QuadroStar

APPLICATION MANUAL

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Important information for the user:

The therapeutic guidelines contained in this manual shall assist you in the practical use of laser therapy in connection with this laser device. The information provided reflects the state of the art in this field. The editor does not assume any liability for any errors, which cannot be precluded despite all due care taken in writing this manual.

The responsibility for the therapeutic procedures performed in connection with this manual solely lies with the user.
The manual does not represent a replacement for clinical experience in laser therapy, hands-on training supervised by an experienced clinician or personal practical experience.

This Application Manual is valid only in connection with the User's Manual of the laser device. Observe all warnings given there for the use of this Class IV laser device!

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Please address your questions to the above address.

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1.1 General

For more than 30 years, lasers have been used in medical applications. Compared to the large number of treatments performed successfully with laser devices, the number of incidents is insignificant. Nevertheless, the use of laser devices requires a very high degree of attention and care. Negligent use of laser radiation may cause serious injury to user and patient.
The radiation emitted by a laser device is of very high intensity and may be dangerous even at some distance to the laser aperture. Incorrect application of laser radiation may cause severe damage to eyes, burns of body tissue.
Non-compliance with the instructions of the user's manual and this application manual may represent a potential risk to the physician, patient and third persons. This application manual describes the use of the laser device as a medical device.
It is the sole responsibility of the attending physician to decide about the suitability of the device and the appropriate treatment method. Under no circumstances, you should perform any treatment if there is the slightest doubt whether the device works properly.

Generally, the operation of this laser device is subject to the following standards and regulations: Regulations on the Prevention of Accidents by Laser Radiation BGV B2, European Standard EN 60 825-1, the German Medical Product Act (MPA) and the German Medical Devices Operator Ordinance (MPBetreibV).

The use of controls or adjustments or performance of procedures other than those described in this Application Manual and the User's Manual may result in hazardous laser radiation exposure.

Never remove the protective covers of the device.

The casing of the laser device may be opened only by specialists employed with or authorized by Asclepion Laser Technologies GmbH. Any attempt of unauthorized persons to service the device may be highly dangerous and will instantly void all warranties.

1.2 Important considerations before the first treatment

The Application Manual in hand contains detailed information on the operation and application of the laser device. This information, of course, can never replace the thorough study of medical literature, personal experience gained under supervision of expert personnel and critical assessment of the situation.
The information provided is to serve as an orientation aid for beginners and for those who do not work regularly with the device.
Before you begin treating patients yourself, we recommend you to study current medical literature as well as contact clinics and physicians in private practices using such type of equipment in order to familiarize with the methods of laser treatment.
We will readily assist you in getting into contact with other laser users. The responsible representative of Asclepion Laser Technologies GmbH will readily inform you accordingly in detail.

Make sure you have understood the principles of laser / tissue interaction, the correlation between the individual application parameters, the application techniques as well as the basics of laser safety.

If you have the slightest doubt, consult experienced colleagues and/or application specialists of Asclepion Laser Technologies GmbH before you begin laser treatment.

1.3 Safety precautions

Improper application of laser light may cause damage. The greatest potential hazards exist to the human eye, as even very low beam intensities may cause irreversible damage to the retina because of the focusing effect of the eye lens.
The nature of injury mainly depends on the wavelength of the laser light.
To ascertain the applicable threshold values of laser power and energy it is necessary to study the relevant complex tables.
For easier reference, a classification of laser devices was introduced which provides direct information about the degree of hazard of a specific laser device [EN 60 825-1, (internationally: IEC 60 825-1)].

Laser Safety

Short form: (For detailed information, refer to the above documents.)

Class 1 The accessible laser radiation is not hazardous.

Class 1M Only applies to the spectral range from 302.5 nm to 4000 nm; these lasers may be hazardous if optical instruments are used in the laser beam.

Class 2 Only applies to the spectral range from 400 nm to 700 nm; they are safe if blink or aversion responses of the eye operate.

Class 2M Only applies to the spectral range from 400 nm to 700 nm; they are safe if blink or aversion responses of the eye operate, but pose a risk if optical instruments are used in the laser beam.

Class 3R Only applies to the spectral range from 302.5 nm and 4000 nm; normally, directly staring into the laser beam is hazardous, but the risk is less than with Class 3B laser devices.

Class 3B Normally, directly staring into the laser beam is hazardous, while the observation of diffuse reflections of the laser beam is usually non-hazardous.

Class 4 Even diffusely scattered laser radiation of these lasers is hazardous to the human eye and may be hazardous to the skin as well. There is a potential risk of fire and explosion.

All laser devices customarily used in dermatological therapy are classified in the class of the highest potential hazards (Class 4). Thus, they additionally require protection from diffusely reflected beams.

Official regulations bind the owner/operator of laser devices to take a number of safety precautions. In addition, for owners/operators of medical laser devices, the German Medical Product Act and the Medical Devices Operator Ordinance apply.
These guidelines among other things prescribe that the following precautions must be taken for medical laser applications:

- Mark the laser area (normally the room where the laser is used) and the laser device with laser warning signs.
- Avoid reflecting surfaces in the laser treatment room.
- Remove combustible substances from the laser area or take the necessary precautions to prevent them from being ignited.
- Check the laser device, the optical fiber and the handpieces for visible defects.
- Observe the instructions given in the User's Manual and the Application Manual provided by the manufacturer.

Laser Safety

- Check the proper function of the safety devices before using the laser device.
- When the laser device is switched on, this state must be clearly visible on the laser device and the entrances to the laser area (warning lamp).
- Make sure that operator, patient and personnel present in the laser area wear laser protective eyewear of an optical density appropriate for the wavelength of this laser according to EN 207. Verify that the protective eyewear is in perfect condition before using it.
- Warn all persons present in the laser area when you are going to switch on the laser device.
- Avoid the generation and spreading of flammable gases or vapors (explosion hazard) in the laser area.
- Provide for efficient smoke evacuation systems for generated vapor (in vaporization).
- Protect the handpieces (especially the optical end faces) from contamination.
- Make sure to use only agents and techniques for cleaning and disinfection approved by the manufacturer.
- Instruct operating personnel on safety aspects once a year.
- Take care to ensure a stable installation of the laser device.

2 Introduction – Basics of Laser Technology

2.1 The laser

Since MAIMAN invented the laser in 1960, it has established itself in all branches of science and technology. Today, modern medicine cannot be imagined without lasers (the first dermatological application by Goldmann dates back to 1963).
Laser is the acronym for „**L**ight **A**mplification by **S**timulated **E**mission of **R**adiation“.
What is typical of a laser? From a practical point of view, the laser is a light source emitting a narrow beam. This beam has a defined wavelength and its uniform waves propagate with little divergence, i.e. almost parallel (collimated), and in phase (coherent).
Lasers are available in the wavelength regions from ultraviolet to infrared with laser powers or energies ranging from a few fractions of a milliwatt for medical applications to the kilowatt range of high-power lasers for use in industry.
If excitation is continuous, the laser is referred to as continuous-wave laser (cw-mode, for instance, argon lasers). If excitation is performed by a single pulse, the laser is called a pulsed laser (e.g. erbium lasers). If the excitation energy is accumulated and then suddenly released, the laser is referred to as a q-switched laser (such as q-switched ruby lasers).

2.2 Physical fundamentals

Inside the laser, energy is pumped into an "active medium". Subsequently, the medium is stimulated to release the stored energy in the form of light. This light is then bundled into a beam by means of mirrors in a so-called resonator.
The medium may be a gas (e.g. argon in a tube), a liquid (e.g. a dye in a solution) or a solid (e.g. a ruby rod, diode).
In general, a light wave is generated when an atom "drops back" from an excited state of a high energy level to a lower-energy state. The difference between the two energy levels corresponds to the energy of the emitted wave and has a defined wavelength (color).
To generate a laser beam, the number of atoms in excited state in a specific active medium must be higher than that of the lower energy level. This kind of energy distribution is called "inversion".
In the laser, emission is triggered artificially by letting a light wave collide with an atom of the same energy. This will do to excite the atom to emit an own wave of the same frequency. That's why this process is referred to as "stimulated emission".

The collimated laser beam is generated by a resonator. In its simplest form, the resonator consists of two parallel mirrors with the laser medium lying in between. If in the medium many light waves are generated by emission, the two mirrors will always reflect those waves back into the medium that are perpendicularly incident on them. Passing through the medium the reflected waves again will hit excited atoms and stimulate them in turn to emit light.
This process is continually proceeding avalanche-like and thus the intensity of the light beam is continuously increasing. At one end of the resonator, a partially reflective mirror is used, which outputs the laser beam, if the threshold intensity is exceeded.

The way, how energy is pumped into the laser thus "charging it up", depends on the active medium used. The customary pumping methods are based on the excitation by high-intensity light, the so-called "optical pumping" (e.g. on ruby lasers), on the excitation by an electrical gas discharge (e.g. on argon lasers), or on direct electrical pumping (diode lasers).

2.3 Technical aspects of the *QuadroStar*

The *QuadroStar* is available with four different wavelengths:
532nm (green), 808nm, 938nm and 978nm (all infrared),
as well as the combination of 532 nm with any of the infrared wavelengths.

The ***QuadroStar* 532** is a frequency-doubled, diode-pumped solid-state laser and based on a newly developed DISC laser technology. Its basic design is shown in Figure 1. The laser DISC consists of a very thin neodymium vanadate crystal ($Nd:YV0_4$), which emits a fundamental beam of 1,064 nm by optical pumping. This beam is converted to a frequency-doubled laser beam of 532 nm (green light) by a lithium triborate (LBO) crystal (frequency-doubling means halving the wavelength).
Compared to the conventional solid-state rod designs, the advantage of this disc geometry is the considerably improved heat management and the higher beam quality. The conversion of the supplied total energy to light energy achieves an efficiency of > 10%, which is very high for this technology.
The laser emits light in the form of a continuous wave with a maximum power of five watts on the skin. The light beam is modulated (e.g. pulse duration and pulse interval) directly by switching the diode current on and off.
The green light is delivered to the skin through a flexible quartz fiber and a handpiece with attached lens. The spot size can be varied, but is intentionally kept small (max 1.5 mm) to obtain a maximum power density. The following spot sizes are selectable: 0.5 mm, 1.0 mm and 1.5 mm.

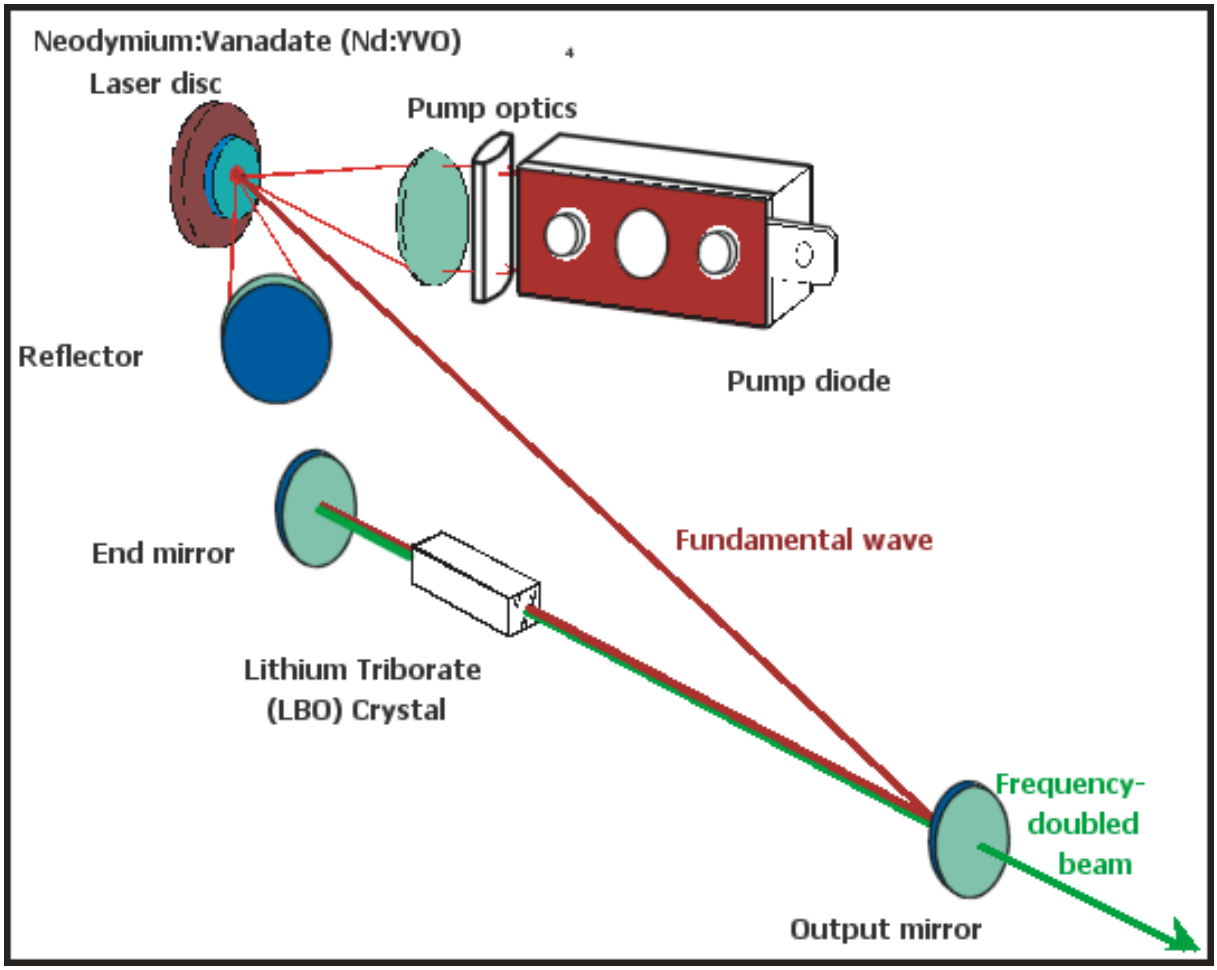


Fig. 1: DISC laser technology of the QuadroStar 532

The ***QuadroStar* 810**, ***QuadroStar* 940** and ***QuadroStar* 980** are diode lasers of 808 nm, 938 nm and 978 nm wavelength, similar to the above mentioned laser diode for pumping the disc. On the diode laser, the radiation is generated by direct conversion of the supplied current to laser light, which is then coupled into the application fiber through an optical system.

3 Safety Notes

In the Application Manual, the following symbols are used to refer you to risks and important notes.

Risk of accidents or physical injury.

Risk of technical damage.

The *QuadroStar* complies with the requirements of the German Medical Product Act (MPG) and thus those of the EC Medical Device Directive (93/42/EEC).
Observe the German Medical Devices Operator Ordinance (MPBetreibV) or the relevant national legislation and regulations regarding the operation of laser devices.

The EC Medical Device Directive (93/42/EEC), MPG and the Medical Devices Operator Ordinance (MPBetreibV) bind the owner/operator, the authorized persons and users of Class IIb devices to take a number of safety precautions. In particular, such devices should be operated only in accordance with the generally accepted rules of technology and the relevant regulations on labor safety and the prevention of accidents.

In handling medical laser devices, observe the currently binding version of the relevant regulations on the prevention of accidents by laser radiation. Furthermore, you are bound to keep a medical device logbook, which is also enclosed with this manual. Our service technician will assist you in filling it in as part of the startup procedure.

Please note that this device must be checked annually for technical safety. The results of these safety checks must be recorded in the medical device logbook.

The laser device must not be installed in explosion-risk areas.

Only persons employed with or authorized by Asclepion Laser Technologies GmbH are allowed to service, repair or modify the device.

Safety Notes

The Regulations for the Prevention of Accidents by Laser Radiation of the German Professional Associations (or any equivalent national regulations) lay down general rules for the protection against hazardous laser exposure. In the context of medical application, they aim to protect operating personnel during laser operation. The laser devices are classified in different classes depending on the potential risks involved.
The ***QuadroStar*** is classified in **Class 4**.

This classification means that improper use of the device constitutes risks to the eyes by direct and scattered laser radiation. Besides, the laser radiation may cause fire and explosion hazards.

To avert these risks, the above regulations bind the owner/operator of the device, inter alia, to meet the following requirements:

- Before initial start-up, the intended use of the laser must be notified to the competent Professional Association and the labor-safety authority.
- A Laser Safety Officer must be appointed in writing.
  The duties of the laser safety officer should include at least the following:

  ⇒ Supervision of the operation of the laser device

  ⇒ Assistance to the owner/operator to ensure safe operation and implement the necessary safety precautions

  ⇒ Co-operation with labor-safety specialists in fulfilling their tasks, including the information about important issues of laser radiation protection.
- While the laser is in operation, the area in which the maximum permissible radiation level may be exceeded, the so-called "laser zone", must be delimited and marked by a laser warning sign. Warning lamps at the entrances must indicate the operation of the laser.

- Personal eye protection: All persons present in the laser zone must wear laser protective eyewear. The laser protective eyewear must provide the following protection levels:

- **532nm (green):**
  Minimum protection level **L4 for D 532nm**

- **808nm, 938nm and 978nm (infrared):**
  Minimum protection level **L3 for D 808-978nm**

  (as per EN 207 in the currently valid version)

4 Information on Laser Treatment with *QuadroStar* 532

4.1 Biophysics of the interaction of light and tissue

The **energy**, **exposure time** and **wavelength** of the laser are the decisive parameters for the biological response. The various constituents of tissue (water, hemoglobin, other pigments) absorb light of different wavelengths more or less strongly. Therefore, the selection of the wavelength has an effect on the selectivity of the laser treatment and thus the probability of unwanted side effects.
Light energy can be used for selectively damaging specific constituents of skin or tissue. The fundamentals of the interaction of light with tissue include:

(1) Reflection, absorption, scattering and transmission of light by/into skin
(2) Effect of heat energy produced by absorption and
(3) Response of tissue to the damage.

The theory of **selective photothermolysis** was developed by Anderson and Parrish[1] **particularly for the treatment of disturbing lesions of skin** already in 1981. This theory, which meanwhile was substantiated by many scientific and clinical studies, says that the thermal damage to a target structure can be spatially restricted, if the ***wavelength*** corresponds to an absorption maximum of this chromophore, the ***pulse duration*** of the light pulse approximates the thermal relaxation time of the respective cutaneous tissue structure and the ***fluence*** is sufficiently high to produce a temperature between approx. 70°C and 100°C in the target. In recent years, lasers were developed or modified that meet the above requirements for the treatment of specific skin irregularities.

[1] cf. Anderson RR, Parrish JA (1983).

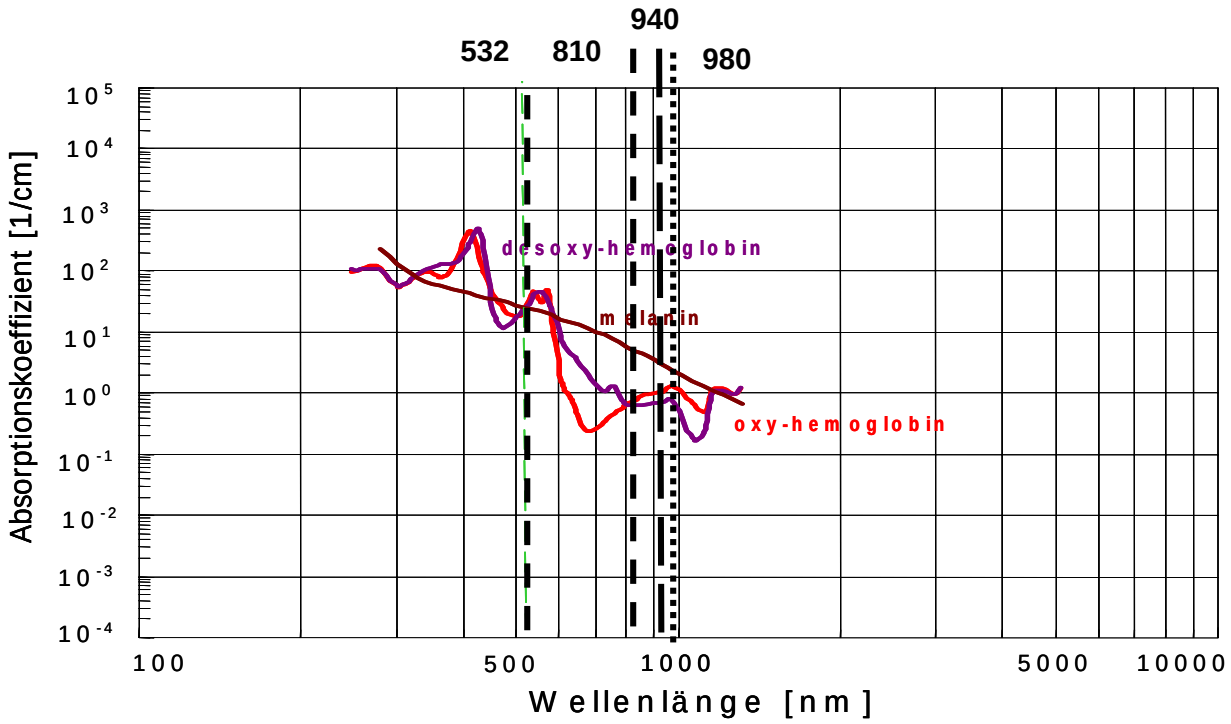


Fig. 2: Absorption coefficients of different wavelengths

Further parameters relevant to the treatment are the **energy density**, the **spot size** and the **pulse repetition rate** (determining the operating speed). In **burst** mode, a defined number of pulses can be preselected, which will not be exceeded, even if you keep stepping on the footswitch.

The **energy density** = energy per area (fluence) is the most crucial parameter for achieving the desired effect of treatment. As the spot size is entered with the square in the formula of the area (Area = π x Radius^2), the energy density is influenced to a much higher degree by the variation of the spot size than by the variation of the energy setting.

The following mathematical relations apply (for round spots):

$$\text{Energy density } [\text{J/cm}^2] = \frac{\text{Energy [J]}}{\text{Area [cm}^2]} = \frac{127 \times \text{Energy [J]}}{(\text{Spot size in mm})^2}$$

$$\text{Energy [J]} = \text{Power [W]} \times \text{Pulse duration [s]}$$

On the device screen, the energy density is displayed as FLUENCE.

4.2 Microvascular lesions

The green light of the *QuadroStar532* is strongly absorbed by hemoglobin, which constitutes the target chromophore in the treatment of blood vessels of the skin. Therefore, a wavelength of 532 nm is well suitable for the treatment of visible superficial vessels. Nevertheless, the absorption by melanin must be considered as well to avoid side effects. However, for the treatment of deeper or larger vessels the use of longer wavelengths is recommended, as the longer-wavelength light can penetrate more deeply into tissue and the lower hemoglobin absorption allows a more even heating across the total thickness of the vessel. That's why small telangiectasias – such that normally appear in the face – can be treated very well by lasers emitting at a wavelength of 532 nm, while for the treatment of veins on the leg, longer wavelengths, such as that of 940 nm or 980 nm are to be preferred.
The pulse duration for the treatment of blood vessels should approximately correspond to their thermal relaxation time. For visible telangiectasias in the face (of 0.15 - 0.3 mm diameter) the ideal pulse duration is approximately 15 – 45 ms (with a sufficiently high fluence!). For vessels of 1 mm diameter, the thermal relaxation time amounts already to 500 ms.

After the treatment, normally transient erythemas and edemas appear, sometimes also incrustation. If the laser was properly applied, purpura is seldom. The same refers to vesiculation and cicatrization as well as pigment changes, since the heating of the skin is restricted to a small area around every vessel.
Minor perivascular damage may be necessary to achieve a permanent occlusion of the vessel. If the vessel wall is damaged insufficiently only, recanalization may occur. This will certainly apply to the exposure of larger vessels with green light. If the exposure time is within the range of the thermal relaxation time of the vessel, the strong absorption by hemoglobin in the upper section of the vessel will be so complete, that a superficial blood coagulation occurs, which will shield the deeper lying vessel layers against further damage.

There is no doubt that with the typical exposure times used for normal treatments with green lasers a certain degree of epidermal damage is unavoidable. However, the fact that no severe side effects appear indicates that the damage is minimal, heals quickly and is of minor clinical significance.

4.3 Pigmented lesions

Pigment cell anomalies may exist in epidermis (ephilides, lentigines, seborrhoic keratoses, melasmas, junction nevi, sun damage), in dermis (intradermal nevi, Nevi Ota, blue nevi) or in both (compound nevi). They may be macular (flat) or nodular (raised).

In general, the laser treatment is based on one of the two following principles:

1) Selective destruction of melanin pigments or of individual melanocytes with the residual dermal structure remaining intact. For the treatment, short-pulsed lasers (Q-switched lasers with pulse emission in nanoseconds or pulsed dye lasers with pulse emissions in microseconds) are needed to concentrate the energy to very small chromophores, the thermal relaxation times of which are lying in these ranges. Normally, Q-switched Nd:YAG lasers (1064 and 532 nm) and Q-switched ruby lasers (694 nm) are used. These lasers are particularly suitable for the treatment of pigmented macular lesions, although in some cases a recurrence of the pigmentary disorder cannot be precluded.

2) The photothermal coagulation of tissue mass (epidermis, solid tumor tissue) leads to a selective necrosis of tissue, local incrustation and a healing process, which is based either on reepithelization or on secondary wound healing depending on the depth of the original lesion. Laser light that is strongly absorbed by melanin (e.g. green light) and exposure times in milliseconds range minimize the damage to the epidermis and the dermis in the environment of the lesion.

Many lasers used with care can sclerose or ablate customary benign changes of the skin with extremely satisfactory results; however one should not forget that cicatrization, though minimal, is likely when destroying a mass of tissue. Nevertheless, compared to cryosurgical, electrosurgical as well as scalpel excisions, lasers will cause less damage to environmental cutaneous tissue and therefore result in a quicker healing and less visible scars.
The lasers used for these applications are argon, copper bromide, carbon dioxide, erbium:YAG and frequency-doubled, long-pulsed neodymium lasers (532 nm).

The *QuadroStar* 532 uses green light and is particularly suited to the treatment of the customary pigmented lesions of epidermis.
As the *QuadroStar* 532 operates with an exposure time of at least five milliseconds, it cannot be used for the selective photothermolysis of structures of the size of melanocytes or even melanosomes. Pigmented lesions, however, consisting of a mass of nevus cells or melanocytes can be ablated successfully. The procedure is selective only in so far as these wavelengths are absorbed more strongly by the pigmented tissue than by the normal (not or only slightly pigmented) skin. The mechanism of destruction is based on thermal necrosis, the degree and depth of which is controlled by the duration, frequency and total number of exposures, i.e. the total energy absorbed by the lesion.

From the histological point of view, the lesions irradiated with the *QuadroStar* 532 are similar to the lesions treated with a carbon dioxide laser: The epidermal constituents of the lesion are ablated and a thermal necrosis of the lesion takes place in the epidermis. Mild perilesional damage is normal and depends on the pathology of the treated lesion. In general, the following rule applies: The thicker and/or deeper the lesion is seated in the skin, the higher must be the applied total energy and the greater must be the degree of damage to the exposed tissue.

However, histological data substantiate that the thermolysis of most of the pigmented cell lesions performed with green lasers involves considerably less damage to the non-affected skin surrounding the lesion, than is the case with cryosurgical or electrosurgical operations.
Keratoses thermolyzed with green light heal as quick as those treated with pulsed carbon dioxide lasers in the pulse range of sub-milliseconds and quicker than those removed by cryosurgery, electrocauterization or surgical curettage. Hence, the cosmetic result is more acceptable and hyperpigmentations and atrophies occur less frequently. Although keratoses are always restricted to the epidermis, a follow-up treatment of all patients treated should be performed with great care, as their presence indicates considerable damage by sunlight.

The following notes on treatments with the wavelength of 532 nm by courtesy of MD W. Petrow, Bonn / Germany. [2].

4.4 Contraindications

In the following situations, laser treatment is contraindicated:

- Presence of carcinogenic, precancerous and malign lesions in the area to be treated
- Taking of drugs that increase the photosensitivity of the skin
- Skin types IV to VI
- Herpes simplex, if treatment is to be performed near the mouth
- Tendency to keloid formation (keloid therapy is possible in combination with other lasers)

It is not advisable to treat pregnant women.

Patients with tanned skin must postpone laser treatment by two to three months!

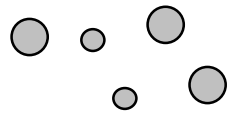
Heavy smoking and/or overweight may adversely affect the efficacy of vascular treatments.

[2] Neither Dr. Petrow, nor Asclepion Laser Technologies GmbH is liable for any faults that are possible despite all care taken. Please observe the respective note on page 1 of this manual!

4.5 Application techniques

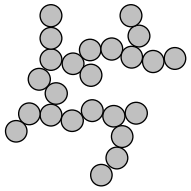
The selection of the right application technique is just as important for the clinical and esthetic result of laser therapy as the selection of the appropriate application parameters.

Single spot technique



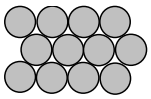
- Technique used for the coagulation of individual vascular and pigmented lesions (e.g. syringomas)
- Use a suitable spot size for every individual localization.

Single vessel technique



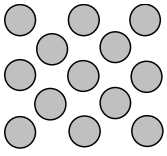
- Use the single vessel technique for the treatment of visible individual vessels. Follow the course of the vessel continuously without overlaps.
- Continue the treatment until the desired result has been achieved.
- Do not fill the gaps between the vessels.
- Treat the central vessels first and then the peripheral branches, if necessary.

Spot-by-spot technique



- Use this technique for small vascular or pigmented changes in regions of high regenerative power and little risk of cicatrization.
- No overlaps.
- Technique for vaporization

Polka dot technique



- Most gentle therapy technique
- Use this technique for the treatment of large vascular or pigmented changes in higher-risk regions.
- Fill gaps in later sessions.
- Very time-consuming

4.6 Notes on treatment

This section contains practical advice for the use of the frequency-doubled solid-state 532 nm laser. Of course, the advice given can never replace the careful study of relevant literature, the personal experience gained under supervision and the critical assessment of the current situation. It shall be a useful support to the novice and those not working regularly with the laser.

To be able to assess the therapeutic success, you should perform a test treatment on a carefully chosen test area first, before treating large skin areas.

That way, it is possible to assess the risk of cicatrization, the healing as well as the inclination to post-inflammatory pigment changes (hyperpigmentation/hypopigmentation). Besides, the patient will get an impression of the treatment procedure of his/her lesion.

The *QuadroStar* 532 was developed for the treatment of smooth tissue (skin) in the following fields: Dermatology, plastic surgery (including esthetic surgery), plastic surgery of the face and oral surgery, and ophthalmology (skin areas surrounding the eyes). The following lesions of the skin, for instance, have been successfully treated for some years:

- Telangiectasias (couperosis)
- Spider Nevi (spider angioma, nevus araneus)
- Senile angiomas
- Capillary hemangiomas
- Nevi flammei
- Spider leg veins (local, fine superficial vessels)
- Sebaceous gland hyperplasia (adenoma sebaceum)
- Pigmented lesions (preferably those with a high melanin percentage)
- Xanthelasmas
- Small fibromas
- Warts
- Condylomas

In general, the clinical protocols below can provide first indications of the treatment of adult patients.

Laser Treatment with *QuadroStar* 532nm

It is advisable to follow the procedure described below unless specified otherwise in the clinical protocols:

Treatment procedure:

- Inform the patient comprehensively of the treatment and after having given him or her time to think it over let the patient sign the **Declaration of Consent**
- Get the aids ready for use (Cool Packs / ice cubes in bag, laser-protective eyewear, local anesthetics, if necessary, white Kajal pen for marking).
- **Cleaning** of the skin and, where required, thorough removal of all cosmetics. If need be, shaving in the area to be treated.
- **Photo** documentation of the initial situation
- Switch on and operate the QuadroStar following the instructions of the User's Manual:
    1. Select spot size (change spacer, if necessary) and enter it.
    2. Adjust the shortest pulse duration specified in the clinical protocol (dependent on skin type!)
    3. Afterwards, adjust the lowest fluence specified.
- **Put on laser-protective eyewear.**
- Perform a **test treatment**, to be able to assess any side effects and the success:
  - **Cool** the area to be treated (except before the treatment of fine vessels)
  - Start with the **lowest recommended fluence**.
  - **Reduce the fluence** if **skin response is too strong**.
  - If **no unwanted side effects** occurred and the **desired result was not achieved increase the pulse duration**, that way automatically the fluence is increased as well
  - In children and patients with sensitive skin, the specified upper values are to be regarded as maximum values!
  - Desired clinical effect in vascular treatment:
    Vessel disappears or shows a bluish-gray discoloration.
    – Avoid persistent white discoloration!
  - Desired effect in other indications:
    Grayish discoloration
    - To assess the result, dab off debris with NaCl solution.
        - **Cooling** after treatment (at least 5 minutes; not below +4°C)
        - Application of **skin-care cream** (e.g. with aloe vera)
        - Post-therapeutic strong sun protection for 6 – 10 weeks (e.g. Day long 50 extreme / Hans Karrer)

Further advice:

- Formation of erythemas, edemas (normally persisting only a few hours, however, in rare cases, they may be persistent up to several weeks), bubbles and crusts partly possible. Tell the patient to refrain from any manipulation on crusts!
- Treat any gaps left in Polka-dot technique in the next follow-up session.
- The final therapy results can often be assessed only after 4 – 10 weeks.

- When treating patients of **skin type III**, proceed with particular care. **Cool** extensively and use the **longest pulse durations specified** for the required energy density (fluence), **if possible**. Of course, you should also perform a test treatment first, as described above.
- In general, **match the spot size to the diameter of the vessel**. This means, that the small vessels of up to approximately 0.5 mm are to be treated with a 0.5 mm spot, the larger ones with a 1.0 mm or 1.5 mm spot.
- This is to be considered particularly for treatments on the legs, as normally these vessels are not only larger, but also deeper. With larger spot sizes, also a greater penetration depth (at the same fluence) is achieved.
- When you **change the spot size** (spacer), set the **new spot size on the display**. In doing so, the fluence remains unchanged (variation of the set power). If the power cannot be increased further after you set a larger spot, the maximum fluence possible will be displayed. If this fluence is too low, you must choose a longer pulse duration.
- The **larger the area to be treated**, the more energy is applied and the stronger is the response by the skin. Therefore, **treatment breaks are required for cooling or it may be necessary to perform the treatment in several sessions** in these cases.
- In treating **fine vessels**, the treated vessel **should be cooled only <u>after</u> laser exposure**. If the vessel is contracted by cooling (or by any other action), it may happen that there is not enough blood (the target!) in the vessel to ensure effective treatment.

Before activating the laser, make sure to read all safety notes given in the User's Manual!

In particular, make sure that <u>all</u> persons present in the laser room wear laser-protective eyewear as specified in the safety notes of this manual!

4.7 Clinical Protocol – Telangiectasias

Preparing the patient

- Removal of cosmetic residues (thoroughly) and **cleaning** of the skin
- It is not advisable to use local anesthetics when treating small vascular lesions.
- Wearing of **laser-protective eyewear** or eye patches for patient's eye protection

Therapeutic parameters

Spot Size	Pulsduration REPEAT	Recommended Fluence	Repetition Rate	Displayed Power
0,5 mm (fine vessels)	fair skin: 5-10ms darker skin:20–40ms	12 - 25 J/cm²	4 – 6Hz	5 Watt (fair skin)
1,0mm (larger vessels)	fair skin: 15-40ms darker skin:20–40ms	10 – 25 J/cm²		

Application technique

- Optimize the parameter settings by means of a **test series**; increase the pulse duration in steps of 2 ms.
- Use the **single vessel technique**, exactly follow the vessels, and do not treat gaps between vessels. Avoid overlapping and multiple treatments.
- Successful treatments with this laser are identified by the instantaneous disappearance of the vessel (decolorization) or the instantaneous linear blue/gray photocoagulation in the lumen; **no persistent white discoloration** of the skin.

Post-op treatment

- **Cooling** after treatment
  (e.g. Cool Packs, temperature not below +4°C, at least for five minutes)
- Application of cooling gel or **skin-care cream**, e.g. ointment containing aloe vera.
- Post-therapeutic **sun protection** (strong sun blocker, approx. for 6 - 10 weeks, e.g. "Day long 50 extreme" / Hans Karrer)

Remarks

- Immediate formation of erythemas and edemas persistent only for a few hours.
- Cooling and anesthesia before the treatment is not advisable, as this will cause a narrowing of the blood vessels thus making them imperceptible. However, during the treatment short and moderate cooling with an ice compress is found to be pleasant by the patient.
- Tell the patient to avoid any mechanical manipulation on possibly forming crusts.
- The final result of the therapy can be assessed only after 4 - 8 weeks.
- Vesiculation and following incrustation are rare.
- Dilated vessels on the lower nostril and in the sebaceous skin of the root of the nose or of the chin are often more resistant to the therapy. They may recur within weeks or require several treatments.

4.8 Clinical Protocol – Nevi Flammei

Preparing the patient

- Removal of cosmetic residues (thoroughly) and **cleaning** of the skin
- Local anesthesia only, if absolutely necessary (e.g. EMLA). Contours can be outlined with a white Kajal pen, as the anesthetized area is discolored.
- Wearing of **laser-protective eyewear** or eye patches for patient's eye protection

Therapeutic parameters

Spot Size	Pulsduration REPEAT	Recommended Fluence	Repetition Rate	Displayed Power
1,0 – 1,5mm	23 ms up to 50 ms	15 - 25 J/cm²	5 – 6Hz	3,5 - 5 watt,

Application technique

- Optimize the parameter settings by means of a **test pulse**; increase the pulse duration in small steps. In the first session, treat a **test area** (1cm²) to find out whether the patient responds to the treatment.
- Use the **Polka dot technique**.
- Treat gaps in follow-up sessions.
- When treating children, use lower parameter settings.
- Effective laser treatment is identified by the instantaneous bluish-gray discoloration, but **no persistent white discoloration** of the skin.

Post-op treatment

- **Cool** after the treatment (e.g. Cool Packs, temperature not below +4°C, at least for five minutes.)
- Application of cooling gel or **skin-care cream**, e.g. ointment containing aloe vera. If necessary, treat the area once with a corticosteroid-containing ointment.
- Post-therapeutic **sun protection** (strong sun blocker, approx. for 6 - 10 weeks)

Remarks

- A test treatment is a good idea to determine the brightening of the treatment area to be expected.
- Tell the patient to avoid any mechanical manipulation on possibly forming crusts; body care is possible using a mild soap.
- The final therapy result can be assessed only after about eight weeks. In most cases, multiple treatments are necessary.
- Vesiculation is rare; post-op incrustations appear frequently, but usually are very fine and superficial; edemas and small erythemas are usually formed only for a few hours. However, in some cases they may persist for up to several weeks.

4.9 Clinical Protocol – Spider Nevi

Preparing the patient

- Removal of cosmetic residues (thoroughly) and **cleaning** of the skin
- Local anesthesia is not necessary; short cooling with an ice compress a few seconds before the treatment is found to be pleasant for the patient.
- Wearing of **laser-protective eyewear** or eye patches for patient's eye protection

Therapeutic parameters

Spot Size	Pulsduration REPEAT	Recommended Fluence	Repetition Rate	Displayed Power
0.5 mm 1 mm* for central vessel	15 - 30 ms up to 40 ms for larger vessels	10 - 18 J/cm²	9 – 10Hz	3 - 5 watts

*** Select the spot size according to the size of the central vessels.**

Application technique

- Optimize the parameter settings by means of a **test pulse**; increase the values in small intervals.
- When treating children, use lower parameter settings.
- **First, occlude the central vessel**. Then apply the **single vessel technique** using a smaller spot size and low parameter settings.
- Do not treat any gaps and **avoid confluent coagulation**!
- The treatment with this laser was successful, if the vessel instantly disappears (**vessel blanching**) or an instantaneous linear blue-gray photocoagulation in the lumen appears, but **no persistent white discoloration** of the skin.

Post-op treatment

- Application of cooling gel or **skin-care cream**, e.g. ointment containing aloe vera. If necessary, treat the area once with a corticosteroid-containing ointment.
- Post-therapeutic **sun protection** (strong sun blocker, approx. for 6 - 10 weeks)

Remarks

- Tell the patient to avoid any mechanical manipulation on possibly forming crusts.
- The final therapy result can be assessed only after about eight weeks.
- Vesiculation is rare; post-op incrustations appear frequently, but usually are very fine and superficial; edemas and small erythemas are usually formed only for a few hours. However, in some cases they may persist for up to several days.
- Inform the patient of the possibility of recidivation after about three weeks.

4.10 Clinical Protocol – Angiomas (e.g. hemangiomas)

Preparing the patient

- Removal of cosmetic residues (thoroughly) and **cleaning** of the skin
- Local anesthesia only, if absolutely necessary; slight cooling with ice packs
- Wearing of **laser-protective eyewear** or eye patches for patient's eye protection

Therapeutic parameters

Spot Size	Pulsduration REPEAT	Recommended Fluence	Repetition Rate	Displayed Power
0.5 – 1.5 mm*****	30 - 40 ms 70 ms*****	20 - 25 J/cm²	4 – 6 Hz	1 - 5 watts

Application technique

- ***** With thicker angiomas, use larger spots with longer pulses. Penetration depth, however, is limited for green light; better results may be obtained with 940nm.
- With larger/thicker hemangiomas, lasing through a small cold glass plate or, even better, through a flat, bubble-free **ice cube** makes treatment very gently by cooling and by compression to reduce the thickness.
- Optimize the parameter settings by means of a **test pulse**, increase the pulse duration in steps of 2 ms. In the first session treat a **test area** (1cm²) to find out whether the patient responds to the treatment.
- Use the **spot-by-spot technique** without overlaps, with larger angiomas the **Polka dot technique**
- Successful treatments with this laser are identified by the instantaneous decolorization or the grayish discoloration of the angioma; **avoid confluent coagulation**.

Post-op treatment

- **Cooling** after treatment
  (e.g. Cool Packs, temperature not below +4°C, at least for five minutes)
- Application of cooling gel or **skin-care cream**, e.g. ointment containing aloe vera. If necessary, treat the area once with a corticosteroid-containing ointment.
- Post-therapeutic **sun protection** (strong sun blocker, approx. for 6 - 10 weeks)

Remarks

- Tell the patient to avoid any mechanical manipulation on possibly forming crusts.
- The final therapy result can be assessed only after eight weeks.
- In almost all cases, dehydration with incrustation occurs for 8 to 10 days; edemas and small erythemas may persist in some cases up to several weeks. Thicker hemangiomas may be difficult to treat, as the green light possibly does not penetrate deep enough into the skin.

Patients with large or purulent hemangiomas affecting life or sight-threatening areas (mouth, pharynx, eyes) or/and extending deeper into the skin, should be referred immediately to special clinics experienced in treating such complex symptoms.

4.11 Clinical Protocol – Spider leg veins (red, up to about 0.5mm)

Preparing the patient

- **Cleaning** of the skin
- Local anesthesia only, if absolutely necessary; slight cooling with ice packs
- Wearing of **laser-protective eyewear** or eye patches for patient's eye protection
- **Inform** the patient of the risk of post-inflammatory hyperpigmentation.

Therapeutic parameters

Spot Size	Pulsduration REPEAT	Recommended Fluence	Repetition Rate	Displayed Power
1 mm	30 -50 ms	18 - 30 J/cm²	5 – 6 Hz	5 watts

Application technique

- Optimize the parameter settings by means of a **test pulse** and increase the exposure in small intervals. In the first session treat a **test area** of 1cm². Larger and blue spider leg veins should be treated with 940nm to obtain better results.
- Use the **single vessel technique**.
- The treatment with this laser was successful, if the vessel instantly disappears (**vessel blanching**) or an instantaneous linear blue-gray photocoagulation in the lumen appears, but **no persistent white discoloration** of the skin.
- It is advisable to cool the treatment area directly before the treatment to allow for contraction of the vessels.
- **First, treat the central vessels** and then the peripheral vessels, in order to sclerose the vessel with the first shot.

Post-op treatment

- **Cooling** after treatment
  (e.g. Cool Packs, temperature not below +4°C, at least for five minutes)
- Application of cooling gel or **skin-care cream**, e.g. ointment containing aloe vera.
  If necessary, treat the area once with a corticosteroid-containing ointment.
- Post-therapeutic **sun protection** (strong sun blocker, approx. for 6 - 10 weeks)
- Application of a compression bandage; no sports / sauna, or similar activities

Remarks

- A test treatment is a good idea to be able to assess the final result of the treatment.
- Tell the patient to avoid any mechanical manipulation on possibly forming crusts.
- The final therapy result can be assessed only after three to six months.
- Vesiculation is rare; following incrustation is usually persistent for two weeks.
  In some cases, edemas and small erythemas may persist up to several weeks.

4.12 Clinical Protocol – Lentigines (solar and senile)

Preparing the patient

- Removal of cosmetic residues (thoroughly) and **cleaning** of the skin
- Local anesthesia, if necessary.
- Wearing of **laser-protective eyewear** or eye patches for patient's eye protection

Therapeutic parameters

Spot Size	Pulsduration REPEAT	Recommended Fluence	Repetition Rate	Displayed Power
1 – 1.5 mm	20 -50 ms	12 -32 J/cm²	7 – 10 Hz	5 watts

Application technique

- Optimize the parameter settings by means of a **test pulse**. Increase the exposure in intervals of 5 ms. In the first session, treat a **test area** of 1cm².
- Use the spot-by-spot technique.
- Coagulate the entire treatment area without leaving any gaps; **avoid confluent coagulation**.
- Exposure of the abnormal epidermis results in a grayish-brownish discoloration of the tissue, which is simply removed using a pad soaked with saline solution.

Post-op treatment

- **Cooling** after treatment
  (e.g. Cool Packs, temperature not below +4°C, at least for five minutes)
- Post-therapeutic **sun protection** (strong sun blocker, approx. for 6 - 10 weeks)

Remarks

- Important: Dab off debris with saline solution to be able to assess the result.
- Tell the patient to avoid any mechanical manipulation on the forming scab.
- Necessary follow-up sessions should be held at intervals of eight weeks.
- The final therapy result can be assessed only after eight to ten weeks.

Particular care is necessary when treating the dorsum of the hand because of the risk of hypertrophic cicatrization!
Make sure to wait for four weeks after the test treatment!

4.13 Clinical Protocol – Epidermal Nevi

Preparing the patient

- Removal of cosmetic residues (thoroughly) and **cleaning** of the skin
- Normally, local anesthesia is not necessary; but on places where several lesions are concentrated, the use of a local anesthetic ointment (e.g. EMLA) is useful.
- Wearing of **laser-protective eyewear** or eye patches for patient's eye protection

Therapeutic parameters

Spot Size	Pulsduration REPEAT	Recommended Fluence	Repetition Rate	Displayed Power
1 – 1.5 mm	20 -55 ms	12 -32 J/cm²	7 – 10Hz	2 - 5 watts

Application technique

- Optimize the parameter settings by means of a **test pulse**. Increase the exposure in intervals of 5 ms. In the first session, treat a **test area** of 1cm².
- Use the spot-by-spot technique.
- Follow the lesion without overlaps and without gaps.
- Coagulate the entire treatment area; **avoid confluent coagulation**.
- Exposure of the abnormal epidermis results in a grayish-brownish discoloration of the tissue, which is simply removed using a pad soaked with saline solution.

Post-op treatment

- **Cooling** after treatment
  (e.g. Cool Packs, temperature not below +4°C, at least for five minutes)
- Post-therapeutic **sun protection** (strong sun blocker, approx. for 6 - 10 weeks)

Remarks

- Important: Dab off debris with saline solution to be able to assess the result.
- Tell the patient to avoid any mechanical manipulation on the forming crust/scab.
- Necessary follow-up sessions should be held at intervals of eight weeks.
- The final therapy result can be assessed only after eight to ten weeks.

Indication must have been ensured. Perform a shave biopsy for histological verification, if necessary!

4.14 Clinical Protocol – Xanthelasmas

Preparing the patient

- Removal of cosmetic residues (thoroughly) and **cleaning** of the skin
- Local anesthesia only, if necessary (e.g. on eyelid)
- Wearing of **laser-protective eyewear** or **eye patches** for patient's eye protection. Particular **care is necessary for treatments near the eye**.

Therapeutic parameters

Spot Size	Pulsduration REPEAT	Recommended Fluence	Repetition Rate	Displayed Power
1 – 1.5 mm	20 – 55 ms	15 – 35 J/cm²	7 – 10 Hz	2 - 5 watts

Application technique

- In the first session, make a **test shot** to assess whether the treatment is effective. A **test treatment** is useful to be able to assess final therapy results.
- Use the **spot-by-spot technique** and follow the small xanthelasmas without overlaps. In the case of **larger xanthelasmas, use the Polka dot technique**; fill gaps in follow-up sessions.
- Coagulate the entire treatment area; **avoid confluent coagulation**.
- Exposure of the abnormal epidermis results in a grayish-white discoloration of the tissue, which is simply removed using a pad soaked with saline solution.

Post-op treatment

- **Cooling** after treatment
  (e.g. Cool Packs, temperature not below +4°C, at least for five minutes)
- Apply **antibiotic ointment** for healing.
- Post-therapeutic **sun protection** (strong sun blocker, approx. for 6 - 10 weeks)

Remarks

- Tell the patient to avoid any mechanical manipulation on the forming crust/scab.
- The final therapy result can be assessed only after six to ten weeks.

4.15 Clinical Protocol – Sebaceous gland hyperplasia

Preparing the patient

- Removal of cosmetic residues (thoroughly) and **cleaning** of the skin
- Local anesthesia, if necessary.
- Wearing of **laser-protective eyewear** or eye patches for patient's eye protection

Therapeutic parameters

Spot Size	Pulsduration REPEAT	Recommended Fluence	Repetition Rate	Displayed Power
1 – 1.5 mm	20 – 50 ms	12 – 32 J/cm²	7 – 10 Hz	2 - 5 watts

Application technique

- Fire **test shots** for optimizing the parameters (begin with a 1.5-mm spot).
- Use the spot-by-spot technique.
- Follow the lesion without overlaps and without gaps.
- Burn out the sebaceous nevi or vaporize them.

Post-op treatment

- **Cooling** after treatment
  (e.g. Cool Packs, temperature not below +4°C, at least for five minutes)
- Dry post-op treatment – scabbing is desired.
- Post-therapeutic **sun protection** (strong sun blocker, approx. for 6 - 10 weeks)

Remarks

- Tell the patient to avoid any mechanical manipulation on the forming crust.
- The final therapy result can be assessed only after six to ten weeks.

4.16 Clinical Protocol – Warts (verrucae vulgares)

Preparing the patient

- Remove any cosmetic residues (thorough!) and degrease the skin.
- Local anesthesia (EMLA), if necessary.
- Wearing of **laser-protective eyewear** or eye patches for patient's eye protection

Therapeutic parameters

Spot size	CW mode	Power
0.5 –1.5*****mm	Briefly depress footswitch until carbonization (charring) has been achieved.	2 - 5 watts

Application technique

- ***** With small warts, choose a spot size that fits the size of the wart.
  Optimize the parameter settings by means of a **test shot**.
- For small warts, use the **single spot technique**;
  ablate large warts by **meandering**.
- Ablate the wart layer by layer at high laser power and long exposure times (with unpeeled warts).
- Set lower parameter values for the treatment of peeled warts to coagulate the tissue.

Post-op treatment

- **Cooling** after treatment
  (e.g. Cool Packs, temperature not below +4°C, at least for five minutes)
- Healing ointment dressing
- Post-therapeutic **sun protection** (strong sun blocker, approx. for 6 - 10 weeks)

Remarks

- Vesiculation is possible
- Tell the patient to avoid any mechanical manipulation on the forming crust/scab.
- The final therapy result can be assessed only after six to ten weeks.
- Longer healing process may be necessary.

Cave: Circumscribed cicatrization – Inform patient accordingly!
Caution: Virus particles may be whirled up. **Evacuation and wearing of a mouth mask are strictly necessary!**

4.17 Clinical Protocol – Condylomas

Preparing the patient

- Remove any cosmetic residues (thorough!) and degrease the skin.
- Local anesthesia (EMLA) or block anesthesia
- Wearing of **laser-protective eyewear** or eye patches for patient's eye protection

Therapeutic parameters

Spot size	CW mode	Power
0.5 –1.5*mm	Briefly depress footswitch until strong blanching has been achieved	2 - 5 watts

Application technique

- * If the condyloma is small, choose a spot size that fits the size.
  Optimize the parameter settings by means of a **test shot**.
- Apply the **single-spot technique** to small condylomas;
  ablate large ones by meandering.

Post-op treatment

- **Cooling** after treatment
  (e.g. Cool Packs, temperature not below +4°C, at least for five minutes)
- Healing ointment dressing
- Post-therapeutic **sun protection** (strong sun blocker, approx. for 6 - 10 weeks)

Remarks

- Vesiculation is possible.
- Tell the patient to avoid any mechanical manipulation on the forming crust/scab.
- The final therapy result can be assessed only after six to ten weeks.
- A longer healing process may be necessary.

Cave: Circumscribed cicatrization – Inform the patient accordingly!

Caution: Virus particles may be whirled up.
Evacuation and wearing of a mouth mask are strictly necessary!

5 Bibliography for *QuadroStar* 532

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6 Information on laser treatment with QuadroStar 810, 940 and 980

6.1 Interaction of NIR laser radiation with tissue

The mathematical relations between the parameters that are important for laser treatment described in Section 4.1 apply independently of the wavelength also to the treatment with lasers in the near infrared (NIR).

However, the effect of NIR laser radiation on skin and tissue is considerably different from that obtained with the green wavelength, as the absorption of NIR light in both blood and melanin is substantially less, whereas in water it is distinctly higher. Besides, the scattering of light in tissue decreases with increasing wavelength (see absorption curves in Fig. 2).

Consequently, this radiation penetrates clearly deeper into tissue, thus – compared to the green wavelength – allowing very deep coagulation of various kinds of tissue. Therefore, these lasers can be used for similar applications as the Nd:YAG laser, which also emits in the NIR (1,064 nm) and which has been used particularly in surgery for many years already.

The removal of pigmented lesions is not advisable with NIR lasers, as the absorption by melanin is quite low.

For vascular treatments, the wavelength of 940 nm is usually preferred because of the – compared to the other two wavelengths – distinctly higher hemoglobin absorption. In these applications, the lower water absorption is favorable regarding the side effects (reduced absorption by the skin surrounding the vessel). The water absorption is maximal at 980 nm – even higher than at 1,064nm. Hemoglobin absorption, too, is higher than with the Nd:YAG laser. Therefore, this wavelength is particularly suitable for the coagulation and cutting of soft tissue in surgery.

In the dental area, the wavelength of 810 nm is used by tradition for the treatment of soft tissue. This wavelength can also be used for laser bleaching of teeth.

6.2 Endovenous laser therapy of varices

This kind of laser therapy is a special case of vascular treatment. However, it should rather be classified in the range of surgical applications because of the – compared to 'normal' vascular laser therapy – considerably more complicated and **sterile procedure**. Outpatient treatment, however, is possible.

Appropriate qualification of the operator and the suitability of the treatment rooms for such a sterile operation are, of course, absolutely required for this laser treatment.

It is known that more than 50% of the population above 50 years of age, predominantly women, has varices. Apart from the esthetic problem and the pain, varices also cause clinical problems. Even so, only very small percentage of the patients has an operation.

The endovascular laser therapy was developed only a few years ago. Within this short period, it has produced very good results: at a comparable success rate, the complications are distinctly less and the cosmetic results obtained are really satisfactory. Besides, the procedure is minimally invasive and less traumatizing. After the operation, normally an instantaneous mobilization is possible. The duration of post-op unfitness for work is considerably shorter. Min et al. reported long-term results of a period of over 3.5 years.

This kind of laser treatment is successfully performed with 810 nm, but also with 940 nm and 980 nm. We recommend the use of 940 nm, as with this laser also the spider leg veins may well be treated thus representing a sensible complement of the spectrum of treatments.

It is not possible to describe the details of this operation in this manual.
To learn this treatment and be able to perform it with the necessary reliability, **it is absolutely necessary to sit in on treatments performed by a specialized colleague who is familiar with this technique**.

Here, only the essential requirements, which go beyond the ones mentioned above, can be described in brief:

For the diagnosis and the planning of the operation, it is absolutely necessary to perform a **duplex sonography**. The treatment requires **anesthesia**; local anesthesia / tumescence anesthesia is possible.

Beside the laser including the fiber, a catheter insertion set is needed, which is placed in the vein **monitored by ultrasound**. The laser fiber is first pushed forward through the catheter and then withdrawn while laser radiation is emitted.

In choosing the laser parameters the individual and anatomical conditions are to be considered. In general, the parameters are to be chosen within the following ranges:

Power:	7 – 15 W	Pulse duration:	0.8 – 2 sec
Pulse per cm:	2 – 3	Energy per cm:	30 – 60 J

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6.3 The use of NIR lasers in surgical branches

For more than 15 years already, the Nd:YAG laser (1,064nm) has established in surgical laser therapy beside the CO_2 laser. With the development of diode lasers in the nineties, the Nd:YAG laser was increasingly replaced by the diode lasers. Initially, it was replaced by diode lasers emitting at a wavelength of 810 nm. Later, when 940 nm and 980 nm diode lasers were developed, it was also replaced by lasers emitting at these wavelengths.

As mentioned above, in dental applications for soft tissue treatment, mainly the laser with 810 nm is used, while the 980 nm laser was preferred in the other surgical branches in recent years.

All three NIR wavelengths are very well suitable for surgical applications, but unlike CO_2 lasers, they can also be used endoscopically without any problems. In the latter applications, the optical fiber of the laser is pushed through the operating channel of the endoscope until it juts out of the endoscope by about 8 to 10 mm.

The fiber must always be kept in this position during laser emission – never release laser radiation when the fiber end is too close to the working channel or even completely slipped back into the endoscope! In this case, there is the risk of endoscope damage or, in extreme cases, even the risk of fire!

Cutting of soft tissue is possible by placing the fiber onto tissue and then dragging it. The necrosis zone depends on the fiber core diameter (with a 400-µm fiber, the necrosis zone is smaller than with a 600-µm fiber), the selected power and the speed of dragging. Normally, it amounts to some tenths of a millimeter. The laser is to be set to cw mode at a power of about 6 to 15 W. For finer structures and thinner fibers, lower values are to be selected.

Coagulation, however, is performed in non-contact mode. If inadvertently the fiber end gets into contact with tissue thus being contaminated, the fiber end must be cleaned before you can continue lasing. Failure to do so will result in absorption of the laser light by the particles sticking to the fiber end. The fiber-to-tissue distance usually is about 5 to 10 mm; the standard fiber used is a 600-µm fiber. The larger and deeper you intend to coagulate, the larger should be the distance and the longer must be the laser exposure time. Vaporization (carbonization and evaporation) at a too high power and too low distance should be avoided as in these cases the coagulation is limited to the area around the evaporated tissue. Typically, the adjusted power ranges between about 8 and 15 W.

Be sure to consider that coagulated tissue is resorbed by the human organism. Hence, with thin layers there is the risk of dangerous perforation!

Furthermore, interstitial coagulation is possible. Operations using this technique are performed with very low powers, but longer exposure times. Carbonization should be avoided with this method, too. In certain applications (e.g. the treatment of thicker hemangiomas), it is possible to see the aiming laser through the skin surface, which allows you to control the position of the fiber when withdrawing it. Unwanted vibrations by the formation of bubbles can be controlled by laying a finger on the respective area. Otherwise, an ultrasound device must be used for control.

Laser Treatment with *QuadroStar* NIR Lasers

To test the fundamental action of the described treatment methods and the various parameters, you can use pieces of meat, such as a cutlet and liver. These materials also allow you to see the varied effects on different types of tissue at the same operating parameters.

Naturally, these tests cannot replace specialist knowledge. To be able to perform surgical treatments with the necessary reliability, **it is absolutely necessary to sit in on treatments performed by a specialized colleague who is familiar with this technique**.

The indications in the various branches, such as dentistry, ENT, gynecology, oral and maxillofacial surgery, pneumology, laparoscopy, urology, oncology, internal medicine are numerous and naturally cannot be described in detail here.

We recommend the study of specialist journals and books.