

Recommendations for medical and aesthetic treatment of the skin using laser or intense pulsed light (IPL) systems

Friedrich Bahmer^a, Michael Drosner^b, Ulrich Hohenleutner^c, Roland Kaufmann^d, Gerd Kautz^e, Wolfgang Kimmig^{f,*}, Michael Landthaler^c, Reinhard Neumann^g, Christian Raulin^h, Nikolaus Seeberⁱ

^a*Dermatologische Klinik, Zentralkrankenhaus, Sankt Jürgen Str. 1, 28205 Bremen, Germany*

^b*cutaris Zentrum für Haut, Venen und Lasermedizin, Candidplatz 11, 81543 München, Germany*

^c*Klinik und Poliklinik für Dermatologie, Universität Regensburg, Franz-Josef-Strauß-Allee 11, 93053 Regensburg, Germany*

^d*Zentrum der Dermatologie der J. W. Goethe-Universität, Theodor-Stern-Kai 7, 60590 Frankfurt am Main, Germany*

^e*Skin and Laser Centre, Am Markt 3, 54329 Konz, Germany*

^f*Kopf- und Hautzentrum, Klinik und Poliklinik für Dermatologie und Venerologie,*

Universitäts-Klinikum Hamburg-Eppendorf, Martinistrasse 52, 20246 Hamburg, Germany

^g*Klinische Abteilung für Spezielle Dermatologie und Umweltdermatosen, Universitätsklinik für Dermatologie,*

Medizinische Universität Wien, AKH Wien, Währinger Gürtel 18-20, A-1090 Wien, Austria

^h*Laserklinik Karlsruhe, Klinik für ästhetische Lasertherapie und dermatologische Kosmetik GmbH,*

Kaiserstraße 104, 76133 Karlsruhe, Germany

ⁱ*Gemeinschaftspraxis Dres. Peter, Seeber, Altheide, Wandsbeker Marktstr. 48-50, 22041 Hamburg, Germany*

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Abstract

The presented guidelines on the use of laser and intense pulsed light (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.

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*Corresponding author. Tel.: +49 40 42803 2638; fax: +49 40 42803 4276.

E-mail address: kimmig@uke.uni-hamburg.de (W. Kimmig).

Requirements

Requirements for physicians who perform dermatologic laser/IPL therapy

Dermatologic laser/intense pulsed light (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:

- *Certification in laser use:* Successful participation in a 1-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).
- *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.

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:

- *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.
- *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.

- *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).
- *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.

Performing laser/IPL treatment: general treatment procedures

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 next Chapter “Performing laser/IPL treatment: laser/IPL type according to main form of laser/light-tissue interaction”).

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 (intra-operative and post-operative, 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.

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.

Cooling the skin

Modern laser systems use different methods for cooling the skin's surface (e.g., contact cooling, cooling spray, and 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.

Pre-treatment

In general, patients should avoid exposure to UV rays to reduce hyperpigmentation of the epidermis. Depending on the planned laser treatment, other pre-treatment 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).

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.

Performing laser/IPL treatment: laser/IPL type according to main form of laser/light–tissue interaction

Laser–tissue interactions that mainly produce thermal coagulation

- *CO₂ laser*: The CO₂ laser (10,600 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 CO₂ laser under “Laser–tissue interactions with a predominantly ablative effect”).

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. Longterm erythema, hyperpigmentation, and permanent depigmentation can occur.

- *Continuous wave (cw) Nd:YAG laser*: The continuous wave Nd:YAG laser (1064 nm, cw, non-specific 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 can occur.

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.

- *CO₂ laser*: CO₂ 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 post-operative pigmentary disorders (permanent depigmentation). 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.

- *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 CO₂ laser (see the given above) or mechanical dermabrasion (using a diamond fraise). One disadvantage of this technique is bleeding if capillaries are opened. Advantages are similar to those of CO₂ laser (see the given above).

Patient information and side effects: Analogous to other pulsed and scanner lasers. Owing to low thermal necrosis, wound healing is analogous to that in dermabrasion.

Selective photothermolysis

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

- *Pulsed dye laser:* Flashlamp-pumped pulsed dye laser (FPDL) (577–600 nm, 200–1500 μs or up to 40 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.

- *Ruby and alexandrite lasers:* The Q-switched ruby laser (694 nm) and alexandrite laser (755 nm), which also emit 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 dyes 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.”

- *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 (see pulsed Nd:YAG laser under “Semi-selective lasers”). 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 re-treatment. Unexpected color changes of tattoo dyes are possible and prior testing is advised. There is a risk of post-therapeutic 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.

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.

- *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.

- *Copper vapor laser*: Continuous wave, pseudo-pulsed laser (578 nm, more specific absorption in hemoglobin than argon laser) with relatively selective vessel coagulation, but similar epidermal coagulation in comparison with argon laser.

Patient information and side effects: Comparable to argon laser.

- *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.

- *Frequency-doubled 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.

- *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.”

- *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 (telangiectasia, spider veins, and 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.

Intense pulsed light (IPL) sources

IPL 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.

IPL 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, telangiectasia, 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.

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.

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 under “Nonvascular

benign neoplasms.” 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.

Vascular conditions

- *Nevi flammei*: The use of yellow-light FPDL 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., CO₂ 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.
- *Telangiectasia*: FPDL, argon laser, copper vapor laser, krypton laser, pulsed Nd:YAG laser (frequency-doubled at 532 or 1064 nm) and IPL devices are equally effective in treating facial telangiectasia. Post-treatment blue-black discoloration associated with FPDL is occasionally bothersome. For more extensive telangiectasia (rubeosis faciei, couperosis, erythrosis interfollicularis) and extrafacial telangiectasia, pulsed laser or IPL 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.
- *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.
- *Spider veins*: In general, fine red spider veins can be treated with FPDL, argon laser, copper vapor laser, KTP laser, or IPL 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 hyperpigmentation is 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.
- *Hemangiomas in pediatric patients/Small, circumscribed initial hemangiomas*: FPDL produces good results; other options are argon laser, copper vapor laser, KTP laser, or IPL, usually requiring several sessions. For 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. For 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, and 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.
- *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 CO₂ laser. Reducing power output and increasing pulse duration is recommended to achieve deeper coagulation.
- *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).
- *Pyogenic granuloma*: For small lesions, cw laser coagulation of lesions in superficial skin layers (see “Angiomas of the lips”) 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.

Nonvascular benign neoplasms (see preliminary note under “Indications in dermatology”)

Xanthelasma, syringomas, sebaceous gland hyperplasia (sebaceous gland epitheliomas), angiofibromas (Brooke’s disease, Pringle’s disease), chondrodermatitis nodularis helioides, 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.

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 CO₂ laser), assuming correct evaluation of treatment indication and technique. The Er: YAG laser is only advisable in very superficial skin changes with minimal infiltration.

Infectious skin diseases/Viral papillomas

There have been reports on successful use of pulsed dye laser and Nd:YAG or CO₂ 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.

CO₂ 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 “Hygiene requirements”). 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.

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.

CO₂ 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 CO₂ or Er: YAG laser followed by Q-switched laser).

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

Scars

- *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, and compression).
- *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 CO₂ laser or Er:YAG laser). The effect and range of adverse effects 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.

Aging skin and wrinkles (skin resurfacing)

- *Ablative 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 CO₂ 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).

- **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 telangiectasia 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., FPD, argon, and frequency-doubled Nd: YAG laser, Q-switched laser, IPL). For type 2-rejuvenation, various lasers are used which either directly or indirectly causes the collagen in the skin to shrink by heating the vessels (these include FPD 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 non-ablative 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.

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.

- **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.

- **Cafe-au-lait spots or nevus spilus:** See also "Lentigines." Recurrence is possible after only a relatively short time. There is lacking knowledge of long-term effects. Test treatment is advisable.
- **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.

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 (CO₂ laser), or initial squamous cell carcinoma affecting specific sites on the body (CO₂ laser).

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, and 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.

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 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.

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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, and Dr. N. Seeber.

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Zusammenfassung

Empfehlung zur Behandlungen mit Laser und hochenergetischen Blitzlampen (HBL) in der Dermatologie

Die aufgeführten Richtlinien zur Durchführung von Laser- und HBL-Behandlungen der Haut entsprechen dem Stand der Lasertechnologie und dem medizinischen Wissen um deren Anwendung aus dem Jahr 2006. Die abgegebenen Empfehlungen richten sich nach den durchschnittlichen Anforderungen an Diagnose und Therapie und können im Einzelfall unzureichend sein. Dies betrifft auch Angaben zur Dosierung bzw. Geräteauswahl, sofern solche vorgenommen wurden. Alle Angaben sollten daher kritisch und unter Einschätzung des jeweiligen Falles übernommen werden.

Schlüsselwörter: Richtlinien; Behandlung; Laser; Hochenergetische Blitzlampen (HBL); Dermatologie

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