

Influence of Photodynamic Therapy in the Control of Postoperative Pain in Endodontic Treatment: A Cross-Sectional Randomized Clinical Trial

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Abstract

Objective: To evaluate the postoperative pain at different times after endodontic treatment with and without the use of photodynamic therapy (PDT) of asymptomatic teeth with apical periodontitis. **Material and Methods:** In this cross-sectional randomized clinical trial, the treatment was performed in a single visit with and without the use of photodynamic therapy. The sample consisted of 10 patients with two teeth in the same jaw, but on different sides (split-mouth), subjected to the same endodontic treatment with reciprocating instrumentation in the apical foramen instrumentation limit. The teeth from each patient were randomly divided into two groups: G1 (Control): endodontic treatment without photodynamic therapy and G2 (PDT): received methylene blue 0.005% and irradiation with a low-level laser. The fillings were performed with a Touch'n Heat technical device and Ah Plus sealer. The treatments of G1 and G2 in the same patient were performed in an interval of 3 weeks between them and the blinding study was ensured during all long treatment. Postoperative pain was recorded using an adapted VAS scale in times of 6, 12, 24, 36, 48, and 72 hours. **Results:** In both groups, the highest value recorded at the VAS scale was 2 mm (no pain), and there were no statistically significant differences in postoperative pain between the groups at any observation times ($p < 0.05$). **Conclusion:** The photodynamic therapy did not have advantages to control postoperative pain in endodontic treatments of asymptomatic teeth with apical periodontitis, since both groups showed low levels of pain in all patients evaluated.

Keywords: Laser Therapy; Low-Level Light Therapy; Endodontics; Toothache.

Introduction

Postoperative pain after endodontic therapy may be a disturbing situation for the patients and dentists, mainly when preoperative pain is present. Postoperative pain is associated with inflammatory response in the periradicular tissues, generated by irritants egressing from the root canal during its treatment [1].

The outcome of endodontic treatment depends on eradication or maximal reduction of the infection inside the root canal [1]. Some strategies such as the enlargement of the foramen and more concentrated sodium hypochlorite irrigant solutions have been used to improve that disinfection process [2-4]. However, these procedures potentially generate an overinstrumentation and extrusion of irrigants, which can lead to a biological irritation and a non-biological origin [5]. Therefore, when a better disinfection reaches the site, pain could occur [3].

Because of the importance of disinfecting the root canal, a new antimicrobial strategy, photodynamic therapy (PDT), is being suggested as an adjuvant to the endodontic treatment [6,7]. The performance of PDT is achieved by a low-level laser therapy (LLLT) action that has proven therapeutic advantages such as biostimulation, inflammation reduction, bone regeneration, analgesic effect [8-12], and, when associated with a photosensitizer, an antimicrobial activity [6,7]. Several reports have demonstrated an optimal outcome when PDT is used for root canal disinfection, giving support to the conventional procedures in endodontic treatment [6,7,12-15].

Knowing that PDT is available as an adjunct to improve the disinfection of the root canal and supported by LLLT properties such as inflammation reduction and analgesic effect, the aim of this paper is to investigate whether the use of PDT can control postoperative pain in patients who undergo treatments in a single visit with teeth diagnosed with asymptomatic necrosis with apical periodontitis.

Material and Methods

Twenty teeth from 10 volunteers requiring endodontic therapy were included in this study. The preconditions to refer patients to this survey were that each patient should present two asymptomatic uniradicular teeth with radiographic signs of apical periodontitis on the same jaw (upper or lower) but on different sides (left or right); such conditions were determined to be a split-mouth study. The selected volunteers were four males and six females, aged 21 to 77 years, and ASA I (American Society of Anesthesiologist).

The 2 teeth of each patient were divided into two groups by raffle, G1 (without PDT) and G2 (with PDT). During the treatment, the patients wore dark glasses to protect their eyes against the laser light (G2) and for them not to notice when the laser machine was used in the turned-off mode (G1). Such conditions ensured a blind study. The endodontic treatments in both groups were performed in a single visit with the same endodontist. A private and unique dental office was used for all the procedures. All patients were scheduled in a morning session with an interval of three weeks between G1 and G2 treatments.

Endodontic Treatment Protocol

A periapical X-ray of each tooth was acquired to confirm the presence of a periapical lesion, the canal anatomy, and its length. Local anesthesia was achieved by local infiltration with 1.8 mL of mepivacaine 2% with adrenaline 1:100.000 (DFL Ind. Com. S.A., Rio de Janeiro, RJ, Brazil). After anesthesia, the tooth was isolated with a rubber dam and accessed in the sequence. A standard treatment protocol of shaping, cleaning, and obturation was followed as described below.

After the pre-flaring, the working length was obtained with a Root ZX II apex locator (J Morita Corp., Osaka, Japan), and the apical limit of instrumentation was established at the apical foramen. A mechanical preparation was performed with the Reciproc System. Apical enlargement was finished using R40 or R50 files (VDW GmbH, Munich, Germany). Irrigation was accomplished with 5.25% sodium hypochlorite solution after each file was used and, before the filling, a passive ultrasonic irrigation (PUI) was performed with ultrasonic (Piezon Master 100, EMS, Switzerland) and irrigator tip (Helse Dental Technology, Santa Rosa de Viterbo, SP Brazil). The root canals were filled with gutta-percha cones and AH Plus sealer (Dentsply DeTrey GmbH, Konstanz, Germany) using a warm vertical compaction technique (Touch 'n Heat™ 5004, SybronEndo Corp., Orange, CA, USA).

The same standard protocol was applied in G1 and G2, differing only in case for G2, where PDT was used before the obturation phase. Previous to the execution of PDT, each root canal received 5 ml of 3% H₂O₂, and it was aspirated with capillary tips (Ultradent Products Inc., South Jordan, UT, USA). After that phase, the photosensitizer Chimiolux 5 (DMC Imp. e Exp. Equipamentos Ltda., São Carlos, SP, Brazil) was applied inside the root canal with an endodontic needle apically to coronally and left to react for 2 minutes. The illumination was performed with a disposable 0.4-mm diameter fiber-coupled, handheld, battery-operated diode laser (Laser Duo, MMOptics Ltda., São Paulo, SP, Brazil). The laser delivered 660 nm light at a total power of 100 mW/cm² out of the fiber. The root canal was irradiated for 180 seconds at 18 J. During irradiation, the fiber was placed within the root canal at its total length, and spiral movements from apical to cervical were applied. In the sequence, the root canals were irrigated with saline solution, dried with sterile absorbent paper points, and filled in the same session as described in G1. The pulp chambers were cleaned, a restorative glass ionomer cement base was prepared, and the access cavities were restored with it. The laser source was applied in both groups; however, in G1, it was used with the power off.

Assessment of Postoperative Pain After Endodontic Treatment

An adapted visual analogue scale (VAS), according to previous study [16], was used to evaluate the postoperative pain (no pain: 0 to 4 mm; mild pain: 5 to 44 mm; moderate pain: 45 to 74 mm; severe pain: 75 to 100 mm). After the appointment, each patient was instructed to mark on the VAS the level of discomfort in intervals of 6, 12, 24, 36, 48, and 72 hours. In cases when the use of analgesic was necessary, the patient was oriented to mark the time and the amount that was taken.

Data Analysis

The comparison among level of pain, total time required for endodontic treatment, and anesthetic time effect were evaluated by the Mann-Whitney test ($p < 0.05$) since the samples did not pass the Shapiro-Wilk normality test ($p < 0.05$). Statistical analysis was performed using the SigmaPlot Software, version 12.5 (Systat Software, Inc., San Jose, CA, USA) considering a level of significance of 5%.

Ethical Aspects

Informed written consent was obtained from each patient before the treatment, and a certification of the research was conform to the Helsinki Declaration of 1975 and granted by the Ethics Committee of the Federal University of Mato Grosso do Sul (CAAE 30377814 6 0000 0021).

Results

A total of 10 volunteers who were scheduled for endodontic treatment were enrolled in this study. There were no statistically significant differences in postoperative pain between the groups at any observation period ($p > 0.05$) (Table 1).

Table 1. Results of the level of postoperative pain in G1 and G2.

Variable (Time Point)	G1	G2	p-value*
	Level of Pain (mm)	Level of Pain (mm)	
6 Hours	1.90 ± 0.53	1.50 ± 0.38	0.893
12 Hours	2.00 ± 0.49	1.80 ± 0.50	0.894
24 Hours	1.60 ± 0.28	1.10 ± 0.26	0.413
36 Hours	1.70 ± 0.25	1.65 ± 0.72	0.253
48 Hours	1.60 ± 0.21	1.60 ± 0.58	0.504
72 Hours	1.60 ± 0.22	1.50 ± 0.51	0.501

G1: Conventional Endodontic Treatment; G2: Endodontic Treatment Associated with the Application of Photodynamic Therapy; *Mann-Whitney test. The results are presented as mean ± standard error of the mean.

No significant differences were observed in the time required to complete the endodontic treatments ($p = 0.361$) or in the duration of anesthetic effect ($p = 1.000$) (Table 2).

Table 2. Results of the time required to complete the endodontic treatments and the duration of anesthetic effect.

Variables	G1	G2	p-value
	Level of Pain (mm)	Level of Pain (mm)	
Time Required (Minutes)	39.30 ± 2.13	43.00 ± 2.18	0.361
Anesthesia Effect (Minutes)	179.50 ± 18.53	195.56 ± 33.58	1.000

In the VAS scale, the highest value marked was 2 mm in intervals of 6, 12, and 24 hours in both groups. The value means “no pain” according to the VAS scale. No patient in this study showed mild, moderate, or severe pain at any time point, and no patient had to take any analgesic after the treatment.

Discussion

The study was performed *in vivo* because there are considerably fewer *in vivo* investigations since reappearance of the PDT as a modality of treatment in endodontics [17]. Besides that, the majority of investigations are about the effects of PDT in terms of bacterial load reduction. Thus, the use of PDT to control the postoperative pain in patients who undergo treatments in a single visit with teeth diagnosed with asymptomatic necrosis with apical periodontitis is recommended because it is unpublished. Factors such as the split-mouth study design, the patients (young and elderly individuals of both genders) presenting good general health, associated with the criteria of inclusion/exclusion of dental elements, the time required to complete the treatment, and the time of the anesthetic effect without significant differences have made the experimental group and the control group similar. Such similarities favor comparisons between the two groups [18].

The chemomechanical preparation of the root canal is a combination of the mechanical effects of instrumentation and irrigation with chemical effects of irrigants to achieve root canal cleaning, shaping, and disinfection [19,20]. However, the complete disinfection of the root canal cannot be achieved because of its complex anatomy [21,22]. Areas untouched by mechanical instrumentation and an ineffective irrigating solution action over such areas do not allow biofilm removal, and the microorganisms can remain in latency, causing failure of the endodontic treatment [22,23].

The PDT has been shown to be an effective approach in reducing bacterial load *in vivo* models when it is added to conventional endodontic therapy [7,13] and recently in endodontic surgery as well [24]. Moreover, when the PDT is applied as an addition to conventional endodontic treatments, the reduction of the number of multidrug-resistant species in root canals has proven to be much more effective [13].

Because the load of bacteria inside the root canal is higher in teeth with apical periodontitis [23], the endodontic treatment protocol applied in the present study was designed to achieve an efficient disinfection of the root canal system. The apical limit was established at the apical foramen by apex locator. The apical enlargement was performed up to five times from the initial apical diameter of the foramen. The irrigation solution delivered was 5.25% sodium hypochlorite, and all root canal treatments were performed in a single-visit.

The steps previously described support the success of the endodontic therapy. However, postoperative pain is frequently associated with them [3,25-30]. Despite the number of visits to conclude the therapy, there was no difference in the outcome between a single-visit and multiple-visit treatments [29,32] however, patients treated in a single visit are more likely to take pain medication [29].

The reduction of postoperative pain by using LLLT in a single-visit endodontic treatment was shown in an investigation in which the laser was applied to both buccal and lingual mucosa at the level of the apices of the first permanent molars after the termination of the endodontic treatment [33]. Because of the capacity of the LLLT to control the pain and the PDT dependence on the laser to be applied, this investigation became valid. In this study, wavelength was applied of range of

600nm to 1100nm, which penetrate further. Those wavelengths are used to treat deeper-seated tissues. In addition, it suggests that the use of single-session intracanal LLLT could be more effective application for reducing postoperative pain.

The results showed that there was no difference regarding postoperative pain. In fact, postoperative pain was absent in both groups. This result may be due to a selection of only asymptomatic cases. Endodontic treatment of teeth without prior pain results in less postoperative pain than do teeth with pain, regardless of the kind and intensity of prior pain [31]. Another explanation for the results presented may have been because of the operator's experience. Operator experience causes unlikely bias in clinical experiments [3].

Because pain evaluation is subjective, there is an important concern about which method is used. The choice of the evaluation method of pain is critical because it must ensure that the patient completely understands it, and the researchers must easily comprehend the data the patients provide. In the present study, an adapted visual analogue scale VAS [16] was used in the feedback form because VAS is a simple and efficient method to evaluate pain and has been routinely used as a reference for many years in the classical investigations about pain [16,27,31,34]. We could observe that the patients easily understood the way to mark the VAS.

Although the present results showed no difference from the use of the PDT for pain control, the addition of PDT to an endodontic therapy seems to be an effective and non-pharmacological approach for endodontic treatment. Beyond that, there is a huge recommendation for new studies using PDT in symptomatic cases, because the use of LLLT on the mucosa apical region of symptomatic endodontically treated teeth was effective in the control of postoperative pain [35]. Furthermore the prevention of pain should be an integral part of dental treatment [36].

Conclusion

The photodynamic therapy did not have advantages to control postoperative pain in endodontic treatments of asymptomatic teeth with apical periodontitis, since both groups showed low levels of pain in all patients evaluated

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