

## Percutaneous and Combined Percutaneous and Intralesional Nd:YAG-laser Therapy for Vascular Malformations

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The numerous types of vascular abnormality are classified in groups according to their pathological and anatomical features. We present case histories of 2 patients who had vascular malformations of the face since birth or early childhood. Application methods, side-effects and complications of percutaneous and intra-lesional Nd:YAG-laser therapy are reviewed for these patients. A 54-year-old woman was treated percutaneously with the Nd:YAG-laser at 1064 nm, with 20–30 W, cw 1–5 s pulses and 2–3 mm spot size. A 59-year-old woman was treated with the combined percutaneous and intra-lesional laser therapy with 30 W, cw 1–5 s pulses and 2–3 mm spot size. In both cases, percutaneous or combined percutaneous and intra-lesional Nd:YAG-laser application resulted in a significant shrinking of the lesion. The Nd:YAG-laser radiation at 1064 nm presents an effective treatment of vascular malformations due to its deep penetration into the tissue. No standardized guidelines for Nd:YAG-laser therapy exist and the treatment parameters should be chosen individually according to the type of vascular malformation. **Key words:** vascular malformation; percutaneous Nd:YAG laser therapy; intra-lesional Nd:YAG laser therapy.

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The numerous types of vascular abnormality are grouped according to their pathological and anatomical features. According to the Hamburg classification of 1988, arterial, venous, lymphatic, arteriovenous and combined malformations must be differentiated, with a further subdivision in truncular and extratruncular malformations. Truncular malformations are based on a dysembryogenesis of mature blood vessels, whereas extratruncular malformations are derived from the primitive capillary network (1–3).

The Nd:YAG-laser produces a continuous-wave infrared light at 1064 nm, which penetrates into the dermis to a depth of 5–7 mm. Good results can be achieved in the treatment of cavernous vascular tumours and voluminous malformations (4–7). This report emphasizes two different methods of Nd:YAG-laser light application: percutaneous laser light application and intra-lesional photocoagulation. In percutaneous application, the laser light is transmitted into the lesion directly through the overlying skin, resulting in coagulation and shrinking of the vascular lesion (6). In order to avoid side-effects such as necrosis and scarring, the skin must be protected from serious heat damage by simultaneously cooling the skin surface with water or ice cubes (4, 6, 8–10). In intra-lesional photocoagulation, the laser light is applied into the vascular tissue directly via a flexible bare quartz fibre by pene-

trating the tissue with a 16-gauge needle and inserting the fibre through the needle. The position of the fibre can be controlled sonographically, by palpation, or by viewing the red light of the pilot laser shining through the skin surface (1, 11, 12).

### MATERIALS AND METHODS

#### Case 1

A 54-year-old woman presented with a combined vascular malformation of the right side of the face, which had been present since birth. In early childhood she had been treated with radiotherapy resulting in a radioderma. No reduction in size of the malformation could be achieved by therapies such as electrocautery or laser treatment (the type of laser and treatment parameters are unknown). The examination revealed blue, bulky and compressible nodes on the right cheek and the upper and lower eyelid involving the conjunctiva and the right palate. Spotted hyper- and hypo-pigmentation, telangiectasia and atrophy of the skin was seen in the middle of the cheek (Fig. 1). The ophthalmological findings showed subconjunctival involvement of the venous malformation at the right upper and lower eyelid, good lid



Fig. 1. Patient 1 with vascular malformation before laser treatment, showing bluish and bulky nodes and telangiectasia on the right side of the face. Note the radioderma caused by childhood radiotherapy.

closure, moderate ectropion, regular fundus and regular ocular pressure. No evidence for degradation of the visual performance or mydriasis was found.

Two treatments at 8-month intervals with the Nd:YAG-laser (Axyon<sup>®</sup>, Aesculap Meditec, Germany) (1064 nm, 20–30 W, cw 1–5 s pulses, 2–3 mm spot size) were performed under general anaesthesia. The laser light was applied percutaneously with simultaneous tissue cooling with ice water.

#### Case 2

A 59-year-old woman presented with a venous malformation of the chin since birth. After an operation at the age of 11, there was immediate recurrence. At the age of 30 years, the patient was treated with radiotherapy and recurrence was noted 15 years after this treatment. Rapid enlargement of the lesion was reported during anticoagulation therapy after an apoplectic insult resulting from hypertonia. The examination revealed a mass of compressible, bluish and bulky nodes of the lower lip and chin. Another large, predominantly subcutaneous, node was seen below the chin (Fig. 3). Two treatments with the Nd:YAG-laser were carried out under general anaesthesia. The laser light was applied percutaneously (30 W, cw 1–5 s pulses, 2–3 mm spot size) with simultaneous tissue-cooling. To minimize the epidermal damage and to prevent the skin from scarring, the skin was cooled with ice water. The cold water was drawn up in a syringe and slowly but continuously dropped on the treated area. The subcutaneous node below the chin was treated intra-lesionally (6 W, cw) with a 600- $\mu$ m bare fibre. After penetrating the tissue with a puncture cannula, the fibre was inserted through the needle and the laser light was applied directly into the vascular tissue. The position of the fibre was controlled and optimized sonographically.

#### RESULTS

No complications occurred after the operations. Four weeks after the first laser treatment, the first patient showed satisfactory regression of the bulky lesions of the eye and lips. The second laser treatment achieved a further improvement and blanching of the vascular lesion (Fig. 2). The follow-up period until the time of writing was about 9 months. The results in the second patient, which were already good after the first treatment, could be further improved with a second laser treatment



Fig. 2. Patient 1 showing size reduction and colour normalization, especially in the area of the eyes and lips, after repeated percutaneous Nd:YAG-laser therapy.

after 7 months (Fig. 4). The follow-up period for the second patient at the time of writing was about 12 months.

#### DISCUSSION

The Nd:YAG-laser produces light at 1064 nm. Light of this wavelength penetrates the skin to a depth of 5–7 mm due to relatively low absorbance but high scattering (13). The absorption of the light induces a temperature increase in the vascular lesion and results in the coagulation of vessels, even those located deep in the dermis (14). Swelling occurs after laser therapy, especially in regions such as the lips and eyelids. To minimize swelling, laser treatment should be performed with intra-operative tissue cooling. Additional cooling after laser treatment (e.g. by cold packs) is helpful. Blisters and scabs form within a few days of percutaneous therapy. Wound healing is normally complete after 2–4 weeks (15).

Percutaneous Nd:YAG-laser therapy was described by Landthaler et al. (15). To prevent side-effects such as necrosis and scarring, the skin must be protected from heat damage



Fig. 3. Patient 2 with vascular malformation before laser treatment, showing compressible, bluish and bulky nodes of the lower lip and chin.



Fig. 4. Patient 2 showing marked regression of the malformation after repeated combined percutaneous and intra-lesional Nd:YAG-laser treatment.

by cooling the surface with water, ice water or ice cubes (4, 6, 8–10). Apfelberg reported good results in 4 patients with haemangiomas and 3 with vascular malformations of the face treated with Nd:YAG-laser, steroids, embolization and surgery (9). The results of these treatments were satisfactory and no further surgery was necessary. Grantzow et al. described 77–98% size reduction in haemangiomas after percutaneous Nd:YAG-laser therapy, depending on the number of treatments (10).

The advantages of intra-lesional photocoagulation in comparison with percutaneous application are the direct penetration of the target tissue without thermal damage to the skin, and the possibility of deeper application of the laser light after inserting the fibre through the needle. The laser light is applied directly into the vascular tissue and leads to a reduction in size of the lesion by producing thrombosis and coagulation necrosis of the tissue (9). The position of the fibre can be controlled sonographically (1, 11, 12). In order to prevent the skin from scarring, the number of punctures should be kept as low as possible.

Possible complications of intra-lesional laser therapy include thermal necrosis of the lower surface of the skin due to incorrect fibre position or high power output, or injury to the facial nerve, which can be prevented by intra-operative facial monitoring which allows confirmation of the electrical integrity of the nerve during surgery (13, 16).

Alani & Warren reported on 11 patients with haemangiomas and 2 with lymphangiomas treated with intra-lesional photocoagulation with the KTP- (potassium-titanyl-phosphate), argon- or Nd:YAG-laser (8). A reduction in size of the lesions was achieved in each patient, with further improvement with repeated treatments. Derby & Low treated 32 patients with vascular lesions with the Nd:YAG-laser, 11 of these lesions were treated intra-lesionally (13). Complete remission was achieved in 6 cases, and marked improvement and size reduction in 14 cases. Recurrence was common (20 cases) and was generally noted after 2–6 months. Gregory described good results in a series of 25 patients with haemangiomas after Nd:YAG-laser treatment, but also reported a high recurrence rate (17).

Werner et al. reported complete remission in 27 of 31 patients with haemangiomas after percutaneous, intra-lesional or combined percutaneous and intra-lesional laser therapy (6). In our experience, combining percutaneous and intra-lesional laser treatment is useful for the therapy of complex malformations, since both deep and superficial vessels can be treated with the optimal parameters and minimal risk of side-effects. The number of laser treatments and the energies necessary for regression depend mainly on the proliferation status, the type and the location of the lesion. The smaller the proliferating part of the vascular lesion, the more effective is the response (6). High-flow lesions with marked arterial circulation or AV-shunting generally respond unsatisfactorily to Nd:YAG-laser treatment. The circulating blood acting as "cooling circuit" probably prevents effective coagulation of the lesion by the absorbed thermal energy. Laser treatment of mucosal vascular tumours achieves better results as on non-glabrous skin, since here the vessels are mostly located superficially and are easily accessible to the laser light (6). Repeated laser treatments are preferred to aggressive single treatments, since the latter bear an increased risk of side-effects due to excessive thermal necrosis (e.g. scarring, prolonged swelling, infection and nerve injury).

Percutaneous, intra-lesional or combined Nd:YAG-laser therapy is a valuable tool in the management of vascular malformations, especially in the predominantly venous type. Output power, spot size, pulse duration and the total energy dose must be individually adapted to size, colour and consistency of the malformation. For this reason, no standardized guidelines for Nd:YAG-laser therapy exist and the treatment parameters should be chosen individually according to the type of vascular malformation.

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