

ORIGINAL ARTICLE, DENTAL MEDICINE

Clinical Assessment of Endodontically Treated Teeth, Restored with or without Radicular Posts

Ekaterina G. Karteva¹, Neshka A. Manchorova¹, Stoyan B. Vladimirov¹, Donka A. Keskinova²

¹ Department of Operative Dentistry and Endodontics, Medical University of Plovdiv, Plovdiv, Bulgaria

² Department of Applied and Institutional Sociology, University of Plovdiv Paisii Hilendarski, Plovdiv, Bulgaria

Correspondence: Ekaterina G. Karteva, Department of Operative Dentistry and Endodontics, Medical University of Plovdiv, 3 Hristo Botev Blvd., 4000 Plovdiv, Bulgaria
E-mail: katya.kk@gmail.com
Tel: +359882420177

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Background: The reduced fracture resistance in endodontically treated teeth requires the use of radicular posts, with their advantages and disadvantages.

Aim: To evaluate the clinical performance of teeth restored with or without radicular posts at 6 and 12 months.

Materials and methods: The study included 22 patients who received endodontic therapy on premolars with a loss of one or two proximal walls. The premolars were divided into groups according to the restoration method: metal post group (MP), fiber post group (FP), and no post group (NP). For the NP group, a dentinal core of fiber-reinforced composite was used. The McNemar test, marginal homogeneity test and Kruskal-Wallis test were used in the statistical analysis. At the 6 and 12 month recall, both the direct composite restorations and the integrity of the post systems were assessed.

Results: At 6-month recall assessment, there was no statistically significant difference in the categories of ‘appropriate colour’, ‘secondary caries’ and ‘obturation integrity’. That was not the case with ‘marginal discoloration’, ‘marginal adaptation’, ‘proximal contact’ and ‘surface smoothness’. The recall at 12 months showed a continuation of this tendency, with significant decrease in the category of ‘adequate colour’. Assessment of post longevity at the two recalls did not show any significant changes. The teeth restored without a post showed survival rates comparable to that of teeth restored with a post for the 12-month period of observation.

Conclusions: There were no failures of the different posts used. The observed changes were attributed to the progressive deterioration of the composite restorations.

BACKGROUND

Endodontic treatment is an integral part of dental practice. Every clinical case presents specific challenges in terms of pain management, complex root canal anatomy, and problematic obturation. The reduced fracture resistance of endodontically treated teeth (ETT), mainly due to insufficient coronal hard dental structures, is a problem with serious clinical complications.¹ A large variety of radicular posts have been used to increase the retention of restorative material.² According to the fabrication method, they fall into two groups: cast post-and-core systems and prefabricated posts. The materials used for these posts are numerous: stainless steel, gold alloys, titanium alloys, fiber-reinforced composite resin, ceramic, and a combination of them. Due to the rapid development of adhesive techniques

in recent years and the emphasis on monoblock obturation techniques, the fiber posts have become widely popular.

On the other hand, the introduction of a post into the root canal space presents an increased risk of a vertical root fracture. There are numerous in vitro studies on the fracture resistance of ETT restored with different post systems.^{3,4} The clinical studies on the problem, however, are scarce. Therefore, the clinical performance of different post systems is not sufficiently examined and needs further research.

Furthermore, a new type of core material has been recently introduced – the fiber-reinforced composite (FRC). The elastic properties and durability of this material are considered superior to that of the commercial particulate filler composites, with a decreased polymerization shrinkage.⁵

This motivated us to examine the clinical performance of ETT restored following three completely different strategies: with a rigid metal post, with a fiber post and with no post, but with a fiber-reinforced composite core instead.

AIM

The aim of the present study was to evaluate and compare the clinical performance of ETT restored with or without radicular posts at 6 and 12 months.

MATERIALS AND METHODS

The study included 22 patients who underwent endodontic therapy on one, two or three premolars. Patient selection was done according to the guidelines published by the American Dental Association (ADA). Only adults (older than 18 years), with no parafunctional oral habits and clinically sound periodontal status were included. The studied teeth were premolars with pulpitis or periodontitis (without previous endodontic treatment) and loss of one or two proximal walls: mesio-occlusal (MO) cavities, disto-occlusal (DO) cavities and mesial-occlusal-distal (MOD) cavities. All patients signed a consent form prior to therapy.

The units of observation were: patients with premolars in need of endodontic treatment; premolars with one or two missing proximal walls; the post-endodontic restoration (assessment of the composite restoration and the radicular post). The study was conducted in the Faculty of Dental Medicine in Plovdiv between November 2014 to September 2016.

The rationale behind the decision of studying premolars was the following:

- Premolars and molars are the teeth that most often exhibit fractures after endodontic treatment. Testori T et al. have investigated 36 vertical fractures: 56% of them are in premolars, 28% in molars and 8% in canines.⁶ This is confirmed in D. Dietschi's review on the risk factors in restoring endodontically treated teeth.⁷

- The results from our survey suggested that Bulgarian dentists use radicular posts mainly in premolars (71.1% of the participants).⁸

The premolars were divided into three groups according to the restoration method: metal post group (MP), fiber post group (FP), and no post group (NP). The post type was randomly assigned to the investigated teeth, and the cavity type was not a criterion for its selection. All teeth were obturated with conventional composite. For the NP group, a dentinal core of fiber-reinforced composite was

applied as well. The rationale for choosing a direct method of restoration was based on the present scientific evidence. In past studies, endodontically treated teeth were predominantly restored with a radicular post and crown.⁹ The advantages of crowns have been confirmed in numerous studies - both clinical and in vitro, reducing the incident of vertical root fractures.^{1,10,11} In contrast, the contemporary approach emphasizes on minimally invasive restorations with maximum preservation of tooth structures. This tendency is supported by the technological advancements in adhesive restorations.¹²⁻¹⁴

CLINICAL PROTOCOL FOR RESTORING THE ETT

Isolation of the operative field was achieved using rubber dam. The initial preparations were performed with diamond burs (Edenta, Germany) and slow-speed metal burs (ELA, Germany). The endodontic access was achieved using round metal burs (Ø1.4 mm, # 801, ELA, Germany) and the glide path was established with K-files #10, 15, 20 (Poldent/ Sendoline, Sweden). The irrigation protocol comprised of 2% NaOCl, distilled water, 17% EDTA, and 50% citric acid. The root canal preparation was performed with ProTaper Universal (F1, Dentsply Maillefer, Switzerland). The obturation technique was single-cone, with sealer AH Plus (AH Plus Jet, Dentsply).

RESTORATIVE TECHNIQUE WITH OR WITHOUT A RADICULAR POST

The teeth were randomly assigned to three groups according to the restoration technique - with a prefabricated metal post (MP), with a fiber post (FP), and with no post (NP). Two-thirds of the root canal was prepared for the cementation of the posts. The metal posts used were passive, with a retentive surface (size 4M, Mani, Japan). The cementation was performed with glass-ionomer cement (Kavitan CEM, Spofa Dental). For the FP group, silane was applied prior to their cementation. All fiber posts had a diameter of 1.3 mm (Contec Blanco #1, Hahnenkratt). Prior to the cementation, the prepared root canal was etched and bonded using the 3-step 'gold standard' adhesive system (Optibond FL, Kerr). Cementation was done with a dual-cured composite cement (EasyCEM, Spofa). The NP group was restored using a fiber-reinforced composite material used as a dentin replacement (GC EverX Posterior, GC Europe). All composite restorations were finished the 3-step 'gold standard' adhesive system and a conventional composite (Valux Plus, 3M ESPE).

CLINICAL EVALUATION AT 6 AND 12 MONTHS

At the end of months 6 and 12 after treatment, all restorations were compared. Both the direct composite restorations and the integrity of the post systems were assessed. The classic USPHS evaluation method for measuring the clinical performance of restorations was used, modified according to the present study objectives.¹⁵ Each criterion receives a mark as follows:

1. A (Alfa): restoration within a range of excellence;
2. B (Bravo): Acceptable restorations, showing minor deviations from the ideal;
3. C (Charlie): Restoration that should be replaced for preventive reasons to avoid future damage;
4. D (Delta): Restorations which require immediate replacement;

Digital photos were made pre-, during and post-treatment, as well as after 6 and 12 months. X-rays were performed before treatment, immediately after the endodontic procedures were completed and at each recall. Their aim was to detect secondary caries, root/post fracture, periapical lesions. An evaluation chart was created, based on the available literature in this field.^{16,17} The criteria used were: loss of tooth, adhesive failure of the post, fracture of the post, vertical root fracture, horizontal root fracture, loss of restoration because of errors in treatment planning, endodontic and periodontic pathology that requires retreatment.

STATISTICAL METHODS

The data were coded and processed using descriptive analysis. The results before and after treatment were compared. Two hypothesis were formed:

1. Null hypothesis (H_0): There are no differences in the studied indexes at 6 and 12 months.
2. Alternative hypothesis (H_1): There are differences in the studied indexes at 6 and 12 months.

The McNemar test and marginal homogeneity test were used. The MP, FP and NP groups were compared, based on the results obtained at 6 and 12 months using the Kruskal-Wallis test. The software used was SPSS, 11.0 (SPSS Inc, Chicago, IL, USA).

CLINICAL STUDY DESIGN

Our clinical study design was created according to the CONSORT Statement, which defines the standard for conducting clinical studies (Fig. 1).

RESULTS

Our clinical study included 22 patients and 35 endodontically treated premolars, restored with a metal post, a fiber post, or with no post. The patients' demographic characteristics are presented in Table 1.

Three of the patients were excluded from the study because of failure to attend the 6-month recall. The data collected on the remaining 19 patients, with 32 treated premolars, is presented in Figs 2 and 3. The final distribution of the treated premolars was uneven due to the initial random selection of patients, combined with the number of patients that rejected a recall and had to be excluded from the investigation. The restorations were assessed at 6 and 12 month recall (Fig. 4).

The results from the comparative assessment of the composite restorations are shown in Table 2.

DISCUSSION

The initial state of all obturations after the completion of the restorative procedures was assessed as A (Alpha). The 6-month recall assessment covered 32 of them. In the 'appropriate colour' and 'secondary caries' categories, 31 of them were scored Alpha. Most of the treated premolars scored satisfactory for 'obturation integrity'. There was no statistically significant difference between their initial state (IS) and the 6th-month recall ($P>0.05$).

Statistical difference was recorded for the 'marginal discoloration', 'marginal adaptation' and 'proximal contact' ($P<0.05$). Two restorations scored Charlie for 'Proximal contact' and two - Charlie for 'marginal adaptation' and 'marginal discoloration', respectively. The 12th-month recall allowed for a comparison between the recorded state at that time, the initial state and the 6th-month state of the obturations. Most of the restorations scored adequately. One of them scored Delta because of an obturation

Table 1. Demographic characteristics

Criteria / Percentages	Sex		Age (yrs)			over 61
	Male	Female	18 - 30	31 - 45	46 - 60	
%	54.3	45.7	23	46	11	20

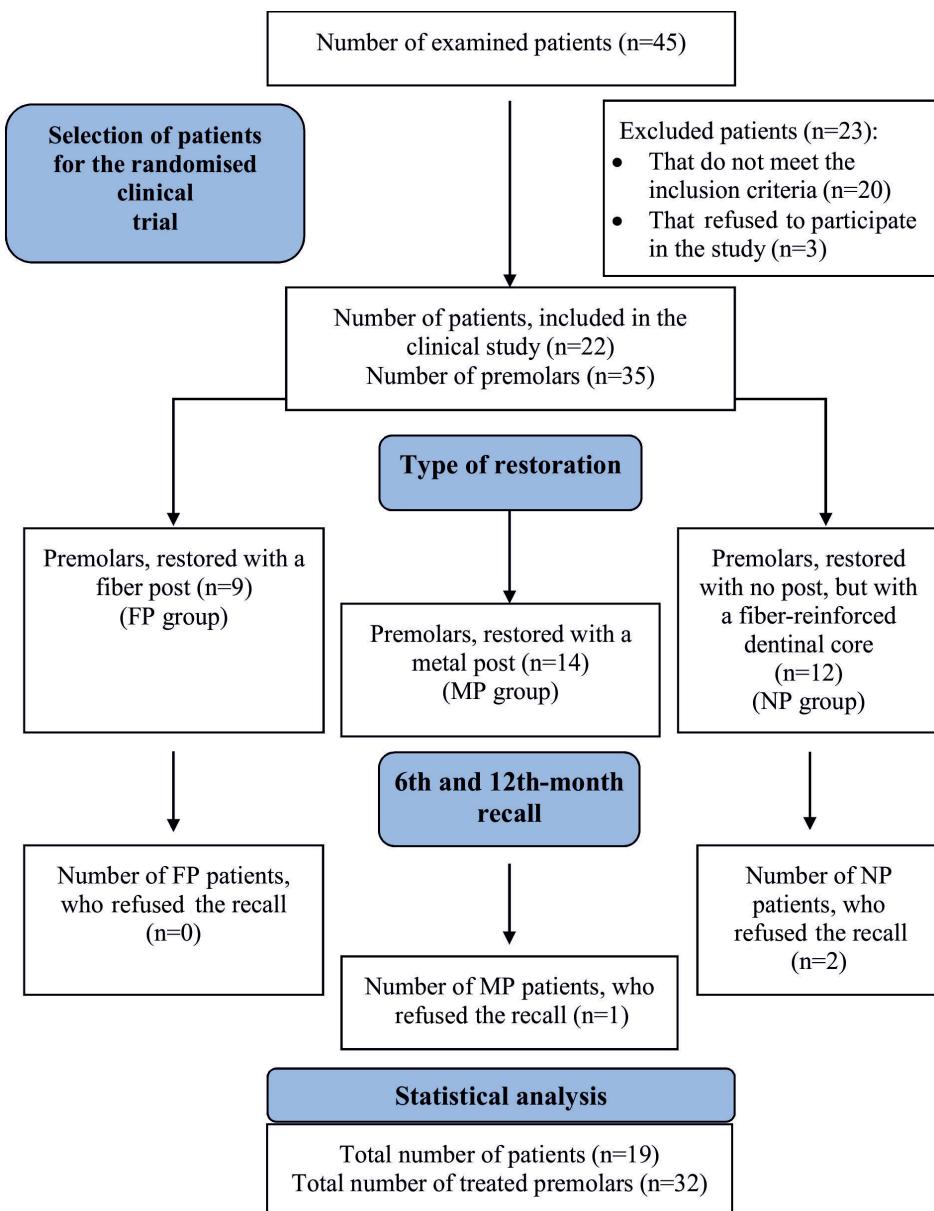
Table 2. Criteria for comparative assessment of composite restorations

Category	Designation	Initial state (IS)	At 6 months	At 12 months	Significance IS/6 months	Significance 6/12 months	Significance IS/12 months
Appropriate colour	A	32	31	20			
	B	0	1	12	p>0.05	p<0.05	p<0.05
	C	0	0	0			
	D	0	0	0			
Marginal discoloration	A	32	23	14			
	B	0	8	17	p<0.05	p<0.05	p<0.05
	C	0	1	1			
	D	0	0	0			
Marginal adaptation	A	32	24	17			
	B	0	7	14	p<0.05	p>0.05	p<0.05
	D	0	1	0			
	C	0	0	1			
Secondary caries	A	32	31	32	P>0.05	P>0.05	P>0.05
	C	0	1	0			
Surface smoothness	A	32	26	22			
	B	0	6	10	p<0.05	p<0.05	p<0.05
	C	0	0	0			
	D	0	0	0			
Proximal contact	A	32	26	29			
	B	0	5	3	p<0.05	p>0.05	p>0.05
	C	0	1	0			
Obturation integrity	A	32	28	31			
	B	0	2	0	p>0.05	p>0.05	p>0.05
	C	0	2	0			
	D	0	0	1			

fracture with integrity loss (**Fig. 4C**). There is a statistically significant decrease in the categories ‘marginal discoloration’ and ‘marginal adaptation’ when compared with the IS. This tendency is also evident in the category ‘Surface Smoothness’. In contrast to the 6th-month recall results, there was an alteration in the obturations’ colour after one year ($P<0.05$). The ‘proximal contact’ category showed significant changes after half a year, but this trend

did not hold after 12 months. The reason behind this is the performed contour restoration at the first recall of two of the obturations.

The comparison between the IS and the results on the 6th and 12th-month recall also showed differences in the categories ‘marginal adaptation’ and ‘marginal discoloration’ ($p<0.005$). There is a progressive aggravation of the marginal integration. The reasons behind this trend can be as follows:

**Figure 1.** Results from the randomised clinical trial.

1. The polymerization shrinkage of the composite material. This is a problem of great clinical significance, with numerous strategies developed for its resolution. M. Tavangar et al. compare the polymerization shrinkage of newly designed composite materials with conventional ones, but with no statistical significance.¹⁸ S. Garoushi et al. experiment with the use of fiber-reinforced composite with satisfactory results.¹⁹
2. Movements on the obturation-hard dental tissue interface. These movements can be caused by either compromising the adhesion to dentin, or the bonding between radicular post-resin cement-radicular dentin. According to researchers, fiber

posts can improve the distribution of masticatory stress along the tooth axis and decrease the flexion of the cusps.^{20,21}

Of the 32 studied premolars, 8 scored B in the category ‘marginal discoloration’ after 6 months, and 17 - after 12 months. These results are higher compared to those of SM Mohan et al. three months after treatment - discoloration is observed in 5 (7.8%) out of 64 ETT.¹⁷ One possible explanation is the difference in the restorative method: only teeth with fiber posts were studied, as well as the shorter post-operative observation period. The premolars in our study were restored using three different techniques - with fiber posts, metal posts

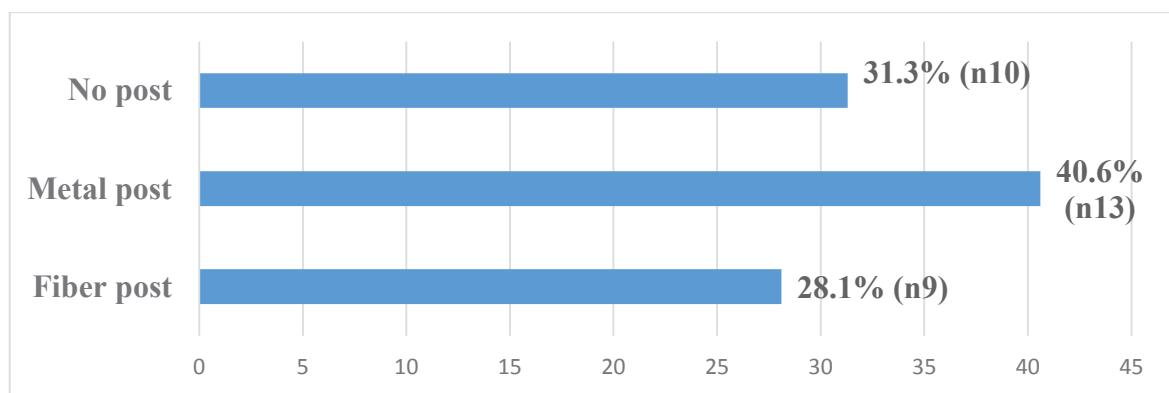


Figure 2. Distribution of the treated premolars by restoration type.

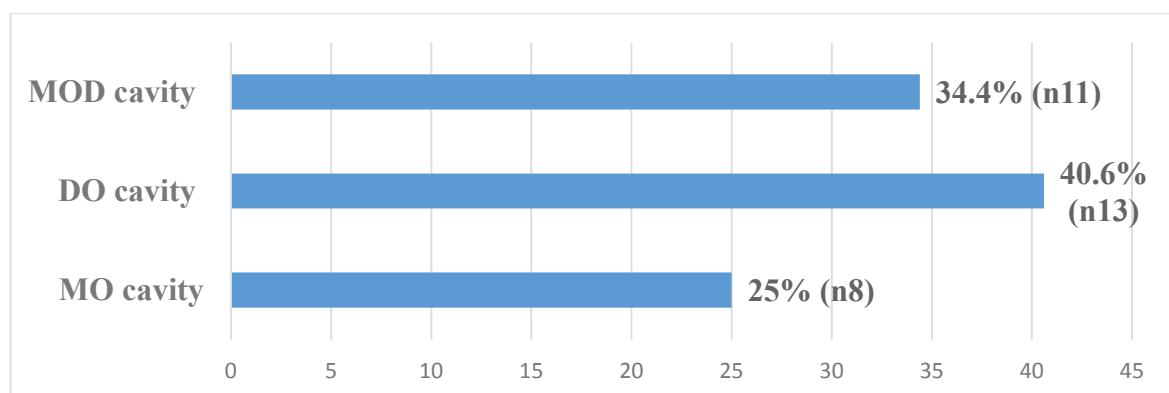


Figure 3. Distribution of the treated premolars by the number of missing proximal walls.

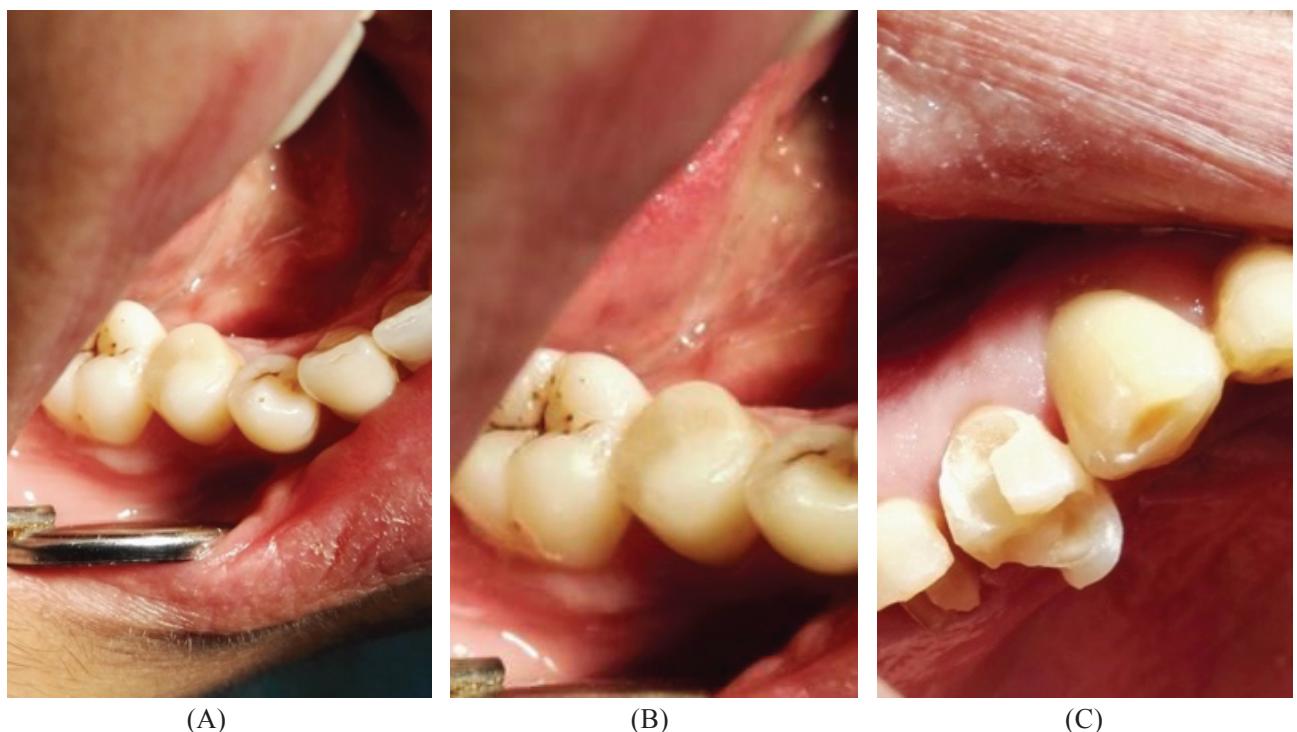


Figure 4. Recall at 6 months (A) and 12 months (B) for tooth 45. Recall at 12 months for tooth 14 (C). There is a partial loss of the restoration.

and no posts. A similar study was conducted by N. Scotti et al., which recorded differences in the marginal adaptation and discolouration between direct restorations in combination with fiber posts and ETT without a post.²²

There are statistically significant differences in the categories 'surface smoothness' and 'proximal contact' after 6 months ($p<0.05$), which is also observed after one year, but only for the former indicator. There are no significant changes in the categories 'secondary caries' and 'obturation integrity'. These results are similar to those of E. Can Say et al., with a similar number of observation units – 39.²³

The number of restorations that scored Bravo for 'appropriate colour' is significantly increased after 1 year. The reasons behind this observation can be the dietary habits of the patients (intake of dark-coloured beverages, smoking), as well as the qualities of the composite material used.

The categories that showed statistical differences for the period of observation were additionally analysed using the Kruskal-Wallis test. The aim was to assess whether the recorded differences were a result of the different restoration methods - with a fiber post, with a metal post and with no post. No statistical difference was found ($p>0.005$).

The assessment of post longevity on the two recalls did not show any problems related to 'loss of tooth', 'adhesive failure of the post', 'vertical/horizontal root fracture' or any of the criteria listed in **Table 2**. The teeth restored with no post showed survival rates comparable to those restored with a post for the 1 year period of observation. It can be assumed that the reasons for the recorded changes in the restorations are the polymerization shrinkage of the composite of choice. Nevertheless, the observed discolouration was successfully removed by polishing of the margins, without the need of any further repairs.

Our results are similar to those of Mohan SM et al., who reported only two cases of fiber post fracture in a 6-month recall.¹⁷ That notwithstanding, a longer observation period is recommended, especially in clinical conditions.

CONCLUSIONS

For the 12-month observation period, there were no recorded changes in the ETT, that can be related to the restoration method - with a metal post, with a fiber post or with no post. The observed differences were attributed to the quality of the composite

restoration only: the progressive deterioration of the marginal adaptation, marginal discolouration, surface smoothness and appropriate colour. For a more precise evaluation of the post type effect, a continuous observation for a more lengthy period is recommended.

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Клиническая оценка эндодонтического лечения зубов, восстановленных с применением или без применения радикулярных штифтов

Екатерина Г. Карцева¹, Нешка А. Манчорова¹, Стоян Б. Владимиров¹, Донка А. Кескинова²

¹ Кафедра оперативной стоматологии и эндодонтии, Медицинский университет - Пловдив, Пловдив, Болгария

² Кафедра прикладной и институциональной социологии, Пловдивский университет „Паисий Хиландарски”, Пловдив, Болгария

Адрес для корреспонденции:

Екатерина Г. Карцева, Кафедра оперативной стоматологии и эндодонтии, Медицинский университет - Пловдив, бул. „Христо Ботев“ № 3, 4000, Пловдив, Болгария
E-mail: katya.kk@gmail.com
Tel: +359882420177

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Введение: Снижение резистентности к переломам в эндодонтически обработанных зубах требует использования радикулярных штифтов со всеми их преимуществами и недостатками.

Цель: Провести оценку клинических характеристик в течение 6 и 12 месяцев после восстановления зубов с применением или без применения радикулярных штифтов.

Материалы и методы: Исследование охватило 22 пациента, получивших эндодонтическое лечение премоляров с потерей одной или двух проксимальных стенок. Премоляры были разделены на группы в соответствии с методом восстановления: группа с металлическими штифтами (МШ), группа с волокнистыми штифтами (ВШ) и группа без штифтов (БШ). Для группы БШ было использовано дентинное ядро из армированного волокном композита. В статистическом анализе использовали тест МакНемара, критерий маргинальной однородности и критерий Крускала-Уоллиса. При контрольных осмотрах на 6 и 12 месяцы были оценены как сами композитные восстановления, так и целостность штифтовых систем.

Результаты: При оценке во время контрольного осмотра на шестом месяце не установлена статистически значимая разница в категориях «соответствующий цвет», «вторичный кариес» и «целостность обтурации». Это не относится

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к «маргинальному обесцвечиванию», «маргинальной адаптации», «проксимальному контакту» и «гладкости поверхности». Контрольный осмотр на две-надцатом месяце установил продолжение этой тенденции со значительным снижением в категории «соответствующего цвета». Оценка долговечности при двух контрольных осмотрах не установила значительных изменений. Зубы, восстановленные без применения штифтов показали выживаемость, сопоставимую с выживаемостью зубов, восстановленных с помощью штифта в течение 12-месячного периода наблюдения.

Заключение: Не установлено никаких нарушений в использованных штифтах. Установленные изменения были связаны с постепенным ухудшением композитных восстановлений.