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Original Article

Evaluation of Wound Healing Following Surgical Excision of Oral Soft Tissue Lesions using Diode Laser (980nm)

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ABSTRACT:

Aim: The aim of the study is to evaluate the wound healing following surgical excision of oral soft tissue lesions using diode laser (980nm). **Materials and Methods:** The study was conducted in the Department of Oral and Maxillofacial Surgery at our centre in Bangalore from November 2016 to August 2018. Thirty patients who were indicated for excisional biopsy were enrolled in the study. Excisional biopsy procedure was performed using the diode laser 980nm set at the power output of 3 W and operated in continuous mode under local anesthesia. Wound healing was evaluated on 1st, 3rd, 7th day and 1month postoperatively. **Results:** In our study there was a statistically significant result in terms of hemostasis, reduction in mean surgical time, faster wound reepithelization and wound healing and less or no post-surgical pain providing ease of operation, field of visibility towards the operator and comfort towards the patient on excision of oral soft tissue lesions using diode laser 980nm. **Conclusion:** Within the limits of our present study, it is possible to conclude that 980 nm diode laser can be safely and effectively used as a treatment modality for oral soft tissue lesions, without any complication. Thus, providing adequate ease of operation with good visibility, wound reepithelization and healing with comfort towards the patient.

Key Words: Diode Laser, Surgery, Biopsy, Wound healing.

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INTRODUCTION

LASER's have made tremendous progress in the field of dentistry and have turned out to be crucial in Oral Surgery as a collateral approach for soft tissue surgery. The relatively new Diode LASER's are semiconductors, mainly with GaAs compounds and mixed crystals. The most commonly used wavelengths are 810, 940 and 980nm, because these wavelengths are very well absorbed by pigmented tissues, haemoglobin and melanin, which makes the diodes suitable for soft tissues surgery, Endodontics, Periodontics and LLLT.[1]

LASER excision is most desirable for any solid, exophytic lesion because of the improved visibility and precise control of tissue removal. The advantages of LASER application are relatively bloodless surgery, minimal swelling and scarring, coagulation, no need for suturing, reduction in surgical time and less or no post-surgical pain. 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.[2]

Wounds produced by the diode laser behave in a different manner than those produced by the scalpel. The acute inflammatory reaction is delayed and minimal; few myofibroblasts are present, and there is little wound contraction. Only small amounts of collagen are laid down, resulting in little scarring or restriction in movement of the soft tissues.

Considering that diode LASER excision, (1) is most desirable for any solid, exophytic-type lesion due to numerous advantages, (2) only have a few clinical studies published, and (3) restores the oral soft tissue structural integrity by avoiding sutures. This study was conducted to evaluate the efficacy of diode LASER towards wound healing on excision of oral soft tissue lesions.

MATERIALS AND METHODS:

Thirty patients of age group 18 to 60 years, both male and female with soft tissue lesions in the oral cavity were included in the study. All the lesions were indicated for excisional biopsy and were referred to the department of Oral and Maxillofacial Surgery, The Oxford Dental College, Bangalore. Type of lesions included in the study were Benign oral soft tissue lesions. The procedure was explained to the patient in the patient's own vernacular language and informed consent was obtained. The patients were informed that they could withdraw from the study at any given time. Detailed case history was taken prior to the procedure. Routine blood investigations were done. We used the diode laser DOCTOR SMILE SIMPLER (980nm) which is a portable unit with direct operating touchscreen selection **(Fig 1).** The maximum output power was 8W and had a continuous as well as a pulsed mode. The optic fiber used was 300µm. The procedure was performed under local anesthesia (lignocaine 2% with 1:200,000 adrenaline) using topical anesthesia, infiltration technique or field block.

The diode laser 980nm was set at 3W power and operated in continuous mode. The patient, operator and the assistant were given safety instructions for use of laser. All three were supplied with protective eyewear for the said laser. The laser beam was guided through a quarz- fiber (300µm), which makes it easier to reach problematic zones in the oral cavity. The activated laser tip was directed at an angle of 10-15 degrees to the tissue lesion **(Fig 2)** and patient was asked about the comfort level. After obtaining the desired comfort level from the patient, activated laser tip was directed on the extended margin of the lesion.[3] The tip was moved in a continuous mode not allowing it to wait at place for long to avoid carbonization of the tissue. Suctioning was obtained with a suction tip to remove the vapor fumes produced during cutting. The tissue was then undermined by raising it with help of suture or Adson's tissue holding forceps and the base of the elevated lesion was excised with the laser tip. The excised tissue was then sent for histopathological evaluation. The excised wound was left with an intension for secondary healing. Patient was given the necessary post-operative instructions and medications were prescribed. Patient was recalled on 1st, 3rd, 7th day and 1month postoperatively for evaluation of pain and wound healing. Assessment of pain was done using VAS: Visual analogue scale.[4] A digital stop clock was used to estimate the duration of the procedure. The duration was recorded in minutes. The stop clock was started at the first contact of the activated laser tip to the tissue lesion and stopped at the end of procedure. A healing index proposed by Landry, Turnbull and Howley was used to describe the extent of clinical healing after laser excision of oral soft tissue lesion. Healing was estimated with a 5-level score index evaluated with the following 5 parameters applying a dichotomic score (0/1): presence/absence of redness; presence/ absence of bleeding on probing; presence/absence of granulation tissue; degree of tissue epithelialization (partial/complete); presence/absence of suppuration. Healing index score from 1 to 5 represents very poor; poor; good; very good and excellent wound healing respectively.[5]

RESULTS:

None of the cases showed any postoperative complications and no surgical procedure showed any postoperative bleeding. The mean age of the study was 37.7 ±11.4 out of which 12(40%) were males and 18(60%) were females **(Table 1).** The most common site of the lesion in our study was gingival (23.3%) followed by tongue (20.0%) and the most common pathological lesion was Fibrous Hyperplasia (36.7%), **(Table 2)**. The mean size of the lesion in our study was 1.29±0.69 $cm^{3,}$ **(Table 3)**. The duration was recorded in minutes and the procedure was ranging from 20-50 minutes with a mean value of 27.8±7.8 minutes, **(Table 4)**. The mean pain (VAS) score in our study on the 1st postoperative day was 1.1±0.7 and on the 3rd postoperative day it was 0.5±0.5 which was statistically significant ($p<0.001$), **(Table 5)**. The excised wound was left with an intension for secondary healing despite various sizes of the lesion. Wound healing was assessed using a Wound healing index proposed by Landry, Turnbull and Howley was used to describe the extent of clinical healing after laser excision of oral soft tissue lesion in our study. On the 7th post-operative day, poor wound healing (WHI score=2) was noted on 1 patient (3.3%); good wound healing (WHI score=3) was noted on 3 patient (10%); very good wound healing (WHI score=4) was noted on 23 patient (76.7%) and excellent wound healing (WHI score=5) was noted on 3 patient (10%). On the 1 month post-operative day excellent wound healing (WHI score=5) was noted on 30 patient (100%) which was statistically significant ($p<0.001$) using Friedman's Test, **(Table 6)**.

Fig 3a-3g and Fig 4a-4h shows clinical photographs of two different lesions excised using diode laser and following postoperative follow up.

Fig 1: Armamentarium

Fig 2: Activated laser tip directed 10-15 degree angle to the tissue lesion

Fig 3a: Identification of lesion

Fig 3b: Protective goggles for safety measures.

Fig 3c: Application of activated laser tip and elevation of the lesion using silk suture.

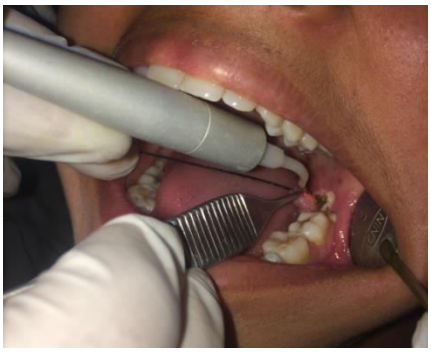

Fig 3d: Undermining and excision of the lesion.

Fig 3e: 1st postoperative day.

Fig 3f: 7th postoperative day.

Fig 3g: 1 month postoperative day.

Fig 4a: **:** Eppulis fissuratum on the labial mucosa

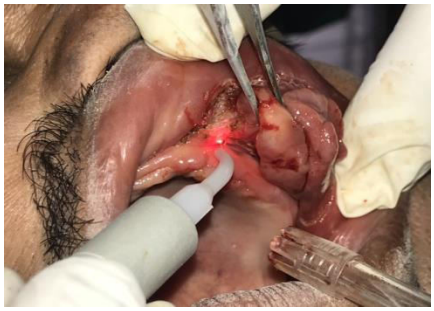

Fig 4b: Activated optical fiber tip excising the lesion.

Fig 4c: By-passing and identifying the labial artery.

Fig 4d: Excised wound with good haemostasis and minimal carbonization of the tissue

Fig 4e: 3rd post-op day. Absence of suppuration and granulation tissues.

Fig 4f: 7th post-op day. Yellow Slough- Protien denaturation over the wound.

Fig 4g: 14th post-op day. Contraction of wound margins. Re-epithelization of the lesion.

Fig 4h: 1month post-op day.

Age and Gender distribution among study Patients			
Variables	Catgeory	n	%
Age	< 20 yrs	2	6.7%
	21-30 yrs	8	26.7%
	31-40 yrs	8	26.7%
	41-50 yrs	7	23.3%
	51-60 yrs	5	16.7%
		Mean	SD
	Mean & SD	37.7s	11.4
	Range	19 - 57	
Sex	Males	12	40%
	Females	18	60%

Table 1: Distribution of participants based on age and gender.

Distribution of type of lesion and type of Anesthesia used among study patients			
Variables	Category	N	%
Site of lesion	Alveolar Mucosa	4	13.3%
	Buccal Mucosa	3	10.0%
	Floor of Mouth	3	10.0%
	Gingiva	7	23.3%
	Hard Palate	1	3.3%
	Labial Mucosa	5	16.7%
	Retromolar Area	1	3.3%
	Tongue	6	20.0%
Path. diagnosis	Fibrous Hyperplasia	11	36.7%
	Gingival Hyperplasia	2	6.7%
	Irritational Fibroma	1	3.3%
	Mucocele	4	13.3%
	Periodontal Abscess	1	3.3%
	Pyogenic Granuloma	5	16.7%
	Traumatic Fibroma	6	20.0%
Local Anesthesia	Infiltration/Block	16	53.3%
	Topical	14	46.7%

Table 2: Distribution on type of Lesion and type of Anesthesia used.

Descriptive for the size of the lesion among the study subjects		
	Mean	SD
Mean & SD	1.29	0.69
Range	0.5 – 2.7 cm	

Table 3: Size Description of the lesion.

Duration of the procedure (in mins) of the study			
Variable	Expression	Mean	SD
Duration (in mins)	Mean & SD	27.8	7.8
	Range	20 – 50	

Table 4: Duration of procedure in minutes

Comparison of mean VAS scores for pain b/w different time intervals using Friedman's test						
Time	N	Mean	SD	Min	Max	P-Value
Day 1	30	1.1	0.7	0	2	<0.001*
Day 3	30	0.5	0.5	0	1	
Day 7	30	0.0	0.0	0	0	
1 Month	30	0.0	0.0	0	0	

Table 5: Comparison of mean VAS scores for pain b/w different time intervals

Comparison of Wound Healing Index Scores b/w different time intervals using Friedman's Test				
Time	Wound Healing	n	%	P-Value
Day 3	Very Poor	0	0.0%	<0.001*
	Poor	27	90.0%	
	Good	0	0.0%	
	Very Good	3	10.0%	
	Excellent	0	0.0%	
Day 7	Very Poor	0	0.0%	
	Poor	1	3.3%	
	Good	3	10.0%	
	Very Good	23	76.7%	
	Excellent	3	10.0%	
1 Month	Very Poor	0	0.0%	
	Poor	0	0.0%	
	Good	0	0.0%	
	Very Good	0	0.0%	
	Excellent	30	100.0%	

Table 6: Comparison of Wound Healing Index Scores b/w different time intervals

DISCUSSION:

Mota-Ramírez A, Silvestre FJ, Simó JM had described the indications and contraindication of oral biopsy. They had also described the procedure and the techniques for sending the tissue to the pathologist for the report. Along with the above, various techniques for the biopsy were also described. The authors concluded that the laser biopsy needs to be at least 0.5 mm wider than conventional biopsy

so as not to affect the field of the pathologist for diagnosis.[6] Romeo U et al, conducted a retrospective animal study using different lasers to evaluate the tissue damage The authors study showed that Diode laser 808 nm with ER, Cr:YSGG showed least thermal artifacts of less than 1 mm while diode laser at 980 nm showed of about 1.5mm.[7] A prospective study was conducted on diode laser application in soft tissue oral surgeries. The authors used two different lasers: 810nm and 940nm. Surgical excision of the lesion and the tissues were sent for histopathological evaluations. Patients were followed up for pain, swelling, healing and scarring. The authors concluded that use of laser was helpful for patient. It had some disadvantages like fumes and charring. Also, the authors noted that even though histopathologically the borders of tissue were charred, they were still useful for proper diagnosis as only 0.5- 1mm margin were affected.[8] In our study, excisional margins of the biopsy were made 0.5-1mm away from the lesion compensating the thermal artefacts. Therefore, laser biopsy did not affect the field of the histopathological diagnosis for the pathologist.

Literature also showed that diode lasers when used cause sufficient tissue damage, like tissue necrosis and/or sloughing and charring of the tissue margins.[9] But, in contrary to this, the tissue sections obtained from biopsy specimens cut by diode laser using relatively low power settings (P-2.0W, λ-940 nm, 30 pps), the margins of the lesion and also the epithelium and the underlying connective tissue as a whole did not show any undesired effects caused by the use of lasers. However, in focal areas at the margins associated with epithelium, areas of coagulation were noticed. Yet, in both the cases, the diagnosis of the lesion from such sections by both the evaluators was not difficult. Hence, tissues obtained by diode lasers using low power settings though contained few undesirable changes, could still be diagnosed. But such minor thermal damage at the margins may pose problems in determining the extent of the lesion as well as diagnosis of dysplastic/neoplastic lesions. Hence, it is advisable to make the incision well beyond the margins of the suspected lesion so that the evaluator is totally free from uncertainty and does not misinterpret the histological picture. But when diode laser was used with higher power settings to obtain a biopsy specimen from a suspected OSMF case as it was difficult to cut with low power settings, clinically, there was complete charring of the tissues at the periphery. In addition, histologically, the margins of the cut sections showed complete coagulation and were without overlying epithelium. In this case, no diagnosis was possible. Though the exact reason for the loss of epithelium is not known, it is probable that the heat generated by the diode laser with high power settings could have led to separation of epithelium from the underlying connective tissue and subsequently lost during tissue processing. However, more tissue samples with this setting have to be carried out for a definitive assessment. From our study, we are in agreement with Mitchell AL that a clinician always should use the lowest possible power settings to get the intended objective and that by increasing power settings, only to cut tissue faster may lead to adverse effects making tissue specimen not acceptable for diagnostic purpose defeating the advantage of using dental laser.

The healing period of scalpel wounds is shorter than with diode laser. However, scalpel surgery causes unpleasant bleeding during and after the operation and it is necessary to cover the exposed lamina propria with a periodontal pack for 7 to 10 days. The diode laser causes minimal damage to the periosteum and bone under the gingiva being treated, and it has the unique property of being able to remove a thin layer of epithelium cleanly. Although healing of laser wounds is slower than healing of scalpel wounds, a sterile inflammatory reaction occurs after lasering.[10] Blood vessels in the surrounding tissue up to a diameter of 0.5 mm are sealed; thus, the primary advantage is hemostasis and a relatively dry operating field. Moritz et al showed in an in vitro and in vivo study the bactericidal effect of diode laser. They found that an extraordinarily high reduction of bacteria could be achieved. It creates locally sterile conditions, resulting in a reduction of bacteremia concomitant with operation. It is also postulated that low output power laser mediates an analgesic effect related to depressed nerve transmission in dentinal hypersensitivity.[11]

The extraordinary rapid cell vaporization with loss of intracellular fluid, chemical mediators (cytokines) and denaturation of intracellular substance and protein is posited to result in a markedly less intense local inflammatory response and consequently less local pain , edema and cicatrix formation, and this may explain the need for small amount of local anesthesia required to perform laser surgery in comparison to the scalpel excision.[12] Being injected is one of the biggest fear in patient undergoing a dental procedure. In our study we could successfully perform the procedure under local anesthesia (lignocaine 2% with 1:200,000 adrenaline) using topical anesthesia 14 (46.7%) and infiltration technique or field block 16 (53.3) based on the site and size of the lesion and the patient's comfort. So, with the use of laser this fear can be eliminated or at least reduced and the amount of local anesthesia can be reduced.

The mean duration of procedure in our study was 27.8±7.8 minutes. The time to perform laser excision is sometimes less than the time required to perform scalpel excision but this not always true as laser may in some cases prolong the operation time rather than shorten it and the time may be affected by the skill of the operator, the equipment available and the clinical entity of the lesion. Since hemostasis is achieved with diode laser during cutting, the field of visibility enormously increases providing good access to the surgical field, reducing the time of surgery by avoiding the control of bleeding thus reducing the duration of the procedure.

A second characteristic sign for inflammation is pain. During and directly after laser treatment there was no pain because all patients had been given local anesthesia before surgery. Surgical treatment with a diode laser always requires anesthesia, because the thermal energy applied always generates pain. Romanos G and Nentwig G carried out a study on the healing characteristics of 980 nm diode laser in various oral soft tissue surgical procedures. They had evaluated for swelling, pain, margins and coagulation properties. The authors found laser was beneficial in various oral soft tissue surgical procedures.[13] The mean pain (VAS) score in our study on the 1st postoperative day was 1.1±0.7 and on the 3rd postoperative day it was 0.5±0.5 which was statistically significant ($p<0.001$). The excised wound was left with an intension for secondary healing despite various sizes of the lesion. Although, the conventional scalpel technique can pe performed, fear of a scalpel surgery which in the minds of mankind is equipped with a sharp object causing bleeding has always implemented in the patients mind prior to the surgery which could increase the pain score. Adding the latest equipment and devices into the profession where we can obtain a bloodless field and where we can avoid sharp instruments into our modern world will eventually bring a psychological relieve towards various oral surgeries.

Derikvand N, Chinipardaz Z, Ghasemi S and Chiniforush N had written an article on versatility of Laser in oral surgical procedure. The laser used was 980 nm at continuous wave. The patients had favorable healing and no post-operative complications.[14] In our study, complete wound re-epithelization was noted on 29 patients on the 7th postoperative day and 1st month postoperatively, complete wound re-epithelization was noted on 30 patients (100%). There can be variations in the wound closure/re-epithelization depending on the size of the lesion as seen in our study, where a case of eppulius fissuratum on the labial vestibule with a size of 2.7 x 2.3 cm did not achieve a complete re-epithelization even after 7th post-op day. The smallest size of the lesion in our study was 0.5 cm^3 and the largest was 2.7 cm^3. There was no infection or postoperative complication post 1month on the wound excised with diode laser which stimulated a good healing.

One of the applications of lasers in dentistry is soft tissue surgery and ablation of lesions. The excision of exophytic lesions is one of this utilization. The advantages of laser application are relatively bloodless surgery, minimal swelling, coagulation, no need for suturing, reduction in surgical time and less or no post-surgical pain.[1,2,4,8] Wound healing was assessed using a Wound healing index proposed by Landry, Turnbull and Howley was used to describe the extent of clinical healing after laser excision of oral soft tissue lesion in our study.[5] On the 7th post-operative day, poor wound healing (WHI score=2) was noted on 1 patient (3.3%); good wound healing (WHI score=3) was noted on 3 patient (10%); very good wound healing (WHI score=4) was noted on 23 patient (76.7%) and excellent wound healing (WHI score=5) was noted on 3 patient (10%). On the 1 month post-operatively excellent wound healing (WHI score=5) was noted on 30 patient (100%) which was statistically significant ($p<0.001$) using Friedman's Test. In our study there was a statistically significant result in terms of hemostasis, reduction in amount of anesthesia needed, reduction in mean surgical time, faster wound reepithelization and wound healing and less or no post-surgical pain providing ease of operation, field of visibility towards the operator and comfort towards the patient on excision of oral soft tissue lesions using diode laser 980nm.

CONCLUSION:

There are various surgical as well as nonsurgical treatment options for oral soft tissue lesions. Amongst all, diode laser provides most acceptable benefits for the patient and the operator. Surgical Diode Laser 980nm provides blood free operating site, which helps in increasing accessibility and sterility for operator at the time of treatment, improves healing and reduces chances of infections postoperatively. Setting the power at 3 W in Continuous wave mode provides efficient cutting ability without any peri-operative and post-operative complications like carbonization, thermal damage and necrosis of the tissues. Excisional margins made 0.5-1mm away from the lesion compensating the thermal artefacts also provides adequate field of the histopathological diagnosis for the pathologist.

Diode laser should be successfully used in oral surgical procedures for achieving adequate hemostasis, disinfection of surgical site, reducing risk of postoperative infection and significantly diminishing postoperative pain. Laser technology has made rapid progress over few past decades, and lasers have found a niche in many surgical specialities. Because of their many advantages, lasers have become indispensable in OMF surgery as an additional modality for soft tissue surgery. There are many uses for lasers in OMF surgery, and the advent of new wavelengths will undoubtedly lead to new procedures that can be performed with laser technology.

Within the limits of our present study, it is possible to conclude that 980 nm diode laser can be safely and effectively used as a treatment modality for oral soft tissue lesions, without any complication. Thus, providing adequate ease of operation with good field of visibility, wound reepithelization, wound healing and comfort towards the patient on excision of oral soft tissue lesions. Despite the enthusiastic acceptance of this technology by professionals and the public, further research, including controlled clinical studies, to investigate the higher efficacy, as well as the other side effects of laser therapy, is still needed.

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