

# The use of interstitial echo-guided diode laser 980-nm for deep vascular anomalies in pediatric patients: a preliminary study

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## Abstract

A wide range of therapeutic options is available to treat vascular anomalies, arising from the systemic therapies to surgery or using lasers. The purpose of this preliminary study is to assess the effectiveness of treatment of vascular anomalies anywhere in the body, along with the use of interstitial echo-guided 980 nm diode laser. The analysis occurs through accurate angio magnetic resonance imaging (MRI) pre- and post-treatment measurements. We enrolled all the patients (16) affected on vascular malformations everywhere in the body, treated from January to August 2012. We obtained excellent results in 6 patients (37.5%) with mean mass reduction of 85%, good in 9 patients (56%) with mean mass reduction of 65% and unsatisfactory in 1 patient (6%). In pediatric patients, low-flow vascular malformations resistant to progressive sclerotherapy or in critical anatomical sites, benefit of echo guided interstitial 980-nm diode laser.

## Introduction

The infantile hemangiomas (IH) do proliferate during the first year of life from the endothelial cells alone, as alike benign tumors behavior. They usually regress almost in the 80% of cases within the 7<sup>th</sup> year of life with no treatment.<sup>1,2</sup>

Vascular malformations otherwise are present at birth in most cases, and do not involve the endothelial proliferation system. They can affect any area of the vascular tree at any level (including arterial, venous, capillary, lymphatic or mixed). The expansion comes up progressively with the body growth, and do not solve spontaneously.<sup>3,4</sup>

A wide range of therapeutic options is available to treat vascular anomalies, arising from the systemic therapies to surgery or using lasers. We might consider some keystones being involved in caring vascular malformations: first, the patient's age and the anatomical location; second, the extent of the lesion and the effectiveness of treatment, which entails both aesthetic as psychological implications; and third, the cost-benefit ratios.<sup>5-7</sup>

The purpose of this preliminary study is to assess the effectiveness of treatment of vascular anomalies anywhere in the body, along with the use of interstitial echo-guided 980 nm diode laser. The analysis occurs through accurate angio-MRI pre and post treatment measurements.

This preliminary report summarizes a new approach, never been described before in literature, with reference to resistant anomalies to local therapy or dangerous to operate.

## Materials and Methods

In this monocentric study we enrolled all the patients affected on vascular malformations everywhere in the body, treated from January to August 2012, using 980-nm interstitial echo-guided diode laser. For each patient the same features were considered: the age at first diagnosis, sex, symptoms, site of the lesion and previous treatments (Table 1 and Figure 1). The patients carried out an MRI to assess 3D sizes and to the same imaging evaluation 3 months after the last laser session.

The treatment was performed under general anesthesia and carried out with cannulas of different sizes needle, according to the lesion range and the anatomic area to be treated.

Under echo-guided visualization with a linear probe (5-7.5 MHz) the insertion of the optical fiber was done according to the Seldinger technique. The cannula came up against the core of the vascular malformation under direct Doppler control. Laser light was set in a power range of 4-10 W (total fluency administered ranging from 800 to 1200 J) carrying out a continuous mode for all malformations treated for 1 to 3 min, with a frequency ranging from 2 to 4 Hz.

## Results

Sixteen patients in this preliminary study were enrolled. Fifteen presented low-flow vascular malformations and one was a lymphangioma.

The results were fixed mainly evaluating some clinical signs, as visual inspection and cosmetic skin improvement, reduction of

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symptoms (pain, heaviness, sting, pulsatility), functional impairment lessening, and volumetric decrease, through the analysis of pre- and post-treatment MRI values (Figures 2-5).

We obtained excellent results in 6 patients (37.5%) with mean mass reduction of 85%, good in 9 patients (56%) with mean mass reduction of 65%, and unsatisfactory in 1 patient (6%).

The mean percentage of reduction in our case series was 71%, while for vascular malformations <10 cm wide it was 95%.

No dangerous adverse effects were detected. No facial nerve injuries were detected. Patients, however, showed a moderate swelling in the site of application for a few days. The pain was easily controlled with drugs in 2-3 days. No atrophy nor cutaneous hyper and/or hypopigmentation were observed. A little scar was detected in a patient with a cheek vascular malformation. The follow-up period varied from 2 to 4 months.

## Discussion

For a long time vascular anomalies treatment in pediatrics had undergone a continuous refinement, due to difficult grouping and a

lot of classifications. When a definitive classification was established by the International Society for the Study of Vascular Anomalies (ISVVA) in 1996, the focus shifted to new protocols and less invasive approaches, with minor implication of the patient, both physically as psychologically.

Surgery has partially lost its central role in the management of the Infantile Hemangiomas in favour of local, systemic therapies or lasers in dangerous areas.<sup>8-13</sup>

However, many surgical indications persist,

particularly in the presence of ulcerated malformations or deep lesions that can cause hemodynamic instability or in particular anatomical sites.<sup>14</sup>

The surgical way often requires some complementary treatments, to maximize the final results in a multidisciplinary approach.<sup>15</sup>

The correct diagnosis and classification of the type of malformation we are facing, do indicate the therapeutic option among a wide range of possibility.<sup>16</sup> Furthermore, the role of the *imaging* [echo-color Doppler, vascular-

MRI, multislice computed tomography (CT) and angiography] is crucial for the correct planning.

Some authors<sup>17</sup> believe that the endolesional diode laser could be reserved to periorbital, intranasal or laryngeal hemangiomas, when we need an extreme selective and less invasive approach to preserve the aesthetic function, or in case we are not capable to arrest bleeding.

We do not agree completely whit this statement, and we do believe some choices move on by several factors and your own personal expe-

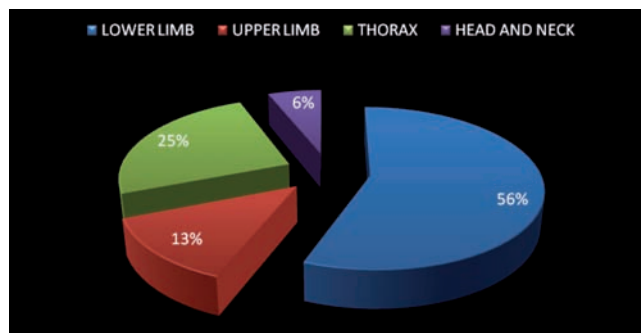


Figure 1. Malformation site distribution of the population studied.

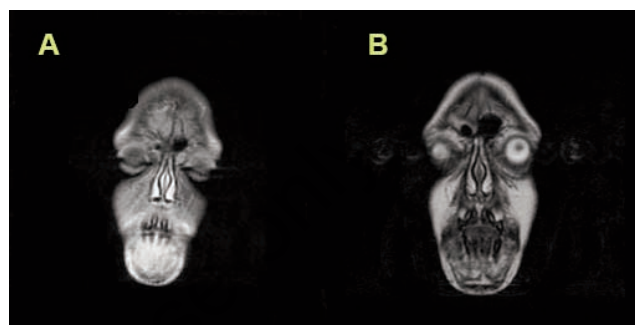


Figure 3. A) Pre-treatment clinical appearance of a chin low flow vascular malformation in a 11-year-old boy, previously treated by sclerotherapy; B) appearance after a single treatment with interstitial echo-guided diode laser 980-nm (5 W for 60 sec).



Figure 2. A) Pre-treatment clinical appearance of a chin low flow vascular malformation in a 11-year-old boy, previously treated by sclerotherapy; B) appearance after a single treatment with interstitial echo-guided diode laser 980-nm (5 W for 60 sec).



Figure 4. A) Pre-treatment clinical appearance of an arm low flow vascular malformation in a 7-year-old boy. The malformation caused great functional impairment with pain, heaviness and local sting; B) appearance after two applications of the interstitial echo-guided diode laser 980-nm (5 W for 150 sec and 10 W for 60 sec). A reduction of the skin component was detected but above all a marked improvement in the upper limb functional with decrease of the troublesome symptoms.



**Figure 5.** Oblique (A) and frontal (B) view of a little scar in a 10-year-old patient with a cheek vascular malformation as a result of a 65 sec for 5 W application of interstitial echo-guided diode laser 980-nm.

rience. As already mentioned, the low-flow vascular malformations increase as the body grows and do not resolve spontaneously. They represent the most common vascular malformations present at birth, becoming symptomatic in children or young adults, with bluish skin discoloration, local swelling and pain. In these patients, before laser session have been tried, other treatments are often been accomplished unsatisfactory.

Superficial venous malformations may respond to argon, potassium titanyl phosphate (KTP) or pulsed dye laser, however the deep component is not reached and the results are moderate.

Nd:YAG laser emitting a continuous wave infrared light on a wave-length of 1064 nm creates a greater degree of thermal injury effective also on deeper lesions.

The intralesional application has been described in very few patients, however, response rates and size reduction are not exciting.<sup>18,19</sup>

Fifteen out of the 16 patients enrolled in this study affected by low flow malformations were already submitted to sclerotherapy without significant benefits. In most cases, the location was so deep in intimate relationship with nervous and muscular structure.

The chance to be surgically effective would in any case be limited by the risk of functional

failures or otherwise would be forced the patient to a long period of rest.

Data collected in this study showed first of all an extreme safety and tolerability of the procedure in children and young patients, with no adverse affects such as skin atrophy, pathological scarring or hyper and hypopigmentation.

The interstitial echo guided laser allows high selectivity and more effective treatment even in areas considered critical or at high bleeding risk. In our cases a large decrease in size has been found since the first session in low-flow vascular malformations with a diameter less than 10 cm.

All patients reported a drastic reduction of pain and swelling in the weeks following the first application. The discromic alterations of the skin presented a clear improvement as it is seen in the photos.

In lesions wider than 10 cm, sessions were more than one but the most important decrease in symptoms was obtained since the first application. We have found instead unsatisfactory results in one patient suffering from lymphangioma, perhaps due to non-effective wave length matching lymphatic structures.<sup>20</sup>

Patients with high-flow vascular malformations were excluded, because these cases need a mandatory association of super-selective embolization before laser or surgery. This way

gives up more chances to achieve lasting and satisfactory results.<sup>21,22</sup>

## Conclusions

In pediatric patients low-flow vascular malformations resistant to progressive sclerotherapy or in critical anatomical sites benefit of echo guided interstitial 980-nm diode laser.

In pediatric patients, the latter represents a less invasive approach, especially in lesions smaller than 10 cm, providing appropriate and effective advantage in minimizing physical and psychological long-term sequelae.

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**Table 1.** Features considered for each patient.

Patient	Age	Sex	Type	Site	Watt X seconds	Treatment (n)
1	12	M	VM	Thigh	5X120	1
2	12	F	VM	Thorax	10X90	3
3	8	F	VM	Thigh	4X120	3
4	14	F	VM	Thigh	5X120	2
5	7	M	VM	Arm	10X90	3
6	10	M	VM	Thigh	5X120	1
7	15	F	VM	Thigh	10X90	2
8	5	M	LM	Gluteus	5X120	3
9	22	M	VM	Thorax	5X180	3
10	18	F	VM	Thorax	10X180	4
11	10	F	VM	Cheek	5X90	2
12	11	M	VM	Chin	5X60	1
13	18	M	VM	Leg	5X120	1
14	10	M	VM	Thorax	10X60	2
15	7	M	VM	Thigh	10X90	1
16	25	M	VM	Foot	5X60	1

M, male; F, female; VM, low flow venous malformation; LM, lymphatic malformation.



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