Randomized Controlled Trial: Comparative Efficacy for the Treatment of Facial Telangiectasias With 532 nm Versus 940 nm Diode Laser

Emily Tierney, MD[1,2] and C. William Hanke, MD, MPH[1]*
[1]*Laser and Skin Surgery Center of Indiana, Carmel, Indiana*
[2]*Department of Dermatology, Boston University School of Medicine, Boston, Massachusetts*

Background: While the 532 nm wavelength has been demonstrated to be effective for facial telangiectasias, 940 nm is a novel wavelength which has only been reported in case reports. While both the 532 and 940 nm wavelengths are effective for facial telangiectasias, we lack evidence to support whether one wavelength is superior.
Study Design: Randomized, blinded split-faced trial for the 532 and 940 nm diode laser wavelengths. Side effects of erythema, crusting, swelling, and blistering (0–5 scale, 0 = not present, 1 = trace, 5 = severe) were assessed. Prior to treatment and at 2 months after a series of two treatments, telangiectasias were assessed (1–10 scale, 1 = focal telangiectasias, 10 = diffuse telangiectasias). Assessment of the degree of improvement in facial telangiectasias was performed by two blinded non-treating physician evaluators from patient photographs.
Results: A total of 24 facial anatomic sites were treated with the 532 and 940 nm wavelengths. Presence and severity of side effects of erythema, crusting, swelling, blistering (0–5 scale, 0 = not present, 1 = trace, 5 = severe) were assessed. Pain associated with the laser treatment was rated as significantly less for the 940 nm wavelength relative to the 532 nm wavelength. Erythema post-treatment was significantly less with 940 nm relative to 532 nm. Significant crusting and swelling were only reported with the 532 nm wavelength. The mean percentage improvement with the 940 nm wavelength (63.0%) was greater than that achieved with the 532 nm wavelength (47.8%) ($P<0.05$). On photographic evaluation, 940 nm was significantly more efficacious for larger caliber vessels than 532 nm. Both wavelengths were equally efficacious for smaller caliber vessels.
Conclusions: While both 532 and 940 nm diode laser produced significant improvement in facial telangiectasias, greater efficacy was found with 940 nm as well as a significantly more tolerable side effect profile. Lasers Surg. Med. 41:555–562, 2009. © 2009 Wiley-Liss, Inc.

Key words: linear telangiectasias; diode laser; 532 nm; 940 nm

BACKGROUND

Facial telangiectasias have been estimated to occur in tens of millions of people worldwide [1]. These malformations have a multifactorial etiology, affecting mostly patients with Fitzpatrick skin types I and II, usually appearing on the nasal ala and medial cheeks [2]. There are numerous associated factors, including chronic actinic damage, rosacea, collagen vascular diseases, estrogens, topical corticosteroids, and inherited conditions, such as hereditary hemorrhagic telangiectasia (HHT) [3]. The pathophysiology of the development of telangiectasias is thought to be related to weakness in the elastic fibers of the vessel wall secondary to chronic sun exposure, resulting in persistent vasodilation [4].

Telangiectasias are commonly defined as dilated capillaries, venules, or arterioles with a diameter of 0.1–1.0 mm [3]. Telangiectasias that originate form the arteriolar side are small and erythematous, while those from the venous side of a capillary tend to be large and bluish colored. Telangiectasias can be classified into four types: simple (linear), arborizing, spider, and punctate [5]. Telangiectasias on the nose and cheeks tend to be arteriolar in etiology and arborizing in morphology [3].

Various treatment modalities have been employed to treat facial telangiectasias, including topical and systemic antibiotics, oral estrogens, cyrotherapy, dermabrasion, electrosurgery, sclerotherapy, and cutaneous laser treatment [4]. The first lasers utilized for telangiectasias were the continuous-wave argon (488 and 514 nm), the continuous wave CO_2 (10,600 nm), and the Nd:Yag (1,064 nm) lasers [1]. However, as vessels do not preferentially absorb the energy produced by the laser, heat is delivered to

*Correspondence to: Dr. C. William Hanke, MD, MPH, Director, Laser and Skin Surgery Center of Indiana, St. Vincent's Hospital, 13400 N. Meridian Street, Suite 290, Carmel, IN 46032. E-mail: cmwhanke@sbcglobal.net
Accepted 4 August 2009
Published online in Wiley InterScience (www.interscience.wiley.com).
DOI 10.1002/lsm.20811

adjacent tissues, with significant risk of scarring and dyspigmentation [1].

Following the theory of selective photothermolysis [6,7], oxyhemoglobin was selected as the chromophore to be destroyed by selective absorption of energy with vascular lasers. The first pulsed dye lasers were specifically designed during the 1980s for the treatment of vascular malformations, with their wavelengths designed to target the peak absorption for oxyhemoglobin, at 418, 542, and 577 nm. The pulsed dye laser was the first laser to follow the principal of selective photothermolysis for vascular lesions [6,7]. Producing yellow light at a wavelength of 585 nm, the energy delivered is preferentially absorbed by oxyhemoglobin [6,7]. The primary disadvantage of this laser is post-operative purpura, which is caused by extravasation of erythrocytes, due to the very fast pulse delivery that disrupts the telangiectatic and normal capillaries [8,9]. The post-operative purpura can last up to 1–3 weeks and can heal with subsequent hyperpigmentation, which lasts ~3–4 months [8,9]. These adverse effects significantly limit the applicability of pulsed dye lasers for the treatment of facial telangiectasias.

A more selective photothermolysis can be achieved by using a pulse duration which is close to or equal to the thermal relaxation time (TRT) of the targeted vessels [6,7]. The TRT for facial telangiectasias of 10–60 milliseconds is significantly longer than the range of pulse duration for the pulsed dye laser (450 microseconds to 50 milliseconds) [10]. Thus, with the development of the frequency-doubled Nd:Yag laser (532 nm) associated with longer pulse durations (10–100 milliseconds), a number of investigators have shown that the pulse duration can be modified to fit the TRT of the individual vessel and location [2,11–13]. This feature allows specific targeting of vessels with minimal collateral damage and purpura [11]. The absorption of green light at 532 nm by oxyhemoglobin is very high, resulting in a high vascular extinction coefficient [11]. The 532 nm wavelength has been shown to be effective for facial telangiectatic vessels up to 1 mm in diameter [2]. However, it has been demonstrated that one of the significant limitations of the 532 nm wavelength is that as vessel diameter approaches and exceeds 1 mm, this laser is less effective, given its shorter wavelength and pulse duration maximum of 60–100 milliseconds [2].

Most recently, novel longer wavelengths, including 940 [14,15] and 980 nm [16], have become available for the treatment of facial telangiectasias. These longer wavelengths can be utilized to treat larger (> 1 mm vessels) and/or deeper vascular lesions that were resistant to the shorter wavelengths associated with pulsed dye (585–595 nm) and frequency doubled Nd:Yag (532 nm) devices. At 940 nm, there is a lesser absorption peak for oxyhemoglobin, resulting in slower and more uniform heating of the vessel with greater efficacy for large diameter vessels [14]. The longer 940 nm wavelength also has a greater depth of penetration and selectively targets deeper vessels. We set to perform a randomized controlled trial to compare the efficacy and side effect profile of the 940 and 532 nm wavelengths in the treatment of facial telangiectasias.

MATERIALS AND METHODS

The study protocol conformed to the guidelines of the 1975 Declaration of Helsinki and was approved by the St. Vincent Hospital Institutional Review Board and Ethics Committee, Carmel IN. Informed consent was obtained from all patients prior to enrollment. All patients were required to be available for longitudinal study over the course of the 5-month period of study treatment and post-treatment evaluation. A prospective, randomized, split-face right-left comparative trial in 10 subjects presenting to our office for desired treatment of facial telangiectasias between July 2008 and November 2008. Patients were excluded from the study if they had active infections, current pregnancy, a history of isotretinoin use in the year prior to laser treatment, a history of keloid scarring, or any cosmetic procedure in the area(s) of treatment in the 12 months prior to the study.

Treatment was administered to the face with the 532/940 nm dual wavelength vascular diode laser (VariLite, Iridex Corp., Mountain View, CA). Patients with both discrete linear telangiectasias and erythematous-type telangiectasias were treated in this study. Patients received a series of two treatment sessions, administered at 6-week intervals. Selection of which side of the face was treated with 532 versus 940 nm was determined at random by a coin toss. Settings utilized for the diode laser with the 532 nm wavelength: fluence 15 J/cm^2, pulse duration 60 milliseconds, spot size 1 mm and for the 940 nm wavelength: fluence 100 J/cm^2, pulse duration 21 milliseconds, spot size 1 mm. After each treatment, patients were immediately treated with cooling with ice for 5 minutes.

At each treatment and at 2 months after the final treatment, two blinded non-treating physician evaluators assessed patient photographs to assess the degree of improvement in facial telangiectasias (Table 1). In addition, the degree of improvement was calculated as the percentage improvement at 2 months after the second treatment. After the treatment, patient perception of the pain of the laser treatment was assessed (Table 2). At 1 week after each treatment, side effect profile (erythema, crusting, swelling, blistering) was assessed.

Statistical Analysis

For each patient, the pre- and post-treatment scores (1–10 scale, 1 = minimal, focal visible telangiectasias in 5–10% of anatomic area, 2 = focal visible telangiectasias in 11–20% of an anatomic area, 3 = focal visible telangiectasias in 21–30% of anatomic area, 4 = visible telangiectasias in 31–40% of anatomic area, 5 = visible telangiectasias in 41–50% of anatomic area, 6 = moderately severe telangiectasias in 51–60% of anatomic area, 7 = moderately severe telangiectasias in 61–70% of anatomic area, 8 = severe telangiectasias in 71–80% of anatomic area, 9 = severe telangiectasias in 81–90% of anatomic area, 10 = severe and diffuse facial telangiectasias in entire

TABLE 1. Blinded Physician Evaluation of Treatment Efficacy

Patient #	Age/gender	Cheek 532 nm (%)	Cheek 940 nm (%)	Nose 532 nm (%)	Nose 940 nm (%)	Upper lip 532 nm (%)	Upper lip 940 nm (%)	Chin 532 nm (%)	Chin 940 nm (%)
1	73 y/o male								
% improvement after tx #1		50.00	60.00	12.50	50.00				
% improvement after tx #2		50.00	80.00	50.00	50.00				
2	65 y/o male								
% improvement after tx #1		50.00	50.00	20.00	30.00	20.00	37.50		
% improvement after tx #2		60.00	70.00	30.00	70.00	30.00	62.50		
3	82 y/o male								
% improvement after tx #1		10.00	30.00	20.00	30.00				
% improvement after tx #2		60.00	70.00	30.00	50.00				
4	55 y/o female								
% improvement after tx #1		50.00	70.00	42.90	57.10				
% improvement after tx #2		70.00	80.00	71.40	85.70				
5	45 y/o female								
% improvement after tx #1		11.10	22.20	22.20	33.30				
% improvement after tx #2		22.20	44.40	22.20	44.40				
6	47 y/o female								
% improvement after tx #1		28.70	57.10	33.30	50.00				
% improvement after tx #2		57.10	71.40	66.70	66.70				
7	53 y/o female								
% improvement after tx #1		42.90	57.10	33.30	33.30			28.60	28.60
% improvement after tx #2		57.10	71.40	50.00	50.00			42.90	57.10
8	47 y/o female								
% improvement after tx #1		50.00	60.00	40.00	50.00				
% improvement after tx #2		57.10	71.40	50.00	66.70				
9	55 y/o male								
% improvement after tx #1		20.00	40.00	20.00	20.00				
% improvement after tx #2		40.00	70.00	33.30	50.00				
10	42 y/o female								
% improvement after tx #1		30.0	40.00	42.90	57.10				
% improvement after tx #2		40.00	71.40	50.00	66.70				

Overall Mean	Cheek 532 nm	Cheek 940 nm	Nose 532 nm	Nose 940 nm	Upper lip 532 nm	Upper lip 940 nm	Chin 532 nm	Chin 940 nm	Overall 532 nm	Overall 940 nm
% improvement after tx #1	34.27%	48.64%	28.71%	41.08%	20.00%	37.50%	28.60%	28.60%	29.78%	42.83%
% improvement after tx #2	51.35%	70.00%	45.36%	60.02%	30.00%	62.50%	42.90%	57.10%	47.80%	62.58%
P-value 532 nm vs. 940 nm	$P < 0.05$		$P = 0.05$		$P > 0.05$		$P > 0.05$		$P < 0.05$	
% improvement after tx #2 is calculated from baseline										

y/o, years old.

TABLE 2. Patient Evaluation of Side Effects

Patient #	Age/gender	Pain 532 nm	Pain 940 nm	Erythema 532 nm	Erythema 940 nm	Crusting 532 nm	Crusting 940 nm	Swelling 532 nm	Swelling 940 nm	Blistering 532 nm	Blistering 940 nm
1	73 y/o male										
Side effects after tx #1		3	2	2	1	0	0	0	0	0	0
Side effects after tx #2		3	2	3	1	0	0	0	0	0	0
2	65 y/o male										
Side effects after tx #1		3	2	3	2	0	0	0	0	0	0
Side effects after tx #2		2	1	2	1	0	0	0	0	0	0
3	82 y/o male										
Side effects after tx #1		4	2	3	2	2	0	2	1	0	0
Side effects after tx #2		3	2	3	2	2	0	1	1	0	0
4	55 y/o female										
Side effects after tx #1		3	1	3	2	2	0	0	0	0	0
Side effects after tx #2		3	1	3	1	0	0	0	0	0	0
5	45 y/o female										
Side effects after tx #1		4	3	2	1	2	0	2	1	0	0
Side effects after tx #2		2	2	2	1	1	0	2	1	0	0
6	47 y/o female										
Side effects after tx #1		3	2	2	1	0	0	1	0	0	0
Side effects after tx #2		2	1	1	1	0	0	1	0	0	0
7	53 y/o female										
Side effects after tx #1		4	3	2	2	0	0	0	0	0	0
Side effects after tx #2		3	2	2	1	0	0	0	0	0	0
8	47 y/o female										
Side effects after tx #1		3	2	3	2	0	0	3	0	0	0
Side effects after tx #2		3	2	3	2	0	0	2	0	0	0
9	55 y/o male										
Side effects after tx #1		3	2	2	2	0	0	0	0	0	0
Side effects after tx #2		4	3	3	1	0	0	0	0	0	0
10	42 y/o female										
Side effects after tx #1		4	2	3	2	0	0	1	0	0	0
Side effects after tx #2		3	2	3	1	0	0	1	0	0	0
Overall mean											
Side effects after tx #1		3.6	2.0	2.5	1.6	0.6	0	1.0	0.2	0	0
Side effects after tx #2		2.8	1.8	2.4	1.2	0.3	0.0	0.7	0.2	0	0
		Pain		Erythema		Crusting		Swelling		Blistering	
P-value 532 nm vs. 940 nm after tx #1		$P < 0.05$		$P < 0.05$		$P > 0.05$		$P > 0.05$		$P > 0.05$	
P-value 532 nm vs. 940 nm after tx #2		$P < 0.05$		$P < 0.05$		$P > 0.05$		$P > 0.05$		$P > 0.05$	

y/o, years old.

anatomic area) for facial telangiectasias, as calculated by blinded physician photographic analysis, were recorded.

The percent improvement in score (Table 1) was calculated as the score difference divided by the baseline score after both one and two treatment sessions. At 1 week after each treatment, side effect of erythema, crusting, swelling, blistering were assessed by each patient (0–5 scale, 0 = not present, 1 = trace, 5 = severe, N/A = not applicable). The paired *t*-test was utilized to test the difference in side effect severity for the two wavelengths (532 nm vs. 940 nm) (Table 2). The paired *t*-test was utilized to test the difference in percentage improvement in score from baseline to post-treatment for the two wavelengths (532 nm vs. 940 nm). Comparisons were made for each wavelength by each anatomic site (cheek, nose, upper lip, chin) and averaged over all anatomic sites treated. *P*-values <0.05 were considered statistically significant.

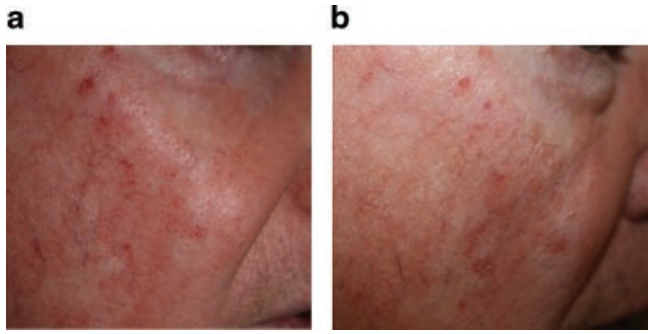

Fig. 1. **a**,**b**: Pre (left) and post (right) 82-year-old Caucasian male status post two treatments with 532 nm diode laser (Varilite laser, Iridex Corp.) at 15 J/cm^2, 60 milliseconds. Used with permission from C. William Hanke M.D.

RESULTS

A total of 24 anatomic sites, including the cheeks, nose, upper lip, and chin, in 10 patients with facial telangiectasias were treated (Table 1). Patients ranged in age from 42 to 82 years and there were a total of 6 women and 4 men (Table 1). Presence and severity of side effects of erythema, crusting, swelling, blistering (0–5 scale, 0 = not present, 1 = trace, 5 = severe) were assessed by patients at 1 week after each treatment (Table 2). Pain associated with the laser treatment was rated as significantly less for both treatments with the 940 nm wavelength (treatment #1: 2.0, treatment #2: 1.8) relative to the 532 nm wavelength (3.6, 2.8) ($P<0.05$). However, all patients tolerated both settings to allow complete treatment of facial telangiectasias. Erythema post-treatment was significantly less with 940 nm (1.6, 1.2) relative to 532 nm (2.5, 2.4) ($P<0.05$). Crusting was only reported with the 532 nm wavelength, where three patients reported crusting (range of severity: 0–2). Swelling was more commonly reported with the 532 nm wavelength, where 5/10 patients reported swelling (range of severity: 0–3), in contrast, with the 932 nm wavelength, only 2/10 patients reported swelling (range of severity: 0–1).

When averaged over all anatomic sites treated, mean percentage improvement with the 940 nm wavelength (63.0%) was greater than that achieved with the 532 nm wavelength (47.8%) (Table 1). On photographic evaluation, 940 nm was significantly more efficacious for larger caliber vessels than 532 nm. Both wavelengths were equally efficacious for smaller caliber vessels. When analyzed by individual anatomic sites, the cheek had the highest overall response. For the cheeks, significantly greater improvement was achieved with the 940 nm wavelength (70.0% improvement, relative to the 532 nm wavelength (51.4% improvement), ($P<0.05$). For the nose, greater improvement was also seen with the 940 nm wavelength (60.0%) relative to the 532 nm wavelength (45.4%) ($P<0.05$). The sample size ($n = 4$) of upper lip and chin regions treated were too small to allow significant comparisons between the two wavelengths; however, there was a trend in both anatomic sites towards greater improvement with the 940 nm wavelength. The results observed in improvement in linear telangiectasias at 2 months post-treatment persisted at 6 months post-treatment.

Clinical pictures of patients demonstrating improvement in facial telangiectasias are seen in Figures 1a,b, 2a,b, 3a,b, 4a,b, and 5a,b.

DISCUSSION

The 532 nm wavelength has been well characterized in the literature to result in significant improvement in facial telangiectasias [2,11–13]. Cassuto et al. [11] reported a series of patients with facial telangiectasias treated with the 532 nm diode-pumped Nd:Yag laser, where all but four subjects had 75–100% vessel clearance. Goldberg and Meine [2] reported a comparison of four frequency doubled Nd:Yag (532 nm) devices in 40 patients, where all treated patients had good to excellent responses. Clark et al. [12] reported a series of 204 patients treated with a 532 nm KTP laser for facial vascular lesions (102 spider angioma, 104 facial telangiectasias) with the 532 nm wavelength, where 98% of spider angiomas and 90% of facial telangiectasias markedly improved or cleared (Figs. 6–8).

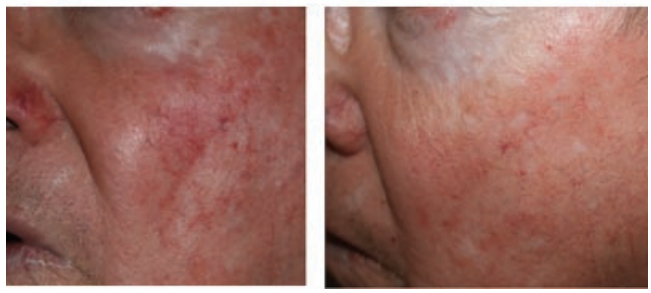

Fig. 2. **a**,**b**: Pre (left) and post (right) 82-year-old Caucasian male status post two treatments with 940 nm diode laser (Varilite laser, Iridex Corp.) at 100 J/cm^2, 21 milliseconds. Used with permission from C. William Hanke M.D.

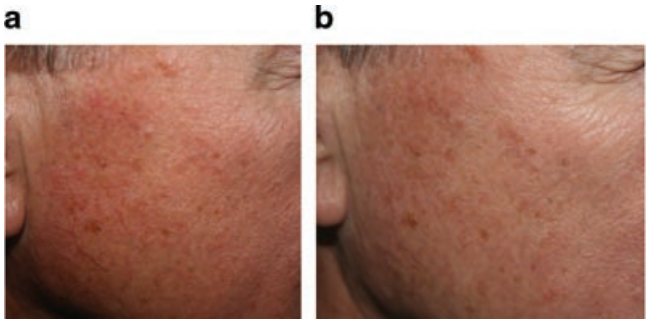

Fig. 3. **a**,**b**: Pre (left) and post (right) 65-year-old Caucasian male status post two treatments with 940 nm diode laser (Varilite laser, Iridex Corp.) at 100 J/cm^2, 21 milliseconds. Used with permission from C. William Hanke M.D.

As noted in our patients, the limitations of the 532 nm wavelength include specific targeting of superficial and smaller caliber vessels up to 1 mm in diameter, with a lack of efficacy for larger and deeper vessels [2,11–13]. The reasons for these limitations include the shorter pulse duration which is less than that of the TRT of deeper and larger caliber vessels [6,7]. In addition, because of the superficial depth of penetration of the 532 nm wavelength, it is also less effective for vascular telangiectasias arising from a deeper feeding vessel [14].

An additional limitation of the 532 nm wavelength is the side effect profile which was significantly more painful and associated with post-treatment crusting and swelling relative to 940 nm [2,11–13]. Post-operative swelling and erythema have been reported universally with 532 nm; however, review of the literature confirmed several cases of crusting, blistering, and resulting permanent scarring and post-inflammatory hyperpigmentation [2,11–13]. In a study by Cassuto et al. [11] in 66 patients treated with the 532 nm diode-pumped Nd:Yag laser, 83% of patients developed microcrusting, and 100%!of patients developed significant post-operative erythema and swelling. In our patients, 30% of our sites treated with the 532 nm

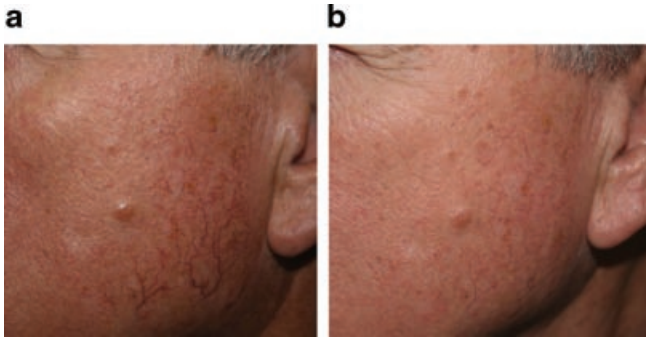

Fig. 4. **a**,**b**: Pre (left) and post (right) 65-year-old Caucasian male status post two treatments with 532 nm diode laser (Varilite laser, Iridex Corp.) at 15 J/cm^2, 60 milliseconds. Used with permission from C. William Hanke M.D.

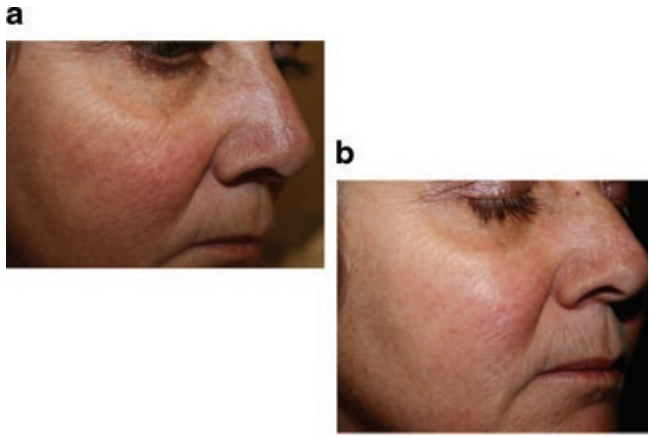

Fig. 5. **a**,**b**: Pre (left) and post (right) 55-year-old Caucasian female status post two treatments with 940 nm diode laser (Varilite laser, Iridex Corp.) at 100 J/cm^2, 21 milliseconds. Used with permission from C. William Hanke M.D.

wavelength developed significant crusting relative to none of the sites treated with 940 nm. One of the potential explanations for the decreased crusting observed in our series with the 532 nm wavelength relative to that of Cassuto et al. [11] is the longer pulse durations utilized in our study (60 milliseconds vs. 15–30 milliseconds) which are significantly closer to the TRT of small to medium sized caliber facial telangiectasias. Clark et al. [12] reported that a few patients in their series of 204 patients treated with the 532 nm KTP device experienced adverse effects. Specifically, one patient developed minimal atrophic scarring and was seen on careful follow-up examination. Another patient developed swelling and blistering; however, this was through to be related to chronic steroid use and resolved after subsequent successful treatment at lower fluences.

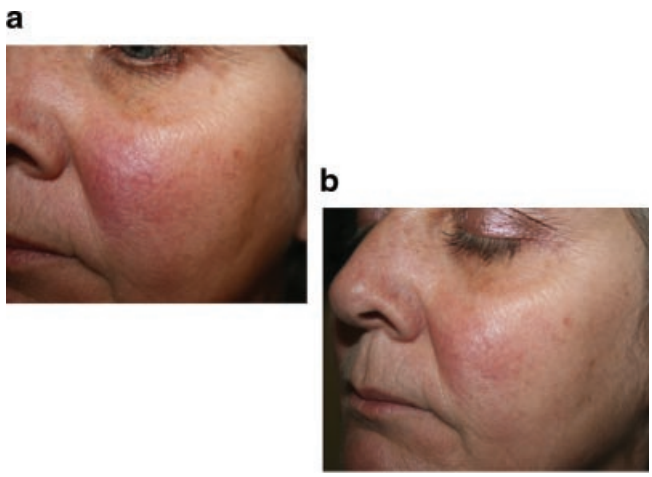

Fig. 6. **a**,**b**: Pre (left) and post (right) 55-year-old Caucasian female status post two treatments with 532 nm diode laser (Varilite laser, Iridex Corp.) at 15 J/cm^2, 60 milliseconds. Used with permission from C. William Hanke M.D.

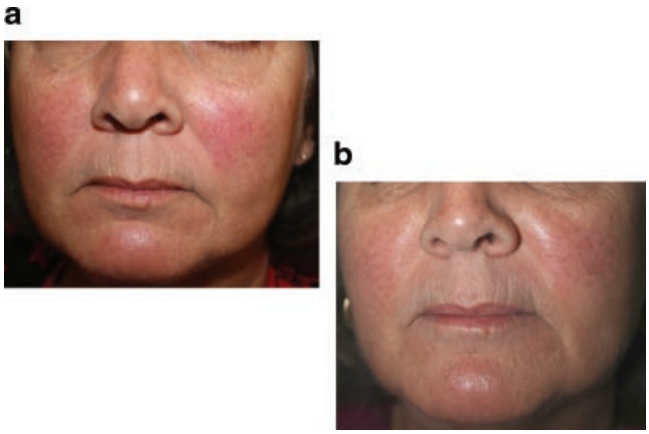

Fig. 7. **a**,**b**: Pre (left) and post (right) 55-year-old Caucasian female status post two treatments with 532 nm diode laser (Varitlite laser, Iridex Corp.) at 15 J/cm^2, 60 milliseconds (left side) and the 940 nm (Varilite laser, Iridex Corp.) at 100 J/cm^2, 21 milliseconds (right side). Used with permission from C. William Hanke M.D.

Two patients developed post-inflammatory hyperpigmentation which subsequently resolved. Pain was not a significant problem for adults; however, two pediatric patients declined treatment secondary to pain. Goldberg and Meine [2] reported that swelling and crusting were reported in a number of patients treated with the diode-pumped frequency doubled Nd:Yag laser; however, no scarring, textural, or pigmentary changes were noted.

One of the limitations of the study is that the 532 nm diode laser utilized has a fixed pulse duration

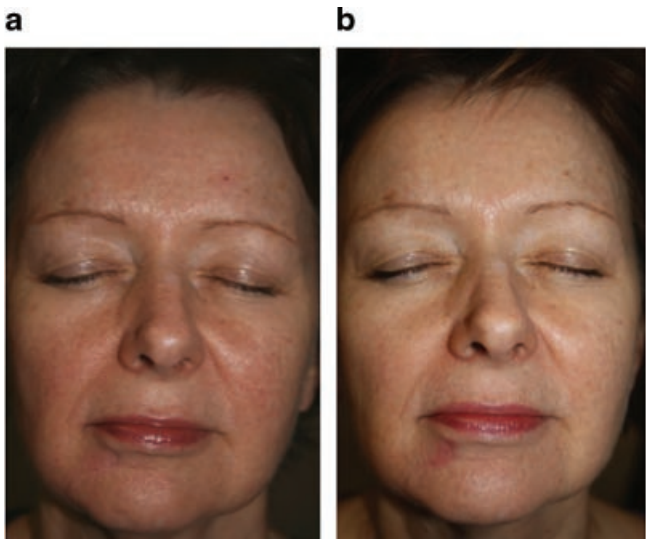

Fig. 8. **a**,**b**: Pre (left) and post (right) 47-year-old Caucasian female status post two treatments with 532 nm diode laser (Varilite laser, Iridex Corp.) at 15 J/cm^2, 60 milliseconds (right side) and the 940 nm (Varilite laser, Iridex Corp.) at 100 J/cm^2, 21 milliseconds (left side). Used with permission from C. William Hanke M.D.

(60 milliseconds). While we have had success with the 60 milliseconds pulse duration with the 532 nm in a pilot study in our clinical practice with treating linear facial telangiectasias, it should be noted that the TRT for small vessels (0.15 mm) is ~10 milliseconds [13]. Thus, the prolonged pulse duration of the 532 nm device utilized in this study may have contributed to its lesser efficacy relative to the 940 nm wavelength.

The 940 nm diode laser found to have greater clearance in our study, has only been reported in one prior study for facial telangiectasias [15]. In this study, 16 subjects with 532 nm resistant vascular lesions were treated with the 940 nm laser [15]. Fourteen of these subjects experienced significant improvement in telangiectasias. Significant side effects occurred in three patients, two of whom developed significant crusting and one of whom developed a blister which resolved without scarring in 1 week. The difference between side effects observed by Carniol et al. [15] relative to the absence of side effects in our series may relate to the utilization of shorter pulse durations or sub-optimal fluences.

The 940 nm wavelength has also been studied in the treatment of leg venulectasias where Passeron et al. [16] found selective clearance of larger caliber vessels with the 940 nm setting. Interestingly in this study, there was only 13.3% clearance of patients with vessels <0.4 mm in caliber (treated at 306 J/cm^2, 10 milliseconds, 0.5 mm spot size), in contrast to the 88.2% clearance of patients with 0.8–1.4 mm vessels (treated at 317 J/cm^2, 70 milliseconds, 1.5 mm spot size). These results correlate with the findings in our study, where the 940 nm wavelength was noted on photographic examination of patients pre- and post-treatment photographs to have significantly greater clearance rates for large caliber vessels relative to 532 nm. Thus, 940 nm presents a significant advantage in patients with larger caliber facial telangiectasias, for which the previous generation of 532 and 585–595 nm lasers have limited efficacy.

Similarly to the results reported herein, Dudelzak et al. [17] recently reported on the success of the 980 nm wavelength in the treatment of facial telangiectasias. Similar to our results with 940 nm, the only side effect seen with the 980 nm wavelength was post-treatment erythema, where no post-treatment crusting, blistering, pigment alteration, or scarring was observed.

Based on the theory of selective photothermolysis [6,7], pulse duration should be selected to match TRT. This means that smaller vessels should be treated using shorter pulse durations than larger vessels [6,7]. Although there is much emphasis in the literature on fluence, the fluence rate is also an important factor in determining the efficacy of a laser as well as the risk of thermal damage to surrounding tissue [6,7,18].

The fluence rate (mW/cm^2) is calculated by dividing the fluence (J/cm^2) by the pulse duration (milliseconds) [6,7,18]. Thus, in our study, the fluence rate for the 532 nm setting (15 J/cm^2, 60 milliseconds) was 250 mW/cm^2, and for the 940 nm setting (100 J/cm^2, 21 milliseconds) was 4,762 mW/cm^2. Thus, the fluence rate for the 940 nm device was 19 times greater than that for the 532 nm device.

This is important because an increased fluence rate produces greater thermal damage and higher localized temperature [6,7,12,18].

The fluence rate of the 940 nm device, which was 19 times greater than that for the 532 nm device, may have played a significant role in the greater efficacy of the 940 nm wavelength in the treatment of linear facial telangiectasias. The 940 nm device, was able to achieve a significantly greater fluence rate with an improved safety profile likely due to the longer wavelength associated with a greater depth of penetration. Likely, if an analogous fluence rate was utilized with the 532 nm setting, significant adverse effects of blistering, crusting, and scarring would result from superficial thermal damage.

CONCLUSIONS

Facial telangiectasias have been successfully treated with a variety of laser wavelengths. Shorter wavelengths (532 nm) are generally effective in the treatment of smaller vessels; longer wavelengths (940–1,064 nm) are more effective in the treatment of larger vessels; however, can be associated with a higher complication rate. In this study, we identified that the 940 nm has the benefits of a longer wavelength in targeting larger caliber and deeper vessels with a safety profile superior to that of shorter wavelength.

Lasers with long wavelengths of light, within the visible spectrum, penetrate more deeply into the skin, making them more suitable for deeper vessels. The 940 nm diode laser was found to have greater efficacy for deeper blood vessels based upon its superior penetration of the dermis with a longer wavelength. In addition, the 940 nm wavelength corresponds with a lesser absorption peak of oxyhemoglobin than that for 532 nm, resulting in slower and more uniform heating of the vessel, with greater efficacy large diameter vessels with an absence of adverse effects. In addition, there is minimal melanin absorption at the 940 nm wavelength, and thus, there is less risk of post-inflammatory change or scarring.

Given the efficacy and safety of the 940 nm wavelength in the treatment of facial telangiectasias, we recommend that this wavelength be added to the standard treatment armamentarium of laser treatments for facial vasculature.

REFERENCES

1. Silver BE, Livshots YL. Preliinary experience with the KTP/532nm laser in the treatment of facial telangiectasia. Cosmet Dermatol 1997;9:61–64.
2. Goldberg DJ, Meine JG. A comparison of four frequency-doubled Nd:YAG (532 nm) laser systems for treatment of facial telangiectases. Dermatol Surg 1999;25(6):463–467.
3. Goldman MP, Bennett RG. Treatment of telangiectasia: A review. J Am Acad Dermatol 1987;17(2 Pt 1):167–182.
4. Goldman MP, Weiss RA, Brody HJ, Coleman WP III, Fitzpatrick RE. Treatment of facial telangiectasia with sclerotherapy, laser surgery, and/or electrodesiccation: A review. J Dermatol Surg Oncol 1993;19(10):899–906.
5. Redisch W, Pelzer RH. Localized vascular dilatations of the human skin, capillary microscopy and related studies. Am Heart J 1949;37(1):106–113.
6. Anderson RR, Parrish JA. Microvasculature can be selectively damaged using dye lasers: A basic theory and experimental evidence in human skin. Lasers Surg Med 1981;1(3):263–276.
7. Anderson RR, Parrish JA. Selective photothermolysis: Precise microsurgery by selective absorption of pulsed radiation. Science 1983;220(4596):524–527.
8. Gonzalez E, Gange RW, Momtaz KT. Treatment of telangiectases and other benign vascular lesions with the 577 nm pulsed dye laser. J Am Acad Dermatol 1992;27(2 Pt 1):220–226.
9. Goldman MP, Martin DE, Fitzpatrick RE, Ruiz-Esparza J. Pulsed dye laser treatment of telangiectases with and without subtherapeutic sclerotherapy. Clinical and histologic examination in the rabbit ear vein model. J Am Acad Dermatol 1990;23(1):23–30.
10. Alora MB, Dover JS, Arndt KA. Lasers for vascular lesions. Dermatol Nurs 1999;11(2):97–102 105-7.
11. Cassuto DA, Ancona DM, Emanuelli G. Treatment of facial telangiectasias with a diode-pumped Nd:YAG laser at 532 nm. J Cutan Laser Ther 2000;2(3):141–146.
12. Clark C, Cameron H, Moseley H, Ferguson J, Ibbotson SH. Treatment of superficial cutaneous vascular lesions: Experience with the KTP 532 nm laser. Lasers Med Sci 2004; 19(1):1–5.
13. Cameron H, Ibbotson SH, Ferguson J, Dawe RD, Moseley H. A randomised, blinded, controlled study of the clinical relevance of matching pulse duration to thermal relaxation time when treating facial telangiectasia. Lasers Med Sci 2005;20:117–121.
14. Uebelhoer NS, Bogle MA, Stewart B, Arndt KA, Dover JS. A split-face comparison study of pulsed 532-nm KTP laser and 595-nm pulsed dye laser in the treatment of facial telangiectasias and diffuse telangiectatic facial erythema. Dermatol Surg 2007;33(4):441–448.
15. Carniol PJ, Price J, Olive A. Treatment of telangiectasias with the 532-nm and the 532/940-nm diode laser. Facial Plast Surg 2005;21(2):117–119.
16. Passeron T, Olivier V, Duteil L, Desruelles F, Fontas E, Ortonne JP. The new 940-nanometer diode laser: An effective treatment for leg venulectasia. J Am Acad Dermatol 2003;48(5):768–774.
17. Dudelzak J, Hussain M, Goldberg DJ. Vascular-specific laser wavelength for the treatment of facial telangiectasias. J Drugs Dermatol 2009;8(3):227–229.
18. Katugampola GA, Lanigan SW. Five years' experience of treating port wine stains with the flashlamp-pumped pulsed dye laser. Br J Dermatol 1997;137(5):750–754.