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Lasers and light sources for acne and rosacea

Speaker: David J. Goldberg
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The role of lasers and light sources for acne and rosacea were discussed in this session. Their main targets for treatment of acne include infundibulum, sebaceous gland, and *Propionibacterium acnes*. Blue and red light, pulsed dye lasers and intense pulsed lights can all be used to treat acne. A study done by Shalita et al using a blue light system, Clearlight®, (407-420 nm) for treating acne showed that there was a 55% reduction in all types of lesions. The patients were treated twice a week for 8 weeks. Seventy-seven percent of patients either improved or markedly improved, while 20% became worse or unchanged. Results could be sustained one month post-treatment. There was another study done by Seaton et al showing pulsed dye lasers could reduce the lesion count by 53% using either 1.5 or 3 J/cm^2 fluence though another study done by Oringer et al did not demonstrate any significant lesion reduction. Ross et al studied the effectiveness of intense pulsed lights of 525-1200 nm and 400-700 nm for treatment of acne. Both groups showed 85% reduction in inflammatory lesion but the lesion count returned to baseline 8 weeks post-treatment.

In the second part of the session, the management of rosacea was discussed. Again, pulsed dye laser was useful in treating rosacea. The study done by Clark et al was quoted. Among the 12 subjects enrolled in the study, there was 75% reduction in telangiectasia, 55% reduction in flushing and 50% reduction in erythema. Intense pulsed light was also effective in clearing rosacea as shown by a study done by Angermeier et al. It was a 2-year study involving 74 subjects with rosacea. It demonstrated 75-100% clearance in erythema in 93% of the subjects. However, complications were found in 18% of subjects and included purpura, oedema and transient hypo-pigmentation. Another study done by Taub et al involved 32 subjects who showed 83% improvement in erythema and 75% in flushing. Complications included purpura, peeling and post-inflammatory hyperpigmentation. Besides subjective observation, objective parameters were also employed to assess the effectiveness of intense pulsed lights. Mark et al used doppler and computer image analysis to assess the severity of rosacea. It showed a 30% decrease in blood flow, 29% decrease in telangiectasia and 21% decrease in erythema intensity. Long pulsed dye lasers, long pulsed KTP (532 nm) laser and long pulsed Nd:

YAG (1064 nm) laser did not have the complication of purpura, but they were not as effective as intense pulsed light in treating diffuse erythema.

In conclusion, laser and light-based therapies have a role in the management of rosacea and acne. For flushing and persistent central face erythema with or without telangiectasia, intense pulsed light and pulsed dye laser are both useful treatment. For rosacea of the phymatous type, ablative lasers should be used instead as the skin is usually thickened and there are irregular nodularities.

Learning points:
Lasers and light sources have a role in the treatment of acne and rosacea. Both intense pulsed light and pulsed dye laser are effective. For rosacea, they are more useful in treating the erythema component.

Lasers in dermatology: a review

Speaker: Elizabeth L. Tanzi

Introduction

Laser technology has progressed very rapidly over the past decade. Successful treatment has been reported on many aspects including congenital defects, vascular lesions, pigmented lesions and the removal of tattoos, scars, and hair. Refinements in laser technology continue to provide patients with more therapeutic choices and improved clinical results.

How it works

Laser light is monochromatic and, at certain wavelengths of light, specific absorption of laser energy can be achieved by distinct cutaneous targets or chromophores such as melanin, haemoglobin or tattoo ink. Also, laser light collimates. It can travel long distance without divergence. Therefore, it can focus on a small spot with precision. Laser light must be absorbed by tissue for a clinical effect to take place and the energy absorbed is measured in joules per square centimetre (J/cm^2) known as energy density or fluence. The amount of energy absorbed is determined by the characteristics of the chromophores present in the skin. Examples of endogenous chromophores are water, melanin and haemoglobin whereas exogenous chromophore is tattoo ink.

Three basic effects are possible once laser energy is absorbed in the skin including photothermal, photochemical or photomechanical. The depth of penetration of laser energy into the skin is dependent upon absorption and scattering. The amount of scattering is inversely proportional to the wavelength of incident light. In general, the depth of penetration of laser energy increases with wavelength until the mid-infrared region of the electromagnetic spectrum. To achieve selective photothermolysis, a proper wavelength which is absorbed preferentially by the intended tissue target or chromophore is selected. To minimise the thermal energy deposited within the skin, the exposure duration of the tissue to light (pulse duration) must be shorter than the chromophore's thermal relaxation time (defined as the time required for the targeted site to cool to one-half of its peak temperature immediately after laser irradiation). Finally the fluence delivered must be sufficient to destruct the target lesions within the allotted time. Therefore, laser parameters (wavelength, pulse duration and fluence) must be tailored for specific cutaneous applications to effect maximal target destruction with minimal collateral thermal damage.

Vascular specific lasers

Vascular specific laser systems target intravascular oxyhaemoglobin. There are three primary absorption peaks: 418 nm, 542 nm and 577 nm. Currently, the most popular devices used to treat vascular lesions include the potassium-titanyl-phosphate (KTP, 532 nm), pulsed dye (PDL, 589-595 nm), Nd:YAG (532/1064 nm) lasers and intense pulsed light source (IPL, 515-1200 nm). KTP and Nd:YAG have been reported to be effective in treatment of facial telangiectasias. The most common side effects are mild erythema, edema, and transient crusting. The limitation of the 532 nm wavelength includes decreased tissue penetration because of its shorter wavelength resulting in diminished absorption by deeper vessels. Also, it is more avidly absorbed by melanin than is the 585-595 nm wavelength of a pulsed dye laser, therefore limiting its use for patients with darker skin types. However, it is preferable to PDL for treating superficial lesions such as facial telangiectasias as it does not cause purpura and it causes less severe erythema.

PDL is considered the laser of choice for most benign congenital and acquired vascular lesions, for example, port-wine stains, facial telangiectasias, haemangiomas, pyogenic graunulomas, and poikiloderma of Civatte. Complications include postoperative purpura which may last for 1-2 weeks and transient dyspigmentation. Vesiculation, crusting, textural change and scarring are rarely seen.

The intense pulsed light (IPL) source emits non-coherent light within the 515-1200 nm portion of the electromagnetic spectrum. It can be used to treat a variety of vascular lesions including facial telangiectasias, port-wine stains and haemangiomas. With longer pulse durations, the IPL source can slowly heat more deeply located vessels, thus improving treatment efficacy and decreasing the risk of postoperative purpura and hyperpigmentation. It can also be used to treat moderately deep, larger caliber spider and reticular veins. Since high fluences are often necessary to adequately damage the vessel, concomitant cooling systems are used to limit unwanted collateral thermal injury.

Laser treatment for hypertrophic scars and keloids

585 nm pulsed dye laser has demonstrated striking improvements in scar erythema, pliability, bulk and dysaesthesia. Significant improvement in scar surface textural analyses, erythema, height, flexibility and symptomatology is observed in treated areas with minimal side effects and treatment discomfort. Significant clinical improvement is usually noted after one or two PDL treatments. Keloids and very thick hypertrophic scars may require additional laser treatments or the simultaneous use of intra-lesional corticosteroid or 5-fluorouracial injections to enhance clinical results.

Pigment-specific lasers

Melanin-specific, high energy, Q-switched (QS) laser systems can successfully lighten or eradicate a variety of benign epidermal lesions (solar lentigines, ephelides, café-au-lait macules, and thin seborrhoic keratoses), dermal pigmented lesions (melanocytic naevi, blue naevi, naevi of Ota/Ito, infraorbital hyerpigmentation, drug-induced hyperpigmenation, Becker's naevi and naevus spilus) and tattoos. Although melanin has a wide absorption spectrum, treatment efficacy decreases as the wavelength of light increases. However, longer wavelength (near infrared range) laser systems are advocated for deeper dermal pigment as it has better penetration.

For optimal pigment removal, the choice of laser is based upon the absorption spectra of the ink colours present within the tattoo. Black pigments absorb throughout the red and infrared spectrum and can therefore be treated with 694 nm, 755 nm, or 1064 nm lasers. Blue and green inks are targeted in the 600-800 nm range. Red, orange, and yellow tattoo inks are specifically destroyed by green light, rendering the usefulness of 532 nm QS Nd:YAG laser. In general, professional tattoos are more difficult to treat than are amateur tattoos due to the heavy concentration of their organometallic ink particles placed deeply in dermis. Several more treatments (8-12) are needed to effect near complete removal of professional tattoo, compared to the average 4-6 treatments typically necessary to rid the superficially sparsely placed carbon-based inks in amateur tattoos. Attention should be paid for removal of cosmetic ink such eyeliner or lipliner as most of them contain iron (or titanium) oxide inks, which are reduced to ferrous oxide form upon laser irradiation. Ferrous oxide is black and insoluble. The pigmentation may be permanent. The most common side effect of laser-assisted tattoo removal is transient pigmentary alteration. A more serious complication of treatment is systemic allergy or localised granulomatous tissue reaction to tattoo ink particle antigens.

Photoepilation

Lasers and IPL sources with wavelengths in the red or near-infrared region (600-1200 nm) are most often used for hair removal since they effectively target melanin within the hair shaft, hair follicle epithelium and heavily pigmented matrix. Epidermal cooling is needed to minimise unwanted epidermal injury and enhance the delivery of fluences to follicular melanin. Pulse duration is also an important parameter for effective photoepilation. To limit the thermal damage, the pulse duration should be shorter than or equal to the thermal relaxation time of the hair-follicle – estimated to be approximately 10 to 100 milliseconds, dependent upon the diameter of the follicles. However, other components of the follicular unit, such as follicular stem cells, do not contain significant amounts of melanin and may be located some distance from the targeted pigmented structures. Therefore, it has been proposed that pulse durations longer then the thermal relaxation time of the shaft (which allows conduction of laser energy with subsequent thermal injury through the entire follicular unit) may be more appropriate to induce permanent hair reduction. Lasers system and IPL sources currently used for the reduction of unwanted hair include the long pulsed ruby (694 nm), long-pulsed alexandrite (755 nm), pulse diode (800 nm), and long-pulsed Nd:YAG (1064 nm) lasers and IPL (515-1200 nm) sources. In general, long-term hair reduction (50-75%) has been demonstrated following treatment with any of the above systems after a series of 3-5 treatments. Side effects include blistering, fine epidermal crusting, purpura, and transient hyper-pigmentation or hypopigmentation. Patients at highest risk of complications are those with recent sun exposure or with naturally darker skin phototypes. The deeply penetrating 1064 nm wavelength is preferable than others as it is less efficiently absorbed by endogenous melanin, and therefore fewer instances of purpura, blistering, crusting and dyspigmentation occur.

Ablative laser systems

Cutaneous laser resurfacing has been widely used in treatment of photodamaged facial skin, photoinduced facial rhytides, dyschromias, and atrophic scars. The CO_2 laser produces the most dramatic improvements in the clinical and histological appearance of photodamaged or scarred facial skin. Epidermal ablation occurs after one pass of CO_2 laser at standard treatment parameters (vaporisation tissue to a depth of 20-60 micrometer), but collagen shrinkage and remodelling requires an additional 1-2 passes. Facial resurfacing with CO_2 laser produces at least 50% improvement in overall skin tone, rhytide severity, and atrophic scar depth. All patients experience at least one week of significant morbidity until complete re-epithelization occurs. Postoperative erythema and oedema are treated with head elevation, ice application, and in extensive cases, short courses of oral corticosteroids. Other side effects include bacterial and viral infection, pigmentary alteration, ectropion and hypertrophic scar formation. Newer trends in ablative facial resurfacing have emerged that offer modest clinical improvements in rhytides and atrophic facial scars with reduced postoperative morbidity and shorter recovery times. Less aggressive techniques include single-pass CO_2 laser ablation and use of modulated (variable-pulsed Er:YAG or combined Er:YAG/ CO_2) laser systems. They are associated with a shorter and less severe post-operative course compared to traditional multi-pass CO_2 laser skin resurfacing.

Non-ablative laser system

Most of the non-ablative laser systems used today emit light within the infrared portion of the electromagnetic spectrum (1000-1500 nm). Absorption by superficial water-containing tissue is relatively weak, thereby effecting deeper tissue penetration. Non-ablative laser resurfacing induces collagen remodelling by creation of a dermal wound without disruption of the epidermis. Although non-ablative lasers are not yet capable of results comparable to those of ablative laser systems, they have been shown to improve mild to moderate atrophic scars and rhytides without external wound. Therefore, non-ablative laser resurfacing is ideal for patients with either mild cutaneous pathology, or in those who are unwilling or unable to undergo an expensive, labour intensive ablative laser resurfacing. Clinical studies have demonstrated the ability of 585 nm and 595 nm PDL to reduce mild facial rhytides with minimal side effects. The most common side effects include mild oedema, purpura, and transient postinflammatory hyperpigmentation. The infrared systems which have been used for non-ablative dermal remodelling include the 1064 nm Nd:YAG, 1320 nm Nd:YAG, 1450 nm diode and 1540 nm Er:glass lasers. The choice of treatment fluences is based on the skin's surface temperature. When skin temperature is maintained at 40-50°C during laser irradiation, dermal temperatures of 60-65°C are reached and collagen contraction and stimulation of neocollagenesis are effected. Epidermal temperatures must be kept below 50°C in order to prevent vesiculation or scarring.

Side effects and complications

It is essential that all patients should receive consultation and counselling prior to treatment to assess his or her specific risk of adverse sequelae. It is important that patients understand the importance of good wound care after a laser procedure. Preoperative laser evaluation should include a basic medical history including documentation of medications and allergies. Any history of abnormal scarring, allergic reaction, excessive sun exposure, herpes simplex virus outbreaks, immune disorders, or previous cosmetic procedures within the involved area should be ascertained. Proper pretreatment education, close physician follow up and carefully executed postoperative wound care regime all help to reduce morbidity.

Learning points:

1. Laser can be used in treatment of vascular lesions, hypertrophic scars, epidermal and dermal pigmented lesions, removal of excessive hair and skin resurfacing.
2. Laser parameters (wavelength, pulse duration and fluence) should be tailored for specific cutaneous applications to effect maximal target destruction with minimal collateral thermal damage.
3. Careful history taking and counselling prior to treatment is necessary to reduce morbidity and to allow early recognition of problems.