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Prevention Of Endodontic Therapy Complications By Modification Of Sealers On Epoxy Resin Basis.

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ABSTRACT

This article deals with the issue of prevention of endodontic intervention complications using a sealer modified by electromagnetic field. Efficiency of complication prevention directly depends on the quality of obturation of the system of micro- and macro-canals. It stated that adhesion improvement is possible by modification of the material obturating the system of root canals. It was registered that the influence of an electromagnetic field resulted in increased adhesion, improvement of strength characteristics of polymer materials. We assume that the influence of an electromagnetic field will similarly influence sealers based on polymer compounds. For our research study we used a device for magnetization providing an electromagnetic impact on an obturation material. After that we investigated changes in the structure of the obturation material determining borders of its adhesion to the tooth root dentine and adhesion strength in the connection of a sealer with walls of the root canal. Results demonstrated that an electromagnetic field impact led to more ordered arrangement of sealer's particles, a decreased number and size of pores; the line of demarcation was not defined, adhesive strength increased. The above mentioned changes provided better obturation resulting in a preventive effect that reduced an incidence of pulpitis and periodontitis complications.

Keywords: polymer sealer, sealer adhesion, impact of an electromagnetic field, scanning electron microscopy, alteration of physical and chemical properties of a sealer.

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INTRODUCTION

In spite of widely spread preventive procedures and personified approach in the treatment of patients, modern therapeutic dentistry frequently faces the challenge of caries complications. All complications arising in the process of endodontic treatment are divided into two groups [1, 5]. The first group is, so called, immediate complications including mistakes in mechanical and chemical root canal processing, perforations, overfilling, break of an instrument in a root canal and others. The second group includes delayed complications: sealer resorption in the root canal, development of an inflammation in the root canal area and so on [4]. Essentially, all complications result from either necrosis of the pulp remained after pulpitis therapy (K04.4 ICD-10) or already infected necrotic masses after periodontitis therapy (K04.4 ICD-10) [2]. Thus, efficiency of complication prevention directly depends on the quality of tooth macro- and micro canals obturation. Therefore, there are 3 components influencing a final therapeutic effect: skills of a dental professional, reactivity of a patient's body and quality of the applied materials [3, 5], the latter being the most important in case of complete performance of two other issues. Quality of tooth root macro- and micro-canals obturation is determined by sealer adhesion to the root canal dentine. Insufficient adhesion results in post-endodontic complications[7]. Improving this parameter and quality of material adhesion to walls of the system of macro- and micro-canals one can obtain pulpitis and periodontitis complications prevention. Attempts to modify available materials and search for novel substances that can reduce risk of complications [5] are being constantly made in order to find options for root canal obturation[6].

Researchers B.A. Ioffe and Y.M. Molchanov are known to devote their investigations to the influence of an electromagnetic field on polymer compounds. B.A. Ioffe in his research studies determined di-electric properties of poly-methylmethacrylate and polyvinyl-chloride in various conditions [2, 3]. Later Y.M. Molchanov invented mechanism of the magnetic field influence on polymer substances. Improvement of adhesive ability and strength of polymer glues was determined [1]. The electro-magnetic field impact was determined to result in increased adhesion, improvement of material strength characteristics [2]. Researchers revealed changes in the structure of the material: monomer particles were placed along magnetic lines parallel to each other; thus, polymerization of the material was performed more orderly, this was determined by the abovementioned properties [7]. We assume that an electro-magnetic field impact on sealers based on polymer compounds will lead to the similar modifications [5-7].

The aim of our study was to provide immediate and delayed complications of pulpitis and periodontitis.

MATERIALS AND METHODS

The study included 40 patients who were indicated to remove premolars. There were selected premolars of the upper and lower jaw with one root canal, since anatomical structure of this group of teeth allows performing an experiment the most precisely. They were divided into two equal groups, where sealers of various producers were applied, but all sealers had polymer compounds in their structure. Each group was divided into two sub-groups (experimental and control), 10 patients each (Table 1). In our study we applied two-component sealers (paste-paste) based on epoxy reisins. We do not mention names of preparations to avoid advertising; however, we can supply the composition of the material declared by manufacturer. Sealer 1 was composed of epoxy reisin, calcium wolframate, zirconium oxide, silicylen, iron oxide – paste A; amines, wolframate, calcium, zirconium oxide, silicylen, silicon oil – paste B. Sealer 2 was composed of: epoxy reisin (bisphenol-A, bisphenol-B), calcium wolframate, zirconium oxide, silicon, iron oxide pigments – paste A; dibenzyldiamine, aminoadamantane, triclodecane-diamine, calcium wolframate, zirconium oxide, silicon – paste B.

Table 1: Distribution of teeth number in the studied groups and sub-groups

Group	Sub-group	Teeth number (pieces)
1	Experimental	10
	Control	10
2	Experimental	10
	Control	10

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Sealers of the experimental groups were modified. For this we applied a device for magnetizing. The exposure time was 20 minutes; strength of an electro-magnetic field was $20*10^4$ - $24*10^4$A/m. Sealers in the experimental groups were processed according to the instruction for use of a manufacturer. Sealers in the control groups were not exposed to an electro-magnetic impact, they were processed according to the instruction for use of a manufacturer.

To assess quality of endodontic therapy we chose 3 laboratory methods of investigations that had the most informative value for the given stage of study:

1. Study of changes in the sealer structure;
2. Determination of borders of sealer adhesion to tooth root tissues;
3. Determination of adhesive strength in the connection sealer-tooth root dentine.

To study changes in the sealer structure in the experimental sub-group samples (after the electro-magnetic field impact) proper components of the system were mixed according to the instruction for use of a manufacturer. Sample preparation was performed on paper palette, sized 30 x 40 mm, with a plastic spatula. Radius of the sealer pattern was 12±2 mm; the sample height was 3 mm. Samples of the control group that were not exposed to a magnetic-field impact, were prepared in the similar way. After mixing all samples were hardened in a dry and dark place at the temperature 25±5°C for 7 days. Samples were prepared for the investigation by scanning electron microscopy. For this a hardened sealer was broken across the middle line and cut in order to fix a sample on an objective table of an optic microscope to previously assess changes and reveal areas of structural differences between modified and non-modified sealers. Samples were further fixed on an objective table of a scanning electron microscope so, that the broken surface of a sample was directed vertically on sensors of the electron microscope. A sealer sample was studied along the line of break in magnification x 1000 and x 2000.

Endodontic treatment of the extracted teeth was performed to determine borders of sealer connection with tooth root tissues. Sealer 1 was used in the first group; sealer 2 was used in the second group. In the control sub-groups sealers were applied according to the instruction for use of a manufacturer, in the experimental sub-groups sealers modified by an electro-magnetic field were applied. Teeth extracted according to orthodontic indications were obturated by the cold gutta-percha lateral compaction technique. After that cross-sectional root splits were performed at various levels (at the apical level, neck level, in the middle of the root level). A contact border of the filling material and tooth root dentine was investigated in a scanning electron microscope (JeolJSM – 6380LV).

To determine adhesive strength in the connection sealer-tooth root dentin we applied a strength testing machine ИР 5046-5. 10 samples were prepared for each sub-group in the study. For this we applied plastic blocks where a fragment of tooth root dentin was fixed. Block diameter was 10 mm, its height 5 mm. The studied sealer in the shape of a cylinder 4±0.5 mm high was placed on the dentin (Figure 1). After that samples were placed in a strength testing machine to determine their strength.

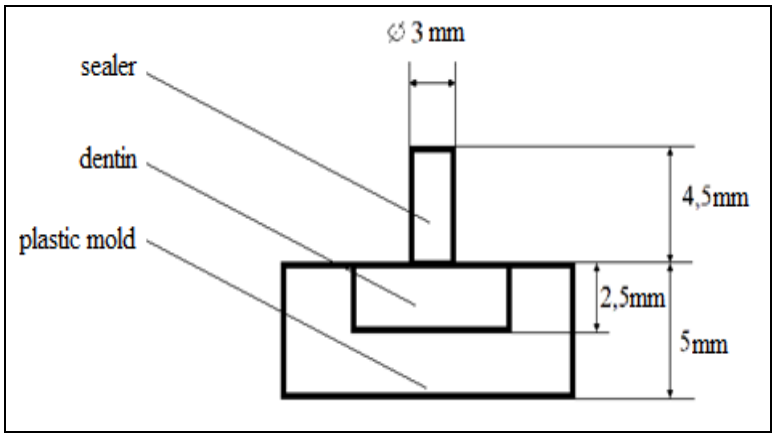

Figure 1: Sample of a plastic block with a fragment of the tooth root dentin and a sealer

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RESEARCH RESULTS

Comparative analysis of the research results in experimental and control sub-groups allowed revealing changes in the structure of a polymer sealer modified by the electro-magnetic field impact (Figure 2, 3).

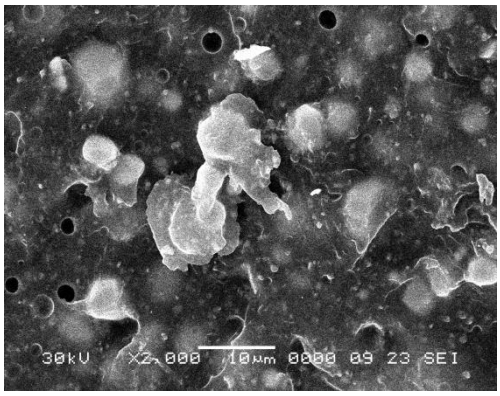

Figure 2: Scanning electron microscopy of a chip of an endodontic sealer № 1, not exposed to the magnetic field impact (control sub-group). X2000 magnification. A large number of pores is determined, particle in a sealer are placed in a random way

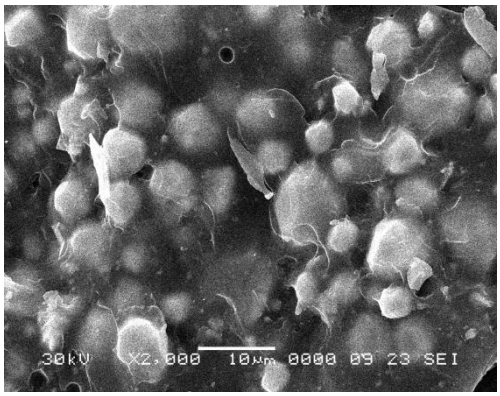

Figure 3: Scanning electron microscopy of a chip of an endodontic sealer № 1, exposed to the magnetic field impact (experimental sub-group). X2000 magnification. An insufficient number of pores is determined, particle in a sealer are placed in an ordered way.

Scanning electron microscopy results demonstrated ordered location of particles in a sealer, a smaller size and number of pores in the experimental sub-group in comparison with the control sub-group.

Scanning electron microscopy results demonstrated the following changes in the determining borders of the sealer contact with the tooth root dentin: a demarcation line between the wall of the root canal and a sealer in the experimental sub-group was absent; this fact supported presence not only mechanical, but chemical adhesion as well (Figure 4, 5).

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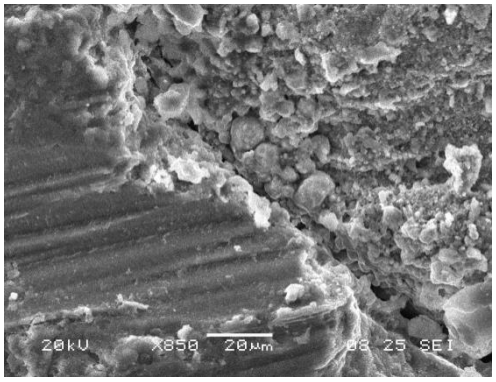

Figure 4: Scanning electron microscopy of a chip of a tooth root. A contact border of sealer 1 and root dentin.
X 850 magnification. In the control sub0group (a sealer is without modification) quality of filling is satisfactory, but a demarcation line is distinctly determined; this characterizes the only way of adhesion – mechanical.

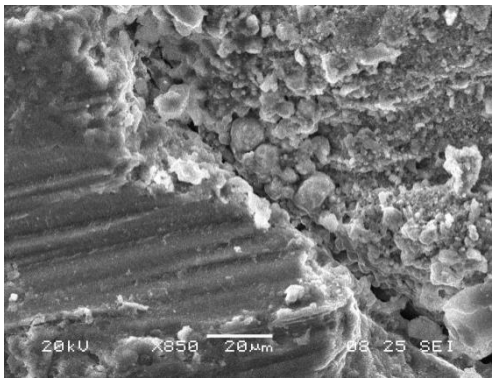

Figure 5: Scanning electron microscopy of a chip of a tooth root. A contact border of sealer 1 and root dentin.
X 850 magnification. In the experimental sub-group (a modified sealer) quality of filling is satisfactory, a demarcation line is not determined; this characterizes not only mechanical, but also chemical adhesion.

Research results aimed at the determination of the adhesive strength in the connection "a sealer-tooth root dentin" allow to conclude the following: an average value of the sealer adhesive strength in connection with the tooth root dentin in the first sub-group of the study with a modified sealer is 4.28 ± 0.02 mPa (H/mm^2), with non-modified – 3.1 ± 0.01 мPa (H/мм^2). An average value of the sealer adhesive strength in connection with the tooth root dentin in the second sub-group of the study with a modified sealer (an experimental sub-group) is 4.04 ± 0.01 mPa (H/mm^2), with non-modified (control group) – 2.97 ± 0.02 мPa (H/мм^2) (Table 2).

Table 2: Adhesive strength values in connection "a sealer-tooth root dentin". Average values

	Control sub-group, мPa (H/мм^2)	Experimental sub-group, мPa (H/мм^2)
Sealer № 1	3.1 ± 0.01	4.28 ± 0.02
Sealer № 2	2.97 ± 0.02	4.04 ± 0.01

DISCUSSION

Thus, we can conclude that sealers' adhesive strength in connection with tooth root dentin improves in 1.37±0.01 times after the electromagnetic field exposure. Increase of strength of adhesive connection provides better adjoining that, in turn, results in better sealing action of the system of macro- and micro-

canals, an apical foramen and an apical delta. Complete 3D obturation of the system of rooth canals enables prevention of post-endodontic complications, both – immediate and delayed.

CONCLUSION

The results of our research study demonstrated that the electro-magnetic field impact on endodontic sealers based on epoxy reisins resulted in changes in the material structure: a number of pores reduced, no demarcation line was determined between the wall of the root canal and a sealer; this supported not only mechanical, but also chemical adhesion. Adhesive strength increased by 37±1% in average. These changes provided better macro- and micro-canals obturation, that allowed excluding the major predisposing factor enabling complications. Therefore, this resulted in preventive effect decreasing incidence of pulpitis and periodontitis complications.

Ethical approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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