Gingival plastic with diode laser

A case report

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_Dental lasers have been used in modern dentistry for more than three decades. The first theoretical principles of laser light were postulated by Albert Einstein in 1916. He suggested that portions of the electromagnetic field could be stimulated and thus produce amplified light. Laser was described as stimulated emission as an inversion of absorption.[1] More than four decades passed from theory to implementation and completion of the first laser device. The first laser, a ruby laser, was produced in 1960 by Theodore Maiman using a ruby crystal and a flash.[2]

The word "laser" is an acronym for light amplification by stimulated emission of radiation. Coherence in terms of time and place is one of the distinguishing features of laser light.[3,4] This means that all the generated laser light waves have the same colour at the same wavelength. Therefore, they are monochromatic. As laser beams are highly concentrated, when focused on a very small area, they can apply extreme energy. Laser light is reflected, transmitted or absorbed by the biological tissue. The influence of laser radiation will depend on interactions with the molecules in the target tissue. The wavelength of the laser energy has different effects on certain tissues of the human body, ranging from cutting tissue to stimulating wound healing.[5]

In the past, laser was regarded as a complex technology with only limited use in dentistry. Through a variety of technical developments and advances, the application range of laser devices is constantly expanding. Nowadays, the number of dentists using new features of laser dentistry and incorporating laser devices into their practice routine is increasing constantly. Possible applications for lasers in dentistry can be divided into four fields: dental surgery, periodontology, endodontology and conservative dentistry, mainly laser-based cavity preparation.

In principle, three types of lasers can be distinguished nowadays. First, there are solid-state lasers, which Maiman realised with his ruby laser. This type of laser uses, among others, crystals of yttrium aluminium garnet (YAG) as the active medium and is doped with ions, such as neodymium (Nd) or erbium (Er). Second are gas lasers, which are constructed

Fig. 1_The Ceralas D15/810 nm diode laser.
Fig. 2_Gingival display before laser treatment.
Fig. 3_Abnormal growth of the gingival tissue around the central and lateral incisors and the canines in the maxillae.



Fig. 1


Fig. 2


Fig. 3

slightly differently from solid-state lasers. Gas lasers contain a noble gas, metal vapours or gas molecules as the active medium. An electric current is usually induced in the gas medium by applying a high electric voltage, which then generates the gas discharge. Third, there are the semiconductor lasers. In this case, the active medium is a semiconductor crystal, such as gallium arsenide.[6–8]

_Laser devices and treatment ranges

The lasers that are most commonly used in dental practice are Er:YAG and Nd:YAG lasers (solid-state lasers), carbon dioxide lasers (gas lasers), as well as argon and diode lasers (semiconductor lasers).[8–10] The Er:YAG laser (wavelength of 1,064 nm) allows for the removal of tooth structure and enamel conditioning, and can be used in both soft-tissue surgery and dental surgery for bone cutting with extreme precision because of its excellent water absorption.[9–11]

The Nd:YAG laser (wavelength of 2,940 nm) is used predominantly in root canals and for the treatment of periodontal disease. There are some indications in soft-tissue surgical procedures for which this laser can be used very well. Because of its absorption range, it can be optimally applied in cases of pigmented soft tissue and pathogens.[9, 10, 12, 13]

The carbon dioxide laser (wavelength of 10,600 nm) is an extremely precise tool for cutting, ablation, coagulation and vaporisation of biological tissue.[9, 10, 13, 14] It can now be used as a matter of routine in surgery as a minimally invasive alternative to the use of the scalpel, for example in vestibuloplasty or fraenectomy. The argon laser (wavelength of 488/514 nm) is mainly absorbed by haemoglobin and is used in soft-tissue surgery.[8–10]

_Diode laser and applications in dentistry

The diode laser has a privileged position among the various laser devices.[8–10] Since its market launch in 1995, the use of diode lasers in dentistry has developed rapidly. At that point, the laser market was dominated by gas and solid-state lasers (carbon dioxide, Nd:YAG and Er lasers). A diode laser uses a solid-state crystal as the active medium. This is a semiconductor laser, which uses a combination of aluminium and gallium arsenide to convert electrical energy into light energy. In certain semiconductor configurations, monochromatic and coherent radiation emission is possible. However, there is a variety of diode lasers in the market with different wavelengths. Wavelengths mainly used in dentistry are in the near-infrared region, ranging from 635 to 980 nm. In principle, diode lasers can be found in the wavelength range of 810 nm to 980 nm, with excellent absorption in melanin and haemoglobin combined with low absorption in water and dental hard tissue. They have a good bactericidal effect and good coagulation qualities. The power spectrum ranges from 1 mW at 635 nm to about 20 W at 810 nm. Depending on the clinical indication, the energy of the injection laser (= diode laser) is transmitted in continuous wave mode or pulse mode either with fibres in contact with the tissue or with the appropriate power from a distance.[9, 15, 16]


Fig. 4


Fig. 5


Fig. 6


Fig. 7

Fig. 4_Gingivectomy of the thickened gingival tissue in the second quadrant.
Fig. 5_Intra-op comparative photograph of the maxillae.
Fig. 6_Post-op gingival display: State after vaporisation of the excessive gingival tissue.
Fig. 7_Second day post-op: Granulating wound, healing by secondary intention.

The diode laser has a very wide range of indications, which can be perfectly integrated into the dental treatment spectrum. It is ideally suited for performing incisions, which are very common in dental surgery, as well as for the removal of benign tumours, fibroids or small haemangiomas in the oral cavity, for uncovering implants, and for use in soft-tissue surgery. It is specifically indicated for peri-implant surgery.[15] Furthermore, the diode laser is used for the decontamination of pathogen-populated surfaces (of implants and teeth).[13]

Laser light destroys anaerobic bacteria, especially Gram-negative bacteria. Owing to the average penetration depth of the diode laser, an overall very good deep bactericidal effect is achieved. But, in the root canal, for example, this effect is not quite as effective as with the Nd:YAG laser.[12, 17]

Other application areas of the diode laser are antimicrobial photodynamic therapy and laser-assisted tooth whitening. Antimicrobial photodynamic therapy is used as part of the systemic treatment of periodontal disease or root canal disinfection. With antimicrobial photodynamic therapy, the bacteria are stained by a photosensitiser and elimi-


Fig. 8


Fig. 9


Fig. 10


Fig. 11

Fig. 8_Pre-op situation.
Fig. 9_First quadrant: The gingival contour was asymmetrical with the smile line.
Fig. 10_Second quadrant: The gingival contour on the central and lateral incisors was uneven and asymmetrical.
Fig. 11_Probing of the height of the clinical crowns of the incisors.

nated by light activation. In laser-assisted tooth whitening, laser energy is applied to enable and accelerate the whitening process, and the effect mechanism is based on the photocatalytic whitening process. Moreover, the diode laser is indicated for the detection of caries and mineralised deposits, such as plaque.[2]

_Case presentations

In the following two clinical cases of gingival surgery using a diode laser, the surgical steps and postoperative wound healing of the patients are presented. The treatments were performed in the department of conservative dentistry and oral surgery at the Agia Varvara general hospital in Athens in Greece and in patients with gingival enlargement. For the treatments, the Ceralas D15/810 nm diode laser (biolitec; Fig. 1) was used.

Case 1

A 35-year-old female patient presented for dental examination in our department. The patient presented with generalised thickened and lobulated gingival tissue in the maxillae, where it had led to impairment of her oral care and to great discomfort. Besides a pollen allergy, the patient was generally healthy. She said that she was a former smoker. Furthermore, the patient reported that while sleeping she tended to breathe through the mouth owing to a deviation of the nasal septum. Her mouth appeared to have been sufficiently conservatively and prosthetically restored, and oral hygiene seemed to be moderate. The clinical examination found generalised gingival enlargement of the periodontium of all of the teeth in the anterior maxillary region (Figs. 2 & 3). There were generalised moderate gingivitis and pseudo-pockets. The red and swollen pseudo-pockets partially covered the vestibular aspect of the crowns. The probing depth of the pseudo-pockets was 4 mm around teeth #13, 12, 22 and 23 and 5 mm around teeth #11 and 21. The dental panoramic radiograph showed no vertical or horizontal bone loss. During clinical diagnosis of gingival enlargement induced by mouth-breathing, generalised moderate gingivitis was found. The patient wished to have the thickened tissue removed. She reported being very sensitive to pain and feared possible bleeding after surgical removal of the tissue. In response to the patient's concerns, we suggested the use of a diode laser as an alternative to the conventional method with a scalpel. The patient opted for laser treatment.

For the removal of the hyperplastic tissue, the Ceralas D15/810 nm was used with a setting of 3 W in continuous wave mode. For the local anaesthesia, Ultracain D-S 1:200,000 (Sanofi-Aventis) was administered and a total amount of 1 ml was infiltrated around the tissue to be removed. The patient and the treatment team were then equipped with the appropriate laser goggles. After verification of the anaesthesia in the surgical area with a dental explorer, removal of the thickened and lobulated tissue was performed. The fibre was guided parallel to the tooth surfaces and to the depth of the tissue (Figs. 4 & 5). Owing to the coagulating effect of the laser, no acute bleeding occurred (Fig. 6). Post-operatively, the patient was instructed to cool the surgical area and to avoid exercise. Furthermore, the patient received a prescription for painkillers in case she experienced pain, and an appointment was scheduled for two days after the surgery in order to check the wound healing. In the surgical area, good wound healing could be observed, and a fibrin layer covered the area of the removed gingiva. The patient reported having felt no pain during the healing process, and there was no restriction of food intake (Fig. 7). She was very happy with the end-result, and afterwards desired to undergo a septoplasty in order to eliminate the problem of the mouth-breathing.

Case 2

In November 2012, a 30-year-old female patient presented to our clinic for the first time. According to the patient, the anterior maxillary teeth were uneven in size (Figs. 8–10). The patient was generally healthy and had no allergies. Her mouth appeared to have been sufficiently conservatively and prosthetically restored, and oral hygiene seemed to be good. Moreover, there were no signs of specific need for periodontal treatment. No noteworthy features were observed extra-orally. The patient had an average smile line. An irregular contour of the gingival line in the anterior maxillary region was evident intra-orally. After probing, it was found that teeth #21 and 22 had a 2 mm higher clinical crown in compar-

ison with teeth #11 and 12 (Figs. 11 & 12). The patient was dissatisfied with her current situation and wished for the gingival line to be symmetrical in the area of the anterior maxillary teeth and for this to be accomplished as painlessly as possible. In addition to the conventional removal of gingival tissue with a scalpel, the patient was offered treatment with the diode laser. She decided on the laser treatment.

For gingival recontouring, the Ceralas D15/ 810 nm was used with a setting of 3 W in continuous wave mode. For the local anaesthesia, Ultracain D-S 1:200,000 was administered and a total amount of 0.8 ml was infiltrated around the tissue to be removed. The patient and the treatment team were then equipped with the appropriate laser goggles. After verifying the anaesthesia in the surgical area with a dental explorer, gingival recontouring was performed by removing the excess gingival tissue and sculpting the gingival line. The fibre was inserted parallel to the tooth surfaces, and the thickened gingival tissue was gradually thinned and removed (Figs. 13 & 14). With the 810 nm diode laser emissions being absorbed by dark underlying substances, damage to the tooth structure was not expected. Post-operatively, the patient was instructed to cool the surgical area (Fig. 15). A wound bandage was not required. An appointment was scheduled for two days after the surgery in order to check the wound healing (Fig. 16). In the surgical area, there was good wound healing, and granulation tissue had formed in the area of the removed tissue. The patient reported having felt no pain during the healing process and could eat normally. She was very pleased with the results.


Fig. 12


Fig. 13


Fig. 14


Fig. 15

Fig. 12_The crowns of teeth #21 and 22 were 2 mm higher compared with teeth #11 and 12.
Fig. 13_Gingival recontouring with an 810 nm diode laser.
Fig. 14_Intra-op comparative photograph of the incisors.
Fig. 15_The patient's smile after laser treatment.

_Conclusion

The possibilities of laser systems, as presented in the case reports using a diode laser, offer new therapeutic approaches and support to many conven-

AD




Fig. 16

Fig. 16_The gingival line after two days of healing.

tional treatments. Nevertheless, laser can currently be considered as an adjuvant therapy and not quite as a true alternative to traditional therapies. Advantages for the patient are painless and bloodless surgical treatment in which secondary bleeding is not expected and suturing is not absolutely necessary. Furthermore, the procedure can be performed quickly, and the healing time is shorter than in the case of conventional gingival surgery. Time will prove whether laser will be capable of replacing traditional and very effective treatment methods through continuous improvement and development of the technology._

Editorial note: A list of references is available from the publisher.

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Kurz & bündig

1916 legte Albert Einstein mit seinem Prinzip der stimulierten Emission die theoretischen Grundlagen für den Laser. Er nahm an, dass Teile des elektromagnetischen Feldes stimuliert werden könnten und damit verstärktes Licht produzierten. Von der Theorie zur Implementierung und Fertigstellung der ersten Lasertechnik vergingen jedoch mehr als vier Jahrzehnte. Der erste Laser – ein Rubinlaser – wurde 1960 von Theodore Maiman unter Verwendung eines Rubins und Blitzlichtes entwickelt.[2] Aufgrund einer Vielzahl technischer Entwicklungen und Fortschritte wurde das Anwendungsspektrum von Lasern stetig erweitert und fand so auch seinen Weg in die Zahnmedizin. Heute wächst die Zahl der Zahnärzte, die die Lasertechnologie fest in ihren Praxisalltag integriert haben.

Grundsätzlich gibt es drei Arten von Lasern: Festkörperlaser, die u.a. Yttrium-Aluminium-Granat-Kristalle (YAG) als aktives Medium verwenden und mit Ionen wie Neodym (Nd) oder Erbium (Er) dotiert sind; Gaslaser, die ein Nobelgas, Metalldämpfe oder Gasmoleküle als aktives Medium enthalten; und zu guter Letzt Halbleiterlaser, bei denen das aktive Medium ein Halbleiter-Kristall ist wie beispielsweise Galliumarsenid (GaAs-Laser).[6-8] Die in der Zahnarztpraxis am häufigsten gebrauchten Laser sind Er:YAG-, Nd:YAG-, CO_2- sowie Argon- und Diodenlaser.[8-10] Dabei hat der Diodenlaser eine privilegierte Position:[8-10] Er eignet sich ideal zur Durchführung von Schnitten sowie zur Entfernung gutartiger Tumore, Myomen oder kleinen Hämangiomen in der Mundhöhle, zur Freilegung von Implantaten, in der Weichgewebschirurgie, bei periimplantären Eingriffen[16] sowie bei der Erkennung von Karies und mineralisierten Ablagerungen wie Zahnstein.[9,10,13,16,17]

In den beschriebenen Fällen wurden bei einer 35- und einer 30-jährigen Patientin gingivale plastische Operationen unter Verwendung eines Diodenlasers (Ceralas D15/810 nm; Biolitec, US) durchgeführt. Im Fall der 35-jährigen Patientin (Abb. 2–8) offenbarte eine durch Mundatmung verursachte Vergrößerung der Gingiva eine allgemein moderate Gingivitis. Das verdickte und gelappte Gewebe wurde mittels Laser entfernt. Aufgrund des koagulierenden Lasereffekts trat keine akute Blutung auf. Die 30-jährige Patientin (Abb. 9–17) befand ihre Oberkieferfrontzähne für ungerade hinsichtlich der Größe und wünschte sich daher eine Harmonisierung des Zahnfleisches im Bereich der oberen Frontzähne. Die Zahnfleischformung wurde durchgeführt durch Entfernung des überschüssigen Zahnfleischgewebes und Formung der Zahnfleischlinie. Dabei wurde die Laserfaser parallel zur Zahnoberfläche eingeführt und das verdickte Zahnfleischgewebe schrittweise verdünnt und entfernt. Zwei Tage nach der Behandlung zeigte sich im Operationsgebiet beider Patientinnen eine einwandfreie Wundheilung. Die Patientinnen waren insgesamt sehr zufrieden mit der Behandlung.

Die vorgestellten Fälle zeigen, dass die Anwendung des Diodenlasers neue therapeutische Ansätze bietet und damit konventionelle Behandlungsmaßnahmen unterstützt. Die Zeit wird zeigen, ob der Laser in der Lage sein wird, traditionelle und effektive Behandlungsmethoden durch kontinuierliche Verbesserung und technologische Weiterentwicklung zu ersetzen.

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