Zimmer KOLLEG

TREATMENT MANUAL
Laser Therapy

GB
Lasers in physical medicine

The development of increasingly specific medical laser systems over the last four decades has continuously tailored individual procedures to certain indications via a rational classification system. Appropriate therapeutic targets have therefore been set for laser systems and operating conditions. Certain laser techniques are used even in physical medicine and have undoubtedly proved successful in justified indications. As a special high-performance laser for physical medicine, the Opton has been designed in line with these scientific advances.

Laser radiation is generated through the stimulation and amplification of light (LIGHT AMPLIFICATION by STIMULATED EMISSION OF RADIATION) in special resonators. In contrast to normal light, the following terms are used to define the characteristics of laser radiation:

- Beam intensity
- Monochromatism
- Collimation
- Coherence

**Beam intensity**
Beam intensity is the radiation output emitted per surface area and per solid angle. It is used to describe brightness or power density.

**Monochromatism**
Lasers emit light in a very small frequency or wavelength range. The Opton laser emits light at two near infrared wavelengths of 810 nm and 980 nm.

**Collimation**
Beams of laser light are emitted parallel to each other, i.e. they are collimated. In physical medicine it is important to ensure that no tissue is destroyed. The laser beam of the Opton laser is thus emitted with a beam width of 35°.

**Coherence**
Coherence refers to the in-phase radiation of laser light. Photons oscillate at the same time (temporal coherence) and in the same direction (spatial coherence), thus avoiding any overlapping effects.

**Physical parameters**

\[
\text{Power} \ [\text{W}] = \frac{\text{Energy} \ [\text{J}]}{\text{Time interval} \ [\text{s}]}
\]

\[
\text{Power density} \ [\text{W/cm}^2] = \frac{\text{Laser beam output} \ [\text{W}]}{\text{Beam cross-section} \ [\text{cm}^2]}
\]

\[
\text{Energy density} \ [\text{J/cm}^2] = \frac{\text{Laser energy} \ [\text{J}]}{\text{Beam cross-section} \ [\text{cm}^2]}
\]

Power density and treatment time are the key parameters for treatment. They describe and determine the energy applied to the tissue in terms of time and surface area. Laser power is of secondary importance with regard to the biological effects targeted, since it refers to the power output at the laser source and not the actual power in the treatment area. This should be borne in mind in particular when spacers are used to enlarge the treatment area during Opton laser therapy.
Laser Effects

**General effects**
Laser light is governed by the laws of optics, just like normal light. Laser light is therefore partly reflected on the surface of the tissue and partly penetrates the tissue where it is scattered and absorbed, subsequently interacting with the tissue. A small amount of laser light also passes through the tissue and re-emerges on the opposite side.

In physical medicine, the proportion of laser light scattered and absorbed by the tissue is determined therapeutically. The outcome depends on the location and amount of laser energy that remains in the tissue and is transformed into other forms of energy.

The biological effects of laser light are referred to as biostimulation and thermal effects.

**Interactions**
In the tissue, laser light hits molecules with certain colors and color properties. In the near infrared range (740 nm – 1400 nm), it is mainly absorbed by melanin, myoglobin and hemoglobin. A thermal reaction, i.e. warming of the tissues, is triggered due to the conversion of light energy into heat. The heat thus generated spreads to neighboring tissues via heat conduction.

*Comment: Other effects such as ionization or the decomposing of molecular bonds do not occur with near infrared lasers in the Opton laser energy spectrum.*

Heating the skin limits the total energy since thermal damage could occur if excessively high doses were applied. The total energy administered can be increased through cooling, at least in white skin, since less blood and therefore less hemoglobin are present in the skin as a result of vasoconstriction due to cooling. Less laser energy is thus absorbed and laser light penetrates the tissue to greater depth.

**Biostimulation**
Some of the laser energy is also transformed into chemical reaction energy whereby molecules are stimulated directly via the transmission of electrons and indirectly through the formation of oxygen radicals. Typical examples include stained respiratory chain molecules such as flavoproteins and cytochrome. This leads to an increase in energy metabolism known as biostimulation.
The Opton laser wavelengths of 810 nm and 910 nm lie within the absorption minimum of melanin and hemoglobin. Maximum penetration of the laser light can thus be achieved. Melanin is contained in the epidermis, which forms a very thin layer and can therefore be easily penetrated by laser energy.

**Maintaining frequency and superposition**

These principles apply for radiation intensities such as those used in physical medicine. As regards treatment, this means that different target locations can be anticipated for the two Opton laser wavelengths.

**Comment:** High-energy, pulsed lasers for surgery and coagulation use non-linear effects leading to photoablation and plasma formation. These effects have no impact on the dosage ranges for physical medicine.

**Maintaining frequency**

No new frequencies are generated during the interaction of light with matter. The laser light remains monochromatic despite scatter and reflection, etc.

**Superposition principle**

There is no reciprocal effect between light waves in matter (not even with the two different wavelengths of 810 nm and 980 nm); they disseminate independently of each other.

**Interactions in tissue**

The main therapeutic effects due to the interaction of light with tissue are based on the distribution of light energy in tissue, which is determined by the absorption to scatter ratio of the laser light.

If laser light is strongly absorbed, it transmits energy over a very short distance on the tissue surface. Power density rapidly decreases. Tissue can consequently be accurately destroyed, which is the desired outcome with surgical lasers.

If, however, the laser light is strongly scattered, the tissue is heated evenly and at depth depending on the dose. In addition, scattering leads to higher power density just below the surface of the irradiated tissue. From this point, power density decreases exponentially with increasing depth.

Scatter and absorption are expressed by the scatter and absorption coefficients, namely \( \mu_s \) and \( \mu_a \), respectively. On the one hand, these are intrinsic properties of the tissue per se, and, on the other hand, they depend on the wavelength of the irradiated light.

Both of the wavelengths for the Opton laser light are scattered primarily in the tissue; \( \mu_s \) is greater than \( \mu_a \) — hence they can also be used therapeutically in deeper layers of tissue. The greatest scatter-induced energy density is apparent beneath the epidermis.
This is defined as the tissue depth at which the superficial dose is reduced by approximately 67% by scatter and absorption (= $e^{-1}$).

The depth of penetration depends on the wavelength and the quantity of chromophores, i.e. the colored components, in the path of the laser light in the tissue.

The actual penetration depth of the laser light is not evenly distributed since tissue composition tends to vary in terms of regularity. Water-containing components such as cells and intracellular fluid exist alongside structures carrying blood, such as capillaries. The distribution of melanin-containing chromophores, for instance, is equally irregular.

**Phototypes according to Fitzpatrick:**

**Type I:** Does not tan, always burns (very pale skin, blond hair, blue/green eyes)

**Type II:** Tans occasionally, frequently burns (pale skin, sandy/brown hair, green/brown eyes)

**Type III:** Tans frequently, sometimes burns (average skin color, brown hair, brown eyes)

**Type IV:** Always tans, does not burn (olive-colored skin, brown/black hair, dark brown/black eyes)

**Type V:** Never burns (dark brown skin, black hair, black eyes)

**Type VI:** Never burns (black skin, black hair, black eyes)

The actual penetration depth depends firstly on melanin density (according to skin type), and secondly on capillarization in deeper layers.
The therapeutic effect of the Opton laser is essentially based on the thermal components of energy transmission and the thermal properties of tissue, which depend on heat conductivity and temperature conductance in the respective tissue. In physical medicine, the aim is to achieve therapeutic thermal effects within a temperature range of up to approximately 43°C. Tissue damage may occur at higher temperatures with a corresponding reaction time but has definitely been recorded at temperatures of 50°C and above. With the same laser power, more energy will be generated in the form of heat in fatty tissue than in tissue containing water. Temperature conductance refers to the amount of heat conducted through a tissue with a constant decrease in temperature. This value can be used to calculate how long the tissue needs to gradually cool down. This is known as thermal relaxation time. The latter is extremely important for treatment since it is used to calculate pulse intensity and the subsequent interval required in order to prevent tissue damage following the application of high pulsed doses in particular.

In addition to heat conduction, heat is also transported through tissues via convection. Temperature distribution therefore also depends on the degree of blood flow through the respective tissue. The better the blood flow through the tissue, the more heat is transported via convection.

Compared to fatty tissue, muscle tissue requires more laser energy in order to maintain constant heat at a certain temperature. Superficial cooling via cold air is frequently recommended during laser therapy if the thickness of the layer of fat over the muscle is considerable. The scattering of laser light in the surface layers will trigger a greater temperature rise beneath the skin, as illustrated in the examples shown below. Cooling is therefore recommended when doses are high with a correspondingly long irradiation time. Comment: Cooling is not required with dynamic radiation.

**Biostimulation**

The stimulation of energy metabolism in the cell respiratory chain allows tissue lesions to heal more quickly. This occurs regardless of the thermal effects of the laser light.

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### Absorption of laser radiation by water and blood

<table>
<thead>
<tr>
<th>Wavelength</th>
<th>Absorption coefficient</th>
<th>Penetration depth</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Water</td>
<td>Blood</td>
</tr>
<tr>
<td>10600 nm (CO2 laser)</td>
<td>10³ cm⁻¹</td>
<td>10³ cm⁻¹</td>
</tr>
<tr>
<td>1060 nm (Nd:YAG laser)</td>
<td>0.1 cm⁻¹</td>
<td>4 cm⁻¹</td>
</tr>
<tr>
<td>514 nm (argon-ion laser)</td>
<td>0.001 cm⁻¹</td>
<td>330 cm⁻¹</td>
</tr>
</tbody>
</table>

### Various heat conduction coefficients

<table>
<thead>
<tr>
<th>Tissue Type</th>
<th>Heat conductivity [W/(cm·K)]¹⁰³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatty tissue (human)</td>
<td>3.00</td>
</tr>
<tr>
<td>Heart (human), 81 % water</td>
<td>5.87</td>
</tr>
<tr>
<td>Kidneys (human), 84% water</td>
<td>5.45</td>
</tr>
<tr>
<td>Liver (human), 77% water</td>
<td>5.86</td>
</tr>
<tr>
<td>Water</td>
<td>5.59</td>
</tr>
<tr>
<td>Blood</td>
<td>6.20</td>
</tr>
<tr>
<td>Copper</td>
<td>4180.00</td>
</tr>
<tr>
<td>Air</td>
<td>0.20</td>
</tr>
</tbody>
</table>

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*Source: Einführung in die Lasermedizin (Introduction to Laser Medicine), Institute for Laser Medicine, Heinrich-Heine University, Ed.: Hering P.; H.-J. Schwarzmaier*
The therapeutically useful mechanisms described below depend less on the effect of the laser light at depth than on the site and strength of the stimulus. Besides treating the affected site, the dose administered that is effective without causing thermal damage is crucial. The therapist calculates the required dose on the basis of the warmth threshold test, which is described further on in this manual. In the case of deeply lying sites, a high dose is occasionally required. This is accompanied by the risk of thermal damage to the skin. Surface cooling via a current of cold air is recommended in these cases.

**Analgesic mechanisms**
Laser light is scattered over the skin and is subsequently absorbed. It is mostly transformed into heat. Weak heat stimulation of the nociceptors of the skin triggers the well-known segmental pain-inhibiting reflexes via the first and second neuron. This is referred to as the Gate Control Theory. Powerful thermal stimuli activate the endorphinergic neural and humoral pain-inhibiting system. Both mechanisms are suitable for treating musculoskeletal pain.

**Reflective effects**
Laser light-mediated segmental reflexes relax the muscles as well as prevent pain. Powerful thermal stimuli are needed in order to trigger this effect.

**Tissue regeneration**
The acceleration of healing processes described comes about mainly through activation of the fibroblasts. The non-thermal nature of the activation process should be emphasized, meaning that only small amounts of laser light energy are therefore required. Depending on the site of the lesion, the reduction in laser light intensity in the tissue will dictate the laser power required, so that in the case of deeper structures such as tendons or joint capsules, high surface doses may prove essential.
The Opton laser simultaneously emits laser light at two wavelengths, namely 810 nm and 980 nm, the total output being halved for each wavelength. Output can be continuously adjusted from 0 W to the maximum value.

**The various laser light release modes**
The laser light release mode used depends on different factors:
- the depth of the site of disease and the purpose of the therapy:
  - analgesia
  - improvement in blood flow
  - muscle relaxation
  - acceleration of healing

**CW mode**
The continuous emission of light, also known as continuous wave, is the most frequently used operating mode. If a high output is applied over a prolonged period, attention must be given to the possibility of overheating the tissue.

**Serial pulses**
With this operating mode, the continuous wave is automatically briefly interrupted at regular intervals. This is recommended for the treatment of deeper sites in particular, in order to prevent the skin from overheating. The discontinuous emission of laser light will allow the surface tissue to cool during the pauses. This substantially reduces the risk of overheating it, especially in dark-skinned subjects, even when a high amount of energy is transferred to the deeper layers.

**Single pulses**
Single pulses are suitable for transmitting high amounts of energy to specific sites, e.g. when treating trigger points or acupuncture points. Single pulses are administered statically.

### Programme | Recommended indication
--- | ---
PO0 | Unpulsed
PO1 | Serial pulse – 0.5 Hz
PO2 | Serial pulse – 1.0 Hz
PO3 | Serial pulse – 2.0 Hz
PO4 | Single pulse – 0.25 sec.
PO5 | Single pulse – 1.0 sec.
PO6 | Unpulsed / serial pulse 1.0 Hz
PO7 | Unpulsed / serial pulse 0.5 Hz
PO8 | Serial pulse – 25 Hz, duty factor 1:1
PO9 | Serial pulse – 4 Hz, duty factor 1:2

For combined treatment:
- Trigger points - static
- Dynamic for muscles in the treatment area

For dynamic surface treatment in painful situations:
- Duty factor 1:1, for pale skin and chronic stage of disease
- Duty factor 1:2, for darker skin and sub-chronic stage of disease
Application techniques

Three options are available:
- Static application
- Dynamic application
- Combined application – static and dynamic.

The high output of the Opton laser means that the treatment can be applied statically to specific areas and dynamically to larger areas. The spacer positions the laser head at a defined distance from the skin. Because of the spread of the laser beam over an angle of 35°, the treatment field is larger than when the beam comes into direct contact with the skin. In the afore-mentioned indications, the laser head/spacer must always be placed vertically onto the treatment area otherwise only a portion of the laser power is effective and the radiation from the invisible laser beam can be dangerous to the patient and the operator.

**Static application**
With static application, the laser head/spacer is placed on the site to be treated and is not moved. Erythema may develop locally after treatment. Static application is always used when the area to be treated is small (e.g. with tendinitis, when the tendon insertion point is to be treated). Static laser light application is particularly suitable for trigger points and acupuncture points.

It is recommended to use the spacer 1 (3.1 cm² treatment area for static application to a specific site, with the 7 W laser. 10 – 20 joules per treated point are recommended for static treatment.

**Dynamic application**
In dynamic application, care must be taken to see that the probe/spacer is always positioned at right angles to the skin surface in order in the first instance to prevent any danger arising from the scattered laser light, and secondly to maintain an effective irradiation angle. The laser head can be moved either backwards and forwards or in circular movements when treating smaller areas. Larger areas are treated more efficiently when divided into smaller sections. Dynamic application is used when the area to be treated is relatively large, e.g. for a torn muscle or a joint.

It is recommended to use the spacer 1 with a treatment area of approximately 3.1 cm² for dynamic treatment with a 7 W laser.

Approximately 50 joules/cm² (sub-acute) – 100 J/cm² (chronic) is the recommended dose guide for subjects with skin types I-IV. Spacer 2 with a treatment area of approximately 9 cm² is recommended for dark-skinned subjects (skin types V and VI).
Combined application – static and dynamic
Very often, pain is not evenly distributed in the treatment area. With many pain syndromes, maximum points such as trigger or pain points lie within the painful region. The trigger points causing the pain are also frequently outside the painful area since they produce radiating pain. Trigger points and principal pain points are treated statically whilst other painful areas are treated dynamically.

Duration of treatment
Dynamic treatment is longer than static treatment.

Whereas the desired energy dose is reached within a few seconds in the case of static treatment of points, the treatment area for dynamic therapy is considerably larger resulting in a longer treatment period. Consequently, the treatment area should not be too big.

High-dose laser treatment
If very high doses are to be administered, the skin can be cooled during treatment with a current of cold air. Cooling should be initiated approximately 1 – 2 minutes before the laser therapy.

Dosage and power
Skin type is crucial in this respect, regardless of whether static or dynamic therapy is being applied. High power is delivered in the case of static application. In dynamic therapy, the laser head is moved backwards and forwards or in circular movements when treating small treatment fields. Larger areas are divided into smaller sections.

In both cases, the laser is applied until the patient feels the heat. The onset of heat-induced pain is a sign of overdose. The affected area should be cooled immediately in order to avoid skin damage.

Since the laser probe is no longer in direct contact with the surface of the skin in dynamic therapy, in contrast to static application, dose-finding must be based on energy density. Energy density is the amount of energy in joules per cm². It is proportional to the distance between the probe and the surface of the skin. It decreases with distance. The greater the distance between the probe and the skin, the lower the energy density.
Determining the warmth threshold

The warmth threshold test is useful for avoiding overdose in subjects with darker and dark skin (skin types IV, V and VI), especially during treatment in CW mode.

Laser energy is scattered over the skin and absorbed to a large extent. In the process, pain-inhibiting reflexes are also triggered. The skin may already be overheated before pain indicating the imminent threat of tissue damage is perceived. This mainly applies to static therapy. If the energy level is too low (red-dotted line in the diagram), the warmth threshold is only perceived after 12 seconds. The tissue temperature could already be high enough to cause damage.

If the energy level is too high, the warmth threshold will peak too early before a sufficiently large, effective amount of energy is applied to the tissue.

Intact thermal perception is a pre-requisite for the warmth threshold test. If this is disrupted locally, the test should be carried out on a heat-sensitive site. In the event of a generalized decrease in temperature perception, the test cannot be carried out.

Practical experience has shown that the subjective heat threshold must be reached between 7 and 11 seconds. The correct power output for treatment (green section of the curve) can thus be determined. The amount of energy (without cooling) must not be too high, in order to avoid thermal damage. Laser treatment is carried out until the desired amount of energy is achieved per point. Heat-related damage can be avoided by reducing the power until the pain disappears or by introducing a brief pause once the heat-pain threshold has been reached.

Point a) in the diagram: power is too high, pain threshold is reached => reduce power
Point b) in the diagram: the correct power has been selected. Heat is perceived. No pain-related damage occurs
Point c) in the diagram: the power is too low, the heat threshold is reached too late or not at all => increase the power

The warmth threshold test provides a useful indication for adjusting the energy dose for dark skin. Regardless of this, every effort must be made during treatment to ensure that heat-related pain does not occur. If pain does occur and the dose stays the same, either leave a greater distance between the laser and the skin (spacer) or move the laser head faster over the treatment area. The power can also be reduced.
Treatment with the Opton laser

The type of operating mode selected will depend on the patient’s skin type. Since laser energy is absorbed in large quantities by melanin, the temperature of the skin quickly rises in dark subjects and may cause damage. (In pulsed mode, the laser energy is delivered interrupted, thus delaying any rise in skin temperature).

- CW mode is selected for pale skin (phototypes I and II)
- Serial pulses are selected for tanned or olive-colored skin (phototypes III and IV) and for dark or black skin (phototypes V and VI).

The greater the pigment density, the lower the laser energy required.

**Selection of treatment parameters**

- Laser power [W]
- Treatment area in the case of dynamic application [cm²]

**Transmitting laser energy using spacers**

Power density is defined once more for the purposes of clarification:

\[
\text{Power density [W/cm}^2\text{]} = \frac{\text{Laser beam output [W]}}{\text{Beam cross-section [cm}^2\text{]}}
\]

It is determined via the following parameters:

- Power output of the laser head [W] and
- Beam cross-section [cm²];

The laser beam of the Opton laser is spread over an angle of 35°, hence the power density is reduced in proportion to the distance of the laser head from the skin.

- Maximum energy transmission occurs on direct contact between the laser head and the skin. This form of treatment should be administered carefully to avoid thermal damage to the skin.

Power density on the skin can only be varied by changing the two parameters above, output and distance from the skin.

**Session procedure with the Opton Laser System**

As mentioned earlier, Opton laser therapy can be administered either statically or dynamically. Purely static therapy is applied solely to trigger points or isolated pain points, and acupuncture points. Dynamic therapy is geared to a painful region. Both techniques should be used in succession in one session.

1st step: Targeted irradiation of the pain and trigger points until the pain threshold is reached.
2nd step: Dynamic laser therapy in the treatment area.
With combined treatment, care should be taken to ensure that static therapy is initially applied to the pain and trigger points. The procedure is described under “Static treatment”. Extensive treatment can then be continued with dynamic application.

**Static treatment**
The pain points and trigger points for static treatment are initially palpated. The heat threshold is then established for a starting dose of 2 watts, in accordance with the criteria outlined above. The treatment is then administered with the power output determined in the test. Every pain point or trigger point is treated. It should be borne in mind that trigger points frequently lie outside the pain area.

Skin type should also be taken into account for static treatment.

**Point treatment technique**
A pain or trigger point should only be irradiated until total energy of 20 joules is reached, depending on tolerance (pain threshold). Serial pulses are applied depending on skin type. Treatment continues until the patient actually feels the heat. Heat-related pain must be avoided. If the heat is perceived as being too great, the laser power is reduced until the intense sensation of heat has subsided. Take a short break.

**Dynamic treatment**
Treatment time
The maximum laser energy to be transmitted during the dynamic treatment of a chronic disease in one session is 100 J/cm². In the case of an acute disease, the maximum transmissible energy is 50 J/cm². The session should be divided into cycles, a cycle always ending if heat-induced erythema appears. In this case, the distance between the laser head and the skin should be increased or the power reduced. If severe skin redness and/or heat-induced pain occurs, there should be a pause for cooling and the treatment thus divided into cycles. The treatment period thus corresponds to the power density and the area for treatment, 1 joule being transmitted per second and watt.

Daily treatment sessions are recommended. In acute stages, the series should comprise at least five sessions. Based on experience acquired to date, chronic stages can comprise ten sessions. The minimum course of treatment is two sessions per week.

**Combined treatment – static and dynamic**

01 Thumb extensor tendons
02 Between metatarsal V and the hamate bone
03 Extensor carpi radialis longus muscle
04 Deltoid muscle at insertion onto humerus
05 Fossa between anterior and medial deltoid muscle
06 Pectoralis minor muscle
07 Trapezius muscle
08 Rhomboïd muscle
09/10 Quadratus lumborum muscle
11 Medial gluteal muscle
12 Piriformis muscle
13 Vastus medialis muscle
14 Peroneus longus muscle
15 Anterior tibial muscle
16 Dorsal foot
17 Approximately 2 cm medially from the medial malleolus (tendon of the tibialis anterior muscle)
Contraindications

Caution
Thermal damage to the skin often occurs at excessively high doses. If local or generalized pain perception is impaired, the warmth threshold test cannot be carried out. In this case, the skin should be examined regularly for redness and other signs of a thermal reaction.

- Irradiation of the eyes
- Irradiation of glandular tissue (e.g. thyroid gland, testes, ovaries)
- Irradiation of epiphyseal plates in children
- Acute inflammation
- Irradiation of malignant, semi-malignant and benign tumors
- Radiogenic skin damage and skin atrophy
- Onset of a photosensitivity reaction (e.g. urticaria) during the course of treatment
- Hematoma of recent occurrence
- Pregnancy
- Abdomen and lower back during menstruation
### Opiton laser treatment procedures

#### Summary table for Caucasians

(Subjects with dark and very dark skin must only be treated with the laser power calculated in the warmth threshold test):

<table>
<thead>
<tr>
<th>Static procedure</th>
<th>Single pulse</th>
<th>7 W (pulse parameters: see below) + spacer 1: 3.1 cm²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Serial pulse</td>
<td>7 W (pulse parameters: see below) + spacer 1: 3.1 cm²</td>
</tr>
<tr>
<td>Dynamic procedure</td>
<td>Continuous</td>
<td>7 W + spacer 2: 9.0 cm²</td>
</tr>
<tr>
<td>Semi-static procedure</td>
<td>Continuous</td>
<td>Spacer 1: 3.1 cm², 2 W Spacer 2: 9.0 cm², 3.5 W</td>
</tr>
</tbody>
</table>

#### Highest permissible pulse widths depending on skin type

Individual tolerance should be determined with the warmth threshold test even in the pulsed mode for subjects with dark (type V) and very dark (type VI) skin:

<table>
<thead>
<tr>
<th>Skin type</th>
<th>Pale skin</th>
<th>Brown/olive-colored skin</th>
<th>Black skin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single pulse</td>
<td>1 s</td>
<td>0.5 s</td>
<td>0.1 s</td>
</tr>
<tr>
<td>Serial pulse</td>
<td>0.5 Hz</td>
<td>1 Hz</td>
<td>1 Hz</td>
</tr>
</tbody>
</table>

#### Laser therapy guidelines

<table>
<thead>
<tr>
<th>Skin types (Caucasian) I – IV</th>
<th>Skin types V – VI</th>
<th>Orthopedic indications</th>
<th>Dermatological indications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orthopedic indications</td>
<td></td>
<td>Dynamic</td>
<td>30 J/cm² max 50 J/cm²</td>
</tr>
<tr>
<td>Sub-acute/acute</td>
<td>Dynamic</td>
<td>Static</td>
<td>10 J/cm² max 30 J/cm²</td>
</tr>
<tr>
<td>Chronic</td>
<td>Dynamic</td>
<td>Static</td>
<td>50 J/cm² max 100 J/cm²</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>20 J/cm² max 80 J/cm²</td>
</tr>
<tr>
<td>Dermatological indications</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skin lesions (blister, ulcer)</td>
<td>10 J/cm²</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intact skin</td>
<td>20 J/cm² max 50 J/cm²</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Further indications

Myopathy, Tendinopathy

Adhesive capsulitis of shoulder

Dynamic surface area treatment of the acromion:
50 J/cm²

Infraspinatus muscle and insertion tendinopathy

Static trigger point treatment:
20 J per point

Combined local treatment of the insertion of the infraspinatus tendon, static and dynamic
50 J/cm²

Supraspinatus muscle and insertion tendinopathy

Static trigger point treatment:
20 J per point

Combined local treatment of the insertion of the supraspinatus tendon, static and dynamic
50 J/cm²

Dosing details, given in joules, are the minimum amount of energy to be transmitted.
Dosing details, given in joules, are the minimum amount of energy to be transmitted.

**Long biceps tendon**

- Combined local treatment, static and dynamic: 50 J/cm²

**Adductor insertion tendinopathy**

- Dynamic surface area treatment: 50 J/cm²

- Static trigger point treatment: 20 J per point

**Radial epicondylopathy**

- Dynamic surface area treatment: 50 J/cm²

- Combined local treatment static and dynamic: 50 J/cm²

- Static trigger point treatment: 20 J per point
**Myopathy, Tendinopathy**

### Ulnar epicondylopathy

- **Dynamic surface area treatment:** 50 J/cm²
- **Combined local treatment, static and dynamic:** 50 J/cm²
- **Static trigger point treatment:** 20 J per point

### Patellar apex syndrome

- **Dynamic surface area treatment:** 50 J/cm²

### Greater trochanteric tendinopathy

- **Dynamic surface area treatment:** 50 J/cm²

### Achillodynia

- **Dynamic surface area treatment:** 50 J/cm²
Dosing details, given in joules, are the minimum amount of energy to be transmitted.

Plantar fasciitis

Dynamic surface area treatment:
50 J/cm²

Pes anserine tendinopathy

Dynamic surface area treatment:
50 J/cm²

Low back pain

Painful muscle tension

Dynamic surface area treatment:
50 J/cm²

Static treatment of trigger and irritation points:
20 J per point

Sciatica

Static trigger point treatment:
20 J per point
Facet syndrome

Combined local treatment, static and dynamic:
50 J/cm²

Arthrosis

Degenerative disease of the knee joint

Dynamic surface area treatment of the quadriceps tendon and intra-articular space:
50 J/cm²

Static point treatment:
20 J per point

Rhizarthrosis

Dynamic surface area treatment:
50 J/cm²

Cervical spondylarthrosis

Dynamic surface area treatment:
50 J/cm²
Dosing details, given in joules, are the minimum amount of energy to be transmitted.

Cervical spondylarthrosis

Static treatment of the irritated segments (C4-C7):
20 J per point

Combined local treatment of the irritated muscle points, static and dynamic:
10 J per point

Trauma

Ankle sprain

Dynamic surface area treatment:
50 J/cm²

Pulled muscle, torn muscle

Dynamic surface area treatment:
50 J/cm²

**Entrapment syndromes**

**Carpal tunnel syndrome**

**Dynamic surface area treatment:**
50 J/cm²

**Morton's neuralgia**

**Dynamic surface area treatment:**
50 J/cm²

**Skin diseases**

**Acne vulgaris**

**Dynamic surface area treatment:**
20 J/cm²

**Herpes simplex**

**Dynamic surface area treatment:**
20 J/cm²

**Verrucas**

**Static treatment:**
20 J per point

**Anogenital warts**

**Static treatment:**
20 J per point

**Wound healing disorders**

**Dynamic surface area treatment:**
10 J/cm²

**Leg ulcer**

**Dynamic surface area treatment:**
10 J/cm²

**Decubitus ulcer**

**Dynamic surface area treatment:**
10 J/cm²
Lasers are divided into different classes depending on performance.

Unlike traditional soft lasers, the Opton is a class 4 device due to its high performance level.

Class 3b or 4 lasers must meet certain technical safety requirements.
In 1987, legislation stipulated that every practice operating a class 3b or 4 laser had to officially appoint a laser protection officer.

Proof of the appointment must be on display in the laser room and is inspected by occupational safety officials (previously the Trade Supervisory Board/Faculty Inspectorate).
On the one hand, the role of laser protection officer can be assumed by the actual operator after appropriate training.

On the other hand, there is an option to appoint an external laser protection officer. In this case, a written agreement must be concluded with the person in question.

Knowledge of the German professional Accident Prevention Regulation (UVV) on Laser Radiation and entitlement to the role of laser protection officer is generally acquired through special training and a subsequent certificate.

Further consecutive national regulations have to be observed.
The laser protection officer and his/her duties in Germany

The laser protection officer must ensure that the necessary safety instructions and protective measures as required by the Accident Prevention Regulation (UVV) on Laser Radiation have been implemented.

The laser protection officer must:
1. Inspect and check the room/premises in which the laser treatment is administered
2. Check the technical safety provisions, focusing in particular on the installation of the door contact switch, the warning lamp and the necessary signs for laser procedures
3. Organize technical safety training for operators and provide appropriate operating instruction
4. Inform the competent industrial safety authority and professional body that the device has been installed
5. Carry out an annual inspection of the practice to check technical safety provisions and arrange safety refresher courses for operators.

Further consecutive national regulations have to be observed.
The laser protection officer must ensure that the necessary safety instructions and protective measures as required by the Accident Prevention Regulation (UVV) on Laser Radiation have been implemented.

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