Blue Semiconductor Laser in Dentistry

In the February 2015 issue of Quintessenz, Prof. Dr. Andreas Braun and Prof. Dr. Roland Frankenberger (Department of Restorative Dentistry, Medical Center for Dental, Oral and Maxillofacial Dentistry at Philipps University of Marburg and University Hospital of Giessen and Marburg GmbH) and development engineer Michael Bertold reported on the introduction of the 445-nm semiconductor laser in dentistry.

> Der 445-nm-Halbleiterlaser in der Zahnmedizin – Einführung einer neuen Wellenlänge. Braun, Andreas / Berthold, Michael / Frankenberger, Roland; Quintessenz 2015;66(2):205–211

Therapeutic diode lasers in the infrared wavelength range from 810 to 980 nm are already used very successfully in dentistry. They enhance both the success and the comfort of treatment. Their effectiveness is based on the absorption of electromagnetic radiation in tissue. The wavelength, the power of the laser, and the duration of irradiation play a decisive role in determining effectiveness. In their study, the authors demonstrate that blue laser light improves the cutting performance in surgical procedures, since pigmented cells and tissue respond very well to energy input in the 445-nm wavelength range. For periodontal and endodontic treatment, the blue laser also ensures deep decontamination.

Mode of action of laser energy in tissue

During laser treatment, part of the energy penetrates human tissue where it is transferred to absorbing molecules. The resulting tissue interaction causes photochemical, thermal, or ablative effects. Non-thermal effects are used for antimicrobial photodynamic therapy (aPDT) for example. To do this, a light-activated agent (photosensitizer) is activated by the laser energy and the energy is transferred to the oxygen present, causing cytotoxic effects to microorganisms. This allows problematic endodontic bacteria in root canal systems such as Enterococcus faecalis to be killed. By contrast, thermal effects are used to gradually or selectively heat up tissue structures. The conventional diode laser with wavelengths from 810 to 980 nm can thus be used for coagulation and to remove tissue using photoablation. Studies show that the advantages are an essentially blood-free surgical field and a reduction in the bacterial colonization of periodontal lesions. It was shown that when preparing root canals, adjuvant laser treatment reduces bacteria considerably better than merely rinsing with sodium hypochlorite. A 980-nm diode laser can also be used to create an antibacterial effect deep in the dental hard tissue.

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Blue laser technology

The absorption properties of the irradiated tissue can vary widely depending on how high the percentages of water, hemoglobin, melanin, lipids, and proteins are. The therapeutic effect of different wavelengths of laser radiation can thus be very different. Since energy does not penetrate as deeply into tissues when absorption is high, coagulating cuts in surgical procedures can be made especially well when the absorption levels in tissue and blood are high. The absorption peak for blood cells is in the range of approximately 430 nm. This means that blue laser light transfers high energy into tissue and can thus cause rapid coagulation. However, water absorbs radiation poorly in this wavelength range,

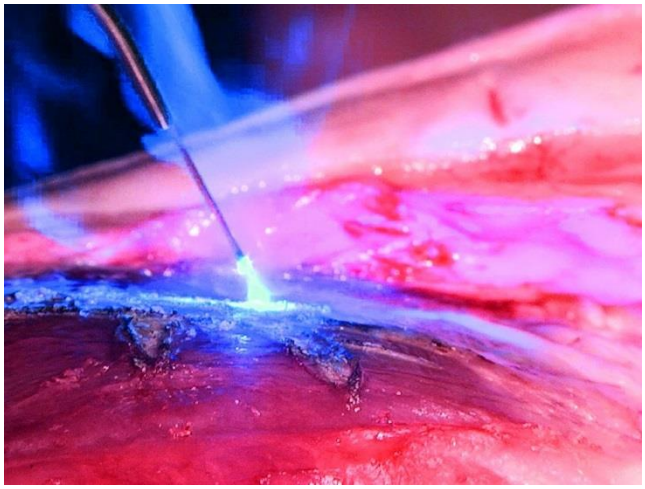
which is why little heat is generated in water through energy input. The authors conclude, "Due to the special absorption properties in tissue components, blue laser allows clean, virtually bloodless cuts with a limited spread of heat in surgical procedures." Due to the low penetration depth, there is very little risk of inadvertently injuring deeper layers. Thanks to the scattering of the laser light, little heat develops in the surrounding tissue.

Case report

In a case report, the authors demonstrate the effect of blue laser light in the treatment of an irritation fibroma.

A 44-year-old patient came to the Medical Center for Dental, Oral and Maxillofacial Dentistry in Marburg with a lentil-sized mucosal lesion in the vestibular area on her right lower lip at the beginning of October 2014. The SIROLaser Blue from Sirona (Bensheim), a Class IV 445-nm diode laser, was used to remove the lesion. Following the manufacturer's instructions, a setting of 2 W in continuous wave mode (cw) and a resulting duty cycle of 100 percent was used to excise the tissue. The handpiece with a 320-µm fiber was used for treatment.

The lesion was grasped with surgical forceps and then removed from mesial to distal by cuts made horizontal to the healthy tissue. While for conventional diode lasers, the fibers are usually conditioned, this was not necessary for the 445-nm laser. No direct tissue contact was required for the cuts. The lesion was then easily removed from the underlying tissue using surgical forceps. Due to the coagulating effect of the laser there was no acute bleeding. The wound did not need to be sutured and was merely flushed with saline solution to clean and moisten the tissue treated. At the regular follow-up after two and seven days, the area was non-irritated and had the expected fibrin coating. There were no signs of secondary bleeding. One month later, the wound was completely healed with no new tissue formation. There was also no scar. The patient reported a burning sensation at the tissue removal site that had now eased and felt no pain or discomfort in the treated area. <



The blue light of the SIROLaser Blue is readily absorbed by the tissue, thus enabling precise, painless cutting.

The excellent absorption in tissue makes the SIROLaser Blue ideal for soft tissue surgery.