Article

Not peer-reviewed version

Laser Forced Dehydration of Benign Vascular Lesions of the Oral Cavity: A Valid Alternative to Surgical Techniques

Margherita Gobbo * and Luca Guarda-Nardini

Posted Date: 26 April 2024

doi: 10.20944/preprints202404.1716.v1

Keywords: Vascular Malformation; Diode Laser; Angioma; Blue light; Conservative

 doi:10.20944/preprints202404.1716.v1

Article

Laser Forced Dehydration of Benign Vascular Lesions of the Oral Cavity: A Valid Alternative to Surgical Techniques

Margherita Gobbo * and Guarda Nardini

Unit of Oral and Maxillofacial Surgery, Ca' Foncello Hospital, 3100, Treviso, Italy

* Correspondence: Margherita.gobbo@aulss2.veneto.it; Tel.: +39 0422 322809; ORCID: 0000-0001-8015-2239

Abstract: *Background and Objectives:* Low-flow vascular lesions are commonly encountered in the oral cavity and may require removal due to aesthetic concern, repeated bleeding or cluttering sensation. Laser devices represent an excellent aid due to their affinity with blood and to their biostimulating properties and have been substituting traditional excision in selected cases. *Materials and Methods:* 30 patients presenting low-flow oral vascular lesions were included. The lesions were clinically evaluated as follows: lesion's site, reason for treatment, lesion's dimension, confirmation of positive diascopy via compression with a glass slide, photograph. The lesions were treated with laser forced dehydration (LFD) and then followed up after 3 weeks, 6 months and one year. Laser source was K-Laser Blu Derma (Eltech, K-Laser S.r.l.). In case of incomplete healing, a further protocol was performed at the three-week follow up and a further follow up scheduled three weeks after. The following aspects were evaluated at each appointment: pain, using a Numeric Rating Scale (NRS) from 0 to 10 (0= no pain, 10= worst pain ever); the need to take painkillers (day of intervention and during follow up); bleeding (yes/no); scar formation. *Results:* Complete regression was obtained in all patients with no side effects. Only one patient required a second LFD protocol. NRS was 0 for all patients for the whole duration of the follow up. None of the patients took painkillers the day of the intervention and during the follow up. One patient declared a slight bleeding the day of the intervention, which she easily managed at home. One patient showed a small non-retracting and non-painful scar at the three-week follow up. No recurrences were found after six months and one year. *Conclusion:* LFD targets endogenous chromophores minimizing damage to adjacent tissue and limiting side effects. LFD is effective and could be considered a conservative alternative to traditional excision in low-flow lesions.

Keywords: vascular malformation; diode laser; angioma; blue light; conservative

1. Introduction

Among vascular anomalies, vascular malformations (VM) are classified based on clinical, histological and histochemical features and are characterized by blood vessels abnormalities. They are distinguished from vascular tumors, which are characterized by endothelial proliferation and aggressive behavior, instead. Among VM, according to the International Society for the Study of Vascular Anomalies (ISSVA) [1] classification, lesions may be (1) simple, (2) combined, (3) of major named vessels, (4) associated with other lesions (mainly syndromes). Simple lesions include: capillary malformations, lymphatic malformations, venous malformations, arteriovenous malformations and arteriovenous fistula [2]. A low-flow lesion originates from a capillary, venous, or lymphatic vessel or from a combination of vessels. Malformations with an arterial component (most commonly arteriovenous) are considered high-flow lesions. Simple VM are low-flow lesions and are frequently encountered in the oral and maxillofacial region. Despite being asymptomatic, they often require treatment due to aesthetic concern, recurrent bleeding -occurring after accidental or chewing trauma- and cluttering sensation due to their position or increasing size [3].

 doi:10.20944/preprints202404.1716.v1

There is no universally accepted treatment of VMs in the oral cavity. In recent years, the coagulative properties of several laser devices, has promoted their use as conservative and effective technique [4]. The technique called "laser forced dehydration" (LFD) can be obtained by moving the beam on the lesion in touchless modality without lingering on the same area for more than 1-2 seconds, in order to avoid thermal damage and overheating. During enlightening, the lesion should visibly change color, from bluish-red to white. The process is mediated by the high absorption and affinity of blue light with hemoglobin, which is the key process of LFD [5]. LFD does not need any anesthesia and can be repeated in case of failure. Moreover, it has a reduced risk of bleeding and an enhanced healing capacity, thanks to the delivery of laser light to tissue.

In the present paper, 30 patients affected by low-flow VM of the oral cavity, were treated with LFD using a blue light diode laser and the so-called "Leopard Technique", a multiple spot pulsed irradiation technique that spares the epithelium and promotes smooth healing [6]. Specifically, each lesion was irradiated interposing a glass transparent slide between the epithelium and the laser beam, in order both to protect the lesion from excessive heating -and thus limiting unwilling effects like bleeding or ulceration- and to compress the lesion and deliver the beam to the core of it (Figure 1) [6].

Figure 1. A) Preoperative aspect of lower lip vascular malformation (VM); B) Glass slide compression before Laser Forced Dehydration (LFD); C) LFD; D) 3-week follow up showing advanced healing. A second protocol of LFD was performed in the same session.

2. Materials and Methods

The present study was conducted between March 2022 and March 2024 at the Unit of Oral and Maxillofacial Surgery of "Ospedale Ca' Foncello" (31100, Treviso, Italy). Ethical approval was obtained (Nucleo Ricerca Clinica, Treviso, prot. 73512 (April 19th 2021) studio osservazionale 976/CE) and all the included subjects signed a written informed consent.

Benign simple capillary or venous malformations, according to the ISSVA classification [1] were treated using LFD. Inclusion criteria were: pigmented black or bluish, soft, non-pulsatile lesions, which showed positive diascopy, involving any area of the oral cavity which was reachable with the laser device. Exclusion criteria were: patients younger than 18 years old, pregnant or breastfeeding women, patients not willing to perform a one year follow up. Laser source was K-Laser Blu Derma (Eltech, K-Laser S.r.l., via Castagnole 20/H, 31000, Treviso, Italy).

2.1. Study Protocol: Clinical Evaluation

The lesions were clinically evaluated and the following data were recorded: lesion site, reason for treatment (bleeding, aesthetic, cluttering), lesion dimension (in millimeters, using a calibrated

 doi:10.20944/preprints202404.1716.v1

paper ruler and considering the wider diameter as final measure), confirmation of positive diascopy via compression with a glass slide, photograph of the lesion.

2.2. Study Protocol: Laser Application

No anesthesia was needed. The lesion was treated with the following protocol, interposing a compressing glass slide between the lesion and the laser beam:

1) Ruby angioma: using a red tip (code MP387 C), 445nm and 970nm wavelength, 909 mJ Energy, 22.73 Hz Frequency, Duty Cycle 9%, 3mm working distance, directly furnished by the red tip.

2) Plain angioma: using a silver tip (code MP387 A), 445nm and 970nm wavelength, 164 mJ Energy, 3.28 Hz Frequency, Duty Cycle 2%, 2-3 mm working distance established by the operator.

The pulsed modality was activated via a pedal and the tip was moved after each laser shot. A net-like path was created on the lesion and the dehydration was witnessed by the whitish of the lesion from the initial bluish-red color (leopard technique). Eventually, the margin of the lesion was retraced to coagulate accessory vessels.

2.3. Study Protocol: Follow up

Each patient was followed up after three weeks, six months and one year, and the following aspects were evaluated:

Pain: using a Numeric Rating Scale (NRS), a unidimensional 11-point scale that is used to estimate the intensity of pain in adult collaborative subjects. Values vary from 0 (= no pain) to 10 (= most severe pain ever experienced), and were reported for the whole three weeks of follow up (the patients were asked to keep a diary). The patients were also asked to report the need to take painkillers during the day of the intervention and during the three-week follow up;

Bleeding: yes or no answer, considering the day of the intervention and the follow up period;

Scar formation: evaluated clinically at three weeks, six months and one year;

Retreatment: at the three-week follow up, a second LFD protocol was performed if necessary, which, in turn, was followed by a further three- week follow up.

3. Results

A total of 30 patients were included in the present study. 16 were females (53%) and 14 males (47%). Median age was 67 years old (minimum 41, maximum 86). 90% of the patients had a positive past and present medical history and 50% of patients took at least three types of medications. 15 Patients (50%) suffered from hypertension (under treatment) and/or previous/actual cardiac disease; 14% of patients (47%) declared hypercholesterolemia or dyslipidemia and 17% of patients suffered from diabetes. The sample included also 10 oncological patients (previous or actual). Four patients (13%) were allergic to penicillin or NSAIDs (Non-steroidal anti- inflammatory drugs). To note, 6 patients were under antiaggregant or anticoagulants. Most patients (22) were non-smokers. Table 1 reports demographic data.

Table 1. Medical History, Medications, Smoking habit (for ex-smokers: n (number of years since when they quit smoking)). Abbreviations: NSAIDs: non steroideal antinflammatory drugs; AMI: Acute Miocardial Infarctuation; GERD: gastroesophageal reflux disease; OCBP: Obstructive Chronic Broncopneumopathy; Ex (month/year): ex-smoker (months/years from when he/she quit smoking).

ID	Gender	Age	Medical History	Medications	Smoking (n)
1	F	63	Carotid stenosis, hypertension, hypercolesterolemia, allergic to preservatives and fragrances	Antiaggregants, anticholesterolemics, anti-hypertensive	No
2	M	66	Myelodisplasia (2011), hypertension, prostate cancer (2015)	Xantin oxidase inhibitor, anti-hypertensive, anticholesterolemics	Ex (18 years)

 doi:10.20944/preprints202404.1716.v1

3	M	76	Hypertension, hypercolesterolemia	Anti-hypertensive, anticholesterolemics, antiaggregants	No
4	M	76	Hypertension, discal hernia (intervention in 2017)	Anti-hypertensives	No
5	M	69	Allergic to penicillin	No	No
6	M	60	GERD	Proton pump inhibitor	No
7	F	59	Uterus cancer (2016), allergic to penicillin	Levotiroxine, benzodiazepine.	Ex (7 months)
8	F	67	Heart failure, hypertension, dyslipidemia, polyarhtrosis, osteoporosis, lung cancer (in 2000 subdued to surgical intervention and chemo-radiotherapy), thyroid nodules, hepatomegaly, AMI in 2002. Pace maker since 2004, OCBP. Allergic to penicillin, NSAIDS, fluoroquinolones and triciclic antidepressants.	Anticoagulants (Coumadin), bronchodilator, anti-hypertensives, diuretics, benzodiazepines, Proton pump inhibitor, digossin, anticholesterolemics, antilipidemics, antidepressants	No
9	M	41	None	No	Yes (10 /die for 20 years)
10	F	67	Autoimmune hypothiroidism, breast cancer	Iodium	No
11	F	67	Autoimmune hypothiroidism	Iodium	No
12	F	66	None	None	Yes (10)
13	M	75	None	None	No
14	F	66	Osteoporosis	Colecalciferol	No
15	F	69	Thyroid Cancer, Hypertension, hypercolesterolemia	Levothyroxine, Anti-hypertensives Anticholesterolemics	No
16	F	69	Thyroid Cancer, hypertension, hypercolesterolemia	Levothyroxine, anti-hypertensives anticholesterolemics	No
17	M	70	Diabetes, hypercolesterolemia, gout, prostate cancer (2018)	Proton Pump Inhibitor, anti-hypertensive, Antiaggregants, Oral antidiabetics, Finasteride	No
18	M	70	Diabetes, hypercolesterolemia, gout, Prostate Cancer (2018)	Proton pump inhibitor, anti-hypertensive, antiaggregants, oral antidiabetics, finasteride	No
19	M	86	Benign prostate hypertrophia, chronic renal failure, atopic dermatitis eczema, hypertension.	Silodosin, anti-hypertensives, beta-blockers	No
20	M	67	Diabetes, parkinson's disease, hypertension, hypercolesterolemia	Antidiabetics, diuretics, selegilin	Yes (20)
21	M	67	Diabetes, parkinson's disease, hypertension, hypercolesterolemia	Antidiabetics, diuretics, selegilin	Yes (20)
22	M	80	Myocardic infarctuation (2018)	Antiaggregant, statins,collyrium	No
23	F	63	Thyroid cancer, hypertension, hypercolesterolemia	Levotiroxine	No
24	F	62	Melanoma, allergic to cats	None	No (ex 10 years)

 doi:10.20944/preprints202404.1716.v1

25	F		Lung cancer, diabetes, syderopenia, vasculopathy with vertebral collapse	Antidiabetics, Proton pump inhibitors, bronchidilator, steroids, Dibase, oxygen therapy.	No
26	F	78	Hypertension	NSAID, anti-hypertensive, diuretic	Ex (18)
27	F	59	Hypothyroidism, Hypertension	Levotiroxin, anti-hypertensives, diuretic	No
28	F	74	Gouge, hypercolesterolemia, allergic to penicillin	Allopurinol, anticholesterolemics	No
29	M	73	Hypertension, ischemic stroke, hyperlipidemia, osteoporosis	Antiaggregants, antilipidemics, anti-hypertensives, benzodiazepines, colecalciferol	No
30	F	71	Ipercolesterolemica, emicarnica	Anticholesterolemics, triciclinc antidepressants, beta blockers	No

Lesions were between 2 and 25mm wide (mean dimension 8.3mm). 4 patients were affected by tongue lesions, 2 patients were affected by gingival lesions, 19 patients were affected by lip lesions, 1 patient was affected by palatal lesion and 4 patients were affected by cheek lesions. The intervention was performed for repeated bleeding in 13 patients, for aesthetic concern in 11 patients and for cluttering sensation in 6 patients.

All the patients obtained a complete disappearance of lesions after LFD, irrespective of lesion's dimension and lesion's site. Only 1 patient required a second LFD protocol at the three-week follow up (the patient with the biggest lesion). Only one patient experienced a slight pain (NRS=4) the very same day of the intervention, despite he did not take any painkillers, whereas two declared a slight tingling immediately after the procedure. NRS was 0 for all the patients from the day after the intervention and for the whole duration of the follow up. None of the patients took painkillers the day of the intervention and during the follow up. Only one patient (the one under anticoagulants) declared a slight bleeding the day of the intervention, which she easily managed via gauze compression at home. One patient showed a small non-retracting and non-painful scar at the three-week follow up. No recurrences were found at the six-month and one-year follow up. One patient showed ulcer formation three weeks after LFD procedure. This happened on the gingiva, a site where slide compression is more challenging, and maybe due to excessive heating. Nonetheless, ulceration was asymptomatic and ended in restitution ad integrum. Table 2 reports detailed characteristics of the interventions.

Table 2. Characteristics of lesions, intervention and outcomes. Abbreviations: LFD: Laser Forced Dehydration.

ID	Site	Reason for intervention	Dimension (mm)	Technique	Pain	Bleeding	Scar	Side effects
1	Lower Lip	Aesthetic	8	LFD	NO	NO	NO	
2	Left Cheek	Bleeding	10	LFD	NO	NO	NO	Slight tingling immediately after application
3	Lower Lip	Bleeding	3	LFD	NO	NO	NO	
4	Left Cheek	Bleeding	15	LFD	NO	NO	NO	
5	Tongue	Clutter	11	LFD	NO	NO	NO	
6	Tongue	Clutter	6	LFD	YES	NO	YES	Slight visible scar, without pain or retraction
7	Left Cheek	Bleeding	12	LFD	NO	NO	NO	

 doi:10.20944/preprints202404.1716.v1

8	Lower Lip	Bleeding	20	LFD	NO	SI	NO	Slight bleeding the day of the intervention
9	Left Cheek	Bleeding	8	LFD	NO	NO	NO	
10	Lower Lip	Aesthetic	8	LFD	NO	NO	NO	
11	Lower Lip	Clutter	25	LFD (2)	NO	NO	NO	
12	Lower Lip	Aesthetic	3	LFD	No	No	No	
13	Tongue dorsum	Bleeding	3	LFD	NO	NO	NO	Slight tingling the day of the intervention
14	Lower Lip	Aesthetic	10	LFD	NO	NO	NO	
15	Lower Lip	Aesthetic	10	LFD	NO	NO	NO	
16	Lower Lip	Aesthetic	5	LFD	NO	NO	NO	
17	Gingiva	Clutter	15	LFD	NO	NO	NO	
18	Lower Lip	Bleeding	10	LFD	NO	NO	NO	
19	Lower Lip	Aesthetic	5	LFD	NO	NO	NO	
20	Lower Lip	Aesthetic	2	LFD	NO	NO	NO	
21	Upper Lip	Aesthetic	5	LFD	NO	NO	NO	
22	Gingiva	Bleeding	15	LFD	NO	NO	NO	Ulcer after treatment
23	Lower Lip	Aesthetic	4	LFD	NO	NO	NO	
24	Lower Lip	Aesthetic	7	LFD	NO	NO	NO	
25	Palate	Bleeding	8	LFD	NO	NO	SI	
26	Lower Lip	Bleeding	6	LFD	NO	NO	NO	
27	Tongue Dorsum	Clutter	3	LFD	NO	NO	NO	
28	Lower Lip	Bleeding	6	LFD	NO	NO	NO	
29	Lower Lip	Bleeding	3	LFD	NO	NO	NO	
30	Lower Lip	Clutter	4	LFD	NO	NO	NO	

Figures 1–3 show clinical cases where LFD was applied.

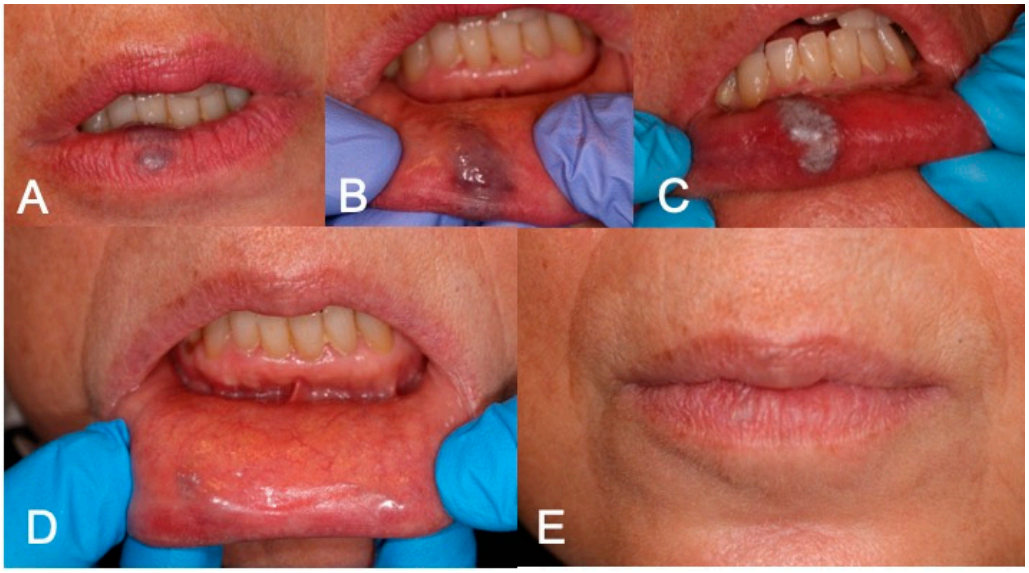

Figure 2. A)-B) Preoperative aspect of lower lip VM; C) LFD; D)-E) 3-week follow up complete healing after LFD.

 doi:10.20944/preprints202404.1716.v1

Figure 1. A) Preoperative aspect of gingival and lip VM; B) LFD; C) 3-week follow up showing complete healing after LFD.

4. Discussion

Vascular anomalies are commonly encountered in the head and neck region and are classified into hemangiomas and VM. Despite their pathogenesis is still unclear, they frequently require medical treatment or surgical removal. Selection of the most appropriate treatment modality is still a debated theme [7]. Considering benign lesions, treatment modalities include: surgical excision, systemic corticosteroids, embolization, cryotherapy, interferon-α, radiation, and sclerotherapy [8].

In general, systemic corticosteroids and interferon-α are eligible for large lesions, especially congenital hemangiomas, whereas embolization is suitable for large VM. Local and conservative approaches are dedicated to small lesions, especially intralesional corticosteroids, cryotherapy, sclerotherapy and surgery [8,9]. The advent of laser therapy in various fields of oral medicine, made it a further alternative, especially with conservative non-contact modalities like photocoagulation and LFD [10]. Multiple devices have been proposed over time, including, semiconductors, 514 nm argon, 532 nm KTP (potassium titanyl phosphate), 585 nm FPDL (flash lamp-pumped pulsed dye laser), 755 nm alexandrite, 810–940 nm diode,1064nm Nd:YAG (neodymium-doped yttrium aluminium garnet), p-NdYAG, and 10600nm CO2 (carbon dioxide) lasers [11,12].

One of the most tested is Nd:YAG laser, characterized by deep penetration and high hemoglobin absorption, but influenced by an imponent thermal reaction that leads to apoptosis and cellular death. Necrosis, scarring and infection are the main reported complications, despite treatment is overall well tolerated and painless. Some authors suggest to cool the lesion down with water during laser enlightening [10]. In our study, we have not cooled the lesion down using water but we have interposed a glass slide between the lesion and the laser beam, in order to reduce the risk of overheating and concomitantly the risk of perforation and bleeding. This technique makes LFD predictable even for inexpert operators.

In our study, we have employed a multiwavelength diode laser. The 810-830 nm diode lasers are selectively adsorbed by hemoglobin and poorly adsorbed by water, allowing a deep penetration into tissue (around 4-5mm) and favoring a photocoagulative process, generated by heat, up to a depth of 7-10mm [13]. The diode lasers are usually equipped with a manageable optic fiber kept at a regular 2-3mm distance from the lesion but not held too long while in action in order to avoid superficial damage and bleeding. The exposure is described to vary between 5 and 10 seconds with an energy output of 2.5-6W. Photocoagulation should extend a bit beyond the visible lesion in order to avoid sloughing and hemorrhage. The preferred modality is usually continuous wave [14]. In our treatments, the blue wavelength was chosen because of its greater specificity for hemoglobin and the infrared wavelength to ensure a sufficiently deep penetration into tissue. In addition, we have not employed a continuous wave modality but activated the beam with short impulses via a pedal, limiting the accumulation of heat into the tissue, following the concept of multiple spot irradiation. The concept of multiple spot irradiation (also called “leopard technique”) was proposed more than 40 years ago, with the idea of sparing the epithelium by separating irradiation spots. In bigger lesions, part of the epithelium in left untreated, and, once the epithelium has matured and stabilized, the remaining areas can be treated while the previously treated areas has already healed [6]. Other authors have proposed a continuous wave modality but ended up having ulcerations in all treated patients, frequently accompanied by the need to take multiple painkillers [6]. Working progressively

 doi:10.20944/preprints202404.1716.v1

in some parts of the lesion, allows the operator to visually understand if the technique is working, since the irradiated area turns from bluish-red to white, and lets the operator decide whether to go on or treat the remaining area in a following appointment, in order to reduce the risk of perforation, overheating and ulceration. At the same time, it is very important to extend photocoagulation while allowing a safety margin that extends slightly beyond the visible lesion. This increases the rate of success and reduces tissue sloughing [14]. In our cohort, we treated quite small lesions, and except for one that required a second session, all the lesions were completely healed after the first follow up. A non-neglectable result is the complete absence of pain and need of analgesics after the procedure.

Another risk of this "blind" technique, is that you don't exactly know the deepness of the lesions and LFD may be ineffective in very deep lesions. Despite some authors have demonstrated that large haemangiomas often stop growing after laser irradiation, others have demonstrated that deeper lesions are not treatable [12,15]. In our study we have treated small lesions and we can affirm the rate of success is very high with simple VM-which are the most frequent in the oral cavity. Moreover, being LFD very conservative, we believe it is worth proposing it as first-line technique, leaving more invasive approaches like intralesional coagulation and excision to failed treatments [16]. At times, LFD can be considered a compromise tool when lesions are complex and risky, maybe with the aim of reducing their dimension and cluttering. As an alternative, LFD can be applied to reduce the dimension of the lesions and then the operator may decide to proceed or not with a second step [16]. In complex cases, a more detailed diagnosis via magnetic resonance imaging is mandatory before the clinical procedure, to avoid the risk of unwanted complications and potentially, ultrasound-guided intervention should be considered [17,18].

Eventually, most of our patients suffered from general health conditions and most of them took one or more medications including an antiaggregant and anticoagulants. As confirmed by other authors, the risk of bleeding is so minimized that drug interruption is not required, even in case of medications that increase the risk of bleeding [2]. In addition, diabetic patients may show a delayed healing in case of surgical interventions and LFD nullifies this risk. Biostimulation offered by the combined wavelengths, enhances tissue regeneration and wound healing even in rare cases of superficial ulceration. In our cohort of patients, even including a certain percentage of diabetic subjects, we had no complications.

5. Conclusions

LFD should be the treatment of choice for small, accessible VM of the oral cavity. The technique can be performed without local anaesthesia, limits the duration of the intervention and is completely atraumatic. Interposing a glass slide, when feasible, drastically reduces the risk of bleeding, but also in case of anatomical obstacles to slide compression (hard palate, gingiva, floor of the mouth), the multiple spot technique can be applied reducing power based on a visual whitening of the lesion and performing multiple sessions until complete resolution of the pathology. The absence of pain during laser application and since the day after the intervention until the completion of follow up is another point in favour of conservative techniques, considering that most approaches require the use of painkillers after the procedure [19].

Funding: This research received no external funding.

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and approved by the Institutional Review Board (or Ethics Committee) of Nucleo Ricerca Clinica, Treviso, prot. 73512, studio osservazionale 976/CE.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Conflicts of Interest: Declare conflicts of interest or state "The authors declare no conflicts of interest".

References

1. Kunimoto K, Yamamoto Y, Jinnin M. ISSVA Classification of Vascular Anomalies and Molecular Biology. Int J Mol Sci. February 2022;23(4):2358.

 doi:10.20944/preprints202404.1716.v1

2. Dell'Olio F, De Falco D, Di Nanna S, Casorelli A, Favia G. Diode Laser Photocoagulation of Oral Venous Malformations in Patients on Anticoagulant Therapy Without Drug Discontinuation. Cureus. 20 march 2020;12(3):e7340.
3. John HE, Phen HS, Mahaffey PJ. Treatment of venous lesions of the lips and perioral area with a long-pulsed Nd:YAG laser. Br J Oral Maxillofac Surg. May 2016;54(4):376–8.
4. Jasper J, Camilotti RS, Pagnoncelli RM, Poli VD, da Silveira Gerzson A, Gavin Zakszeski AM. Treatment of lip hemangioma using forced dehydration with induced photocoagulation via diode laser: report of three cases. Oral Surg Oral Med Oral Pathol Oral Radiol. March 2015;119(3):e89-94.
5. Frigerio A, Tan OT. Laser applications for benign oral lesions. Lasers Surg Med. October 2015;47(8):643–50.
6. Miyazaki H, Ohshiro T, Romeo U, Noguchi T, Maruoka Y, Gaimari G, et al. Retrospective Study on Laser Treatment of Oral Vascular Lesions Using the «Leopard Technique»: The Multiple Spot Irradiation Technique with a Single-Pulsed Wave. Photomed Laser Surg. June 2018;36(6):320–5.
7. Zheng JW, Zhou Q, Yang XJ, Wang YA, Fan XD, Zhou GY, et al. Treatment guideline for hemangiomas and vascular malformations of the head and neck. Head Neck. August 2010;32(8):1088–98.
8. Johann ACBR, Aguiar MCF, do Carmo MAV, Gomez RS, Castro WH, Mesquita RA. Sclerotherapy of benign oral vascular lesion with ethanolamine oleate: an open clinical trial with 30 lesions. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. November 2005;100(5):579–84.
9. Mulliken JB, Fishman SJ, Burrows PE. Vascular anomalies. Curr Probl Surg. August 2000;37(8):517–84.
10. Medeiros R, Silva IH, Carvalho AT, Leão JC, Gueiros LA. Nd:YAG laser photocoagulation of benign oral vascular lesions: a case series. Lasers Med Sci. November 2015;30(8):2215–20.
11. Ulrich H, Bäumler W, Hohenleutner U, Landthaler M. Neodymium-YAG Laser for hemangiomas and vascular malformations -- long term results. J Dtsch Dermatol Ges. June 2005;3(6):436–40.
12. Landthaler M, Hohenleutner U. Laser therapy of vascular lesions. Photodermatol Photoimmunol Photomed. Dicember 2006;22(6):324–32.
13. Ohshiro T. Laser Treatment for Naevi. 1996ª ed. New York: Wiley; 17415 p.
14. Bradley PF. A review of the use of the neodymium YAG laser in oral and maxillofacial surgery. Br J Oral Maxillofac Surg. February 1997;35(1):26–35.
15. Alani HM, Warren RM. Percutaneous photocoagulation of deep vascular lesions using a fiberoptic laser wand. Ann Plast Surg. August 1992;29(2):143–8.
16. Romeo U, Del Vecchio A, Russo C, Palaia G, Gaimari G, Arnabat-Dominguez J, et al. Laser treatment of 13 benign oral vascular lesions by three different surgical techniques. Med Oral Patol Oral Cir Bucal. March 2013;18(2):e279-284.
17. Miyazaki H, Romeo U, Ohshiro T, Kudo T, Makiguchi T, Kawachi N, et al. Treatment strategies for large oral venous malformations using intralesional laser photocoagulation. Lasers Med Sci. novembre 2014;29(6):1987–90.
18. Miyazaki H, Ohshiro T, Watanabe H, Kakizaki H, Makiguchi T, Kim M, et al. Ultrasound-guided intralesional laser treatment of venous malformation in the oral cavity. Int J Oral Maxillofac Surg. February 2013;42(2):281–7.
19. Górriz-Gómez E, Vicente-Barrero M, Loras-Caballero ML, Bocanegra-Pérez S, Castellano-Navarro JM, Pérez-Plasencia D, et al. Sclerotherapy of face and oral cavity low flow vascular malformations: our experience. Br J Oral Maxillofac Surg. January 2014;52(1):43–7.