Laser treatment of epidermal nevi: A multicenter retrospective study with long-term follow-up

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Background: Patients with epidermal nevi strongly demand cosmetic improvement. Laser treatment appears appealing and is frequently used in clinical practice. Nevertheless, large series with long-term follow-up are missing, preventing definitive conclusions about its real benefit.

Objective: To evaluate the long-term effectiveness and safety of lasers for epidermal nevi.

Methods: Bicentric, retrospective, cohort study, including all patients treated with a laser for an epidermal nevus with more than a 1-year follow-up.

Results: Seventy patients were treated for different types of epidermal nevi, mostly with ablative lasers: 23 verrucous epidermal nevi, 16 nevi sebaceous, 26 Becker nevi, 2 inflammatory linear verrucous epidermal nevi, 1 smooth-muscle hamartoma, 1 rounded and velvety epidermal nevus, and 1 nevus lipomatosus superficialis. The follow-up period was a median of 37 months (range, 12-127 months). Better results, fewer recurrences, and higher patient satisfaction were noted in treatments for verrucous epidermal nevi than for nevi sebaceous. Q-switched lasers failed to show any degree of improvement in almost all patients with Becker nevus.

Limitations: The retrospective nature of the study.

Conclusions: Ablative lasers can treat verrucous epidermal nevi with good long-term esthetic results but have limited long-term efficacy for nevus sebaceous. Q-switched lasers failed to improve Becker nevi. (J Am Acad Dermatol 2020;83:1606-15.)

Key words: ablative laser; Becker nevus; CO_2 laser; epidermal nevus; Er:YAG laser; ILVEN; nevus lipomatosus superficialis; nevus sebaceous; Becker's nevus; smooth-muscle hamartoma; verrucous epidermal nevus.

Epidermal nevi (EN) are a heterogeneous group of hamartomatous skin lesions defined by the proliferation of keratinocytic, glandular, follicular, or muscular components of the skin. Multiple components are usually present in a single lesion, but the type is defined according to the predominant cell types. The most common types are the verrucous EN (VEN), also called keratinocytic EN, and the nevus sebaceous (NS). Other types include inflammatory linear VEN (ILVEN), Becker nevus (BN), smooth-muscle hamartoma, nevus comedonicus, porokeratotic eccrine nevus,[1] rounded and velvety epidermal nevus (RAVEN),[2] and nevus lipomatosus superficialis.[3]

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EN has an incidence of 1 to 3 cases/1000 births[4] and represents a frequent motive for consultation in dermatology, with an esthetic complaint and a strong cosmetic demand for removal. Because the surgical excision is often limited by the size and location of the EN, many nonsurgical techniques have been proposed, including cryotherapy, electrocautery, dermabrasion, and chemical peels.[5] Unfortunately, such approaches give inconsistent results and carry a strong risk of scars.

Lasers have been also proposed for treating different types of EN, with encouraging results. Nevertheless, most articles are case reports or series with small numbers of participants and generally a limited follow-up, thus preventing reliable conclusions about the true benefit of laser therapy for EN.[6-50] The objective of this study was to assess the long-term effectiveness and safety of laser approaches in treating the different types of EN.

CAPSULE SUMMARY

- In the absence of satisfactory treatments for epidermal nevi, lasers are promising.
- Our study demonstrates that improvement with ablative lasers varies between verrucous and sebaceous nevi, with better long-term results for verrucous nevi. It also shows that Becker nevus is not a good indication for Q-switched lasers.

METHODS

We conducted a retrospective cohort study in the dermatology departments of the University Hospital of Nice in France and the Academic Medical Center of the University of Amsterdam in the Netherlands.

We included all patients with any type of EN who were treated with a laser in our departments between 2007 and 2018. All patients were contacted by telephone to assess their self-evaluation and satisfaction and asked to send a clear picture to assess the long-term effectiveness of the laser treatment. We excluded all patients with a follow-up of less than 1 year, patients who could not be contacted, and patients treated only for hair removal of BN. All patients with an immediate complete failure of the laser treatment were included, because no follow-up was needed.

The laser treatment was performed by 3 dermatologists experienced with lasers (F.L.D., A.W., T.P.). The erbium lasers used were the 2940-nm erbium-doped yttrium aluminium garnet (Er:YAG) lasers supErb: XL (Baasel Lasertech, Starnberg, Germany) and Burane (Alma Lasers, Liege, Belgium), and the CO_2 lasers were the UltraPulse (Lumenis Inc, Santa Clara, CA) and Fraxel Repair (Solta Medical, Hayward, CA) in the Netherlands and France centers, respectively.

Digital color photographs were taken at baseline, soon after the last session, and at the last follow-up. All photographs were independently evaluated by 2 dermatologists (A.A., F.F.) for physician global assessment (PGA) after the treatment (short-term [ST-PGA]) and at the last follow-up (long-term [LT-PGA]). ST-PGA and LT-PGA were graded from 0 to 6 (0 = 100% improvement, 1 = 90%-99% improvement, 2 = 50%-89%, 3 = 25%-49%, 4 = 1%-24%, 5 = no improvement, 6 = worsening). Patients were asked for their satisfaction (not satisfied, satisfied, very satisfied) and self-evaluation from 0 to 5 (0 = cleared, 1 = almost cleared, 2 = good improvement, 3 = slight improvement, 4 = no change, 5 = worse) at the last follow-up. Any degree of recurrence or persistent adverse effects, including scarring, seen by the dermatologist or mentioned by the patient were noted. Age, sex, lesion characteristics, and site were noted, and results were analyzed for each type of EN.

RESULTS

There were 88 patients with EN treated in both centers with various lasers between October 2007 and August 2018. Of these, 8 patients were lost to follow-up and unreachable (4 VEN, 2 NS, and 2 BN), and 10 patients were treated recently with a follow-up of less than 1 year (6 VEN, 1 NS, 2 BN, and 1 RAVEN). Thus, 70 patients were included: 23 had VEN, 16 had NS, 26 had BN, 2 had ILVEN, and the remaining 3 had RAVEN, nevus lipomatosus superficialis, and smooth-muscle hamartoma. The follow-up ranged between 12 and 127 months (mean, 47.3 months; median, 37 months). Age, laser type, improvement, scarring, recurrence, and the follow-up period of each patient are reported in Tables I-IV.

Almost all VEN were treated with CO_2 or Er:YAG ablative lasers. Only 2 patients had hyperpigmented thin VEN and were thus treated with Q-switched (QS) lasers. Among the 23 patients with VEN, only 4 (17%) showed moderate, poor, or no improvement. Two patients (8.7%) had a ST-PGA of 0, and 16 patients (69.6%) had a ST-PGA of 1 and 2, 8 patients each, resulting in 18 patients with good to complete improvement. Seven of them (39%) showed partial or complete recurrence (Table V). After a follow-up, which ranged between 12 and 106 months (mean, 45.2 months; median, 37 months), 3 patients had a poor response, 2 showed no response, and 1 worsened. The remaining 16 patients (69.6%) kept

Abbreviations used:

BN:	Becker nevus
EN:	epidermal nevus
Er:YAG:	erbium-doped yttrium aluminium garnet laser
LT-PGA:	long-term physician global assessment
NS:	nevus sebaceous
RAVEN:	rounded and velvety epidermal nevus
ST-PGA:	short-term physician global assessment
VEN:	verrucous epidermal nevus

an improvement of more than 50%. At the last follow-up, 14 patients (82%) were still satisfied or very satisfied with the treatment results.

Sixteen patients were treated for NS, and 8 (50%) showed an initial improvement of more than 50%. However, 14 patients (88%) had partial or complete recurrence at long-term follow-up, but half of them were satisfied with the temporary or partial improvement. The follow-up ranged from 13 to 127 months (mean, 45 months; median, 36 months).

A QS laser was used in 26 patients to treat their BN. For each of them, a test session was initially performed on 1 to 4 areas using different wavelengths, including 1064 nm, 755 nm, 694 nm, and 532 nm (total number of treated areas, 56). Only 3 patients (5.4%) experienced any degree of improvement, which was slight to moderate in 2 of them, with complete recurrence soon after. The third had a good to excellent improvement after 4 sessions of QS 755-nm laser without recurrence but with a relatively short follow-up of 12 months.

Some rare forms of EN are presented in Table IV. Two cases of ILVEN showed 50% to 89% improvement, mainly with the pulsed dye laser on the erythematous parts of the lesion. The only case of RAVEN, or acanthosis nigricans-like epidermal nevus, was slightly improved with the Er:YAG ablative laser with a rapid and complete recurrence. A nevus lipomatosus superficialis was treated successfully with a CO_2 laser, but the lesion partially recurred 2 years later. The last case showed a partial improvement of the erythema of a smooth-muscle hamartoma with a pulsed dye laser.

DISCUSSION

In the present long-term follow-up study, we found a differential response pattern to laser therapy based on the type of EN. For patients with VEN, 81.8% exhibited more than 50% improvement, mainly with ablative lasers. After a mean follow-up of 45.2 months, the success rate remained high, with 16 good responders of the 22 patients evaluated (72.7%). Accordingly, 78.3% of these patients graded their improvement as good, almost cleared, or cleared, with a satisfaction rate of 82.6% after a mean follow-up of more than 3 years.

These results corroborate those of Alonso-Castro et al,[11] with good results in 93% of patients with VEN. Nevertheless, they reported a lower recurrence rate (20%) than in our study (50%) but a higher rate of hypopigmentation or scarring (46.6%) than in our study (27%).[11] This might be explained by a more superficial ablation in our practice, differences in the follow-up, or by recording minor recurrences in our study. Thual et al[13] also demonstrated a good response in 86% of their 21 patients and a recurrence rate of 38% with a short follow-up of 7 and 11 months for some patients. Both articles agreed that thickness of VEN is not predictive of poor response, which conforms with our observations. Park et al[14] achieved good results in 15 of 20 patients treated with the Er:YAG laser, with a recurrence rate of 25%, without any scar after a follow-up of 2 years.

A randomized controlled study revealed 100% success, 0% recurrence, and 50% scarring or dyspigmentation with the pulsed CO_2 laser compared with 90% success, 30% recurrence, and 10% dyspigmentation with the pulsed Er:YAG laser. However, the only significant difference was the shorter healing time with Er:YAG.[7] In our series, we did not observe a statistical difference in recurrence when use of the Er:YAG laser was compared with the CO_2 laser ($P = .5$).

Regarding NS, only 8 patients (50%) had more than 50% improvement: 88% (7 of 8) showed some degree of recurrence, and permanent scars developed in 38%. Among the 16 NS patients, only 2 patients did not experience recurrence, but 1 had a superficial scar. The recurrence rate of NS was 90% for patients treated in Nice and 83% for Amsterdam compared with 50% and 40%, respectively, for VEN (without statistical differences between the 2 centers for the 2 types of EN). The potential bias associated with the difference between operators did not alter our results, because each type of EN had the same outcome in both centers, regardless of the treating physician. In both NS and VEN, many recurrences appeared beyond the first year. This highlights the importance of long-term follow-up after treating these lesions.

We believe that the increased rate of recurrence and scarring in NS, compared with VEN, is related to the histologic differences between them. NS is mainly a dermal lesion whose main components are sebaceous glands, immature hair follicles, and sweat glands with sometimes additional epidermal anomalies, whereas VEN is purely epidermal (keratinocytic) with acanthosis, papillomatosis, and

Table I. Characteristics and results of patients with verrucous epidermal nevus treated with laser

Patients		Lesion		Treatment		Results						
No.	Age, sex	Site	Size	Type (No. of sessions)	Parameters	ST-PGA	LT-PGA	Patients' self-evaluation	Patients' satisfaction	Recurrence	Scar	Follow-up
Verrucous epidermal nevus												
1	14 y, M	Nose	Small	Er:YAG* (1)	3 mm, 13 J/cm^2	1	1	1	S	No	No	1 y
2	15 y, F	Neck	Small	Er:YAG* (1) then CO_2† (2)	3 mm, 13 J/cm^2 N/A	1	1	1	S	No	Partial	4 y 6 mo
3	23 y, M	Neck	Medium	Er:YAG* (1)	2.5 mm, 13 J/cm^2	1	2	2	S	Partial	No	4 y 3 mo
4	17 y, F	Sternal	Small	Er:YAG* (2)	2.5 mm, 13 J/cm^2	3	Absent	2	S	Partial	No	6 y 2 mo
5	30 y, F	Hand	Medium	CO_2† (2)	150-200 mJ/cm^2	4	6	5	NS	Complete	Yes	4 y 8 mo
6	51 y, M	Scalp	Medium	Er:YAG* (1)	2.5 mm, 13 J/cm^2	0	2	1	VS	Partial	No	1 y 11 mo
7	16 y, F	Eyelid	Small	Er:YAG* (2)	1.5 mm, 10 J/cm^2	1	1	1	S	No	No	2 y 6 mo
8	16 y, M	Neck	Small	Er:YAG* (1)	3.5 mm, 10 J/cm^2	Absent	2	4	NS	Partial	No	8 y 10 mo
9	41 y, F	Palmar	Medium	Er:YAG* (2)	3.5 mm, 16 J/cm^2	2	5	3	S	Complete	No	2 y 10 mo
10	14 y, F	Lower lip	Small	QS 532 (1)	2 mm, 4 J/cm^2	3	3	2	S	No	No	5 y 9 mo
11	17 y, F	Forearm	Medium	Er:YAG* (1)	1.5-3 mm, 10 J/cm^2	1	1	1	VS	No	Hypopigmentation	1 y 8 mo
12	18 y, F	Neck	Small	Er:YAG* (2)	2.5 mm, 13 J/cm^2	2	3	3	NS	No	Yes	6 y 4 mo
13	6 y, F	Hemicorporal	Large	Er:YAG* (2) armpit only	2.5 mm, 13 J/cm^2	1	2	1	S	Partial	No	3 y 1 mo
14	16 y, M	Scapular	Medium	Er:YAG* (1)	3 mm, 16 J/cm^2	2	4	2	S	No	Yes	1 y 9 mo
15	18 y, F	Scalp	Medium	CO_2† (1) then Er:YAG* (2)	2 mm, 225 mJ/cm^2 2.5 mm, 10 J/cm^2	1	1	1	S	No	Yes	1 y 3 mo
16	13 y, M	Armpit	Large	CO_2† (1)	5-7 W	0	2	1	VS	Superficial	No	1 y 6 mo
17	5 y, M	Neck	Small	Er:YAG* (1)	10-13 J/cm^2	2	5	4	NS	Complete	No	4 y 9 mo
18	9 y, M	Neck	Small	CO_2† (1)	5 W then 2.5 W	1	1	1	VS	No	No	1 y 10 mo
19	12 y, M	Axilla, groin	Small	CO_2‡ (2)	2 mm, 15-25 W - 225 mJ	2	2	2	S	No	No	1 y
20	49 y, F	Shoulder, elbow	Medium	QS 755 (3)	2-3 mm, 10-16 J/cm^2	4	2	1	S	Partial	No	7 y
21	24 y, F	Abdomen	Small	CO_2‡ (2)	N/A	2	0	0	S	No	No	5 y
22	12 y, F	Thorax	Small	Fr CO_2‡ (2)	N/A	2	0	0	S	Complete	No	7 y
23	11y, F	Forehead	Small	CO_2‡ (1)	2 mm, 200 mJ, 17 W	2	1	1	S	No	Yes	2 y

Er:YAG, Erbium-doped yttrium aluminium garnet laser; *F*, female; *Fr*, fractional; *LT-PGA*, long-term physician global assessment; *M*, male; *N/A*, not applicable; *No.*, number; *NS*, not satisfied; *S*, satisfied; *QS*, Q-switched; *ST-PGA*, short-term physician global assessment; *VS*, very satisfied.

*Burane (Alma Lasers, Liege, Belgium).

†Fraxel Repair (Solta Medical, Hayward, CA).

‡UltraPulse (Lumenis Inc, Santa Clara, CA).

Table II. Characteristics and results of patients with nevus sebaceous treated with laser

Patients		Lesion		Treatment		Results						
No.	Age, sex	Site	Size	Type (No. of sessions)	Parameters	ST-PGA	LT-PGA	Patients' self-evaluation	Patients' satisfaction	Recurrence	Scar	Follow-up
Nevus sebaceous												
24	13 y, M	Forehead	Small	Er:YAG* (1)	2.5 mm, 16 J/cm^2	3	3	2	VS	Partial	Minimal	2 y 3 mo
25	10 y, M	Cheek	Small	Pulsed CO_2† (1)	150 mJ, 10 Hz	5	Absent	4	NS	Complete	No	5 y 4 mo
26	10 y, F	Retro auricular	Small	Er:YAG A (2)	2.5 mm, 10 J/cm^2	1	Absent	3	NS	Complete	Yes	10 y 7 mo
27	18 y, F	Cheek	Small	Er:YAG* (2)	2.5 mm, 10 J/cm^2	3	2	2	S	No	Yes	7 y 5 mo
28	7 y, F	Cheek	Small	Er:YAG* (2)	2.5 mm, 10 J/cm^2	4	5	3	S	Complete	No	5 y 6 mo
29	13 y, M	Cheek	Small	CO_2 and Fr CO_2† (1)	8 and 150 mJ/cm^2	2	2	2	S	Partial	Yes	4 y 6 mo
30	7 y, F	Forehead	Small	Test Er:YAG* (1)	13 J/cm^2	4	5	4	NS	Complete	No	4 y 9 mo
31	17 y, M	Neck	Small	SP CO_2† (1)	8 W then 3 W	1	2	1	VS	Partial	No	3 y 6 mo
32	16 y, M	Cheek	Small	SP CO_2† (1)	5 W	6	5	4	NS	Complete	No	1 y 7 mo
33	16 y, F	Nasal	Small	Er:YAG* (2)	3.5 mm, 16 J/cm^2	3	Excised	4	NS	Complete	No	1 y 1 mo
34	16 y, M	Neck	Small	CO_2‡ (1)	2 mm, 7-10W, 225 mJ	2	6	5	NS	Partial	Keloid	2 y
35	29 y, F	Cheek	Small	CO_2‡ (1)	2 mm, 20 then 3.5 W	2	1	1	S	Partial	No	3 y
36	20 y, M	Chin	Small	CO_2‡ (1)	N/A	3	6	5	NS	Complete	Yes	1 y 6 mo
37	14 y, M	Neck	Small	CO_2‡ (1)	1 mm, 3W, 225 mJ	2	1	1	S	Partial	No	2 y
38	16 y, F	Earlobe	Small	CO_2‡ (1)	2 mm, 15 then 6 W	2	1	1	S	Partial	No	3 y
39	16 y, M	Forehead	Small	CO_2‡ (1)	7 W, 225 mJ	2	0	0	VS	No	No	2 y

Er:YAG, Erbium-doped yttrium aluminium garnet laser; *F*, female; *LT-PGA*, long-term physician global assessment; *M*, male; *N/A*, not applicable; *No.*, number; *NS*, not satisfied; *QS*, Q-switched; *S*, satisfied; *SP*, short pulse; *ST-PGA*, short-term physician global assessment; *VS*, very satisfied.

*Burane (Alma Lasers, Liee, Belgium).

†Fraxel Repair (Solta Medical, Hayward, CA).

‡UltraPulse (Lumenis Inc, Santa Clara, CA).

Table III. Characteristics and results of patients with Becker nevus treated with laser

Patients		Lesion		Treatment	Results						
No.	Age, sex	Site	Size	Type (No. of sessions)	ST-PGA	LT-PGA	Patients' self-evaluation	Patients' satisfaction	Recurrence	Scar	Follow-up
Becker nevus											
40	16 y, M	Flank	Large	Test QS 755 and QS 532	5 both	5	4	NS	No improvement	No	1 y 3 mo
41	22 y, F	Cheek	Small	Test QS 755 and QS 532	5 both	…	4	NS	No improvement	No	4 y 5 mo
42	15 y, F	Shoulder	Large	Test QS 1064, QS 755 and QS 532	5 all	5	4	NS	No improvement	No	8 y 4 mo
43	18 y, M	Forearm	Medium	Test QS 755	5	5	4	NS	No improvement	No	2 y 7 mo
44	40 y, F	Arm	Large	Test QS 755 and QS 532	5 both	5	4	NS	No improvement	No	2 y 3 mo
45	18 y, M	Arm	Large	Test QS 755 and QS 532	5 both	5	4	NS	No improvement	No	3 y 9 mo
46	19 y, F	Arm	Large	QS 755 (1)	5	…	4	NS	No improvement	No	3 y 8 mo
47	38 y, F	Hip	Large	Test QS 1064, QS 532, QS 755, and LP 755	5 all	5	4	NS	No improvement	No	8 y 3 mo
48	13 y, M	Thorax	Large	Test QS 755 and QS 532	5 both	5	4	NS	No improvement	No	5 y 3 mo
49	16 y, M	Flank	Large	Test QS 1064, QS 755 and QS 532	5 all	5	4	NS	No improvement	No	8 y 10 mo
50	29 y, F	Abdomen	Large	Test QS 755 and QS 532	5 both	5	4	NS	No improvement	No	3 y 3 mo
51	20 y, M	Arm	Large	Test QS ruby	5	5	4	NS	No improvement	No	10 y 1 mo
52	17 y, M	Arm	Medium	Full treatment QS 755 (2)	3	5	4	NS	Complete	No	1 y 11 mo
				Test QS 532	4	5	4				
53	61 y, M	Scapular	Medium	Test QS 532, QS 755	5	…	4	NS	No improvement	No	1 y
54	36 y, M	Scapular	Large	Full treatment QS 755 (2)	3	5	4	NS	Complete	No	7 y 8 mo
				Test QS 1064, QS 532	5 both	5					
55	15 y, F	Thigh	Large	Test QS 755, QS 532	6 both	5 both	4	NS	No improvement	No	2 y 6 mo
56	26 y, F	Shoulder	Large	QS 755 (4)	2	1	…	…	No	No	1 y
57	13 y, M	Shoulder	Large	Test QS 755	5	…	…	…	No improvement	No	…
58	20 y, F	Shoulder	Large	Test QS 1064, QS 755, QS 694, QS 532	5 all	…	…	…	No improvement	No	…
59	17 y, F	Thorax	Large	Test QS 1064, QS 755, QS 532	5 all	…	…	…	No improvement	No	…
60	15 y, M	Cheek	Small	Test QS 1064, QS 755	5 both	…	…	…	No improvement	No	…
61	37 y, F	Breast	Large	Test QS 755, QS 532	5 both	…	…	…	No improvement	No	…
62	30 y, M	Face	Large	Test QS 1064, QS 755, QS 532	5 all	…	…	…	No improvement	No	…
63	22 y, F	Arm	Large	Test QS 755, QS 532	5 both	…	…	…	No improvement	No	…
64	16 y, M	Thorax	Large	Test QS 755, QS 532	5 both	…	…	…	No improvement	No	…
65	18 y, M	Cheek	Large	Test QS 755, QS 532	5 both	…	…	…	No improvement	No	…

F, Female; *LP*, long pulsed; *LT-PGA*, long-term physician global assessment; *M*, male; *No.*, number; *NS*, not satisfied; *QS*, Q-switched; *ST-PGA*, short-term physician global assessment.

Table IV. Characteristics and results of other rare types of epidermal nevi treated with laser

Patients		Lesion		Treatment	Results					
No.	Age, sex	Site	Size	Type (No. of sessions)	ST-PGA	LT-PGA	Patients' self-evaluation	Patients' satisfaction	Recurrence	Scar	Follow-up
ILVEN											
66	51 y, M	Right trunk and leg	Large	Verrucous: CO_2 (8) Erythematous: PDL (3)	2	2	3	S	Partial	No	3 y
67	61 y, M	Pretibial	Small	Erythematous: PDL (3)	2	Absent	2	S	No	No	2 y
RAVEN											
68	15 y, F	Shoulder	Small	Er:YAG (1)	4	5	4	NS	Complete	No	5 y 4 mo
Nevus lipomatosus superficialis											
69	28 y, F	Buttocks	Small	CO_2 (1)	2	4	3	S	Partial	No	2 y 6 mo
Smooth-muscle hamartoma											
70	18 y, F	Cheek	Medium	PDL (1)	3	3	…	…	Yes	No	5 y 5 mo

Er:YAG, Erbium-doped yttrium aluminium garnet laser; *F*, female; *ILVEN*, inflammatory linear verrucous epidermal nevus; *LT-PGA*, long-term physician global assessment; *M*, male; *No.*, number; *NS*, not satisfied; *PDL*, pulsed dye laser; *RAVEN*, rounded and velvety epidermal nevus; *S*, satisfied; *ST-PGA*, short-term physician global assessment.

hyperkeratosis.[4] Thus, VEN can be removed completely or almost completely with excellent cosmetic outcomes, whereas recurrence is expected in NS when only the superficial part is treated, and scarring is unavoidable if one tries to treat the dermal part deeply. Partial improvement of NS lesions can be achieved, but patients need to realize the high risk of scarring and recurrence.

For both types, we do not recommend treating with aggressive laser settings or trying to treat the whole thickness deep into the dermis in 1 session. To avoid disfiguring scars, it is wise to treat first just the superficial or papillary dermis and, later, if necessary, the remaining deeper parts. We recommend performing several passes to flatten the lesion first and then to decrease, if necessary, the power for the last passes to avoid treating too deeply in the dermis.

Targeting a cosmetically acceptable scar could be considered as the end point to avoid recurrence. Our results support this for the deeper lesions such as NS. However, scar or dyspigmentation did not develop in most patients treated for VEN in our study because they were not treated too deeply. Thus, all of them have remnants of their lesions (LT-PGA = ≥1). Interestingly, although the clearance was not complete, long-term results remain good, and most of the patients were satisfied or very satisfied at the long-term evaluation.

Some studies mentioned that the degree of improvement is affected by the larger size and thickness of the lesion, but this was not seen in our results. Almost all nonsatisfied patients have lesions of small size, whereas the only 2 patients treated for large VEN were satisfied. We did not find significant association with the degree of improvement according to the body site. However, the only 2 VEN located on the hand did not respond very well, and 3 of the 4 unsatisfied patients with VEN were treated for neck VEN. This might be explained by the high mobility of the treated areas, which could alter the healing process.

When we evaluated the populations of the aforementioned studies together with our patients, 53 patients with VEN were treated only with CO_2 lasers (different modes and parameters) and 42 patients with Er:YAG lasers. Scars or permanent hypo- or hyperpigmentation developed in 21 patients (39.6%) after CO_2 lasers vs in 6 patients (14.3%) after Er:YAG lasers (P = .006). The thermal effect of the CO_2 laser might be the origin of these adverse effects. We cannot exclude a potential bias linked to the procedural differences between the different physicians, but the only controlled comparative study was in favor of this difference, although not significant, with a small number of participants. In

Table V. Verrucous epidermal nevus and nevus sebaceous treatment response, recurrence, and long-term patient satisfaction

Nevus	ST-PGA	Patients, No.	Recurrence, No. (%)	Scar, No. (%)	Satisfaction, No. (%)		
					Very satisfied	Satisfied	Not satisfied
VEN	Good response: 0, 1, 2	18	7 (39)	6 (33)	4	12	2
	Moderate, poor or no response: 3, 4, 5, 6	4	3 (75)	1 (25)	0	3	1
	Absent ST-PGA*	1	1	0	0	0	1
	Total	23	11 (48)	7 (30)	4 (17.4)	15 (65.2)	4 (17.4)
NS	Good response	8	7 (88)	3 (38)	2	4	2
	Poor or no response	8	7 (88)	3 (38)	1	2	5
	Total	16	14 (88)	6 (38)	3 (18.8)	6 (37.5)	7 (42.8)

NS, Nevus sebaceous; *ST-PGA*, short-term-physician global assessment; *VEN*, verrucous epidermal nevus.
*The only patient without ST-PGA was lost to follow-up from the laser treatment until more than 8 years later.

our study, there was almost no difference; scarring or hypopigmentation occurred in 25% of the patients with Er:YAG vs 28.6% with CO_2.

Our study reveals that pigmentary lasers, regardless of their wavelengths, were not effective in treating the hyperpigmentation of BN. Only 3 patients (11.5%) experienced any degree of improvement. Only 1 of them (3.8%) maintained the improvement after 4 sessions of QS at 755 nm, but with a relatively short follow-up of 12 months. These results argue against the use of lasers for treating the pigmentary component of BN. Of note, no patients were treated with both hair removal and QS lasers. Thus, it is impossible to say whether combining the 2 procedures would improve these results.

Picosecond lasers do not seem to bring any advantage compared with QS nanosecond lasers, and the only case report so far showed poor efficacy.[31] Interestingly, an Er:YAG laser was reported to be superior to QS 1064 nm. A success rate of 100% was obtained without recurrence at 2 years.[36] Such promising data were corroborated recently with 50% of good responders and without recurrence at 1 year.[28] However, these data need to be confirmed in larger series.

The 2 patients with ILVEN reported improvement with pulsed dye laser for erythema and CO_2 laser for the verrucous component, with partial recurrence in 1 patient. We previously reported the successful treatment of ILVEN with the Er:YAG laser, with a partial recurrence after 6 months.[44] Two small case series demonstrated that ILVEN has a recurrence rate of 60% to 80% after being treated with a CO_2 laser.[11,19]

The main limitations of our study are its retrospective nature and the lack of histologic confirmation of the diagnosis in most of the patients. In most cases, however, the diagnosis of EN is easy and remains clinical. Although retrospective, the study was conducted in 2 university hospitals with a large experience in treating medical conditions with lasers, and all the treatments were performed by only 3 physicians, thus reducing the variability linked to physician experience. Moreover, only 8 patients were completely lost to follow-up, and the 70 remaining patients could be contacted for assessing the long-term evolution. Our results also emphasize the need of an international long-term registry for these rare lesions treated with lasers to better assess the success rates, long-term efficacy, adverse effects, and patient-reported outcomes.

CONCLUSION

Our study shows that ablative lasers can achieve good cosmetic results for VEN, with a high rate of good to excellent immediate outcome and a low rate of long-term recurrences. In contrast, NS has a strong tendency to recur and to develop a scar when treating deeply. In BN, QS lasers did not provide any benefit in almost all patients and should no longer be considered for treating the hyperpigmented component of such EN.

REFERENCES

1. Brandling-Bennett HA, Morel KD. Epidermal nevi. *Pediatr Clin North Am*. 2010;57(5):1177-1198.
2. Ersoy-Evans S, Sahin S, Mancini AJ, Paller AS, Guitart J. The acanthosis nigricans form of epidermal nevus. *J Am Acad Dermatol*. 2006;55(4):696-698.
3. Bergonse FN, Cymbalista NC, Nico MM, et al. Giant nevus lipomatosus cutaneus superficialis: case report and review of the literature. *J Dermatol*. 2000;27(1):16-19.
4. Asch S, Sugarman JL. Epidermal nevus syndromes. *Handb Clin Neurol*. 2015;132:291-316.
5. Fox BJ, Lapins NA. Comparison of treatment modalities for epidermal nevus: a case report and review. *J Dermatol Surg Oncol*. 1983;9(11):879-885.
6. Levi A, Amitai DB, Mimouni D, Leshem YA, Arzi O, Lapidoth M. Picosecond 532-nm neodymium-doped yttrium aluminum garnet laser-a promising modality for the

management of verrucous epidermal nevi. *Lasers Med Sci*. 2018;33(3):597-601.
7. Osman MAR, Kassab AN. Carbon dioxide laser versus erbium: YAG laser in treatment of epidermal verrucous nevus: a comparative randomized clinical study. *J Dermatol Treat*. 2017;28(5):452-457.
8. Bhat YJ, Hassan I, Sajad P, et al. Evaluation of carbon dioxide laser in the treatment of epidermal nevi. *J Cutan Aesthetic Surg*. 2016;9(3):183-187.
9. López V, López I, Ricart JM. Successful carbon dioxide laser treatment for verrucous epidermal nevi on the nipple. *Dermatol Surg*. 2013;39(12):1936-1937.
10. Lapidoth M, Israeli H, Ben Amitai D, Halachmi S. Treatment of verrucous epidermal nevus: experience with 71 cases. *Dermatol Basel Switz*. 2013;226(4):342-346.
11. Alonso-Castro L, Boixeda P, Reig I, de Daniel-Rodríguez C, Fleta-Asín B, Jaén-Olasolo P. Carbon dioxide laser treatment of epidermal nevi: response and long-term follow-up. *Actas Dermosifiliogr*. 2012;103(10):910-918.
12. Paradela S, Del Pozo J, Fernández-Jorge B, Lozano J, Martínez-González C, Fonseca E. Epidermal nevi treated by carbon dioxide laser vaporization: a series of 25 patients. *J Dermatol Treat*. 2007;18(3):169-174.
13. Thual N, Chevallier J-M, Vuillamie M, Tack B, Leroy D, Dompmartin A. CO2 laser therapy of verrucous epidermal nevus [in French]. *Ann Dermatol Venereol*. 2006;133(2):131-138.
14. Park J-H, Hwang E-S, Kim S-N, Kye Y-C. Er:YAG laser treatment of verrucous epidermal nevi. *Dermatol Surg*. 2004;30(3):378-381.
15. Pearson IC, Harland CC. Epidermal naevi treated with pulsed erbium:YAG laser. *Clin Exp Dermatol*. 2004;29(5):494-496.
16. Boyce S, Alster TS. CO2 laser treatment of epidermal nevi: long-term success. *Dermatol Surg*. 2002;28(7):611-614.
17. Verma KK, Ovung EM. Epidermal and sebaceous nevi treated with carbon dioxide laser. *Indian J Dermatol Venereol Leprol*. 2002;68(1):23-24.
18. Alam M, Arndt KA. A method for pulsed carbon dioxide laser treatment of epidermal nevi. *J Am Acad Dermatol*. 2002;46(4):554-556.
19. Michel JL, Has C, Has V. Resurfacing CO2 laser treatment of linear verrucous epidermal nevus. *Eur J Dermatol*. 2001;11(5):436-439.
20. Kaufmann R, Hibst R. Pulsed erbium:YAG laser ablation in cutaneous surgery. *Lasers Surg Med*. 1996;19(3):324-330.
21. Hohenleutner U, Wlotzke U, Konz B, Landthaler M. Carbon dioxide laser therapy of a widespread epidermal nevus. *Lasers Surg Med*. 1995;16(3):288-291.
22. Hohenleutner U, Landthaler M. Laser therapy of verrucous epidermal naevi. *Clin Exp Dermatol*. 1993;18(2):124-127.
23. Ratz JL, Bailin PL, Wheeland RG. Carbon dioxide laser treatment of epidermal nevi. *J Dermatol Surg Oncol*. 1986;12(6):567-570.
24. Lee HE, Park SB, Lee JH, Im M. Nevus sebaceous treated with fractional carbon dioxide laser followed by pulsed dye laser. *Indian J Dermatol Venereol Leprol*. 2014;80(5):478-480.
25. Chung BY, Han SS, Kim BW, Chang SE, Lee MW. Effective treatment of congenital melanocytic nevus and nevus sebaceous using the pinhole method with the erbium-doped yttrium aluminium garnet laser. *Ann Dermatol*. 2014;26(5):651-653.
26. Kiedrowicz M, Kacalak-Rzepka A, Królicki A, Maleszka R, Bielecka-Grzela S. Therapeutic effects of CO2 laser therapy of linear nevus sebaceous in the course of the Schimmelpenning-Feuerstein-Mims syndrome. *Postepy Dermatol Alergol*. 2013;30(5):320-323.
27. Ashinoff R. Linear nevus sebaceus of Jadassohn treated with the carbon dioxide laser. *Pediatr Dermatol*. 1993;10(2):189-191.
28. Al-Saif F, Al-Mekhadab E, Al-Saif H. Efficacy and safety of short-pulse erbium:yttrium aluminum garnet laser treatment of Becker's nevus in Saudi patients: a pilot study. *Int J Health Sci*. 2017;11(3):14-17.
29. Wulkan AJ, McGraw T, Taylor M. Successful treatment of Becker's nevus with long-pulsed 1064-nm Nd:YAG and 755-nm alexandrite laser and review of the literature. *J Cosmet Laser Ther*. 2018;20:211-214.
30. Balaraman B, Friedman PM. Hypertrichotic Becker's nevi treated with combination 1,550 nm non-ablative fractional photothermolysis and laser hair removal. *Lasers Surg Med*. 2016;48(4):350-353.
31. Chan JC, Shek SY, Kono T, Yeung CK, Chan HH. A retrospective analysis on the management of pigmented lesions using a picosecond 755-nm alexandrite laser in Asians. *Lasers Surg Med*. 2016;48(1):23-29.
32. Piccolo D, Di Marcantonio D, Crisman G, et al. Unconventional use of intense pulsed light. *Biomed Res Int*. 2014;2014:618206.
33. Meesters AA, Wind BS, Kroon MW, et al. Ablative fractional laser therapy as treatment for Becker nevus: a randomized controlled pilot study. *J Am Acad Dermatol*. 2011;65(6):1173-1179.
34. Choi JE, Kim JW, Seo SH, Son SW, Ahn HH, Kye YC. Treatment of Becker's nevi with a long-pulse alexandrite laser. *Dermatol Surg*. 2009;35(7):1105-1108.
35. Glaich AS, Goldberg LH, Dai T, Kunishige JH, Friedman PM. Fractional resurfacing: a new therapeutic modality for Becker's nevus. *Arch Dermatol*. 2007;143(12):1488-1490.
36. Trelles MA, Allones I, Moreno-Arias GA, Vélez M. Becker's naevus: a comparative study between erbium:YAG and Q-switched neodymium:YAG; clinical and histopathological findings. *Br J Dermatol*. 2005;152(2):308-313.
37. Trelles MA, Allones I, Vélez M, Moreno-Arias GA. Becker's nevus: erbium:YAG versus Q-switched neodimium:YAG? *Lasers Surg Med*. 2004;34(4):295-297.
38. Moreno Arias GA, Ferrando J. Intense pulsed light for melanocytic lesions. *Dermatol Surg*. 2001;27(4):397-400.
39. Nanni CA, Alster TS. Treatment of a Becker's nevus using a 694-nm long-pulsed ruby laser. *Dermatol Surg*. 1998;24(9):1032-1034.
40. Kopera D, Hohenleutner U, Landthaler M. Quality-switched ruby laser treatment of solar lentigines and Becker's nevus: a histopathological and immunohistochemical study. *Dermatol*. 1997;194(4):338-343.
41. Tse Y, Levine VJ, McClain SA, Ashinoff R. The removal of cutaneous pigmented lesions with the Q-switched ruby laser and the Q-switched neodymium: yttrium-aluminum-garnet laser. A comparative study. *J Dermatol Surg Oncol*. 1994;20(12):795-800.
42. Nelson JS, Applebaum J. Treatment of superficial cutaneous pigmented lesions by melanin-specific selective photothermolysis using the Q-switched ruby laser. *Ann Plast Surg*. 1992;29(3):231-237.
43. Tan OT, Morelli JG, Kurban AK. Pulsed dye laser treatment of benign cutaneous pigmented lesions. *Lasers Surg Med*. 1992;12(5):538-542.
44. Hammami Ghorbel H, Lacour J-P, Passeron T. Treatment of inflammatory linear verrucous epidermal nevus with 2940 nm erbium fractional laser. *J Eur Acad Dermatol Venereol*. 2014;28(6):824-825.
45. Conti R, Bruscino N, Campolmi P, Bonan P, Cannarozzo G, Moretti S. Inflammatory linear verrucous epidermal nevus:

why a combined laser therapy. *J Cosmet Laser Ther*. 2013;15(4):242-245.

46. D'Antuono A, Balestri R, Zauli S, et al. Carbon dioxide laser: first-line therapy in vulvar inflammatory linear verrucous epidermal nevus. *Dermatol Ther*. 2012;25(1):92-94.
47. Ulkur E, Celikoz B, Yuksel F, Karagoz H. Carbon dioxide laser therapy for an inflammatory linear verrucous epidermal nevus: a case report. *Aesthetic Plast Surg*. 2004;28(6):428-430.
48. Sidwell RU, Syed S, Harper JI. Pulsed dye laser treatment for inflammatory linear verrucous epidermal naevus. *Br J Dermatol*. 2001;144(6):1267-1269.
49. Molin L, Särhammar G. Perivulvar inflammatory linear verrucous epidermal nevus (ILVEN) treated with CO2 laser. *J Cutan Laser Ther*. 1999;1(1):53-56.
50. Alster TS. Inflammatory linear verrucous epidermal nevus: successful treatment with the 585 nm flashlamp-pumped pulsed dye laser. *J Am Acad Dermatol*. 1994;31(3 Pt 1):513-514.