Review Article

The Use of Intense Pulsed Light (IPL) for the Treatment of Vascular Lesions

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Abstract:

According to the English literature, various lasers and light sources (i,g. argon ion lasers, pulsed KTP lasers, diode lasers and Nd:YAG lasers, pulsed dye laser(PDL), intense pulsed light sources (IPLS) are applicable for the treatment of different vascular lesions. These conditions are the most important indication for laser therapy. This review summarizes the current literature on IPL with regard to the treatment of vascular lesions.

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Introduction

Intense pulsed light (IPL) systems use flashlamps and cut-off filters to generate pulsed polychromatic incoherent high-intensity light in a broad wavelength spectrum, (in the range of 500 to 1400 nm). Vascular lesions are clearly a key indication for IPL systems. Depending on the cut-off filter that used, treatment of superficial or deeper vascular lesions including facial telangiectasia, diffuse redness, poikiloderma of civatte, port wine stains (PWS), hemangiomas, and leg veins can be faciliated (1,2). The target chromophores are hemoglobin and its variants: oxyhemoglobin (predominantly in red type lesions), deoxyhemoglobin (predominantly in blue type lesions), and methemoglobin which absorbs light with peaks at 418, 542, and 577-595 nm. The basic mechanism of IPL system is the selective photothermolysis (1,3,4,5,6,). For the prevention of unselective injury to the peripheral environment pulse duration should be lower than the thermal relaxation time of the target structure, similar to laser devices. Indeed, it is hard to interpret the results from different studies using IPL devices, because of the variety of IPL machines, their great variability in treatment parameters and follow-up periods (3).

IPL and Telangiectasias

Telangiectasias characterized by dark red blotches that occurring in at least 15-20% of the population (1,7). They caused by permanent dilation of groups of superficial capillaries and venues, near the surface of the skin or mucosal surface (7). The most common location are on the face around the nose, cheeks, and chin that often leads to hyperpermeability and haemorrhage and cause significant problems. The Causes of cutaneous telangiectasia included: I.Genetic (Congenital neuroangiopathies, Congenital poikiloderma, Hereditary hemorrhagic telangiectasia); II.Acquired disease with a secondary cutaneous component (Collagen vascular diseases,); III.Component of a primary cutaneous disease(i.e. Rosacea, Varicose veins, Basal cell carcinoma); IV. Hormonal

(Pregnancy, Estrogen therapy); V. Physical damage (Radiodermatitis, Physical trauma). This red spidery marks can closely mimic the behaviour of benign vascular neoplasms (1,7,8).

Fodor et al. compared in a prospective side-by-side study, an IPL device (Vasculight, Lumenis, London, UK; filter: 515, 550, or 570nm, fluence: 15–38 J/cm2; pulse duration not stated) to a Nd:YAG laser with 25 participants with telangiectasias, leg veins, or cherry angiomas. More patients with telangiectasias, cherry angiomas, or leg veins (less than 1 mm) preferred IPL treatments whearas patients with leg veins(less than 1 mm) favored Nd:YAG treatment. IPL treatments were associated with lower pain scores than Nd:YAG treatments (2,9). Nymann et al. treated 13 patients with telangiectasias due to radiotherapy in a randomized split lesion trial, with a long-pulsed dye laser ((LPDL),V-beam Perfecta, Candela Corp., Wayland, MA, USA; 595nm, pulse duration: 6–20ms; fluence:6–12 J/cm2) vs. IPL (Ellipse Flex, Danish Dermatologic Development, Hoersholm, Denmark;530–750 or 555–950nm; spot size: 10 to 48 mm; pulse duration: 10–20 ms; fluence: 8–20 J/cm2) three treatments at six-week intervals. Median vessel clearances were significantly better with the LPDL (90%) than with the IPL (50%) (2,10). Another study noted the novel PDL with a compression handpiece to be superior to high fluence IPL for telangiectasias, but treatment took longer, were more painful and caused more posttreatment edema (1,11).

A recent study found, the KTP laser (Gemini; Laserscope, San Jose, CA) has a same effect in comparison with IPL (Starlux, Palomar Medical Technologies, Burlington, MA) but KTP has more side effects (edema and pain) (12). Also, Bjerring et al. evaluated the IPL system (Ellipse, Flex, Danish Dermatologic Development; 555–950nm; spot size: 10mm to 48mm; pulse duration: 10–30 milliseconds; fluence:10–26J/cm2) in 24 patients with facial telangiectasias. According to their results, 79% of patients obtained a more than 50% improvement, and clearance rates were 76–100% in 37.5% of patients. Side effects (moderate erythema and edema without scarring) were minimal and transient (13).

In another study, successful treatment of 140 patients with linear and spider facial telangiectasias with an IPL device was reported. According to their results, 67.1% of patients had excellent response (80-100%), 30.7% had good response (40–80%) and 2.1% had poor clearance (less than 40%) (2,14).When treating more than 500 patients with telangiectasias with an IPL, Clementoni et al. obtained excellent results in 87% of the patients (15). Another study suggested especially patients with progressive essential telangiectasias profit from IPL treatment (16).

IPL and leg vein

Visible leg veins are present in approximately 40% of women and 15% of men. More than 70% have a family history.they are a common cosmetic distress (17). Leg telangiectasias differ from ectatic vessels (port-wine stains or hemangiomas) in diameter of the vessel and thickness (18). For many years, sclerotherapy known as gold standard for leg telangiectasias (19).

In recent years, lasers have come to play an significant role in the treatment of this condition. Most of these laser and light devices that used are the KTP laser, the PDL, the long-pulsed alexandrite laser, and IPL devices with various filters to emit wavelengths that selectively target the oxyhemoglobin (20). The choice of wave length, energy fluence and pulse duration that are using in IPL source, is depended on the type and size of target vessels. longer wave lengths may be applied for deeper vessels and for higher diameter vessels, longer pulse duration should be used (21). Suitable condidates for laser or IPL treatment are: patients with needle phobias, primary telangiectatic matting (or secondary to sclerotherapy treatments,below the ankle veins, and patients with a history of a poor response to sclerotherapy or adverse reactions to the sclerosants (19).

After review of litertures, we found some studies that evaluated effect of IPL on the leg telangiectsias treatment. Most studies report good result of smaller vessels:

Goldman et al. demonstrated a 90% clearance rate of 159 patients with vessels of <0.2 mm diameter and of 80% in vessels of 0.2–1 mm in diameter.Overal, the incidence of adverse effects were minimal that include erythema, edema, mild burning, blistering and hypopigmentation in 1-3% (22). Also, Schroeter et al. observed similar results and reported clearance rates of 92.1, 80, and

81% in vessels of <0.2, 0.2–0.5, and 0.5–1 mm diameter in their multi-center study of 40 patients Intense pulsed light seems to be most effective for superficial, red telangiectasias less than 1 mm (23). Another study evluated effects of contact cooling on IPL treatment of 25 patients with leg telangiectasias. Contrast to the contact cooling sites, uncooled sites showed 7 were improved, 5 were unchanged, and 3 were worsened, but cooled sites showed 10 were improved, 5 were unchanged, and none were worsened (P<.05). howevere, eight noncooled sites (unchanged or worsened) were consequently treated with cooling, six of them improved (P<.001) and two with no change. Less pain and erythema and edema was noted at all cooled sites. (P<.003)(24). Also, a side-by-side study compared intense pulsed light and Nd:YAG laser in vascular lesions. Twenty-five patients with telangiectases, leg veins, or cherry angiomas treated by IPL and Nd:YAG laser in the same area. One year after completing treatment, patients were asked their satisfaction; 72% of them had good to excellent results after Nd:Yag treatment, while only 48% felt the same after IPL. Patients with telangiectases, cherry angiomas, or leg veins <1 mm were more satisfied after IPL, while those with leg veins >1 mm were more satisfied after Nd:Yag. Overall, agreement with treatment of vascular lesions was greater with Nd:Yag laser (9).

IPL and Port-wine stains

Port-wine stains (pws) are benign vascular malformations that include ectatic blood vessels within the dermis (25). In contrast to hemangiomas, pws are localized defects of vascular morphogenesis, probably caused by disturbance in embryogenesis (26). They are present at birth and occur similarly in boys and girls, with a prevalence of 0.3% to 0.5% in the general population (25). PWS are commonly located on the face and neck (83%) but can essentially affect any part of the body and do not resolve spontaneously. The lesion tends to grow over time (19). In addition, enlagement of others structures such as the lips, gingivae and tongue can occure that may lead to face dysmorphism. PWS are also associated with some syndromes such as Sturge-Weber and Klippel-Trenaunay syndromes. The heterogeneous nature of these lesions may explain their variable response to thraputic modalitiese such as laser therapy. The pulsed dye laser has been the choice of treatment for port wine stains over the past 20 years (27). Moreover, about 20% of PWS are resistant to this treatment; especially lesions in adult patients with darker skin types (28,29,30,31,32). Therefore, try to improvement of PWS treatment methods is highly attractive.

In the past 5 years there has been increasing studies on the role of intense pulsed light system (IPL) in the treatment of port wine stains (27). Avoiding the common side effect of purpura of PDL treatment and using larger spot sizes, IPLS is increasingly used for vascular indications, including PWS treatment (27,33,34).

Philipp babilas et al, in a recent study evaluatd the efficacy of IPL treatment of PWS in contrast to the short pulsed dye laser (SPDL) and the long-pulsed dye laser (LPDL). Eleven patients with previously untreated PWS and 14 patients who had been previously treated with laser were included in this study. In previously untreated PWS, a single IPL device (555–950 nm; spot size: 10mm_48mm; pulse duration: 8–14 milliseconds; fluence: 11.0–17.3 J/cm2) or LPDL treatment induced an average clearance rate of 25–50%; a single SPDL treatment induced an average clearance rate of <25%. IPL treatments were rated significantly (P<0.05) better than treatments with the SPDL (3).

Other articles also provide data from controlled side by- side comparisons of IPL and the standard therapy, the dye laser(PDL). Faurschou et al, in recent study, treated 20 patients with PWS in a equal trial with a pulsed dye laser (PDL) Versus IPL (StarLux, Palomar Medical Technologies; pulse duration: 5–10 milliseconds, fluence: 7–14 J/cm2). They found that both PDL and IPL significantly lightened PWS, whereas median clinical improvements were significantly better with the PDL (65%) than with the IPL (30%) (35). On the other hands, another study in 2008, compared two different treatment options (IPLS and PDL) in pws. Each PWS was divided into equally two red areas. One hundred patients (69 females, 31 males, aged 0.1–74.2 years) with 130 PWS areas included in this study. Sixty-four percent of the patients had not been treated before. Superior clearing of PWS by IPLS was found in 57.7%

of the treated areas and this result is statistically significant (P=0.0005), whereas superior clearing of PDL was found to be 13.8% (36).

A retrospective study was performed by Raulin et al, to assess the efficacy of intense pulsed light in the treatment of port wine stains. A total of 37 patients with 40 port wine stains were assessd. 70% of patients were able to achieve good to complete clearing. They concluded that intense pulsed light is an effective and safe method for treating port wine stains especially purple port wine stains (34).

Bjerring P et al, evaluated a second generation IPL system (Ellipse Flex, Danish Dermatologic Development; lem¼555– 950 nm; spot size: 10mm_ 48mm; pulse duration: 8– 30 milliseconds; fluence: 13–22 J/cm2) for treatment of Fifteen PWS patients, who were found to be resistant to multiple PDL therapy in the past. According to their results, 46.7% of patients were responders to IPL treatments and others were non-responders (53.3%). All responders obtained more than 50% reduction in lesion. All PWS, except those located in the V2 area of the face, responded to the treatments. They found the IPL treatment modality is safe and efficient for the treatment of PWS, except for those located in the V2 area (37).

Another study that obtained the same results is trial of Ho WS et al. Twenty-two Chinese patients(17 female and 5 male) with port wine stains treated by intense pulsed light system for five to seven times at intervals of 3 to 4 weeks. More than 90% of patients had more than 25% of clearing and the most of patients (50%) had 25% to 50% of response. Although 40% of the patients showed more than 50% clinical clearance, only 9% of the patients were able to achieve more than 75% clearing (33).

McGill et al. compared a pulsed dye, an alexandrite, a KTP, and a Nd:YAG laser as well as an IPL device (Lumina, Lynton Lasers, Cheshire, UK; lem=550–1,100 nm; spot size: 10mm_10mm, fluence: 28–34 J/cm2, double pulsed 10 milliseconds delay) in eighteen previously PDL-treated patients with PWS. In this study, the alexandrite laser was the most successful. IPL resulted in PWS vanishing in six patients, the KTP and Nd:YAG lasers were the least effective (38).

The results of a 3-year prospective controlled clinical trial study (with using an intense pulsed light system called the Lumina) showed that eight of the 12 subjects had some degree of fading in their port wine stains. All of the 4 patient who do not show any response, had pink port wine stains. In addition, the more distal lesions from head area tended to be less responsive (27).

IPL and Hemangiomas

Hemangiomas are the most common soft tissue tumors in infancy with an overall incidence of 10-12% by the first year of life. Actually they are benign endothelial cell neoplasms which are absent in the first few weeks of life or present as precursor lesions.They are more common in girls, premature infants, and infants of mothers who underwent post chorionic vellus sampling (19,39).

The precursor lesion is commonly as a telangectasia surrounded by a border of pallor, pink macules, and patches with a blue bruise like hue. The deeper the lesion the more blue hue we see. Superficial hemangioms are the most common type which composes 50-60% of the cases mixed or combined superficial and deep hemangiomas are seen in 25-35% of cases. Deep hemangiomas make up 15%of cases (19,40).

The lesions usually begin to involute in the first year of life and continue this phase for several years. 60% of them will regress by 6 years of life. The color changes form a deep red to gray purple color and the surface flattens. The mass becomes less firm as it involutes. Some hemangiomas resolve completely while others may leave an atrophic, telangectatic, fibro fatty appearance (19).

The most common complication is ulceration which occurs in 10% of the infantile hemangiomas. Other complications may depend on the size and location and the associated anomalies of the hemangiomas.The approach ‘active-non intervention’ is the best approach to many hemangiomas which means intermittent follow ups and watching and explaining the condition to parents. There are different treatments for life or function threatening hemangiomas like corticosteroid therapy as systemic,topical or intra lesional forms, topical 5% imiquimod topical, interferon 2a 2b, vincristin,etc (19).

Laser therapy including the PDL,Nd:YAG, alexandrite, IPL, and KTP-based platforms seems to be the most effective method especially on the

superficial lesions.PDL is the most effectively used device and the treatment of choice for the superficial lesions but does not change the growth pattern of deep hemangiomas. It also has complications like cutaneous atrophy, hypo pigmentation, ulcer and scarring. Also, PDL is the treatment of choice for telangectatic residues after the resolution of hemangiomas (1,41).

Because of the wide range of wavelengths and pulse durations, IPL has affect on both superficial and deep vascular lesions (47). The system operates by selective photothermolysis. It supplies sufficient energy in order to raise the temperature of the blood vessel to induce coagulation without causing damage to the healthy tissue that surrounds it (43).

There is no post treatment purpura, but there is greater risk of pigmentary changes, blistering and scarring,especially if the practitioner is not experienced enough. Also often a short lived erythema is noticed (44). The physician selects the appropriate parameters in order to treat vessels of different size which are located in different depths (43).

Several studies have been done on the use of IPL in the treatment of hemangiomas. In 1998 Marla C Angermeier studied 200 patients with different vascular lesions with IPL who 45 cases of them had facial hemangiomas. She treated the hemangiomas with triple pulses using 550, 570 and 590nm filters depending on the depth of the lesions. The highest filter was first used and then depending on the clinical response a lower filter or filters were used during the same session. The response was optimal when coagulation or persistent blanching of the lesion occurred. The energy influence was usually 50-60 j/cm2 with pulses of 3.8, 3.1 and 2.5 or 2.4, 3.8, and 4.2 ms and interpulse delay time of 20 to 30ms. After 2 months the patients returned for follow up. The rate of clearance was assessed via pre and post photography. Most single vascular lesions like small hemangiomas resolved completely after a single treatment. The results did not correlate with skin type or extent of the facial lesions. Younger patients needed fewer treatment sessions. She reported these side effects following the procedure: 1-edema more than 2 days, 2- transient hypo pigmentation which resolved within 4 months. Scarring was not observed (43).

In another study in 2010 Dong-Ni Li et al used IPL with optimal pulse technology on 62 patients with infantile hemangiomas with a mean age of 6 months and skin types 3to 4 according to Fitzpatrick skin types. 4-5 IPL treatments with 4 weeks interval were done and the patients were assessed 3 months post IPL treatments. Pre and post photographs were taken and compared. 76%of the infantile hemangiomas improved and more than 80% cleared. The procedure had less than 5% side effects which were transient. There were no scarring or pigmentary changes in the patients who underwent this procedure (45).

Over all because of the wide range of wavelengths in the IPL technology, it is becoming an alternative for laser treatment but it is greatly dependent on the experience of the practitioner. In order to keep the adverse effects minimal, proper patient selection and diagnosis should be done (46).

IPL and Poikiloderma of civatte

Poikiloderma of civatte is a clinical manifestation of photo aging which presents as a reticulated patch, red to red brown in color with telangectasia which spares the perifollicular lesion. Commonly the lateral aspect of the neck, lateral cheeks and the upper chest are affected with sparing of the sub mental area. It usually occurs in fair skinned middle aged individuals. Mild atrophy and hyper pigmentations are sometimes seen. In pathology telangectasia, irregular hyper pigmentation and dermal atrophy of the basal layer is seen (42).

There are few studies on the treatment of poikiloderma of civatte with an IPL source. Although effective treatment of poikiloderma of civatte is difficult due to the existence of vascular and pigmented components, IPL with its wide range of wavelengths seems to be a good device which permits treatment of the both components simultaneously.

In a study done by Goldman and Weiss in 2000, 135 patients with poikiloderma of civatte on the neck or upper chest were treated with IPL, in 1-5 sessions. The parameters used were a 515 nm filter with pulse durations between 2 to 4ms in the first session and then using a 550-570nm filter with a delay time of 10ms and a double pulse mode of 2-4ms in the final session. They had clearance of more than 75% of the lesions (the hyper pigmentation and telangectasia) in more

than 82% of the patients and also improvement in skin texture. Less than 5% side effects including pigment changes occurred (47).

Goldman and Weiss also studied 66 patients with typical changes of poikiloderma of civatte on the neck in 2001. They underwent IPL treatment sessions at various settings every 4 weeks until the desired improvement occurred. The extent of the telangectasia and hyper pigmentation reduced 50-70% after a mean 2.8 sessions of treatment. Hypo pigmentation occurred in 5% of the cases. They concluded that the IPL is an effective method due to the resulting appearance and the minimal side effects it has (48)

Also in 2008 Rusciani et al studied 175 patients with poikiloderma of civatte of the neck and chest treated with various IPL settings. The patients had an average of 49 years of age. They were treated with IPL three sessions every three weeks and were visited 3 months after the last sessions as follow up. A cutoff filter of 550 nm was used in the first visit, with fluences ranged between 32-36 j/cm^2. Energy was delivered in pulse durations between 2.5 to 3.5 ms with pulse delay of 10 to 20 ms. Cut off filters of 515and 590 nm were used after to affect the superficial and deep components of the hemangiomas. The pulse times used were ranged between 2.5 and 4.5ms, delay time of 10 to 30ms and fluences ranging between 33-38 j/cm^2. 80% of the vascular and the pigmented components were cleared. Less tan 5%of the individuals had side effects which were minimal and transient. None of them had scarring or pigmentary changes (6).

Overall IPL can be considered a safe and effective therapy for poikiloderma of civatte due to its wide range of wave lengths which allows treating both the pigmentation and the telangectasia at the same time.

Miscellaneous

Data from the previous literature have demonstrated the theraputic role of IPL in the treatment of many other vascular lesions such as spider nevi (3,16,19,49,50), angioma (51,52,53),poikiloderma of civatte (19,46,47,48), extra-truncular venous malformations (19,54), angiokeratoma (3,55). There are many lesions that have a vascular component making them responsible to successful treatment with IPL with or without PDT, such as non-melanoma skin cancers, actinic keratosis or superficial basal cell carcinomas (2,56,57). Also, there are evidences for successful treatment of erythrosis (2,3,67,68), rosacea (3,60,61), and acne (3,62,63,64,65,66,67) by IPL with minimal side effects.

Advantages and Disadvantages of IPL

Depending on the combination of particular wavelengths, pulse durations, pulse intervals, and fluences, the wide spectrum of various cosmetic procedures can be treated with IPL devices (1,2,19). Patient's rapid recovery time is one of the greatest advantages of IPL treatment (5). Further advantages to lasers are lower purchase price, large spot size, high skin coverage rate, high versatility, robust technology (1,2,3). More covered area and more uniform light penetration is achived by selection of the bigger the spot size. Small-sized red eruption have better response to shorter wavelengths (5).

However,the main disadvantage of intense pulsed light is the lack of adequate skin cooling that can lead to a higher risk of complications in dark-skinned patients, if not used correctly. On the other hand, the great range of selectable parameter highlights the risk of adverse events because of nonspecific thermal damage, especially for untrained physicians and even more, for having "technicians" operate these devices at high fluences (1,2,3). Other disadvantages of IPL can included inconsistence of emitted spectrum and fluence,the heavy weight of handpiece, large spot size, light cannot be focused, gel application required (hampers the observation of immediate local response) and direct contact of handpiece to the skin required (3). Pain and transient erythema are the most complications reported (3,5). Other rare complications included: blistering, purpura, crusting, hypopigmentation, hyperpigmentation, atrophia, scarring, hypertrophic scarring, or keloid formation, and infection (68,69).

Conclusion

In summary, numerous comparative trials affirm IPLs similar even more effectiveness and compatibility to lasers with rare adverse events. But it is important to keep in mind that choose of the best option is essential for patient to benefit

from this important treatment modality (5). A higher patient satisfaction rate and fewer complications may influenced by proper selection of patients, laser parameters,treatment intervals, cooling systems, and avoiding sun exposure between treatments (5). Today, good results of IPL for vascular lesions has been widely accepted and among a wide variety of these lesions, cherry angiomas and reticular and teleangiectatic veins had the best response to IPL (5). Selection of proper bandpass filters is defined by the patient's skin type and the existing skin condition. More caution to detail should be made when treating darker patients, especially with the newer high-powered devices (1).

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