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Treatment of hemangiomas with 595 nm pulsed dye laser dermobeam

The third generation dye lasers are pulsed dye lasers with a wavelength of 595 nm. Hemangiomas are the most common benign tumor in infancy, and ulceration is their most frequent complication. We used a 595 nm, Dermobeam 2000® laser (from Deka© MELA Calenzano, Italy), using a dynamic skin cooling system (Spray) as the cooling method. The diameter of the spots was 7 mm, the energy density (fluence J/cm^2) from 4 to 8 J/cm^2. The emission modality (repetition rate) was repeated at 0.5 Hz. We initially chose a long pulse duration of 30 msec, but in the majority of cases it was 0.5 msec. The SmartSpray Cooling system parameters were : freezing, flood, duration, and advance. The spray length was from 60%. The delay (advance or anticipation) was 10 msec. The anesthetic effect limited the need for additional topical, local or general anesthetic. In a prospective study, we treated 16 patients with 22 cutaneous hemangiomas from July 2000 to February 2002 (over a 19 month period), with a mean follow up of 22.44 months (10 to 42 months). Our purpose was to review the therapeutic response of ulcerated hemangioma to the third generation pulsed dye laser. The female/male sex ratio was approximately 3 :1 (12 girls, and 4 boys). Patients were aged from 1 to 15 months, for a mean of 4.9 months. We tried to evaluate the therapeutic response of ulcerated hemangiomas to 595 nm wavelength pulsed dye laser. We observed no adverse effects ; however 2 failures due to pain were recorded from ulcerated hemangiomas as the severity of the subcutaneous component of the mixed hemangiomas remained unchanged. These 2 cases showed proliferation of the subcutaneous component, and required general corticosteroids. We examined the children about 10 to 15 days after the first treatment, and evaluated the residual pain. The treatment could be continued while the pain level is low (1 session in most cases), and until the ulceration heals (after 4 sessions). Laser therapy was always effective on severe bleeding, but recurrences were frequent and it was necessary to treat hemangiomas until the end of the cicatrisation. Laser therapy is indicated for hemangiomas only in rare instances : due to the refractory ulceration failing to heal after 2 weeks of specialized dressing, aesthetic risk due to localization (such as philtrum, columella, or nasal margin). It is also possible to treat residual telangiectasia. No uniformly effective treatment modality was found.

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All dye lasers permit the treatment of port-wine stains, which are classic indications for dye laser, while hemangiomas are hardly ever treated. The third generation of dye laser emits light with a wavelength of 595 nm and offers the best performance for treating hemangiomas. Hemangiomas represent the most common benign tumor in infancy, and ulceration represents their most frequent complication [1]. Thirty eight percent of the lesions are localized on the head and neck, often in periorificial localization causing functional problems [2]. Hemangiomas usually appear a few days to weeks after birth. They are present at birth in 2.6% of mature newborns. Initially, lesions may be small red spots or nodules. Subsequent proliferation during the first 9 months of life, rarely beyond 18 months, may lead to a large, or disfiguring or ulcerated birthmark, with pain and the necessity for steroid therapy [3]. Such an evolution is seen in 8 to 12% of all children during the first 12 months, and in up to 22% of premature infants with a birth weight lower than 1 kg [2, 3]. Complications appear during this proliferative phase : bleeding, functional impairment, interference with vital functions due to the obstruction of

eyes, nose, throat, ear, or anus. The subsequent period of regression persists for up to 10 years. Findings show that a normal skin texture is present in only 50% of children. In the other 50% of patients, residual skin changes remain, like telangiectasia, hyperpigmentation, atrophy, sagging, fibrofatty tissue residuum, or scarring. All active therapeutic methods have a substantial risk of side-effects : local therapies include surgery, embolisation, sclerotherapy, magnesium seeding, X-ray, carbon dioxide snow, liquid nitrogen ; or systemic treatments using corticosteroids or interferon. Surgery is limited to patients in whom function is impaired. The obligatory regression of the hemangiomas has been the major argument in favour of allowing spontaneous involution in the lesions. Flashlamp-pumped pulsed dye laser which is the "gold standard" for treatment of port wine stains, is now recommended in the treatment of hemangiomas for preventing complications and cosmetic disfigurement. The comparison of hemangioma treatment via pumped dye laser (585 nm) and frequency-doubled Nd : YAG (532 nm) does not show any differences [4], however there are no reports of treatment with a third generation pulsed dye laser (wavelength of 595 nm) [5-7].

Materials and methods

Clinical data

In a prospective study, we treated 16 patients with 22 cutaneous hemangiomas from July 2000 to February 2002 (over a 19-month period), with a mean follow-up of 22.44 months (10 to 42 months). Our purpose was to review the therapeutic response of ulcerated hemangioma to the third generation pulsed dye laser. We recorded 10 cases of ulcerated hemangioma, 5 with bleeding, and 4 superficial (1 for esthetic reasons). The female/male sex ratio was 3 :1 (12 girls, and 4 boys). Patients were aged from 1 to 15 months, for a mean of 4.9 months. They were Caucasians of European or Maghrebian origin (phototype II to V). Each patient was evaluated by chart review. The following variables were extracted : age, gender, anatomic localization, involved area, complications at time of the first consultation, number of treatments, hemangioma texture and color, ulceration and improvement after laser therapy. Photographs were taken under standardized conditions before and after treatment.
The primary measure of efficacy was the quantitative assessment of improvements in lesional volume, texture and color. The outcome was evaluated on the following scale : 0 no improvement. 1, poor (0-25% improvement) ; 2, fair (26-50% improvement) ; 3, good (51-75%) ; and 4, excellent (76-100%) ; and on the efficiency on the ulceration.

Laser therapy

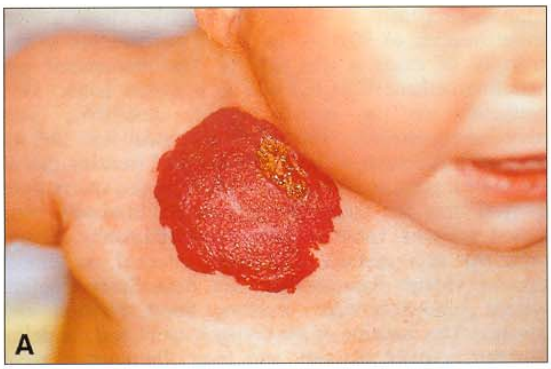
We used a 595 nm, Dermobeam 2000® laser (from Deka© MELA Calenzano, Italy), associated with a skin cooling system (Spray) [7]. The treatment was made on the ulcerated area and 5 mm around the same. Two passages were made with a 10% overlap. Laser energy was delivered to the skin through an optical fiber and lens which focused the beam. The spot size was 7mm, the energy density (fluence J/cm^2) from 4 to 8 J/cm^2. This was purpuragenic fluence. The emission modality (repetition rate) was repeated at 0.5 Hz. We initially chose a long pulse duration of 30 msec in only 2 patients, but in the majority of cases it was 0.5 ms. The pressurized gas (tetrafluoroethane $C_2H_2F_4$) was in a frozen bottle. This synthetic ice is non-flammable, non-toxic, and environment-friendly. The cryogen content was 200 ml per bottle. A length of 100% (= 40 ml of freezing gas at one pulse), permits 5000 pulse laser. Cryogen spurts were sprayed onto the target through an electronically controlled solenoid valve positioned approximately 20 mm from the skin surface. The spurt covered an almost circular, 15 mm diameter area. The SmartSpray Cooling system parameters were : freezing, flood, duration, and advance. The duration of the cryogen spurt, and the delay between cryogen delivery and laser illumination were controlled by a programmable digital delay generator. The spray pulse length was from 60%. The delay (advance or anticipation) was 10 ms. This allowed for a safe delivery of higher energy fluences by limiting the cooling epidermis, while leaving the temperature of the vessels unchanged. The consequent anesthetic effect limits the need for additional topical, local or general anesthetic. Generally, 10 to 30 msec prior to each laser pulse are needed. This epidermal cooling minimizes the risk of adverse effects, such as hyperpigmentation (23% without cooling method), hypopigmentation, and scars.

Results

We tried to evaluate the therapeutic response of ulcerated hemangiomas to 595 nm wavelength pulsed dye laser. Pain disappeared totally in 10/12 cases of ulcerated hemangiomas after 1 or 2 treatments *(Figs. 1, 2, 3)*. Healing was obtained in all 10/12 cases, with 1 to 4 treatments (1 to 2 in 90 % of cases) at intervals of 2 to 8 weeks *(Fig. 3)*. We observed no adverse effects ; however there were 2 failures deriving from excessive pain with ulcerated hemangiomas due to of the significance of the subcutaneous component. These mixed hemangiomas remained unchanged. They had a very deep ulceration with secondary infection. These 2 cases showed a proliferation of the subcutaneous component, and required general corticoids (1 to 2 mg/kg/day for 1 to 3 months). Children were examined about 10 to 15 days after the first treatment, in order to evaluate the residual pain, and continue the treatment until the cessation of pain (as early as the 1° session, in the majority of cases), and for healing ulceration, which can be achieved after 4 treatments *(Fig. 3 a-b)*. Two patients had hemangiomas on the nose and one on the nasal tip, the so-called "Cyrano" angioma. These 3-month-old girls with an ulcerated hemangioma of the upper lip of 1 month's duration underwent 4 sessions of flashlamp-pumped pulsed dye laser, 2 weeks apart. An improvement was noted after two treatments and the lesion showed a major size and color improvement over a total treatment period of 3 months.
Laser therapy was always effective on severe bleeding, but frequent recurrences were observed and it was necessary to treat hemangiomas until the end of the cicatrisation.

Discussion

The first report of laser being used in the treatment of hemangiomas in early infancy was made with the argon laser (wavelength : λ = 488 and 514 nm) [8, 9]. The therapeutic effect was limited to superficial lesions, because of the relatively shallow penetration of argon laser. Nd :Yag



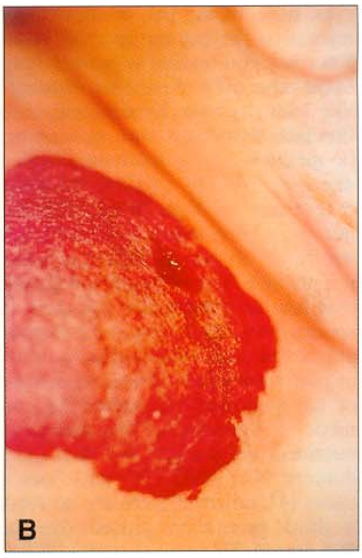
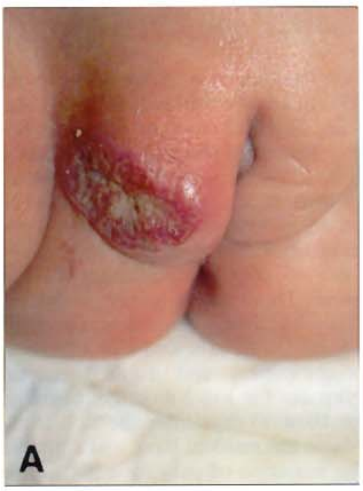


Figure 1. ***a*** *before,* ***b*** *after treatment : Patient number 7, localization right shoulder ; size 38 mm, 2 sessions at 3 week intervals.*



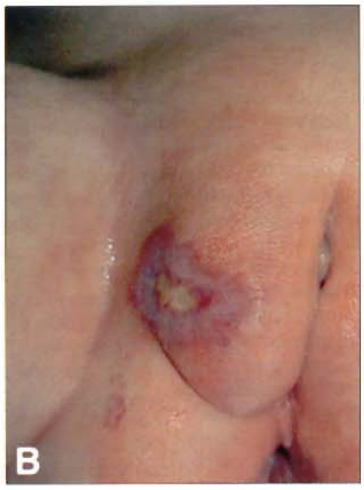
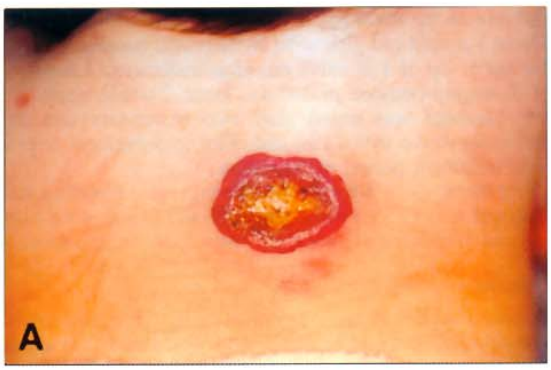


Figure 2. ***a*** *before,* ***b*** *after treatment : Patient number 15, localization : genital, right vulvar ; size 30 mm, only 1 session.*



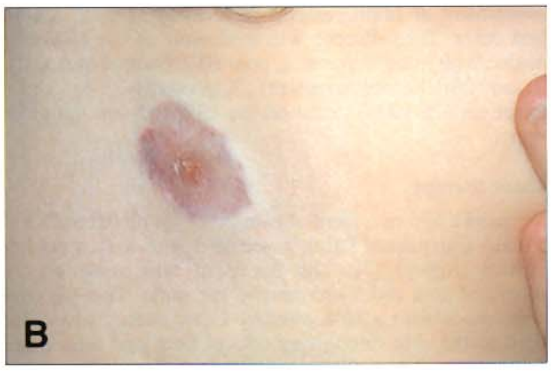


Figure 3. ***a*** *before,* ***b*** *after treatment : Patient number 6, localization on back (scapular) ; size 53 mm, 4 sessions at 2 week to 2 month intervals.*

	Birth date/Age at treatment/gender	Localization /size (mm)	Ulceration /pain	Number of sessions/intervals	Following scale/efficiency	Days	Fluence (J/cm^2)/ spot size (mm)	Pulse duration (msec)
1	27/05/99 ; 15 months/M	Philtrum ; 12	0/aesthetic indication	2 at 3 months	3/Yes	60	4/7	0.5
2	21/03/00 ; 7 months/F	Buttock, 56 × 43	Yes/++	2/3 weeks, 1 with general anesthesia	4/Yes	1	8/2	30
3	01/07/00 ; 9 months/M	Right forehead ; 14/diffuse neonatal hemangiomatosis	Yes/bleeding	1	1/Yes	Bleeding recurrence, surgery	5/7	0.5
4	22/08/00 ; 1 month/F	Right occipital ; 22	Yes/++	1	3/Yes	1	8/2	30
5	15/09/00 ; 4 months/F	Right buttock ; 44	Yes/+/bleeding	1/ at 1 month no 2nd TTT.	3/Yes	2	5.5/7	0.5
6	16/11/00 ; 4 months/F	Back (scapular) ; 53	Yes/+++/bleeding	4/2 weeks at 2 months	4/Yes/regression	2/improvement after 13 months	4-5.5/7	0.5
7	22/11/00 ; 2.5 months/F	Right shoulder ; 38	Yes/+++	2/3 weeks	3/Yes	1	6.5/7	0.5
8	25/01/01 ; 6 months/F	Right hand and wrist ; 63 × 41	Yes/+++/necrosis	1/subcutaneous component	0/Failure /Systemic corticoids	Pain, necrosis	6/7	0.5
9	13/04/01 ; 5 months/F	Left lumbar, 47 × 34	Yes/+++/oozing	1/subcutaneous component	0/Failure /Systemic corticoids	Ulceration, oozing	6/7	0.5
10	18/04/01 ; 4 months/M	2 hemangiomas right internal canthus ; 4 and 2 mm	Yes/bleeding	2/1 week	4/yes		5/5	0.5
11	28/05/01 ; 1.2 months/F	Right of the neck, 20	Yes/+++/bleeding	1	3/yes	1	4 and 6/7	0.5
12	17/10/01 ; 6 months/F	2 hemangiomas : left legs and thorax 31 × 28	Superficial	3/2 months	3/regression		5-6.5/7	0.5
13	06/11/01 ; 6 months/F	Left hands 12 × 9	Superficial	1	3/regression		6.5/7	0.5
14	02/12/01 ; 5 months/F	3 hemangiomas on the scalp 12 × 7, and 1 left abdo	Superficial	3/1 month	3/improvement		6/7	0.5
15	31/01/02 ; 4 months/F	Genital, right vulvar 30 mm	Yes/+++/subcutaneous component	1	2/Yes, improvement of pain in one session	2 days	6/7	0.5
16	20/02/02 ; 3 months/M	Cyrano, nose and upper lips	Yes on lips/+++, pain due to heating	4/10 days. Association with systemic corticoids	3/Yes, normal heating	1 day, after first session	6/7	0.5

laser is effective for thick hemangiomas because of the deep penetration of its wavelength (λ = 1064 nm) [10]. The Nd :Yag laser has also has been used for intralesional coagulation principally in German studies [11]. The KTP laser (λ = 532 nm) is an alternative choice in the regression phase [4]. To decrease the risk of nonspecific thermal damage to the epidermis and papillary dermis, the flashlamp-pumped pulsed dye laser (λ = 575-600 nm) has been used [12]. The wavelength of 595 nm corresponds to an absorption peak of hemoglobin (the major chromophore in blood) [13]. The pulse energy is mainly absorbed by blood vessels, and converted to heat causing thermal damage and thrombosis of the target vessels. A pulse width of 450 µs is below the thermal relaxation time of the target tissue. The flashlamp-pumped pulsed dye laser selectively destroys ectatic blood vessels without any significant side effects [13]. The beam limited the depth of penetration, which did not exceed 0.7 mm. Laser therapy is indicated for hemangiomas only in rare instances [1]. For refractory ulceration, that fails to heal after 2 weeks of specialized dressing, low fluences are available [4-7]. The efficiency of flashlamp-pumped pulsed dye laser is very high in this case. For aesthetic risk due to the localization, such as philtrum, columella, nasal margin or nasal tip, as in 3 of our cases [14]. Flashlamp pulsed dye laser is also a successful treatment of diffuse neonatal hemangiomatosis [15]. We can also treat residual telangiectasia. No uniformly effective treatment modality was found, but generally a 7-mm spot size can be used with a 0.5 to 6 msec pulse duration ; and a fluence of 5 to 7 J/cm^2. In many cases several techniques could be used as a follow-up. Traditional conservative management of hemangiomas is based on the spontaneous involution by the age of from 3 to 7 years [2, 3]. But the final development cannot be predicted in initial lesions.

In our patients no success was obtained in treating hemangiomas with a significant subcutaneous component [5]. The influence of flashlamp-pumped pulsed dye laser on the subcutaneous part of hemangiomas is practically nil [12]. Other treatment is necessary as in rapidly progressive compound lesions. Not all hemangiomas require laser treatment. We can limit the indications of flashlamp-pumped pulsed dye laser to non inflammatory or telangiectatic ulcerated hemangiomas, large hemangioma, and localization risk (on the face, or peri orificial...). Maceration and frictional stress are the major factors in ulceration [2-3]. However, telangiectatic or inflammatory hemangiomas can spontaneously lead to ulceration. In this case persistent ulcerations may develop immediately after treatment with the flashlamp-pumped pulsed dye laser [1]. Hemangiomas occur in the proliferative phase, and perhaps ulcerations might have developed without treatment, the skin injury induced by the laser playing a role in precipitating or causing ulceration [6]. Sometimes the association of laser and corticosteroids is necessary, and we believe that this association is synergistic just like our cases of "cyrano" hemangioma. We have noted that with the use of corticosteroids in areas treated with flashlamp-pumped pulsed dye laser, involvement of hemangiomas is more rapid. This generally allows for the use of low doses of corticosteroids (1 mg/kg/day) for less time (1 month) [2, 3]. In rapidly growing tumors, the combination of corticosteroids with flashlamp-pumped pulsed dye laser using the SmartSpray Cooling system can be beneficial [7]. Hemangiomas with a deep component do not benefit from flashlamp-pumped pulsed dye laser, as its efficiency is limited by the depth of vascular injury [5, 13]. Furthermore, early therapeutic intervention with pulsed dye laser may fail to prevent proliferative growth of the deeper or subcutaneous component despite early intervention [5].
The aim of treatment in hemangiomas is to stop further progression and to induce regression in order to prevent complications. It is possible to achieve this in 96.6 % of the treated lesions with the flashlamp-pumped pulsed dye laser 585 nm [13]. We can now recommend early active laser treatment in ulcerated and/or painful hemangiomas following failure after 1 week of sufficient topical treatment, and initial and small lesions, especially in periorificial localization, in order to prevent unpredictable severe complications [4, 12]. However, according to our study, we have no grounds for suggesting preventive treatment for all cases, and consequently cannot recommend this [16, 17]. A recent study compared treatment with pulsed dye laser 585nm with a wait-and-see policy [16]. It was a prospective, randomized controlled trial in which 121 infants, aged 1-14 weeks, were enrolled with early hemangiomas, and followed up to age 1 year. All infants completed the study. The number of children whose lesions showed complete clearance or minimum residual signs at 1 year was not significantly different in the pulsed dye laser 585nm treated and observation groups. However, PDL treated infants were more likely to have skin atrophy and hypopigmentation. The only objective measure of resolution that improved with pulsed dye laser 585 nm treatment was hemangioma redness. So for the moment pulsed dye laser 585 nm treatment in uncomplicated hemangiomas is no better than a wait-and-see policy.
The flashlamp-pumped pulsed dye laser 585 nm was the therapy of choice, only when there was an indication for treatment of hemangioma (ulceration principally) [12]. The frequency doubled Nd :YAG laser has been recommended for pursuing further treatment in the regression phase of hemangiomas in order to optimize the cosmetic appearance [4]. For young children, we prefer the 595 nm flashlamp-pumped pulsed dye laser due to its low incidence of side effects and pain, thanks to its wavelength and dynamic skin cooling system (Spray) [7]. However for the moment there is no superiority of 595 nm flashlamp-pumped pulsed dye laser, under second generation 585 nm.
In conclusion, the 595 nm flashlamp-pumped pulsed dye laser with contact cryotherapy has proved to be an effective method with few side effects in the early treatment of risk-related superficial hemangiomas in infancy, and for ulcerated hemangiomas without a subcutaneous component [1, 5].

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