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Clinical effectiveness of diode laser therapy in managing intraoral soft tissue lesions: A prospective observational study

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Abstract:
Traumatic fibroma is a common intraoral soft tissue lesion requiring effective surgical management with minimal post-operative morbidity. This prospective clinical study evaluated 30 patients aged >14 years with clinically diagnosed traumatic fibroma treated by 940–980 nm diode laser excision under local anesthesia, with post-operative pain, healing, hemostasis, infection, swelling and patient satisfaction assessed over 15 days. Median pain decreased significantly from 2 (interquartile range 2–3) at baseline to 0 (0–0) on day 15 ($p<0.0001$), 83.3% of patients showed excellent healing by day 15, 80% achieved adequate intraoperative hemostasis and no post-operative infection or swelling was observed. Diode laser excision provided effective lesion removal with excellent hemostasis, rapid healing, minimal post-operative discomfort and high patient satisfaction. These findings advance knowledge by supporting diode laser excision as a safe, minimally invasive and clinically effective approach for managing traumatic fibroma.

Keywords: Diode laser, healing, hemostasis, oral soft-tissue lesions, pain, patient satisfaction

Background:
Since the introduction of the first ruby laser by Maiman in 1960, the use of lasers in oral surgery has radically revolutionized soft-tissue care **[1]**. Diode lasers (800-980 nm) belong to the most popular of the systems available, due to their compact form, cost-effectiveness and accurate delivery by fiber optics, allowing focused photothermal ablation and coagulation **[2].** Haemoglobin and melanin absorb diode lasers strongly, producing good hemostasis and little collateral damage. Diode lasers are well suited for excision, biopsy, frenectomy, gingivoplasty and photocoagulation treatments **[3].** The clinical advantages of diode lasers over traditional scalpel surgery include less intraoperative bleeding, less post-operative discomfort, faster healing and enhanced patient comfort **[4].** The safety and efficacy of these devices for soft tissue surgeries in both adult and pediatric patients were further supported by a comprehensive review by Sadiq et al, who reported low problems and great patient satisfaction. Randomized clinical trials comparing lasers to cold steel and electrocautery have consistently shown benefits such as less need for sutures, reduced operative time and decreased analgesic consumption **[5, 6].** Lasers like CO_2 and Er:YAG offer additional advantages of precise cutting with minimal thermal penetration **[7]**, but diode lasers remain a practical and widely available option. Moreover, the diode device is distinguished by its compact design, portability and relatively lower cost in comparison to other laser technologies. These attributes render it a favourable option for dental professionals and specialists across various surgical applications. The diode laser operates at three distinct wavelengths: 810, 940 and 980 nm **[7]**. A previous study examined the thermal effects of diode lasers operating at wavelengths of 830 nm and 940 nm in contact applications, revealing minimal thermal impact at the carbonization zone during histological tissue analysis **[8].** Experts have recognized the diode laser's effectiveness as a viable alternative for soft tissue surgeries within the oral cavity, particularly when compared to other laser types, including carbon dioxide (CO2) and erbium lasers **[2, 9].** Therefore, it is of interest to assess the clinical effectiveness of diode laser therapy for intraoral soft-tissue lesions, evaluating post-operative pain, healing, hemostasis, complications and patient satisfaction.

Materials and Methods:
A prospective observational study was conducted after obtaining approval from the Institutional Ethics Committee (IEC No. RADCH/EC/80/2024, Dt. 29/11/2024). Informed consent was obtained from all participants. The study was carried out in the Department of Oral Medicine and Radiology at Dr. R. Ahmed Dental College and Hospital, Kolkata, West Bengal. Individuals aged above 14 years, regardless of gender or lesion etiology, were considered for inclusion. Eligible participants had benign peripheral soft-tissue tumors of any size, site or shape that could be managed under local anesthesia and were willing to comply with follow-up visits. Patients with clinically suspected malignant lesions were excluded from the study. The required sample size was calculated using *G** Power software (Version 3.1.9.7, Heinrich-Heine-Universität Düsseldorf, Germany), based on parameters derived from a previous study **[3].** With $\alpha = 0.05$ and power = 0.95, the minimum sample size estimated was 24. To account for a 20% attrition rate, a final sample size of 30 participants was determined. All patients underwent diode laser ablation for lesion excision. Local infiltration with 2% lignocaine containing 1:100,000 adrenaline was administered at the surgical site, followed by preoperative site preparation using povidone-iodine. A diode laser unit operating in the range of 940–980 nm (input voltage DC 26V/4A,

fibre core diameter ≥300 µm) was used in continuous contact mode with a gentle sweeping "paintbrush" technique to thermally ablate the lesion. A saline-moistened gauze intermittently removed charred tissue and maintained a clear surgical field. No sutures were placed and the wound was allowed to heal by secondary intention. Post-operative care involved advising standard oral hygiene and prescribing paracetamol 500 mg as needed for pain management. Clinical outcomes were assessed at baseline, immediately post-operatively, day 7 and day 15**.** Pain was evaluated using a Visual Analog Scale (VAS, 0–10), healing was graded using the Landry Wound Healing Index and intraoperative and post-operative hemostasis, infection, swelling and patient satisfaction (5-point Likert scale) were recorded.

Statistical analysis:

Data were analyzed using IBM SPSS Statistics for Windows, Version 27.0.(Armonk, NY: IBM Corp). Normality was checked by the Shapiro–Wilk test. Friedman's test with Dunn's post hoc was used for repeated measures. A p-value less than five percent was considered statistically significant.

Result:

The study comprised 30 patients with a mean age of 40.1 ± 11 years. The sample included 17 females (56.7%) and 13 males(43.3%). The most common site of lesion involvement was the buccal mucosa (46.7%), followed by the lower lip (10.0%) and the retro commissural area (10.0%). Other sites included the labial mucosa (6.7%), hard palate(6.7%), ventral surface of the tongue(6.7%), lower vestibule, tip of the tongue, dorsum of the tongue and lateral border of the tongue(each 3.3%). Regarding laterality, 50.0% of the lesions were on the left side, 26.7% on the right and 23.3% were bilateral **(Table 1).** Pain scores decreased significantly over time, as depicted in **Table 2 and Figure 1**. Initially, at baseline (T0), the mean pain score was 2.53 ± 1.5, with a median (Inter-quartile Range (IQR)) of 2(2–3). By the post-operative 7th day (T1), the mean decreased to 0.467 ± 1.14, with a median of 0(0–0). Subsequently, by the post-operative 15th day (T2), the mean pain score further reduced to 0.2 ± 0.61, maintaining a median of 0(0–0). Statistical analysis showed a substantial difference of median pain scores between the three time points ($P < 0.0001$). The pain score at T0 was substantially higher than T1 and T2 in the pairwise comparisons. However, the difference between T1 and T2 was not significant. Most of the individuals (96.7%) were classified as good healing status at T0 whereas poor healing was reported in 3.3%. At this time no cases were classed as excellent or very good. By T1, healing improved significantly with 73.3% of participants rated as excellent and 10.0% rated as very good. The good category remained the most common with only 16.7% and no cases were classified as poor. At T2, healing continued to progress with 83.3% of the participants showing excellent healing, 10.0% graded as very good and just 6.7% showing good healing. No participants had poor healing at this time **(Table 3 and Figure 2).** Bloodless field was obtained in 24 subjects (80.0%) and minor bleeding was observed in 6 subjects (20.0%) at the time of surgery (T0). At T1, bloodless field was obtained in all patients (100.0%) with total hemostatic control. At T2, the majority continued to be in this position with 28 patients (93.3%) having a bloodless field whereas mild bleeding was noted in just 2 cases (6.7%) **(Table 4 and Figure 3).** Notably, there was no evidence of infection or edema throughout follow-up. Patient satisfaction at the end of the study was high, with a mean score of 4.97 ± 0.83 and median (IQR) score of 5 (5-5) on the 5-point scale, indicating a satisfactory patient reported outcome.

Table 1: Demographic profile and anatomical distribution of lesions among study participants

Characteristics	Mean±SD/N(%)
Age (in years)	40.1 ± 11
Gender	
Females	17(56.7 %)
Males	13(43.3 %)
Site	
Buccal Mucosa	14 (46.7%)
Hard Palate	2 (6.7%)
Labial Mucosa	2 (6.7%)
Lower Lip	3 (10.0%)
Lower Vestibule	1 (3.3%)
Retrocommisural Area	3 (10.0%)
Dorsum of Tongue	1 (3.3%)
Tip of the Tongue	1 (3.3%)
Lateral Border of the Tongue	1 (3.3%)
Ventral Surface of the Tongue	2 (6.7%)
Laterality	
Both	7 (23.3%)
Left	15 (50.0%)
Right	8 (26.7%)

SD: Standard deviation; N: frequency

Table 2: Descriptive statistics and comparisons of the pain scores at all-time points

Time Points	Mean±SD	Median (IQR)	P value[a]
T0	2.53±1.5	2(2-3) [a]	<0.0001*
T1	0.467±1.14	0(0-0) [b]	
T2	0.2±0.61	0(0-0) [b]	

*Note: T0: At the time of surgery; T1: Post-operatively 7th day; T2:Post-operatively 15th day; SD: Standard deviation; IQR: Inter-quartile Range; a: analyzed by Friedman's test; *: statistically significant (P≤0.05); Different superscript letters imply a statistically significant difference between the follow-ups.*

Table 3: Distribution of the study subjects according to the Healing Status and various follow-up

Healing Status	T0	T1	T2
Excellent	0 (0.0%)	22 (73.3%)	25 (83.3%)
Good	29 (96.7%)	5 (16.7%)	2 (6.7%)
Poor	1 (3.3%)	0 (0.0%)	0 (0.0%)
Very Good	0 (0.0%)	3 (10.0%)	3 (10.0%)

Note: T0: At the time of surgery; T1: Post-operatively 7th day; T2:Post-operatively 15th day

Table 4: Distribution of the study subjects according to the hemostatis status and various follow-up

Hemostatic Status	T0	T1	T2
Bloodless Field	24 (80.0%)	30 (100.0%)	28 (93.3%)

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Slight Bleeding	6 (20.0%)	0 (0.0%)	2 (6.7%)

Note: T0: At the time of surgery; T1: Post-operatively 7th day; T2:Post-operatively 15th day

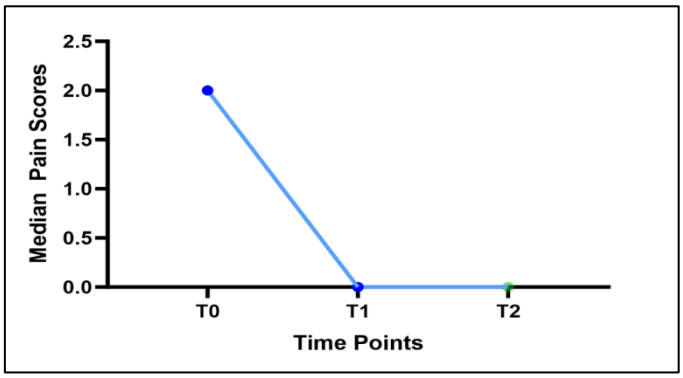


Figure 1: Line graph showing the median trend in Pain scores across time points

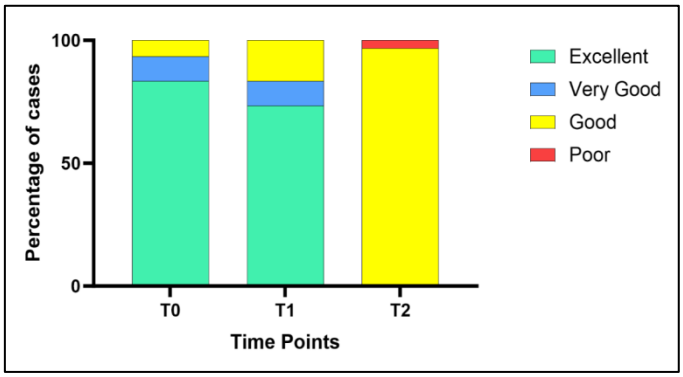


Figure 2: Stacked bar graph showing percentage distribution of healing index scores across time points

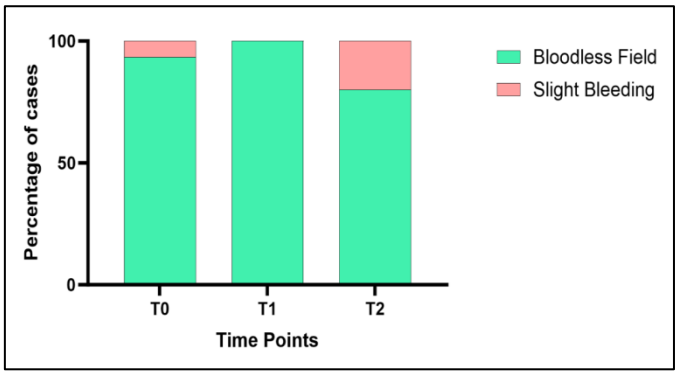


Figure 3: Stacked bar graph showing percentage distribution of hemostasis status across time points

Discussion:

A traumatic fibroma, or irritational fibroma, is a benign, exophytic lesion that usually occurs in reaction to localized trauma, often involving the lower labial mucosa, buccal mucosa or tongue **[10–12].** These lesions are good candidates for minimally invasive excision procedures because of their small size (typically <10–20 mm in diameter) and benign nature **[13].** Of these, diode lasers have become the modality of choice because of their precision, superb hemostasis and capacity to decrease post-operative discomfort while expediting recovery. The most common current application of lasers is in soft tissue operations in dentistry, especially for diode lasers, due to their advantageous tissue interaction profiles and little collateral damage **[14].** The results indicate the outstanding clinical efficacy of diode lasers in intraoral soft tissue surgery. Ge *et al.* investigated burning mouth syndrome patients for analgesic effects of low-level diode laser therapy at 660, 810 and 975 nm wavelengths. In the randomized trial 53 participants completed the trial and all three wavelength groups showed significant pain relief of 40% (median) but no significant differences were found between the wavelengths. These findings support the use of diode laser irradiation in the management of oral pain. However, direct comparison to the current study is limited as the work of Ge *et al.* studied non ablative photobiomodulation for a chronic neuropathic condition while the current study assessed postoperative pain following surgical excision **[15]**. Similarly, Amaral *et al.* **[4]** reported much less post-operative discomfort and swelling following fibrous hyperplasias excision with a diode laser than after scalpel surgery. Similar to our findings, Sufiawati *et al.* published positive clinical results following diode laser excision of benign oral soft tissue lesions in three patients. The procedures were completed in 10 to 20 minutes and the intra-operative bleeding was minimal; no pain was reported. At the two-week assessment, although some patients still had visible healing ulcers, subsequent follow-up showed satisfactory healing without infection, swelling, scarring, or recurrence. These findings are consistent with the present results where the median pain scores were reduced to zero by the seventh postoperative day and excellent healing was observed in 83.3% of patients by day 15. However, the present investigation's shorter follow-up limits conclusions regarding complete tissue maturation and long-term recurrence **[16]**. Çayan *et al.* **[6]** found that lasers had a slower healing process due to thermal coagulation, but the ultimate quality of healing was same or better with little scar formation. The present study revealed a high hemostasis rate (80–100%), in accordance with the studies by Amaral *et al.* **[4]** and de Jesus *et al.* **[5]**, which also described almost bloodless surgical fields when employing diode lasers, decreasing the requirement for sutures and increasing the procedures efficiency. Diode lasers provide similar bleeding control as electrocautery but with more precision **[5].** Sánchez-Martos *et al.* in their systematic review of 7 randomized controlled trials of peri-implant mucositis found photothermal diode laser therapy more efficacious than antimicrobial photodynamic therapy in reducing bleeding on probing, with both therapies improving plaque index and probing depth. These studies demonstrate the effects of laser-tissue interactions on inflammatory and vascular responses. Eighty percent of patients had a bloodless surgical field in the operating room, which increased to 100 % by Day 7 **[17]**. Diode lasers are similar to scalpel and electrosurgery in recurrence. As shown in a network meta-analysis by Luo *et al.* **[18]**, laser

excision can considerably decrease leukoplakia recurrence by sterilizing the peripheral tissue. CO_2 and Er:YAG lasers are associated with even less thermal spread and are preferred in delicate or esthetic areas **[7].** In pigmentary lesions cryotherapy might be useful, but in dysplastic lesions there is a higher chance of recurrence **[19].** In all investigations, patient satisfaction is uniformly excellent, with patients preferring the bloodless field, lack of sutures and minimum post-operative pain **[5, 6].** Hashim *et al.* compared nonsurgical debridement + adjunctive diode laser therapy versus surgical treatment for peri-implantitis in a randomized clinical trial. The laser-treated group reported significantly lower postoperative discomfort. Four of the 17 laser-treated participants who completed follow-up had treatment failure, while there were no treatment failures in the surgical group. These results suggest that improved patient comfort may not necessarily be associated with improved long-term clinical effectiveness. Although the present study demonstrated high patient satisfaction and favorable short-term postoperative outcomes, the absence of a conventional surgical control group and longer follow-up prevents definitive conclusions regarding comparative superiority **[20]**. Importantly, laser excision also reduces chair time, boosting practice efficiency. Thermal artifact at histopathological margins is a legitimate concern, although Romeo *et al.* **[21]** found no loss of diagnostic accuracy with the right approach. Er: YAG and CO_2 lasers create the fewest artifacts, followed by diode lasers, while electrocautery causes the greatest distortion of tissue. Diode lasers in general are a very useful tool in oral soft tissue surgery, since they provide a good balance of cost-effectiveness, efficiency and patient acceptability. Other lasers have their place, but diode lasers will suffice for most office treatments. However, the absence of a control group makes a direct comparison with traditional excision techniques difficult and the short duration of follow-up makes it impossible to draw conclusions about long-term results or recurrence. Furthermore, this study did not include histological evaluation of thermal artifacts, which may be crucial in borderline or diagnostically difficult lesions. Despite these limitations, the results substantially support the clinical usefulness of diode lasers in the management of benign intraoral soft tissue lesions such as traumatic fibroma.

Conclusion:

Diode laser therapy provided a successful minimally invasive, bloodless and suture less approach for the excision of traumatic fibroma. The technique significantly reduced post-operative discomfort, accelerated healing and achieved high patient satisfaction without infection or edema. Thus, data support diode laser therapy as an effective option for routine soft tissue surgery, particularly for benign exophytic lesions such as traumatic fibroma.

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