SVOA Dentistry

e-ISSN 2753-9172

ScienceVolks Open Access

Case Series

Clinical Applications of a 450 nm Blue Diode Laser in Oral Soft Tissue Surgery and Submandibular Calculus Management: A Series of Three Cases

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https://doi.org/10.58624/SVOADE.2026.07.030

Received: June 17, 2026

Published: July 03, 2026

Citation: La Terra SL, Buoncristiani F, Caccianiga G, Alzahrani F, AL Dweesh N. Clinical Applications of a 450 nm Blue Diode Laser in Oral Soft Tissue Surgery and Submandibular Calculus Management: A Series of Three Cases. *SVOA Dentistry* 2026, 7:4, 220-231. doi: 10.58624/SVOADE.2026.07.030

Abstract

Background: Conventional near-infrared diode lasers (810-980 nm) are widely used in oral soft tissue surgery but may produce collateral thermal effects due to deeper tissue penetration. The 450 nm blue diode laser exhibits higher absorption by hemoglobin and melanin, potentially enabling more precise incision, effective hemostasis, and reduced thermal injury. This case series evaluated its clinical application in selected oral soft tissue lesions and laser-assisted access for submandibular calculus removal.

Methods: Three patients with giant cell fibroma, oral squamous papilloma, and submandibular calculus respectively, were treated using a 450 nm blue diode laser (1 W, continuous-wave mode, contact mode, 200 µm fiber tip). Outcomes assessed included intraoperative bleeding, procedure duration, need for suturing, postoperative pain (visual analogue scale [VAS]), healing time, complications, recurrence, patient satisfaction, and operator-related outcomes.

Results: Complete treatment was done in all cases without intraoperative complications. Excellent hemostasis was observed, and no sutures were required. Mean operative time was 5.33±0.47 minutes. Mean VAS pain scores were 2.33±0.47 at 24 hours and 1.00±0.00 at 3 days. Complete healing occurred within 7-9 days (mean: 8.0±0.82 days). No infections, delayed healing, neurosensory disturbances, complications, or recurrence were observed during the 6-month follow-up period. Patient satisfaction and operator-rated visibility were consistently high.

Conclusion: The 450 nm blue diode laser demonstrated favourable clinical performance in selected oral soft tissue procedures and laser-assisted access for the removal of submandibular calculus. Precise tissue incision, effective hemostasis, low postoperative discomfort, and uneventful healing were consistently observed. Further, controlled clinical studies are required to validate these findings.

Keywords: *450 nm Diode Laser; Blue Diode Laser; Oral Soft Tissue Surgery; Giant Cell Fibroma; Oral Squamous Papilloma; Sialolithiasis; Submandibular Sialolith; Hemostasis.*

Introduction

Laser-assisted soft tissue surgery has become increasingly popular in dentistry. Their ability to provide precise tissue incision, effective bleeding control, and improved patient comfort has contributed to their widespread use in clinical practice [1, 2]. Diode lasers are among the most commonly used laser systems because of their compact size, affordability, ease of use, and favorable interaction with soft tissues containing hemoglobin and melanin. Near-infrared diode lasers (810-980 nm) have been used in a variety of procedures, including gingivectomy, frenectomy, operculectomy, depigmentation, and periodontal surgery [3-5]. Despite these advantages, their ability to penetrate deeper tissues increases the risk of thermal effects in adjacent tissues [6].

Of late, the 450 nm blue diode laser is gaining attention among clinicians due to its unique optical and biological properties [7, 8]. The shorter wavelength of 450 nm spectrum, unlike conventional infrared diode lasers, exhibits greater absorption by hemoglobin and melanin. This results in higher superficial energy deposition and reduced tissue penetration [9, 10]. As a result, this wavelength may provide greater surgical precision while reducing thermal damage to adjacent tissues [8, 11].

On the other hand, the reduced penetration depth of blue diode lasers may be beneficial in delicate oral procedures where protection of surrounding tissues is important. Research suggests cleaner incision margins, limited carbonization, and decreased collateral thermal injury with the 450 nm wavelength when compared with conventional diode laser systems [10, 12]. Moreover, its strong hemoglobin absorption helps with effective hemostasis and better visualization during surgery [12]. These characteristics may promote wound healing and reduce postoperative complications [6].

Laser-assisted surgery provides several clinical advantages over conventional scalpel surgery, including a relatively bloodless surgical field, reduced need for sutures, decreased bacterial contamination, and improved patient comfort Although scalpel surgery is considered the gold standard for precise incision, it is often associated with increased intraoperative bleeding and postoperative discomfort. Despite the growing interest in blue diode laser technology, evidence supporting its clinical applications and advantages in dentistry remains relatively limited. Therefore, further evaluation of the 450 nm diode laser and comparison with conventional surgical techniques and traditional diode laser systems may help define its role in oral soft-tissue procedures.

Case Presentation

Patient Selection

This case series describes the clinical application of a 450 nm blue diode laser in the management of selected oral lesions and submandibular calculus removal in a private clinical setting in Central Italy. Three consecutive patients presenting with these findings were treated by the same operator using a standardized laser protocol

Patients aged ≥18 years with lesions considered suitable for laser-assisted treatment and without systemic conditions known to impair wound healing were included. No restrictions were applied regarding sex, ethnicity, or socioeconomic status. Patients with suspected malignant lesions, immunocompromised status, incomplete clinical records, or inadequate follow-up were excluded. Written informed consent was obtained from all patients for treatment and publication of clinical data and photographs.

Laser Parameters and Surgical Protocol

All procedures were performed using a 450 nm diode laser (Doctor Smile®, Vicenza, Italy). The laser was operated at 1 W in continuous wave (CW) mode using a 200 μm optical fiber in contact mode. Local anesthesia was achieved using 3% mepivacaine without vasoconstrictor.

For the soft tissue lesions, a circumferential incision was performed around the lesion margins to achieve complete removal through incision-excision technique. Excised specimens were submitted for histopathological examination.

In the submandibular calculus case, the laser was used to perform a precise soft tissue incision and provide surgical access to the duct. This facilitated calculus removal under direct visualization. The laser was primarily employed for tissue exposure and hemostatic control rather than for direct ablation of the calculus.

Outcomes Evaluated

The following clinical and patient-related outcomes were evaluated in all cases:

- Intraoperative bleeding (none, mild, moderate)
- Need for suturing
- Operating time (minutes)
- Postoperative pain using a visual analogue scale (VAS, 0-10)
- Healing time (days)
- Postoperative complications
- Recurrence during follow-up
- Patient satisfaction using a 5-point Likert scale
- Intraoperative visibility using a 5-point Likert scale
- Ease of procedure and operator perception of handling and precision using a 5-point Likert scale

All patients were followed clinically at 3, 7, and 14 days and at 1, 3, and 6 months postoperatively.

Data Collections

Preoperative clinical features, laser parameters, intraoperative findings, healing outcomes, and follow-up details are summarized in Table 1.

Case 1

A 71-year-old male non-smoker (ASA I) presented with a painless, slow-growing lesion on the right half of the soft palate. The patient noticed the lesion approximately one year ago. This small pedunculated non-indurated papillary lesion measured 8 mm in diameter.

The lesion was excised using a 450 nm diode laser at 1 W CW in contact mode with a 200 μm fiber tip under minimal local anesthesia. The procedure took approximately six minutes. There was no intraoperative or postoperative bleeding, and sutures were not required.

Histopathological examination of the lesion confirmed it to be giant cell fibroma. It was characterized by numerous stellate-shaped and spindle-shaped fibroblasts within the connective tissue and hyperplastic stratified squamous epithelium without inflammatory infiltrate.

Postoperative pain was mild, with VAS scores of 2 at 24 hours and 1 at 3 days. Complete healing occurred within 9 days, with no complications or recurrence during the 6-month follow-up period. Patient satisfaction, intraoperative visibility, and ease of the procedure were all rated a score of 5 on the Likert scale.

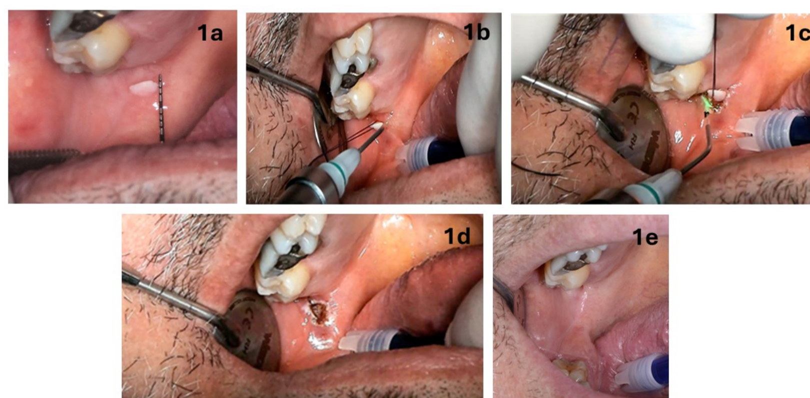

Figure 1. Excision of a giant cell fibroma using a 450 nm blue diode laser.

(a) Preoperative view showing a pedunculated lesion on the right soft palate. (b) Circumferential excision using the incision–excision technique. (c) Intraoperative view during lesion removal. (d) Immediate postoperative view demonstrating excellent hemostasis. (e) Thirty-day follow-up showing complete healing without scarring or recurrence.

Table 1. Baseline demographic and clinical characteristics of the included cases.

Case no.	Age/Sex/Medical History	Lesion Type/ Onset	Anatomical Location	Size(mm)	Clinical Presentation	Treatment	Histology	Follow up
1	71/M/non-smoker ASA1	Giant cell fibroma, 1 year	Right half soft palate	8	Painless slow-growing, asymptomatic, small, pedunculated non indurated nodule with papillary surface	Laser-assisted complete excision	Presence of numerous large, stellate-shaped (star-shaped) and spindle-shaped fibroblasts within the subepithelial connective tissue. The overlying stratified squamous epithelium is hyperplastic, with elongated, narrow rete ridges with no inflammatory infiltrate	3, 7, and 14 days, 1, 3, and 6 months
2	42/M/heavy smoker/ASA 1	Submandibular calculus, 1 year	Submandibular duct	4	palpable small and hard yellowish lump felt under the tongue, painful	Laser-assisted access for calculus removal	NA	3, 7, and 14 days, 1, 3, and 6 months
3	76/M/ non-smoker/ ASA 1	Oral squamous papilloma, 2 years	Right lingual margin	6	slow-growing white-pink well circumscribed, sessile painless mass, papillary, cauliflower-like surface covered by translucent mucosa	Laser-assisted complete excision	Proliferation of stratified squamous epithelium with mild keratinization, parakeratosis, and fibrovascular cores, along with koilocytotic changes. No dysplasia or invasion	3, 7, and 14 days, 1, 3, and 6 months

ASA: American Society of Anesthesiologists (ASA)

Case 2

A 42-year-old male heavy smoker (ASA I) presented with pain and swelling in the sublingual region. This worsened especially during eating and salivary stimulation. There were also additional symptoms such as xerostomia, foul taste, and difficulty swallowing. Clinical examination revealed a small hard yellowish swelling in the region of Wharton's duct suggestive of submandibular sialolithiasis. The calculus measured approximately 4 mm.

A 450 nm diode laser was used at 1 W CW in contact mode with a 200 µm fiber tip to perform soft tissue exposure and facilitate calculus removal. This was done under local anesthesia with 3% mepivacaine without vasoconstrictor. The procedure lasted approximately five minutes with no bleeding or sutures required.

Postoperative pain was mild, with VAS scores of 3 at 24 hours and 1 at 3 days. Complete healing occurred within 7 days, with no recurrence during the 6-month follow-up period. Patient satisfaction and intraoperative visibility were both rated 5 on the Likert scale, while ease of the procedure received a score of 4.

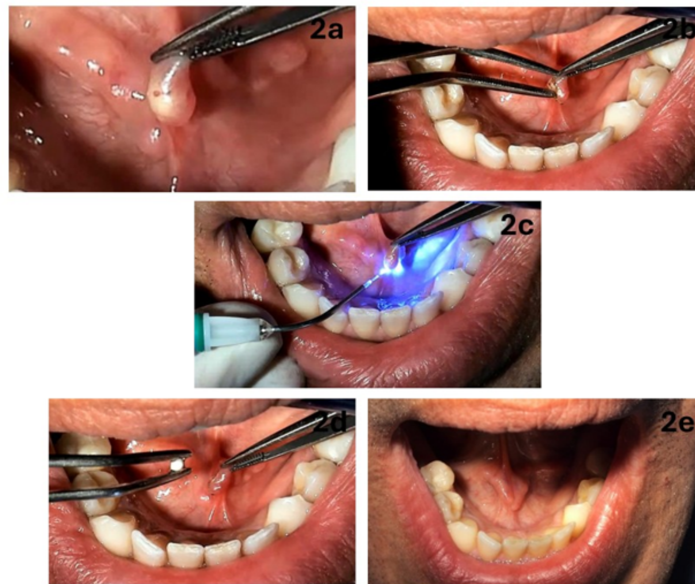

Figure 2. Laser-assisted access for a submandibular calculus.

(a) Preoperative view showing a submandibular calculus. (b) Intraoperative stabilization of the calculus using surgical forceps. (c) Laser-assisted soft tissue incision and exposure of the calculus. (d) Immediate postoperative view showing the surgical site and removed calculus. (e) Thirty-day follow-up demonstrating complete healing without complications.

Case 3

A 76-year-old male non-smoker (ASA I) presented with a slow-growing exophytic lesion on the right lingual margin. This lesion was present for approximately 2 years. Clinical examination revealed a well-circumscribed sessile white-pink papillary lesion with a cauliflower-like appearance measuring approximately 6 mm.

The lesion was excised completely using a 450 nm diode laser at 1 W CW in contact mode with a 200 µm fiber tip under local anesthesia. The procedure took approximately five minutes to complete. No significant intraoperative bleeding occurred, and no sutures were required.

Histopathological examination confirmed oral squamous papilloma. The lesion was characterized by stratified squamous epithelial proliferation with fibrovascular cores and koilocytotic changes. No evidence of dysplasia or invasion was identified.

Postoperative pain was mild, with a VAS score of 2 at 24 hours and 1 at 3 days. Complete healing occurred within 8 days. No complications or recurrence were observed during the 6-month follow-up period. Patient satisfaction, intraoperative visibility, and ease of the procedure were all rated 5 on the Likert scale.

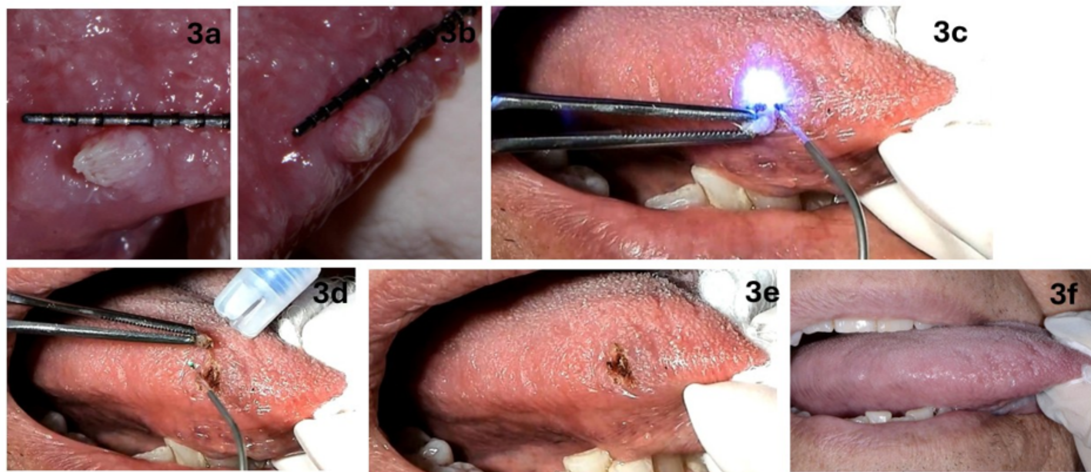

Figure 3. Excision of an oral squamous papilloma using a 450 nm blue diode laser.

(a & b) Preoperative view showing a papillary lesion on the right lingual margin. (c) Circumferential excision using the incision–excision technique. (d) Intraoperative view during lesion removal. (e) Immediate postoperative view showing complete lesion excision and excellent hemostasis. (f) Thirty-day follow-up demonstrating complete healing without recurrence.

Statistical Analysis

All data were analyzed using descriptive statistics. Continuous variables, including operative time, postoperative pain, healing time, and Likert scale scores for intraoperative visibility, ease of procedure, and patient satisfaction, were expressed as mean ± standard deviation (SD).

Categorical variables, including intraoperative bleeding, need for suturing, complications, and recurrence, were reported as absolute frequencies and percentages. Given the small sample size and descriptive design of this case series, inferential statistical analysis was not performed.

Results

Three patients with oral soft tissue lesions or related conditions were treated using a 450 nm blue diode laser. Baseline demographic and clinical characteristics of the patients are summarized in Table 1. The age of the patients ranged from 42 to 76 years, with a mean age of 63 years. All procedures were completed successfully using the same laser settings (450 nm, 1 W, continuous wave, contact mode, 200 μm fiber tip) under minimal local anesthesia. A summary of the overall clinical findings is presented in Table 2.

Intraoperative Outcomes

All procedures were completed successfully using identical laser settings (450 nm, 1 W, continuous-wave mode, contact mode, 200 μm fiber tip) under minimal local anesthesia. The procedural details and clinical outcomes of all cases are summarized in Table 3.

Hemostasis was achieved in all cases, resulting in a clear surgical field. No sutures were required. Procedure duration ranged from 5 to 6 minutes, with a mean operative time of 5.33 ± 0.47 minutes (Table 4).

Patient-Centered Outcomes

Low postoperative pain scores were recorded in all patients and were effectively managed with over-the-counter analgesics. The mean VAS pain score was 2.33 ± 0.47 at 24 hours and decreased to 1.00 ± 0.00 by the third postoperative day (Table 4).

Uneventful healing was recorded in all cases, with complete healing observed within 7-9 days (mean healing time: 8.00 ± 0.82 days). No postoperative infections, delayed healing, or other complications were observed. All patients reported high satisfaction with treatment outcomes and assigned a score of 5 on the Likert scale (Table 4).

Operator-Centered Outcomes

Intraoperative visibility (mean score: 5.00 ± 0.00) and ease of procedure and handling characteristics (mean score: 4.67 ± 0.47 (Table 4) showed favourable operator-related outcomes in all cases. Similarly, hemostasis was achieved in all cases, and clear visualization of the surgical field was maintained throughout the procedures.

Follow-up Outcomes

During the follow-up period of 6-month, no recurrence was observed. Similarly, no postoperative complications or adverse events were recorded during the follow-up. The distribution of categorical clinical outcomes, including intraoperative bleeding, need for suturing, complications, and recurrence, is presented in Table 5.

Table 2. Summary of clinical outcomes following treatment with 450 nm blue diode laser.

Parameter	Findings
Number of cases	3
Age range	42-76 years (mean age: 63 years)
Gender distribution	3 males
Lesion location	soft palate (33,3%), submandibular duct (33,3%), lingual margin (33,3%)
Maximum diameter of the lesion	0.4 to 0.8 cm (mean: 0.6 cm)
Onset	1-2 years (mean: 1.33 years)
Diode laser wavelength	450 nm
Power setting	1.0 W continuous mode
Anesthesia used	Local (3% mepivacaine), minimal
Procedure duration	5-6 minutes per lesion (mean: 5.33 minutes)
Bleeding	None; no sutures required
Healing time	7-9 days (mean: 8 days)
Postoperative pain	Mild, managed with over-the-counter analgesics. Mean visual analogue scale (VAS) score = 2.33 at 24 hours, 1. at 3 days post operation
Recurrence rate	0% (no recurrence at 6-month follow-up)
Complications	None reported
Ease of procedure	High (Mean 5-point Likert scale value = 4.66)
Patient satisfaction	High (all patients satisfied with outcomes. Mean 5-point Likert scale value = 5)

Table 3. Case-specific procedural and clinical outcomes.

Case No.	Laser Settings (450 nm)	Anesthesia used	Intraoperative Bleeding/ Sutures	Procedure Time (min)	Post-op Pain 24 hrs, 3 days (VAS 0–10)	Healing Time (days)/ Complications	Recurrence	Intraoperative Visibility (Likert 1–5)	Ease of Procedure (Likert 1–5)	Patient Satisfaction (Likert 1–5)
1	450nm, 1 W, CW, 200 µm fiber, contact	Local 3 % mepivacaine, no vasoconstrictor	None/No	6	2, 1	9/ None	No	5	5	5
2	1 W, CW, 200 µm fiber, contact	Local 3 % mepivacaine, no vasoconstrictor	None/No	5	3,1	7/ None	No	5	4	5
3	1 W, CW, 200 µm fiber, contact	Local 3 % mepivacaine, no vasoconstrictor	None/No	5	2,1	8/ None	No	5	5	5

Table 4. Descriptive statistics of continuous outcome variables.

Variable	Mean ± SD	Median	Min–Max
Operative time (min)	5.33 ± 0.47	5	5–6
Postoperative pain 24h (VAS 0-10)	2.33 ± 0.47	2	2-3
Postoperative pain 3 days (VAS 0-10)	1 ± 0.0	1	1-1
Healing time (days)	8.00 ± 0.82	8	7-9
Intraoperative visibility (Likert 1-5)	5 ± 0.00	5	5-5
Ease of procedure (Likert 1-5)	4.67 ± 0.47	5	4-5
Patient satisfaction (Likert 1-5)	5 ± 0.00	5	5

Table 5. Frequency distribution of categorical outcome variables.

Variable	Category	Frequency (n)	Percentage (%)
Intraoperative bleeding	None	3	100%
	Minimal	0	0%
	Moderate	0	0%
	Severe	0	0%
Need for suturing	Yes	0	0%
	No	3	100%
Complications	Yes	0	0%
	No	3	100%
Recurrence	Yes	0	0%
	No	3	100%

Discussion

The present case series evaluated the clinical application of a 450 nm blue diode laser for the management of benign oral soft tissue lesions and laser-assisted access for submandibular calculus removal. Across all cases, the laser provided effective tissue incision, excellent hemostasis, favorable surgical visibility, low postoperative discomfort, and uneventful healing. No postoperative complications or recurrences were observed during the 6-month follow-up period.

Characteristics of the 450 nm Blue Diode Laser

Infrared diode lasers operating between 810 and 980 nm are commonly used in dentistry. These wavelengths penetrate deeper into tissues and may cause greater thermal effects in the surrounding tissues. In contrast, the 450 nm blue diode laser has greater absorption by hemoglobin and melanin, leading to shallower energy penetration and more localized tissue interaction [14].. This characteristic may improve cutting precision while reducing collateral thermal damage [11].

Experimental studies have shown that blue diode lasers (around 450 nm) can effectively cut tissue while causing less carbonization, reduced thermal spread, and lower temperature increases than longer-wavelength diode lasers [7, 9, 10, 13]. This may be due to the strong absorption of blue light by tissue pigments, which supports efficient cutting and coagulation at relatively low power settings while minimizing thermal damage to surrounding tissues [15].

Clinical Advantages and Comparison with the Literature

The findings of this case series show effective hemostasis in all cases. This resulted in a clear surgical field. Moreover, all procedures were completed under minimal local anesthesia, and no sutures were required. Postoperative pain was low, and complete healing occurred within 7-9 days without complications. High patient satisfaction and favorable operator ratings for intraoperative visibility and ease of the procedure suggest potential clinical benefits of the 450 nm wavelength.

These findings are consistent with previous studies that reported effective cutting, coagulation, and favorable healing outcomes with blue diode lasers [7, 9, 16]. Previous histological investigations of 445–450 nm diode lasers have reported minimal thermal injury to adjacent tissues while maintaining adequate specimen quality after soft-tissue excision [10, 11]. In addition, the high absorption of blue light by hemoglobin may have contributed to the effective hemostasis observed in the present cases. [12].

Laser-Assisted Access for Submandibular Calculus

The submandibular calculus case should be interpreted as an adjunctive application of the 450 nm diode laser rather than evidence that the laser can replace conventional calculus removal techniques. In the present case, the principal benefit of the laser was the provision of precise soft tissue access and excellent hemostasis, facilitating minimally invasive calculus removal. Although blue-violet wavelengths have shown selective interactions with calcified deposits in experimental settings, their clinical role in calculus management remains incompletely defined [17]. Therefore, the 450 nm diode laser may be considered a useful adjunct for preparing for surgical access in such cases.

Limitations and Future Research

There are a few limitations in this report. The small sample size of this case series and the absence of a control group restrict the generalizability of the findings. In addition, the short follow-up period does not allow us any assessment of long-term recurrence and tissue stability. Future studies are needed that have larger patient cohorts, longer follow-up durations, and compares blue diode lasers against conventional scalpel surgery and infrared diode lasers to further establish clinical efficacy, safety, and patient-reported outcomes.

Implications for Practice

The findings of this study suggest that the 450 nm blue diode laser may represent a useful minimally invasive option for the management of selected benign oral soft tissue lesions. The effective hemostasis, absence of intraoperative bleeding, lack of need for suturing, and favorable healing observed in this series indicate potential benefits for both clinicians and patients. Although further evidence is required, the 450 nm wavelength appears promising for precise soft tissue surgery in routine dental practice.

Conclusions

Within the limitations of this case series, the 450 nm diode laser demonstrated favorable clinical performance in selected oral soft tissue procedures and laser-assisted access for submandibular calculus removal. Precise tissue incision, effective hemostasis, good surgical visibility, low postoperative discomfort, and uneventful healing were consistently observed. Larger controlled clinical studies are required to further define its effectiveness and clinical applications in oral surgery.

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Salvatore Luca La Terra: Conceptualization, Data curation, Methodology, Writing- Original draft preparation, Writing- Reviewing and Editing. Proofreading, Supervision.

Francesco Buoncristiani: Conceptualization, Data curation, Methodology, Writing- Original draft preparation, Writing- Reviewing and Editing. Proofreading.

Gianluigi Caccianiga: Conceptualization, Data curation, Methodology, Writing- Original draft preparation, WritingReviewing and Editing, Supervision.

Faisal Alzahrani: Proofreading, Writing- Original draft preparation, Writing- Reviewing and Editing.

Naief AL Dweesh: Proofreading, Writing- Original draft preparation, Writing- Reviewing and Editing.

Source of Funding

None.

Consent

Informed consent for treatment and publication was obtained from the patients.

Conflict of Interest

The authors declare that there is no conflict of interest.

Acknowledgements

Data are available upon reasonable request. The data are stored as de-identified participant data and are available on request to Salvatore Luca La Terra (laterra3@virgilio.it) and Francesco Buoncristiani (info@dentistasanvincenzo.it).

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