Uses of Laser in Oral and Maxillofacial Surgery

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Abstract: ***Because of their many advantages, lasers have become indispensable in OMS as a modality for soft tissue surgery. Based on manufacturer estimates, approximately 10% to 20% of all oral and maxillofacial surgeons have one or more lasers in their offices, and most surgeons have access to lasers in the hospital. Lasers not only enhance the current surgical options for treatment, but also have expanded the scope of practice. There are many uses for lasers in OMS, and the advent of new wavelengths will undoubtedly lead to new procedures that can be performed with them. One elusive use is hard tissue surgery. Although the Er: YAG has been approved for hard tissue use in the United States and currently is being used in general dentistry, it is still not yet practical or proven for large-volume osseous or extraction surgery, in which the greatest opportunity for innovation and clinical use exists. With future research, it is possible that the right wavelength laser will be developed for this purpose, allowing an increased base of procedures performed with lasers in OMS.***

Keywords: Er: YAG

1. Introduction

The past decade has seen a veritable explosion of research into the clinical applications of lasers in dental practice, and the parallel emergence of organizations to support laser dentistry with an international focus. Once regarded as a complex technology with limited uses in clinical dentistry, there is a growing awareness of the usefulness of lasers in the armamentarium of the modern dental practice, where they can be used as an adjunct or alternative to traditional approaches. Traditionally, lasers have been classified according to the physical construction of the laser (e.g., gas, liquid, solid state, or semiconductor diode), the type of medium which undergoes lasing (e.g., Erbium: Yttrium Aluminium Garnet (Er:YAG)) (Table 1), and the degree of hazard to the skin or eyes following inadvertent exposure. The purpose of this paper is to provide an overview of various laser applications which have been developed for dental practice, and to discuss in more detail several key clinical applications which are attracting a high level of interest.(1)

2. Types of Laser

Carbon dioxide (CO2) lasers continue to be a major instrument for soft tissue surgery for excel- lent affinity to water-based tissues. The wavelength of 10, 600nm is readily absorbed by water thus, it will not penetrate far into tissues (0.1-0.23mm) without repeated or prolonged use making it ideal for superficial lesions and resurfacing of the skin. It is also used for removal of the sialoliths.

Nd:YAG lasers (1064nm) are used for hair removal, in addition for removal of tattoos and pigmented lesions if q-switched. Nd:YAG and Ho:YAG (2.12µm) are frequently used in bone and cartilage ablation.

Ho:YAG lasers are used for adhesions and foreign body removal while treating joint irregularities and performing discectomy of the perforated disk.

Er:YAG lasers (2.94µm) have become the most popular lasers for treatment of hard tissues, teeth and bone. Frequency doubled Nd:YAG or KTP laser (532nm) is strongly absorbed by haemoglobin, melanin and other similar pigments being used for treatment of telangiectasia and keloid scars if q-switched.

Alexandrite lasers (720-800nm) are used for hair removal and tattoo removal, if q-switched, as are the ruby laser (694nm) and dye laser (400-1000nm).

Argon (488, 514nm) and krypton lasers (531nm) are readily absorbed by hemoglobin, mela- nin and other similar pigmentation and are useful in the treatment of the port-wine stains. Argon, KTP, Nd:YAG and diode lasers are used to treat oral soft and/or vascular lesions by ablation, incision, excision or coagulation. The excimer laser (UV outputs) are absorbed by proteins, and mostly used in ophthalmic surgery [2, 3, 4]

3. Application of Laser in Oral Surgery

More than in any other dental specialty, lasers have played an integral role in the practice of OMF surgery. Lasers and rapidly becoming the standard of care for many procedures per formed by oral and maxillofacial surgeons. The reason for this transition is due to the fact that many procedures can be executed more efficiently and with less morbidity using lasers as compared to a scalpel, electrocautery or high frequency devices. Because many of these procedures are routine for the practicing surgeon, the laser is merely used as a better tool to facilitate the same goals; the transition to laser surgery by most OMF surgeons has been gradual and relatively simple. Many new procedures have been developed specifically to take advantage of the unique properties of the laser or can be done only via a laser; because there is no analogous procedure using conventional surgical instruments. On the other hand, there are procedures that although possible with other modalities, have become popular to perform using the laser because of its inherent advantages. Early lasers were bulky and historically used for major cases in operating theaters (5, 6)

Laser Osteotomy:

Experimental laser osteotomies were performed in vitro and in vivo with use of different wavelengths including excimer lasers, Er:YAG, CO2 and Ho:YAG lasers. The laser light Application of Diode Laser in Oral and Maxillofacial Surgery emitted by Er:YAG and CO2 lasers are well absorbed by water. The wavelength of the Er:YAG laser, moreover, is also well absorbed by hydroxyapatite, and of the CO2 laser is highly absorbed by collagen. Therefore, these wavelengths seem to play an increasingly important role in OMF surgery [7].

Benigin Oral Lesions:

For soft tissue surgery several wavelengths including Er:YAG, CO2, Nd:YAG and diode lasers were investigated over the past years. Excision of benign lesions, such as fibroma, papilloma, mucocele, gingival lesions, benign salivary glands lesions, salivary stones, epulisfissurata, tongue lesions and hyperplastic tissue excisions, Removal of these lesions using lasers is minimally invasive and can make the surgery less extensive, and may reduce the need for general anesthesia or in-patient hospital care, resulting in the lowered overall costs [8, 9]

Temporomandibular joint laser-assisted surgery:

Arthroscopic surgery has become the treatment of choice for internal derangements of the temporomandibular joint using Er:YAG, CO2 and Ho:YAG lasers. Using this technique procedures such as discectomy, discoplasty, synovectomy, hemostasis, posterior attachment contraction, and eminectomy can be performed on an outpatient basis through two incisions less than 2mm each [10, 11]

Advantages:

There are many advantages to the use of lasers in OMF surgery. The advantages of laser surgery include: hemostasis and excellent field visibility, precision, enhanced infection control and elimination of bacteremia, lack of mechanical tissue trauma, reduced postoperative pain and edema, reduced scarring and tissue shrinkage, microsurgical capabilities, less instruments at the site of operation, asepsis due to non-contact tissue ablation and prevention of tumor seeding . The hemostatic nature of the laser is of great value in OMF surgery. It allows surgery to be performed more precisely and accurately because of increased visibility of the surgical site.(12, 13)

Use of low level laser therapy:

Post-surgical pain while there is accumulating evidence to support the analgesic capabilities of LLLT when used post-surgically; the mechanisms of this effect are unclear. The effect has been explained in terms of interference with the mediation of the pain message and/or the stimulation of endorphin production, although direct evidence for these mechanisms has yet to be published. The effectiveness of LLLT for treating post-surgical pain arising from the oral cavity has been investigated in several studies. There are reports that a single episode of LLLT (irradiance 0.9-2.7 J) is100 per cent effective for apical periodontitis following root canal treatment and post-extraction pain (14)

Laser Wound Healing:

Methods using low-powered lasers to improve wound healing have been noted for many years but the reported results have been mixed. While the risk of thermal damage from low-powered lasers appears minimal, the Council considers the application of laser energy purely for the purpose of improved wound healing to be controversial and not well supported by clinical studies.(15)

4. Conclusions

Laser technology for caries detection, resin curing, cavity preparation and soft tissue surgery is at a high state of refinement, having had several decades of development up to the present time. This is not to say that further major improvements cannot occur. Indeed, as is in the case with laser abrasion, the fusion of concepts from differing technologies may open the door to novel techniques and treatments. The field of laser-based photochemical reactions holds great promise for additional applications, particularly for targeting specific cells, pathogens or molecules. A further area of future growth is expected to be the combination of diagnostic and therapeutic laser techniques in the one device, for example the detection and removal of dental caries or dental calculus etc (16, 17)

Reference

[1] Australian Dental Journal 2003;48:(3):146-155
[2] Shokrollahi, K., Raymond, E., & Murison, MS. (2004). Lasers: Principles and Surgical Applications. Journal of Surgery, 2(1), 28-34.
[3] Strauss, R. A. (2000). Lasers in Oral and Maxillofacial Surgery. Dental Clinics of North America, 44(4), 851-873.
[4] Gabrić, Pandurić. D. (2010). Physical and Ultrastructural Bone Effect Comparison between Laser and Surgical Drill. PhD thesis. University of Zagreb.
[5] Strauss, R. A. (2000). Lasers in Oral and Maxillofacial Surgery. Dental Clinics of North America, 44(4), 851-873.
[6] Stabholz, A., Zeltser, R., Sela, M., Peretz, B., Moshonov, J., Ziskind, D., & Stabholz, A. (2003). The Use of Lasers in Dentistry: Principles of Operation and Clinical Applica- tions. Compendium of Continuing Education in Dentistry, 24(12), 935-948.
[7] Deppe, H., & Horch, H. H. (2007). Laser Applications in Oral Surgery and Implant Dentistry. Lasers in Medical Science, 22(4), 217-221.
[8] Golnabi, H., & Mahdieh, M. H. (2006). Trend of Laser Research Developments in Global Level. Optics & Laser Technology, 38(2), 122-131.
[9] Maiman, T. H. (1960). Stimulated Optical Radiation in Ruby. Nature, 187-493.

[10] Clayman, L., & Kuo, P. (1997). Lasers in Maxillofacial Surgery and Dentistry. Thieme: New YORK
[11] Müller, J. G., Berlien, P., & Scholz, C. (2006). The Medical Laser. Medical Laser Application, 21(2), 99-108.
[12] Einstein, A. (1917). Zür Quantentheorie der Stralung. Physiol Z, 18-121
[13] Schawlow, A. L., & Townes, C. H. (1958). Infrared and Optical Masers. Physical Re- view, 1112-1940.
[14] Kawakami T, Ibaraki Y, Haraguchi K, Odachi H, Kawamura H, Kubota M, Miyata T, Watanabe T, Iioka A, Nittono M. The effectiveness of GAlAs semiconductor laser treatment to decrease pain after irradiation. Higashi Nippon Shigaku Zasshi 1989; 8:57-62.
[15] Zandona, AF, Zero, DT. Diagnostic tools for early caries detection. J Am Dent Assoc 137(12): 1675–1684, 2006.
[16] Walsh LJ. Dental lasers: Some basic principles. Postgrad Dent 1994; 4:26-29.
[17] Walsh LJ. Emerging applications for infrared lasers inimplantology. Periodontol 2002;23:8-15