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ORIGINAL RESEARCH REPORT

Intense pulsed light for the treatment of Rosacea and Telangiectasias

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Abstract

Background: Rosacea is a chronic disease that affects the aesthetic appearance of skin. The use of intense pulsed light (IPL) has shown significant clearing in erythema, telangiectasia, and papules in rosacea. We seek parameters for IPL that will achieve optimal reduction in the appearance of rosacea with minimal adverse effects. *Objective:* To investigate the use of IPL on 102 patients at various parameters (fluence and pulse duration) in the treatment of rosacea. *Methods:* 102 patients with mild to severe rosacea were treated with IPL treatment using the NaturaLight IPL system (Focus Medical, Bethel, CT). Patients received treatments at 1–3 week intervals, with an average of 7.2 treatments. The Reveal Imager (Canfield Scientific, Fairfield, NJ) was used for photodocumentation and analyses. *Results:* Treatments were given at 2.5/5 ms double, triple, or quadruple pulsed with 20–30 ms delay time. A 530 nm filter was used with fluences varying from 10–30 J/cm^2, or 10–20 J/cm^2 with a 420 nm filter for those patients with acneiform breakouts in addition to telangiectasias. 80% of patients had reduction in redness, 78% of patients reported reduced flushing and improved skin texture, and 72% noted fewer acneiform breakouts. There were no complications or adverse effects. *Conclusion:* The use of IPL at specified parameters provides optimal therapy for the treatment of rosacea.

Key Words: *lasers and light sources, rosacea, telangiectasia*

Introduction

Rosacea is a chronic skin disease characterized by redness and episodes of flushing. It is thought to be a disease of the fair though any ethnicity can be afflicted. Disease severity ranges from mild to severe and can affect any age group, typically most severe in the 30 s to 50 s (1).

Causes of rosacea have been proposed to be vasogenic and partly neurogenic; blushing is a neurally mediated function. The vascular etiology is suggested due to minute amounts of plasma extravasated during vasodilation, which induces an inflammatory response; repeated vasodilation intensifies the inflammatory response (2). Patients with rosacea also have a defective skin barrier and may be hyperirritable (3). Dirschka and colleagues and Laquieze and colleagues demonstrated increased transepidermal water loss in the skin of patients with rosacea (4,5). Also described in the pathogenesis of rosacea, cathelicidin and serine protease activity appear to be central to the disease (3,6). Gallo and colleagues have demonstrated that elevated epidermal serine protease activity occurs in rosacea and causes the deposition of cathelicidin-derived peptides in the skin (6). These peptides have the ability to cause inflammation when injected in the skin (3).

Flushing and erythema are vascular components and represent increased numbers of erythrocytes in mildly inflamed vasculature. Chronic extravascular fluid accumulation in the superficial dermis causes damage to the lymphatic vessels and subsequent inflammatory edema (7). In addition, neutrophil elastase released at the site of inflammation degrades the extracellular matrix and Type IV collagen in the capillary walls reducing the integrity of blood vessels (8,9). Reduction in the integrity of the upper dermal connective tissue allows passive dilation of vasculature causing the telangiectatic component (10).

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The clinical presentation of rosacea is varied. Its four primary subtypes are erythematotelangiectatic (i.e. vascular), inflammatory (i.e. papulopustular), phymatous and ocular.

The earliest possible clinical stage of vascular rosacea is a recurrent blush, followed by erythema which becomes constant, and eventually telangiectasias form in some individuals (3).

A telangiectasis refers to a visibly dilated blood vessel, 0.1–1.5 mm in diameter, on the skin or mucosal surface. Facial telangiectasias can occur spontaneously, or they can be caused by excessive ultraviolet exposure, collagen vascular disease, acne rosacea, pregnancy, alcohol or estrogen ingestion, or topical corticosteroid application.

Inflammatory rosacea reflects the vasoreactivity of the individual, distinguishing rosacea papules to be a deeper red than similar papules in acne. In addition, acne rosacea is not centered around a comedo as it is in typical acne and inflammation is greatest on the central cheeks (3). Small papulopustules or large granulomatous nodules may occur (3).

Ocular rosacea is common with an incidence of ~50% in rosacea patients, as has been determined in some ophthalmologic studies (3). Symptoms range from a sensation of dryness to edema, tearing, pain, blurry vision, chalazia and corneal damage (3). Physical findings include blepharitis, meibomian impaction, keratitis, corneal neovascularization and corneal ulceration and even rupture (3).

Sebaceous hyperplasia or overgrowth of sebaceous glands may be a prominent feature in some rosacea patients. Rhinophyma, a nasal sebaceous hyperplasia, is clearly linked to the disease (3).

Several triggering factors have been implicated in the exacerbation of the condition. Among these include sun exposure, alcohol, oral contraceptive pills (OCPs) or other hormonal influences, intense emotion, wind and hot beverages. Long-term use of corticosteroids – whether topical or systemic – inevitably results in the exacerbation of rosacea.

Topical and oral medications are available for treatment of rosacea. Metronidazole for topical use and azelaic acid cream are useful in rosacea (11,12,13). Nonirritating benzoyl peroxide preparations are also useful in treating the inflammatory forms of rosacea (14).

Tetracyclines are the most commonly prescribed oral drugs for rosacea (15,16,17). Their mechanism of action is primarily anti-inflammatory in rosacea because there is no bacterial stimulus for the disease (18,19). Doxycycline in 40 mg capsules was approved by the FDA in 2006 for the treatment of inflammatory lesions (papules and pustules) of adult patients with rosacea (20). Clark described a case of a 23-year-old man who had a facial rash for 18 months that waxed and waned (21). Improvement was seen with 100 mg oral minocycline for several weeks and switching to topical metronidazole gel 0.75% (21).

The most severe forms of rosacea; inflammatory lesions and particularly refractory nodules, respond well to isotretinoin therapy (22). Topical tretinoin has been reported to be helpful over the long term (22). Isotretinoin 0.5 mg/kg per day for 20 weeks has been used with success (16). In a study by Vienne et al., daily application of a 0.05% retinaldehyde cream for 6 months was found to yield positive and statistically significant outcomes in 75% of those patients undergoing treatment (23). Specifically, improvements were found in erythema and telangiectasias, the vascular components of rosacea (23). The drawbacks of retinoic acid therapy include delayed onset of effectiveness, dry skin, erythema, burning and stinging (23).

Topical vitamin C preparations have been studied in the reduction of the erythema of rosacea (24). Daily use of an over-the-counter cosmetic 5.0% vitamin C (L-ascorbic acid) preparation was used in an observer-blinded and placebo-controlled study (24). Improvement of erythema was noted in 9 of the 12 participants. This was suggested to be due to the antioxidant effect of L-ascorbic acid against the free-radical production in the inflammatory reaction of rosacea (24).

Rosacea alters the aesthetic appearance of the skin and as a result can be devastating to individuals with this disease. Many patients reach a plateau in the improvement of rosacea with topical and oral medications and desire further mitigation of the redness. It is important to be able to optimize treatment for rosacea beyond available medications and obtain further reduction in the severity of the disease. This has been achieved with lasers and IPL therapy.

Long-Pulsed laser systems have become the mainstay of therapy to treat congenital and acquired vascular lesions. These lasers include the KTP (532 nm), long-pulse frequency-doubled Nd:YAG (1064 nm), and flashlamp-pumped pulsed dye laser (PDL) (585 nm), and are being used to treat telengiectasis (3,25,26,27). A flash lamp-pumped pulsed dye laser uses spot sizes ranging from 2–10 mm to deliver a fluence averaging 5–10 J/cm^2 (26). The use of larger spot sizes permits deeper dermal penetration and destruction of larger-caliber vessels (26). Intracutaneous hematomas leading to visible purpura that occur after pulsed dye laser are adverse effects that patients have not tolerated well and started the widespread use of IPL (IPL) for treatment of essential telangiectasias (28).

Lasers use the process of selective photothermolysis, described by Anderson and Parrish, to effectively treat rosacea and other cutaneous vascular lesions (26,27). They irradiate a target site at specific wavelengths of light of the electromagnetic spectrum (26). The target is called a chromophore, which absorbs light at a specific wavelength. Hemoglobin is the chromophore in blood vessels and absorbs light at a wavelength of 577 nm, corresponding to the

third absorption peak of oxyhemoglobin. By selecting a cutoff filter specific for the absorption wavelength of the chromophore, energy can be deposited in the blood vessels, preventing damage and subsequent scarring to the surrounding tissues (27). A cutoff filter filters light of wavelength that is below the wavelength of the filter, thereby allowing the wavelengths above to pass through. Longer wavelength cutoff filters are used to treat deeper and larger blood vessels and shorter wavelength cutoff filters are used to treat smaller-caliber vessels. Pulse duration should also be adjusted to limit damage to surrounding structures. Pulse duration must be less than or equal to the targeted thermal relaxation time of the chromophore, ie, the time necessary for the target to cool by half of its peak temperature after laser irradiation. Adverse effects are minimal and include erythema and transient purpura.

IPL uses the mechanism of photothermolysis and specific wavelengths to selectively destroy blood vessels by targeting chromophores within the vessels (27). A noncoherent pulsed light source emits light at a wavelength in the range 500–1200 nm. A cutoff filter will filter out the spectrum of light of wavelengths less than the number designated on the filter; therefore one can choose a cutoff filter that will selectively destroy tissue depending on the absorption spectra of the tissue, thereby also preventing damage to the surrounding tissue. Longer wavelengths in the visible spectra penetrate more deeply and thus can be used for telangiectasias that are situated deeper in the dermis as well as for large-caliber vessels. Lower cutoff filters (515 or 550 nm) are effective in treating smaller-caliber vessels, but interact more readily with epidermal and dermal melanin. Therefore shorter wavelength filters should be reserved for treating fair-skinned individuals (Fitzpatrick skin phototypes I–II).

Energy densities should be set appropriate to the lesion being targeted. Larger vessels require more energy to heat up and smaller vessels heat more quickly (29). Deeply situated vessels, such as in hypertrophic port-wine stains or cavernous vascular lesions, and larger vessels require higher energy densities (50–75 J/cm^2) for adequate coagulation. Smaller vessels are usually treated with fluences ranging from 25–45 J/cm^2 (26). Pulsed light is appropriate for fine telangiectasias and general redness due to surface vascularity (29). It is not appropriate for blue vessels or vessels larger than 1 mm (29).

Pulses are delivered as a train of single, double or triple pulses; each pulse lasting 2–25 ms for larger vessels and 2.5–5 ms for smaller vessels. Longer pulse widths are gentler while shorter bursts of energy produce a stronger reaction (29). Keeping the pulse duration (generally between 0.5–88.5 ms) lower than the thermal relaxation time of the target structures may spare the surrounding tissue from excess heating (27). Varying intervals between pulses range within 10–500 ms; the delay between pulses allows the non-target tissues to cool down while the heat is retained in the target of interest (27). The larger spot size with IPL may make it simpler to treat an entire face (27).

The use of single pulses is possible, and high fluences can be split into multiple pulses as well; the intervals between the individual pulses can be set at values between 1 and 300 ms. This delay allows the epidermis cells and smaller vessels to cool down between pulses while the heat is retained in the larger (target) vessels, resulting in selective thermal damage (the principle of thermokinetic selectivity) (30).

Methods

A retrospective analysis was done on 102 patients who were treated for rosacea using the NaturaLight system (Focus Medical, Bethel, CT) between 2010 and 2011. In this study we evaluated the efficacy of IPL treatment using the NaturaLight IPL system (Focus Medical, Bethel, CT) on patients with rosacea. The NaturaLight system (Focus Medical, Bethel, CT) produces an intense beam of light emitted through filtered glass in the range of wavelengths 420 nm–1200 nm. The absorbed light produces heat that thermally destroys the adjacent tissue (29).

Treatments were given at 2.5–5 ms double, triple, or quadruple pulsed with 20–30 ms delay time. A 530 nm filter was used with fluences varying from 10–30 J/cm^2 or 10–20 J/cm^2 with a 420 nm filter for those patients with acneiform breakouts in addition to telangiectasias. Spot size was 10 mm $\times$ 40 mm. Patients received treatments at 1–3 week intervals. The Reveal Imager (Canfield Scientific, Fairfield, NJ) was used for photodocumentation and analyses pretreatment and 1–3 weeks post treatment.

Initial vascular treatment settings varied according to skin type. Darker skin absorbs light more aggressively and produces faster heating of the skin (29). This absorption competes with the vasculature for light and affects the efficacy of the treatment (29). Therefore, treatment parameters were adjusted on a patient to patient basis. As the initial setting, no one was given more than 25 J/cm^2 for skin type 1, 21 J/cm^2 for skin type 2, 17 J/cm^2 for skin type 3, 13 J/cm^2 for skin type 4, and 10 J/cm^2 for skin type 5. Fluences were increased incrementally by 1 J/cm^2 at subsequent sessions and were based on efficacy, safety and tolerance of the treatment at the previous visit. The entire face was treated for all patients. The study included patients in the age range of 15 to 69 years, with 94 women and 8 men. All 102 patients in the study had redness, 42 had flushing, 35 had acne and 55 had telangiectasias (Figure 1). Eleven patients had mild rosacea, sixteen had mild to moderate rosacea, twenty-two had moderate rosacea, twenty-four had moderate to severe rosacea, and twenty-nine had severe rosacea (Figure 2). Mild

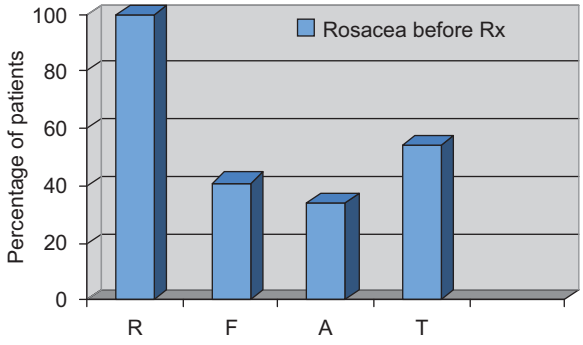

Figure 1. Percentage of patients who had redness, flushing, acne, and telangiectasia before the first treatment. R = redness, F = flushing, A = acne, T = telangiectasia.

rosacea was defined as minimal redness with no acneiform papules, and severe rosacea was defined as extreme redness with acneiform papules. Two patients had skin type 1, 42 patients had skin type 2, 47 patients had skin type 3, 9 patients had skin type 4, and 2 patients had skin type 5 by Fitzpatrick Skin Type (Figure 3).

Patients were advised on a pre-treatment and post-treatment regimen. The pre-treatment regimen involved avoidance of certain products for 2 weeks including; retinols, glycolic/salicylic acids, vitamin C, and to prevent sun exposure. The post-treatment regimen involved application of sunscreen with SPF 30 immediately after the procedure, avoidance of cosmetic products containing synthetic ingredients, mineral oils, and perfumes, and avoidance of spicy foods.

Results

80% of patients had reduction in redness by clinician assessment and photodocumentation, 78% of patients reported reduced flushing and improved skin texture, and 72% noted fewer acneiform breakouts at 1–3 weeks post treatment (Figures 4–8). Photodocumentation showed a 51% reduction in telangiectasias.

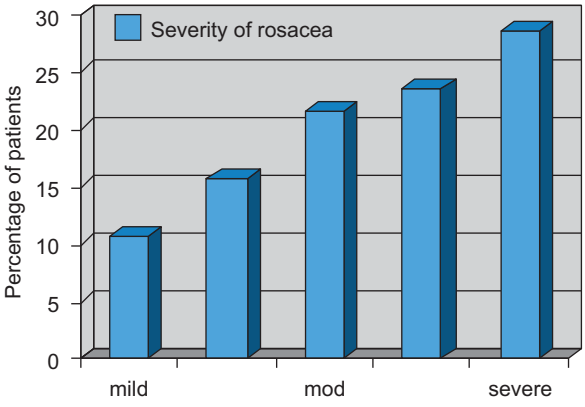

Figure 2. Percentage of patients who had mild, mild to moderate, moderate, moderate to severe, and severe rosacea before treatment.

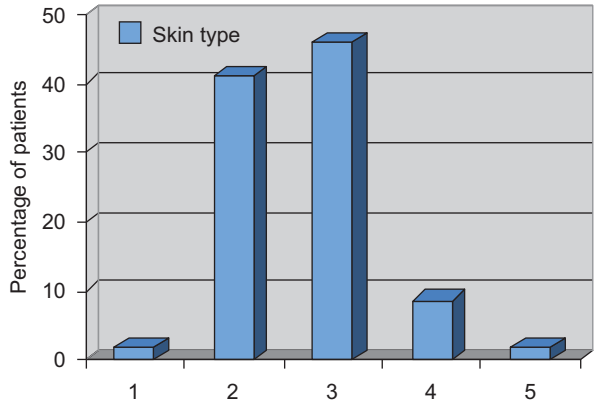

Figure 3. Percentage of patients with skin type 1–5.

There were no adverse effects in any patient, including erythema or edema. Average age of the patients was 44. The number of treatments ranged from 1–15 with 7.2 as the average. 81 patients had 10 treatments or less, and 21 patients had more than 10 treatments. Average energy used was 15 J/cm^2.

Statistical analyses

The estimated risks of the four outcomes of improvement in redness, flushing, acne or telangiectasia were determined by logistic regression analyses, and are presented as odds ratios with 95% confidence intervals. SAS version 9.2 was used for the analyses.

Increasing the number of treatments in patients with mild, moderate or severe rosacea was significant for reducing redness, flushing, acne and telangiectasia. One number increase in treatments showed 3.2 odds of improvement in redness, 1.8 odds of improvement in flushing, 4.5 odds of improvement in acne and 1.3 odds of improvement in telangiectasia. In our study, treatment intervals varied between 1 and 3 weeks for all patients and statistics showed no significant change in improvement of any factor (redness, flushing, acne and telangiectasia) by varying

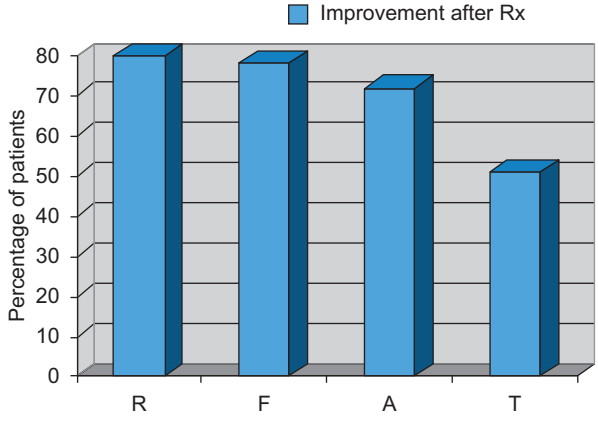

Figure 4. Percentage of patients that improved as assessed at 1–3 weeks after the last treatment. R = redness, F = flushing, A = acne, T = telangiectasia.

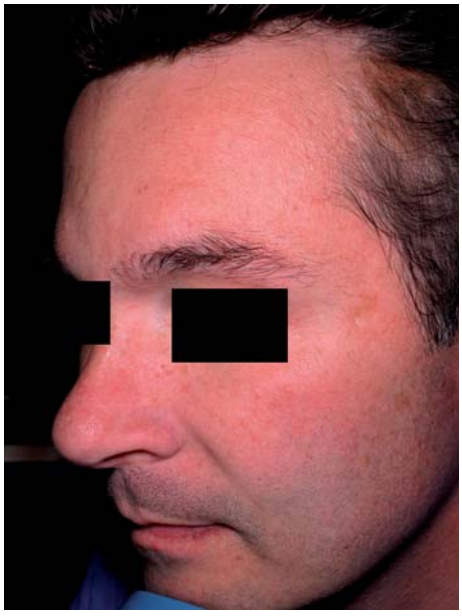

Figure 5. Pretreatment standard photograph showing redness in a patient with severe rosacea.

treatment intervals between 1 and 3 weeks. Change in pulse width by 1 ms between the range of 2.5 and 5 ms was also not significant for improvement of any factor.

Discussion

Success in the treatment of rosacea using IPL therapy has been widely documented. Schroeter et al. reported treatment of 60 patients with telangiectasia due to rosacea using PhotoDerm®VL (ESC Medical Systems, Yokneam, Israel) and Vasculight (Lumenis, Yokneam, Israel) systems. 75–87% clearance was achieved using a cut off filter of 550 nm,

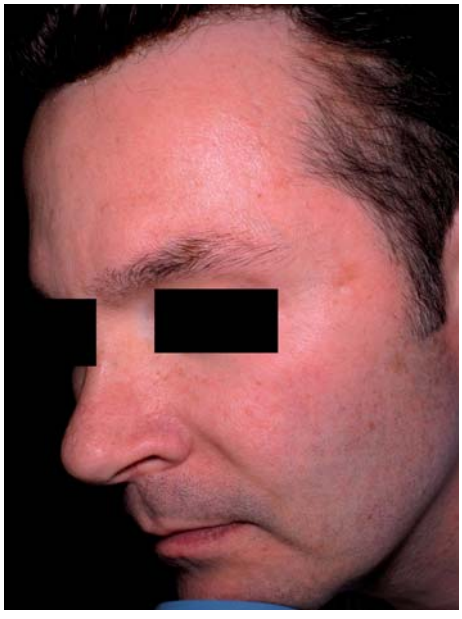

Figure 6. Post treatment standard photograph showing reduction of redness in a patient with severe rosacea.

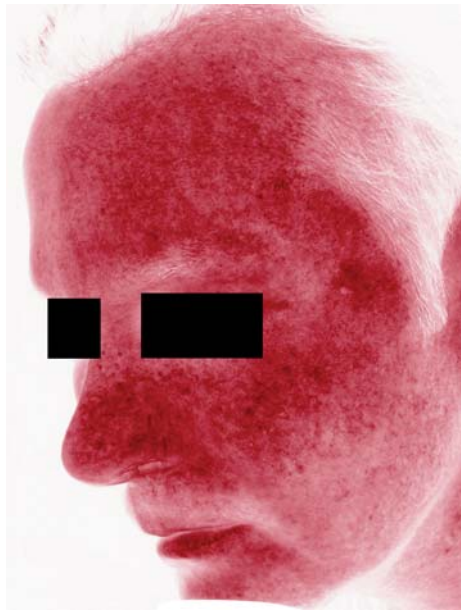

Figure 7. Pretreatment photograph by Reveal Imager (Canfield Scientific, Fairfield, NJ) showing redness in a patient with severe rosacea.

mean pulse duration of 4.8 ms, mean fluence of 30.4 J/cm^2, and an average of 4.1 treatments (31). Angermeier described a study where 153 patients with telangiectasia were treated with IPL source PhotoDerm®VL (ESC Medical Systems, Yokneam, Israel). 75–100% clearance was seen at follow up 2 months after treatment using a cutoff filter 550, 570, pulse width 2.5–6 ms, pulse delay 20–30 ms, fluences 36–45 J/cm^2, with 1–4 treatments. Three patients with rosacea experienced 75–100% clearance with 1 treatment (32). Raulin et al. reported a good to excellent clearance rate in 13–14 patients

Figure 8. Post treatment photograph by Reveal Imager (Canfield Scientific, Fairfield, NJ) showing reduction of redness in a patient with severe rosacea.

after 1–10 sessions with PhotoDerm®VL (ESC Medical Systems, Yokneam, Israel) (33).

A recent study evaluated the efficacy of IPL treatment using the Vasculite Plus IPL system (Lumenis Inc., Santa Clara, CA) on rosacea patients (27,34). It was found that 83% of patients had reduced redness, 75% noted reduced flushing and improved skin texture, and 64% noted fewer acneiform breakouts (27,34). Treatments were given at 2.4/4.0 ms double pulse with a 20 ms delay time (27,34). A 570 nm filter was used with fluences varying from 32–36 J/cm^2 or 27–32 J/cm^2 with a 560 nm filter (27,34). Patients received treatments at 3-week intervals, with an average of 3.6 treatments (27,34).

One pilot study has been done which demonstrates improvement of rosacea from an objective perspective after treatment with the Photoderm®VL (ESC Medical Systems, Yokneam, Israel) (27,35). Three components have been measured in 4 patients; reduction of blood flow, intensity of erythema, and reduction in the area of the cheek occupied by telengiectasias (27,35). Blood flow was measured using a scanning laser Doppler and it decreased by 30% (4). The study involved 4 patients treated 5 times at 3-week intervals (27,35). All were females, ages 43 to 55 years (35). Parameters of the IPL were 515-nm filter, single pulse duration of 3 ms, fluences between 22 and 25 J/cm^2 and an average of 8 to 12 pulses (35). Computer generated images from clinical photographs were able to quantify the telengiectasias and erythema (35). A 29% decrease in the telengiectasias and a 21% decrease in the erythema were detected (35).

Because of the broad-band light source with a spectrum range 420–1200 nm with IPL systems, longer wavelengths can be used to treat deeper lesions, whereas pulsed dye, argon and carbon dioxide lasers use monochromatic light and cannot be adjusted. With IPL, a larger surface area can be treated. In addition, by splitting the energy into 2, 3 or 4 pulses with different pulse delays, the skin can be cooled between pulses and thus prevent adverse effects such as burning of the skin or pigmentation changes.

In our study a 530 nm filter was chosen as oppose to a higher wavelength filter i.e. 560 nm due to increased targeting of telangiectasias in the superficial dermis, where it is also beneficial in reducing erythema. A broad filter of 420–1200 nm used in the case of acneiform breakouts associated with telangiectasias allows the heat generated by the light to degrade the oil gland located in the superficial dermis in addition to telangiectasias.

Conclusion

IPL therapy at specific parameters (pulse width 2.5–5 ms, double, triple or quadruple pulsed with 20–30 ms delay time, 530/420 nm filter, fluences in the range 10–30 J/cm^2) is a safe and effective method of treating the various components of rosacea. In order to minimize adverse effects, treatment parameters should be adjusted on a patient-to-patient basis, and varies according to skin type, severity of rosacea, and tolerance to treatment. Patients can increase the number of treatments should they desire a further reduction of redness or papules. They should also be advised to avoid triggering factors and can be followed up at the clinic should there be increase of any component of rosacea, which can be documented with photos.

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