of anesthetic solution on post-operative pain level was also investigated. According to the results, the difference between the groups in terms of post-operative pain level was not statistically significant. Previously, there are no study evaluating the effect of the type of anesthetic solution on post-operative pain level. Thus, a direct comparison cannot be done. Kara et al²² have evaluated the effect of the gluma and diode laser on postoperative sensitivity. They reported a significant reduction in post-preparation sensitivity level in both groups when compared with the control. However, they evaluated pain response to tactile stimulus which is correlated with the diameter and number of exposed dentine tubules²³. In the present study, post-preparation spontaneous pain, correlated with pulpal inflammation, was evaluated. It is likely that pulpal inflammation was reversible because none of the teeth become necrotic. This may explain the result of the present study.

In the present study, EPT and cold test was used to evaluate the vitality of the samples. However, EPT readings were only used for statistical test. Cold test scores were not included to statistical analyses because it is more like that after preparation the teeth

become more sensitive to cold test because of exposed dentinal tubules²³.

It is well known that EPT is a subjective test which assess the function of pulp nerves. It is impossible to detect pulpal blood flow by using EPT. This is the most important limitation of the present study. An objective test LDF can be used for the determination of PBF. However, there are conflicting reports about the accuracy of LDF in determining PBF. A recent systematic review revealed that LDF and pulse oxymetry were the most accurate diagnostic methods in testing vitality of teeth²⁴. In contrast, Ghouth et al²⁵ conducted a clinical study evaluating the accuracy of LDF and reported that LDF is unable to differentiate between teeth with vital and non-vital pulps. Additionally, they mentioned that, some further developments are needed in terms of assessing pulpal blood flow with LDF, before clinical use of it.

According to the result of the present study, it can be concluded that the type of the anesthetic solution does not affect the vitality of the teeth after full-crown preparation. Using 4% Articaine (1:100.000) solution for anesthesia makes teeth more sensitive to EPT when compared with 3% Mepivacaine. The type of the anesthetic solution does not affect the post-preparation pain level.

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