



Is phototherapy effective in the management of post-operative endodontic pain? A systematic review of randomized controlled clinical trials



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ABSTRACT

Background: The aim of the current review was to answer the P.I.C.O.S question: In patients with post endodontic pain (Population), what is the effect of phototherapy (Intervention) as compared to placebo (Comparator) on post endodontic pain (Outcomes) considering only randomized clinical trials-RCT (Study design)?

Methods: The outline of this systematic review followed the PRISMA (Preferred Reporting Items for Systematic Review and Meta-Analysis) guidelines. Main databases [MEDLINE (1952–February 2019), EMBASE (1984–February 2019), Cochrane Central Register of Controlled Trials and Cochrane Oral Health Group Trials Register (1993– February 2019)] were searched. PEP was selected as the main outcome variable. The details of the data from the accepted studies were charted according to the research designs, author/country, demographics, involvement of teeth, phototherapy administration, follow-up duration, main results and PEP outcomes.

Results: A total of 5 RCTs were included. The wavelengths of diode lasers ranged from 808 to 970 nm. Power output was reported in all the studies ranging from 50 milliwatts (mW) to 5000 mW. All the included studies evaluated PEP after root canal therapy, root canal retreatment or surgical endodontics. Out of the five clinical studies, a total of three studies showed comparable PEP outcome between phototherapy and control groups. However, two studies showed statistically significant improvement in PEP in the phototherapy group as compared to the control group.

Conclusion: It remains debatable whether phototherapy reduces PEP after root canal therapy. Further robust RCTs with standard laser parameters are warranted to assess the efficacy of phototherapy in the management of PEP.

1. Introduction

Postoperative pain, also called as flare-up is a very common side effect which greatly effects the patient's quality of life [1,2]. It manifests as pain and/or swelling after a few hours or days requiring an immediate visit to the dental office [3]. It can further be explained by the inflammatory process caused by the chemical, microbial or mechanical trauma to the pulp and the surrounding tissues leading to possible extrusion of contaminants the apical foramen [4,5]. This results in exacerbation of the neuropeptide expression C-type nerve fibers present in the periodontal ligament, resulting in a longer healing time of the region affected [4,5]. Recent studies have presented several strategies for the management of post-endodontic pain (PEP) categorised as pharmacological and non-pharmacological [6]. The former

comprises of prescription of non-steroidal anti-inflammatory drugs (NSAIDs), steroidal anti-inflammatory drugs, acetaminophen, anti-histamines, narcotic analgesics, long lasting anaesthesia and intracanal medication [7–9]. Non-pharmacological strategies involve anxiety reduction protocol, intracanal laser therapy [10], and cryotherapy [11].

In contrast to photodynamic therapy, which involves the use of photosensitizing agents, phototherapy consists of exposure to specific wavelengths of light using lasers, light-emitting diodes or polychromatic polarised light [12]. In recent years, phototherapy has become a successful treatment option in the management of several oral disorders in dentistry [13–18]. Moreover, phototherapy is used to reduce pain, to enhance the process of wound healing via vasodilation and to have an efficacy on the inflammatory parameters [19]. On a cellular level, phototherapy results in the alteration of cellular functions, like

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adenosine triphosphate (ATP) production, synthesis of proteins and prostaglandins, release of neurotransmitters, growth and differentiation of cells, phagocytosis [20].

Recent studies reported the use of phototherapy in the management of PEP. These studies have reported advantageous effects in relation with PEP. Lopes et al. [4] in their recent randomized controlled clinical trials (RCTs) reported significant reduction in the PEP scores after the administration of phototherapy. On the contrary, Asnaashari et al. [1] reported comparable results in both the control and phototherapy groups at follow-up. There seems to be an inconsistency with regards to the role of phototherapy in the management of PEP after root canal therapy. Therefore, a systematic review is deemed necessary to evaluate the clinical efficacy of phototherapy compared with placebo in PEP. Therefore, the aim of the current review was to answer the P.I.C.O.S question: In patients with post-operative endodontic pain (Population), what is the effect of phototherapy (Intervention) as compared to placebo (Comparator) on post-operative endodontic pain (Outcomes) considering only RCTs (Study design)?

2. Materials and methods

2.1. Study protocol

The outline of this systematic review followed the PRISMA (Preferred Reporting Items for Systematic Review and Meta-Analysis) guidelines [21].

2.2. PICOS eligibility criteria

2.2.1. Study design type

Only blinded, placebo-controlled, RCTs or controlled clinical trials (CCTs) were considered. Articles published in other than English language were not incorporated in the current review. Non-randomized clinical trials were also excluded

2.2.2. Participants

Studies consisting of ≥ 10 patients per group which have undergone endodontic treatment like root canal treatment, root canal retreatments and surgical endodontic.

2.2.3. Intervention

Clinical trials comparing the clinical efficacy of phototherapy in any form with active intervention (Fig. 1).

2.2.4. Outcome measures

The only outcome measure which was assessed was pain. In addition, all studies were examined for reports of adverse events by the patients (with the use of phototherapy) at each recall visit. We only included trials that reported any of these outcomes with a minimum follow-up of a single day.

2.3. Database sources and search plan

Searches in both electronic and manual literature were performed in the main databases; MEDLINE (1952–February 2019), EMBASE (1984–February 2019), Cochrane Central Register of Controlled Trials and Cochrane Oral Health Group Trials Register (1993–February 2019) for articles that focused the PICOS question using the following terms: (Phototherapy) AND (endodontic therapy) AND (postoperative pain) AND (retreatment). The author individually performed the screening of the titles and selection process for eligible articles. If data pertinent to the inclusion criteria was not found in the abstract, or if the abstract was missing, the article was chosen for full-text reading. Subsequently, full-text articles that satisfied the inclusion criteria were recognized and included in the systematic review. Reference lists from original studies were manually hand searched to identify papers that may have missed

during the electronic data search. Manual hand searching of the following peer-reviewed journals was performed: *Journal of Endodontic, Clinical Oral Investigations, Endodontics & Dental Traumatology, and Lasers in Medical Science*. Published studies that satisfied the inclusion criteria were handled for data abstraction. Reviewer planned and assessed the project in a way that the design of the proposal goes in accordance with the PRISMA guideline [21].

2.4. Data items and abstractions

The details of the data from the accepted studies were charted according to the research designs, author/country, demographics, involvement of teeth, phototherapy administration, follow-up duration, main results and PEP outcomes. Data gathered were constructed on the focused PICOS question summarized for the current review.

3. Results

3.1. Search results

A total of 30 study titles and abstracts were initially identified. After removal of the duplicates ($n = 0$), initial screening of titles and abstracts was performed, and 22 articles were excluded as irrelevant to the PICO question. A total of 8 papers were selected for full-text reading. Of these 8 articles, 3 studies were further excluded. After the final stage of selection, 5 studies [1,4,6,22,23] were included and processed for data extraction. All studies were performed at health care centres and university hospitals.

3.2. General description of included studies

All clinical studies were RCTs, out of which one study was a triple blind placebo-controlled [6] and one double blind [22]. Two studies were performed in Turkey [6,23], while remaining each were performed in Brazil [4], Iran [1] and Germany [22], respectively. A total of 131 individuals were included in the control group with mean age ranging between 25.76 to 39.2 years, while a total of 151 individuals were included in the phototherapy group with mean age ranging between 30.84 to 39.93 years. Among the type of phototherapy used, 2 studies used gallium-aluminium arsenide [22,23] and 1 study used indium gallium aluminium [4], respectively. The follow-up duration ranged from 1 to 7 days in the included studies [1,4,6,22,23]. Information regarding funding sources (Government or university) was reported in 1 study [23] (Table 1). None of the study participants in the included studies experienced any side effects related to phototherapy treatment.

3.3. Phototherapy parameters of the included studies

All of the studies utilized phototherapy without the use of photosensitizing agents (photodynamic therapy). Out of all the studies included, two studies reported the use of gallium-aluminium arsenide [22,23], while 1 study [4] used indium gallium aluminium. The wavelengths of diode lasers ranged from 808 to 970 nm. Energy fluence was reported in 3 studies [1,4,23]. Power output was reported in all the studies ranging from 50 milliwatts (mW) to 5000 mW. One study [6] reported power density. The duration of irradiation was reported in all the studied ranging from 25 to 300 s [1,4,6,22,23]. Only 3 studies reported optic fibre diameter as 0.6 [1], 0.2 [6] and 0.6 [22] mm respectively. None of the included studies reported pre-irradiation time and number of laser sessions (Table 2).

3.4. Main outcomes of the studies

All the included studies evaluated post endodontic pain after root canal therapy, root canal retreatment or endodontic surgery

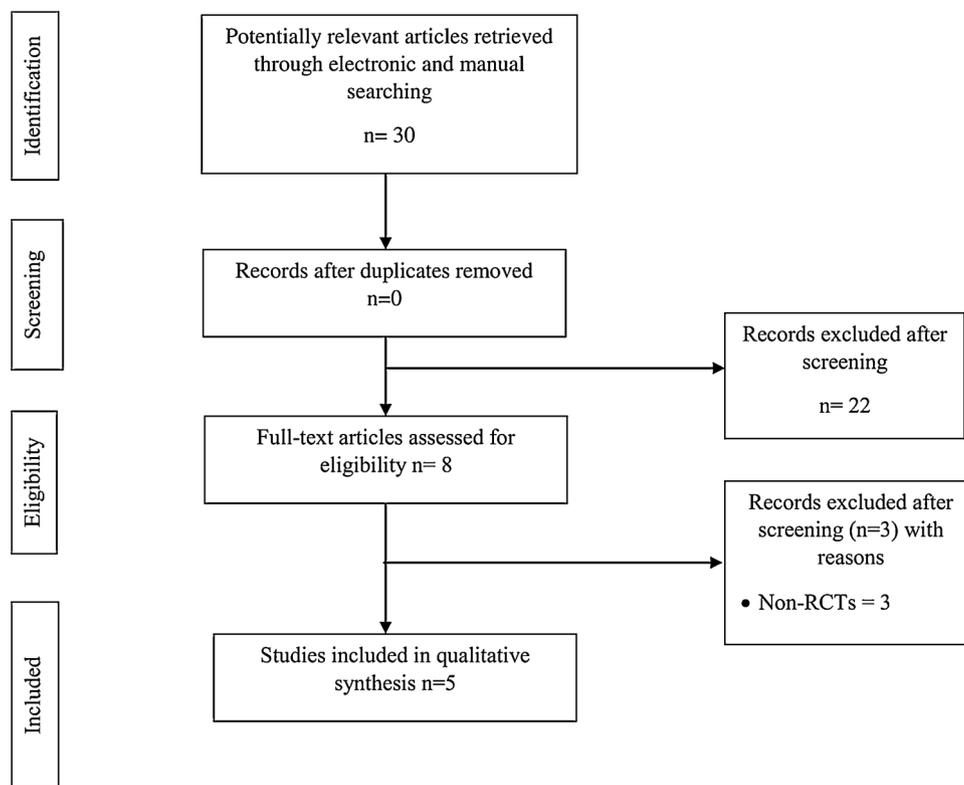


Fig. 1. RISMA flow diagram for studies retrieved through the searching and selection process.

[1,4,6,22,23]. Out of the five clinical studies, a total of three studies showed comparable post endodontic pain outcome between phototherapy and control groups [1,6,23]. However, two studies showed statistically significant improvement in post endodontic pain in the phototherapy group as compared to the control group [4,22] (Table 1).

4. Discussion

To the authors' knowledge, this is the first systematic review to evaluate whether phototherapy is efficacious in lessening PEP after root canal therapy. The present study was based on the hypothesis if phototherapy significantly reduces PEP as compared to no phototherapy. Only two studies [4,22] out of 5 clinical trials showed statistically significant improvement in PEP in the test group as compared to the control group (Table 3).

Phototherapy affects both local microcirculation and cellular metabolism and exerts regenerative effects [24,25]. Phototherapy increases the amount of prostaglandins, such as prostaglandin I₂ that exhibits anti-inflammatory effects, immunoglobulins and lymphokines that play a role in the immune system, and beta-endorphins that are involved in analgesia [26]. Phototherapy inhibits the synthesis of inflammatory factors and pain-related neurotransmitters [27]. Furthermore, phototherapy increases the removal of pain-inducing substances, including substance P, histamine, and dopamine, and inhibits cyclooxygenase-2 [28,29]. Moreover, phototherapy doubles lymphatic drainage [26]. Phototherapy can also affect the permeability of the cell membrane to calcium, sodium, and potassium ions. This permeability change causes the degradation of bradykinin [30], induces the production of endorphins by increasing the activity of cellular receptors [31], decreases the activity of C fibers, and increases the action potential of neurons [30]. All of these biological activities could explain the favorable results presented in this study.

It is note-worthy that the included studies had either significant heterogeneity or there was a lack of data pertinent to laser parameters [1,4,6,22,23]. Parameters such as energy fluence, power density, power

output and exposure time of laser light, either varied considerably or were not available in some studies. Other factors such as fibre diameter also has an overall effect on power density and energy output during laser application and can modify the actual amount of energy released during the process, potentially affecting the proliferation of cells and hence anti-inflammatory efficacy of phototherapy [32]. Therefore, further well-designed studies with accurate laser parameters are required in order to clearly understand the efficacy of phototherapy in the management of PEP.

The literature shows conflicting results with regard to the effect of age on postoperative pain. Although some studies concluded that age affects postoperative pain [29,33], some studies concluded that it does not have a significant effect [34,35]. However, the mean age of the patients in the present study ranged from 25 and 40 years. This wide age difference could have a clinical significance and may explain the potential differences in the pain outcomes. Furthermore, According to Williamson and Hoggart [36], patients prefer the VRS because it is simple, but it is the least sensitive of the scales. On the other hand, the NRS is more efficient, relatively easy to interpret and has greater statistical sensitivity. In this systematic review, both scales presented similar statistical values. These pain scales may have chosen due to their efficiency and ease of evaluation through telephone calls, thus avoiding the need for a second session.

Ostrom et al. [37] found in their clinical study that women are more sensitive to pain than men, which was measured as follows: pressure, mechanical, and thermal pain sensitivity. However, Wiesenfeld-Hallin [38] attributes the difference in sensitivity between men and women to the inherent biological mechanisms and further adds that sex hormones influence pain threshold and tolerance. This variation in the literature can be explained because women present a higher prevalence of pain than men [39]. However, this conclusion may be mis-leading since it depends on pain stimulus. In brief and acute stimuli, women tend to feel more pain than men, but it was found that women report better pain adaptation to prolonged painful stimuli [40].

There are certainly some limitations in the present systematic

Table 1
General characteristics of the included studies in reverse chronological order.

Author et al., Year, Journal name	Study Design	Country of study	Sample demographics n; Mean age (Age range); M/F	Teeth involved	Follow up (days)	Main outcomes	Funding source
Metin et al. [2018; <i>Lasers in Medical Science</i> [23]	RCT;	Turkey	Laser 38; NA; NA Control 38; NA; NA	Maxillary incisors with persistent apical periodontitis and/or periapical diameter ≤ 10 mm	Up to 7	Comparable results in the pain scales between the laser and control groups were observed	University funded
Lopes et al. 2018; <i>Clinical Oral Investigations</i> [4]	RCT	Brazil	Laser 30; 30.84 \pm 8.14; 15/15 Control 30; 28.1 \pm 8.51; 8/22	Mandibular molars (except third molars) with little or no pain	1 (24 h)	Significant results in the pain scales between the experimental and control groups were observed	Not funded
Arslan et al. 2017; <i>CONSORT Randomized Clinical Trial</i> [6]	Triple blind RCT - placebo controlled	Turkey	Placebo 17; 25.76 \pm 8.14; Laser 16; 32.62 \pm 9.27; 8/8	Mandibular molars requiring RCR with pain VAS < 50 and a percussion pain VAS < 50	Up to 7	Comparable results in the pain scales between the placebo and laser groups were observed	Not mentioned
Asnaashari et al. 2017; <i>Journal of Lasers in Medical Science</i> [1]	RCT	Iran	Laser 41; NA; NA Control 20; NA; NA	Mandibular molars requiring FCR	Up to 2	Comparable statistical changes in the pain scales between the control and test group were observed	Not funded
Kriesler et al; 2004; <i>International Journal of Oral and Maxillofacial Surgery</i> [22]	Double-blinded RCT	Germany	Laser 26; 39.93 \pm 14.7; 10/16 Control 26; 39.2 \pm 16.0; 11/15	Teeth requiring endodontic surgery	Up to 7	Significant statistical changes in the pain scales between the laser and control group were seen	Not mentioned

RCT – randomized controlled trial, GaAlAs - gallium-aluminum-arsenide diode laser, RCR – Root canal retreatment, VAS – visual analog scale.

Table 2
Laser parameters of included studies.

Investigators	Type of laser	Wavelength (nm)	Energy fluence ($J\ cm^{-2}$)	Power output (mW)	Power density ($mW\ cm^{-2}$)	Duration of irradiation (seconds)	Optic fibre diameter (mm)	Number of laser sessions
Metin et al [23]	GaAlAs	810	3.87	129	NA	300	NA	NA
Lopes et al. [4]	Indium-gallium aluminium	808	360	100	NA	25	NA	NA
Arslan et al. [6]	Diode	970	NA	5000	2.86	30	0.2	NA
Asnaashari et al. [1]	NA	808	70	100	NA	80	0.6	NA
Kriesler et al. [22]	GaAlAs	809	NA	50	NA	150	0.6	NA

GaAlAs; gallium-aluminum-arsenide diode laser, NA; not available, LED; light emitting diode, nm; nanometers, $J\ cm^{-2}$; joules per square centimeters, mW; milliwatts, $mW\ cm^{-2}$; milliwatts per square centimeters, mg/ml; milligram per milliliter.

Table 3
Clinical endodontic parameters of the included studies.

Author et. al	Pain
Metin et. al [23]	Phototherapy ^a Baseline: 2.03 ± 0.39 Follow-up: 1.15 ± 0.36 Control ^b Baseline: 2.46 ± 0.56 Follow-up: 1.57 ± 0.50
Lopes et al. [4]	Phototherapy ^c Baseline: 0.53 ± 0.86 Follow-up: 0.10 ± 0.40 Control ^b Baseline: 0.77 ± 0.82 Follow-up: 0.40 ± 0.62 Phototherapy ^c Baseline: 1.43 ± 2.60 Follow-up: 0.27 ± 1.05 Control ^c Baseline: 1.87 ± 2.64 Follow-up: 1.00 ± 2.08
Arslan et al. [6]	Phototherapy ^a Baseline: 17.94 ± 15.91 Follow-up: 0.56 ± 1.54 Placebo ^a Baseline: 32.59 ± 20.85 Follow-up: 5.29 ± 12.43
Asnaashari et al. [1]	NR
Kreisler et al. [22]	NR

NR – not reported.

^a VAS pain scores (VAS – visual analog scale).

^b VRS pain scores (VRS – verbal rating scale).

^c NRS pain scores (NRS – numerical rate scale).

review. Firstly, as there were less number of clinical studies included in the review, the scientific evidence is presented as weak. Secondly, no meta-analysis could be performed in the present systematic review and the results are solely presented as narrative outcomes. Quantitative outcomes with total overall effect of phototherapy may have reported different outcomes. Although the present systematic review suggests that phototherapy could be an important therapeutic modality in reducing PEP in patients who have undergone root canal therapy, more number of RCTs are warranted to confirm these findings. Such RCTs should be of high methodological quality, designed and conducted following Consolidation Standards of Reporting Trials (CONSORT) Statement. They should include important concerns such as standardized laser parameters, valid pain scales and efficacy of phototherapy on different severity levels of pain. However, because significant prognostic factors remain to be analyzed and further high-quality studies are warranted, it is arduous to give recommendations of phototherapy for clinicians.

5. Conclusion

It remains debatable whether phototherapy reduces post-operative endodontic pain after root canal therapy. Further robust RCTs with standard laser parameters are warranted to assess the efficacy of phototherapy in the management of post endodontic pain.

Conflict of interest statement

None.

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