Lasers for the treatment of rosacea

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Abstract

Rosacea is a very common dermatosis, which affects almost 6% of the general adult population, and is characterized by the appearance of flushing, telangiectasias, stinging, papules, and pustules. Due to the heterogeneity of clinical appearances, there are many therapeutical modalities that can be applied. In the last decades, the mainstream of rosacea therapy consists of the use of highly selective laser systems. The objective of this review paper is to access the efficacy and safety of different light sources and lasers in treating rosacea.

Introduction

Rosacea is a chronic, inflammatory disorder that includes abnormal cutaneous innate immune responses and neurovascular dysregulation (1). Clinical features varied, with key components being frequent facial redness and inflammatory lesions (2). Increased reactivity of blood vessels leads to transient erythema and flushing, and persistent centrofacial erythema and telangiectasia (3). Inflammatory response induces papulopustular, phymatous changes, and ocular inflammation. Chronic inflammation may present in the thickening of areas such as the nose, ears, and cheeks, as the result of oedema, sebaceous hyperplasia, and fibrosis. In the granulomatous variant, more monomorphous, persistent skin-colored to dull red-brown facial papules are seen (4).

Rosacea is a very common dermatosis, first appearing during middle age, more often in lighter skin phototypes individuals (5). In the

systematic review, L. Gether, et all. found that 5,46% of the adult general population is affected by rosacea, with no prevalence between men and women (6). Since rosacea is chronic, facial dermatosis with such high incidence, it represents a big psychological and sociological burden on the patients (7).

Several different, but interrelated, pathological mechanisms have been proposed in rosacea. Along with genetic predisposition that plays a significant role in the pathogenesis of rosacea, environmental triggers are considered as important contributing factors, like ultraviolet light and other factors (e.g., spicy food, heat, alcohol, dome medication, etc.) (8). Additional important pathomechanisms of rosacea imply skin barrier dysfunction and penetration of sensory irritants, as well as greater follicular infestation with commensal microbes Demodex mites (folliculorum and brevis), associated with an intense perifollicular inflammatory infiltrate (9, 10). Furthermore, several clinical features of rosacea (including transient erythema, persistent centrofacial erythema, telangiectasias, and flushing) indicate the important role of the vascular system dysregulation in its pathogenesis, like increase angiogenesis and blood flow (11).

Considering the heterogeneity of skin changes and clinical manifestations, that is pathognomonic for rosacea, many therapeutical options can be applied in the treatment, such as regular skincare regiments, a local and oral antibiotic, different anti-inflammatory and anti-parasite treatments, isotretinoin, etc. (12). Usually, the inflammation (papules and pustules) responds well at the local or oral medical therapies. On the other hand, vascular disturbance presented as erythema, telangiectasias and a rhinophyma, are very persistent and commonly require additional physical modalities, such as laser treatments (13). Vascular laser therapy represents the main therapeutic option for rosacea with dominantly erythematotelangiectatic skin presentation, along with topical $_1$adrenoreceptor agonists, electrocautery, and radiofrequency (13).

The use of lasers in dermatology has in general increased in the last decades. The name LASER is an acronym that stands for Light Amplification of Stimulated Emission of Radiation, which describes the process of light generation (14). The foundation of laser-tissue interaction is defined mainly by the theory of selective photothermolysis, which was first introduced by Anderson and Perish in 1983 (15, 16). In their study, it has been shown that selective heating of target tissue can be achieved by an appropriate choice of laser wavelength and pulse duration, which allows heating of the target cells, but not the surrounding tissue. The desired effect only occurs when light is absorbed by a target chromatophore (i.e., hemoglobin, water, melanin), converting light to heat. Theory of selective photothermolysis made possible the development of different selective tissue lasers.

There are several types of light sources and non-ablative lasers that can be used for erythema and telangiectasias in rosacea, the ones with the most success are: pulse dye laser (PDL), Long pulse Neodymium:Yttrium-Aluminum-Garnet (Nd:YAG), Intense pulsed light (IPL), Potassium-titanyl-phosphate (KTP). In treating changes that are the result of hyperplasia and fibrosis, good results have been achieved in using ablative lasers (CO2 laser) (17).

Material and Methods

In our research, we have focused on the following electronic databases - Science Direct and PubMed/MEDLINE for published articles. Furthermore, we have included reference lists of different articles on which we focused. Databases were limited to the period 2000–2020, but studies that represent a turning point in the application of lasers in dermatology and surgery were also included in the research process (papers from 1981, 1983, and 1996). Only studies in English were included. The following search terms were used to generate the data: Rosacea laser treatment, Effectiveness Safety, Undesirable effects, Pulse dye Lasers (PDL), Long pulse Neodymium:Yttrium-Aluminum-Garnet (Nd:YAG) Laser, Intense pulsed light (IPL), Potassium-titanyl-phosphate (KTP), CO2 laser.

Results

Pulse dye Lasers

Pulse dye Lasers (PDL) are the most usually implemented lasers for treating rosacea, and there are over 500 clinical articles supporting its efficiency and safety in treating rosacea (18). PDL emit a wavelength of 585nm and 595nm and targets hemoglobin as chromatophore, which provokes conduction of heat from erythrocytes inside the lumen to the entire wall of the blood vessel, and so it causes complete coagulation in superficial dermal vessels (19).

It has been shown that usage of a 5- or 7-mm spot size, fluences between 5 and 7 J/cm2, and pulse duration of 0.45 milliseconds, produce good to an excellent reduction in telangiectasia, erythema, and overall appearance as well as a decrease in papules and pustules (20). It has been noticed that treating rosacea with PDL also leads to decreasing or total absence of Demodex mites in hair follicles, which could explain the clinical improvement in presence of papules and pustules in rosacea patients (21, 22). Also, it has been shown that treating rosacea with PDL causes a decrease in nerve fiber density and the number of substance P immunoreactive nerve fibers, which helps in improving rosacea stinging condition (23). Side effects reported in PDL treatment include edema, erythema, purpura, and pain, but were all defined as transient and mild (24, 25).

Many studies have shown that treating rosacea with PDL is safe and effective, and some authors are considering it as a gold standard for rosacea laser treatments (20).

Long pulse Neodymium:Yttrium-Aluminum-Garnet (Nd:YAG) Laser

This laser type emits wavelengths of 1064nm and has 3-5 times greater absorption of methemoglobin than oxyhemoglobin (26). Pulse durations for the long-pulsed Nd:YAG may range up to 300 milliseconds and the fluences up to 900 J/cm2 (27). Spot sizes range from 3 to 10 mm. The mechanism of action is based on the theory of selective phototermolysis, which explains how the laser energy leads to local vascular necrosis, and collagen destruction, and at the same time sparing the surrounding tissue (28). Although PDL has greater absorption for haemoglobin than Nd:YAG laser, the long pulse of Nd:YAG allows deeper penetration and so treating deeper and larger caliber telangiectasias (29). Nd:YAG laser shows some affinity to local melanin which helps in conducting the heat and local destruction of blood vessels, but also increases the possibility

of hyper or hypopigmentation (30). Because the risk of scarring is increased, it is essential not to overlap the pulses and to use adequate skin surface cooling methods. For treating facial telangiectasias Nd:Yag laser has shown to be very effective, especially for deeper and resistant dilated blood vessels in comparison with PDL (27).

Potassium-titanyl-phosphate

Potassium-titanyl-phosphate (KTP) emits wavelengths of 532nm and has high affinity for oxyhemoglobin. Pulse durations range from 1 to 150 milliseconds, fluences up to 240 J/cm2, and spot sizes up to 5 mm (27). In comparison with long lapse Nd:YAG laser, because of its shorter wavelength, KTP shows more affinity for melanin absorption. Potassium-titanyl-phosphate is very effective in treating telangiectasias in rosacea, but also provokes more dyspigmentation formation (31). Depending on vessel size laser spot, fluence, and pulse durations are chosen to ensure the highest possible chromophore absorption, while minimizing possible side effects. Comparative studies of KTP and PDL have shown more swelling, purpura, and pain with the KTP, but KTP appears to be more effective (32).

Intense pulsed light

Intense pulsed light (IPL) uses xenon flash lamps and emits unfiltered broad-spectrum (500-1200nm), which by filtering can be customized for specific disorders (27). For rosacea inflammatory and vascular lesions, shorter wavelengths are applied (33). Some IPL-s allow multiple pulsing with different pulse durations and pulse intervals, which permit treating both superficial and deeper telangiectasias. In comparison with PDL treatment, it has been noticed that IPL provokes less purpura formation (34). Some studies have shown that IPL for rosacea-associated erythema is safe and effective, with high success rate in treating papulopustular rosacea and erythemotelangioectatic rosacea (35).

CO2 laser

In recent years, laser treatments have been included in treating sebaceous hyperplasia and fibrosis in rosacea and have taken the place of surgical procedures and electrocauterization. CO2 laser emits wavelengths of 10600nm and has a high affinity to water (36). Tissue destruction is nonselective with CO2 laser and it is performed by vaporization in skin cells, which leads to local destruction of tissue. Advantages in using CO2 laser opposed to surgical procedures for treating rhinophyma are shorter downtime, lesser bleeding, better control of the depth of the injury, and in all better aesthetic results (36). By the study results, it has been shown that CO2 laser treatment for rhinophyma produces good cosmetic results with minimal complications development.

Discussion

Given the literature presenting results of clinical studies (35), and by our personal clinical experience, the use of highly selective lasers can be considered as highly effective in the treatment of rosacea with a high safety level. For the treatment of papuloeritematous form of rosacea, as well as for diffuse erythema, the best results could be achieved by using PDL. To treat

telangiectasia, slightly better results could be attained by using Nd: YAG or KTP lasers. In recent years, IPL devices have been upgraded to be more user friendly, so they could be very successfully used in the treatment of both telangiectasia and diffuse erythema, with minimal chances of developing side effects.

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