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Usefullness of Laser in Oral and Maxillofacial Surgery

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ABSTRACT

Lasers have revolutionized dental treatment since three and a half decades of the twentieth century. Theodore Maiman in 1960 invented the ruby laser, since then laser is one of the most captivating technologies in dental practice. Lasers have been used in initial periodontal therapy, oral surgical procedures, and also in implant treatment. Further research is necessary so that laser can become a part of the dental armamentarium. This paper gives an insight towards the uses of laser in Oral & Maxillofacial Surgery.

Key words: Laser, Oral & Maxillofacial Surgery.

INTRODUCTION

Laser systems and their application in dentistry and especially oral surgery are rapidly improving today. The specific advantages of lasers are incision of tissues, coagulation during operation and postoperative benefits. Semiconductor diode lasers (Gallium arsenide (GaAs), gallium-aluminum-arsenide (GaAlAs)) are portable compact surgical units with efficient and reliable benefits. They are assigned according to economic and ergonomic consideration and offer reduced costs in comparison to other modern hard laser devices(1). This laser can be used in a continuous or pulsed mode of operation through contact or noncontact application on tissues according to the clinical approach and treatment method. The noncontact delivery is utilized to focus the emitted photons on tissue in order to create larger spot diameter, lower fluency, lower energy and gain for coagulation of superficial lesions, for example in removing the vascular tissues. Diode laser with wavelengths ranging from 810 to 980 nm in a continuous or pulsed mode was used as a possible modality for soft tissue surgery in the oral cavity. Based on the photo thermal effect of the diode laser, the lesions of the oral mucosa are removed with an excision technique, or by ablation/vaporization procedures[1-3].

History of evolution of Lasers

- First LASER – MASER (Microwave Amplification by Stimulated Emission of Radiation) - Theodore H. Maiman in 1960.
- Second LASER – Neodymium LASER (SNITZER,1961).
- Carbon Dioxide LASER – LOBENE &FING, 1966.

Components of lasers

- An active medium.
- An external energy source.
- An optical resonator.

Classification of Lasers

Lasers can be classified according its spectrum of light, material used and hardness etc.

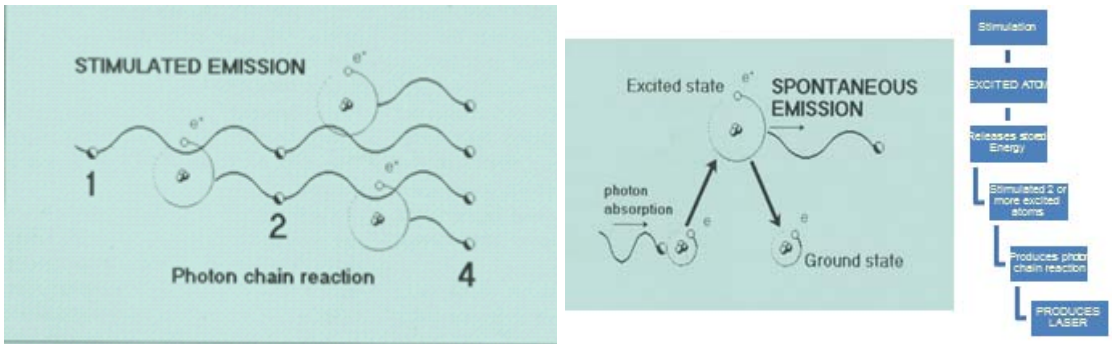
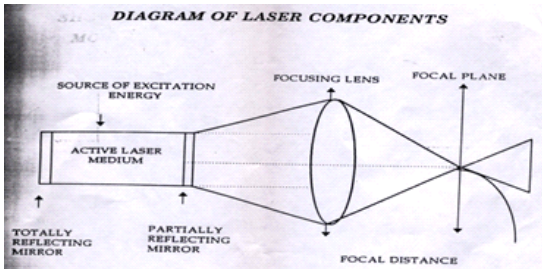


Fig. 1: laser physics



They are also classified as:-

Soft lasers and Hard lasers.

The current soft lasers in clinical use are the[1]:

1. Helium-neon (He-N) at 632.8 nm (red, visible).
2. Gallium- arsenide (Ga-As) at 830 nm (infra-red,invisible).

The Hard lasers are[1]

1. Argon lasers (Ar) at 488 to 514 nm
2. Carbon-dioxide lasers (CO2) at 10.6 micro-meter
3. Neodymium-doped yttrium aluminum garnet
4. (Nd:YAG) at 1.064 micrometer.
5. Holmiumyttrium-aluminum-garnet (Ho:YAG) at 2:1.micro-meter.
6. Erbium,chromiummyttrium-slenium-gallium-garnet(Er,Cr:YSGG) at 2.78 micro-meter.
7. Neodymiummyttrium-aluminum-perovskite(Nd:YAP) at 1,340 nm.

Types of lasers

On the basis of output energy

- Low output, soft or therapeutic eg. Low-output diodes
- High output, hard, or surgical eg.CO2,Nd:YAG,Er:YAG

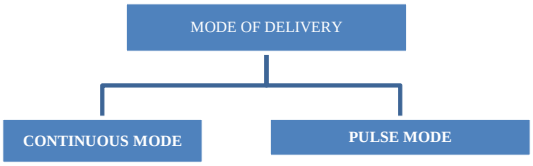
On basis of state of gain medium-

- Solid state-eg.Nd:YAG, Er:YAG, Er,Cr:YAG
- Gas- eg.HeNe, Argon,CO2
- Excimer-eg.ArF, KrCl
- Diode- eg.GaAlAs

On the basis of oscillation mode

- Continouswaveeg. CO2, Diodes
- Pulsed wave eg.Nd: YAG, Er: YAG

Mode of application



Precautions before and during Irradiation

1. Use glasses for eye protection (patient, operator, and assistants).
2. Prevent inadvertent irradiation (action in noncontact mode).
3. Protect the patient's eyes, throat, and oral tissues outside the target site.
4. Use wet gauze packs to avoid reflection from shiny metal surfaces.
5. Ensure adequate high speed evacuation to capture the laser plume

Applications of Lasers in oral surgery

- Hemostasis.
- Malformations.
- Preprosthetic surgeries.
- Precancerous lesions.

- Cysts.
- Benign tumors.
- Scar corrections
- Gingivectomy.
- Frenectomy
- Removal of granulation tissue.
- Removal of melanin pigmentation and metal tattoos.
- Subgingival debridement and curettage.
- Osseous recontouring as well as in implant surgery.
- Maintenance of implants.
- Low Level Laser Therapy.

Different Types of Lasers used in oral surgery[3]

Laser	Wavelength	Indications
Argon	488 nm, 514 nm	Pigmented lesions, Vascular anom-alies, Plastic surgery
Diode	620-900 nm	Periodontal surgery, Bleaching, Photodynamic therapy, Soft laser therapy, Other soft tissue proce-dures
CO2	10,600 nm	Soft tissue procedures
Nd:YAG	1,064 nm	Soft tissue procedures, Periodontal surgery, Pigmented lesions
Ho:YAG	2,100 nm	Arthroscopic surgery, soft tissue surgery
Er,Cr:YSGG	27Ba nm	Bone surgery, Periodontal surgery, Cavity preparations
Er:YAG	2944 nm	Bone-surgery, Skin resurfacing,

Frictional keratosis

These lesions can be treated with laser therapy. Small questionable lesions can be excised by using carbon dioxide laser with a 0.2mm spot size. It is applied perpendicular to the elliptical outline around the lesion. After the outline is created, the edge of the tissue is lifted using tissue forceps and the underlying tissues are dissected with laser beam at a slight angle. The lesion can be removed easily and sent for pathological examination[4,5].

Smokeless tobacco induced white lesions

These lesions are reversible after cessation of the habit. The lesions that persist even after cessation, especially those that exhibit ulceration should be sent for examination. They can be excised by using the laser in a focused mode. They are usually accessible to the laser occurring in the mucolabial or mucobuccal fold in the mandible[4,5].

Nicotinic Stomatitis

These lesions are usually asymptomatic. If the patient complains of pain, burning or ulceration, laser treatment can be done to eradicate it. A carbon dioxide laser is used in a defocussed, continuous mode perpendicular to the tissue surface along the long axis of the lesion. The lesion is wiped with saline to remove the lased surface so that the nonlased surfaces will be revealed. After finishing the process, the final lased surface layer is left undisturbed to act as barrier and help in the protection of the healing surface. A palatal splint is fabricated to help the patient protect the lased surfaces during eating and drinking. An Nd:YAG contact round surgical probe can also be used in a similar manner to the carbon dioxide laser[5]

Solar Cheilitis

It is a premalignant lesion involving the vermilion border of the lips and mostly the lower lips. If the lesion is not treated, it may transform into a squamous cell carcinoma. Using laser under microscopic control has been found to effective in the removal of the lesion. A carbon dioxide laser can be used at a focused spot to outline the lesion by passing between the vermilion and the hair bearing skin of the anterior lip surface and extending it towards the commissures and posteriorly to the labial vestibule. It should include about 2-3 mm of the surrounding normal mucosa within the target tissue. After the outline is done, the laser is held 4-6- cm away from the tissue and a crosshatching patter is produced in the defocussed mode. After the lasing procedure is finished, the surfaces are wiped with a moistened gauze sponge, then the

surface is coated with an antibiotic dressing and a nonadherent pad is taped[5,6].

Leukoplakia

These lesions can be removed with laser and encourages regeneration of new, healthy epithelium. Small lesions can be removed with a focused carbon dioxide laser with a margin of 3-4mm. The decision of whether excision or vaporization should be done is based on the texture and thickness of the lesion.Thickened hyperkeratotic lesions have less water content, therefore, vaporization cannot be done. Diffuse lesions cannot be managed by excision. In such lesions, carbon dioxide lasers can be used in a defocussed mode to produce cross hatched pattern[4,5].

Erythroplakia

Erythroplakia is managed by excision with the help of a carbon diode laser in a pulsed mode to outline the lesion. Then the laser beam is set on focused mode in a continuous wave and a laser moat is created around the lesion. The dysplastic changes that occur in the epithelium may affect the deeper tissues also. Therefore the upper portion of the lamina propria should also be included in the specimen. Multiple deep biopsy samples should be taken to prevent infiltration[4,5].

Keratoacanthoma

The lesion can be excised with carbon dioxide laser. This is done by limited scarring of the tissue. The laser is set on pulsed mode and an outline is created around the lesion. Then the laser beam is directed perpendicular to the outline margin and a full thickness wedge is removed. Once it is removed, the tissues can be approximated with sutures[4,5].

Verrucous carcinoma

The exophytic lesion can be readily excised along with the base of the lesion using a carbon dioxide laser or Nd:YAG contact laser. Whether or not laser holds a long term value in the control of leukoplakia has not been determined yet. Horsch et al reported 78% cure rate using carbon dioxide laser and hand piece. Using laser under microscopic control provided better control and precision[7].

Oral Papillomatosis

The mucosa is erythematous and has a papillary surface. It can be managed with a carbon dioxide laser or an Nd:YAG contact laser. Sachs and Borden were the first to treat this lesion with a carbon dioxide laser[8].Diffuse lesions can be managed by vaporization with CO_2 laser after selective punch biopsies have been taken. The laser is set on continuous defocussed mode and using the cross hatching method, the area of the lesion is covered. The lased tissue surface is wiped off with saline soaked sponge. The contact Nd:YAG laser with a round probe can also be used to eliminate the lesion by stroking the surface in a similar cross hatched manner without lifting the tip of the probe from the surface of the lesion[5].

Lichen Planus

Erosive lichen planus can be controlled by laser treatment. Carbon dioxide laser should be used along with selected local and systemic medications. This laser is set on a continuous, defocused mode and the usual cross hatched pattern is used. The contact Nd:YAG laser with round probe can also be used. This condition cannot be cured by laser treatment; it is used for palliative treatment. It has been reported from patients that there is a significant decrease in burning sensation from the lesion. Hong-Sai reported that there is an improvement in the histologic appearance after laser therapy[5].

Recurrent Aphthous Ulcers

The ulcer is painful on palpation. Recently Low Level Laser Therapy(LLLT) has been used. It helps in immediate pain relief and accelerates wound healing. According to De Souza et al, 75% of the patients reported that there is a significant pain relief in the same session after laser treatment and the lesion is totally regressed in 4 days. When steroids are used, it takes 5-7 days for regression [9]. Bladowski et al also found that diode laser used at low levels reduces the wound healing period to half compared to pharmaceutical method[10].

Recurrent Herpetic Simplex Lesions

Various lasers wavelengths have been found to be effective in treating these lesions including HeNelaser(660nm)and Erbium:YAG laser (2940nm)[14,15].

Mucocele

Laser treatment can be done to remove mucoceles. The mucocele can be unroofed and then excised with the gland tissue using Laser HF[5]. This laser uses high frequency technology which helps in precision cutting and reduces the risk of necrosis. The lesion is excised using fibroma removal mode(975nm, continuous wave). The wound margins are sealed with a defocussed beam without side effects or complications. Re-epithelialization takes about three weeks[5].

Oral sub mucous fibrosis

The condition is well recognized for its malignant potential and is particularly associated with areca nut chewing, the main component of betel quid. Betel quid chewing is a habit practiced predominately in Southeast Asia and India. Diode Laser is a treatment for Oral Submucous Fibrosis[16].

Oral cancer

Oral cancer in particular is a highly prevalent neoplasm. Standard treatment for most of the tumors is radical surgery combined with stage-based neo-/adjuvant therapy. Laser surgery has become a reliable treatment option for oral cancer as well as for precancerous lesions. The use of lasers in tumor surgery has several advantages: remote application, precise cutting, hemostasis, low cicatrization, reduced postoperativepain and swelling, can be combined with endoscopic, microscopic and robotic surgery. CO2 and Er-YAG lasers are mainly absorbed by water, resulting in a minimal penetration depth and fast heating, with effective removal of soft and hard tissue. CO2 lasers are mainly used as laser scalpels for the excision of tumors from soft tissues[5, 6, 15, 16]. In a defocused mode, CO2-lasers are used for superficial tissue vaporization, to treat precancerous lesions in the oral cavity[3, 4]. The Er-YAG laser seems to be a highly efficient tool for cutting both soft and hard tissues with minimal damage to the surrounding tissue. Nd:YAG lasers emit light at a wavelength range of 1064 nm, which is in-between the absorption maxima of water and blood. The penetration depth is therefore deeper than that of CO2- or Er:YAG lasers and may reach 4 mm, with the possibility of a larger zone of damage to the surrounding tissue. However, due to a higher potency of coagulation, Nd-YAG-lasers are recommended for tissue resection in cases of hemorrhage. Nd:YAG lasers are used for the excision of cancer in a focused mode as well as for the removal of precancerous lesions in a defocused mode[17].

Preprosthetic surgeries

Soft tissue surgery may be performed with any of the soft tissue lasers. Osseous surgery may be performed with the erbium family of lasers. Erbium laser is the laser of choice for the osseus reduction.

Dental Implantology

A. Implant recovery: One advantage of use of lasers in implantology is that impressions can be taken immediately after second stage surgery because there is little blood in the field due to the haemostatic effects of the lasers. There also is minimal tissue shrinkage after laser surgery, which assures that the tissue margins will remain at the same level after healing as they are immediately after surgery.

B. Implant site preparation: Lasers can be used for the placement of mini implants especially in patients with potential bleeding problems, to provide essentially bloodless surgery in the bone.

C. Removal of diseased tissue around the implant: Lasers can be used to repair ailing implants by decontaminating their surfaces with laser energy. Diode, CO2 &Er:YAG lasers can be used for this purpose. Lasers can also be used to remove granulation tissue in case there is inflammation around an already osseointegrated implant.

D. of socket: In immediate implant dentistry after extraction of tooth, without any infection, socket can be sterilized immediately without any pain.

E. PeriImplantitis: Since the laser does not transmit damaging heat, it can be utilized to vaporize any granulation tissue as well as clean the implant surface in peri-implantitis cases. This procedure eliminated the acute state of periimplantitis, resulting in positive GTR, and allowing the patient extended use of the implant.

F. Sinus lift procedure: Lasers can also be used

in the sinus lift procedure. The procedure can be done by making the lateral osteotomy with a decreased incidence of sinus membrane perforation.

The yttrium-scandium-gallium-garnet (YSGG) laser is the optimal choice for not cutting the sinusmembrane.The YSGG laser can also be used to make the osteotomy for a ramal or symphyseal block graft. Bone grafts done with lasers have been demonstrated to decrease the amount of bone necrosis from the donor site and the osteotomy cuts are narrower, resulting in less postoperative pain and edema[18].

Excisonal procedure

- Multiple pyogenic granulomas
- Excision with carbon dioxide laser

Lasers on bio stimulation

- Biostimulation may be useful for improving healing with in the oral cavity *Gamaleya 1977* Positive results in the treatment of recurrent apthous stomatitis with soft lasers *Korytny 1978*
- High therapeutic efficiency and shortening of diseases duration when mucosal disease such as acute herpetic stomatitis, exudative erythema multiforme and gingivitis were treated in children with low energy lasers *Lutsyl 1981.*

Recent Advances

Waterlasesystem is a revolutionary dental device that useslaser energized water to cut or ablate soft and hard tissue.Periowave, a photodynamic disinfection system utilizes nontoxic dye (photo sensitizer) in combination with lowintensity lasers enabling singlet oxygen molecules todestroy bacteria[19]

CONCLUSION

Lasers have shown rapid strides in technological advances since its inception in 1960's. The emergence of lasers with variable wavelengths and its wide application in the management of oral lesions may influence the outcome of treatment and treatment planning of patients. The exponential progress in laser technology has enabled oral & maxillofacial surgeons to treat lesions that were previously deemed untreatableand produced poor results.Thousands of patients including children have been benefitted with laser technology. In the future, it is likely that continued improvements in laser technology will bring about revolutionary change in the approach towards managing oral lesions.

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