Initial therapy of periodontitis using dental lasers

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Fig. 1


Fig. 2


Fig. 3

Fig. 1: In the oral hygiene phase, mechanical cleaning is first carried out using ultrasonic scalers and polishing agents, protruding filling and crown margins are removed, and the actual prosthetic restoration is carried out after systemic periodontal therapy has been completed. **Fig. 2:** Ultrasonic scaler for mechanical debridement after staining with a plaque disclosing agent. **Fig. 3:** Breaking up the biofilm surface using scaling and root planing.

Gingivitis and marginal periodontitis are predominantly bacterial diseases. Periodontitis is a chronic, multifactorial inflammatory disease caused by the accumulation of bacterial biofilm on the tooth surface. It is promoted by an impaired local and/or systemic immune response.[1] Clinically, therapy must primarily have an anti-infective character. The reduction or elimination of this infectious disease is usually carried out by mechanical treatment of the affected tooth and root surfaces of the gingival pockets and adjacent soft tissue. Possible individual risk factors of the patient must be identified and eliminated as far as possible. In special cases, local or systemic antibiotic support is indicated.[2]

In our long-standing practice, adjuvant use of dental lasers of different wavelengths is an indispensable therapeutic option. Additional interdisciplinary cooperation with other specialist areas is always advisable. For some time now, knowledge about the possibilities of bacterial reduction by medical lasers has led to this treatment option being used to support local periodontal therapy.[3]

The new S3 guidelines on systematic periodontal therapy, presented at the German Dentists' Conference in November 2018, recommend adjuvant systemic antibiotic administration with subgingival instrumentation after careful evaluation of the severity of the condition and individual co-factors. The efficacy of supportive systemic antibiotic administration in combination with mechanical periodontal therapy has been largely proved.[4] Nevertheless, antibiotics still have numerous unexplored influences on human microbiota and pose the risk of resistance development. The scientific findings of recent years on the one hand and new approaches for holistic treatment on the other hand drive the search for treatment strategies for successfully treating patients with marginal periodontitis without additional antibiotic therapy. In recent years, the number of people refusing antibiotics, but also patients with intolerance or resistance, has increased steadily. With the development of antimicrobial photodynamic therapy (aPDT) and new laser technologies, it has become possible to inactivate or destroy microorganisms that are difficult or impossible to reach mechanically without damaging the surrounding tissue.[5]

Treatment planning and sequence

In principle, the sequence of periodontal therapy is similar for all forms of the disease. It is divided into stages or phases depending on the spread, severity and duration of the disease. In detail, however, the therapy shows remarkable differences, which depend on the disease type, the patient's attitude, age and general illnesses, and the preferences of the clinician. Naturally, all roads lead to Rome.

Pre-phase of periodontitis treatment: Systemic examination and oral hygiene

Prior to the actual therapy, anamnesis of the patient's systemic health, a careful diagnostic assessment and radiographic examination are carried out in order to make a preliminary diagnosis. There are cases, such as gingival pocket abscesses, in which local emergency therapy needs to be carried out without any delay. In these cases, we perform laser treatment in our practice immediately. Creating optimal oral hygiene and establishing cooperation with the patient regarding future appointments are vital for long-lasting treatment success. Professional supragingival plaque and calculus removal, the removal of iatrogenic risks and bacterial hiding places, and instruction in simple, yet effective plaque control quickly improve the overall oral situation.

First and second phases of the initial treatment: Causal, antimicrobial, anti-infective

After the initial findings and a preliminary diagnosis, the findings, diagnosis and prognosis are verified in the context of the initial treatment phase. Radiographic examination is also a prerequisite for determining an exact diagnosis. At the beginning of the initial treatment, the team of clinicians focus on oral hygiene. This is often described by some authors as being part of the pre-phase. After plaque and inflammation reduction in the pre-phase through oral hygiene by the patient and the dentist and, as a result, regression of greatly swollen gingival areas, clinical assessments should be made (probing depth, attachment loss), which serve as the foundation for the definitive diagnosis, the prognosis and developing the final treatment plan.[2] While the measures of the pre-phase are carried out with all patients, the treatment modalities can deviate in the second phase of the initial treatment.

In the second phase, closed root cleaning can be performed on the one hand—with or without the use of medication or laser of suitable wavelengths—and on the other hand, direct surgical treatment can be started, depending on the individual case. Periodontal surgical intervention without preceding non-surgical therapy is only indicated in rare cases. In 98 % of the cases treated in our practice, we initially prefer closed non-surgical pocket therapy and, whenever the patient gives his or her consent, the use of dental lasers. In mild cases, especially with chronic periodontitis, closed and laser-assisted therapy are often sufficient—provided the patient cooperates. In severe cases, it is possible to move directly from an intensive pre-phase to surgical corrective therapy. In this regard, the updated classification of periodontal diseases can help clinicians decide. However, the content of this classification is not to be discussed further in this article. In the clinical daily routine, closed and open therapies are applied one after the other. As a consequence, less periodontal tissue has to be treated openly and tissue loss appears to be lower post-operatively.


Fig. 4


Fig. 5

Fig. 4: Insertion of photosensitiser into all gingival pockets for full-mouth disinfection. **Fig. 5:** Excess photosensitiser rinsed off before using laser light.

Treatment goals of non-surgical anti-infective therapy

The objective of traditional non-surgical therapy is to eliminate microorganisms causing inflammation from the pocket and the adjacent tissue, to achieve teeth with a clean, smooth, bio-acceptable root surface and, in rare cases, to remove diseased, possibly infected tissue.[6–9] However, complete elimination of all pathogenic microorganisms is not possible—no matter which method is used. Even the removal of diseased, infected tissue through curettage is, according to the latest findings, no longer indicated, with rare exceptions. In 2019, Jockel-Schneider et al. reported on the adjuvant systemic



Fig. 7


Fig. 6



Fig. 8

Fig. 6: With flexible fibre, the photosensitiser is activated by laser light of a suitable wavelength and the bacterial membrane is destroyed as a result of the formation of oxygen radicals. **Fig. 7:** Example of a user-friendly touch screen for selecting the various therapy options already stored in the programme by the manufacturer (Schneider Dental). **Fig. 8:** Flexible laser fibres also allow access to the bifurcation area or where the tooth position is unfavourable.

administration of antibiotics with subgingival instrumentation, which, however, must always be accompanied by mechanical destruction or rupture of the bacterial biofilm in order to improve its effectiveness.[4]

Laser in periodontics

This is where dental lasers come into play. In the context of periodontal treatment, three different laser types are commonly used: Nd:YAG laser, the different types of diode lasers and the Er:YAG laser. More than 20 years ago, the Nd:YAG laser was used to decontaminate periodontal pockets, and in recent years, various diode lasers have become established. The Er:YAG laser has clearly receded into the background in its use for periodontal therapy, although it was even used for removing dark concretions on the root surface, using a so-called feedback system. In principle, the Er:YAG laser is very well suited for de-epithelialisation or for ablating both hard- and soft-tissue. Lastly, it was possibly the high acquisition costs of an Er:YAG laser that brought the diode laser into the foreground of various therapy concepts. With diode lasers, different wavelengths need to be distinguished: wavelengths of 660 nm, which are only used in connection with a photosensitiser; and 810, 940 and 980 nm, which are most commonly used. With the 810 nm, both blue photosensitisers and indocyanine green can be used for aPDT. A diode laser with a 980 nm wavelength does not require any additional dye and it can be used without additional agents both for decontaminating periodontal pockets and for cutting soft tissue. In our practice, however, the use of a combination of a photosensitiser and laser therapy has been proved, particularly in the bifurcation area, which is usually difficult to reach, and generally in the posterior region. When lasers with wavelengths of 940, 980 or 1,064 nm are solely employed for treating periodontal pockets, higher energy values are used and, as a result, a thermal effect in the tissue is achieved. This treatment, therefore, requires local anaesthesia, which is not usually required for aPDT (the combination of a photosensitiser and laser energy). Manufacturers of dental laser systems often provide various scientific studies upon request if clinicians are interested in specific products.

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Fig. 9

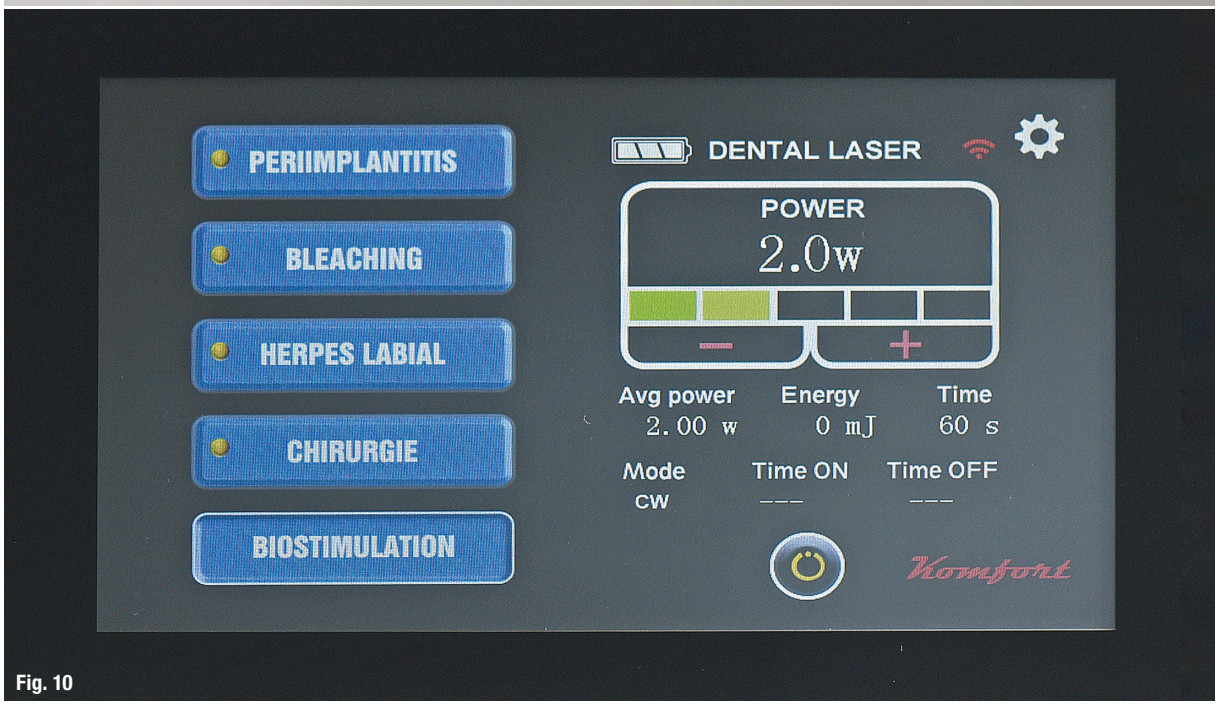


Fig. 10

Fig. 9: Example of a therapy handpiece for transmucosal dye activation and/or biostimulation … **Fig. 10:** … and the according settings on the screen.

Owing to the good clinical experience we have had using aPDT, I would like to explain the basic procedure of this therapy on the basis of the following case study. After the universally valid hygiene measures at the beginning of the initial therapy (Figs. 1 & 2), the laser is additionally used for removing subgingival calculus and plaque (Fig. 3). It is advantageous if the pocket bleeding can already be reduced to a minimum in this phase so that the dye can successfully attach itself to the bacterial surface and is not diluted by bleeding or washed out of the pocket. In addition, blood leads to the absorption of laser light energy, which sometimes poses an additional problem in the case of acute inflammation. First, the dye (photosensitiser) is applied to the periodontal pockets using a blunt cannula (Fig. 4). After an exposure time of 1 to 2 minutes, the excess dye is rinsed off the tooth surfaces (Fig. 5). Irradiation is then carried out in the area of the pocket by introducing suitable flexible laser fibres (Figs. 6–8). Transgingival beam application with a handpiece with a diameter larger than that of the exit window (8–12 mm) is also used in our practice. Yet, experience has shown that laser light energy and its biological effect are significantly weakened (Figs. 9 & 10). In addition to photodynamic processes as part of a Low Level Laser Therapy, effects at the cellular level are discussed later in this article.

In our daily clinic routine, we observed a significant increase in wound healing immediately in the post-operative period compared with a control group of patients who were treated without lasers. In our practice, this became apparent through a quicker reduction of the probeable pocket depths.[10] The laser fibres used for pocket decontamination are recommended for single use and are sterile-packed, depending on the manufacturer. Some manufacturers offer disposable tips that are attachable to the large-diameter light stick. Despite sterilisation procedures, multiple use is not recommended for hygienic reasons. In periodontal therapy, laser light not only treats

inflamed tissue but also ensures that the bacteria it contains are immediately and efficiently combated, which also virtually eliminates the risk of bacteraemia.[11] However, the optimal result of systematic periodontal therapy is not only the elimination of inflammatory processes but also the regeneration of the periodontal structures. The less tissue is injured during treatment, the faster regeneration can begin.

Antimicrobial photodynamic therapy

In recent years, aPDT for inactivating pathogenic biofilm has established itself as a minimally invasive technique as an alternative to the classical disinfection procedures used in dentistry. It can be used in an adjuvant fashion for treating acute and chronic infections in the various phases of implant treatment. With aPDT, complication-free and immediate bacterial reduction in the infected tissue is achieved by a photodynamic reaction mechanism. A sterile light-active dye solution is applied to the periodontal pockets as a photosensitiser. During the exposure time of at least 60 to 180 seconds, photosensitiser molecules diffuse into the biofilm and attach themselves to negatively charged centres of the bacterial wall. Clinically, the breaking open of the biofilm surface by means of previous scaling has been proved. Afterwards, as an essential step before laser light application, photosensitiser residues are carefully rinsed off. The adsorbed photosensitiser molecules are then activated unhindered by means of non-thermal laser light.

A quantum mechanical transfer process produces singlet oxygen molecules at the photosensitiser molecules though energy absorption and spin change. This potent oxidisation agent causes lethal, irreversible damage to the bacteria on the bacterial wall through the oxidation of membrane lipids. Fungi too are usually destroyed according to the same principle. This achieves photodynamic decontamination of the infected pocket tissue and the treated root surface. Eukaryotic cells are not stained, owing to their membrane potential, so no singlet oxygen is formed on them, which makes this particular kind of treatment rather gentle.[12] So far, various studies on photodynamic therapy have been published. The most common therapy concept is a combination of closed curettage with dye and dental lasers.[13–16] One must also mention the treatment potential of indocyanine green in combination with an 810 nm wavelength laser. A decisive advantage of this dye is its effectiveness against Gram-positive and Gram-negative bacteria, as well as against numerous viruses and fungi. The iodine-free and, thus, non-allergic component has also been highlighted by other authors.[17] In contrast to the established sensitiser methylene blue (absorption maximum at 660 nm), this dye has no intrinsic effect and is only activated and degraded when laser light enters. It is not absorbed by the intestinal mucosa.

Conclusion

Today, there is hardly any field in modern dentistry that could not benefit from the use of a laser, either as a replacement of conventional therapy forms or as a supportive measure. Not only can laser treatment improve existing therapy concepts in the various areas of dentistry, but, according to our experience, it can also increase the comfort of the patient during surgery owing to its minimally invasive and tissue-conserving nature.

Wavelengths of 660, 810, 980 and 1,064 nm are clinically suitable for supporting the initial therapy of marginal periodontopathies. aPDT in combination with diode lasers with wavelengths of 660 and 810 nm represents an alternative method to the known pharmacological and chemical decontamination procedures for the prevention and treatment of peri-implant infections. An adjuvant systemic antibiotic administration with subgingival instrumentation must be decided by the dentist according to the patient's individual risk profile. Since no resistance to individual bacterial species is known to date in laser applications, in particular aPDT, repeated laser decontamination of inflamed pockets can also be carried out within the framework of periodontal therapy in order to offer the organism better conditions for healing and regeneration. The various laser devices available on the market demand sufficient instruction and training efforts from the dentist's side. Thus, after completing a course to become a laser safety officer, which is prescribed by law for operating a dental laser, we strongly recommend attending user courses that entail practical exercises or live surgeries.

Literature

about the author



Germany-based dentist **Dr Frank Liebaug** is specialised in laser dentistry, implantology and regenerative periodontal therapy, among others. He graduated from the University of Leipzig and the Medical Academy in Erfurt in Germany in 1990 and received his PhD in 1992. Since 2010, he has been giving guest lectures at the University of Shandong in China. Today, he works as a private practitioner in a joint practice in Steinbach-Hallenberg in Germany.

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