

Side Effects and Complications Using Intense Pulsed Light Sources

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Introduction

Lasers have been well known in dermatologic applications for about 50 years - in contrast to flash lamps, also called intense pulsed light sources (IPL), which have been available for clinical applications for less than 20 years.

There are many differences between lasers and IPL. A laser emits monochromatic light whereas an IPL emits a whole range of wavelengths between approximately 250 nm and 1200 nm. Cut-off-filters reduce this range and enable the treatment of different skin conditions. Water is used as cooling agent for the flashlamp and also as a filter in the infrared range where most of the light is emitted in. As there is an emission of a wide spectrum of wavelengths that are not absorbed by the chromophores of skin, unspecific heating of the surrounding tissue occurs when using therapeutic energy densities.

Flash lamps are applied for a variety of indications, such as hair removal, treatment of vascular and pigmented lesions and photo-rejuvenation. All these treatments can be performed with one device by changing the cut-off-filters. However, the therapeutic range of energy is rather small and therefore, negative side effects such as burns, blisters, vesicles, erosions and crust formation, as well as hypo- and hyperpigmentations are common.

All precautions pertaining to laser treatment of the skin have to be observed with flash lamp applications as well. Particularly, a clear diagnosis has to be established before treatment and if treatment is performed by non-medical staff, it has to be supervised by a physician.



Hypopigmentation following treatment in sun tanned skin

Methods

The first IPL was called "Photoderm™" and was developed around 1985. The most commonly used flash lamps are xenon-chloride lamps. These flash lamps produce a very short, intense, incoherent, full-spectrum white light impulse. The lamp is comprised of a sealed tube, often made of fused quartz, which is filled with a mixture of gases, primarily xenon, while electrons carry the electrical current to the gas mixture. A high voltage power source, usually a capacitor, is necessary to energize this gas mixture.

A flash is initiated by first ionizing the gas mixture with high voltage and then an intense pulse of current is sent through the tube. Ionization is necessary to decrease the resistance of the gas so that a pulse of thousands of amperes can travel through the tube. When the trigger pulse is applied, the gas becomes ionized and the capacitor immediately discharges into the tube. When this pulse travels through the tube, it excites electrons surrounding the xenon atoms elevating them to higher energy levels. The electrons immediately drop back to a lower energy level producing photons in the process.

Conclusions

The principle of selective photothermolysis and specific absorption abilities of chromophores in the skin allow minimizing negative side effects and also predicting the effects of laser radiation (1). Also for IPL, it is necessary to be aware of interactions between tissue and radiation to achieve good results with the least possible side effects. The most important factors are the absorption spectra of the cutaneous chromophores: melanin, hemoglobin and water.

Chromophore wavelengths

- Melanin 400 – 700 nm, declining absorption in higher wavelengths
- Hemoglobin maximum in 410 nm, 500 – 600 nm
- Water < 230 nm and > 2,800 nm

As there are overlaps in the absorption spectra of melanin and hemoglobin, targeting one specific chromophore is not possible.

Unspecific heating of epidermal melanin causes most side effects

- Burns with blister formation
- Crusts
- Postinflammatory hyperpigmentation
- Vesicles
- Erosions
- Potential infection
- Depilation
- Hypopigmentation
- Scars and keloids

Unfortunately there are only few publications dealing with the potential risk factors for side effects in treatment with IPL in contrast to lasers.

Greve et. al. (9) assess the increasing number of treatments that are performed in cosmetic and aesthetic dermatology. The potential earnings are high and therefore inexperienced physicians and beauticians buy IPL devices. There are various reasons for malpractice: deficient training, lack of documentation, inadequate and inexact information of patients, incorrect determination of indications and diagnoses, failure to perform test treatments and incorrect operation of IPL. Thus new rules and regulations are necessary to minimize treatment errors. Also, dermatological training is recommended additionally to a laser or IPL specific training before acquiring permission for cosmetic treatments, as tumors can often be found on sun damaged skin that require adequate treatment. The base for IPL treatment is the right diagnosis.

Drosner et. al. state in their guidelines for laser- or flashlamp- assisted hair removal that both devices are well tolerated and effective for this indication. However, as these devices are very popular, both practitioners and patients need to be careful to avoid permanent negative side effects instead of the desired permanent hair reduction. The ideal patient for laser hair removal is fair skinned with black coarse hair (10). Individuals with dark skin, and especially tanned patients, are at higher risk for pigmentary changes and side effects. Pre-, parallel and post-treatment cooling, as well as a reduction of the fluence, can prevent adverse effects such as pigment alteration and scar formation.

Summary

IPL offers various settings and therefore allows for the treatment of a broad range of skin conditions, however not quite as broad as lasers. In developing new IPL technology – at the moment the third generation is on the market – treatment options are expanding. Compared to lasers the use of IPL requires greater caution as the risk of side effects is greater while the therapeutic range is much smaller.

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Treatment with excessively high energy density, followed by the development of crusts and vesicles



Several weeks after treatment – there are still hyperpigmentations and scar s



Erosions after treatment with excessively high energy density



Hypopigmentation after treatment with IPL

Scar formation after treatment with IPL

Crusts