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Original Article

Dentistry Section

Effect of Passive Ultrasonic Irrigation and Laser Disinfection in Single Visit Root Canal Therapy on Postoperative Pain

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ABSTRACT

Introduction: Postoperative pain is an unwanted common sensation after endodontic treatment. Postoperative discomfort affects anywhere from 3 to 58% of patients. Complete elimination of bacteria in the form of biofilm from the canals is very difficult. But there is no one unique irrigant that can meet all the requirements of ideal irrigant.

Aim: To compare and evaluate the effect of Passive Ultrasonic Irrigation (PUI) and laser disinfection for postoperative pain and discomfort after a single visit root canal therapy in non vital single rooted teeth.

Materials and Methods: This randomised clinical study was conducted on 44 patients, in the Department of Conservative Dentistry and Endodontics, KM Shah Dental College and Hospital, Vadodara, Gujarat, India, from July 2018 to December 2018. Administration of local anaesthetic agent (1:2,00,000 lignocaine with adrenaline) followed by isolation with rubber dam and access cavity preparation was done. Cleaning and shaping of the teeth were done. The patients were randomised into two groups using a flip coin procedure. In Group A, laser disinfection was done using 810 nm diode laser, 2 W power. In Group B, ultrasonic agitation with 5.25% of sodium hypochlorite (NaOCl) was done. Final irrigation with normal saline was done followed by obturation and postendodontic restoration using composite resin. Postendodontic evaluation was done by the blinded evaluator with help of modified verbal rating scale for 6 hours, 24 hours, 48 hours and 7 days. After evaluation, the data was collected and statistically analysed using Pearson's Chi-square test with 5% level of significance using Statistical Package for the Social Sciences (SPSS) version 20.0.

Results: Among 44 patients, 25 were male and 19 were female. The age of 10 patients was between 40-60 years, age of 28 patients was 30-40 years, while age of remaining 6 patients was between 18-29 years. The results showed no statistically significant difference in the postoperative pain and discomfort of PUI and laser disinfection when used for disinfection in a single visit root canal therapy (p-value= 0.086).

Conclusion: Both PUI and laser disinfection are equally effective in reducing postoperative pain and discomfort after single visit root canal treatment. In the initial hours, laser disinfection has slightly higher edge over PUI.

Keywords: Necrosed teeth, Photodynamic therapy, Sodium hypochlorite

INTRODUCTION

Postoperative pain is an unwanted common sensation after endodontic treatment. The incidence of postoperative discomfort ranges from 3% to 58%. Factors affecting pain after root canal treatment may be mechanical, chemical and/or microbial injury to the pulp or peri-radicular tissues [1]. Complete elimination of bacterial biofilm from the canals is very difficult because of many reasons [2]. None of the commercially available irrigant meet all the requirements of ideal irrigant [3]. In this case, other disinfecting devices are useful in reducing/elimination bacterial biofilm. Passive Ultrasonic Irrigation (PUI) was first described by Weller RN et al., in 1980. The 'non cutting' action of the ultrasonically actuated file was referred to as 'passive.' Passive ultrasonic irrigation works by sending acoustic energy into the root canal from an oscillating file or smooth wire to an irrigant. Ultrasonic waves carry the energy, which can cause irrigant cavitation and acoustic streaming [4,5].

Low intensity lasers are recommended to eradicate the bacterial biofilms from accessible and non accessible areas of canal and lateral canals. The invention of a fiber delivery system has made this possible [6]. In 1971 Weichman JA and Johnson FM used laser for the first time in endodontics [7]. It has been demonstrated that laser light emitted straight into the root canal has a bactericidal effect. However, the laser has a limitation in that it can only project light in a straight line. As a result, the photosensitiser is being used with irrigant to their full potential for impact. So, that light can also spread through the lateral canals as well [8]. The antibacterial effect of a laser beam is based on thermal properties of laser tissue interaction [9]. In dentinal disinfection, a high power diode laser has been employed with good results. The diode laser has proven to be a valuable resource [10,11].

Hence, numerous in vitro and ex-vivo studies [12-18] have examined the antimicrobial efficacy and debris removal, but there is scarce literature available for postoperative pain in a single visit endodontic therapy by comparing PUI and laser disinfection during root canal irrigation. So, this present study was designed with the null hypothesis that there was no difference between postoperative pain and discomfort of both during root canal therapy.

MATERIALS AND METHODS

This randomised clinical study was conducted in the Department of Conservative Dentistry and Endodontics, KM Shah Dental College and Hospital, Vadodara, Gujarat, India, for six months from July 2018 to December 2018. Study protocol was approved by the Institutional Ethics Committee (SVIEC/ON/Dent/SRP/18080).

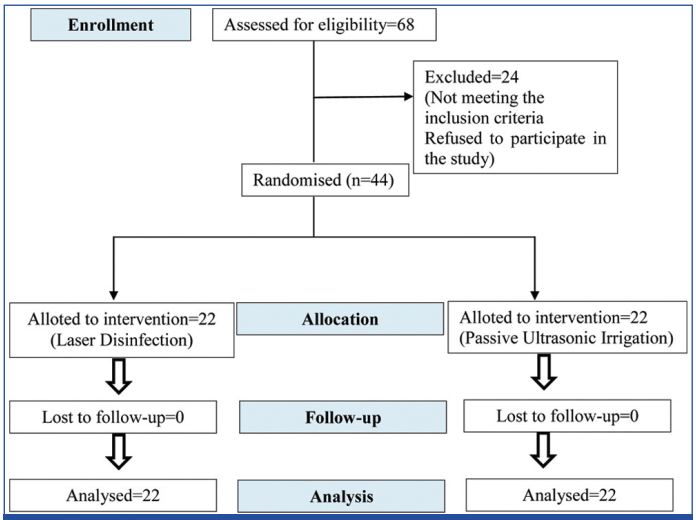
Sample size calculation: Minimum sample size required were 34 (17 per group) with 95% Confidence Interval (CI) and 80% power using this formula:

$$n=2\times(Z_{\alpha/2}+Z_{1-\beta})^2/(M_1-M_{2/\sigma})^2$$

To compensate for the dropout, additional five samples (20%) were included per group, so the final sample size were 22 patients per group. Total 44 patients who required at least one root canal treatment in single rooted non vital teeth were considered for the study..

Inclusion and Exclusion criteria: Patients between 18 to 60 years of age who were having nonvital teeth (i.e., negative test of pulpal sensitivity by electric pulp testing or thermal stimuli prior to anaesthesia) having single canal with fully formed apex (Vertucci's type 1) and ready to sign the consent were included in the study. Patients with non restorable tooth, compromised periodontal health, acute apical abscess, calcified canal and canal with resorption, pregnancy or lactating women, systemic problems like hypertension and diabetes, allergic to antibiotics, corticosteroids or any inflammatory drugs and those who had taken analgesic or anti-inflammatory drugs within the last 12 hours were excluded from study.

The patients enrolled in the clinical study are presented in CONSORT flow chart [Table/Fig-1].



[Table/Fig-1]: CONSORT flow chart.

Study Procedure

For maxillary teeth, local infiltration anaesthesia and for mandibular teeth, inferior alveolar nerve block anaesthesia was given using 1:200000 Lignocaine with adrenaline (nirlife). Rubber dam isolation followed by access cavity preparation was done with help of "Endo access" bur and "Endo Z" bur to design the access cavity. In case of deep proximal caries involvement, firstly the excavation of caries and access opening was done followed by buildup of involved proximal wall with nanohybrid composite (GC Solare X). Working length determination was done with #10 K-file (Mani) with the help of apex locator (Root ZX mini, J Morita) followed by Chemo Mechanical Preparation (CMP) by step back, crown down or hybrid method depending upon canal configuration. During preparation, irrigants like 5.25% sodium hypochlorite, 0.2% chlorhexidine gluconate and 0.9% normal saline was used. Sodium hypochlorite and chlorhexidine were not used in conjugation to avoid reaction [19]. Then the patients were randomly divided into the two groups by flip coin method.

Group A (n=22)-Laser Disinfection (Photoactivated Disinfection): After CMP, methylene blue dye solution (50 µg/mL) was prepared by dissolving dye in 20 mL of saline. Dye used in photoactivated disinfection releases the singlet of oxygen which causes membrane and DNA damage to microorganisms [20]. So, a sterile disposable syringe was used to place the dye in the coronal part of the access cavity. The dye remained in the cavity for five seconds following which, a laser light of 2W/810 nm diode laser (Picasso Lite) was applied in continuous mode with intermittent application for irradiation time of 5-10 seconds followed by 20 seconds break, moving the tip of the laser unit from coronal to apical direction. This process was repeated for 5 times. Then final irrigation was done with sterile normal saline.

Group B (n=22)-Passive Ultrasonic Irrigation (PUI): After CMP, final irrigation with sodium hypochlorite and agitation was done with the help of ultrasonic tip (IrriSafe, SATELEC) attach to the ultrasonic unit (Suprasson P5 booster) with power setting from 4-8 for 2-3 minutes. The agitation was done in continuous mode, with the tip inserted 1 mm from the working length and remaining there throughout the agitation. Then final irrigation was done with sterile normal saline.

Obturation was done using the lateral compaction technique. Postendodontic restoration was done using composite resin (GC Solare X). Postendodontic evaluation was done by the blinded evaluator with help of modified verbal rating scale with telephonic conversation [Table/Fig-2] [21].

Modified verbal rating scale [21]	
0	No pain
1	Slight pain/discomfort
2	Moderate pain relieved by analgesics
3	Moderate to severe pain not completely relieved by analgesics
4	Severe pain/swelling not relieved by analgesics and required unscheduled visit

[Table/Fig-2]: Modified verbal rating scale.

The follow-up considered in the study was 6 hours, 24 hours, 48 hours and 7 days. If patients complain of pain, they were prescribed with ibuprofen 200 mg as over-the-counter drug.

STATISTICAL ANALYSIS

After evaluation, the data was collected and statistically analysed using Pearson's chi-square test with 5% level of significance using Statistical Package for the Social Sciences (SPSS) Software 20.0 (IBM SPSS Inc, Chicago, IL). Statistical analysis was analysed using Independent sample t-test. For all statistical analyses, probability levels of p-value <0.05 will consider statistically significant.

RESULTS

Among the 44 patients treated, 25 were male (56.81%), while 19 were female (43.18%). The age of 10 patients (22.72%) was between 41-60 years, age of 28 patients (63.63%) was 30-40 years, while age of rest 6 patients (13.63%) was between 18-29 years.

In Group A, out of 22 patients, 14 patients had no pain while eight patients had slight pain at 6 hours interval. In Group B, out of 22 patients, 19 patients had no pain while three patients had slight pain at 6 hours interval [Table/Fig-3]. In Initial hours, no statistically significant difference was found in both the groups. The p-value was 0.086 (p>0.05). At 24 hours, 48 hours and 7 days interval, all of the patients had no pain.

Postoperative time	Laser disinfection		Passive ultrasonic irrigation	
	No pain	Slight pain	No pain	Slight pain
6 hours	14	8	19	3
24 hours	22	0	22	0
48 hours	22	0	22	0
1 week	22	0	22	0

[Table/Fig-3]: Number of symptomatic patients in laser disinfection and Passive Ultrasonic Irrigation (PUI).

The statistical analysis of the results of the present study showed no statistically significant difference in the postoperative pain and discomfort of PUI and laser disinfection during a single visit root canal therapy of a non vital single rooted teeth using modified verbal rating scale [Table/Fig-4].

Postoperative time	Group	N	Mean	Std. Deviation	Test of significance (p-value)
6 hours	Group A	22	0.36	0.492	0.086
	Group B	22	0.14	0.351	
24 hours	Group A	22	0	0	NA
	Group B	22	0	0	
48 hours	Group A	22	0	0	NA
	Group B	22	0	0	

1 week	Group A	22	0	0	NA
	Group B	22	0	0	
Difference in pain in 1 week from 6 hours	Group A	22	0.36	0.492	0.086
	Group B	22	0.14	0.351	

[Table/Fig-4]: Comparison between laser disinfection and Passive Ultrasonic Irrigation (PUI) using Independent t-test).
p-value <0.05 was considered as statistically significant

DISCUSSION

In the coronal and middle levels, the most extensively used clinical approach of alternate irrigation with sodium hypochlorite (NaOCl) and Ethylenediamine Tetraacetic Acid (EDTA) is successful in removing debris and smear layers, although it is less effective in the apical third. This is owing to the limited root canal dimensions in this area, as well as the high surface tension of irrigant fluids, which inhibits penetrability through the root canal walls [22]. When attempting to irrigate the root canal system, the common problems observed are, creation of air bubbles and vapour locks, which prohibit fluid from moving into the tight confines of fins, isthmuses, and lateral canals. Physical agitation of the fluid utilising mechanical vibration, ultrasonic energy, or lasers has been used to improve the degree of contact of irrigating fluids [23].

So, the null hypothesis for this study was not rejected. The results of this study showed no statistically significant difference in the postoperative pain and discomfort of PUI and laser disinfection during a single visit root canal therapy of non vital single rooted teeth using modified verbal rating scale. The results of this study are in accordance with these following studies [Table/Fig-5] [12-18].

Susila A and Minu J conducted a systematic review in 2019 and found comparable results and concluded that during endodontic treatment, mechanical active irrigation devices are helpful in lowering postoperative pain and enhancing canal and isthmus cleanliness [24].

Through an action known as acoustic streaming, PUI creates a continuous movement of the irrigant and increases debris removal [4]. Ultrasonic activation of NaOCl can raise the temperature of the fluid, enhancing their effects and speeding up responses between agents in the fluid and hard and soft tissues, as well as improving smear layer removal. Ultrasonic energy causes cavitation at the instrument's tip, in addition to acoustic streaming. Shear stress is created as a result of the explosions and implosions, which can physically destroy biofilms and damage the microorganisms [25,26].

In situations of infection, low level laser irradiation has been considered as an adjunct to chemo-mechanical root canal preparation. The bactericidal impact of low-level laser irradiation, often known as Photodynamic Therapy (PDT), has been researched by a number of researchers. Microorganisms exposed to a light-sensitive substance become susceptible to irradiation light, causing a photochemical process that produces free radicals and singlet oxygen. This causes bacterial cell walls to rupture and the microbes to die [20].

Low intensity lasers have an antibacterial effect on bacteria by altering their cell walls. On the surface of the bacteria, there are a lot of vesicle forms (membrane blebbing). That's what happens when the two outside membrane layers separate, causing the inner membrane layer to separate from them. In addition, a modest restructure of the cell membrane is likely to have a significant impact on cell metabolism [7].

Diode lasers have a flexible and thin fiber, which enables easy access to narrow canals and enhances the efficacy of disinfection in the radicular dentinal tubules to a depth of 500 µm. It has unquestionable bactericidal effect, similar to the Nd:YAG laser. The sterilisation effect of the diode laser resembles that of Nd:YAG laser. The diode laser's reduced penetration depth compared to the Nd:YAG laser reduces the likelihood of an undesirable temperature rise. When 20-second rest intervals were permitted after each cycle of laser therapy, however, the temperature rise in the periodontal ligament did not surpass the safe limit (10 C) [10]. The diode laser stimulates cell proliferation while inhibiting inflammation-propagating enzymes. Furthermore, diode lasers have a wide range of applications. In addition to these characteristics, diode lasers are reasonably priced, which is increasing their use in general practice [11].

Author's name and year	Place of study	Number of subjects	Irrigation technique used	Parameters compared	Conclusion
Ahmetoğlu F et al., (2013) [12]	Turkey	51 Mandibular premolars	Self-Adjusting File (SAF) system, Passive Ultrasonic Irrigation (PUI), and Conventional Irrigation (CI)	Calcium hydroxide removal	Ultrasonic Irrigation technique was significantly more effective than SAF and CI in removing CH dressing
Lloyd A et al., (2014) [13]	Tennessee	14 Premolars	Standard Needle Irrigation (SNI) or Photon-Induced Photoacoustic Streaming (PIPS)	Debris removal	Eliminating debris from complex canal spaces was achieved at a significantly greater level using laser-activated PIPS irrigation compared with SNI.
Mohan D et al., (2016) [14]	Kerala	53 Maxillary incisors	Conventional Endodontic Treatment (CET), Photo Activated Disinfection (PAD), and a combination of CET and PAD	Bacterial load of *E. faecalis*	PAD used along with CMP reduced the bacterial load of *E. faecalis*
De Meyer S et al., (2017) [15]	Belgium	Resin root canal model	Syringe Irrigation (SI), Ultrasonically Activated Irrigation (UAI), and Laser Activated Irrigation (LAI)	Antimicrobial effect	Laser-activated irrigation removed more biofilm than ultrasonically activated irrigation.
Özkoçak I et al., (2018) [16]	Turkey	70 Incisors	Negative control, Positive control, 10 mL 2% chlorhexidine (CHX), 10 mL 5% NaOCl, diode laser, Er:YAG laser, and Indocyanine Green (ICG)-diode laser (PDT).	Antibacterial efficiency	Promising results were obtained by using PDT with ICG.
Plotino G et al., (2019) [17]	Italy	Transparent resin model radicular canal filled with dentin debris	ultrasonic insert 15.02; ultrasonic insert 25/25 IRRI K; ultrasonic insert 25/25 IRRI S; sonic insert 20/28 Eddy on a vibrating sonic air-scaler handpiece; 20.02 K-file inserted on a Safety M4 handpiece	Elimination of debris from canal irregularities	Both sonic and ultrasonic activation demonstrate high capacity for dentin debris removal.
Mancini M et al., (2021) [18]	Italy	85 Premolars	Endoactivator, ultrasonic, laser	Smear layer removal	Laser showed best results.
Dedania MS et al., (2021, Present study)	India	44 Single rooted teeth	Photo Activated Disinfection (PAD) and Passive Ultrasonic Irrigation (PUI)	Postoperative pain	In initial hours, the incidence of postoperative pain is slightly higher in Laser Disinfection as compared to Passive Ultrasonic Irrigation.

[Table/Fig-5]: Comparison of the past and present study results [12-18].

Limitation(s)

Limitations of the study include single rooted teeth, short recall period, limited sample size and confounding factors may be individual's response towards pain, anterior and premolars anatomy which may affect the final outcome and subjectiveness of verbal rating scale. Further future research is still required with multi rooted teeth, other mechanical agitating devices and larger sample size.

CONCLUSION(S)

Within the limitations of the study, it can be concluded that laser disinfection and PUI can be used as an adjunct to conventional needle irrigation system. But in initial hours, the incidence of postoperative pain is slightly higher in laser disinfection as compared to PUI.

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