The Therapeutic Efficacy of Different power of Diode Laser in Surgically Apicectomized Teeth

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The utilization of laser technology in the field of clinical dentistry has achieved significant advancements and exhibits potential for further growth in the future. The noticeable improvement in treatment planning and prognosis has been apparent with the growing employment of lasers in the treatment of both hard and soft oral tissues. The objective of this study was to assess the antimicrobial effectiveness of a diode laser in the context of surgical endodontic treatment, specifically apicectomy, among patients. The current study encompassed a cohort of 50 patients who had previously received unsuccessful conventional endodontic treatment and presented with discernible periapical lesions as evident in periapical radiographs. The treatments were carried out at the teaching clinics of the faculty of dentistry at Wasit university between May 2023 and July 2023. The apicectomy procedures were routinely conducted by a single oral surgeon in a controlled and uniform environment. Laser irradiation was executed using a diode laser device (Epic pro Biolase, USA) employing the troughing option to assess the reduction in bacterial levels (decontamination), bacterial growth was monitored across four distinct phases. Clinical examinations and radiography were performed to evaluate patients visiting the Oral and maxillofacial surgery clinics within the Faculty of Dentistry at Wasit University. The results indicated that among the examined teeth, 27 exhibited cyst formation (54%), and 23 teeth were identified as having granulomas (46%). Diode Laser treatment displayed a significant disinfecting effect in cases of pre-apical lesions, leading to a higher proportion of inactivated E. faecalis and S. mitis cells ($P < 0.01$). Notably, laser irradiation using the parameters (0.6w, 3J/cm², 5s) showed noticeable variations in disinfection efficacy compared to (0.4w, 1J/cm², 5s) laser irradiation for both microorganisms. We concluded that the diode laser exhibited a noteworthy reduction in the number of bacterial colonies subsequent to irradiation employing varying power levels. The decrease in bacterial count correlated positively with the escalation in laser intensity. Consequently, diode laser irradiation emerges as a potential adjunct for disinfection, offering an efficacious approach for treating teeth afflicted by periapical lesions.

Keywords: Periapical lesions; Apicectomy; Diode laser; Endodontics.

1. Introduction

In the year 1916, Albert Einstein, a theoretical physicist of German origin, put forth the proposition that photons had the capacity to stimulate the release of identical photons from atoms that were previously in an excited state[1]. In the year 1928, Ladenburg [2] put out indirect data that lends support to the notion of stimulated emission. Fabrikant [3] suggested in 1940 that gas discharges might exhibit the potential for amplifying light through stimulated emission under suitable conditions. However, this study's limitation lay in the absence of long-term follow-up. Following World War II, Lamb and Retherford [4]demonstrated the possibility of generating population inversions through nuclear magnetic resonance. Additionally, Purcell and Pound [5] illustrated stimulated emission of radio waves. The inaugural laser was developed by Maiman [6] using intense light pulses from a flash lamp to excite a ruby rod. The first functional laser (633 nm) emerged from a helium-neon mixture [7]. Numerous laser technologies have been investigated for endodontic applications during the past few years. Maiman [6] made the first attempt, a pulsed ruby laser that emitted light with a wavelength of 0.694 m. Early dental laser research pioneers, such as Stern and Sognnaes [8] initially focused on replacing high-speed instruments, yet, the ruby laser proved unsuitable due to the translucency of dental tissue at this wavelength. The development of endodontic lasers was hastened by the introduction of the Nd:YAG dental laser ten years later. Adrian [9] examined the Nd:YAG laser's impact on rhesus monkey tooth pulp in 1977. Soft tissue removal, bacterial reduction, and dentinal tubule sealing were all previously impossible with the Nd:YAG laser until the advent of direct-contact fiber-optic delivery systems. Presently, an ample body of research validates the potential utility of laser systems like [Nd:YAG, Er:YAG, Ho:YAG, CO2 at 9.6 µm, diode lasers, and low-intensity] lasers in endodontic therapy. The effectiveness of various wavelengths, safe energy levels, postoperative comfort, adequate bacterial reduction, and structural modifications with careful consideration of temperature elevation have all been proven by extensive study. The use of low and high- intensity laser treatment has been reported both in in vitro investigations and in clinical endodontic operations The term "apicoectomy" refers to the surgical procedure of removing the apex, or root end, of a tooth. This can be done on its own, or in conjunction with the placement of a retrograde filling for apical sealing [10]. The apicoectomy operation was explained in detail by J. Farrar [11] in 1884. He called it "a bold act, which removes the entire cause [of disease] and which will lead to a permanent cure, which may not be the best in the end, but the most humane." Black [12] asserts that root resection, which entails the removal of the root apex, was first used as a therapy for "pyorrhea alveolaris" complicated by a dental abscess in the late 19th century, providing an effective substitute for tooth extraction. The medical intervention commonly referred to as an apicoectomy, also known as root excision or amputation, involves the surgical removal of the apices of teeth that have undergone previous successful root or pulp canal therapy. While conventional endodontic methods have high success rates, failures can occur due to shortcomings in cleaning, shaping, obturation, iatrogenic factors, and loss of coronal sealing. In instances of failure, re-treatment is advocated over tooth extraction. Re-treatment typically entails either conventional (non-surgical) or surgical endodontic approaches [13] . In the speciality of endodontics, a range of laser wavelengths has been employed for the purpose of cleansing and disinfecting canal walls and dentinal tubules, eliminating the smear layer, and effectively sealing the tubules[14], [15],[16] , [17],[18],[19]. Diode lasers are increasingly being used in endodontic therapy, in large part because their capacity to kill bacteria has been studied in both in vitro [20] and in vivo [21] research. Supplemental tools like lasers have been studied in response to the complexity of the root canal system and the possibility of endodontic therapy failure that goes along with it. Lasers have been utilized in therapeutic applications, specifically by directly irradiating root canals. This approach is sometimes accompanied with the administration of irrigants into the canals. Additionally, lasers are employed in conjunction with photosensitizers to facilitate antimicrobial photodynamic therapy. Furthermore, lasers are utilized for pain management through a process known as photobiomodulation.

2. Material and Methods:

Preparation of Solutions and Culture Media

The solutions and traditional as well as differential culture media listed below have been prepared in accordance with the manufacturers' instructions. Sterilization of the culture media was achieved through autoclaving at a temperature of 121°C, maintained under 1 bar pressure, and for a duration of 15-20 minutes.

Specimen collection

Clinical specimens were collected from the lesions of 50 patients who were suffering from periapical lesions and were attending the Teaching Hospital of Dentistry College, Wasit University, located in Wasit city. The collection took place during the period from May 2023 to July 2023, and the specimens were obtained using swabs with transport media. These swabs were aseptically transferred while maintaining cooling conditions to the Central Public Health Lab in Wasit Province, specifically to the Departments of Microbiology and Virology.

Study Design

A periapical radiograph was utilized to identify the presence of periapical lesions in a cohort of 50 patients who had previously received unsatisfactory conventional endodontic treatment for their periapical lesions. Patients included were between the ages of 25 and 45. All procedures were performed in the instructional clinics of the faculty of Dentistry at Wasit University between May and July of 2023.

Methods of Diagnosis

The periapical radiographs were obtained by utilizing a dental X-ray device manufactured by Jiangsu Dynamic Medical Technology Co., Ltd., located in Jiangsu, China. The device operated at a current of 1.5 mA at a distance of 30 cm, with a total filtration comparable to 2.5 mm of aluminum. Additionally, a dental X-ray sensor (refer to Appendix II and III) was employed to capture the images, as depicted in figures (1) and (2). The measurement of the periapical lesion was conducted in millimeters, with reference to the maximum diameter of the radiolucent area observed at either the apex or lateral surface of the root. The conclusive identification of radicular nodules and granulomas necessitates the utilization of surgical biopsy and subsequent histological analysis. Nevertheless, the distinction between cysts and granulomas was made only based on radiographs, with consideration given to the clarity of the bone edge in order to determine the nature of the lesion. Individuals exhibiting sufficient boundaries and a radiopaque encircling structure encompassing the radiolucent region adjacent to the root of the corresponding dental structure were categorized as cysts, whereas those displaying a radiolucent area were designated as granulomas [22]

Figure (1): Dental Digital X Ray Unit

Figure (2): Dental Digital X Ray Sensor

Surgical procedure:

All apicectomy procedures were conducted under local anesthesia with 2% lidocaine hydrochloride (Houwns Co.,Ltd., Korea) and epinephrine (1:10000) by the same oral surgeon. Clinically and radiographically evaluating fifty patients with fifty lesions each. Only periapical surgery was performed on roots affected by periapical lesion. A buccal full- thickness mucoperiosteal membrane was elevated, and an ostectomy was performed using a handpiece-mounted rounded tungsten carbide drill with copious sterile saline irrigation. After obtaining a specimen from the periapical region containing the lesion, the periapical lesion was eliminated by curettage. 1-2 mm of the root apex was removed with the smallest beveling, the periapical region and root canal were thoroughly irrigated with Distal water, and another swab was obtained from the periapical region. The root canals were obturated with gutta-percha to obtain hermetic seal of the canals. Epic pro dental laser (Biolase) with two different powers were applied to the periapical area and a swab was again taken from the area after each power applied. Suturing of the flap was done using silk suture 3-0 and postoperative antibiotic and analgesic was given to the patient. suture removal was after 5-7 days postoperatively [23] .

Laser irradiation technique:

Using diode laser device (Epic pro Biolase, USA) operating at 100V – 240V at 1.2A/0.5A with semi-conductor diode medium and wavelength 940nm ± 20nm, fiber tip diameter 300 um, 400 um with pulse duration (10um – 100ms) with technical specifications (see Appendix I). Laser irradiation of periapical surgical area would be achieved with two different intensity

(0.4w and 0.6w) and the total power were 1J and 3J, respectively. While the elapsed time was set to 5 seconds. All of these techniques were developed with the goal of reducing or controlling the negative outcomes of heat interactions with tissues. Laser energy factors including spot size modification, power density, exposure time, and pulse duration all played a role in the degree of thermal injury to the root's outer surface [24]. figure (3).

Figure (3): Diode laser device (Epic pro Biolase, USA)

To evaluate the reduction of bacterial level (decontamination), bacterial growth examined throughout 4 periods;

1. Before periapical area irrigation with Distal water,
2. After area irrigation for 10 seconds with Distal water (before laser irradiation),
3. After laser irradiation with (0.4w, 1J/cm2, 5s) and lastly,
4. After laser irradiation with (0.6w, 3J/cm2, 5s).

Specimens were taken carefully from the lesion area by sterile disposable transport media swaps, then were kept in an incubator at (37 ºC/ 2 hr.). Such swabs were, cultured initially on MacConkey and Blood agar, then Mitis Salivarius Agar with Tellurite (MSAT) which is an enriched selective and differential medium for the isolation of Streptococcus mitis, Streptococcus salivarius, and other oral Streptococci and Enterococci found in clinical specimens were used for isolation and identification and incubated at 37 ºC for 24 hours to examine if there is any bacterial growth in order to check the antibacterial activity of diode laser[25].

Re-isolation of bacteria

Oral specimens were obtained with transport medium swabs. Bacterial counts in samples were performed before periapical area irrigation with Distal water, After area irrigation for 10 seconds with Distal water (before laser irradiation), After laser irradiation with (0.4w, 1J/cm2, 5s) and lastly, After laser irradiation with (0.6w, 3J/cm2, 5s). The suspension of samples was prepared by mixing them with 1 ml of diluents consisting of 0.1% peptone in 0.85% saline, in a ratio of 1:99. The peptone solutions were initially prepared and afterwards diluted in a tenfold manner. These dilutions were then cultured in triplicate on MSAT Agar using the pour plate method for bacterial count. A volume of 0.1 ml was used for each culture. The enumeration of Streptococcus colonies was conducted by observing colonies with a typical blue appearance, while Enterococci colonies were identified by their blue/black coloration. The incubation period for both bacterial species was 24 hours at a temperature of 37˚C. The plates were examined after being inoculated with a sample dilution that resulted in a colony count ranging from 30 to 300 colonies per plate[26]. The quantification of bacterial population (colony-forming units, CFU) per milliliter or gram of sample was determined through the division of the number of colonies by the dilution factor, which was then multiplied by the volume of specimen added to the liquefied agar medium.

Statistical analysis

The data were analyzed (SAS, 2018) program. It has been used to detect the effect of the different factors on the study parameters, and the T-test was used to compare the means in this study.

3. Results

Diagnosis

Clinical examinations and radiography were employed to assess a total of 50 patients who attended the Oral and Maxillofacial Surgery clinics at the Faculty of Dentistry of Wasit University. Of these patients, 34 were male and 16 were female. The study utilized laser therapy in conjunction with intraoperative apicoectomy to facilitate revascularization and achieve uneventful periodontal regeneration. In addition, the findings revealed that cyst formation was observed in 27 (54%) of the examined teeth. The number of teeth with granulomas was determined to be 23, or 46%, as depicted in the figure below (4).

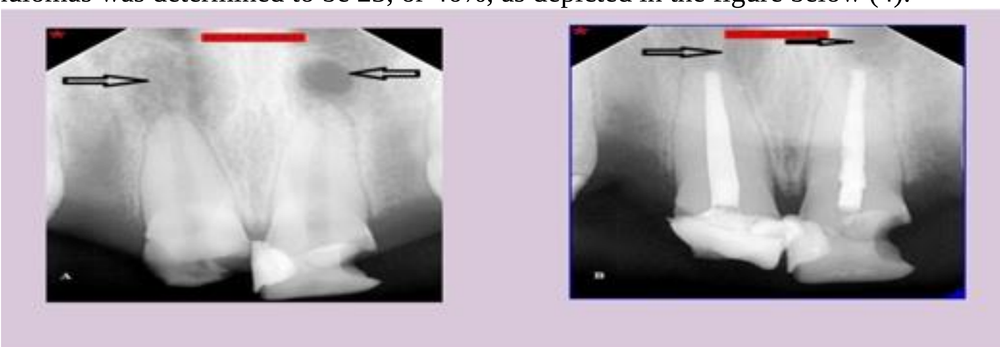

Figure (4): Radiographs of upper right and left central incisors showing periapical lesion

Apecictomy

Treatments with [periapical planning, apicoectomy, apicoectomy with retro-filling, apicoectomy with retro-instrumentation, and canal retro-filling with simultaneous surgery] are the types of surgical procedures that are utilized the most frequently for the purpose of treating endodontic failures, accidents, and complications resulting from conventional treatments. [These surgical procedures] are also among the most frequently used for treating endodontic complications. Apicoectomy methods as showed in figures (5) involve the surgical extraction of the apex of a tooth root or the excision of the root end. This technique can be performed independently or in combination with the installation of a retrograde filling to stabilize the apical region of the root.

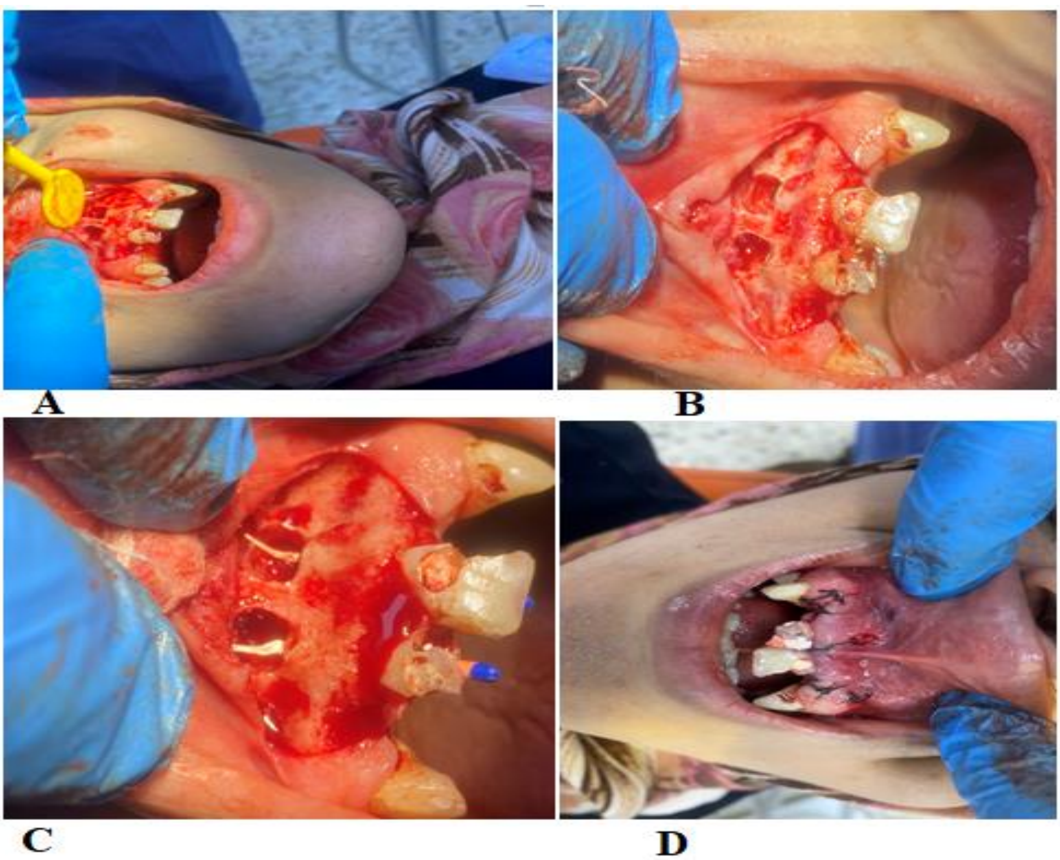

Figure 5: A. The root resection was performed and swabs were taken before and after cleaned with distal water. B. Following the removal of the granulation tissue, the bacterial reduction was obtained with two powers of Diode laser irradiating. Swabs were also taken after two power irradiation. C. Root canal filling. D. Flap repositioning and suture.

These results denote statistically significant differences obtained with T-test. Diode Laser had greater disinfecting effect in pre-apical lesions, which is showed higher percent of dead E. faecalis and S. mitis cells ($P<0.01$). laser irradiation with (0.6w, 3J/cm2, 5s) showed differences in disinfection effectiveness compared to (0.4w, 1J/cm2, 5s) laser irradiation in both microorganisms. laser irradiation (figure 6) with two different powers was more effective and it’s showed a statistically significant difference compared with the values before irradiation, table (1).

Table (1). Antimicrobial effectiveness of diode laser irradiation with mean percentage of dead Enterococcus and Streptococcus bacterial cells (mean log10)

Groups	% of Dead bacteria		T-test
	Enterococcus M±SD	Streptococcus M±SD	
Before irrigation with Distal water	NA	NA	NA
After area irrigation for 10 seconds with Distal water	24.15±1.67	26.21±0.89	2.43NS
After laser irradiation with (0.4w, 1J/cm^2, 5s)	43.23±1.79	41.14±1.28	2.52NS
After laser irradiation with (0.6w, 3J/cm^2, 5s)	74.65±4.55	76.43±3.23	1.94NS
T-test	8.34*	6.74*	-
*(P≤0.01)			

Values represent mean ±S.D, Sample no.= 50.

*This indicates that there are highly significant differences at the probability level (P≤0.01) in the analysis of variance between groups

NA horizontally, it indicates that there are no significant differences in the analysis of variance between the two bacteria.

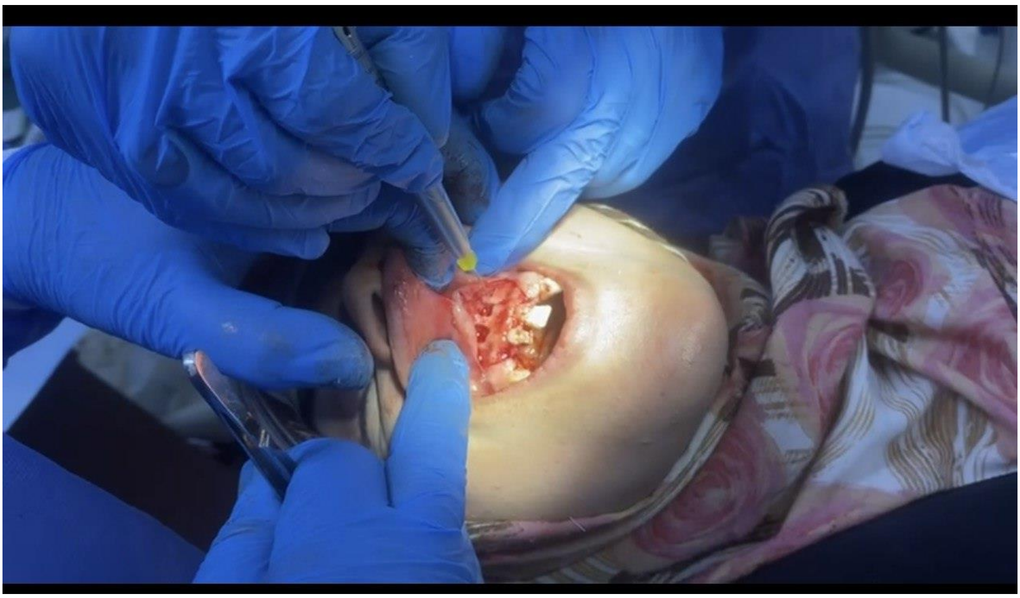

Figure 6: Laser Irradiation

4. Discussion

The clinical and radiologic assessments were conducted. The utilization of laser therapy in conjunction with intraoperative apicoectomy has been found to contribute to the process of revascularization and the successful regeneration of periodontal tissues without any complications. Non-invasive conservative methods for endodontic therapy have proven to be successful in treating a considerable proportion of periapical pathological diseases, hence minimizing the necessity for apical procedures to a minimal extent. Therefore, in situations where endodontic re-treatment is not feasible or undesired, apical surgery arises as the most favorable clinical indication for tooth preservation. Excision of the periapical lesion, removal of the root apex, and the following placement of retrograde root canal filling are the three steps that make up the apicoectomy treatment. The migration of residual bacteria, their metabolites, and organic waters from the root canal system to the area of the periapical may be responsible for the failure of apical procedures to be successful. The occurrence of this phenomenon might be attributed to the reduced sealing capability of [retrograde filling materials], which may result in the infiltration of the retrograde filling and cavity wall interface. Moreover, the presence of exposed "dentinal tubules" on the resection surface can also contribute to this matter[27], [28],[29] ,[30],[31]. Moreover, these residual bacteria have the potential to exist in extraradicular refractory infections[32], [33].and infiltrate the periapical tissues[34]. The success rate of apical surgical therapy has increased thanks to the development of new methods, materials, and procedures. These improvements are made to better seal the [dentinal cut surface and retrograde filling material], making for better biological conditions for tissue healing and repositioning of cement:tissue. The utilization of laser technology in dentistry has been increasingly prevalent, this phenomenon has led to the initiation of numerous research endeavors aimed at examining the effectiveness of distinct high intensity laser wavelengths in the ablation-based removal of dental hard tissue. The reason for this phenomenon can be attributed to the significant rates of absorption exhibited by these wavelengths when interacting with the different constituents of the tissue under consideration[35],[36]. For this particular rationale, it becomes feasible to employ those distinct wavelengths in the context of apicoectomy. In order to achieve a smoother and less permeable cut dentine surface, researchers have undertaken in vitro experiments on apicoectomies utilizing laser irradiation. These investigations have shown that laser irradiation has the ability to close dentinal tubules by inducing the melting and recrystallization of the dentinal structure[37],[38],[39],[40]. This occurs as a result of the melting and recrystallization of the dentinal structure. In addition, lasers have been used in clinical settings for periapical treatments[41], [42], and these procedures have been subjected to long-term evaluation with following clinical and radiographic surveillance [38]. The laser light has the ability to conduct apical root ablation, and it also has a bio modulating impact, which boosts cellular activity and makes it easier for wounds to heal. Both of these benefits contribute to faster overall healing. Furthermore, it promotes the reduction of microbiological activity at the surgical site. A variety of laser wavelengths have been utilized in the field of endodontics to perform several tasks, including cleaning and disinfecting the canal walls and dentine tubules, removing the smear layer, and sealing the tubules [39-44]. The utilization of diode lasers in endodontic therapy has witnessed a notable surge in recent times, mostly due to the antibacterial properties exhibited by lasers. Extensive research has been conducted to explore the in vitro [20] and in vivo [21] efficacy of lasers in combating microbial infections. The most common surgical methods for endodontic failures, accidents, and complications from conventional treatments are curettage with periapical planning, apicoectomy, retro-filling, retro- instrumentation, and simultaneous filling during surgery [43]. Apicoectomy is a surgical procedure that entails the extraction of the apex of a tooth root or the excision of the root end. This procedure can be performed independently or in conjunction with the placement of a retrograde filling, aiming to effectively seal the apical portion of the root[44]. The apicoectomy process was comprehensively elucidated and defined by J. Farrar [45] in 1884. Farrar characterized it as a courageous intervention that eliminates the root cause of an illness, ultimately resulting in a lasting remedy that, while not necessarily optimal, is the most compassionate approach.

According to Black [46], the root-resection procedure, which involves amputation of the root apex, was developed in the late 19th century as a viable alternative to dental extraction for the treatment of "pyorrhea alveolaris" aggravated by a dental abscess. Apicoectomy, also known as root resection or root amputation, refers to the surgical procedure that involves the removal of the apices of teeth that no longer have pulp and have previously undergone successful root or pulp canal therapy. The purpose of this procedure is to eliminate identified or unidentified infection, granulation tissue, or cystic regions that affect these teeth, while still preserving the majority of the roots in their original position[47]. The integration of lasers into endodontics was implemented as an adjunctive modality to standard antibacterial therapy .

Several researchers have investigated the antibacterial properties of Nd:YAG, diodes, Er:YAG, and photoactivated disinfection (PAD). In the subsequent part, a comprehensive assessment is conducted on each laser in order to identify a suitable protocol that exhibits a high likelihood of achieving successful outcomes in teeth afflicted with apical periodontitis .

The diode laser is a type of semiconductor laser that employs a solid-state active medium consisting of gallium, arsenide, aluminium, and/or indium. The wavelength range suitable for dental applications spans from 800 to 1,064nm, and it is capable of emitting light in both continuous wave and gated pulsed modes. In order to transport this light, an optical fiber is employed as the transmission medium. The utilization of lasers in endodontic treatment techniques commenced in 1980, marking the inception of their application in this field. Subsequently, their usage has progressively broadened throughout time. According to the literature, diode lasers are widely employed in the field of dentistry[48].

Diode lasers possess wavelengths measuring 810 nm and 980 nm, and exhibit a fiber diameter range spanning from 200 µm to 600 µm. SchulteLünzum et al. [49]provided evidence of the efficacy of a 980-nm-wavelength diode laser in eradicating germs residing inside the canal space and deep within the dentine tubules. According to Benedicenti et al. (2008), the incorporation of a diode laser alongside a traditional endodontic procedure resulted in a higher efficacy rate of the treatment in a controlled laboratory setting. Additionally, the utilization of the diode laser dramatically reduced the presence of contaminants within the canal space. The diode laser is commonly used due to its cost- effectiveness compared to alternative laser technologies, as well as its user-friendly nature and convenient portability[50],[51],[52],[53].

Apical cysts are a consequence rather than a causative factor of apical lesions, and their presence may impede but not entirely prevent the progression of peri-apical lesions following nonsurgical root canal therapy [54]The primary approach of their treatment mostly involves endodontic treatment or surgical excision of cysts through apicoectomy. The success of root canal therapy relies on the effective disinfection of the root canal system and the prevention of subsequent reinfection. Historically, this task has been achieved by the utilization of mechanical devices, the application of disinfectant solution for irrigation purposes, and the insertion of intracanal medication during intervals between treatments. Regardless of whether rotary or manual procedures are employed, the utilization of mechanical equipment results in the preservation of significant portions of the root canal.

The prevailing consensus in the medical community is that the implementation of uncomplicated surgical interventions, along with effective infection control measures, can result in successful wound healing. In cases when this particular therapeutic approach fails to effectively address periradicular pathologies, it is advisable to explore alternative therapy options. The predominant method for surgically addressing chronic severe periradicular lesions is apical excision. The utilization of novel technologies, such as laser irradiation, has been found to enhance the efficacy of many medical interventions[55],[56]. The underlying principle behind the operation of lasers is the generation of thermal energy, which afterwards induces detrimental effects on bacterial cells. In recent times, there has been a growing utilization of laser systems as a viable approach for antimicrobial therapy in the treatment of infected dental canals, peri-apical lesions, and cysts .

These substances exhibit high efficacy in eradicating microorganisms and promoting the healing of injured tissue within brief time intervals. In light of these favorable outcomes, we conducted an inquiry into the efficacy of diode laser radiation as a standalone disinfection method for treating infected canals and periapical lesions, particularly those housing periapical cysts. This investigation aimed to determine the potential applicability of this approach within clinical settings. The thermal energy produced by the laser had a detrimental effect on a significant proportion of bacterial cells present in periapical lesions. Furthermore, there was no discernible disparity in effectiveness noted among microorganisms that exhibited a high degree of similarity in both their phenotypic and genotypic characteristics. This study demonstrated that the utilization of a diode laser resulted in a more pronounced disinfecting effect in pre-apical lesions, as evidenced by a larger percentage of deceased E. faecalis and S. mitis cells. The disinfection efficacy of laser irradiation was shown to vary between microorganisms when comparing two different sets of parameters: (0.6W, 3J/cm2, 5s) and (0.4W, 1J/cm2, 5s). The application of laser irradiation at two distinct power levels demonstrated greater efficacy, exhibiting a statistically significant disparity when compared to the control group that did not receive any treatment. The findings of this study were consistent with the research conducted by Bytyqi A. et al., 2021. The purpose of this investigation was to examine the antibacterial efficacy of diode lasers against a clinical strain of E. faecalis and S. mitis. The selection of this particular bacterium was based on its frequent occurrence in cases of suboptimal endodontic procedures and its notable resistance to various forms of endodontic treatment. One of the challenges hindering the eradication of E. faecalis is its capacity to develop a biofilm within the canal area. According to Siqueira (2011), the incineration of biofilm bacteria is more challenging compared to their planktonic counterparts[57]. A biofilm is a sophisticated assembly of many bacteria that produce a defensive and adhesive extracellular polymeric substance (EPS) or exopolysaccharide, forming a protective matrix. Exopolysaccharides with a negative charge function as physical and mechanical obstacles, impeding the penetration of antibacterial agents into the biofilm structure

The findings of this investigation were consistent with the conclusions drawn by Benedicenti et al. (2008), Schulte-Lünzum et al., and Moritz et al., all of whom reported successful eradication of E. faecalis bacteria within biofilm using diode lasers. Although there is no definitive literature that elucidates the precise mechanism of the laser's activity against E. faecalis, Moritz et al. conducted an investigation and noted an interaction between the ions generated by the laser and chemicals present on the cell wall. The aforementioned reaction resulted in the degradation of protein molecules within the cellular wall, thereby leading to the disruption of the bacterial cell membrane. The bacteria undergoes significant metamorphosis as a result of even the slightest disturbance to its membrane [49]. Furthermore, it is postulated that the laser beam's thermal impact disrupts the integrity of the cell membrane by a temperature elevation ranging from 42 to 52°C, surpassing the typical physiological temperature of 37°C. At the given temperature, the biomolecular alterations occur, resulting in a substantial modification of the membrane Nevertheless, the proportion did not surpass 76%, so indicating that the disinfection process was not entirely efficacious. The incomplete eradication of bacterial cells may be attributed to the profound infiltration of bacteria into tubules and the limited capacity of heat to effectively reach these regions. In contrast to conventional watering methods, laser light has the ability to effectively reach deeper regions within dentin tubules. Research findings indicate that diode lasers possess the capability to irradiate the dentin at a depth of 500 μm, hence demonstrating their effectiveness in the reduction of germs. Additionally, the utilization of diode laser irradiation in conjunction with irrigation using sodium hypochlorite (NaOCl) demonstrated more favorable outcomes

Enterococcus faecalis and Streptococcus mitis are microorganisms that possess the ability to survive in both aerobic and anaerobic environments. Furthermore, these microorganisms have the capability to endure extended periods of time in the absence of essential nutrients. The ability to penetrate further into dentin tubules affords them protection from the thermal effects produced by laser treatment. As an illustration, it has been demonstrated that the conventional irrigant chlorhexidine exhibited a 93% reduction in bacterial viability, but the laser treatment resulted in a 70% reduction The presence of a biofilm in E. faecalis confers the ability for the bacterium to endure various environmental stresses [54]. The study conducted by Bergmans et colleagues (2019) shown a statistically significant decrease (99.7%) in E. faecalis. Conversely, Rahimi et al (2018) did not see a significant reduction in their study. The findings of our study indicate that, on average, there was a 70% decrease in viability within the 6-mm wounds. This shows that the diode laser did not exhibit significant disinfection properties. According to Rahimi et al's study [56], the combined utilization of laser technology and sodium hypochlorite (NaOCl) shown enhanced efficacy in biofilm removal compared to the individual application of either technique. In contrast, several studies have documented that laser treatment resulted in a reduction in bacterial counts, albeit with superior efficacy observed for NaOCl.

The study conducted by Meire et al. [58] examined the impact of several lasers, a 2.5% sodium hypochlorite (NaOCl) solution, and photodynamic therapy on biofilms formed by E. faecalis. The findings of their study indicated that sodium hypochlorite (NaOCl) had the most efficacy in biofilm eradication, while the diode laser demonstrated the lowest efficiency.

The bactericidal effects of wavelengths 810-nm and 1064-nm on Enterococcus faecalis were found to be insignificant, as the bacterium appeared to be nearly transparent to these wavelengths However, lasers may continue to be employed in endodontic treatment because to their ability to destroy germs through the application of heat. The bacterial cells experience cell death as a consequence of the absorption of light and heat by the surrounding substrates, specifically dentin. An further potential mode of action is the direct impairment of bacterial cells by the laser light.

5. Conclusion:

The diode laser exhibited a noteworthy reduction in the number of bacterial colonies subsequent to irradiation employing varying power levels. The decrease in bacterial count correlated positively with the escalation in laser intensity. Consequently, diode laser irradiation emerges as a potential adjunct for disinfection, offering an efficacious approach for treating teeth afflicted by periapical lesions.

Conflict of interest

There was no conflict of interest.

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