LASER TECHNOLOGY AND ITS APPLICATIONS IN ORAL AND MAXILLOFACIAL SURGERIES - A REVIEW

Running Title: Applications of lasers in oromaxillofacial surgeries

Nivesh Krishna R[1], Dinesh Prabu M[2]

R. Nivesh Krishna
Saveetha Dental College and Hospitals,
Saveetha Institute of Medical and Technical Sciences,
Saveetha University,
Chennai, India,

Dr. Dinesh Prabu M
Senior lecturer,
Department of Oral and Maxillofacial surgery,
Saveetha Dental College and Hospitals,
Saveetha Institute of Medical and Technical Sciences,
Saveetha University, Chennai - 600077.

Corresponding author
Dr. Dinesh Prabu M
Senior Lecturer,
Department of Oral and Maxillofacial surgery,
Saveetha Dental College and Hospitals,
Saveetha Institute of Medical and Technical Sciences,
Saveetha University,
162 , PH Road , Chennai 600077,
Tamil Nadu, India

ABSTRACT:

Aim: To review the application of Lasers in Oral and Maxillofacial surgeries and the advantage of using them.
Background: The term LASER refers to Light Amplification by Stimulated Emission of Radiation. Recent advances in both soft tissue and hard tissue laser technology have brought a revolution in the field of dentistry. The applications of lasers play a vital role in modern surgical procedures. Lasers use high energy photons at controlled wavelengths to heat or ablate biological tissue thereby making the procedures painless. Lasers are important in ablative, reconstructive and aesthetic surgical procedures.
Objective: There are many variations in the types of lasers used in oral and maxillofacial surgical procedures starting from a regular tooth extraction to removal of malignant tumours. With the advent of newer technologies, it has become imperative for dentists to become familiar with these developing modern techniques. The use of lasers in oral and maxillofacial surgery has seen a substantial increase for performing various surgical procedures at ease. Also the number of surgeons opting to use them on a regular basis is increasing day by day.
Conclusion: This article serves to update practitioners on the development and current applications of this modern tool in regular practice and efficiently perform dental treatment and also reviews the applications of laser technology used in various oral and maxillofacial surgical procedures by giving a detailed idea on the availability, evolution, types and the significance of the use of lasers in dentistry.

KEYWORDS: LASER, CO2 lasers, Diode lasers, Nd:YAG lasers, Oral lesions, Oro Maxillofacial surgeries

INTRODUCTION:

The development of lasers began in 1917 with the theory of stimulated emission by Albert Einstein. His concept was based on Planck's quantum theory of light being composed of small pockets of energy called quanta.The first laser was tested on May 16, 1960. The first reported use of lasers specific to Oral and Maxillofacial surgery was CO2 lasers for excision of premalignant and malignant lesions.The first use of lasers for removal of oral cancers was done in 1974[1]. Currently, lasers are viewed as an integral part of many of the surgical and medical practices employed. Hence, it becomes increasingly important to understand the rationale behind the use of lasers so as to use them efficiently and without undue inhibitions. There are plenty of soft and hard tissue procedures which will be performed with lasers in oral surgery. Soft tissue laser technology serves to be a viable alternative to the scalpel[2]. The most commonly used soft tissue lasers are CO2, Nd:YAG and Diode lasers. These lasers are used in many soft tissue procedures such as Frenectomy, gingivectomy, gingivoplasty, gingival depigmentation, incisional and excisional biopsies for both benign and malignant lesions and many more[3]. The efficacy of these soft tissue lasers as incisive agents in surgical procedures

was first studied by Yamamoto *et al*. using ruby lasers. It was also noted that the use of lasers led to reduced hemorrhage and maintained a clean surgical field of operation[4]. Since the day of introduction, laser technology is considered to be much more superior when compared to the conventional needles and scalpels. Procedures such as impacted teeth removal, osseous recontouring, bone osteotomies, bone grafting procedures, crown lengthening are performed using hard tissue lasers. The Er i.e. the Erbium family of lasers are the commonly used hard tissue lasers. These types of lasers use extremely short pulse duration and thus are capable of ablating the layers of the highly calcified tissues such as bones with minimal thermal effect thus reducing the postoperative complications. Other laser types such as super-pulsed Nd:YAG, diode, CO2, Ho:YAG are used as alternatives to Er lasers but have not been proven so effective for use in hard tissue procedures[5,6].

Apart from the hard and soft tissue lasers, there are also other types of available lasers such as gas lasers which includes Helium-neon lasers (eg. Nitrogen laser), Argon laser (eg. Carbon dioxide laser), Krypton laser(eg.Carbon monoxide laser) and Xenon ion laser (eg.Excimer laser) and solid state lasers such as ruby lasers and Er:YAG lasers. Dye lasers, semiconductor lasers and chemical lasers are also available. The current indications for the use of lasers in oral and maxillofacial surgeries includes biopsy procedures, laser ablation, coagulation for hemostasis, surgical extraction of teeth, temporomandibular joint arthroplasty, apicectomy, frenectomy etc[7]. Lasers are used in procedures enabling prosthetic rehabilitation of patients and also used in the treatment of epulis fissuratum, vestibuloplasty, maxillary tuberosity reduction, removal of tori and correction of ridge abnormalities. Lasers are currently employed for blepharoplasty, endoscopic brow lift, cosmetic skin resurfacing, and scar revision[8].Previously our team has done many researches, systematic reviews and surveys which has led to the idea of the current topic on impaction removal[9-23].The aim of this article is to review the application of Lasers in Oral and Maxillofacial surgeries and the advantage of using them.

APPLICATIONS OF LASERS IN ORAL AND MAXILLO-FACIAL SURGICAL PROCEDURES

1. REMOVAL OF ORAL MUCOSAL LESIONS

- **ORAL LEUKOPLAKIA** - Oral leukoplakia is a premalignant lesion of the oral mucosa. A random clinical trial which was conducted to compare the pain, swelling and post-operative complications after excision of oral leukoplakia using carbon dioxide laser and cold knife. This eventually culminated in carbon dioxide lasers showing minimum tenderness and inflammation when compared to cold knife excision. Photodynamic therapy (PDT) is an advanced laser technique used in excision of oral leukoplakia in which there is no damage to collagenous tissue structures. PDT is found to be most economical with minimum pain and maximum aesthetics[24].
- **LICHEN PLANUS** - Oral lichen planus is a common chronic inflammatory disorder. In symptomatic patients diode laser (940nm) shows effective treatment towards relieving oral lichen planus[25]. Follow up sessions show drastic improvement and healthy oral mucosa of the patient.
- **GINGIVAL MELANIN PIGMENTATION** - Simsek et al compared the procedures using diode and Er: YAG laser in treating gingival melanin pigmentation (GMP). The patient's comfort level, effectiveness, post-operative pain, requirement and time taken for the procedure was considered. The results showed diode lasers are way more effective in consuming time than Er: YAG[26].
- **FORDYCE GRANULA** - Excising fordyce granule using high power diode laser showed great aesthetic results in postoperative procedure. It is shown that both low and high intensity diode lasers are effective towards fordyce granula.
- **PRECANCEROUS LESIONS** - Carbon dioxide lasers can be helpful in treating precancerous lesions using different methods of vaporization. But the best result comes up with using defocused technique[27]. Whereas other methods show less penetration of deeper-lying cells which results in a higher recurrence rate.
- **ORAL MELANOMA-** About three fourths of oral melanomas can be treated using carbon dioxide lasers along with removal of surrounding dental organs and curettage of the alveoli in order to achieve complete excision[28].

2. ORAL BENIGN LESIONS

- **MUCOCELE** - Mucocele is a lesion involving minor salivary glands commonly seen in lower lip and buccal mucosa. A study was done to compare the excision of mucosa using scalpel and carbon dioxide laser. It culminated with a carbon dioxide laser showing better results and quick wound healing than traditional scalpel excision.
- **RANULA** - Ranula is the formation of the mucous after trauma to the sublingual gland from the arrest of sublingual ducts[29]. Lai et al reported treating ranula with a carbon dioxide laser which has shown minimal or no recurrent rate[30]. Lasers are used in the marsupialization of the ranulas.
- **PYOGENIC GRANULOMA** - Pyogenic granuloma is commonly developed in pregnant women. Studies suggest that utilizing carbon dioxide laser procedure in excising of pyogenic granuloma showed a monotonous surface during initial treatment. After 1 year of follow-up sessions it resulted with no recurrence and normal periodontal tissues[31].
- **GINGIVAL HYPERPLASTIC LESION** - Asnaashari et al used diode laser (810nm) in order to remove all gingival hyperplastic lesions[32]. This resulted in getting back to normal structure after removal of the whole lesion in a single visit and no recurrence is seen for about 6 months after the procedure.

- **EPULIS FISSURATUM** - Epulis fissuratum is a pseudo tumor commonly seen in patients using ill fitted dentures. A study reveals that using carbon dioxide lasers in patients under antithrombotic therapy shows no postoperative complications[33].
- **LYMPHANGIOMA** - Lymphangioma is a congenital lesion. In a case report, it was stated that it can be treated using a carbon dioxide laser with the parameters of 3 watt (W), continuous wave with 90-degree angulation of the tip. This resulted with no recurrence[34].
- **HEMANGIOMA**- Genovese et al described using Gallium arsenide high potential diode laser which resulted in drastic minimization of bleeding and maximization of postoperative hemostasis while treating hemangioma[35].

3. FRENECTOMY

Labial frenum is a fold of oral mucosal membrane which extends from lips to alveolar gingival mucosa. A study described that labial frenectomy procedure was done using conventional surgical technique and Nd: YAG laser. It resulted that the Nd: YAG laser showed that sutures are unnecessary with minimized trans-operative bleeding and surgical time than conventional surgical technique[36].

4. ANKYLOGLOSSIA (TONGUE TIE)

A study was done to compare between Er: YAG and diode lasers in order to review the discomforts in the patients with treating ankyloglossia. It resulted that the Er: YAG laser was more efficient than diode laser because it performs by the need of topical anaesthesia application[37].

5. HEMOSTASIS

Major property of the laser is it gives bloodless procedures thus increasing the visibility and clear operating field. The principle behind this property of laser is by contracting the vascular collagen wall leading to constriction of the vessel opening, resulting in hemostasis.

6. DENTAL IMPLANTOLOGY

Carbon dioxide and Er: YAG lasers are used only at low power. Using laser in the second stage of implant surgery results in minimal trauma and post-operative pain. Major advantage of using a laser in the second stage of implant surgery is that impressions can be made immediately due to its hemostatic effects. Also, shrinkage of the tissue is less so that the margins will remain the same[38].

ADVANTAGES OF LASER SURGERIES:

Lasers have stood the test of time. Though they are still not very popular due to the hesitation on expertise of dentists they are widely used because of the following advantages that they offer. Lasers incise tissue more efficiently than a scalpel. Since they provide the added advantages of sterilization of the field of operation, decrease mechanical trauma by a contact-free incision and minimize postoperative swelling, pain, and scarring they are the choice of modern dentistry. Significant advantages are

- Effectively coagulates the blood vessels in the field of surgical operation, thus maintaining a bloodless field
- Increased accuracy in surgical procedures due to its ablative properties
- Effective control by the operator on the depth of penetration of the laser beam thereby reducing postoperative complications[39]
- Better healing as compared to scalpel wounds which is done traditionally
- Reduced need for sutures.
- The use of a laser can decrease morbidity after surgery, and reduces the need for anesthetic.
- Lasers also provide the advantage of sterilization of the field of operation, decrease mechanical trauma and minimizes postoperative swelling, pain, and scarring[40].

CONCLUSION:

Laser dentistry is exciting yet, good scientific principles require caution and sound judgement to be used in developing new laser applications for treating patients. Looking at the future, it is expected that specific laser technologies will become essential components of contemporary oral and maxillofacial surgical practice over the next decade. An oral and maxillofacial surgeon should therefore strive to obtain sufficient knowledge on the application of lasers. A thorough understanding of the use of soft tissue and hard tissue lasers is significant in order to carry out a systematic approach on the usage of the same.

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