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Treatment of vascular lesions in the head and neck using Nd:YAG laser

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SUMMARY. Introduction: **Vascular lesions in the head and neck region, including both haemangiomas and vascular malformations, are common and many different treatment modalities have been used for their removal. In the past decade, the Nd:YAG laser has emerged as a new mode of treatment for vascular lesions, and the purpose of this paper was to determine its clinical value.** Patients and methods: **A prospective study was conducted in 111 patients with vascular lesions in the head and neck region. They were treated with the Nd:YAG laser by photocoagulation. Of these, 96 had small lesions, with surface diameters of less than $3 \times 3\,cm^2$, and 5 had large lesions, with surface diameters of more than $3 \times 3\,cm^2$. The patients were all followed-up carefully until complete healing was recorded, along with any complications.** Results: **In both groups of patients, tissue sloughing occurred within 2–3 days. Healing time in small lesions was 2–3 weeks, and in large lesions 3–4 weeks. Three patients with small lesions and one patient with a large lesion experienced minor complications.** Conclusion: **The Nd:YAG laser is a safe and effective tool for treating vascular lesions.** © **2005 European Association for Cranio-Maxillofacial Surgery**

Keywords: **haemangiomas; vascular malformations; laser therapy**

INTRODUCTION

Vascular lesions, including both haemangiomas and vascular malformations, are common pathological entities. More than 50% of these benign lesions are located in the head and neck region. The International Society for the Study of Vascular Anomalies adopted the classification of *Mulliken* and *Glowacki* (1982) for vascular lesions in 1996. This classification divides vascular lesions into tumours (haemangiomas, others) and malformations (capillary, venous, arteriovenous, lymphatic, combined).

Haemangiomas tend to develop after birth, and grow during the first year of life, and then slowly involute. They have a characteristic endothelial structure. More than 50% involute completely by the age of 4 or 5 years (*Mulliken* and *Glowacki*, 1982; *Shapshay* et al., 1987). That is why physicians tend to adopt a wait and see policy in the first years of life, rather than treating haemangiomas surgically. However, the process of involution is often accompanied by more or less visible scarring, especially in the facial region. Vascular malformations, on the other hand, are usually noted at birth, grow in concert with body growth and do not tend to regress (*Mulliken* and *Glowacki*, 1982). For the sake of simplicity, this paper refers to both (haemangiomas as well as vascular malformations) as vascular lesions. The distinction is only made when describing specific cases.

Many different modalities for treatment of vascular lesions have been used so far: surgery, embolisation, steroid therapy, cryosurgery, electrodessication, etc. (*Shapshay* et al., 1987) In the past decade, therapy with the neodymium:yttrium–aluminum–garnet (Nd:YAG) laser has emerged as new alternative. The laser's beam is poorly absorbed in water and selectively absorbed by haemoglobin. Due to its poor absorption in water, the laser penetrates deeply into the tissue, down to a depth of 4 – 5 mm. As it passes through tissues, the laser beam emits heat and thus coagulates tissue down to the depth of about 7–10 mm, a process called photocoagulation. Its selective absorption by haemoglobin causes selective photocoagulation within blood vessels. The Nd:YAG laser beam can be delivered by a flexible optic fibre, which makes it very easy to handle. These properties are excellent for treating vascular lesions (*Shapshay* et al., 1987; *Burkey* and *Garrett*, 1996; *Bradley*, 1997; *Werner* et al., 1998).

In this study, a series of patients with vascular lesions ($n = 111$) were treated with the Nd:YAG laser, and the results are presented.

PATIENTS AND METHODS

Patients

Over a 4 year period, 111 patients with predominantly intraoral vascular lesions were treated using the Nd:YAG laser. The locations are presented in Table 1. Most patients had small vascular lesions,

[1]*Support*: This work was supported by the Slovenian producer of medical lasers, Fotona (Fotona, Stegne 7, SI-1000 Ljubljana, Slovenia, http://www.fotona.si).

measuring less than 3 cm in two dimensions. Five patients had large lesions, measuring more than 3 cm in two dimensions.

Procedure

The laser used was the Nd:YAG component of the combined Er:YAG/Nd:YAG Twinlight laser (Fotona, Ljubljana, Slovenia). Power settings were in the range of 8.00–12.00 W per pulse, pulse frequencies 35–55 Hz and pulse durations (self-set) 125–150 μs. The wavelength was a constant 1064 nm, and the optic fibre diameter 320 μm. During treatment, the fibre tip was in direct or very close contact with the tissue surface. In rare cases of minor bleeding, it was switched to defocussed mode, moving the fibre tip 1–2 cm away from the tissue surface, and thus achieved haemostasis.

During treatment, the borders of the lesion were first outlined on the mucosa, with a safety margin of 1–2 mm. Afterwards, one systematic pass was first made over the lesion. Shrinkage and blanching were observed, and one or two more passes were made. The passes were made in a spotlike fashion, with margins around each treated spot, in order to avoid overlap and tissue necrosis (*Dixon* et al., 1986).

Small vascular lesions were treated without compression, as the penetration depth of the Nd:YAG laser was sufficient to treat the whole volume. In large vascular lesions, however, the penetration depth of the Nd:YAG laser was too small to reach to the bottom of the lesion. By compressing the lesion, it was flattened and thus the laser beam could coagulate its entire thickness (*Shapshay* et al., 1987; *Bradley*, 1997; *Werner* et al., 1998). For lesions of the tongue and cheek, glass slides were used for compression and photocoagulation was performed through the glass slide (Fig. 1). For lesions of the palate and vestibulum, a modified test tube with a side window was used as a compression tool (Fig. 2). The side window served for inserting the laser fibre tip. The bottom of the test tube was used for compression, and photocoagulation was performed directly through it (Fig. 3).

In cases of intraoral vascular lesions extending to the skin, a combination of glass slide compression and intralesional photocoagulation was used (*Achauer* et al., 1999). Direct transcutaneous photocoagulation would have damaged the skin, leading to scarring. The fibre was thus inserted into the vascular lesion subcutaneously through a wide bore needle, and at the same time the lesion was compressed. Systematic intralesional passes were made and shrinkage was observed (Fig. 4).

Patients with small lesions were treated in one session, under local anaesthesia as out-patients.

Table 1 – Locations of vascular lesions

	Number	% of total
Lip	51	46
Tongue	35	32
Buccal mucosa	21	19
Hard palate	2	2
Subcutaneous	2	2
Total	111	100

Fig. 1 – Glass slides in use for compression of tongue. *Note:* Fibre tip pointing at lesion.

Fig. 2 – Modified test tube with side window.

Fig. 3 – Modified test tube in use for compression of palate – observe optic fibre inserted through side window.

In patients with large lesions, one session was usually not enough, and one or two more "touch-up" sessions were necessary. Sometimes, a corrective surgical procedure was necessary as the final step. Some of the large lesions were treated on an out-patient basis, whereas others were hospitalised to simplify management of bleeding.

After treatment, patients were given non-steroidal analgetics and sometimes oral lidocain gel to ease discomfort during meals. Patients were monitored weekly until healing was complete.

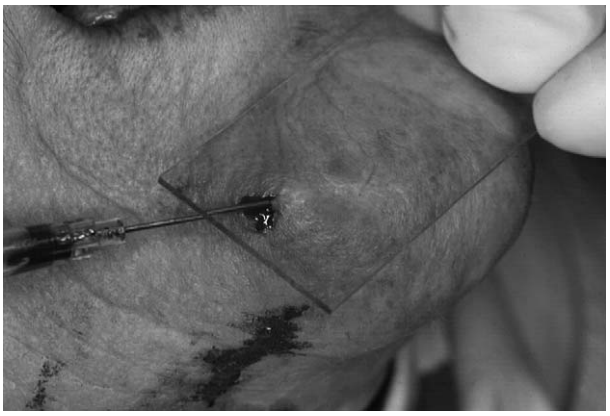

Fig. 4 – Intralesional photocoagulation with compression – optic fibre introduced via wide bore needle.

RESULTS

Small lesions

In patients with small vascular lesions, tissue sloughing occurred within 2–3 days, and healing with re-epithelization was complete 2–3 weeks post-treatment. None of the patients experienced bleeding or pain of any great intensity. Scarring was generally aesthetically acceptable (Fig. 5).

In this group of patients, there were three cases with complications. In one patient treated for a small varix of the vermilion of the lower lip, deep tissue necrosis occurred down to the orbicularis muscle. The necrotic portion was excised and the wound sutured in layers, and subsequent healing was uneventful (Fig. 6). A similar situation occurred in another patient with a vascular malformation of the right side of the tongue. Necrosis was very extensive but was allowed to heal by secondary intention and the scar was practically invisible 1 year post-treatment (Fig. 7). Another patient experienced an episode of mild, transient paraesthesia of the right half of the lower lip after photocoagulation of a small lesion in the right lower oral vestibulum, in close proximity to

Fig. 5 – a – Small venous malformation of lip before laser treatment; b – Immediately post-treatment, observe shrinkage and blanching; c – one week post-treatment, lip covered with fibrin after tissue sloughing; d – three weeks post-treatment, lip healed.

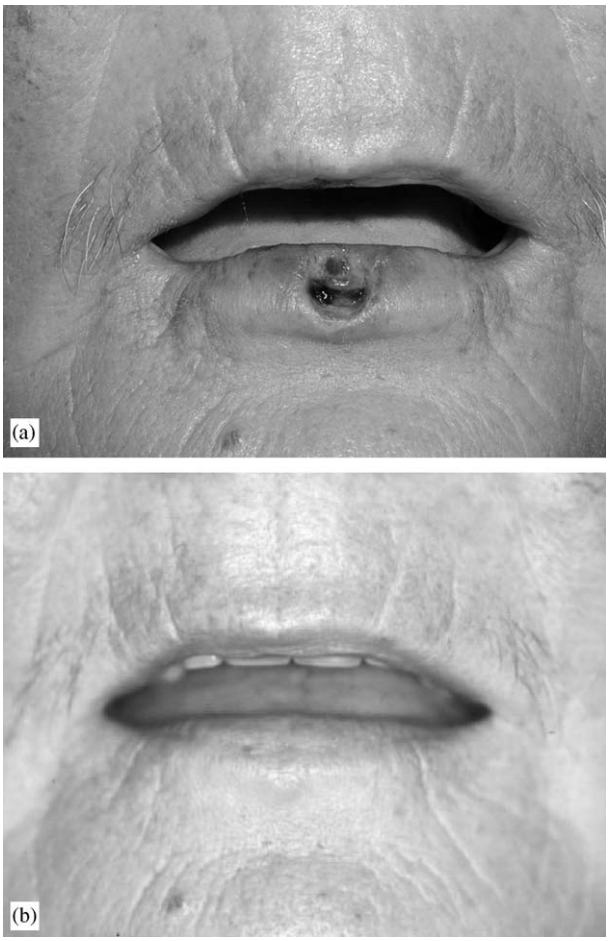

Fig. 6 – a – Necrosis down to orbicularis muscle 1 week after removal of a small varix of lower lip; b – uneventful healing after excision of necrosis and suturing.

the mental foramen. Complete sensory recovery took 2 weeks.

Large lesions

In patients with large vascular lesions, tissue sloughing also occurred within 2–3 days, but complete healing took longer, usually 3–4 weeks. There were no cases of serious bleeding, and pain was well controlled with the use of oral analgesics and topical anaesthetics. Tissue scarring was slightly more prominent here. Three patients in the group with large vascular lesions were treated under general anaesthesia to facilitate any bleeding control needed. In patients who underwent intralesional photocoagulation, there was no tissue sloughing, as the surface remained unchanged. Interstitial scarring, however, did occur and could be readily palpated.

One of the patients in the group with large vascular lesions developed an infection of the tongue after tissue sloughing had occurred. The infection was controlled with oral antibiotics, as described (Case 1).

The five cases of large vascular lesions are presented as case reports.

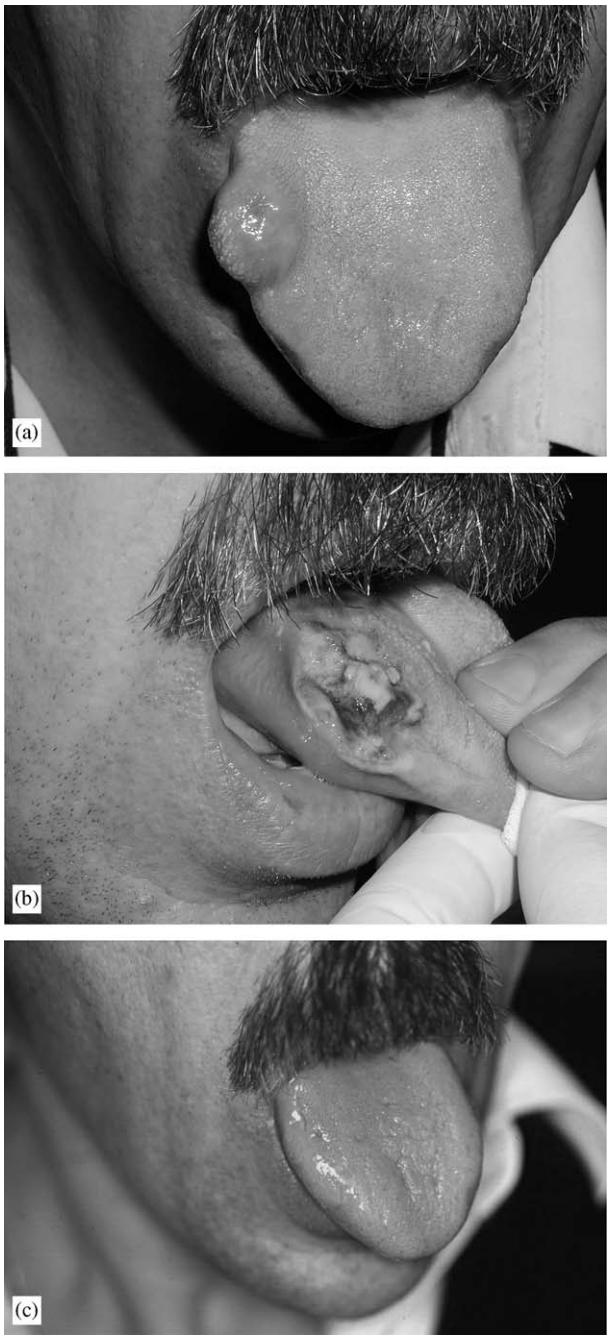

Fig. 7 – a – Small venous malformation of tongue before treatment; b – extensive necrosis 1 week after laser treatment; c – tongue healed by secondary intention, 1 year post-treatment.

Case 1: A female patient, age 73, was treated for a large cavernous haemangioma of the right side of the tongue and floor of the mouth, without the use of compression. She experienced a recurrence 1 year after complete removal with the laser. The lesion was treated once more, this time using compression with glass slides. After this, the patient developed an infection of the treated site, which was controlled with oral antibiotics. Healing was uneventful, and 2 years after the second treatment, the tongue was still free of recurrence (Fig. 8).

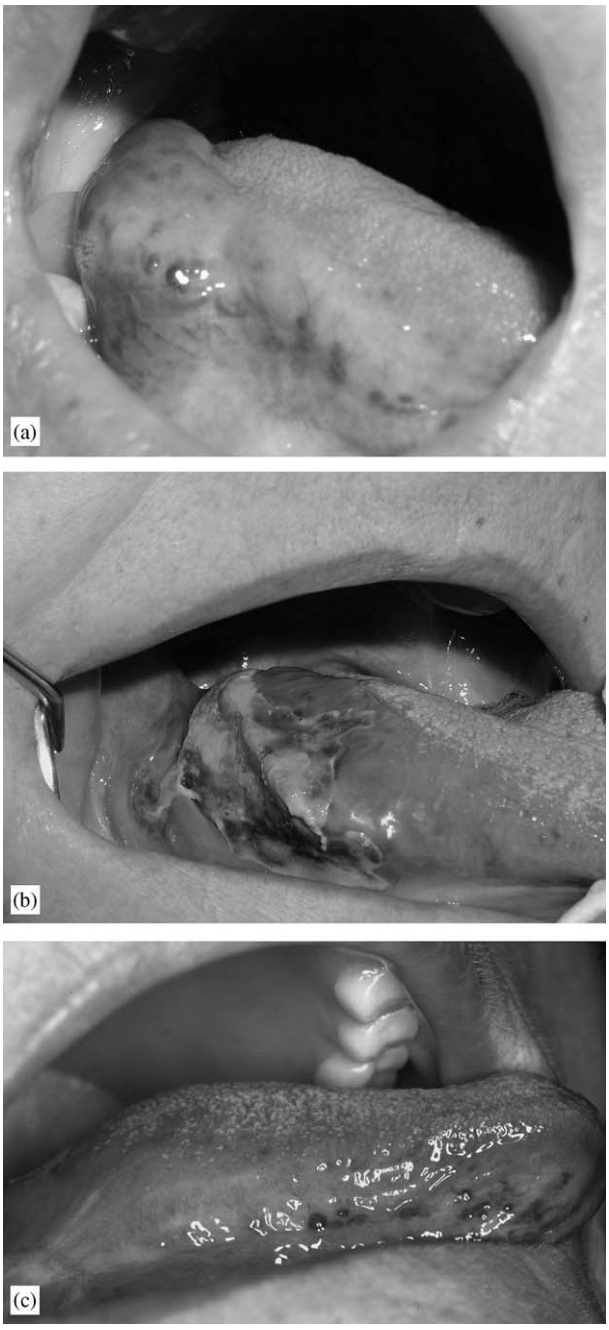

Fig. 8 – a – Large recurrent cavernous haemangioma of tongue before treatment; b – one week post-treatment, tongue covered with fibrin after tissue sloughing; c – four weeks post-treatment, tongue healed.

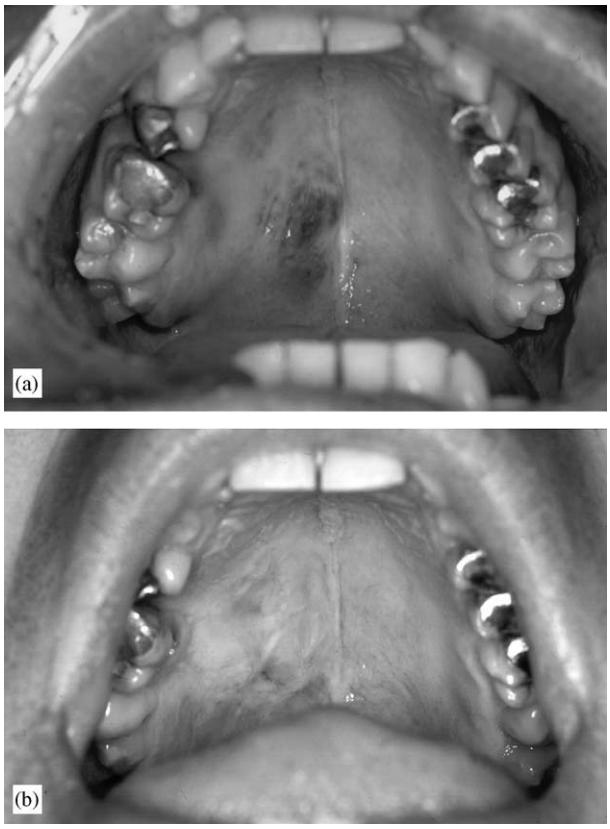

Fig. 9 – a – Venous malformation of palate before laser treatment; b – lesion of palate resolved.

Case 2: A 29-year-old female patient with a large haemangioma of the left side of the lower surface of the tongue had been treated 20 times (!) previously during a period of 8 years using sclerosing agents. The last of these treatments was performed in 1990. In the year 2000, the lesion started to grow again, and in 2001, the patient was treated with the Nd:YAG laser for the first time, using compression with glass slides. After laser therapy, the lesion shrank, but a bulky mass of intralingual scar tissue from previous sclerosing treatments remained. However, this was not troublesome to the patient, and she declined its excision.

Case 3: A 38-year-old male patient had a large venous malformation of the right side of the hard and soft palate, with an interdental extension into the right superior vestibulum. The first session of photocoagulation was performed without the use of compression. The lesion shrank, but remained quite large centrally. The second session was done using compression with the modified test tube (Fig. 3) and the lesion resolved completely (Fig. 9).

Case 4: In an 11-year-old female patient, a large venous malformation of the upper lip was present. She was treated twice with intralesional photocoagulation with 3 month intervals, both times under general anaesthesia. The lesion became smaller and firmer, and appeared ''deflated'' due to scarring. Three months after the second laser treatment, the residual lesion was excised, again under general anaesthesia. The final result was aesthetically satisfactory (Fig. 10).

Case 5: The largest vascular lesion was present in a 73-year-old female. The venous malformation extended from the right side of the tongue onto the floor of the mouth, further into the left inferior vestibulum, lower lip mucosa and skin of the chin. The patient was treated in two sessions. During the first session, the vestibulum, lip and, very carefully,

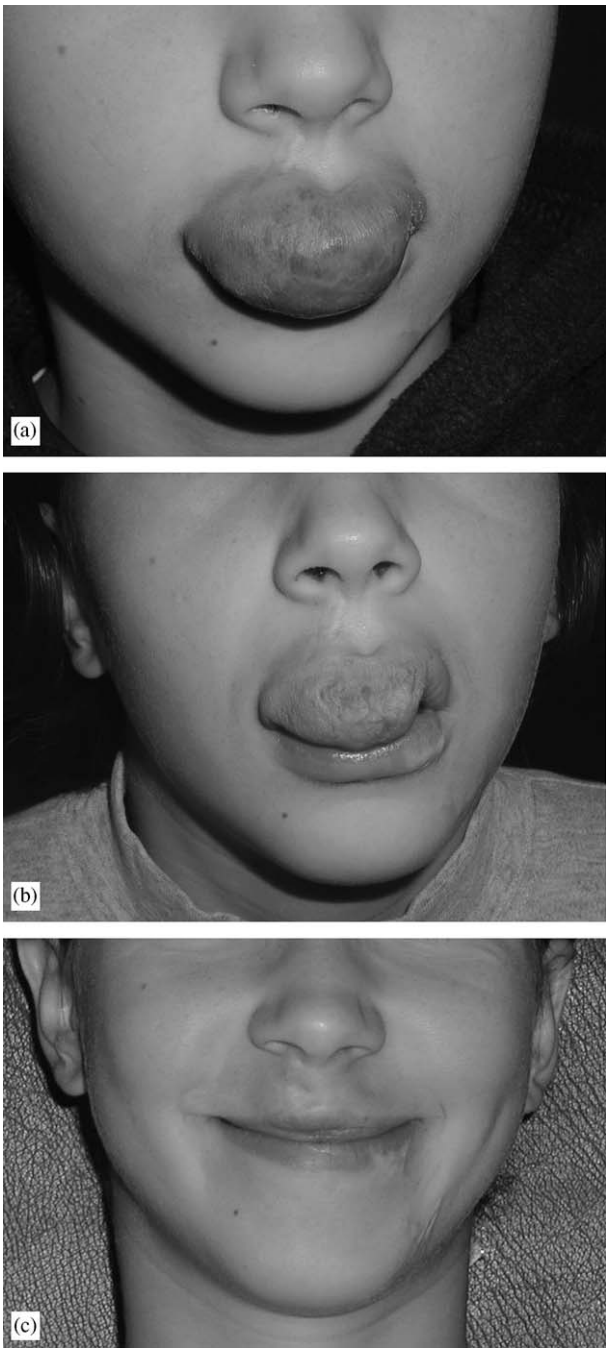

Fig. 10 – a – Large venous malformation of upper lip before laser treatment; b – lip after two sessions of laser treatment, lesion is smaller and appears "deflated;" c – final result after surgical exscision (scars on the left side of the chin are from previous treatments with sclerosants).

the chin were treated. The chin was photocoagulated intralesionally. In the second session, 1 month later, the tongue, floor of the mouth, and again the chin were treated, using intralesional photocoagulation for the chin once more. A small area of skin necrosis developed ($5 \times 7\,mm^2$), where the skin covering the vascular lesion was very thin. This area healed with a small scar, which is barely visible. All other sites healed uneventfully. The vascular lesion was still not completely eradicated, but the patient refused further treatments (Fig. 11).

DISCUSSION

Although haemangiomas and vascular malformations are two pathologically separate entities, the diagnostic and therapeutic procedures used for their removal were identical, as were also the healing phases after their removal. Pre-treatment histological diagnostics was not performed, as haemangiomas and vascular malformations are as a rule benign, and tissue sampling would cause unnecessary bleeding. In Case 1 of the large lesions, a histological sample taken some years previously proved the lesion to be a cavernous haemangioma. In this paper it is generally referred to both haemangiomas and vascular malformations as vascular lesions, except when describing specific cases. In these, the distinction between haemangiomas and vascular malformations was made clinically.

Vascular lesions of the head and neck have a relatively high incidence, can be very troublesome to the patient and are often difficult to remove. The Nd:YAG laser can serve as an effective treatment tool as long as certain general precautions and limitations are observed (*Shapshay* et al., 1987, *Bradley*, 1997; *Werner* et al., 1998; *Achauer* et al., 1999).

In patients with large lesions (measuring more than 3 cm in two dimensions) one first has to rule out the *high flow* type, i.e. arterio-venous malformations with a feeder artery. Clinically, a characteristic bruit (or thrill) can often be heard palpatated over such a lesion. Examination with Doppler ultrasound and/or angiography prior to laser treatment in large vascular lesions is mandatory, to ensure that the lesion is of the low flow type. In high flow lesions, the feeder artery has to be identified and occluded, and photocoagulation should only be performed afterwards (*Shapshay* et al., 1987). Otherwise there is the risk of haemorrhage, possibly life threatening. However, the vast majority of vascular lesions in the head and neck region are small, measuring less than 3 cm in two dimensions, and of the low flow type. They can be treated under local anaesthesia on an out-patient basis (*Burkey* and *Garrett*, 1996; *Bradley*, 1997; *Werner* et al., 1998).

Perforation of the mucosa covering the lesion should be avoided. The fibre tip with the emitting laser beam should not be held in the same place too long and should be slowly moved over the lesion, observing tissue shrinkage and blanching. Photocoagulation has to be performed with a safety margin, slightly beyond the visible extent of the lesion. In this way, tissue sloughing does not occur within the hypervascularized area, which again could lead to haemorrhage (*Bradley,* 1997).

Nerves may be damaged irreversibly by photocoagulation. Therefore some authors advise the employment of cryosurgery as an alternative in areas

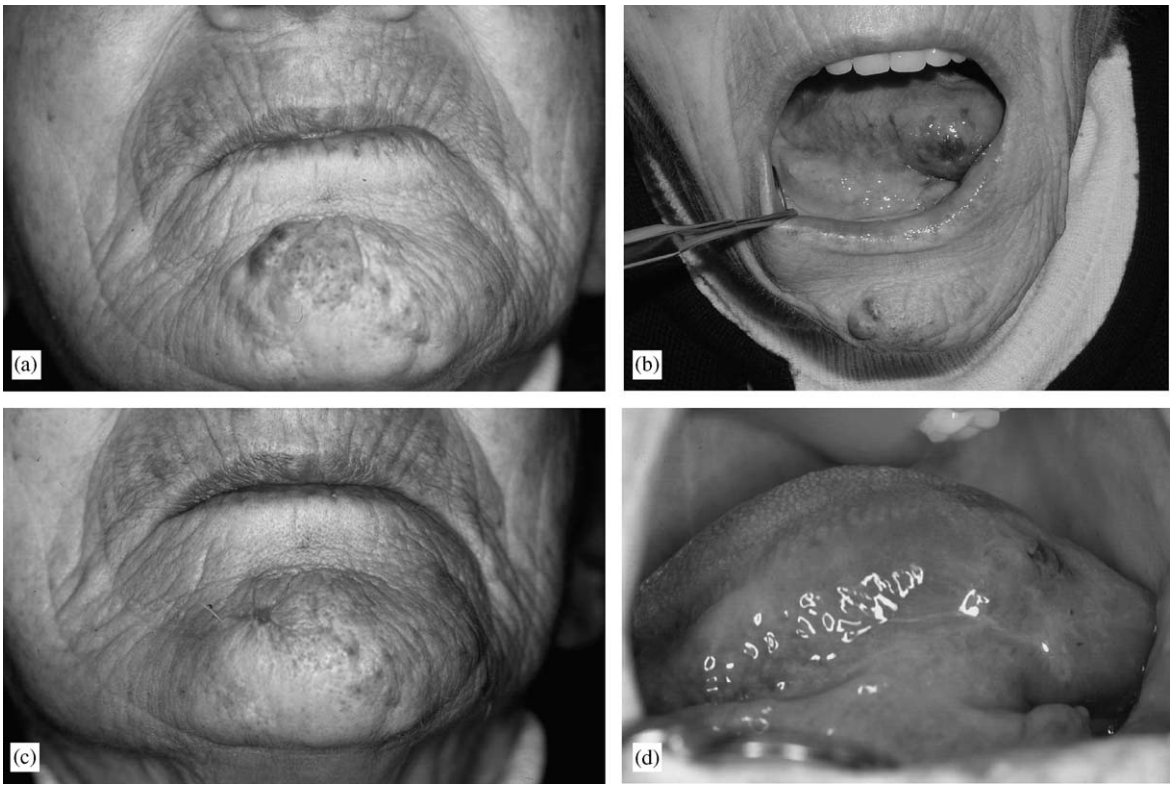

Fig. 11 – a – Large venous malformation of chin, tongue and floor of the mouth before laser treatment; b – tongue and floor of the mouth before laser treatment; c – lesion of chin removed; d – Lesion of tongue removed.

adjacent to the nerves, as it is considered not to cause irreversible damage (*Bradley*, 1997). As already described, the paraesthesia observed in one case was transient only. When treating around salivary gland orifices, one has to bear in mind the risk of post-treatment stenosis. Again, some authors advise cryosurgery in these areas, for similar reasons (*Bradley*, 1997).

When treating subcutaneous vascular malformations, one has to be careful not to damage the skin surface, in order to avoid scarring. The optic fibre should be inserted into a wide bore needle, which is then passed into the lesion as a trocar. Intralesional photocoagulation is then performed as described above (*Achauer* et al., 1999). Ultrasound can be used for better guidance and control (*Werner* et al., 1998). Some authors advocate transcutaneous laser treatment and simultaneous cooling of the skin surface, which also leaves the skin undamaged (*Chang* et al., 1997).

Observing these precautions, the complication rate in Nd:YAG laser treatments is very low. Indeed, in this series it was lower than anticipated.

It is not clear why the two complications of tissue necrosis described above occurred on the lower lip and tongue. The two patients were treated just like the other patients with small vascular lesions. However, these two cases strongly support the notion that a careful approach has to be chosen when treating vascular lesions with the Nd:YAG laser. During treatment, all that is clinically obvious is shrinkage and blanching of the lesion. The degree and extent of deep coagulation become obvious only when tissue sloughing occurs, which is within a few days after treatment, and can be more extensive than expected. It takes some experience before the clinician can readily estimate the degree of deep coagulation during treatment. That is why it is better to be less radical when performing the initial treatment and to later perform one or two touch-up treatments for removing residual hypervascular tissue.

The modified test tube with a side window proved to be a useful compression tool in areas where compression cannot be achieved with glass slides. It is heat resistant, easy to make and cheap. We came upon the idea after the first session of treatment of the large vascular malformation of the hard palate, when the lesion was incompletely removed and it became obvious that compression would be beneficial (Case 3).

CONCLUSION

In the past decade, the Nd:YAG laser has been used increasingly in the treatment of different types of low flow vascular lesions. Laser treatment is quick, bloodless, safe, and easy to learn. Postoperative problems and discomfort are minimal, and so is scarring. Complications occur rarely. It must, however, be used with certain precautions, as the degree of tissue coagulation is not immediately obvious.

When used appropriately, the Nd:YAG laser is a very useful tool for removal of vascular lesions.

References

Achauer BM, Chang CJ, VanderKam VM, Boyko A: Intralesional photocoagulation of periorbital hemangiomas. Plast Reconstr Surg 103: 11–16, 1999

Bradley PF: A review of the use of the neodymium YAG laser in oral and maxillofacial surgery. Br J Oral Maxillofac Surg 35: 26–35, 1997

Burkey BB, Garrett G: Use of the laser in the oral cavity. Otolaryngol Clin North Am 29: 949–961, 1996

Chang CJ, Anvari B, Nelson JS: Cryogen spray cooling for spatially selective photocoagulation of hemangiomas: a new methodology with preliminary clinical results. Plast Reconstr Surg 102: 459–463, 1997

Dixon JA, Davis RK, Gilbertson JJ: Laser photocoagulation of vascular malformations of the tongue. Laryngoscope 96: 537–541, 1986

Mulliken JB, Glowacki J: Hemangiomas and vascular malformations in infants and children: a classification based on endothelial characteristics. Plast Reconstr Surg 69: 412–420, 1982

Shapshay SM, David LM, Zeitels S: Neodymium-YAG laser photocoagulation of hemangiomas of the head and neck. Laryngoscope 97: 323–330, 1987

Werner JA, Lippert BM, Gottschlich S, Folz BJ, Fleiner B, Hoeft S, Rudert H: Ultrasound-guided interstitial Nd:YAG treatment of voluminous hemangiomas and vascular malformations in 92 patients. Laryngoscope 108: 463–470, 1998

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