Technique Of Ultrasound-navigated Intralesional Nd:YAG Laser Coagulation Of Congenital Vascular Disorders

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Citation

Abstract
The treatment of voluminous hemangiomas or vascular malformations, particularly of the infiltrative type, is difficult and requires a combination of methods such as surgical excision, embolisation, laser therapy, sclerotherapy and magnesium spiking (1,2,3,4). Ultrasound- navigated intralesional Nd: YAG (Neodymium:Yttrium-Aluminium-Garnet)-Laser coagulation has been proven valuable, particularly in treating venous malformations of the infiltrating type.

INTRODUCTION
The treatment of voluminous hemangiomas or vascular malformations, particularly of the infiltrative type, is difficult and requires a combination of methods such as surgical excision, embolisation, laser therapy, sclerotherapy and magnesium spiking (1,2,3,4). Ultrasound- navigated intralesional Nd: YAG (Neodymium:Yttrium-Aluminium-Garnet)-Laser coagulation has been proven valuable, particularly in treating venous malformations of the infiltrating type.

MATERIAL AND METHODS
Ultrasound-navigated intralesional Nd: YAG laser coagulation was performed on 21 patients aged from 3 months to 28 years (mean age: 17.8 years) with cavernous hemangiomas or vascular malformations (Table). 12 patients had vascular malformations primarily of the venous kind, whereas arteriovenous components were predominant in 5 patients. In 4 children, an extensive hemangioma was the indication for intralesional laser therapy. All patients with hemangiomas underwent ultrasound (color-coded duplexsonography), patients with vascular malformations underwent additional MR- and MR-angiography. Laser coagulation is performed under general anesthesia.
Table 1. Total energy applied after intralesional laser treatment

<table>
<thead>
<tr>
<th>Patient angeborene Gefäßfehlbildung*</th>
<th>Gesamtenergie (Joule)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1  H (Kind)</td>
<td>4230</td>
</tr>
<tr>
<td>2  AVM</td>
<td>5520</td>
</tr>
<tr>
<td>3  AVM</td>
<td>1450</td>
</tr>
<tr>
<td>4  VM</td>
<td>1110</td>
</tr>
<tr>
<td>5  VM (Kind)</td>
<td>6320</td>
</tr>
<tr>
<td>6  VM</td>
<td>4530</td>
</tr>
<tr>
<td>7  H (Kind)</td>
<td>780</td>
</tr>
<tr>
<td>8  VM</td>
<td>450</td>
</tr>
<tr>
<td>9  H (Kind)</td>
<td>1790</td>
</tr>
<tr>
<td>10 VM</td>
<td>1430</td>
</tr>
<tr>
<td>11 AVM</td>
<td>3420</td>
</tr>
<tr>
<td>12 VM (Kind)</td>
<td>2780</td>
</tr>
<tr>
<td>13 VM</td>
<td>5410</td>
</tr>
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<tr>
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<td>1910</td>
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<tr>
<td>18 AVM</td>
<td>5630</td>
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</tr>
<tr>
<td>20 VM</td>
<td>1970</td>
</tr>
<tr>
<td>21 VM</td>
<td>1050</td>
</tr>
</tbody>
</table>

*H = Hemangioma, VM = Venous Malformation
AVM = Arteriovenous Malformation

Figure 2

Fig 1. Schematic illustration of ultrasound navigated intralesional Nd: YAG-Laser coagulation of a vascular malformation in the gluteal region

Requirements and Technique of the Ultrasound-Navigated Intralesional Nd:YAG Laser Coagulation

Requirements:

- Neodym-YAG-Laser (1064nm), Medilas, by. Dornier
- Bare fiber: 600 µm
- Ultrasound: ultrasound and color-coded duplexsonography (using a high resolution ultrasound system, 5 - 13 MHz; Duplex, Harmonic Imaging, Fa. Siemens)
- Steristrip to mark bare fiber after introducing the cannula
- Puncture cannula: 18G, 70mm, pvb – a SIMS trademark

Laserparameter:

- Laser power: 7 – 10 Watt
- Modus: continuous wave (cw)
- Duration of laser application: up to a maximum of 170 seconds per region

Technique

(click here to see video-clip)

1. Sonographic evaluation and documentation of vascular
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malfromation immediately before laser treatment.

Figure 3

2. Puncture of skin and subcutis approx. 2 – 3 cm from the lesion.

Figure 4

3. Placement of the cannula with the bare fiber into the lesion (not intraluminal!) under sonographic control (the bare fiber should not surpass the tip of the cannula during introduction of the cannula)

Figure 9

4. Placement of the bare fiber to the area marked by the steristrip which was applied before laser treatment, in order to define how far the bare fiber surpasses the tip of the cannula

5. In case of subcutaneous location of the lesion, digital control of the position of the bare fiber from the outside so that the fiber tip is located at least 5 mm from the skin. In addition, the red helium-neon pilot beam can be helpful in checking the position of the bare fiber.
6. Sonographic control of the bare fibers position which should be located on the vessel wall of the vascular malformation.

7. Laser treatment under digital control – when crepitation as a sign of vaporisation of the laser fiber occurs, new ultrasound control of the bare fiber position is to be performed. Do not remove the bare fiber completely, the cannula should remain approx. 1 cm in situ.
8. Renewed placement of the cannula (see number 3), to allow further laser treatment of other areas of the lesion.


RESULTS

Three months after lasering, a volume reduction between 60% and 80% in hemangiomas (n=4), between 20% and 70% in venous malformations (n=12) and 0% to 70% in arteriovenous malformations (n=5) was achieved. With exception of necrosis in one patient which healed spontaneously, no further complications occurred.

DISCUSSION

Hemangiomas and vascular malformations differ in regard to form, size and clinical course and therefore require individual treatment schedules (1,2,5). Hemangiomas having a depth diameter greater than 2-3 cm, cannot be successfully treated with a Nd:YAG laser (direct transcutaneous or transcutaneous laser treatment with surface cooling) due to the limited penetration depth of the laser beam. Intralesional or intravascular Nd:YAG laser therapy is more effective on voluminous hemangiomas (5,14). Already in 1982 Waldschmidt et al. (2) punctured hemangiomas and applied laser energy directly at the endothelium.

Vascular malformations, in particular those which infiltrate tissue (muscle or subcutis) are difficult to treat surgically since the resection of healthy tissue cannot be avoided due to missing boundaries (4). Especially when the vascular malformation is located deep in the subcutis or muscle, or at immediately adjoining nerves and functionally important tissues, ultrasound allows exact placement of the laser fiber to the vessel wall and continuous control of the fibers.
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position (13). Healthy tissue can so be protected. The condition of vessels and perfusion can be analysed immediately after laser therapy with ultrasound. If necessary, a change in laser energy can be made in order to achieve the desired effect which is the occlusion in vascular malformations. (15,16).

Emboliisation at the distal lower extremity is limited due to the danger of spasms with resulting ischemia (4). Intralesional Nd:YAG laser therapy can lead to volume reductions in the case of arteriovenous malformations with minor shunt behaviour or for predominantly venous or combined vascular anomalies. In literature, volume reductions between 50% and 90% using intralesional Nd:YAG laser therapy have been reported in treatment of hemangiomas and vascular malformations (1,3,5,7). A 70% volume reduction was reported using MR-controlled intralesional Nd:YAG laser therapy on 16 patients with congenital vascular malformations (7). The results of the methods mentioned above are similar to ultrasound-navigated laser therapy (7,9,10,11,12,14).

Two different kinds of intralesional application are described: 1. Leaving the bare fiber and the cannula in the same position during the irradiation of the area. 2. Withdrawing the bare fiber and the cannula simultaneously at a speed of 1mm/sec. During laser treatment (2). We use the first technique, to add a specific amount of energy to a definitive area.

When using a metal cannula, the risk of overwarming of the cannula exists when the bare fiber doesn’t surpass the tip of the cannula adequately. For this reason, some authors use a teflon cannula. The advantage of the metal cannula lies in the placement within the lesion since the bare fiber does not have to be removed temporarily in this case.

CONCLUSION

Intralesional Nd:YAG laser coagulation is an effective and minimally invasive method for treatment of voluminous hemangiomas, in particular infiltrating types. This method is meaningful in combination with embolisation for treating arteriovenous malformations with large shunts. Ultrasound navigation of the laser fiber enables the exact placement and thus protects the surrounding tissue. The success of therapy can be controlled immediately after laser application by means of color-coded duplexsonography.

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