ISSN: 2581-5989
PubMed - National Library of Medicine - ID: 101738774

International Journal of Dental Science and Innovative Research (IJDSIR)
IJDSIR : Dental Publication Service
Available Online at: www.ijdsir.com
Volume – 6, Issue – 2, March - 2023, Page No. : 317- 327

Efficiency of diode lasers in oral and maxillofacial surgery

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Citation of this Article: Dr. Soumya Sulibhavi, Dr. Santosh S Gudi, Dr. Girish Chour, Dr. Bheemappa FB, Dr. Soumya Desai, Dr. Rahber Firdous, "Efficiency of diode lasers in oral and maxillofacial surgery", IJDSIR- March - 2023, Volume – 6, Issue - 2, P. No. 317 – 327.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Semiconductor Diode Lasers (Gallium arsenide, gallium - aluminum arsenide) are portable compact surgical units with efficient and reliable benefits. The precise wavelength depends upon the material used in the semiconductor Lasers. The beam from the Diode Laser is usually more divergent than that of the other Lasers, requiring additional optics to produce a collimated output beam. The Diode Laser wave lengths are very well absorbed by pigmented tissues, haemoglobin and melanin, which makes the Diode Laser suitable for soft tissue surgery, endodontics, periodontics and low-level Laser therapy.

The present study was conducted on 100 patients to evaluate the efficacy of diode lasers in maxillofacial surgical procedures. The procedures with the Diode Laser were carried out under local anesthesia with different power settings based on the type of the surgery.

Follow up was done on 3rd day, first week, second week, and 1 month for evaluation of pain, swelling, infection, and healing at surgical site.

In this study using Diode Lasers showed the depth and amount of soft-tissue ablation can be more precisely controlled, due to its easy application, adequate coagulation, no need to suture in most of the cases, less in flammation and pain, low time of treatment, better repair and recovery and the rare intra-operative and post-operative complications.

It is an effective and predictable method when per forming surgeries in oral soft tissues.

And hence We conclude that the clinical application of the Diode Laser in oral and maxillofacial surgical procedures seems to be of beneficial effect for daily practice as the depth and amount of soft-tissue ablation can be precisely controlled.

Keywords: Semiconductor, Diode Laser, Gallium Arse nide, Low Level Laser Therapy, Soft-Tissue Ablation.

Introduction

Various surgical instruments used for incision of oral mucosa have been compared for speed and ease of incision, degree of haemostasis and charring, acute soft tissue injury, pain, swelling and wound healing rates[1,2]. For soft tissue surgery, scalpels and a conventional electrosurgery unit are the instruments of choice. Lasers came in to the field of surgery as an alternative to conventional surgical systems. However, scalpels cannot provide the hemostasis that is helpful when used for highly vascular tissue. The advantages of using Lasers for soft tissue surgery include coagulation (and therefore a relatively bloodless surgery), sterilization of the surgical site, minimal swelling and scarring, minimal or no suturing and significantly reduced pain[3,4]. The need for haemostasis in highly vascular areas such as the head and neck region led to the wide- spread use of electro surgery. The conservative nature of the treatment accom plished with Laser has tremendous clinical advantages[54], and proponents of the Laser emphasize its inherent haemostatic effect with less peripheral tissue injury than with electrosurgery. This has led to claims of less postoperative pain, faster wound healing, less blood loss, and more rapid recovery. The Aim and Objective of this study was to evaluate the efficiency, usefulness and advantages of Diode Laser in oral & maxillofacial surgery (OMFS).

Materials and methods

The present study was conducted on 100 patients in the Department of Oral and Maxillofacial Surgery, P.M.N.M Dental College and Hospital, Bagalkot. Informed consent was taken from the patient before the procedure.

Selection criteria

Inclusion criteria

1. Medically fit patients.
2. Patients in the age group of 18 to 55 years.
3. Patients who were willing to participate in the study and surgical procedures included.

a. Excisional Biopsy
b. Incisional Biopsy
c. Frenectomy
d. Operculectomy
e. Incision for minor oral surgical procedures like:

- Alveolo plasty procedure
- For implant placement
- Surgical removal of impacted teeth
- Exposure of impacted canine
- For open reduction with internal plate fixation (ORIF)

Exclusion criteria

1. Medically compromised patients or not fit for treatment with Lasers.
2. Patients other than 18 to 55 years of age group.

3. Patients who were not willing to participate in the study.

Materials

DIODE LASER: In the present study, we used CHEESE II medical Diode Laser.

Technical specifications of laser used.

- Laser type: Gallium-Aluminum Arsenide (GaAIAs) - Semiconductor Laser
- Wavelength: 980+/- 10nm
- Output power: 0.1W – 10W
- Operation mode: CW, Single, Repeat
- Pulse width: 1ms- 1000ms or continuous
- Aiming beam: Diode Laser of 650nm+/-10nm, 4mW (max), adjustable brightness.
- Laser class: 4
- Fiber connector: SMA 905
- Hand piece: 400mm fiber

Surgical procedure

Intra oral mucosal incisions given for oral surgical procedures with Diode Laser, with pre-set manufacture's power settings (watt 4 to 5), the procedures were included like creas tal incision for al Veloplasty, excisional biopsy, incisional biopsy, frenectomy, operculectomy, incision for triangular flap in implant placement cases and surgical removal of impacted tooth, mucoperiosteal incisions or making button hole for exposure of impacted canine and vestibular incisions for ORIF. After completion of all the respective procedure the flaps were sutured with 3-0 Mer silk or 3-0 vicryl (round body) suture.

- Post-operative instructions were given.
- Patient advised for suture removal after 7 days (if me silk suture used).
- Antibiotics and analgesics prescribed in required cases.

Procedure: incisional biopsy with diode

Figure 1: laser pre-op lesion

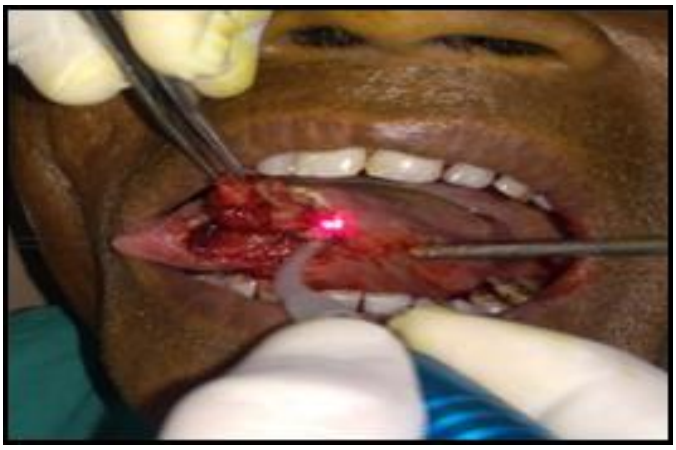


Figure 2: Biopsy with diode laser

Figure 3: 3RD Day follow-up

Figure 4: 2ND week follow-up

Results and discussion

- In our study, we included patients from 18 years to 55 years of age, the mean value (MV) being 36.23 years and the standard deviation (SD) value being 12.13.
- The mean and standard deviation values for the respective procedures are alveolo plasty (MV: 4.30, SD: 0.35), canine exposure (MV:4.67, SD:0.58), crown lengthening (MV: 2.80, SD: 0.27).

excisional biopsy (MV: 4.88, SD: 0.85), frenectomy (MV:5),incision for hybrid implant placement (MV:4.58, SD:0.38), incision for the surgical removal of impacted teeth(MV: 4.70, SD: 0.35), incisional biopsy (MV: 4.60, SD: 0.40), operculectomy (MV: 3.80, SD: 0.45), ORIF (MV: 5.80, SD: 0.45) (Table 4 and Fig.4)

- The mean value for pain score on the day of surgery was 1.28 with a SD of 0.70; on 3rd day was 0.85 with a SD of 0.61; after 1 week, 2 weeks and 1 month was 0.00 with a SD of 0.00
- Post-operative swelling was assessed on day of surgery, 3rd day, 1st week, 2nd week and one month. No swelling was noticed on the day of surgery in all the patients, and in 12% of patients develop swelling by 3rd day and which was absent in 86% of the cases. After the 3rd day, the swelling was significantly reduced thereafter and by the end of the 1st week, 2nd week and 1st month, no swelling was noticed.
- All the patients treated with the Diode Laser were assessed for post-operative infection during the follow up period. Incidence of post-operative infection was 0.00%.
- The change in the healing status was assessed by the healing index given by **Landry et al(1988)**. The healing status was good after 1 week in 45% of the cases, followed by 25% in the 2nd week and further 18% of the cases after one month. A 'very good' healing score was noted in 23% of the cases after 1 week, 16% of the cases after 2 weeks and 7% of the cases after a month
- There was statistically significant difference noted between the 1st week and 2nd week, 1st week and one month, and 2nd week and one month for healing status, assessed by Wilcoxon matched pairs test with z-value being 4.8599, 6.1539 and 4.1972 respectively and with p-value being for all the three comparative parameters was 0.0001.

which showed significant improvement in the healing status of all cases treated with Diode Laser, thus the study was statistically significant (p-value-0.0001) for healing parameter

- The mean difference between the pain scores on the day of surgery compared with 1st week, 2nd week, and one month was noted as 1.28 and SD being 0.70, the percentage change between either of the intervals being 100.00 % with z-value being 8.1470 and the p-value being 0.0001 for all the three comparisons, which indicates statistical significance for reduction in the pain. (P-value-0.0001)
- There was no difference noted on comparison between 1st week and 2nd week, 1st week and 1 month, 2nd week and 1 month, which showed there was significant reduction almost no pain. The p-value for all

the pain scores was 0.0001, thus the study was statistically significant for pain.

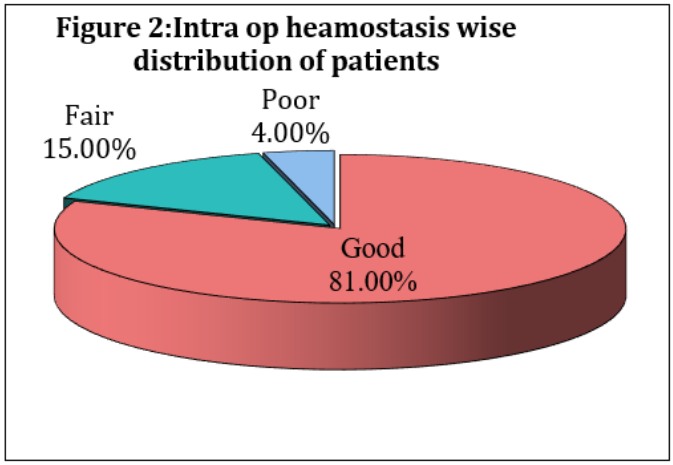
Table 1: Mean and SD Watt used of patients by procedures.

Procedure	Mean Watt used	SD Watt used
Alveolo plasty	4.30	0.35
Canine Exposure	4.67	0.58
Crown Lengthening	2.80	0.27
Excisional Biopsy	4.88	0.85
Frenectomy	5.00	0.00
Hybrid Implant	4.58	0.38
Impaction	4.70	0.35
Incisional Biopsy	4.60	0.40
Operculectomy	3.80	0.45
ORIF under LA	5.80	0.45
Total	4.59	0.74

Table 2: Intra op heamostasis wise distribution of patients

Intra op heamostasis	No of patients	% of patients
Good	81	81.00
Fair	15	15.00
Poor	4	04.00
Total	100	100.00

Graph 1:



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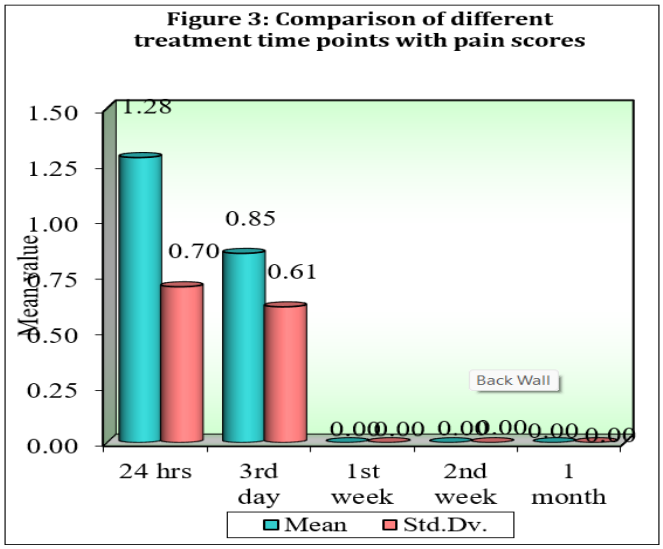

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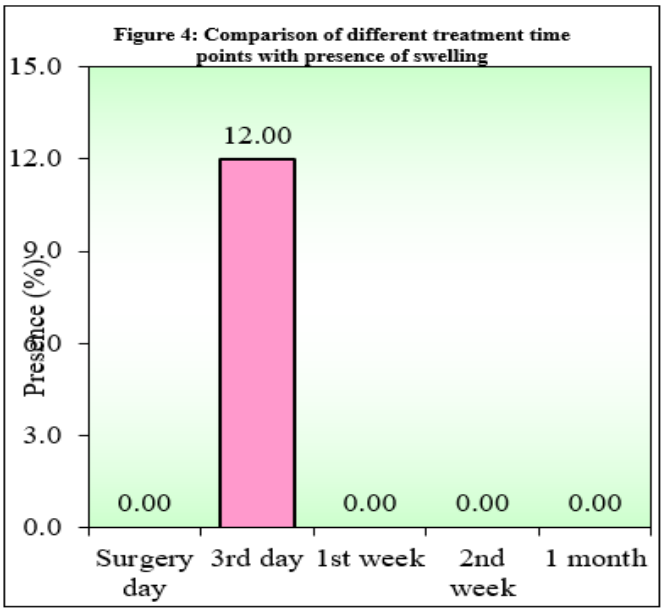
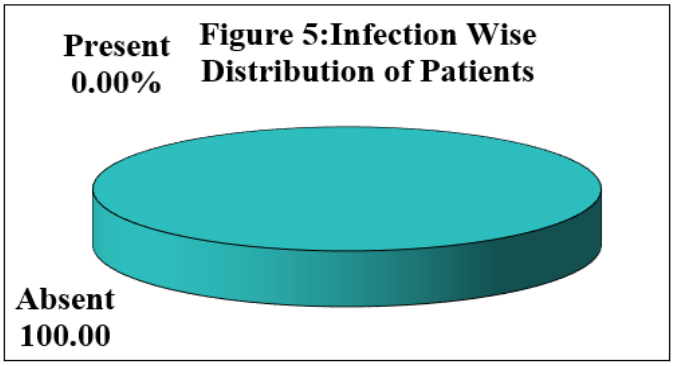
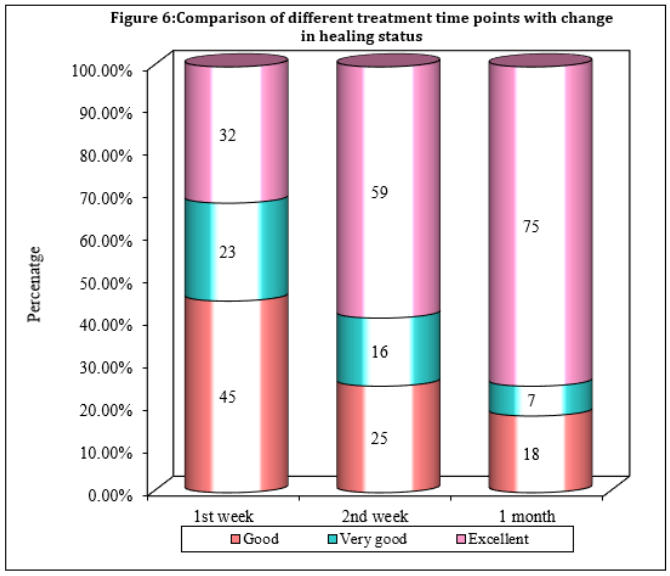


Graph 4:



Graph 5:



Discussion

Lasers have played an integral role in the practice of Oral & Maxillofacial Surgery than in any other dental specialty. Lasers are rapidly becoming the standard of care for many procedures performed by oral and maxillofacial surgeons. The reason for this transition is due to the fact that many procedures can be executed more efficiently and with less morbidity using Lasers as compared to a scalpel, electrocautery or high frequency devices.

Earlier Lasers were bulky and were used only for major cases in operating theatres; but today, access to small, portable, office-based Lasers with improved intraoral delivery systems have made it possible to treat even minor routine procedures in the clinic[12,13].

One of the applications of Lasers in OMFS is soft tissue surgery such as excision of exophytic lesions and ablation of lesions. The Laser transmits energy to the cells causing warming, welding, coagulation, protein denaturation, drying, vaporization and carbonization. Also, the Laser instantly disinfects the surgical wound as well as allowing a noncontact type of operative procedure and therefore no mechanical trauma to the tissue[10,14,15]. Hence Laser has numerous advantages such as coagulation, bloodless field, minimal swelling, scarring, reduction in surgical time, less or no post-surgical pain, no requirement of sutures.

The relatively new semiconductor Diode Lasers (GaAs, GaAlAs) are portable, compact, surgical units with efficient and reliable benefits. They are designed according to economic and ergonomic considerations and have reduced costs in comparison to other modern hard Laser equipment.

Diode Lasers have a wavelength between 805 and 980 nm. They can be used in the continuous as well as pulsed mode and according to the clinical indication with a contact or noncontact handpiece[8]. The study by Desiate A et al[8] provided correct selection and application of Diode Lasers in soft tissue oral surgical procedures.

The haemostatic ature of the Laser is of great value in OMFS[11] as it allows the surgery to be performed more precisely and accurately due to increased visibility of the surgical site. This particular character is very useful in cases of hemangioma or in removal of inflamed epulis fissurata, or any procedure involving incision of the tongue, soft palate and tonsillar pillars.

The normal lateral thermal damage due to Laser results in contraction of collagen that is contained within vascular walls and is manifested by constriction of vascular lumen, resulting in the sealing of blood vessels up to 500 micrometres in diameter. The capillary and small venous vascular lesions are coagulated, allowing for enbloc excision of the vascular lesions. Also Laser is particularly applicable in patients who have coagulation disorders, decreasing the potential blood loss compared with scalpel surgery[53].

Strauss. R. A et al[11] showed that Lasers generally result in blood less surgical field. The Laser can be used as a haemostatic tool to stop bleeding in the field and to allow for similar postoperative wound management in other modalities of treatment. The cause of hemostasis is

the contraction of the vascular wall collagen rather than the coagulation of blood.

Sebnam Erchalik Yalcinkaya et al[12] showed that the Lasers, although having penetration depth of only about 0.1 to 0.2 mm, have higher affinity for wet tissue and hence they are highly absorbed in oral mucosa which is more than 90% moist. It allows the precise removal of tissue in a virtually blood less field, thus the mucosa can be removed easily & thoroughly for a constant depth, while the damage to the surrounding tissue is minimal.

The study by Fornaini C et al[17] showed that the use of Laser technique in exposure of impacted teeth has several advantages such as allowing selective inter vention, minimal invasion and preservation of Perio dontal tissue. The greatest of the advantages being the complete absence of bleeding, thus providing a dry field for immediate bonding of orthodontic brackets to enamel, hence preventing the chances of detachment and reducing the risk of a further re-exploration, thus being positively related to the success of the therapy[17].

Mazarei Sotoode Set al[17] shows that complete removal of benign exophytic soft tissue lesions with Diode Laser has been associated with reduced healing time and minimal bleeding. Eliades A et al[9] showed that the use of Diode Laser was promising in the field of oral soft tissue surgery with advantages of minimal blood loss and minimal discomfort to the patient.

The whole procedure was performed without pain and that no sutures were necessary. Haemo stasis was optimum immediately after the removal of the lesions.

In this study, the use of Diode Laser in OMFS allowed increased surgical precision and accuracy, thereby reducing unnecessary damage to underlying tissues with the procedure including no bleeding in a majority of the cases (96%), thus resulting in improved visualization of the surgical field, eliminating the need for post-op sutures, and shortening the operation time

Diode or therapeutic Lasers, also called biostimulators have an anti-inflammatory effect, being highly efficient in the rapid healing of wounds as well as the reduction of acute and chronic pain based on their photo-bio stimulating activity. Anti-inflammatory Laser activity is based on the reduction of prostaglandin (PGE2) release, changing the direction of arachidonic acid. It has been proven that in acute inflammatory conditions Laser lowers the activity of tumor necrosis factors (TNFs). The changes in activity of neuro transmitters especially sero tonin, beta-endorphin and acetylcholinesterase result in its analgesic mechanism. Diode Laser causes the transient variation along the neuron, resulting in the disturbance of transmission signals as well as the inhibition of complex reactions thus setting up an action potential[11,52].

Amarillas Escobar et al[51] found that the use of therapeutic Laser in the post operative management of patients after the surgical removal of impacted third molars markedly reduced pain. Markovic And Todorovic et al[49] reported the effect of Lasers in decreasing post-operative pain and trismus and minimizing edema after third molar surgery. According to Ishii et al[50], vaporization by Laser causes minimal damage to the adjacent tissues thus reducing the acute inflammatory reactions and post-operative pain. Sealing of nerve ending reduces postoperative pain.

Antimicrobial effect of Laser is based on the concept of nontoxic photosensitizer, which bears a positive charge, can directly target both gram-positive and gram-negative bacteria. After exposure to the light of an appropriate wavelength, the photosensitizer is activated, resulting in high energy or electron transfer to available molecular oxygen with consequent formation of high reactive

oxygen such as singlet oxygen and free radicals. This process produces a cascade of oxidative events that causes damage to intracellular proteins, membrane lipids, and nucleic acids. Apart from decontamination efficacy, Laser therapy has shown great promise in the removal of the smear layer and debris. The removal of the smear layer facilitates the antibacterial effect[52].

Laser induced wound healing is excellent because of a definite and clean wound, generally healing with secondary intention with no scar formation compared to scalpel incisions. This may be due to the minimal degree of wound contraction following Laser irradiation which occurs through induction and formation of smaller number of myofibroblasts and collagen[23,24].

Tissue healing and scarring is also improved with the use of Laser[22]. This improvement is due to combination of decreased lateral tissue damage, less traumatic surgery, more precise control of the depth of tissue damage, and fewer myofibroblast in Laser wounds when compared to scalpel wounds

Overall, the plus point of Laser includes a bloodless surgical and postsurgical course, the ability to seal nerve endings and lymphatics, minimal swelling and scarring, maintenance of the elastic tissue properties, coagulation and minimal cutting or no suturing in most surgical procedures, reduction in surgical time, reduction in the need for postoperative analgesics/narcotics, and reduced bacterial count[17,33].

The advantages of using Laser surgery are as follows: less or no post-operative pain due to the sealing of the sensory nerve endings with the heat of the Laser beam[26]more precise and visible cuts[27]; diminished hemorrhage which provides better vision for operator[28]; little post-operative edema; minimal or no suturing; less anesthesia and minimal risk of infection due to the Laser's capability of sterilization[29].

Conclusion

Laser technology has made rapid progress over few past decades, and Lasers have found a niche in many surgical specialties. Because of their many advantages, Lasers have become indispensable in oral and maxillofacial surgery (OMFS) as an additional modality for soft tissue surgery. The Diode Laser can be used with very good results in oral and maxillofacial surgery for the removal of soft tissue lesions, being especially used in small exophytic lesions, in Esthetic procedures, such as the recontouring or reshaping of gingival, in crown lengthening, frenectomy, etc. Using Lasers, the depth and amount of soft-tissue ablation is more precisely, due to its easy application, adequate coagulation, less inflammation and pain, low time of treatment, better repair and recovery and the rare intra-operative and post-operative complications, is an effective and predictable method when performing surgeries in oral soft tissues. Therefore, Diode Lasers are becoming a tool present in routinely clinical practice. However, further comparative studies are still needed, mainly to assess their long-term efficacy. We evaluated and conclude that the clinical and surgical application of the Diode Laser in oral and maxillofacial surgery seems to be of beneficial effect for daily practice especially for minor surgical procedures.

Abbreviations

OMFS: oral and maxillofacial surgery

GAAS: gallium arsenide

GAALAS: gallium-aluminum arsenide

LLLT: low level laser therapy

SD: standard deviation

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