

Clinical and Bacteriological Considerations for Applying Diathermy in Treatment of Teeth with Partial Pulp Necrosis

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Abstract

Background: The aim of the present pilot study was to assess the bactericidal efficacy of a high frequency diathermy irradiation in treatment of teeth with diagnosed partial pulp necrosis.

Methods and Results: The study included 83 patients aged between 22 and 54 years (mean age of 39±10 years) with irreversible pulpitis and signs of partial pulp necrosis in multi-rooted teeth (n=83). All patients were randomized in two groups in accordance with conducting therapy modes: 1) a conventional root canal treatment (Group 1, n=40); 2) a conventional treatment protocol in conjunction with a high frequency diathermy irradiation (Group 2, n=43). The postoperative sensitivity of treated teeth was assessed with the help of the Verbal Rating Scale (VRS). The quality of a root canal disinfection was evaluated by the presence of a cultural growth. The periapical index scoring system (PAI) was used for evaluation of periapical changes in every tooth after endodontic therapy. The occurrence of postoperative pain in Groups 1 and 2 demonstrated a similar reduction in toothache dynamics at all time intervals when assessments were made, and analysis of tooth radiographs in both groups of patients did not reveal a significant difference. As for the evaluation of a cultural growth, the signs of turbidity were detected in 6 samples of Group 1 and in 4 samples of Group 2.

Conclusion: The possible antimicrobial efficacy of a high frequency diathermy in treatment of teeth with partial pulp necrosis was demonstrated. However, further studies should be made to confirm the results of this clinical trial. (**International Journal of Biomedicine. 2020;10(2):148-152.**)

Key Words: multi-rooted teeth • partial pulp necrosis • diathermy irradiation • antimicrobial efficacy

Introduction

Involvement of tooth pulp in an infectious inflammatory process inevitably leads to irreversible conditions, which usually may be resolved with an application of partial pulpotomy or pulpectomy.⁽¹⁻³⁾

According to the study of de Oliveira et al.,⁽⁴⁾ the prevalence of irreversible pulpitis from all the teeth with diagnosed pulp pathologies is up to 46%-47%, and with no significant difference between men and women.

Leakage of existing composite restorations is one of the main reasons for advanced pulp degradation, especially in deep class II caries lesions. The cervical part of proximal cavities is usually considered as one of the most susceptible to the formation of marginal gap because of resin polymerization shrinkage and poor bonding to caries-affected dentin.⁽⁵⁻⁸⁾

In addition, the character of bacterial flora of a resin-dentin interface, along with initial cytotoxicity of a filled resin material, may substantially contribute to the progression of pulp pathology, particularly on a background of inflammatory pulp changes.⁽⁹⁻¹²⁾

Eventually, due to unfavorable circumstances, irreversible pulpitis may degenerate into a necrobiotic state in a short period of time. The term «necrobiosis» was first introduced by L. Grossman to explain a tooth pulp condition. However, there are many dentists who from the practical standpoint usually to refer it as a «partial pulp necrosis» or «partially necrotic pulp.»^(1,13)

It must be underlined that the coronal portion of pulp in cases of partial pulp necrosis is usually presented by necrotic tissue and contains many pathogens and their toxic byproducts, while the radicular segment is vital despite the inflammatory reaction.⁽¹⁴⁾ Therefore, the presence of vital tissue in the apical part of a root canal expands the opportunity to perform the generally acceptable treatment principle of a partial pulpectomy, which has a more promising prognosis for a tooth

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and its periradicular tissues than a total pulpectomy.^(15,16)

Nevertheless, the critical role of microorganisms at the beginning of pulpal and periapical disease should not be underestimated, because the primary endodontic cases are typically presented by the polymicrobial mix of approximately equal proportions of Gram-negative and Gram-positive species, in which the latter ones are most responsible for a failed outcome of a root canal therapy.⁽¹⁷⁻²⁰⁾

That is why, in order to increase the success rate of treatment of teeth with advanced pulp pathologies many studies have been aimed to find the way to fight infection more efficiently and have emphasized application of aggressive disinfectant solutions.^(21,22)

However, it has been found that injudicious use of aggressive solvents and bactericidal agents in an effort to kill all opportunistic pathogens in a root canal system might be the cause of a more depleting effect on residual vital tissues of the periapical zone.^(23,24)

Therapeutic principles for pulpectomy, as well for pulpotomy and pulp capping, are the same and assert that proper treatment of a pulp wound is of paramount concern.^(2,14)

There are few studies indicating the efficacy of electrocautery in rehabilitation of teeth with chronically inflamed pulp, but most of them were aimed to increase the treatment efficacy of pulp lesions in primary teeth. The obtained clinical data and results of radiographic examinations revealed that in cases of established antiseptic conditions the use of monopolar diathermy might be a good alternative to a standard therapy, which means an application of aggressive irrigating solutions and medications.^(25,28)

The potency of diathermy to stop bleeding from a pulp stump is undisputable. In addition, such treatment may defend the pulp wound from possible invasion of pathogens into the bloodstream and create comfortable conditions for sealer setting because of the low risk of oozing from the apical side, and may cause a positive bactericidal effect in a lumen of a root canal due to the short-term rise in temperature.⁽²⁹⁻³²⁾

Experimental studies by Fish and MacLean might serve as the first example of a bactericidal effect of high temperatures in dentistry, when they cauterized gingival tissue in order to prove the sterility of tissues in a periradicular zone.⁽³⁾

Nowadays, there are many studies demonstrating the beneficial antimicrobial effect of lasers caused by thermal irradiation alone or in conjunction with irrigating solutions. However, there are no available data that might describe or evaluate a diathermy in terms of bactericidal abilities.⁽³³⁻³⁶⁾

The aim of the present pilot study was to assess the bactericidal efficacy of a high frequency diathermy irradiation in treatment of teeth with diagnosed partial pulp necrosis.

Materials and Methods

The study included 83 patients aged between 22 and 54 years (mean age of 39±10 years). They were diagnosed with irreversible pulpitis and signs of partial pulp necrosis in multi-rooted teeth. The total number of multi-rooted teeth in the study was 83. Written informed consent was obtained from all participants.

Exclusion criteria were cases of total pulp necrosis in at least one of the roots of a tooth, and teeth with an x-ray confirmation of apical periodontitis. All cases were done by one operator and assigned for a single-visit treatment protocol. All patients were randomized in two groups in accordance with conducting therapy modes: 1) a conventional root canal treatment; 2) a conventional treatment protocol in conjunction with a high frequency diathermy irradiation. It should be noted that principles of cavity preparation and root canal chemomechanical instrumentation, as well as the technique of permanent obturation for all teeth in the study, were similar and performed with a consideration of aseptic rules.

However, the following differences in treatment protocols were made. In Group 1 (n=40), a radicular pulp tissue was severed with a sterile hand instrument; in Group 2 (n=43), a pulp wound was cauterized at first and was followed by severing pulp with a sterile instrument. Cauterization was performed with the help of a «ДК-35MC» electrocautery unit in a pulse mode.

In addition, there were distinctions in treatment protocols of both groups caused by culture sampling. In Group 1, before root canal sealing the following steps were undertaken: (1) disinfecting the root canal obturation with a warm 0.5% sodium hypochlorite solution; (2) drying of the canal with paper points; (3) irrigating the canal with a saline solution and sampling dentin from the cervical third of a root canal with a sterile hand reamer of appropriate size; (4) transferring the reamer with a dentine mash into a tube with 5 mL of Brain Heart Infusion (BHI) broth; (5) irrigating the canal with a saline solution; (6) drying the canal with paper points.

In Group 2, steps (1) and (2) were the same; at step 3, root dentin was exposed to high frequency electromagnetic radiation. The following steps were as in Group 1: (4) taking a culture; (5) irrigating with saline and (6) eliminating moisture.

Radicular dentin was irradiated at a power level of 4.1W and radiofrequency of alternating current cycles at 2640kHz («ДК-35MC» electrocautery unit). Radiation was performed by insertion of the endo tip into a cervical third of the root canal for 3 sec. During manipulation, the main consideration was to avoid direct contact of an activated endo tip with dentine.

The quality of a root canal disinfection was evaluated by the presence of a cultural growth. Results of microbial tests were assessed after four days of incubation, and the appearance of turbidity indicated the presence of a residual microflora.

The postoperative sensitivity of treated teeth was assessed on the basis of patient complaints and registered with the help of the Verbal Rating Scale (VRS) at 24h, 3 days, 7 days and 14 days. Every patient was asked to evaluate causal tooth sensitivity on a scale from 0 to 3, taking into account a previous toothache experience.

Radiographs were taken before, during, and right after the treatment to assure a proper filling. Recall x-ray examinations were taken in the interval of about 6 months, 1 year and 2 years, and at other times in cases of emergency. The periapical status of all teeth was examined using the periapical index scoring system (PAI). Scores of 1 or 2 assumed that periapical changes were absent and that teeth with values from

3 to 5 were pointing to the presence of apical periodontitis. For multi-rooted teeth, the root with the highest PAI score was recorded.

Statistical analysis was performed using StatSoft Statistica v7.0. The mean (M) and standard deviation (SD) were calculated. Student’s unpaired and paired t-tests were used to compare average values for data with normal distribution. Group comparisons with respect to categorical variables are performed using chi-square tests with Yates correction or, alternatively, Fisher’s exact test when expected cell counts were less than 5. A probability value of $P < 0.05$ was considered statistically significant.

Results and Discussion

The obtained results of the present clinical trial revealed that the mean values describing the occurrence of postoperative pain in both groups of patients were almost the same, with a similar reduction in toothache dynamics at all time intervals that assessments were made (Table 1). There were two cases of flare-ups in Group 1 and one case in Group 2, which were successfully managed with periosteal releasing incisions and had no influence on the total outcomes of provided therapies.

Analysis of tooth radiographs in both groups of patients did not reveal a significant difference. There were two cases of radiographically detected periapical bone changes in Group 1 and two cases in Group 2, with no clinical manifestations that would confirm the presence of obvious pathology (Tables 2, 3).

When we examined the tubes with culture mediums for growth after the assigned 4-day period of incubation, there were 6 samples in Group 1 with signs of turbidity; in Group 2, four cases of cultural growth were detected ($P=0.510$).

Successful root canal treatment with a long-term prognosis depends on many factors and the most important of them are high infection control, proper instrumentation and quality canal obturation.⁽³⁷⁾

The number of clinical trials associates the occurrence of endodontic failures mainly with insufficient antiseptic protocols and passage of resistant microorganisms down through the root canal into its periapical zone.⁽³⁸⁾

In addition, it has been reported that a few germs, such as *E. Faecalis* and *C. albicans*, may survive root canal chemomechanical instrumentation and resist high concentrations of antimicrobial agents with different pH values due to formation of biofilms within dentinal tubules.^(39,40)

In relation to this, the results of several studies indicate that a thorough root canal obturation is necessary in order to entomb the residual pathogenic microflora within the walls of root canal dentin.^(41,42)

The application of laser thermal energy to disinfect a dry root canal and activation of hypochlorite solutions have been debated in many *in vitro* studies and also in limited clinical trials. However, despite real benefits of laser usage in conjunction with irrigating solutions, further comprehensive studies must be undertaken to reveal whether lasers should be used as a unique treatment modality.^(34,36)

Table 1.
Severity of postoperative pain after root canal therapy in groups

Pain severity	Day 1		Day 3		Week 1		Week 2	
	Group 1 n (%)	Group 2 n (%)	Group 1 n (%)	Group 2 n (%)	Group 1 n (%)	Group 2 n (%)	Group 1 n (%)	Group 2 n (%)
No pain (0)	5 (12.5)	7 (16.3)	9 (22.5)	7 (16.3)	18 (45)	20 (46.5)	29 (72.5)	32 (74.4)
Mild (1)	14 (35)	15 (34.9)	21 (52.5)	22 (51.2)	19 (47.5)	19 (44.2)	11 (27.5)	11 (25.6)
Moderate (2)	19 (47.5)	19 (44.2)	10 (25)	14 (32.5)	2 (5)	4 (9.3)	-	-
Severe (3)	2 (5)	2 (4.7)	-	-	1 (2.5)	-	-	-
Mean±SD	1.45±0.78	1.37±0.81	1.03±0.7	1.16±0.69	0.65±0.7	0.67±0.68	0.28±0.45	0.26±0.44
<i>P</i>	>0.05		>0.05		>0.05		>0.05	

Table 2.
PAI in Groups 1 and 2

Groups	Group 1					Group 2				
	1	2	3	4	5	1	2	3	4	5
PAI score										
Right after filling	39	1	-	-	-	41	2	-	-	-
After 6 months	29	11	-	-	-	34	9	-	-	-
After 1 year	20	20	-	-	-	23	20	-	-	-
After 2 years	10	28	2	-	-	12	30	1	-	-

Table 3.
Descriptive analysis for PAI in Groups 1 and 2

Interval	Groups	Min	Max	Mean	SD	<i>P</i>
Right after filling	Group 1	1	2	1.03	0.15	>0.05
	Group 2	1	2	1.05	0.21	
After 6 months	Group 1	1	2	1.28	0.45	>0.05
	Group 2	1	2	1.2	0.41	
After 1 year	Group 1	1	2	1.5	0.5	>0.05
	Group 2	1	2	1.46	0.5	
After 2 years	Group 1	1	3	1.88	0.52	>0.05
	Group 2	1	3	1.74	0.49	

One of the earliest attempts to use diathermy for pulpal disinfection was made by Ferranty in order to bring back a single-visit treatment modality into endodontic practice. However, he mainly emphasized proper shaping and cleaning of canals to achieve better therapeutic results.⁽⁴³⁾

In the present pilot study, it was hypothesized that applying a high frequency diathermy irradiation in addition to cauterizing a pulp wound may serve as an additional thermosterapeutic effect against root canal pathogens in treatment of teeth with partial pulp necrosis.

Thus, the results of cultural growth demonstrated that a conventional antimicrobial therapy was effective in 85% of cases. However, after diathermy irradiation, a bactericidal efficacy was detected in approximately 91% of samples. In addition, it was noted that the presence of a low difference between the groups in values of residual microflora was not associated with the outcomes of radiographic examinations.

In conclusion, the occurrence of postoperative pain in Groups 1 and 2 demonstrated a similar reduction in toothache dynamics at all time intervals when assessments were made, and analysis of tooth radiographs in both groups of patients did not reveal a significant difference. As for the evaluation of a cultural growth, the signs of turbidity were detected in 6 samples of Group 1 and in 4 samples of Group 2.

Therefore, the possible antimicrobial efficacy of a high frequency diathermy in treatment of teeth with partial pulp necrosis was demonstrated. However, taking into account the low number of clinical results and a short period of observations, further studies should be made to confirm the results of this clinical trial.

Competing Interests

The authors declare that they have no competing interests.

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