

Effectiveness of Diode Laser in Intraoral Soft Tissue Surgeries - An Evaluative Study

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Abstract

Introduction: The clinical application of the diode laser seems to have beneficial effects in surgery. The laser provides precise and rapid tissue dissection, excellent haemostasis and lessens post-operative inflammation. This study was done to assess the clinical effectiveness of diode laser in the management of different varieties of intraoral soft-tissue lesions. **Materials and Methods:** After applying exclusion criteria, a total of 50 samples were selected with benign intraoral soft-tissue lesions treated with a diode laser under local anaesthesia between September 2017 and September 2020. Each patient was followed up on the 3rd, 7th and 15th post-operative days for healing, pain, infection and swelling. **Results:** From all patients, a total of 50 were evaluated in the study; out of all, 60% of patients had no pain on the 2nd follow-up. As per the Landry Index of Healing, 54% of patients had excellent healing. None of the cases had post-operative bleeding, infection was present in 4% at the 1st-2nd follow-up, and in 2% of cases, post-operative swelling was present. The efficacy of diode lasers was tested using the Chi-square test and $P < 0.01$, which was statistically significant. **Discussion:** Diode laser seems to be superior over conventional treatment modalities as it provides a bloodless dry field and increases patient comfort during surgery. It also lessens the post-operative pain and swelling. Diode laser can safely and effectively be used as a treatment modality for benign soft-tissue lesions, without any complication and without compromising the health and function of patients.

Keywords: Diode laser, intraoral surgery, soft tissue

INTRODUCTION

The inclusion of lasers in oral and maxillofacial surgery has been since the mid-1960s.^[1-3] A laser is a device that emits light (electromagnetic radiation) through a process of optical amplification based on the stimulated emission of photons.^[4] Its effects on the biological tissue depend on the wavelength of the monochromatic light that can be reflected, scattered or absorbed.^[5] The advantages of laser are precise and rapid tissue dissection, a bloodless field due to sealing of blood vessels, so it reduces the surgical site morbidity and lessens the post-operative inflammatory sequelae such as pain, swelling and post-operative infection; hence, it offers excellent patient acceptance.^[6-9] Lasers are being widely used for intraoral soft-tissue procedures, including gingivectomy, frenectomy, gingivoplasty, gingival depigmentation, epulis, benign tumour removal, second-stage implant exposure, irradiation of aphthous ulcer, coagulation of free gingival graft of donor sites and soft-tissue crown lengthening.^[5,10-14]

In this study, various soft-tissue lesions have been included and treated with a diode laser, and the result was evaluated. The diode laser has high absorption in tissues pigmented with haemoglobin, melanin and collagen chromophores and low absorption in dental hard tissues with a cutting depth of 2–6 mm.^[15]

MATERIALS AND METHODS

This evaluative study was conducted after approval of the protocol by the Institutional Review Board (No.

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KSDEC/17-18/Apr/29); a total of 50 patients were selected as per the exclusion criteria of the study from September 2017 to September 2020. Follow-up was taken of patients on the 3rd, 7th and 15th day postoperatively to assess pain, wound healing and post-operative complication. The efficacy of diode lasers was tested by the use of the Chi-square test and $P < 0.01$, which is a statistically and clinically significant value.

The aim of this study was to assess the clinical effectiveness of diode lasers in the management of soft-tissue intraoral lesions. The main objectives are to check for bleeding at the surgical site during and after treatment, to check for post-operative pain, infection and healing and to check for tissue scarring and patient acceptance.

Inclusion criteria included benign soft-tissue lesions irrespective of size, site and shape, random patients irrespective of age, sex, aetiology and socio-economic status, lesions that can be managed under local anaesthesia and patients agreeable for follow up. Exclusion criteria was malignant lesions.

Fifty patients on the basis of the inclusion and exclusion criteria of the study and thus different patients of soft-tissue intraoral lesions were selected. The patients underwent laser treatment with the removal of soft-tissue lesions with a diode laser tip. Patients were followed up on the 3rd, 7th and 15th post-operative days for healing, pain, infection and swelling.

The patients selected for the study underwent ablation by diode laser. Local anaesthesia with adrenaline (1:100,000) infiltration was given at the site of the lesion. Pre-surgical workup with betadine was done. Laser ablation was done with a diode laser unit having a wavelength of 980 nm; input voltage DC 26V/4A and fibre core diameter $\geq 200 \mu\text{m}$ were used in continuous mode (paint brush manner) with light hands and lesion gradually ablated from mucosa by thermal energy. A gauze piece wet with normal saline was used to keep wiping out the ablated tissue so that a clear surgical field was easily maintained. The wound was allowed to heal secondarily.

Pre-operative and post-operative pain, haemostasis and healing were followed up on the 3rd post-operative day. Healing after seven days and 15 days was indexed on the basis of the Healing Index by Landry and pain measure with a Visual Analogue Scale.

RESULTS

In this study, we have used a diode laser 980 nm wavelength to treat 50 patients with various oral soft-tissue lesions [Table 1 and Figures 1-4].

Seven (14%) patients had mild pain (burning sensation), 2 (4%) patients had moderate pain and 41 (82%) patients had no sensation during laser application. Thirty-seven (74%) patients had noticed mild-to-moderate (nagging uncomfortable) pain, 3 (6%) patients had moderate pain and 10 (20%) patients had no pain on the 1st follow-up (3rd post-operative day). Twenty (40%) patients had mild annoying pain to discomfort, and 30 (60%) patients had no

Table 1: Details of all patients included in the study

Soft tissue lesion	Number of patients (%)
Fibroma	18 (36)
Leucoplakia	13 (26)
Pyogenic granuloma	7 (14)
Mucocele	6 (12)
Tooth exposure	3 (6)
Papilloma	2 (4)
Verrucous hyperplasia	1 (2)
Total	50

pain on the 2nd follow-up (7th post-operative day). None of the patients had pain on the 15th post-operative day [Table 2].

Seventeen (34%) patients had poor, 30 (60%) patients had good and three (6%) patients had very good healing according to the Landry index on the 1st follow-up (3rd post-operative day). Two (4%) patients had poor, 12 (24%) patients had good, 28 (66%) patients had very good and 8 (16%) patients had very good healing according to the Landry index on the 2nd follow-up (7th post-operative day). Two (4%) patients had good, 21 (42%) patients had very good and 27 (54%) patients had excellent healing according to the Landry index on the 3rd follow-up (15th post-operative day) [Table 3].

Thirteen (26%) out of 50 patients had mild bleeding intraoperatively. Post-operative bleeding was not seen in any of the patients out of 50 [Table 4].

There was only one case of angiolipoma in which suturing was done. Post-operative complications infection was present in 2 (4%) patients on the 3rd and 7th post-operative days, and in 1 (2%) patient, post-operative swelling was present [Table 4].

DISCUSSION

This study presents our clinical experience from the application of diode laser (980 nm) in the field of oral and maxillofacial surgery. Various kinds of lasers [Carbon dioxide lasers, Nd: YAG lasers, Ho: YAG lasers, Er: YAG lasers, Alexandrite lasers Argon, KTP] are used in different surgeries, but CO₂, Nd: YAG and Diode lasers are used in the oral cavity most frequently.^[16-21]

Lasers provide improved haemostasis through enhanced coagulation [Table 4]. Similar studies have been done by Koppolu *et al.*, and Reddy *et al.*, showing similar results.^[22,23] Coagulation occurs when tissue absorbs a controlled heat build-up, resulting in coagulation of blood proteins and sealing of small diameter vessels. At a temperature above 60°C, enzymes, cytokines and other bioactive molecules are instantly denatured due to photocoagulation.^[4,22,23] Laser damage to erythrocytes attracts a population of platelets which encourage intraluminal thrombosis, further decreasing the blood loss. This explains why the laser wound had minimal blood loss in comparison to the scalpel, and this is especially important in our study because lasers provide excellent haemostasis.^[23]

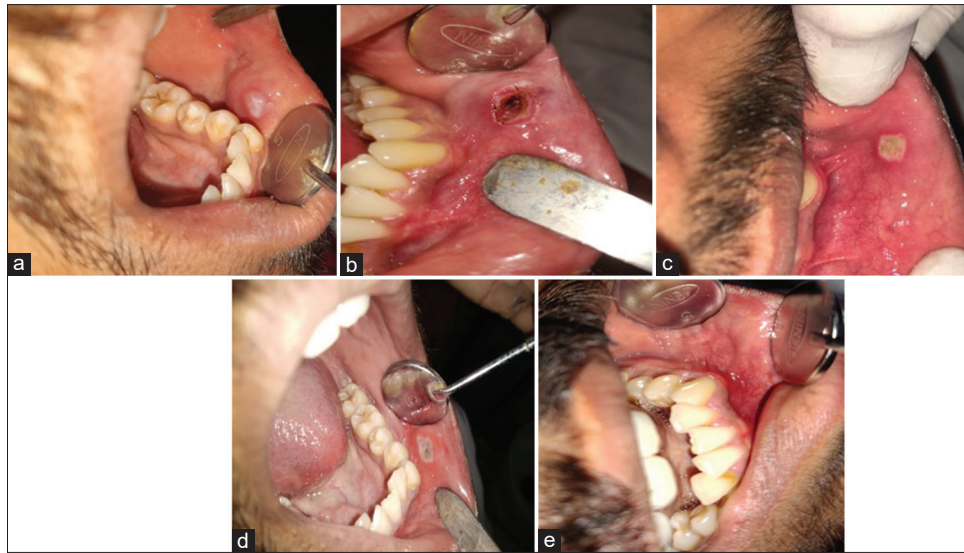


Figure 1: Case 1 - MUCOCELE excision. (a) Pre-operative photograph. (b) Immediate after excision. (c) Follow-up after 3 days. (d) Follow-up after 7 days. (e) Follow-up after 15 days

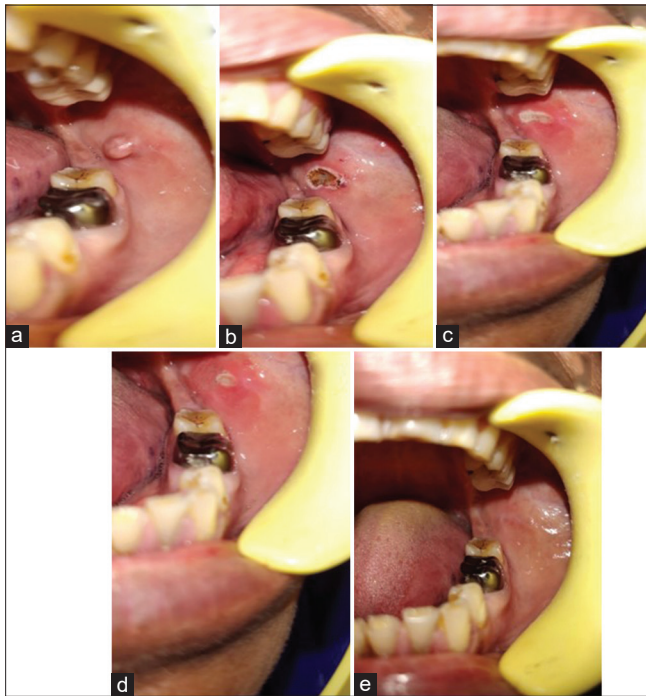


Figure 2: Case 2 - FIBROMA excision. (a) Pre-operative photograph. (b) Immediate after excision (c) Follow-up after 3 days (d) Follow-up after 7 days. (e) Follow-up after 15 days

There was one case of angiolipoma in this study, which required suturing. During soft-tissue procedures, adequate haemostasis is produced without the need for sutures. Care should be exercised to avoid collateral thermal damage from excessive power and pulse repetition rate.^[24,25]

Statistically significant less pain is noticed after the 7th–15th post-operative day [Table 2]. Similar studies have been done by Pradeep Koppolu and Reddy *et al.*, showing similar results.^[21-23] The study done by White JM *et al.*, in which patients

received both Nd: YAG laser and scalpel surgical techniques; most laser-treated sites evoked minimal discomfort without anaesthesia, while scalpel surgery required anaesthesia. Reports of pain relief mechanisms appear to originate in stimulating oxidative phosphorylation in mitochondria and through modulating inflammatory responses. Various studies reports of positive patient responses to laser treatment are usually dismissed by critics because of the impossibility of implementing a controlled study.^[26]

Since a predominant cause of dental disease is attributed to pathogenic bacteria, treatment success involves reducing micro-organisms. Using lasers for surgical techniques can produce tissue temperatures effective for reducing bacteria. However, bacterial reduction has been found to occur at temperatures as low as 50°C. Furthermore, bacterial reduction has been demonstrated in both *in vitro* and *in vivo* clinical studies. Antimicrobial activity occurs primarily through photothermal effects due to absorption.^[24,27]

It is generally accepted that opportunistic bacteria can contribute to post-operative infections. Treatment success often involves reducing such pathogenic bacterial species through prescribed antibiotics and rinses. Because laser energy has been shown to reduce bacteria, fewer risks of post-operative infections occur.^[25,27] In this study, infection was present in two patients on the 3rd and 7th post-operative days, and in one patient, post-operative swelling was present [Table 4].

The optimal appearance of a post-operative laser surgical site will be pink in the zone of ablation that may be accompanied by a superficial layer of coagulum, which may serve to protect the surface. Depending on different laser parameters and the type of wavelength, coagulum layers can range from 0.01 to 1.0 mm thick, which aids in haemostasis. As healing occurs, regardless of device, physiologically, a zone of reversible oedema surrounds the surgical site.^[24,28] In a study comparing

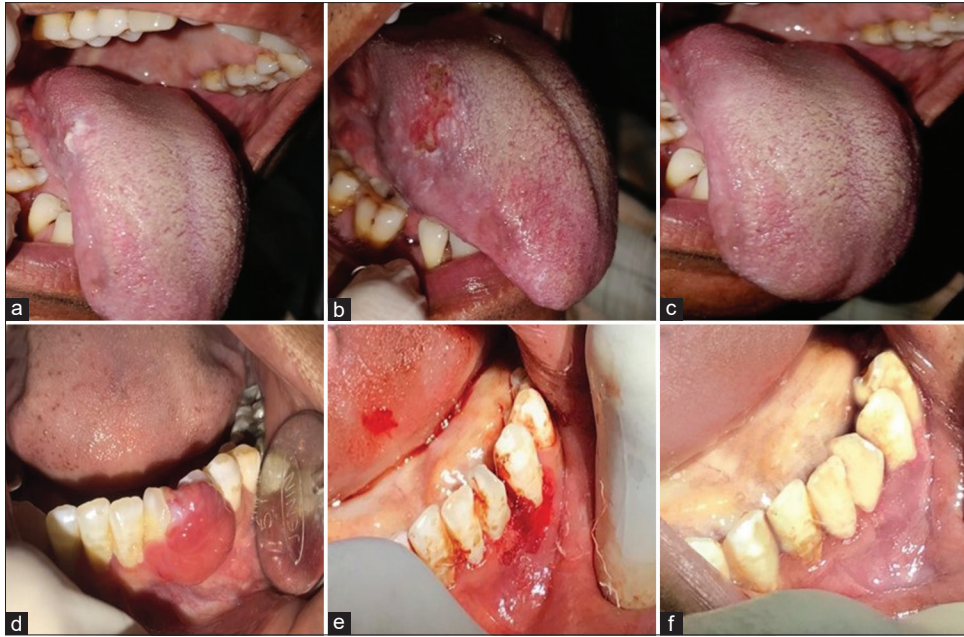


Figure 3: Case 3, 4 - Ablation of leucoplakia (a-c) and excision of pyogenic granuloma (d-f). (a and d) Pre-operative photograph. (b and e) Immediate after excision. (c and f) Follow-up after 15 days

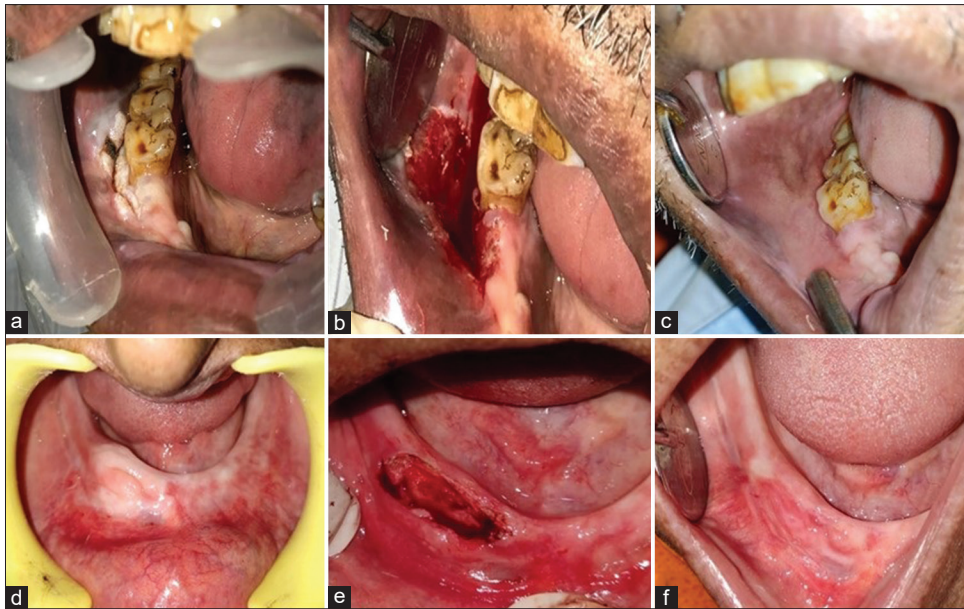


Figure 4: Case 5, 6 - Excision of verrucous hyperplasia (a-c), correction of the flabby ridge (d-f). (a and d) Pre-operative photograph. (b and e) Immediate after excision. (c and f) Follow-up after 15 days

wound healing after scalpel, electrosurgery and Nd: YAG laser surgery in beagle dogs, it was shown that surgical sites appeared to be clinically healed 14 days postoperatively.^[24,29] However, histologically, the electrosurgery site continued to have a high degree of inflammatory infiltrate. Immediately, postoperatively, the laser can offer protection to the surgical site through a coagulum surface and, as mentioned previously, bacterial reduction. Studies have shown additional benefits with laser use, such as minimal wound contraction and minimal scarring when compared to scalpel surgery.^[27-30]

Out of 50 cases, five cases were of leucoplakia in buccal mucosa, in which a second application of laser was required. Different definitions for recurrence may result in different rates reported in the literature.^[31-33] Similar results are shown in studies by Yang *et al.*, and Monteiro *et al.*, some patients treated with laser can recur. Chiesa *et al.*, concluded in their study that the age of the operated patients and the size of resected lesions are significantly predictive for the development of relapses and new leucoplakia.^[34,35] The small portable size of the unit is beneficial for the surgeons, and apart from that, diode laser is more economical

Table 2: Pain assessment on the basis of the Visual Analogue Scale

VAS	Pain			
	Intraoperative (pain/burning sensation), n (%)	Post-operative day 3, n (%)	Post-operative day 7, n (%)	Post-operative day 15, n (%)
0	41 (82)	10 (20)	30 (60)	50 (100)
1-3	7 (14)	37 (74)	20 (40)	0
4-6	2 (4)	3 (6)	0	0
7-9	0	0	0	0
10	0	0	0	0

0: No pain, 1-3: Mild, 4-6: Moderate, 7-9: Severe, 10: Worst pain, VAS: Visual Analogue Scale

Table 3: Assessment of healing

Healing index	Healing		
	Post-operative 3 day, n (%)	Post-operative 7 day, n (%)	Post-operative 15 day, n (%)
1	0	0	0
2	17 (34)	2 (4)	0
3	30 (60)	12 (24)	2 (4)
4	3 (6)	28 (56)	21 (42)
5	0	8 (16)	27 (54)

Healing index by Landry - 1: Very poor, 2: Poor, 3: Good, 4: Very good, 5: Excellent

Table 4: Post-operative complication

Post-operative Complaints	Number of patients, n (%)	Follow up
Bleeding post-operative	0	0
Swelling	1 (2)	Post-operative 3 rd day, 7 th day
Infection	2 (4)	Post-operative 3 rd day, 7 th day

Infection - 1: No, 2: Mild, 3: Moderate, 4: Severe, Swelling - 1: No, 2: Mild, 3: Moderate, 4: Severe, Bleeding - 0: No bleeding, 1: Mild bleeding

than other lasers. An additional advantage of laser use in practice is the psychological effect on the patient. It instils greater confidence in the mind of the patient for the doctor who is seen as using the latest and sophisticated equipment for treatment.^[35]

CONCLUSION

Good intraoperative haemostasis is achieved following the application of a diode laser, thereby avoiding the use of sutures that, in turn, significantly reduces the time of surgery. Post-operative pain was also significantly reduced, and no signs of post-operative infection were noticed when compared to surgical excision. Thus, the application of diode laser shows excellent results with healing and hence can be used in the management of oral soft-tissue lesions.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given her

consent for her images and other clinical information to be reported in the journal. The patient understands that name and initials will not be published and due efforts will be made to conceal identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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