

MAIN ADVANTAGES AND DRAWBACKS OF DIFFERENT TYPES OF DENTAL LASERS IN SOFT-TISSUE ORAL SURGERY

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ABSTRACT

INTRODUCTION: Dental lasers are applied in all areas of oral surgery, including soft-tissue and bone surgery as well as in biostimulation of postoperative wounds for the induction of healing processes. The main types of lasers used for soft tissue oral surgery are CO₂ lasers, Nd:YAG lasers, diode lasers, erbium lasers Er:YAG and Er,Cr:YSGG.

AIM: The purpose of the literature review presented in this paper is to summarize the most frequently discussed advantages and drawbacks of dental laser application in soft-tissue surgical manipulation and to provide an overview of the indications for use of different laser types. The paper also discusses the advantages of dental lasers over conventional surgical methods.

MATERIALS AND METHODS: The academic databases and search engines used as sources were: PubMed, Medline and Google Scholar from January 2010 to December 2020. A total of 175 publications relevant to the topic concerned were found. Thirty-six articles were then shortlisted as containing specific information on the practical application of lasers in oral surgery. The present study focuses on articles examining signs such as need for anesthesia, bleeding, coagulation ability, duration of surgery, need for sutures, fear of manipulation, presence of postoperative scars and recurrences.

RESULTS: Laser treatment provides possibility for surgery without infiltration anesthesia, along reduction of intraoperative bleeding, shortening of operative time, and eliminating the need for wound suturing. Erbium lasers (Er,Cr:YSGG, Er:YAG) prove to be the least invasive and thus contribute to faster healing with the possibility of histological evaluation, but appear to be inferior with regard to their hemostatic ability, where CO₂ and diode lasers show better results.

CONCLUSION: Dental lasers are an effective alternative in performing soft-tissue surgery since operating with them offers a number of benefits both for the patient and the oral surgeon.

Keywords: *laser, soft tissue, oral surgery*

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INTRODUCTION

Dental lasers are applied in all areas of oral surgery, including soft-tissue and bone surgery as well as in biostimulation of postoperative wounds for the induction of healing processes. The main types of lasers used in dental surgery have emission wavelengths in the invisible spectrum range of 700÷10 000 nm. These include CO₂ lasers with a wavelength

of 10.6 nm, Nd:YAG lasers (1064 nm), semiconductor diode lasers GaAs and GaAlAs with wavelengths of 810 nm ÷ 980 nm and erbium lasers Er:YAG and Er,Cr:YSGG with wavelengths of 2940 nm and 2780 nm respectively. Efficient laser performance depends on the type of irradiated tissue and the absorption degree of the relevant wavelength of the laser beam as well as on the laser power and exposure time (1). While all of the above laser systems are used in soft-tissue surgeries, recent studies point out that for operation on hard tissues, erbium lasers are largely preferred owing to their minimal thermal trauma and negative effects on surrounding tissues (2,3,4,5).

The application of dental lasers in soft-tissue surgery is constantly increasing from standard manipulations such as frenectomies, excision of exophytic lesions, uncovering impacted teeth for orthodontic purposes—gingivectomy, wisdom tooth circumcision, exposing dental implants, to many other less frequent laser procedures such as excision of malignant formations, treatment of precancerous lesions—leukoplakia, treatment of gingival hyperpigmentation, vestibuloplasty, cystectomy, etc.

Aim: The purpose of the literature review presented in this paper is to summarize the most frequently discussed advantages and drawbacks of dental laser application in soft-tissue surgical manipulation and to provide an overview of the indications for use of different laser types. The paper also discusses the advantages of dental lasers over conventional surgical methods. The object of the study involves signs including bleeding, need for anesthesia, duration of surgery, scars, recurrences, etc.

MATERIALS AND METHODS

The academic databases and search engines used as sources were: PubMed, Medline and Google Scholar from January 2010 to December 2020. The following were set as inclusion criteria for the present study:

- ◆ publications written in English
- ◆ clinical studies involving at least 30 participants
- ◆ laboratory in vivo animal studies
- ◆ laboratory studies with animal and human material
- ◆ research papers within the last 10 years
- ◆ review articles

The academic search returned a total of 175 publications relevant to the topic concerned. Thirty-six articles were then shortlisted as containing specific information on the practical application of lasers in oral surgery. The remaining 139 publications were excluded from the study as they failed to meet the inclusion criteria or for lack of sufficient scientific justification. The present study focuses on articles examining signs such as need for anesthesia, bleeding, coagulation ability, duration of surgery, need for sutures, fear of manipulation, presence of postoperative scars, and recurrences.

RESULTS

A detailed analysis of the articles included in the present review revealed that frenectomy is one of the most commonly performed surgeries with the laser technique being preferred since the procedure was primarily used with children. Most of the publications reviewed comprise comparative studies on laser methods versus conventional frenectomy or comparative studies on the different types of lasers. The parameters examined include postoperative pain, impaired speech and eating patterns, intraoperative bleeding, type of anesthesia and the need of sutures. Other frequently performed surgical procedures discussed in the publications are gingivectomy, excision of exophytic lesions, exposing dental implants, vestibuloplasty, etc.

The following results on the **possibility for laser application only under contact anesthesia, without the use of injectable anesthesia**, were found:

- ◆ In the majority of cases under review, diode lasers allowed surgery only under contact anesthesia (6,7,8).
- ◆ In 100% of the cases, erbium lasers Er:YAG and Er,Cr:YSGG provided painless surgical intervention, requiring only contact anesthesia (9,10).
- ◆ When comparing two types of lasers—diode laser and Er:YAG—no need for injectable anesthesia was reported for 2/3 of the patients treated with Er:YAG, whereas none of the patients could be operated on without a local anesthetic agent in the diode group (11).
- ◆ In the publications reviewed, no data was found regarding the possibility of using only contact anesthesia with CO₂ and Nd:YAG lasers.

Bleeding was one of the main parameters examined intraoperatively during frenectomy as well as in other soft-tissue manipulations (7,11–17)

- ◆ The comparative reviews revealed significantly lower levels of intraoperative bleeding in laser interventions as opposed to conventional surgeries (12,13,15).
- ◆ When comparing intraoperative bleeding with Er:YAG and CO₂ lasers, fairly lower levels were reported for patients treated with the latter (14,18,19).
- ◆ One study reported less bleeding when operating with a diode laser compared to Er:YAG (11).

Another common parameter monitored in dental laser surgeries is the **reduction of the surgery time** in relation to its duration when applying conventional methods. Many authors investigated this parameter intraoperatively and most of them reported a significantly shortened intervention time when using lasers (10,12–14,20,21), while others have not detected any statistically significant differences (19).

The **rate of healing of the operative wound** with reduced epithelialization time appears to be the object of the study of many of the publications. The following findings were reported:

- ◆ Er:YAG and Er,Cr:YSGG lasers provided shorter healing times compared to CO₂ lasers, with minimal thermal effect on surrounding tissues and less histological changes after irradiation (14,19,20,22–24).
- ◆ Two of the publications discussed faster wound healing time in scalpel surgery as opposed to the diode laser-assisted treatment (20,25).
- ◆ Erbium lasers Er,Cr:YSGG and Er:YAG provided shorter epithelialization time compared to the conventional scalpel technique (26,27).

There are a number of publications addressing the **possibility of histological evaluation** following laser surgeries, the presence of tissue changes and the quality of excision:

- ◆ Erbium lasers proved to be less invasive, with minimal thermal effect and almost no histological changes compared to CO₂ lasers (19,22,23).
- ◆ Diode lasers offered the possibility of taking biopsy specimens (25), however, from a clinical stand point, it was suggested that the method induced serious thermal effects in small lesions

(mean size below 3 mm) and was not as reliable as with larger excisions (28).

- ◆ In the majority of cases CO₂ lasers allowed histological examination of the excised tissues (29).
- ◆ Epithelial, stromal, and vascular damage were most pronounced in Nd:YAG. Diode and CO₂ lasers showed good histological results, but the best results were achieved with Er:YAG (23).

Another common parameter in the studies is **postoperative pain and functional disorders in speech and eating patterns**. Some authors did not find any significant statistical difference regarding pain or oral function (6,11,13). Conversely, many other researchers observed significantly lower degrees of the postsurgical discomfort and pain in speech and eating as a result of laser application (1,7,12,15,21).

The present study also investigated the **fear factor** as another commonly observed parameter. Fear of an impending manipulation, especially in pediatric patients, appears to be a major problem in performing surgical procedures. For this reason, some authors examine the degree of perception and acceptance of laser procedures (1,16,30,31) with results pointing towards a more positive attitude to laser treatment.

Many of the authors' studies confirm that the application of dental lasers is also more advantageous over conventional surgical techniques in that there is no **need for sutures** of the surgical wound (6,10,13,15).

The risk of recurrence after frenectomies is another factor taken into consideration in the publications reviewed. The following results were reported:

- ◆ In a 4-month follow-up of patients who had undergone laser frenectomy with Er,Cr:YSGG and CO₂ lasers, no recurrence was reported in any of the patients (14).
- ◆ In a 3-year follow-up of patients with CO₂ laser-assisted frenectomy, 2 cases of recurrence were observed out of a total of 156 patients (32).

Another parameter examined by researchers is the **presence or absence of postoperative scarring**:

- ◆ No scarring was reported in a 2-week follow-up of patients who had undergone diode laser frenectomy (16, 32) or diode laser vestibuloplasty (33).

- ◆ The Er:YAG laser treatment revealed reduced scarring compared to the CO₂ laser manipulation (22).

Many of the authors researched and proved the ability of **lasers to limit the possibility of developing postsurgical infection** (9,23,32,34).

DISCUSSION

The reduction of intraoperative bleeding proves to be an indisputable advantage of dental lasers over conventional methods. The degree of their efficiency in terms of coagulation ability varies between different types of lasers. CO₂ lasers have proven to have the best hemostatic ability due to their long wavelength of 10.6 μm, with maximum tissue penetration of 0.2 mm (35). Erbium lasers are inferior to the other types of lasers regarding bleeding control as they operate in pulse duration modes with water/air spray. Decreasing the power of the water/air spray leads to an increase in the coagulation potential (11). Many comparative studies demonstrate a reduced hemostatic ability of erbium lasers. Nevertheless, their advantage over standard surgical techniques is indisputable as evidenced in Makarova et al.'s study (27), using Er:YAG laser to reduce bleeding time in patients with platelet disorders. Diode lasers also provide good bleeding control compared to conventional methods and Er:YAG lasers. Excellent hemostasis was achieved using diode lasers in laboratory experiments and zero bleeding was observed even after an anticoagulation therapy (35). Bleeding control when operating with lasers is essential as it contributes to better visibility for the operator and reduction of operative time. The reduced bleeding results from the ability of lasers to seal blood vessels.

The possibility to operate without injectable anesthesia is an important advantage of lasers, as for many patients this is often the most unpleasant part of the manipulation. This strongly applies to surgeries with pediatric patients. Some authors attribute the painlessness of laser procedures to the sealing of the nerve endings by laser irradiation, which also helps to reduce postoperative pain. According to most of the studies, the least painful lasers proved to be Er:YAG and Er,Cr:YSGG due to their water/air spray, which has an additional cooling and analgesic effect and reduces the feeling of tissue burning and

charring. Some authors argued that diode lasers allowed surgery without infiltration anesthesia (6,7).

No data to confirm this possibility with CO₂ and Nd:YAG lasers was found in the reviewed publications.

The healing of operative wounds is directly linked to the extent of involvement of surrounding tissues, the thermal effects of laser beams and the charring of tissues. In their study, Merigo et al. (23) observed that epithelial, stromal, and vascular changes were significantly smaller with Er:YAG lasers as compared to Nd:YAG, CO₂ and diode lasers. Furthermore, Kazakova et al. (18) reported the thinnest coagulation layer with Er:YAG lasers, deeper coagulation layer thickness with CO₂ lasers and the widest layer with diode lasers. These factors, along with a faster healing capacity, contribute to the accurate performance of histological examinations when taking biopsies (23,25). Angiero et al. (28) found a correlation between the size of specimens taken with a diode laser and the reliability of the reading of the histological sample—with smaller size specimens the method may not be as accurate.

Shortened duration of surgery time for laser manipulations, compared to conventional ones, results from the reduction of intraoperative bleeding, hence the better visibility and accessibility to the operative field as well as the lack of requirement for sutures.

Lasers are gaining ground as an alternative to conventional surgeries due to the uneventful and painless postoperative course observed. Certain authors ascribe the reduction of postoperative pain and swelling to the fact that laser irradiation seals nerve endings and lymphatic vessels (14). The lack of need for sutures attributes to the reduction of postsurgical discomfort.

Laser irradiation of tissues in surgical manipulations reduces the risk of postoperative infection. Although the wound surface is left to regenerate by secondary epithelialization, it is covered with a coagulating layer of proteins, acting as a biological dressing and guarding against external irritation, subsequent contamination and infection (14,33,36). Owing to the thermal effect of lasers, with the incision of tissues, they are simultaneously being disinfected.

CONCLUSION

Dental lasers are an effective alternative in performing soft-tissue surgery since operating with them offers a number of benefits both for the patient and the oral surgeon. They are known to reduce intraoperative bleeding and the duration of surgical time. Following laser-assisted treatment, researchers report smooth postoperative period with low levels of pain and functional disorders in speech and eating, a short period of healing of the operative wound without resultant complications.

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