Dental lasers: A new tool for the treatment of periodontal and peri-implant infections

Dr Gérald Mettraux

Periodontal infections without proper treatment lead to the loss of teeth. The reason for periodontal infections is dental plaque. A central role in this process is given to black-pigmented gram-negative anaerobes, yet other factors such as smoking, immunodeficiency and diabetes can influence the formation and progression of plaque. The classical treatment of periodontitis is based on the use of mechanical energy, for which the goal is to eliminate the infection and stabilise the attachment.

When clinical studies in the 1970s identified the possibilities and long-term results of periodontal therapies, dental implants were still a new concept in dentistry. Antibiotics and regenerative technologies were part of classical periodontitis treatment. Until recently, this had not changed much. The limits of periodontal therapy were hardly discussed. The maintenance of periodontally involved teeth was limited but the call for fixed tooth replacements was growing. The time for the "artificial root" had come. The field of implantology was developing rapidly and soon rivalled periodontal therapy in the field of restorative dentistry.

After years of unquestioned success, however, it was back to business. Dental implants were suddenly developing infectious lesions similar to those that occurred with periodontitis, and were failing. At the end of the 1980s, new diagnostics such as mucusitis and peri-implantitis based on disease patterns and retrospective studies found their way into clinical practice.

It did not take long to realise that the aetiologcal factors were the same as those responsible for periodontitis. Risk factors also corresponded. Moreover, studies were showing that periodontitis could facilitate the formation of a peri-implantitis. It all came back to the classical periodontal therapy.

After a long period of scientific silence, the analogy of the classical periodontal treatment was extended to infections that occurred with dental implants. In 2000, N.P. Lang developed the CIST principle (Cumulative Interceptive Supportive Therapy). Depending on the outcome of the clinical and radiological examination, the treatment combined mechanical treatment, local disinfection, systemic use of antibiotics and surgical incision. Although the principle was good, the outcome was not satisfactory.

The need for a new treatment principle was evident. Studies have shown that peri-implant infections occurred at least five years in 15 per cent of all placed implants (Berglundh et al. 2002). Only one conclusion can be made: in both types of oral infections retained insurmountable: the surface of an implant could not be mechanically treated and was considered as ‘sacred’. After all, the rough implant surface is responsible for the osseo-integration. Therefore, the classical treatment of periodontal infections and its limits was not suitable for the treatment of peri-implant infections.

The following tissues play a major role in the treatment of periodontitis and peri-implant infections:

- Soft tissue: gingival, mucosa, epithelium, connective tissue; Hard tissue: enamel, dentine, cementum, bone, calculus, titanium; and Enzymes/pigment tissue: bacteria, viruses, fungi.

These can be divided into three groups: water, hydroxylapatites and enzymes/pigment. Classical treatment is predominantly based on mechanical energy utilised in the form of instruments that are more than 1,000 times larger than the infections they are meant to treat and cannot reach far sites and rough surfaces. The laser as a light source can overcome this limitation of the classical periodontal treatment by reaching farther and is thus more able to achieve a bacteria-free rough surface. Laser light makes it possible to treat the three groups directly with different wavelengths. The size of the wave corresponds to the size of the bacteria.

The outcome of the CIST therapy can be significantly improved by dental lasers. If laser treatment and the principle of multiphase periodontal therapy are added, a new concept is at hand that synergistically includes all successful methods.

Table 1 lists the absorption of the three laser systems in all three elements, as well as their utilisable effects. All three systems provide a decontamination of the surface. The most important attributes of the laser systems regarding decontamination are given in Table 2.

These laser systems can be utilised in all stages of the CIST treatment protocol including debridement and decontamination, Er:YAG and antibacterial Photodynamic Therapy (PDT) can be used for closed treatment of the implant surface, as well as the Diode laser which has a good effect on black pigmented bacteria. In addition, CO₂ laser and Er:YAG can be used for open treatment. Studies are currently underway that may show if the use of antibiotics and disinfectants is still necessary.

Table 1: Absorption characteristics of the three laser systems.

<table>
<thead>
<tr>
<th>Laser system</th>
<th>Absorption</th>
<th>Co₂</th>
<th>Diode laser</th>
<th>Er:YAG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application</td>
<td>Water</td>
<td>Pigments</td>
<td>Hydroxylapatite</td>
<td>Water</td>
</tr>
<tr>
<td>Surfaces</td>
<td>Open</td>
<td>Pocket surfaces</td>
<td>Pocket surfaces</td>
<td></td>
</tr>
<tr>
<td>Decontamination</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Lesions with right parameters</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Calculus removal</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>PDT</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

Wave length!
For incipient caries even a minimally invasive therapy will sacrifice healthy hard tissue. Icon now offers a revolutionary solution: First, the enamel surface is prepared with a specially developed HCl gel. The pore system is then filled, stabilized and sealed with a light-curing resin, thus arresting caries progression and preserving healthy hard tissue – without drilling.

Icon is indicated for incipient caries with non-cavitated enamel and a radiological lesion progression into the outer third of the dentine. Treatment sets are available for proximal and smooth surface applications. DMG. A smile ahead.

More information at www.drilling-no-thanks.com
The treatment of a peri-implantitis can be performed in the following phases:

**Initial phase**
- Hygiene instructions, mechanical debridement with carbon curets, 3 x 30 secs treatment with diode laser or antibacterial PDT
- Re-treatment after one week
- Another laser treatment after one week in case clinical parameters show improvement
- Surgical incision in case clinical parameters show no improvement

**Evaluation phase**
- Evaluation after four weeks.

**Surgical phase**
- Flap elevation, mechanical debridement of the surface;
- Surgical incision with a diode laser or ultrasound; decontamination of the surface with Er:YAG, CO₂ or diode lasers;
- Augmentation or reduction of the gingival tissue.

**Supportive treatment phase**
- Enrolment of the clinical and radiological parameters, hygiene instructions.
- Dependant on the presence of infection go back to the phases mentioned above.

**Case 1**
The left X-ray in Figure 1 shows acute peri-implantitis on implant 24 with Pus, BOP, probing depth 10 mm. Therapy consisted of mechanical debridement, 5 x 50-second treatment per session with a diode laser, two times repeated with in three weeks. The patient took 5 x 500 mg Flagyl over the course of seven days. There was no incision of the tissue, since the infection could be eliminated after triple use of the diode laser.

**Case 2**
The pictures on the left of Figure 2 show peri-implantitis on implant 25 that has not responded to diode laser treatment. An excessive amount of cementum was detected and removed with a Cavitron, followed by decontamination of the surface with a CO₂ laser and augmentation of bone tissue.

**Case 3**
Figure 3 shows peri-implantitis in the maxillary front region. The lesion was extensive and did not respond very well to treatment with a diode laser. Therefore, the implant surface was surgically displayed. The CO₂ decontamination was followed by augmentation with Bio-Oss and Bio-Gide. The figure shows the implant incision, as well as two X-rays before and three years after treatment.

An important factor for a successful peri-implant treatment is the periodontal condition of the residual dentition.

Diode lasers do not only have a decontaminating effect but also show biostimulating effects that can be of benefit for the healing of peri-implant defects.

**Conclusion**
The laser systems presented in this article offer new possibilities that augment the classical treatment of periodontal and peri-implant infections. Treatment protocols should be discussed. By selecting the correct wavelength, the causes of periodontal and peri-implant inflammation can be treated more effectively with decontaminating laser systems in the closed pockets (Diode, antibacterial PDT, Er:YAG) and in open flaps (CO₂ laser, Er:YAG). The use of antibiotics can be reduced, owing to the decontaminating effect of the laser on tissues and surfaces.

The development of a new therapy for peri-implantitis offers new possibilities for periodontal treatment. Further studies are required to define the parameters for each working step in laser treatment.