



Intense Pulsed Light (IPL) from Dermatology to Ophthalmology

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Article Info

Article Notes

Received: August 20, 2021

Accepted: October 06, 2021

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Abstract

Intense pulsed light (IPL) are medical-esthetical procedures that emit light at a wavelength of 500 – 1200 nm, interacting with epidermal and dermal tissues. IPL is a relatively new treatment of growing popularity thanks to its versatility and efficacy, mainly in dermatology and recently also in ophthalmology. These devices are used to treat dry eye disease, meibomian gland dysfunction, rosacea, and periocular lesions with outstanding results.

Review

Intense pulsed light (IPL) therapy emits light that is converted to heat-inducing ablation applied to vascular structures. This process of photothermolysis selectively destroys blood vessels and has been used for the destruction of telangiectasias. Other mechanisms of action include mild local warming that has been used to decrease inflammation¹.

IPL emits pulsed light at a 500 – 1200 nm wavelength. Longer wavelengths (1000 nm) penetrate more deeply and can be used for telangiectasias situated deeper in the dermis and large vessels. Lower cut off filters (500 to 600 nm) effectively treat smaller calibre vessels but interact more readily with epidermal and dermal melanin¹. The micro pulses allow the epidermis cells and smaller vessels to cool down between pulses. At the same time, the heat is retained in the larger vessels, resulting in selective thermal damage².

IPL is used to treat facial skin damage, including wrinkles, coarseness, laxity, and dyspigmentation³ because it increases collagen synthesis⁴. IPL is used in rosacea because it ablates the abnormal vessels (erythema and telangiectasia) and improves the dermal connective tissue disorganization and elastosis by collagen remodelling⁵.

Over the past 20 years, there has been rapid development and proliferation of the technology, with application in multiple fields of medicine, mainly for Dermatology⁶⁻⁹. The first IPL device obtained regulatory approval from the Food and Drug Administration (FDA) in the USA in 1995 for treating lower extremity telangiectasias¹⁰. These devices were first developed to treat benign vascular lesions¹¹. In 1997, Raulin *et al* successfully treated patients with telangiectasias of the face and legs and published cases of permanent hair removal supporting the efficacy and safety of this technique¹¹⁻¹³. Since then, the systems have proliferated thanks to their low cost and versatility in various conditions^{8-9, 14-15}. Several studies also show the effectiveness of the IPL in treating symptoms associated with skin ageing, and hyperpigmentation, getting the remodelling of the dermis¹⁶⁻¹⁸.

In 2003, Mark *et al* published data that supported the use of IPL to reduce the blood flow and resolve telangiectasia and erythema associated with rosacea¹⁹. Many studies have pointed to the efficacy and applicability of IPL, confirming similar or superior efficacy compared to laser systems¹¹ versatility (they act on different chromophores, as melanin, and haemoglobin), safety, and reasonable costs¹¹. Also current IPL devices have calibration systems, integrated cooling, and tuning resulting versatile. IPL devices are very popular in many medical offices^{11,15,20-22}.

Rosacea

Ocular rosacea is estimated to occur in up to three-quarters of patients with rosacea. It frequently produces a foreign-body sensation, dryness, burning, itching, redness, photophobia, tearing, and blurred vision²³. There are many treatment options for rosacea, including IPL. IPL benefits rosacea, improving the dysfunction of the meibomian glands, clearing telangiectasia, and reducing erythema. IPL emits polychromatic light in millisecond pulse duration for delivering selective energy to target blood vessels, which is essential for rosacea treatment^{1,17,24}. In addition, a local increase in the temperature during the treatment affects the blood flow in the treated area and improves metabolism¹⁸⁻¹⁹. As a result, residues of tissue catabolism products are removed, which may also indirectly influence the reduction of oedema or bags under the eyes¹⁸⁻¹⁹.

Dry Eye

IPL is being used to treat dry eye disease (DED) related to meibomian gland dysfunction (MGD), one of the options. MGD is the leading cause of evaporative dry eye, and when DED and MGD occur as comorbidities increase disease severity and have a significant adverse impact on patients' life quality²⁰⁻²². In 2009, Toyos treated patients with rosacea with IPL, improving their dry eye symptoms^{25,26}. This discovery has led to the commercial development and promotion of IPL devices that are specific for dry eye treatment. Currently, the two main devices are the M22 Optima device (Lumenis Ltd, US) and the E>Eye device (E-Swin, France)²⁷. The mechanisms of IPL in DED⁹ can be related to 1) improving the inflammatory state of the ocular surface and the meibomian glands, 2) neurotrophic effect, improving the state of the cornea by acting on the parasympathetic nerve fibers, 3) thrombotic effect on the micro vascularization of the eyelids, reducing the presence of telangiectasias, 4) photomodulatory effect based on fibroblasts regeneration and collagen synthesis and, 5) antimicrobial effect by acting directly on Demodex or indirectly as a vector on bacterial proliferation especially *Bacillus Olerinus*²⁸⁻³².

For the treatment of MGD, IPL is applied to multiple locations (typically six) across the face, under the inferior eyelids, nasally and temporally. Typically, three or four

IPL sessions are applied over approximately three to four months. The results are promising, decreasing DED symptomatology and clinical signs by approximately 90%^{26,33,34}; nevertheless, evidence is scarce for few clinical trials³⁶. IPL is safe and does not damage eye structures; the biggest concern is the local effect on the skin³⁶.

IPL indication to treat depends on the individual's skin pigmentation level. The Fitzpatrick Skin Types classification is commonly used, measuring the skin's tolerance to sunlight and its tendency to tan or burn³⁶⁻³⁹. There are six Fitzpatrick Skin Types, ranging from I (very fair skin, which always burns and never tans) to VI (black skin).

Traditionally, people with darker skin tones (types V to VI) were not good candidates for IPL due to risks of inducing hypopigmentation and scarring³⁷⁻³⁹. Fortunately, this problem is beginning to be solved with a new system, Thermaeye Plus. Thermaeye Plus combines the distribution of micropulses and each pulse's energy and time parameters, making it possible to treat all types of patients, even with highly pigmented grade VI skin, as has been published in patients with DED and MGD^{33,34,40}. This device is highly adaptable, using different and interchangeable filters, including a 650nm filter, for treating MGD in all skin types, a 520nm filter to treat the Demodex more efficiently, and an 800nm filter to treat vascular lesions (telangiectasias) and also to stimulate the production of new collagen, improving the tone, texture, and luminosity of the skin giving a lifting effect to treat wrinkles in the periocular structures⁴⁰.

In conclusion, IPL therapy is clinically effective and safe with great results as a non-invasive technique^{11,40,41}. Today, IPL is one of the new treatments for dry eye disease (DED) and meibomian gland dysfunction (MGD), showing great results. We believe that the research will continue to advance to clarify the mechanism of action of IPL better and help us improve the technology adapting it to its use in Dermatology and Ophthalmology. We will improve the results, surely combining it with other therapies such as artificial tears, anti-inflammatories, eyelid massage or even new technologies such as Radiofrequency^{42,43}.

Conflict of interest Disclosures

C. Verges is a consultant to MDS. The authors have no other relevant affiliations or financial involvement with any organization or entity with a financial interest in or financial conflict.

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