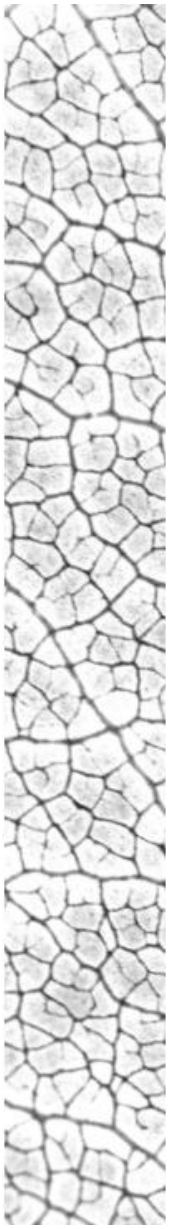

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Evaluate the efficacy of laser therapy in root canal disinfection with different irrigants protocols: a systematic review and meta-analysis

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Abstract

Background and aim: laser treatment protocols are challenging and the most effective method with desirable and excellent results is controversial, so the present study aims to evaluate the efficacy of laser therapy in root canal disinfection with different irrigants protocols.
Method: From the electronic databases, PubMed, Cochrane Library, Embase, ISI have been used to perform a systematic literature between 2010 and 2020. Therefore, a software program (Endnote X8) has been utilized for managing the electronic titles. Searches were performed with mesh terms.
Result: A total of 26 potentially relevant titles and abstracts were found during the electronic and manual search. Finally, a total of five publications fulfilled the inclusion criteria required for this systematic review. Mean difference of photodynamic therapy and control group was (MD, -3.29 95% CI -3.80, -2.79. P= 0.00) among five studies
Conclusion: The results show that the use of antimicrobial photodynamic therapy can be considered as an alternative to conventional treatment.

Keywords: antimicrobial photodynamic therapy, laser therapy, root canal disinfection

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INTRODUCTION

The development of pulpal and periapical pathology can be attributed to Microorganisms. The success of the treatment is observed when the Microorganisms are completed eliminated from the root canal system (Trindade, et al. 2015, Qi, et al. 2019). To be successful in treatment, cleaning and instrumentation processes are essential. Standard methods include the use of antibacterial constituents between treatment and obturation sessions, which disinfect the root canal. However, complete removal of Microorganisms from the root canal system appears to be significant and challenging (Lee, et al. 2017). Primary root canal infections are usually associated with biofilm and Gram-negative anaerobic bacteria (G-), and secondary root canal infections are usually associated with one or more bacterial species, especially Gram-positive bacteria (G +). Persistent root canal infections include Enterococcus faecalis (E. Faecalis) (Tabassum, & Khan, 2016, Siqueira Jr, 2001). Also Candida species may also be observed. Studies show that conventional root canal treatments are not suitable for creating a complete disinfection environment, high-power lasers can be used to achieve a good result to obtain approximately 99% bacterial eradication (Moritz, et al. 1997. Bordea, et al. 2020. Shehab, Al-Sabawi, & Alkhalidi, 2020). However, one of the limitations of using this method is its high temperature, which cause dental tissues damage. Therefore, low-power lasers are used in which the minimum temperature increase is approximately 0.5 ° C and does not cause morphological changes in the structure of dental tissues. But it may lead to photochemical events. Given that laser treatment protocols are challenging and the most effective method with desirable and excellent results is controversial, so the present study aims to evaluate the efficacy of laser

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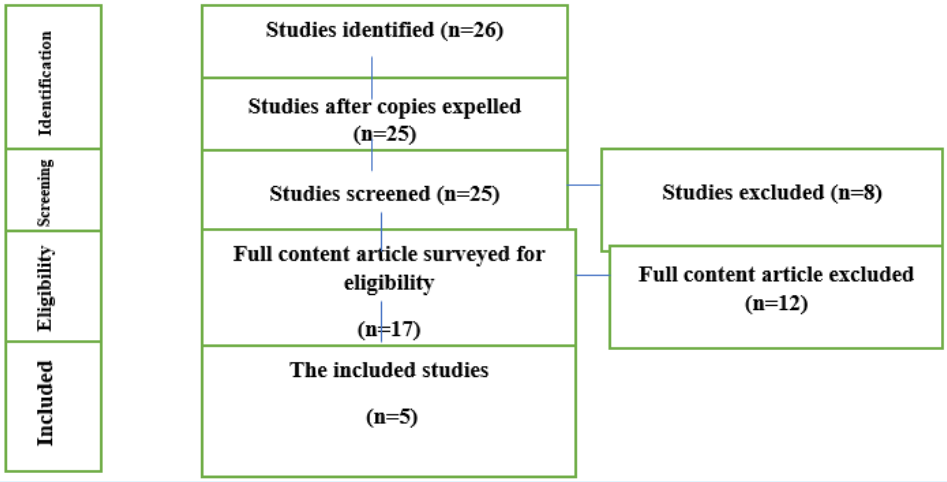

Fig. 1. Study Attrition

therapy in root canal disinfection with different irrigants protocols.

METHOD

Search strategy

From the electronic databases, PubMed, Cochrane Library, Embase, ISI have been used to perform a systematic literature between 2010 and 2020. Therefore, a software program (Endnote X8) has been utilized for managing the electronic titles. Searches were performed with mesh terms:

("Photochemotherapy/adverse effects"[Mesh] OR "Photochemotherapy/methods"[Mesh] OR "Photochemotherapy/standards"[Mesh]) OR "Photopheresis"[Mesh]) OR ("Laser Therapy/adverse effects"[Mesh] OR "Laser Therapy/methods"[Mesh] OR "Laser Therapy/standards"[Mesh])) AND ("Dental Implantation, Endosseous, Endodontic"[Mesh] OR "Root Canal Obturation"[Mesh] OR "Dental Pulp Diseases"[Mesh]) AND ("Dental Pulp Cavity"[Mesh] OR "Root Canal Preparation"[Mesh] OR "Root Canal Therapy"[Mesh])) AND "Microorganisms, Genetically-Modified"[Mesh]. This systematic review has been conducted on the basis of the key consideration of the PRISMA Statement–Preferred Reporting Items for the Systematic Review and Meta-analysis (Moher, et al. 2009).

Selection criteria

Inclusion criteria

1. Only in-vitro studies
2. Human
3. Effect of antimicrobial photodynamic therapy of various wavelengths on the growth and formation of various G + biofilms

Effect of antimicrobial photodynamic therapy of various wavelengths on the growth and formation of various G - biofilms

4. Laser treatment
6. in English

Exclusion criteria

1. Animal studies
2. Other branches of dentistry (implantology, periodontics, or surgery)
3. Studies that did not report the mean of CFU

Data Extraction and method of analysis

The data have been extracted from the research included with regard to the study, years, Sample size, microorganism, laser parameter, chromophore, concentration, incubration time. For Data extraction, two reviewers blind and independently extracted data from abstract and full text of studies that included. Moreover, mean differences between two groups (photodynamic therapy and control) with 95% confidence interval (CI), fixed effect model and Inverse-variance method were calculated. Random effects were used to deal with potential heterogeneity and I^2 showed heterogeneity. The Meta analysis and forest plots have been evaluated with the use of a software program available in the market (i.e., Comprehensive Meta-Analysis Stata V16).

RESULTS

According to the research design, 26 potentially important research abstracts and titles have been discovered in our electronic searches. At the first phase of the study selection, 8 research have been with regard to the topics and abstracts. Therefore, we fully assessed the complete full-text papers of the rest 17 studies in the second stage so that we excluded 12 publications due to the lack of the defined inclusion criteria. Then, five papers remained in agreement with our inclusion criteria required (**Fig. 1**). **Table 1** reports the individual studies in this meta-analysis.

Five in-vitro human studies of this systematic review and meta-analysis conducted with 406 human teeth, The canals of these teeth were instrumented and sterilised prior to bacterial inoculation, which noted in all

Table 1. Studies selected for systematic review and meta-analysis

Study. Year	Sample size	Microorganism	laser					Chromophore	Concentration (mg/mL)	incubration time (min)
			type	Wavelength (nm)	Power output (mW)	Spot size (µm)	Exposure time (Seconds)			
Camacho-Alonso et al. 2017	102	E. faecalis	DL	660	100	-	60	MB	0.1	3
Prażmo et al. 2017	46	E. faecalis	DL	635	120	-	120	TBO	13-15	2
Susila et al. 2016	80	S. mutans E. faecalis	DL	635	100	200	30	MB	25	5
Pinheiro et al. 2016	18	E. faecalis	DL	660	100	600	40	MB	-	3
Tennert et al. 2014	160	E. faecalis	DL	635	100	-	120	TBO	13-15	1

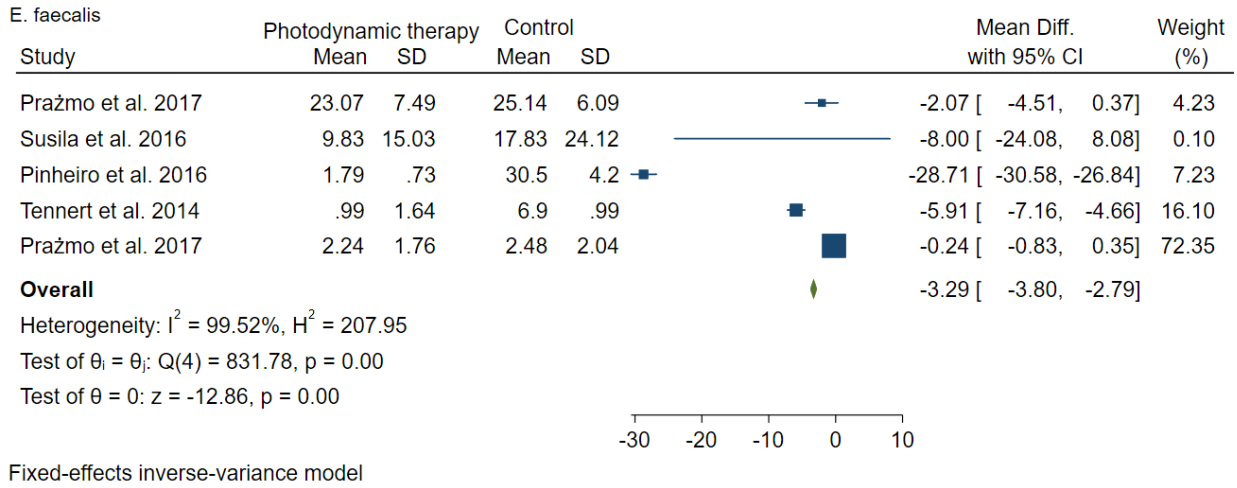

Fig. 2. Forest plots showed photodynamic therapy showed the greatest reduction of endodontic infection by E. faecalis compared to conventional treatment

studies, with the exception of two (Susila,et al. 2016), (Pinheiro, et al. 2016).

The lasers that utilized in these studies were Diode laser at wavelengths ranged 660-635 nm. The diameters of the optical fibers used for transmitting the light source in one study (Susila,et al. 2016) 200 µm and one study (Pinheiro, et al. 2016) 600 µm, other studies don't reported this parameter. In these studies, the power output ranged between 100-120 mW. The Exposure time range was between 30-12 seconds.

The most utilized chromophores for photodynamic therapy in dentistry are methylene blue and toluidine blue, with duration of application between 1-5 minutes. All studies evaluated, the effect of the association between conventional treatment and antimicrobial photodynamic therapy as a method of treatment in secondary/persistent endodontic infections.

Camacho-Alonso et al. 2017 (Camacho-Alonso, et al. 2017), evaluate the antibacterial efficacy of photodynamic therapy (PDT) and chitosan against Enterococcus faecalis and assess the possible enhancive effect of chitosan on the photosensitizer methylene blue in experimentally infected root canals of extracted human teeth in vitro and Prażmo et al. 2017 (Prażmo, Godlewska, & Mielczarek, 2017), investigate the effectiveness of photodynamic therapy in the elimination of intracanal Enterococcus faecalis biofilm. Susila et al. 2016 (Susila,et al. 2016), combined effects of photodynamic therapy and irrigants in eradicating common endodontic pathogens. Pinheiro et al. 2016 (Pinheiro, et al. 2016), evaluate the antimicrobial activity against Enterococcus faecalis of photodynamic therapy applied before and after reciprocating instrumentation of permanent molars. Tennert et al. 2014 (Tennert, et al. 2014), determine the antibacterial effect of photodynamic therapy on Enterococcus faecalis biofilms in experimentally infected human root canals in primary infections and endodontic retreatments. All studies that select in present systematic review and meta-analysis showed positive effects of antimicrobial photodynamic therapy on E. faecalis biofilms reduction.

Mean difference of photodynamic therapy and control group was (MD, -3.29 95% CI -3.80, -2.79. P= 0.00) among five studies and heterogeneity found (I^2 = 99.52%; P =0.00). This result showed there was statistically significant difference between photodynamic therapy and conventional treatment (p=0.00) and there was statistically significant difference between studies (p=0.00) (**Fig. 2**). Due to heterogeneity in studies, meta-analysis cannot be relied upon.

DISCUSSION

The use of antimicrobial photodynamic therapy has been considered due to its antimicrobial effects and different wavelengths (hehab, Al-Sabawi, & Alkhalidi, 2020, Mohammadi, et al. 2017). However, some studies

show that antimicrobial photodynamic therapy is less successful than conventional methods (Hoedke, et al. 2018). The concentration and duration of action of NaOCl in the root canal and this can change the results of a study, therefore, depending on these variables, the effectiveness of antimicrobial activity may change (Chiniforush, et al. 2016). Therefore, the results of a study can depend on different parameters, different chromophores, different doses of irradiation, light sources with different wavelengths are used in different power outputs. In this case, consensus on the results and achieving a standard protocol is almost impossible (de Miranda, & Colombo, 2018). During the use of photodynamic therapy, various chromophores are used to obtain antimicrobial effect, such as toluidine blue O and methylene blue (Camacho-Alonso, et al. 2017, Prażmo, Godlewska, & Mielczarek, 2017, Pourhajibagher, et al. 2017, Asnaashari, et al. 2017). Wavelengths of 600 to 660 nm and the use of laser light without chromophore activation can be effective in minimizing root canal bacteria. Chromophores in different concentrations also affect the overall effect of photodynamic antibacterial therapy. In any case, the results of the studies are variable and discrepancies are observed in the data. Methylene blue concentrations have been reported between 15 µg/mL and 0.1 mg/mL, while the concentration of aqueous toluidine varies from 15 µg/mL to 15 mg/mL(Pourhajibagher, et al. 2016. - Tennert, et al. 2015. Marinic, et al. 2015). Even the wavelength was not the same in the selected studies and the output power was between 0.2-5 W. The use of an intracanal fiber can increase the uniformity of light distribution along the root canal, thus improving the disinfection efficiency with light activated disinfection. All these differences, which were observed in different studies, made it difficult for the authors to write the present article, because they could not reach a consensus on the comparison between the laser parameters. Photodynamic therapy has an antimicrobial effect and the synergistic effect of NaOCl and photodynamic therapy presents positive results, the authors took this into account in their reviews. The meta-analysis also showed that there is a significant difference between photodynamic therapy and the conventional treatment, but again it is important to note that this result cannot be invoked because the study methods were not quite similar. For this reason, few studies have been included in meta-analysis. To ensure these results, more studies with the same methodology in the future are required, and the comparison of variables is a challenging that must be considered. It is recommended that for future studies, all the limitations of previous studies and the present study be considered in order to reach a general reference in this field.

CONCLUSION

The results show that the use of antimicrobial photodynamic therapy can be considered as an alternative to conventional treatment. The results of this study can be of great help to other researchers to use better and more efficient methods.

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