MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
SUMY STATE UNIVERSITY
ACADEMIC AND RESEARCH MEDICAL INSTITUTE

Eastern Ukrainian Medical Journal

116, Kharkivska st., Sumy 40007, Ukraine eumj.med.sumdu.edu.ua
e-mail: eumj@med.sumdu.edu.ua ISSN: 2663-5909 (print)/2664-4231 (online)

How to cite / Як цитувати статтю: Dobrovolskyi D, Gevkaliuk N. Comparative assessment of the root canal irrigation quality with experimental intra-root resorption in vitro. *East Ukr Med J*. 2024;12(3):625-631

DOI: https://doi.org/10.21272/eumj.2024;12(3):625-631

ABSTRACT

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COMPARATIVE ASSESSMENT OF THE ROOT CANAL IRRIGATION QUALITY WITH EXPERIMENTAL INTRA-ROOT RESORPTION IN VITRO

Introduction. To date, intra-root resorption of teeth is poorly understood, although it is often encountered in dental clinics.

This study aimed on assess and comparison of different methods of irrigation and antiseptic solutions activation used for root canal treatment, and focus on cleaning the area of simulated intra-root resorption.

Methods. 24 extracted teeth were used, which the simulation of internal resorption was reproduced by dissection the inside of the root canal under the control of an electron microscope (Karl Kaps, Germany) in. Distilled water, sodium hypochlorite 5.25 %, sodium hypochlorite 3 %, chlorhexidine 2 % were used for comparative assessment of irrigation quality by staining with Indian Ink dye.

Results. When using an endodontic needle and passive irrigation with the studied irrigation solutions, the dye remained on the inner surfaces of the root canal walls, which indicated their insufficient cleaning. The use of auxiliary cleaning methods - sound and ultrasonic irrigation nozzles - showed better cleaning of the root canal resorption zone. When using the sound activation of the irrigator with the EndoActivator device, the dye partially remained in the simulated resorption zone, while a significant part of the root canal system was cleaned. The use of ultrasonic activation of the irrigator with the P5 XS device showed that all dye-stained root canals of the samples were cleaned. Zones of simulated root resorption did not show any dye residues visually and under electron microscope control.

Conclusions. The quality of root canal cleaning in case of intra-root resorption in terms of visual assessment of their transparency and under the control of an electron microscope was more pronounced when using methods of activating irrigation solutions with sound and ultrasonic activators.

Keywords. Tooth root; Intra-root resorption; Root canal; Irrigation and activation of antiseptic solutions.

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ПОРІВНЯЛЬНА ОЦІНКА ЯКОСТІ ІРИГАЦІЇ КАНАЛІВ ЗУБІВ ІЗ ЕКСПЕРИМЕНТАЛЬНОЮ ВНУТРІШНЬО-КОРЕНЕВОЮ РЕЗОРБЦІЄЮ IN VITRO

Вступ. На сьогоднішній день внутрішньо-коренева резорбція зубів вивчена недостатньо, хоча в стоматологічних клініках з нею часто стикаються.

Це дослідження було спрямоване на оцінку та порівняння різних методів іригації та активації антисептичних розчинів, які використовуються для обробки кореневих каналів зубів, та акцентувати увагу на очистці зони імітованої нами внутрішньо-кореневої резорбції.

Методи. Було використано 24 екстирпованих зубів, у яких імітацію внутрішньої резорбції відтворювали шляхом препарування внутрішньої частини кореневого каналу під контролем електронного мікроскопа «Karl Kaps, Німеччина». Для порівняльної оцінки якості іригації шляхом забарвлення барвником «Indian Ink» було застосовано дистильовану воду, гіпохлорит натрію 5,25 %, гіпохлорит натрію 3 %, хлоргексидин 2 %.

Результати. При використанні ендодонтичної голки та пасивної іригації досліджуваними іригаційними розчинами барвник залишався на внутрішніх поверхнях стінок кореневих каналів, що свідчило про недостатню їх очистку. Використання допоміжних методів очистки - звукових та ультразвукових насадок для іригації показали більш якісну очистку зони резорбції кореневого каналу. При використані звукової активації іриганта приладом EndoActivator барвник частково залишався в зоні імітованої резорбції, при цьому значна частина системи кореневих каналів була очищеною. Використання ультразвукової активації іриганта приладом P5 XS показало, що всі забарвлені барвником кореневі канали зразків були очищені. Зони імітованої кореневої резорбції візуально та під контролем електронного мікроскопа не виявили залишків барвника.

Висновки. Якість очистки кореневих каналів при внутрішньо-кореневій резорбції за показниками візуальної оцінки їх прозорості та під контролем електронного мікроскопа була більш виражена при використанні способів активації іригаційних розчинів звуковими та ультразвуковими активаторами.

Ключові слова. Корінь зуба; Внутрішньо-коренева резорбція; Кореневий канал; Іригація та активація антисептичних розчинів.

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INTRODUCTION / ВСТУП

One of the pathological conditions that are often encountered in the clinic of therapeutic dentistry, but are currently poorly understood, is intra-root teeth resorption [1, 2]. According to the theory of the American Association of Endodontists, resorption is defined as a condition associated with a pathological process occurring within dentin, cement or bone tissue [3]. It is known that internal "pulpal" resorption is the destruction of intra-root dentin and dentinal tubes along the inner walls of the root canal [4, 5, 6].

To date, most clinical and experimental studies [7] are focused on external tooth root resorption, while internal hard tissue resorption is no less of a problem for the practicing dentist. Insufficient attention to the problem of internal root resorption often leads to diagnostic errors and complications that reduce the quality of treatment, and its results are often ineffective and do not meet the patient's expectations. Today, there is no doubt that in order to avoid diagnostic errors and to improve the quality of endodontic treatment of teeth, affected by internal resorptive process, thorough cleaning of the root canal with antiseptic solutions and auxiliary endodontic devices should be performed before the root canal filling stage.

Insufficient attention to the problem associated with the medical treatment of root canals with intra-root resorption serves as the basis for this study.

Therefore, the purpose of this study is to evaluate and compare different methods of irrigation and activation of antiseptic solutions used for root canal treatment, and to focus on cleaning the area of simulated intra-root resorption.

Materials and Methods. To achieve the goal of comparing the types of medical treatment, identifying the most effective methods of root canal irrigation and areas simulating intra-root resorption, 24 extruded third molars were used in the study, which were removed according to indications. The simulation of internal resorption was reproduced by preparing the inner part of the root canal with a thin carbide endodontic bur under the control of an electron microscope (Karl Kaps, Germany). The access cavity was dissected using a spherical diamond bur and a high-speed handpiece, and the root canal mouth was searched for using an electron microscope. Root canals were passed with a 10-size K-file. In the largest root canals in terms of size and diameter, the inner part of the canal was prepared with elongated carbide endodontic burs, artificially simulating intra-root resorption. Control of the size and extent of the simulated intra- root resorption was performed using targeted X-ray images (Fig. 1).

Figure 1 – Estimation of the magnitude and extent of simulated intra-root resorption on targeted X-ray images

At the next stage, the hard tissues of the teeth were cleaned, namely, their decalcification (Clering technique) and stained with Indian Ink [8]. For the study using the Clering technique, the teeth were cleaned of surrounding tissues and blood. In order to achieve high-quality cleaning of pulp tissue residues, the samples were stored in a 5.25% sodium hypochlorite solution for 48 hours at room temperature (37°C), thereafter the samples were rinsed in running water for 4 hours to remove the remaining sodium hypochlorite. The samples were decalcified with a 5% nitric acid solution, keeping them in the acid for 2-3 hours at room temperature to achieve demineralisation. Solution was stirred 3-4 times per hour and replaced with a fresh one. After decalcification, the teeth were rinsed in running water for four hours to remove traces

of nitric acid. The process of dehydration was carried out by a series of rinses with ethyl alcohol, starting with 80% solution for 8 hours, then 90% solution for an hour and rinsing in 100% ethyl alcohol for an hour.

Results. We have found that after teeth decalcification and dehydration, the transparency of their tissues was achieved, as the process of creating transparent teeth involves a number of physical and chemical changes. The inorganic components of a tooth are dissolved by decalcification and then removed by dehydration. Subsequent immersion in the cleaner makes the tooth transparent, changing its refractive index (Fig. 2).

Figure 2 – The result of obtaining a transparent tooth after immersion in the cleaner (Clering technique)

It should be noted that as soon as the transparent tooth was removed from the cleaning agent, the solvent evaporated and air and moisture were reintroduced into the tooth, resulting in a change in the sample opacity (Fig. 3). We timed the period required for the tooth to become transparent in the cleaning agent. It was found that this time is directly proportional to the time required for the sample to become cloudy when it is outside the cleaning agent.

We used transparent tooth model obtained after the cleaning technique to obtain information about the morphology of root canals, root canal instrumentation techniques, and control of canal cleaning with various irrigants and instruments. The technique of teeth cleaning is quite informative, easy to use and does not require special equipment. We completed all the preparation procedures within 5-7 days, which allowed us to clearly see the small structural details of the root canals. The next stage of the study of the internal structure and anatomy of the tooth was injection of a dye into the root canal, the dye Indian Ink was used. It was injected into the pulp chamber of the tooth using an endodontic needle No. 27. Then the dye was extracted through the canal system by applying negative pressure through the apical part of the tooth using an aspiration system. The appearance of the dye at the top of the tooth root indicated the end of the process. Excess dye was removed from the tooth surface with a gauze swab soaked in 100% ethyl alcohol. For complete cleaning, teeth were placed in methyl salicylate, which makes them transparent after two days, and kept in the solution until the study. The cleaned and stained tooth samples are shown in Figure 4. Studies of the quality of irrigation were carried out in those dye-stained canals where intra-root resorption of the tooth was previously simulated.

The tested samples were mounted on a negatoscope, and the quality of cleaning was compared visually using a dental microscope (Karl Kaps). For the comparative evaluation of the quality of irrigation, we used four types of solutions: distilled water, sodium hypochlorite 5.25%, sodium hypochlorite 3%, and chlorhexidine 2%. Irrigation treatment of root canals was carried out for 2 minutes. To study the effectiveness of the methods of activating the irrigation solution, the following methods were used in the study: irrigation using an endodontic needle No. 27, the method of sound activation with the EndoActivator device (Dentsply-Maillefer, Switzerland), passive ultrasonic activation using an ultrasonic scaler P5 XS (Acteon Group/Satelec, France) and an IRR 25/21Acteon/Setelec nozzle. The power level of the ultrasonic scaler was set at 10 out of 20. Activation of the irrigation solution in the drug channel was carried out for 2 minutes.

Figure 3 – Changes in transparency - cloudiness of the tooth sample outside the cleaning agent

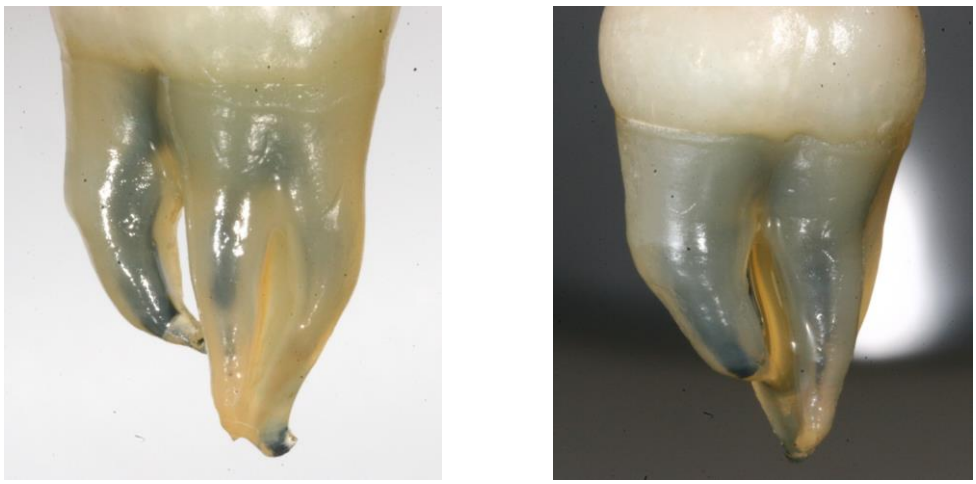

Figure 4 – Cleaned and dye-stained tooth samples “Indian Ink” for further evaluation of irrigation quality

The results of the comparative evaluation showed that the method of solution activation affects the effectiveness of root canal irrigation. Visually, the colour of the root canals of teeth on the verge of simulated resorption did not change significantly when using an endodontic needle and all the studied irrigation solutions. At the same time, when using auxiliary cleaning methods - sound and ultrasonic irrigation nozzles - a better cleaning of the root canal resorption zone was shown.

Analysing the quality indicators of root canal cleaning obtained by us, we found that when using an endodontic needle and passive irrigation, the dye remained on the inner surfaces of the root canal walls, which indicated insufficient cleaning (Fig. 5).

When using the sound activation of the irrigator with the EndoActivator device, the dye partially remained in the simulated resorption zone, while a significant part of the root canal system was cleaned (Fig. 6).

Figure 5 – Dye residues “Indian Ink” on the inner surface of root canals

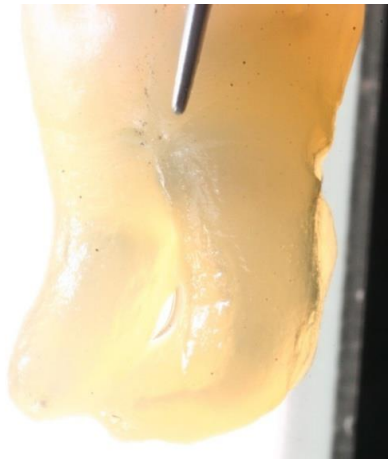

Figure 6 – Partial dye retention “Indian Ink” in the simulated resorption zone

Evaluating the effectiveness of irrigation of the simulated intra-root resorption zone, we found that the use of ultrasonic activation of the irrigator with the P5 XS device showed the best results. All the dye-stained root canals of the samples, without exception, were cleaned, zones of simulated root resorption visually under the control of an electron microscope did not show any dye residues (Fig. 7).

Therefore, taking into account the above results, root canal cleaning with the help of auxiliary instruments that help in the improved irrigation of various solutions did not affect their thickness end density. Out of the 24 teeth studied, the result was positive in those canals where the cleaning was performed using sound and ultrasonic cleaning methods. In our opinion, the effect of using 5.25% sodium hypochlorite with a combination of ultrasonic cleaning gave the best visual result, which was manifested by transparency of the place of our simulated intra-root resorption under the influence of magnification with a clinical microscope (Karl Kaps).

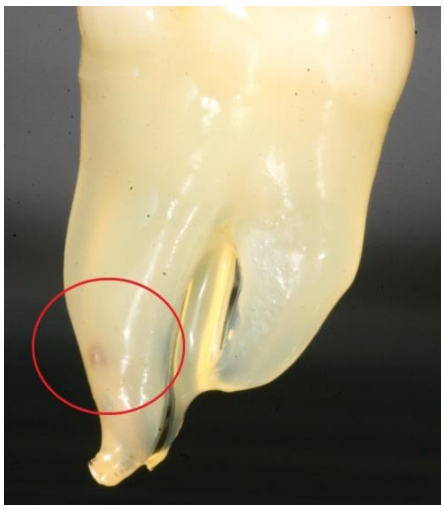

Figure 7 – Root canals and simulated root resorption zones are completely free of dye “Indian Ink”

Discussion. It is known that the key to successful endodontic treatment is adequate antiseptic treatment of the root canal. At the same time, dentists often face the problem of high-quality mechanical, medical treatment and irrigation of the canal affected by intra-root tooth resorption, since resorptive bays create conditions for the accumulation of infected organic residues, dental chips, etc.

We have established that after the completion of decalcification and dehydration of teeth, transparency of their tissues was achieved. The process of creating transparent teeth involves a number of physical and chemical changes. For the first time, the technique of cleansing to obtain a transparent tooth was performed by Okumura [9] for the histological study of internal anatomy of calcified tissues. Subsequently, the method was improved Tagger [10], and this technique was used to study the morphology of the root canals of teeth Robertson [11]. The inorganic components of the tooth are first dissolved by decalcification, and then the fluid, lipid components and gases are removed by dehydration.

In our study, we compared the quality of drug treatment of root canal areas simulating intra-root resorption in vitro using different root canal irrigation solutions and devices to improve their mechanical and chemical cleaning. Based on our data, it can be concluded that the quality of dye washout from the root canal and the area of internal root resorption by any of the studied irrigation solutions did not demonstrate significant differences.

CONCLUSIONS / ВИСНОВКИ

The quality of root canal cleaning during intra-root resorption in terms of visual assessment of their transparency and under the control of an electron microscope was more pronounced when using methods of activating irrigation solutions with sound and ultrasonic activators. Our comparative assessment of the quality of root canal irrigation with experimental intra-root resorption in vitro will allow increasing the success of endodontic treatment.

PROSPECTS FOR FUTURE RESEARCH / ПЕРСПЕКТИВИ ПОДАЛЬШИХ ДОСЛІДЖЕНЬ

They are in the studied effect and quality of root canal cleaning with intra-root resorption.

AUTHOR CONTRIBUTIONS / ВКЛАД АВТОРІВ

Dmytro Dobrovolskyi [A,B,C,D]
Natallia Gevkaliuk [A,D,E,F]

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article.

FUNDING / ДЖЕРЕЛА ФІНАНСУВАННЯ

None.

CONFLICT OF INTEREST / КОНФЛІКТ ІНТЕРЕСІВ

The authors declare no conflict of interest.

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Received 11.04.2024
Accepted 05.07.2024

Одержано 11.04.2024
Затверджено до друку 05.07.2024

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