DOI: 10.1111/j.1610-0387.2007.06513.x

Recommendation

Recommendation for Laser and Intense Pulsed Light (IPL) Therapy in Dermatology

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Recommendations for Medical and Aesthetic Treatment of the Skin using Laser or Intense Pulsed Light (IPL) Systems

The following guidelines on the use of laser and IPL systems in treating skin conditions and imperfections reflect the state of laser technology and medical knowledge of its use as of 2006. The recommendations contained herein are based on average requirements for diagnosis and treatment which in actual practice may vary in individual patients. Recommended dosages and equipment selection may also vary according to treatment situation. These recommendations should thus be critically interpreted while keeping in mind individual patient factors.

1 Requirements

1.1 Requirements for physicians who perform dermatologic laser / IPL therapy

Dermatologic laser / IPL therapy should be performed according to dermatological standards. Therapy must be performed by or with the assistance of a dermatologist; or under his or her direct supervision and guidance with the potential for prompt intervention.

Additionally, the responsible physician must meet the following training and certification requirements:

1.1.1 Certification in laser use

Successful participation in a one-day long medical laser course on the principles of laser technology, laser safety (in accordance with accident prevention regulations on "laser radiation"), as well as medical and specialized dermatological uses of different laser systems. Certification should be received from a laser center or equivalent academic institution that is operated independently of any equipment manufacturer and that has been approved by the quality assurance commission of the German Society of Dermatology (DDG), German Society for Laser Medicine (DGLM) or German Society of Laser Dermatology (DDL).

1.1.2 Certification in dermatologic laser therapy

Certification according to dermatological standards, including performance of a minimum of 110 laser / IPL treatments under the instruction of a specialist. Of these, a minimum of 25 treatment sessions each for vascular (25) and pigmentary (25) skin changes, benign (25) and premalignant (25) skin tumors, and 10 skin-resurfacing treatments should be performed.

1.2 Specifications for treatment rooms, technical equipment, hygiene, and personnel

Compliance with all specifications contained in the applicable accident prevention regulations (in Germany "Unfallverhütungsvorschrift" [UVV]) under "laser radiation" (BGV B2) is required. These regulations should be consulted for further details.

1.2.1 Specifications concerning treatment rooms

The design of treatment areas should comply with § 7 and § 8 of the accident prevention regulations on "laser radiation" (BGV B2) from 01/01/1993.

1.2.2 Technical equipment requirements

All laser systems used must comply with applicable EU directives (i.e., they should be CE marked); they must also be regularly serviced and meet the specifications in the accident prevention regulations (BVG B2). Compliance with the German law on medical products is mandatory.

1.2.3 Hygiene requirements

When using laser systems that generate fumes, appropriate measures must be taken to minimize associated risks (e.g., hazards arising from virus particles or burnt-off material) to patients and personnel (including the use of protective wear for the eyes, mouth, and nose, as well as exhaust systems).

1.2.4 Personnel requirements

In accordance with the accident prevention regulations, a certified laser safety officer must be appointed in writing to operate the laser equipment, unless the physician fulfills this function himself.

2 Performing laser / IPL treatment

2.1 General treatment procedures

2.1.1 Consultation and consent

After obtaining the patient history, findings, diagnosis, and determining an indication for laser / IPL therapy, the patient should be thoroughly informed of methods, risks, potential adverse effects, chances of success, and alternative treatment options. The last point also includes other laser / IPL techniques that may not be available at the present location. The consultation should be tailored to the chosen treatment method (see 2.2).

2.1.2 Documentation
The following data should be collected and recorded in the patient file:
- Preoperative diagnosis
- Indication for treatment
- Informed consent
- Type of anesthesia
- Type of treatment (laser / IPL type)
- Cooling system
- Therapy parameters
- Histological findings (if applicable)
- Side effects
- Complications: intraoperative and postoperative, infections, delayed complications

It is advisable to keep records of the following:
- Photo documentation (forensic and billing reasons)
- Type of procedure (surgical procedure)
- Result of procedure and long-term assessment
- Test sites for treatment of large lesions and alternative procedures

2.1.3 Anesthesia
Measures must be taken to prevent pain during various laser / IPL procedures. Depending on the patient (e.g., children) and method (e.g., laser dermabrasion) various forms of anesthesia may be required: topical anesthetic (e.g., cold, local anesthetic applied with an occlusive dressing), local anesthesia (infiltration or conduction anesthesia) intravenous analgesics, or general anesthesia.

2.1.4 Cooling the skin
Modern laser systems use different methods for cooling the skin's surface (e.g., contact cooling, cooling spray, cold-air cooling) to reduce any related pain as well as to protect the epidermis from thermal damage, thereby allowing the use of higher energy densities.

2.1.5 Pretreatment
In general patients should avoid exposure to UV rays to reduce hyperpigmentation of the epidermis. Depending on the planned laser treatment, other pretreatment measures may be needed to improve healing and minimize any undesired side effects (e.g., superficial removal of body hair for epilation or pigment removal or pre-cooling of the epidermis).

2.1.6 Follow-up care
Depending on the method of laser therapy, follow-up treatment sessions may be needed to enhance healing and minimize adverse effects. For many procedures, skin cooling is sufficient follow-up treatment. In laser ablation and treatment of larger areas of the skin or around the eyes, additional anti-swelling measures (e.g., NSAID) may be needed. When using laser ablation, preventive measures against herpes may also be necessary. Depending on the treatment method, patients should be advised to avoid UV exposure.

2.2 Laser type according to main form of laser-tissue interaction
2.2.1 Laser-tissue interactions that mainly produce thermal coagulation
2.2.1.1 CO_2 laser
The CO_2 laser (10600 nm, absorption mainly by tissue water) allows vaporization of superficial layers as well as cutting of the skin surface with a focused beam. Tissue ablation is possible at high energy densities using pulsed laser or a scanner system (see 2.2.2.1).
Patient information and side-effect profile:
Depends on the indication and type of procedure. Vaporization of deep tissue is associated with scarring and sometimes even keloids. Thermal necrosis in superficial skin layers is advantageous for hemostasis and disadvantageous for wound healing. Long-term erythema, hyperpigmentation, and permanent depigmentation can occur.

2.2.1.2 Continuous wave (CW) Nd:YAG laser
The continuous wave Nd:YAG laser (1064 nm, CW, nonspecific absorption, deep penetration of tissue) is suitable for large-volume tissue coagulation (e.g., hemangiomas, vascular malformations).
Patient information and side effects:
Due to the extensive necrosis caused by thermal coagulation: pain, delayed wound healing, and scarring

2.2.2 Laser-tissue interactions with a predominantly ablative effect
Given predominant absorption in tissue water and brief exposure times (pulse mode / very short pulses or CW mode with continuous deflection / scanner), various laser systems enable ablation of the surface of the skin with resulting thermal damage that is less than that achieved with CW mode or even virtually absent.

2.2.2.1 CO_2 laser
CO_2 laser is used in pulsed mode with pulse durations in the ms range or with a modified handpiece with a rapidly moving beam and brief tissue exposure times for ablation of the skin surface. There is almost no coagulation and only limited subsequent necrosis. Compared with conventional (mechanical) dermabrasion, this technique is a largely bloodless procedure that offers controlled ablation density and has advantages, for example, in difficult-to-treat areas such as the eyelids, neck, and backs of the hands.
Patient information and side effects:
Ablation of large surface areas (e.g., "skin resurfacing") in particular is associated with a risk of superinfection and postoperative pigmentary disorders (permanent depigmentization). There is a small amount of residual thermal damage and thus, compared with dermabrasion or Er:YAG laser ablation, healing may be somewhat prolonged. The risk of scarring mainly depends on ablation depth. Other potential side effects are formation of milia, hypertrichosis, scarring, keloids, and persistent erythema.

2.2.2.2 Erbium:YAG laser
The pulsed Er: YAG laser (2940 nm, maximum absorption in tissue water) allows ablation of the skin surface with almost no thermal damage (minimal necrosis due to coagulation) and thus achieves greater precision in ablation than CO_2 laser (2.2.2.1) or mechanical dermabrasion (using a diamond fraise). One disadvantage of this technique is bleeding if capillaries are opened. Advantages are similar to those of CO_2 laser (2.2.2.1)
Patient information and side effects:
Analogous to other pulsed and scanner lasers. Due to low thermal necrosis, wound healing is analogous to that in dermabrasion.

2.2.3 Selective photothermolysis
Given their wavelength-related absorption in certain chromophores (hemoglobin, melanin, tattoo pigments), various pulsed Q-switched lasers enable targeted destruction of specific structures.

2.2.3.1 Pulsed dye laser
Flashlamp-pumped pulsed dye laser (FPDL) (577–600 nm, 200–1500 µs or up to 40 milliseconds (ms), predominant absorption in oxyhemoglobin) is mainly suitable for photothermolysis of superficial neovascularizations or vascular malformations. It is superior to other

techniques in treating nevi flammei in children (and also adults), in particular. Shorter pulse durations of 200–450 μs are generally used for smaller-caliber vessels (< 200 μm) longer durations (1.5–40 ms) for larger ones. Performing a test treatment is advisable.
Patient information and side effects:
Pain depending on treated area, although generally minimal. Depending on age and location or extent of area to be treated, general anesthesia may be needed in young children. With short pulse durations there may be blue-black discoloration of the treated surface immediately after therapy. Low risk of pigmentary disorders and superinfections. Scars are very rare. Treatment of a single area usually requires several sessions.

2.2.3.2 Ruby and alexandrite lasers
The Q-switched ruby laser (694 nm) and alexandrite laser (755 nm), which also emits red light, use pulse durations in the nanosecond range to destroy melanin as well as for photothermolysis of tattoo dyes. Alexandrite laser is also used with longer pulse durations (5-100 ms) for laser epilation.
Patient information and side effects:
For use in pulsed mode (nanosecond pulses): pain and inflammatory reaction with post-therapy formation of crusts and possibly faint atrophic scars as well as lasting depigmentation depending on intensity and frequency of retreatment, but as a rule minimal. Relatively frequent post-therapeutic (generally temporary) hypopigmentation due to effect on melanin, rarely hyperpigmentation, especially with dermal pigmentation. Unexpected color changes of tattoo dys are possible and prior testing is advised. Possible allergic reactions when treating tattoos cannot be ruled out.
For epilation see under "Laser and light epilation."

2.2.3.3 Nd: YAG laser
Quality-switched Nd: YAG lasers (1064 nm) are used with pulses in the nanosecond range mainly for destruction of deep, blue-black tattoos. At the same beam diameter, the depth of penetration at this wavelength is larger than that of the ruby or alexandrite laser. If the frequency is doubled (532 nm), this laser is also suitable for photothermolysis of red dyes and melanin. 1064 nm Nd:YAG laser with pulses in the millisecond range is used for photothermolysis of hair follicles and treatment of vessels (2.2.4.6). Frequency-doubled (532 nm), millisecond-pulsed lasers are used for vascular conditions, but are generally less effective than FPDL and have a higher rate of side effects (pigmentary changes, danger of epithelial damage with small scars)
Patient information and side effects:
Pain and inflammatory reaction with post-therapy formation of crusts and possibly faint atrophic scars as well as lasting depigmentation depending on intensity and frequency of retreatment. Unexpected color changes of tattoo dyes are possible and prior testing is advised. There is a risk of posttherapeutic hypopigmentation at frequencies of 532 nm, which is smaller at 1064 nm. Hyperpigmentation is rare. Possible allergic reactions when treating tattoos cannot be ruled out.

2.2.4 Semi-selective lasers
The settings on such lasers (wavelength, pulse duration, etc.) are insufficient for truly selective photothermolysis (or not for every indication), yet with appropriate irradiation parameters they allow relatively selective damage of structures containing hemoglobin or pigment.

2.2.4.1 Argon laser
The argon laser (488 / 514 nm, moderately selective absorption in hemoglobin and melanin) is primarily used for superficial coagulation, especially vascular changes; it may also be used for vaporization with a focused beam and high power density.
Patient information and side effects:
Given thermal interaction with subsequent coagulation, inflammatory reaction, and necrosis, patients must be informed of the possibility of scarring and pigmentary changes. Depending on the technique used and the treated site, therapy can be quite painful. Several treatment sessions are generally required. For multiple skin changes or when treating larger areas, perform a test treatment. Possibility of long-term depigmentation and / or hyperpigmentation and / or small scars.

2.2.4.2 Copper vapor laser
Continuous wave, pseudo-pulsed laser (578 nm, more specific absorption in hemoglobin than argon laser), relatively selective vessel coagulation, but, similar to argon laser, epidermal coagulation.
Patient information and side effects:
Comparable to argon laser.

2.2.4.3 Krypton laser
Continuous wave laser that emits either green or yellow light. Hemoglobin absorption is not much better than that of the Argon laser. On the whole, limited clinical experience.
Patient information and side effects:
Comparable to argon laser.

2.2.4.4 fd-Nd: YAG laser (532 nm)
High-frequency, pulsed quasi-continuous wave laser. Similar uses as argon laser, but due to higher power levels and thus smaller pulse components, treatment is less painful with comparable effectiveness.
Patient information and side effects:
Comparable to argon laser.

2.2.4.5 Diode laser
The diode laser (810, 940, 980 nm, minimal selective absorption in hemoglobin and melanin) is used for thermal coagulation of superficial blood vessels and for selective photothermolysis of hair follicles.
Patient information and side effects:
For treating vessels: depending on pulse duration, comparable to argon laser.
For epilation see "Laser and light epilation"

2.2.4.6 Pulsed Nd: YAG-Laser
Pulsed Nd: YAG laser (1064 nm) is used for epilation with selective photothermolysis (see "Selective photothermolysis") as well as semi-selective coagulation of superficial vessels, especially with skin cooling (telangiectases, spider veins, phlebectasia)
Patient information and side effects:
Depending on location and irradiation parameters, therapy may be quite painful. Risk of atrophy, small scars, and pigmentary changes as seen in use of argon laser; side effects may be reduced by cooling of the treated area.

2.2.5 Intense pulsed light (IPL)
Intense pulsed light sources are not lasers. They produce high-energy flashes of light of several milliseconds' duration with a broad wavelength spectrum, ranging from visible light to well into the infrared spectrum. Filters are used to cover the light source, eliminating certain wavelengths in order to optimize treatment of different conditions. For pigmentary

changes, the selected wavelength begins at shorter wavelengths (typically about 550 nm); for treatment of vascular changes it begins at a longer wavelength (typically 580–590 nm). Flashlamp systems of the older generation did not filter out infrared light; due to the infrared portion and imprecise choice of parameters, relatively mild side effects resulted such as epithelial coagulation with subsequent pigmentary changes and small scars. Newer flashlamp systems of the second generation use circulating water to filter out the infrared portion of longer wavelengths, significantly reducing associated side effects.

Intense pulsed light sources operate on the principle of selective photothermolysis and, given the relatively flexible settings for treatment parameters (wavelength, pulse durations in milliseconds, double and multiple pulses), can be used in a wide variety of conditions (e.g., vascular changes such as nevi flammei, telangiectases, spider nevi; superficial pigmentary changes; epilation; and photo rejuvenation). The typically large exposure areas enable rapid and effective treatment of larger areas.

Patient information and side effects:

Depending on selected treatment parameters, associated discomfort may be slight or more pronounced. Depending on the device used, a clear gel should be applied to skin to aid movement of the handpiece, which can also be cooled to help cool the skin. With proper use, side effects are rare, although they are possible and include hypopigmentation and hyperpigmentation, blisters, crusts, and atrophic scars.

These side effects are much more common with older, first generation flashlamps which emit a higher proportion of infrared light.

2.2.6 Excimer laser

This refers to UVB radiation emitted by an excimer (excited dimer) laser at a wavelength of 308 nm in quasi-continuous wave (high-frequency short pulses) mode. Excimer laser allows circumscribed treatment of skin changes that are accessible to UVB therapy and are thus UV light therapy devices. Strictly speaking, they are therefore not the subject of this guideline. The reader is directed to the guideline on UV light therapy in dermatology.

2.3. Indications in dermatology

The information presented here is merely intended to serve as recommendations. Determining indications for treatment and choice of laser vary for each patient and according to the experience of the practitioner. Basically, coagulation and ablative lasers that target superficial layers of the skin can be used for any skin change that could also be treated with other ablative measures (e.g., curettage, surgical snare) (see 2.3.2). Treatment of these skin changes belongs to standard dermatologic knowledge and thus will not be further discussed in the following. If necessary, results of a test patch can help decide the appropriate approach.

2.3.1 Vascular conditions

2.3.1.1 Nevi flammei

The use of yellow-light flashlamp-pumped pulsed dye laser is currently the method of choice given the related efficacy and side effect profile. Improved results may be achieved using the double-pulse technique, i.e., treatment with variable pulse durations during a single treatment session. In special circumstances, high-energy flashlamps or argon, continuous wave krypton, copper vapor, or potassium titanyl phosphate (KTP) lasers may be used in adult patients, although, depending on treatment method, side effects may be more common (pigmentary changes, scarring). Laser ablation or coagulation (e.g., CO_2 laser or Nd: YAG-Laser) can also be used on an individual basis in patients with livid nevi flammei or nevi flammei related to tuberous sclerosis.

It is advisable to test a smaller area of the skin prior to treating large areas or in order to assess treatment effects and possible side effects and to determine the best irradiation parameters (beam diameter, power density). In general, multiple sessions are needed to achieve good results.

2.3.1.2 Telangiectasia

Flashlamp-pumped pulsed dye laser, argon laser, copper vapor laser, krypton laser, pulsed Nd: YAG laser (frequency-doubled at 532 nm or at 1064 nm) and IPL devices are equally effective in treating facial telangiectasias. Post-treatment blue-black discoloration associated with flashlamp-pumped pulsed dye laser is occasionally bothersome. For more extensive telangiectases (rubeosis faciei, couperosis, erythrosis interfollicularis) and extrafacial telangiectases, pulsed laser or intense pulsed light systems have distinct advantages in terms of scarring and hypopigmentation compared with continuous-wave techniques. The frequency of side effects for treatment of facial lesions is very low for all treatment modalities.

2.3.1.3 Spider nevi

Comparable to telangiectasia. In more pronounced, papular spider nevi laser therapy is usually only moderately successful; use of a laser with good coagulation properties (e.g., Argon laser) is possible. Simultaneously pressing the lesion with a glass spatula, partly emptying the hemangiomatous component of the lesion, along with longer irradiation times, is often successful.

2.3.1.4 Spider veins

In general, fine red spider veins can be treated with flashlamp-pumped pulsed dye laser, argon laser, copper vapor laser, KTP laser, or intense pulsed light sources. Especially for treatment of the legs, however, consideration should be given to the typical side effects of continuous wave laser. The pulsed dye laser, which is less problematic in this regard, is suitable if longer pulsed (1.5–40 ms) laser types are used for thermocoagulation of spider veins with a diameter up to 1 mm. Post-treatment hyperpigmentations are very common and often remain for several months.

Larger-caliber spider veins can be treated using long-pulsed (up to 20 ms) alexandrite, Nd: YAG (1064 nm) or diode laser; pulsed Nd: YAG lasers are now considered the laser of choice. Nevertheless, there is a risk of (initial) hyperpigmentation, (later) depigmentation, and scarring.

2.3.1.5 Hemangiomas in pediatric patients

Small, circumscribed initial hemangiomas:

Flashlamp-pumped pulsed dye laser produces good results; other options are argon laser, copper vapor laster, KTP, laser, or IPL, usually requiring several sessions.

Superficial hemangiomas:

Pulsed dye laser or IPL are the methods of choice given their efficacy / side effect profiles. The use of more strongly coagulating lasers is not advisable given associated pain and greater risk of side

effects. Several sessions are usually required.
Larger nodular, deep hemangiomas:
It is not possible to make general recommendations since the use of laser or IPL is mainly determined by individual patient needs and the experience of the practitioner. Depending on the condition, it may be advisable to use various laser systems (e.g., those specifically for vascular lesions, ablation, coagulation) alone or in combination, or possibly in conjunction with interstitial laser therapy. Particularly with coagulation laser therapy, special attention should be given to the risk of scarring and tissue damage (e.g., nerves). Referral of patients to specialized treatment centers is advised.

2.3.1.6 Angiomas of the lips (venous lake)
Laser coagulation (argon, krypton, copper vapor, KTP, or pulsed Nd: YAG) or pulsed dye lasers (usually requiring several sessions) may be used. For larger lesions, possible careful use of CW Nd: YAG or CO_2 laser. Reducing power output and increasing pulse duration is recommended to achieve deeper coagulation.

2.3.1.7 Senile angiomas (ruby spots)
Coagulation of lesions in superficial skin layers can be achieved with argon, krypton, copper vapor, KTP, pulsed Nd: YAG laser or with pulsed dye laser (usually requiring several sessions). In principle, ablative laser is also a possibility. Risk of adverse effects should be noted (scarring, permanent depigmentations).

2.3.1.8 Pyogenic granuloma
For small lesions, CW laser coagulation of lesions in superficial skin layers (see 2.3.1.6) is possible; larger lesions are generally treatable with laser ablation and / or coagulation. Several sessions are usually required. Primary surgical procedures are often a better option.

2.3.2 Nonvascular benign neoplasms (see preliminary note in 2.3)
Xanthelasma, syringomas, sebaceous gland hyperplasia (sebaceous gland epitheliomas), angiofibromas (Brooke's disease, Pringle's disease), chondrodermatitis nodularis helicis, and others.
Good results are often achieved in superficial layers of the skin with laser coagulation or ablation, paying heed to potential adverse effects (scarring). In patients with flatter xanthelasmas, resolution can also be initiated by several sessions with pulsed dye laser.

2.3.3 Precancerous skin changes
Before initiating laser therapy in patients with precancerous skin changes, diagnosis by a dermatologist as well as biopsy confirmation are needed. Documentation of disease course and long-term clinical follow-up examinations should be ensured. Leukoplakia, cheilitis actinica without infiltrative growth, actinic keratoses, Bowen's disease, and erythroplasia of Queyrat can be managed well with laser ablation (usually CO_2 laser), assuming correct evaluation of treatment indication and technique. The Er: YAG laser is only advisable in very superficial skin changes with minimal infiltration.

2.3.4 Infectious skin diseases
Viral papillomas
There have been reports on successful use of pulsed dye laser and Nd: YAG or CO_2 laser hyperthermia for treatment of warts. Laser coagulation or ablation is also possible, but given the considerable risk of scarring, usually advisable only after all other conservative methods have been exhausted.
CO_2 laser ablation therapy of condylomata acuminata is usually a bloodless procedure that spares normal tissue. Infectious diseases may be transmitted by laser smoke and precautionary measures are required (see 1.2.3). For patients with potentially infectious diseases and those with HIV, electrocoagulation, argon plasma coagulation, or coagulation with Nd: YAG laser are preferable, although these methods are associated with a heightened risk of thermal necrosis and subsequent scarring.

2.3.5 Tattoos
CAUTION: Red, reddish, purple, light, earth-colored, and especially skin-colored decorative tattoos can change irreversibly to black or dark brown after therapy with Q-switched laser. The possibility of allergic reactions arising from laser therapy of tattoos cannot be ruled out.
CO_2 laser therapy of tattoos is currently considered a last resort given that it necessarily leads to scarring; in individual situations it may be used, however, after the patient has been thoroughly informed of the risks involved. In special situations, combination therapy with various laser systems may be advisable (e.g., primary dermabrasion with CO_2 or Er: YAG laser followed by Q-switched laser).

2.3.5.1 Decorative tattoos
Q-switched laser is currently the laser of choice for removing decorative tattoos. Ideally, the color of the laser light should correspond to the absorption spectrum of the tattoo dyes. Q-switched ruby, alexandrite, Nd: YAG, or frequency-doubled Nd: YAG lasers may be used. Test treatment to evaluate the response to therapy is advisable in individual patients. Treatment generally requires several sessions.

2.3.5.2 Traumatic and other accidental tattoos
Test treatment is advisable given the highly variable response to laser therapy depending on the type of embedded material.

2.3.6 Scars
2.3.6.1 Hypertrophic scars and keloids
There are reports on successful use of pulsed dye laser, especially in active, highly vascularized hypertrophic scars and keloids as well as on the use of Er: YAG laser in "thermal mode" (subablative Er: YAG laser) to flatten and lighten hypertrophic scars.
The (repeated) use of laser ablation can be attempted to smooth hypertrophic scars. To treat keloids, laser ablation is usually combined with other treatment forms (e.g., cryotherapy, steroid injections, pulsed dye laser, compression).

2.3.6.2 Atrophic or sunken scars and acne scars
All scars which are treatable by dermabrasion can also be treated by laser methods that involve ablation of superficial layers of the skin with minimal thermal residual necrosis (i.e., pulsed or scanned CO_2 laser or Er: YAG laser).
The effect and range of adverse affects are generally comparable to those associated with dermabrasion.
Subablative exposure using Er: YAG laser (thermal mode) can improve the appearance of atrophic scars.
In individual situations, the use of laser coagulation to treat superficial layers of the skin (e.g., argon laser) may also be considered.

Several treatment sessions are often required; these should be scheduled at least six months apart.
Acne patients who have received isotretinoin should not receive ablation laser treatment over large areas for at least 12 months afterward.

2.3.7 Aging skin and wrinkles (skin resurfacing)
2.3.7.1 Ablation methods
In principle, age-related skin changes may be treated by laser ablation therapy with minimal thermal residual necrosis. Good results can be achieved when precise laser technique is used, in particular when treating skin that has been damaged by acne or for fine or moderate facial wrinkles. Long-term results show stable treatment outcomes over several years. In terms of long-term effects of skin tightening, most experience has been with pulsed or scanned carbon dioxide laser. Er: YAG laser has a lower risk of side effects and can produce comparably good results, although usually only after several treatment sessions.
Given that treatment is for aesthetic purposes, special care should be taken to inform patients of possible side effects (e.g., provocation of herpes or acne, persistent erythema, irritant dermatitis, hyper-depigmentation and persistent depigmentation, milia, scarring, and hypertrichosis).

2.3.7.2 Non-ablative methods
Non-ablative skin rejuvenation is aimed at improving the appearance of the skin without removing superficial skin layers. Two types are distinguished: type 1, which involves removal of pigmentary changes (e.g. lentigines) and telangiectases to improve the skin's appearance and type 2, which uses thermal induction to shrink collagen, thereby tightening the skin and reducing wrinkles.
For type 1 rejuvenation, devices are used which have proven effective in treatment of vascular and pigmentary changes (e.g., FPDL, argon, and frequency-doubled Nd: YAG laser, Q-switched laser, IPL).
For type 2 rejuvenation, various lasers are used which either directly or indirectly cause the collagen in the skin to shrink by heating the vessels (these include flashlamp-pumped pulsed dye laser below the purpuric threshold, Er: YAG and Er: glass laser, various diode lasers, and IPL). Although available studies show that these therapies are far less effective than ablation, most of them do not entail any significant risk of side effects.
The effectiveness and long-term results of nonablative methods for type 2 skin rejuvenation cannot yet be reliably determined given lacking data. Further studies with larger patient numbers and long-term follow-up are needed.

2.3.8 Pigmented skin changes
The indication for laser treatment of pigmented skin changes should be determined by the patient's dermatologist and confirmed by biopsy if there is any doubt as to the nature of the lesion, especially if malignant potential is suspected.

2.3.8.1 Lentigines
Simple removal is possible with Q-switched laser, the wavelength of which has relatively specific for absorption by melanin, without significant side effects. IPL is an alternative for thermal treatment of lentigines.
Only in exceptional situations should laser ablation of superficial skin layers be used; the risk of scarring should be noted.

2.3.8.2 Cafe-au-lait spots or nevus spilus
See lentigines (2.3.8.1). Recurrence is possible after only a relatively short time. There is lacking knowledge of long-term effects. Test treatment is advisable.

2.3.8.3 Pigmented melanocytic nevi
The treatment of pigmented melanocytic nevi with Q-switched laser, the wavelength of which has relatively specific for absorption by melanin, is currently out of favor as a routine method. (see also the guidelines on melanocytic nevi). Given that the melanocytic cells are insufficiently damaged and lacking experience or long-term results on reactions of sublethally damaged cells to laser therapy, this method of treatment is reserved for use only in individual situations or clinical studies. The only even partially certain indication for treatment is currently lightening of Ota nevi.
Given the risk of scarring and lacking histological control, use of laser ablation or coagulation should also be reserved for use on an individual basis and only after careful consideration.
Clinically unequivocal, non-pigmented, papular dermal nevi are an exception; in principle, treatment with laser ablation is possible. Histological confirmation should always be attempted, e.g., by shave biopsy.

2.3.9 Rare indications
Laser therapy is never the method of choice for treating malignant or other infiltrating skin changes given the lack of histological control. In exceptional circumstances, laser therapy may be chosen after careful consideration by experienced laser therapists. Possible indications could include multiple skin changes or palliative use.
Good clinical follow-up, with corresponding patient compliance, is mandatory for such interventions. Examples include initial Kaposi's sarcoma (palliative treatment with pulsed dye laser), superficial multicentric basal cell carcinoma on the trunk (CO_2 laser), or initial squamous cell carcinoma affecting specific sites on the body (CO_2 laser).

2.3.10 Laser and light epilation
The goal of epilation with laser or light sources is to permanently damage the hair follicles using selective photothermolysis. Light absorbed by the pigment in the hair follicle (root, hair shaft) leads to heating of follicle structures which results in thermal damage and reduces hair growth. Lasers with longer wavelengths are typically used with pulse durations of several milliseconds (alexandrite laser, diode laser, Nd: YAG laser, IPL).
Multiple studies clearly show the effectiveness of treatment, although adequate epilation generally requires several sessions. The numbers of hairs as well as pigmentation and thickness are reduced. Hair reduction cannot yet be considered permanent as repeated treatments (albeit in larger intervals) are usually needed to maintain a good outcome. Treatment sometimes also leads to re-growth of much thinner hair with decreased pigmentation. The darker the hair, the more amenable it is to treatment; the clinical effect on light or white hair is thus very limited. For this reason, especially when using laser or IPL for epilation, careful attention should be paid to ensuring that the skin is not tanned as this is associated with greater likelihood of side effects such as blisters, crusts, pigmentary changes, and scars. The latter does not apply to long-pulsed Nd: YAG laser,

which is FDA-approved for treating darkly pigmented skin.

2.3.11 Treatment of acne

Regarding the treatment of acne with various laser and flashlamp systems, there are reports on both successful and ineffective outcomes, some of which directly contradict each other. The rationale behind treatment is, on the one hand, thermal damage of the sebaceous glands and on the other a photodynamic effect on porphyrin produced by propioni bacteria. This minimally-invasive technique does not involve and risks such as development of resistance or sensitization (as seen with antibiotic use) or teratogenous effects (as seen in isotretinoin therapy). In addition, it has a positive effect on inflammatory and non-inflammatory acne lesions and seborrhea. Good results have been reported after 6–8 treatments.

It is not yet possible to conclusively state whether and which laser or IPL therapy is definitively effective.

Consensus formation

Quality assurance commission of the German Society of Dermatology
Occupational Association of German Dermatologists e. V.
German Society of Laser Dermatology e. V. (DDL)

Subcommission: Physical treatment methods in dermatology
Leader: Prof. Dr. E. Hölzle
Board of authors: Prof. Dr. F. Bahmer, Prof. Dr. M. Drosner, Prof. Dr. U. Hohenleutner, Prof. R. Kaufmann, Dr. G. Kautz, Dr. W. Kimmig, Prof. Dr. M.J.E. Landthaler, Prof. Dr. R. Neumann, Dr. Ch.Raulin, Dr. N. Seeber
These recommendations were developed without third party support, financial or otherwise.
Date created: 01/2007
Planned review date: 12/2009

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