Application of Laser in Periodontics: A New Approach in Periodontal Treatment

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Introduction

The use of lasers for treatment has become a common phenomenon in the medical field. The first laser device was made by Maiman in 1960, based on theories derived by Einstein in the early 1900s. The application of a laser to dental tissue was reported by Stem and Sognnaes in 1964, describing the effects of ruby laser on enamel and dentine with a disappointing result. However, with the recent advances and developments of wide range of laser wavelengths and different delivery systems, researchers suggest that lasers could be applied for the dental treatments including periodontal, restorative and surgical treatments.

Currently, numerous laser systems are available for dental use (Table 1). Neodymium-doped:Yttrium-Aluminium-Garnet (Nd:YAG), carbon dioxide (CO2) and semiconductor diode lasers have already been approved by the United States Food and Drug Administration for soft tissue treatment in oral cavity. The Erbium-doped:Yttrium-Aluminium-Garnet (Er:YAG) laser was approved in 1997 for hard tissue treatment in dentistry and recent studies and developments reported many positive results. This suggests that the Er:YAG laser system is a promising apparatus, which will be able to revolutionise and improve clinical dental practice, in particular periodontal treatment.

**Table 1. Current laser wavelengths commonly used in clinical dentistry**

<table>
<thead>
<tr>
<th>Type</th>
<th>Active Medium</th>
<th>Wavelength</th>
<th>Clinical Application</th>
<th>Company</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas Lasers</td>
<td>Neodymium</td>
<td>1,064 nm</td>
<td>Soft tissue incision and ablation Subgingival curettage</td>
<td>Biolase</td>
</tr>
<tr>
<td></td>
<td>Gallium-Arsenide (GaAs)</td>
<td>655-810-980</td>
<td>Caries and calculus detection Soft tissue incision and ablation Subgingival curettage Bacterial decontamination</td>
<td>Redlase, KaVo, Odyssey, Syrana, Deka, Fotona, Periolase</td>
</tr>
<tr>
<td></td>
<td>Gallium-Arsenide (GaAs)</td>
<td>2,780 nm</td>
<td>Soft tissue incision and ablation Subgingival curettage Bacterial decontamination</td>
<td>Deka, Fotona, Periolase</td>
</tr>
</tbody>
</table>

Application of Laser for Periodontal Treatment

Scaling and root planning is the traditional method of controlling subgingival microflora for management of periodontal diseases. The objectives of subgingival debridement are to eliminate not only the adherent and unattached bacterial plaque, but also deposits of calculus. However, removal of calculus using conventional hand instruments has been reported to be incomplete and rather time consuming. In order to improve the effectiveness and efficiency of root surface debridement, various devices such as sonic and ultrasonic scalers, and more recently lasers have been used (Figure 1). Many studies have demonstrated that sonic and ultrasonic instrumentation, when compared with manual instrumentation, results in equal and superior treatment outcomes.

The use of lasers for periodontal treatment becomes more complicated because the periodontium consists of both hard and soft tissues. Among the many lasers available, high power lasers such as CO2, Nd:YAG and diode lasers can be used in periodontics because of their excellent soft tissue ablation and hemostatic characteristics. However, when they are applied to the root surface or alveolar bone, carbonisation and thermal damage have been reported. Therefore the use of these lasers is limited to gingivectomy, frenectomy and similar soft tissue procedures including the removal of melanin pigmentation of gingiva.

Recently, Er:YAG and Erbium-Chromium doped:Yttrium-Selenium-Gallium-Garnet (Er,Cr:YSGG) laser scaling was introduced as an alternative or an adjunctive to conventional scaling and root debridement (Figure 2 and 3). Of all the lasers available, the absorption of the Er:YAG and Er,Cr:YSGG lasers in water is nearly the highest. These lasers effectively ablate all biologic tissues that contain water molecules. The erbium laser group has emerged as a promising laser system for periodontal indications.

Several clinical studies have reported the application of Er:YAG laser for periodontal treatment. Watanabe et al. demonstrated efficient calculus removal with no side effects and uneventful reduction of pocket after Er:YAG scaling. Schwarz et al. reported that equal or slightly better results were observed at six months after laser treatment of periodontal pockets, compared to conventional mechanical debridement using hand scalers and found significantly higher reduction of bleeding on probing scores and improvements in clinical attachment.
level after laser treatment. Schwarz et al. also demonstrated that nonsurgical periodontal treatment with laser alone and a combination of Er:YAG laser and scaling and root planning using hand instruments may result in clinically and statistically significant improvements in the clinical parameters with no difference between two treatments, 12 months after treatment.

Er:YAG laser was also proposed for the implant maintenance, taking advantage of its bactericidal or decontamination effect. Peri-implant infection results in inflammation of the surrounding soft tissues and can induce a breakdown of the implant supporting alveolar bone. It is associated with the presence of a subgingival microflora, which seems to be quite similar to that in periodontal pockets and contains a large variety of Gram-negative anaerobic bacteria. Matsuyama et al. performed debridement of implant abutment surface by Er:YAG laser and reported effective removal of plaque and calculus without producing damage to the implant surface. Also, Kreisler et al. observed a nonexcessive heat generation on the implant surfaces and effective decontamination by means of the Er:YAG laser.

Even though successful experimental results and clinical results have been reported so far with the Er:YAG laser, further studies are required to better understand the effects on periodontium for its safe and effective application during the periodontal treatment. Therefore, randomised controlled clinical trials and more basic studies have to be encouraged and performed to determine the most optimal and safest parameters for laser treatment.

Advantages and Disadvantages

Advantages of laser treatment in periodontics are effective and efficient soft and hard tissue ablation with a greater hemostasis, bactericidal effect, minimal wound contraction, minimal collateral damages with reduced use of local analgesia. In addition, the small popping sound of the lasers in action with Er:YAG seems to produce less stress to patients than the high pitch vibration sound of most of the ultrasonic devices.

Despite numerous advantages of using lasers, the use of laser also has disadvantages that require precautions to be taken during clinical application. Laser irradiation can interact with tissues even in the non-contact mode, which means that laser beams may reach the patient’s eye and other tissues surrounding the target in the oral cavity. Clinicians should be careful to prevent inadvertent irradiation to these tissues, especially to the eyes. Protective eyewear specific for the wavelength of the laser in use must be worn by patient, operator, and assistant.

It is recommended that dental laser users to attend certification courses provided by some dental laser organisations and follow laser safety guidelines such as the Laser Code of Practice from the Hong Kong Surgical Laser Association. A good understanding in laser wavelength characteristics, tissue interaction and laser device specification provide a platform for achieving the best results.

Finally, the cost and size of laser device still constitute an obstacle for clinical application of the lasers. Laser devices like Er:YAG and Er,Cr:YSGG are usually cumbersome and rather difficult to set up in small dental surgeries in Hong Kong.

Future Developments

There is a great potential for laser systems to be developed further to include additional features and
functions. The Alexandrite laser is a solid-state laser, which could remove dental calculus selectively\(^{11}\). Mechanism of selective ablation has not been clarified yet. The development of this laser for clinical use is widely expected due to its excellent ability for selective calculus removal from the tooth structure.

**Conclusion**

In summary, laser treatment is expected to serve as an alternative or adjunctive to conventional mechanical periodontal treatment. Currently, among the different types of lasers available, Er:YAG and Er,Cr:YSGG laser possess characteristics suitable for dental treatment, due to its dual ability to ablate soft and hard tissues with minimal damage. In addition, its bactericidal effect with elimination of lipopolysaccharide, ability to remove bacterial plaque and calculus, irradiation effect limited to an ultra-thin layer of tissue, faster bone and soft-tissue repair, make it a promising tool for periodontal treatment including scaling and root surface debridement.

Finally, in order to have a successful periodontal treatment in long term, patients need to be motivated. It is not so much the technology but the motivation and psychology that matter when it comes to practice of oral hygiene before, during and after the periodontal treatment to maintain a good and stable periodontal condition.

**References**