
INFLUENCE OF IRRIGATION SOLUTIONS ON POSTOPERATIVE PAIN IN ENDODONTIC

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Abstract: The aim of this study was to evaluate the impact of different irrigation solutions on the level of post-operative pain in patients with irreversible pulpitis undergoing single-visit endodontic therapy.

A total of 80 patients with symptomatic irreversible pulpitis were included in this prospective randomized follow-up clinical study. To avoid and minimize interpersonal variability in treatment, all endodontic therapy procedures were the same for all patients, and the therapy was performed by one therapist. The patients were randomly divided into four groups according to the type of irrigant solution used during the root canal instrumentation phase: in the first group, the root canals were irrigated with 5.25% sodium hypochlorite (Chloraxid 5.25% CerKamed medical company Poland), in the second group 2% sodium hypochlorite were used (Chloraxid 2% CerKamed medical company Poland), in the third group irrigation was done with 3% hydrogen peroxide, while in the fourth group 2% chlorhexidine gluconate (Gluco-Chex 2% CerKamed medical company Poland) was used. The visual analogue scale (VAS) was used to determine the intensity of pain after intervention. The patients recorded the data in the survey questionnaire in the periods of 6 hours, 12, 24 and 48 hours, as well as 7 days after the intervention. It was indicated that the patients determine and record the spontaneous pain and the pain during percussion. Each patient was scheduled seven days after the intervention, when they returned the completed questionnaire. Preoperative and postoperative pain intensity in the indicated periods were evaluated using the Kruskal–Wallis test. A two-sided analysis with a significance level of $p < 0.05$ was used to determine statistical significance.

Pain after endodontic therapy is quite common, but most often due to the intensity does not require reinvention and does not disturb the patient's daily life. The pain reaches its peak 6-12 hours after the intervention and is most intense, after which it significantly decreases. On the seventh day most patients no longer feel any pain or it manifests as slight discomfort. The appearance and intensity of the pain is influenced by the used irrigation. Hypochlorite at a concentration of 5.25% gives significantly higher pain than other examined irrigants in the first 6, 12, and 24 hours, not only in duration but also in intensity of that pain. After 48 hours the difference between the groups for percutaneous pain was insignificant, while for spontaneous pain there was significance between the hypochlorite groups and chlorhexidine. After 7 days there is no difference in the degree of pain no matter what the irrigation was used. All irrigants have their advantages and disadvantages. Which irrigant is most suitable to use during processing depends on the diagnosis. The use of 5.25% hypochlorite is not recommended for teeth with vital pulp as an irrigant, which significantly increases the pain after the endodontic therapy.

Keywords: endodontic irrigation, endodontic therapy, irreversible pulpitis, irrigation solutions, post-endodontic pain

1. INTRODUCTION

The goal of endodontic therapy is to preserve the tooth, restore its function, as well as achieve pain relief (13). Pain can be the reason for which the patient asks for treatment; it might be appear during the intervention, immediately after it or much later when it is most often a consequence of the failure of the therapy. The pain, which is an accompanying phenomenon of the tooth disease, depending on the diagnosis, subsides with the dentist's intervention itself, for which the patients are especially grateful. In some cases, the pain occurs soon after the end of the intervention, which is particularly frustrating for both the patient and the dentist. This pain also occurs if only the cleaning and shaping of the root canal has been done or the obturation has also been completed. It occurs after several hours and can last several days after endodontic treatment (10).

Pain characteristics are often studied (21). The description of pain is subjective and depends on each individual. Unfortunately, it is difficult to objectively measure the patient's discomfort level or pain intensity(23).Data for this variable depend on subjective information provided by the patients themselves and are not a reliable parameter. Even with the same intensity of pain, patients will experience and describe it completely differently. For some, moderate pain with a similar intensity is tolerable, for some it is terrible and unbearable (4). It has been shown that most patients can declare the intensity if they are given directions and a visual or graphic scale, where they can write down their answer. There are more such scales, and it has been proven that with the different methods for measuring

the intensity of pain, a high mutual correlation was obtained (12). The most common way to quantify pain is with the help of the Visual Analogue Scale (VAS).

The aim of many studies has been to investigate the causes of post-endodontic pain. But despite numerous studies on this topic, the mechanism of occurrence of postendodontic pain is still unclear. This pain is usually associated with several factors and occurs more often: in teeth that were symptomatic before the intervention, in infected root canals and in the case of systemic steroid therapy applied for another disease. The pain also increases with overinstrumentation, overfillings, traumatic occlusion or insufficiently treated canals (21). Pain also depends on the final apical instrument, cleaning and shaping technique, the duration of the instrumentation, the design of the canal instruments (24). Among the papers that examined the various causes of the occurrence of postendodontic pain, there are also those that examined the influence of irrigants, which are an essential part of endodontic therapy (3, 7). Although irrigants and intracanal medications work inside the root canal system, they still come into contact with the periapical tissue through unwanted extrusion or passive leakage through the apex. The aim of this study was to evaluate the impact of different irrigation solutions on the level of post-operative pain in patients with irreversible pulpitis undergoing single-visit endodontic therapy.

2. MATERIALS AND METHODS

A total of 80 patients with symptomatic irreversible pulpitis were included in this prospective randomized follow-up clinical study. To avoid and minimize interpersonal variability in treatment, all endodontic therapy procedures were the same for all patients, and the therapy was performed by one therapist. The patients were randomly divided into four groups according to the type of irrigants solution used during the root canal instrumentation phase: in the first group, the root canals were irrigated with 5.25% sodium hypochlorite (Chloraxid 5.25% Cerkamed medical company Poland), in the second group 2% sodium hypochlorite were used (Chloraxid 2% Cerkamed medical company Poland), in the third group irrigation was done with 3% hydrogen peroxide, while in the fourth group 2% chlorhexidine gluconate (Gluco-Chex 2% Cerkamed medical company Poland) was used.

After application of anesthesia (Artinibsa 4% with adrenaline 1:100,000 Inibsa Dental Spain), isolation was performed with a rubber dam. The Reciproc® blue R25, R40, R50 system (VDW GmbH, Munich, Germany) and the VDW.GOLD RECIPROC endomotor (VDW GmbH, Munich Germany) are used for root canal treatment. During the instrumentation and shaping, irrigation was performed with one of the indicated irrigants, after which they were also used in the final irrigation along with EDTA solution according to the final irrigation protocol. The filling was completed in the same appointment and the tooth was closed temporarily. The visual analogue scale (VAS) was used to determine the intensity of pain after intervention. The patients recorded the data in the survey questionnaire in the periods of 6 hours, 12, 24 and 48 hours, as well as 7 days after the intervention. It was indicated that the patients determine and record the spontaneous pain and the pain during percussion. Each patient was scheduled seven days after the intervention, when they returned the completed questionnaire. Then a composite restoration was placed. Preoperative and postoperative pain intensity in the indicated periods were evaluated using the Kruskal–Wallis test. A two-sided analysis with a significance level of $p < 0.05$ was used to determine statistical significance.

3. RESULTS

The level of pain after intervention was compared: intragroup – in the groups of each of the applied irrigants individually in five measurement times; and between groups – between the groups of each of the irrigants in the five measurement times.

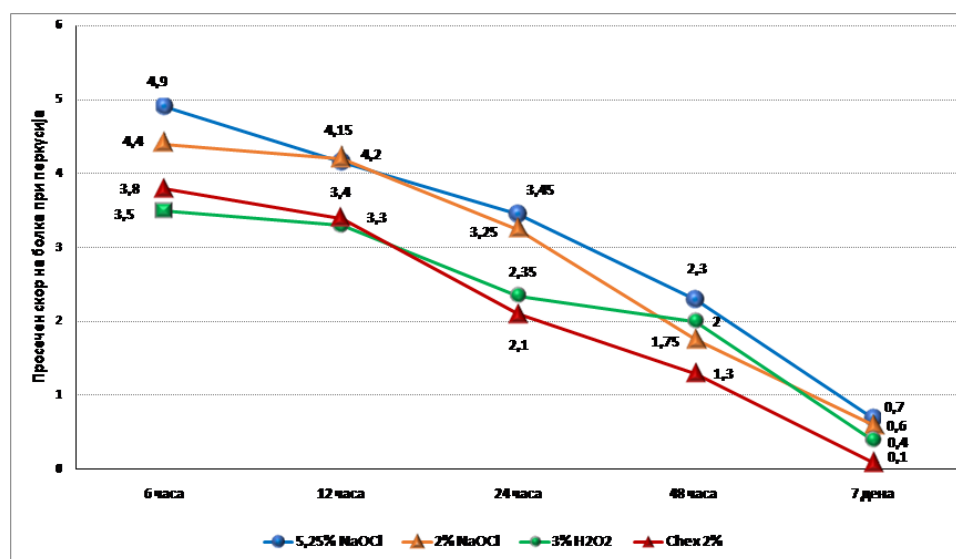
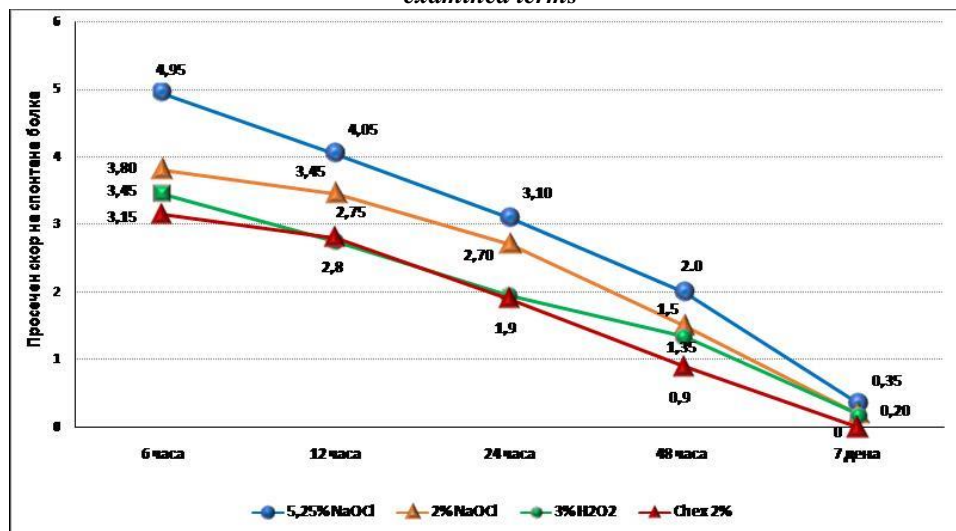
In all four groups, a significant decrease (Friedman Test) was observed in the level of spontaneous and percussive pain during the five measurement times with the highest level after 6 hours and the lowest level after 7 days (Chi-Square=72.239; $df=4$; $p = 0.00001^*$). The intensity of pain in the first hours after endodontic therapy was quite intense, but it decreased in all groups (Graph. 1 a and b). It can be noted that even if there is spontaneous pain, it decreases faster than percussive pain. After seven days, spontaneous pain was confirmed to be 14% (this percentage differed between groups), but pain on percussion although of very low intensity was still present in 40% of cases.

For a more vivid presentation of pain, it has been grouped into 5 categories: 0=no pain, 1-3=mild pain; 4-6=moderate-severe pain; 7-9=very severe pain; and 10=worst possible pain. The analysis was done at the five follow-up times (6 hours, 12 hours, 24 hours, 48 hours and 7 days). The results are shown in the following tables (table 1 and 2).

Different irrigants with different concentrations can cause pain of different intensity and duration, when the same processing method and instruments are used. In cases where 5.25% hypochlorite was used, the pain intensity was always the most intense. 6 hours after treatment only in the group irrigated with 5.25% hypochlorite, 15% of patients had intense spontaneous pain and 25% intense pain on percussion which was not the case in any other

group. Analysis between groups (Mann-Whitney U Test) indicated a significant difference between: a) Group I and II ($p=0.0215$); b) Group I and III ($p=0.0032$); and c) Group I and IV ($p=0.0006$) – everywhere in addition to a significantly higher level of spontaneous pain after 6 hours in Group I.

Graph 1. Average a) spontaneous and b) percussive pain on the VAS according to the irrigant used in the examined terms



After 12 hours, severe pain was no longer registered even in the first group. However, pain decreased more slowly in the hypochlorite groups than in the chlorhexidine and hydrogen irrigated groups. In that period, there was no significant difference between the two groups with different concentrations of hypochlorite, but they still had higher pain than the other two groups.

24 hours after endodontic treatment, the highest level of spontaneous pain was moderate and represented at most in 50% of patients in Group I and only in 10% of patients in Group II. In the other groups, there was only insignificant pain. The difference between the two hypochlorite groups compared to the other two was significant.

For $p>0.05$, there was no significant difference between the patients of the four groups with different irrigation in relation to the level of pain after 7 days of endodontic treatment for the Kruskal-Wallis H test where $p=0.0501$ (Tab 1)

Table 1. Analysis according to irrigation groups and level of spontaneous pain at 5 follow-up periods

Spontaneous pain level	groups			
	5,25% NaOCl	2% NaOCl	3% H ₂ O ₂	Chex 2%
After 6 hours				
mild	25%	45%	65%	65%
moderate	60%	55%	35%	35%
strong	15%	0%	0%	0%
After 12 hours				
mild	35%	55%	95%	80%
moderate	65%	45%	5%	20%
After 24 hours				
No pain	10%	0%	0%	0%
mild	40%	90%	100%	100%
moderate	50%	10%	0%	0%
After 48 hours				
none	10%	5%	10%	25%
mild	80%	95%	90%	75%
moderate	10%	0%	0%	0%
After 7 days				
none	65%	80%	80%	100%
mild	35%	20%	20%	0%

Table 2. Analysis according to level of of pain on percussio at 5 follow-up periods

Spontaneous pain level	groups			
	5,25% NaOCl	2% NaOCl	3% H ₂ O ₂	Chex 2%
After 6 hours				
mild	35%	25%	40%	35%
moderate	65%	75%	60%	65%
strong	35%	25%	40%	35%
After 12 hours				
mild	30%	25%	70%	60%
moderate	65%	75%	30%	40%
strong	5%	0%	0%	0%
After 24 hours				
No pain	5%	0%	0%	0%
mild	40%	70%	95%	100%
moderate	50%	30%	5%	0,00%
After 48 hours				
none	10%	5%	5%	5%
mild	70%	85%	90%	95%
moderate	20%	10%	5%	0%
After 7 days				
none	30%	50%	63,16%	90%
mild	70%	50%	36,84%	10%

For $p < 0.05$, the analysis indicated a significant difference between the patients of the four groups with different irrigation in terms of the level of percussive pain after intervention at all measurement times (Table 2). According to the analysis, we determined that: between the groups (Mann-Whitney U Test) indicated a significant difference between: a) Group I and III ($p=0.0149$); b) group I and IV ($p=0.0265$); and c) group II and III ($p=0.0239$) everywhere in addition to a significantly higher level of pain on percussio after 6 hours in Group I (5.25% NaOCl) and Group II (2% NaOCl). For $p < 0.05$, there was a significant difference between the patients of the four groups

with different irrigation regarding the level of pain on percussion after 7 days for Kruskal-Wallis H test $p=0.0024$. (table 2)

4. DISCUSSIONS

Although unexpected for patients, who believe that after a visit to the dentist, the pain should disappear completely after endodontic therapy, pain is still a common finding. In the literature, there are often contradictory data on the incidence of post-therapy pain. The reported incidence of this type of pain ranges from 13.2% to 64.7% according to studies by Kane et al. (17), from 25%–40% according to Ince (15), and 50% according to Levin (19). Explanations for why there are such large differences in the representation shown are: differences in the methodology of the study (prospective or retrospective study), the selection of patients, the diagnosis of the diseases, the experience of the examiners or the period in which the pain was studied. Another question is which pain is monitored: will light spontaneous or percussive discomfort be counted as pain, or will only the unbearable intense pain that occurs during the formation of an abscess or sinus tract be considered?

During the endodontic therapy of acute and chronic apical periodontitis, it is expected that pain will occur, and even an exacerbation will occur, with subsequent pain and swelling. However, there are also numerous papers that record that the pain is greater in teeth with vital pulp compared to teeth with necrotic pulp or during retreatment. The strength of the pain shown in the paper by Gotler et al (2,10) is significantly higher, and the incidence of pain in vital teeth is 63.8%; compared to the incidence in necrotic cases where it occurs in 38.5% of cases. It is believed that even the slightest injury to the healthy periapical tissue causes a much more intense secretion of inflammatory mediators, such as prostaglandins, leukotrienes, serotonin, histamines and bradykinin, which themselves are mediators of pain (1). In our study, only patients with a diagnosis of irreversible pulpitis were included, and the intensity of pain in the first hours after endodontic therapy was quite strong. Our results were consistent with the findings of Levin et al. (19).

That our results can be considered relevant is also confirmed by the completely uniform prerequisites and characteristics of our respondents, who belonged to the four investigated groups. In all groups, the age, gender, type of teeth (maxillary or mandibular and single-rooted and multi-rooted teeth) were exactly the same. Even the symptomatology before the start of endodontic therapy was equally represented in all groups. In this way, we believe that all factors that could have an impact on the obtained results, and are related to the influence of irrigation, have been removed and that there is a high external and internal validity of the results of this paper.

In the study, we used the most commonly used irrigants in endodontics. Sodium hypochlorite (NaOCl) is the most commonly used solution for irrigation in endodontics due to its organolytic effect and antimicrobial activity, which however depends on its concentration (9). However, there is still no definitive opinion on what is the optimal concentration of hypochlorite that would be used in endodontic therapy. In the United States, the most popular is 5.25 -6% hypochlorite in teeth with a narrow apical opening, while in Europe 2%–3% NaOCl is more commonly used. Chlorhexidine is not a very often used irrigant despite its low toxicity, unlike hydrogen peroxide which is the most common irrigant in our country.

In all four groups, a significant decrease in the level of both percussive and spontaneous pain was observed during the five measurement times with the highest level after 6 hours and the lowest level after 7 days. A significant difference was found in the level of spontaneous pain after intervention between all measurement periods. There was no need for reintervention in any patient during the follow-up period. After seven days, the pain in the patients was absent or insignificant, that is, there was weak pain on percussion. This finding coincided with the largest number of studies by Graunaite (11), Arora M (5), Cruz (6). In the systematic review paper on the prevalence of pain before, during and after the intervention by Pak and White (21) it is shown that after 7 days the pain remains present in 11% of patients. In our study spontaneous pain after seven days was roughly in line with their result and was 14% (on average, why this percentage differed between groups), but pain on percussion was still present in 40% of cases. Percussive pain also decreases significantly, but still after 7 days it is more often present than spontaneous pain.

When we compared the strength of the pain that appeared after using the studied irrigants, it was shown that the group with 5.25% hypochlorite gave the strongest pain, not only in terms of duration, but also in terms of intensity of that pain. Definitely the strongest pain is obtained when using 5.25% hypochlorite, compared to all other investigated groups and in all investigated periods. This is consistent with the work of Jaiswal (16); and Farzaneh, et al (8). Verma et al. (24) examined the effect of two concentrations of hypochlorite (5% and 1%) on the occurrence of pain over a period of one week after the end of treatment. They showed that with a lower concentration of hypochlorite, pain occurs less often, but the difference was not significant. In our results after 7 days, where only a small number of patients had mild percussive pain and there was no significant difference between the groups.

The question arises why irrigation affects the appearance of pain? Irrigation solutions are used to clean and disinfect the contents of the root canal. But although these materials are intended to be retained in the root canal, they always

come into contact with the periapical tissues, either through inadvertent extrusion or leakage (14). That the penetration of the irrigant together with the debris from the canal occurs more pronounced if the irrigant has a higher concentration is also confirmed by the studies of Parirokh (22) and Ozlek (20). This is also consistent with a retrospective study conducted on members of the American Association of Endodontists, of which 42% of clinicians reported experiencing severe postoperative pain or serious complications at least once a year when using 5.25% NaOCl. That is also the reason why producers still strive to get more biocompatible irrigant according to Kleier et al. (18).

Until now, no ideal irrigation system has been found that does not have its disadvantages. Therefore, it may be important to determine the choice of what to irrigate during instrumentation and according to the clinical characteristics of each individual case. We worked on teeth with vital pulp in this study. The thought arises - do we need to use hypochlorite with a high concentration, when in principle there is no infection in the canal, so we do not need special antimicrobial activity. And would we get different results in terms of pain if we were working on teeth with infected pulp, such as gangrene and necrosis. Would you get completely different results here, because in such cases the elimination of the infection is necessary.

5. CONCLUSIONS

Pain after endodontic therapy is quite common, but most often due to the intensity does not require reinvention and does not disturb the patient's daily life.

The pain reaches its peak 6-12 hours after the intervention and is most intense. On the seventh day most patients no longer feel any pain.

The appearance and intensity of the pain is influenced by the used irrigation. Hypochlorite at a concentration of 5.25% gives significantly higher pain than other examined irrigants in the first 6, 12, and 24 hours, in duration but also in intensity. After 7 days there is no difference in the degree of pain no matter what the irrigation was used.

The use of 5.25% hypochlorite is not recommended for teeth with vital pulp as an irrigant, which significantly increases the pain after the endodontic therapy.

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