THE INFLUENCE OF POST PREPARATION ON APICAL SEALING DEPENDING ON THE TYPE OF OBTURATION

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Abstract: In endodontically treated teeth, often due to the loss of a large part of the hard dental tissue, the placement of an intracanal post is indicated, which serves as a retention for the prosthetic crown. During the preparation for the post, the chain of asepsis can very easily be interrupted. According to the literature, teeth restored with a post have a less favorable prognosis than those that have been endodontically treated and restored with crown only. The most likely reason for this is the violation of the integrity of the canal filling during the preparation for the post, which can easily be displaced, damaged or extruded, especially in the case when the previous filling was unsuccessful. The aim of this study was to compare the apical sealing after the preparation for the post with the two types of filling techniques applied. Methods: In this in vitro study, 200 single-rooted teeth were used. After endodontic treatment, the teeth were randomly assigned into two groups of 100 teeth each. according to the obturation technique used: warm vertical compaction (WVC), or single-cone (SC) techniques. Then, the coronal root filling material was removed in order to create a post space. 80 specimens from both groups received post preparation, while 20 teeth serving as controls were treated endodontically only. The quality of the apical filling was analyzed by microleakage tests using dye penetration of 2% methylene blue solution. All specimens were sectioned at 2.5 mm from the tooth apex. Transverse sections were photographed and analyzed using a computer program to determine micropermeability by dye amount. Results: Regarding the filling before post preparation, microleakage was more frequently notices in teeth in which the single cone filling technique was used compared to teeth treated with the warm vertical condensation technique, but the difference was not statistically significant (36.25 vs 28.5 %, $p > 0.05$); The preparation for the post significantly damages and reduces the quality of the remaining filling in the root canal ($p < 0.05$) The technique with which the canal is filled before preparation affects the quality of the remaining filling, but in both techniques, a significant increase in microleakage occurs ($P<0.05$). Conclusion: The quality of the root canal filling is important for the integrity of the apical seal. The post space preparation negatively influenced the apical integrity of the filling materials in the both groups. Obturation with warm vertical showed lower microleakage compared to single-cone obturating technique after post preparation.
Keywords:: Endodontic treatment, root canal preparation, obturation quality, post-space preparation, microleakage

1. INTRODUCTION

The goal of endodontic therapy is to eliminate infection from the root canal and to prevent any further contamination of the endodontic space. Innovations in materials, equipments and techniques continue to sophisticate endodontic treatment procedures enhancing the incidence of predictable clinical success. It is widely accepted and confirmed that a natural tooth is always the best choice over any replacement (Hargreaves & Cohen 2011).

The restoration of endodontically treated teeth often requires intracanal post retention, due to the loss of a large portion of hard tissue or a fractured tooth (Tsintsadze and all.2015; Ghoddusi and all. 2013). The main purpose of the post is to provide protection and retention for the affected tooth (2). It is also crucial to seal the root canal system effectively to prevent microleakage and the entry of bacteria into the periapical area, which can ultimately impact the success of root canal treatment (Mahmoudi at all. 2022; Grecca at all. 2006; Savadkouhi at all. 2016).

Microleakage from the post space can occur as a result of loosening of the post or fracture of the tooth, but if there is damage of the remaining part of the filling in the apical part, it will undoubtedly lead to reinfection of the periapical space and the appearance of periapical lesions (4, 16). According to the literature, teeth restored with a post have a less favourable prognosis than those that have been endodontically treated and restored with composite fillings (Abramovitz at all. 2001).

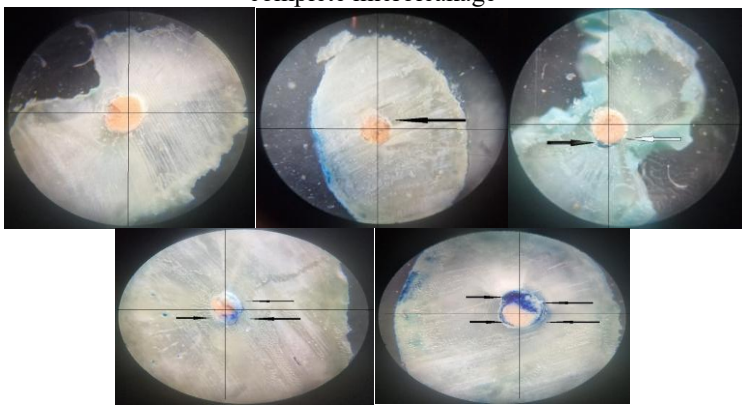
Teeth restored with an intracanal post and crown were extracted more frequently than teeth that were not post-retained, whereas this risk was much lower if only a crown was placed on endodontically treated teeth (Eckerbom, Flygare and Magnusson 2007). Metzger and all. (2000) indicated that endodontically treated teeth in which part of the root filling material was removed have a weaker obturation ability than those that are completely filled.

The dislodging of the integrity of the apical seal during post space preparation is probably the reason for the failure of post-retained teeth. The preparation of the root canal for placement of post may cause displacement of the remaining filling material, especially if the previous filling was unsuccessful (Aydemir at all. 2009).
Over the past decades, a large number of studies have been conducted and published on the problem of residual filling after post preparation. The results are quite contradictory and no definitive conclusions or specific suggestions can be drawn from them that would indicate the advantage of a particular technique or method for removing the canal filling. All of this leads us to the goal of this research, which was to compare the apical sealing after the preparation for the post with the two types of filling techniques applied.

2. MATERIAL AND METHODS

In this in vitro study, 200 single-rooted teeth were used. To obtain a standard root length, the coronal portion of samples was cut with a diamond bur under water spray 15mm from the apex. A #10 k-file was inserted of each root canal through the apical foramen to confirm the patency of the root canal. Endodontic therapy was performed with nickel-titanium rotary instruments (Fanta-AFRotaryfile) (Shanghai, China), according to the manufacturer's recommendations. An amount of 5 mL of 2.5% sodium hypochlorite solution was used to irrigate at every change of file. Final irrigation was performed with alternating use of 2.5% NaOCl and 17% EDTA (DiaPrep Pro 17%, DiaDent, Seoul, Korea) ultrasonically activated in three applications.
The samples were divided into two experimental groups and two control groups.After endodontic treatment, the teeth were randomly assigned into two groups of 100 teeth each, according to the obturation technique used: warm vertical compaction (WVC), or single-cone (SC) techniques. As a material for definitive obturation filling in all samples, a bioceramic material (ReMTAPlus, Israel) was used.
80 specimens from both groups received post preparation, while 20 teeth were in the control group and did not undergo post preparation. This was followed by post preparation using Largo-Peeso reamers in three sizes. The coronal area of all the samples was covered with self-cured glass-ionomer (GC Fuji II, Japan).
The quality of the apical filling was analyzed by microleakage tests using dye penetration of 2% methylene blue solution. Before being placed in methylene blue, the external surface of the root, even the apical end, was covered with nail varnish. All specimens from both the experimental and control groups were placed in a dye for 48 hours at room temperature at atmospheric pressure. After 48 hours, the specimens were removed from the dye followed by rinsing with tap water to remove excess dye.
All specimens were sectioned at 2.5 mm from the tooth apex. The sections were placed on glass slides and the dye penetration was analyzed with a REICHERT MicroStarIV microscope (ScientificInstruments, NY. USA) under a magnification of 4 x o.o1 times. Transverse sections were analyzed using a computer program to determine microleakage by dye amount.
To determine the degree of permeability, the transversal section was visually divided into four parts. According to the amount of dye penetration observed on the perimeter of the filling, a quantitative coding was performed: 0 - if there was no microleakage; slightly - if the dye penetrated up to a quarter of the circle, medium if the dye covered half of the perimeter of the circle rim, high - if the dye covered up to ¾ of the circle, and if dye was observed on the entire perimeter microleakage was determined as total

Figure 1. Determination of microleakage and coding: a) no micropermeability, b) weak c) medium, d) heavy e) complete microleakage



Source: pictures from the authors' own research

3. RESULTS

To obtain data on whether and to what extent the post preparation affects the quality of the filling, a comparison was made between the study group (prepared for a post) and the control group (treated in the same way, but no post preparation was performed). The comparison of by cross-sectional analysis is presented in the following tables.Table 1 shows the microleakage according to the type of obturation technique before post preparation. Slight microleakage was registered only in 2 (10%) teeth in which the single cone obturation technique was used, and in none of the teeth treated with the warm vertical condensation technique. Although obturation with the single cone technique showed poorer results, but the difference was insignificant (p=0.49).

Table 1. Microleakage depending on obturation technique before post preparation (control group)

CG				
mikroleakage	Type of obturation			p - value
	n	single cone n (%)	warm vertical n (%)	
no penetration	38	18 (90)	20 (100)	Fisher's exact p=0,49
slight penetration	2	2 (10)	0	

Source: data from the authors' own research

To determine how much the post preparation damages the remaining apical filling, a comparison was made between the study groups before and after preparation (Table 2). Microleakage was recorded in 52 (32.5%) teeth from the study group (IG) and only in 2 (5%) from the CG, with a statistically significant difference between the two groups (Chisquare=12.3 p=0.0005). The tested difference in the distribution of teeth without leakage, with slight, medium, heavy and complete leakage between the study and control groups was statistically significant (p=0.014).

Table 2. Quality of remaining apical filling in the test and control groups after post preparation

mikroleakage	group n	Study group n (%)	Control group n (%)	p – value	difference between two proportions
no dye penetration	146	108 (67,5)	38 (95)	Fisher's exact *p=0.014	***p=0,0005
slight penetration	35	33 (20,63)	2 (5)		*p=0,02
Medium penetration	10	10 (6,25)	0		p=0,1
Heavily penetration	4	4 (2,5)	0		p=0,31
Complete penetration	5	5 (3,13)	0		p=0,26

*sig p<0,05

Source: data from the authors' own research

Table 3 shows the microleakage in study group obturated with the single cone technique in compared to control group treated with the same technique. 51 (63.75%) of the experimental and 18 (90%) of the control group did not show micropermeability and the difference was significant (Chisquare=5.15 p=0.023). The tested difference in the distribution of the tooth treated with the single zone technique, which was sealed hermetically or has a different degree of dye penetration, between the subjects and the control group was statistically confirmed as significant (p=0.36).

Table 3. Quality of the remaining apical filling in the tested and control groups with the single zone technique

single cone техника					
mikroleakage	**group** n	Study group n (%)	Control group n (%)	p - value	difference between two proportions
no dye penetration	69	51 (63,75)	18 (90)	Fisher's exact p=0.36	*p=0,023
slight penetration	16	14 (17,5)	2 (10)		p=0,41
Medium penetration	6	6 (7,5)	0		p=0,21
Heavily penetration	4	4 (5)	0		p=0,31
Complete penetration	5	5 (6,25)	0		p=0,25

*sig p<0,05

Source: data from the authors' own research

Significantly more frequent microleakage was registered in study groop treated with the warm vertical technique compared to control group treated with the same technique - 23 (28.75%) vs 0%, (Chisquare=7.5p=0.063).
The tested difference in the distribution of the tooth treated with the warm vertical technique, which was without dye penetration , with slight Medium Heavy Complete penetration, weak, medium, great and complete dye permeability, between the examinees and the control group was statistically confirmed as significant (p=0.0013).

Table 11. Quality of the remaining apical filling in the examined and control groups obturated with warm vertical technique

warm vertical technique					
	group			p - value	difference between two proportions
mikroleakage	n	Study group n (%)	Control group n (%)		
no dye penetration	77	57 (71,25)	20 (100)	Fisher's exact ***p=0,013	**p=0,006
slight penetration	19	19 (23,75)	0		*p=0,0155
Medium penetration	4	4 (5)	0		p=0,31

*sig p<0,05, **sig p<0,01, ***sig p<0,0001

Source: data from the authors' own research

Microleakage was more often registered in the group obturated with the single cone filling technique compared to the group treated with the warm vertical condensation technique, but the difference was not statistically significant if only samples without microleakage were compared (Table 5). However, if the distribution of samples in all examined categories is compared, the difference in the filling technique used is statistically confirmed as significant (p=0.027), i.e. Obturation with warm vertical showed lower microleakage compared to single-cone obturating technique.

Table 18. Quality of the remaining apical filling depending on the obturation technique after post preparation.

	Type of obturation			p - value	difference between two proportions
mikroleakage	n	single cone n (%)	warm vertical n (%)		
no dye penetration	108	51 (63,75)	57 (71,25)	Fisher's exact *p=0.027	p=0,31
slight penetration	33	14 (17,5)	19 (23,75)		p=0,33
Medium penetration	10	6 (7,5)	4 (5)		p=0,51
Heavily penetration	4	4 (5)	0		*p=0,043
Complete penetration	5	5 (6,25)	0		*p=0,023

*sig p<0.05

Source: data from the authors' own research

4. DISCUSSION

The success of root canal treatment is closely related to the quality of root canal obturation (Quaresma at all. 2023). A hermetic apical seal is necessary to ensure a successful endodontic treatment; it is important not to disrupt the integrity of the same during postspace preparation, but also not to create root dentin defects. For example, the preparation with Gates-Glidden drills caused fewer root defects than Largo-Peeso reamers and Exacto drills (Zuli at all.2020).
According to available literature data, many questions remain unanswered in various aspects of root canal preparations for posts. In our research, we aimed to answer the question of what happens with the remaining filling in the apical third of preparations for posts obturated with two different filling techniques.
Passive methylene blue dye penetration is probably the technique most commonly used to evaluate the apical seal, and was chosen for this study because of its simplicity and limited cost (Dong, Xie &Xu, 2023).
We decided to compare the two most commonly used obturation techniques. Warm vertical compaction has been the predominant obturation technique and the single-cone technique has gained popularity due to its procedural simplicity and the superior characteristics of bioceramic-based sealers. This was also shown in our study, so that the obturation with a single cone is no less valuable in quality from the much more advanced warm vertical condensation. The same cement from the bioceramic cement category was used in both groups of the study, which differ from the study by Li and all. (2025) who used different types of filling techniques with different cements. However, they themselves conclude that their inconsistent results may be attributed to the limited sample size,

reducing the power to detect subtle differences.The use of bioceramic sealers, especially has increased due to its favorable physical and chemical properties including easy use, lack of shrinkage, good flowability, injection capacity, short setting time, minimal tooth discoloration and good adaptability (Quaresma at all. 2023). This is also shown by several studies, such as those by LanYu-yan et al. (2017) and Hajihassani et al. (2022), which confirm that bioceramic cements have lower microleakage permeability and higher film thickness and solubility than the other sealers tested compared to other sealers tested.

Our study clearly showed that post preparation leads to damage to the remaining part of the filling. Statistically significant difference was shown between teeth before and after post preparation. This was also proven in both groups with different types of obturation. This means that regardless of the obturation technique used, the negative impact of post preparation cannot be avoided.

According to the literature, post preparation also affects the integrity of the filling. According to Grecca et al. (2009), during post preparation, the remaining filling material can become dislodged, which can create a path for re-infection of the root canal system. Disruption of the remaining filling occurs if the canal is insufficiently filled or proper condensation, i.e. three-dimensional obturation of the root canal, is not achieved. Other authors confirm in their studies that more frequent periapical changes are found in teeth restored with the use of a root canal post, compared to endodontically treated teeth where no post was used and only a crown was placed for restoration (Almohefer at all. 2025).

A large number of data in studies often relate to the sealing capacity of canals filled with different techniques or materials. Although the data obtained are often quite contradictory, the results of our study showed that the warm vertical condensation gutta-percha technique shows better sealing capabilities of root canals compared to the single-cone gutta-percha technique when planning canal preparation for post placement. Our results are similar to those obtained by Küçükkaya et al. (2017), who compared the obturation capacity of three filling techniques after post preparation: cold lateral compaction, vertical warm compaction, and single-post filling. They show that after post preparation, cold lateral compaction and single-post fillings caused a significant increase in the percentage volume of root canal voids, but that teeth filled with warm gutta-percha had no or minimal damage to the filling during post preparation.

5. CONCLUSION

The quality of the root canal filling is important for the integrity of the apical seal. The post space preparation negatively influenced the apical integrity of the filling materials in both groups. However, after preparation, the quality of teeth obturated with warm vertical compaction shows significantly less damage after post space preparation

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