REVIEW ARTICLE

Lasers in dental implantology: A review

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Abstract

Dental implants have revolutionized the field of dentistry over several decades and are proven to be a legitimate treatment option. As practice of dental implants became more common worldwide, the means of its improvement should be taken into consideration. Lasers can be particularly useful for delivering and supporting the dental implant treatment. Dental lasers have numerous applications in the field of dentistry, and this parallel expansion of laser dentistry and implant dentistry is quite discernible. Advent of different laser systems has a considerable spectrum of application in soft and hard tissues. Innumerable applications of dental lasers have been proposed for clinical use ranging from pre-surgical preparation, placement, second stage recovery, and gingival management, through the treatment of peri-implantitis. Along with these, there lie other benefits such as ablation of target tissues and ability to reduce bacterial contamination. Various wavelengths of dental lasers discovered so far, not all of them are of use in implantology. A laser works primarily through stimulated emission. The light reaches biological tissues and get reflected, absorbed, or scattered in surrounding tissues. Lasers primarily used in the field of implant dentistry are solid state lasers Nd:YAG, Nd:YAP, Er:YAG, Er,Cr:YSGG, semiconductor diode lasers, and gas lasers such as carbon dioxide lasers. Some of these are used for soft-tissue applications having excellent coagulative properties and some works for hard-tissue application described below in this review. When compared to traditional methods, lasers are gentle, less invasive, and less painful. Various studies have documented the capacity of laser wavelength and laser parameters used in implantology. In addition, laser characteristics are important because of the different reactions, they can produce on implant surfaces. Therefore, proper knowledge of properties of lasers and its mode of action are also important for its advantageous use. The aim of this article is to debrief the application of lasers in implant dentistry in a comprehensive manner.

Introduction

Implant dentistry has revolutionized the treatment outcomes and so as advent of lasers in the field of dentistry. The use of lasers in dentistry has grown in last 10-12 years with advent of soft-tissue diode lasers which are cost-effective, portable, and reliable. Lasers have many clinical applications in improving the pre-surgical, surgical, post-surgical, and prosthetic phases of modern implant dentistry. The part of lasers in implantology was explored by Romanos *et al*., and they concluded that soft-tissue lasers could be of benefit in implant dentistry.[1] Light is emitted via laser primarily through stimulated emission. It may get transmitted, reflected, scattered, or absorbed on reaching the surrounding tissues. This light along with its antibacterial abilities may be absorbed by implants and surrounding tissues. The advantage of using lasers in implant dentistry includes hemostasis, decreased swelling, minimal damage to soft tissues, diminished infection, and reduced pain postoperatively.[2] In this article, we will review the use of lasers in various aspects of implant dentistry.

Laser Wavelengths Used in Implantology [Table 1]

Diode lasers

Diodes, with varying wavelengths 810 or 980 nm, are most commonly used. These lasers target pigments in soft tissues, e.g., hemoglobin and melanin. Higher wavelengths are absorbed

Table 1: Different lasers and their effects

Study	Wavelength of laser	Type of study	Effects
Kreisler *et al.*[5]	Nd:YAG	*In vitro*	Cracks, melting
	Ho:YAG		Cracks
	Er:YAG		Surface changes at higher power settings
	CO_2		Surface changes at higher power settings
	GaAlAs		No surface alterations
Oyster *et al.*[9]	CO_2	*In vitro*	No significant temperature rise
Romanos *et al.*[10]	Diode (980 nm)	*In vitro*	No surface modifications
Romanos *et al.*[10]	Nd:YAG	*In vitro*	Extensive melting
Sasaki *et al.*[11]	Er:YAG	*In vitro*	Minimal surface changes
Romanos *et al.*[12]	CO_2, Er, Cr:YSGG	*In vitro*	Osteoblast attachment

better in water, therefore, making 980 nm diode more useful and safer around implants.[3] Romanos suggested that 980 nm diodes are safer for titanium implants even at higher power settings, and 810 nm diode lasers may damage the surface of implants.[4] Therefore, 980 nm diode is considered the only diode useful in implant therapy but with some confines in depth, speed, and efficiency of cutting. The foremost advantage is its small size and relatively low cost.

Neodymium: YAG lasers

These fiberoptic-delivered contact lasers operate at a wavelength of 1064 nm and are poorly absorbed in water but swiftly absorbed in tissue pigments. These are effective in coagulation and hemostasis but because of higher penetrating depth has a potential of damage.[3] These lasers have positive effects in pocket therapy, but Kreisler *et al*. reported that Nd: YAG laser energy melts implant surface.[5] Therefore, it is a contraindication near implants.

Carbon dioxide (CO_2) lasers

These lasers are delivered in continuous-wave mode, gated-pulse mode, and also in short pulses with a wavelength of 10,600 nm. This wavelength is readily absorbed in water, collagen, and hydroxyapatite and thus efficient for vaporization of soft tissues. CO_2 lasers exhibit strong hemostatic and bactericidal properties. These lasers have minimal depth of penetration thereby reducing lateral thermal damage.[3,6] CO_2 laser energy is not absorbed to a significant level by metallic surfaces thereby reducing potential of damage to the metallic implant surface. Various applications of this laser in implant dentistry include uncovering implants at second stage surgery, in decontamination and periimplant care.[6,7]

Erbium lasers

Erbium lasers contain two wavelengths: Er:YAG at 2940 nm and Er,Cr:YSGG at 2780 nm. These are readily absorbed in water and hydroxyapatite.[3] Because of its water absorption, these are safe around implants and in the treatment of peri-implantitis and mucositis. Erbium lasers are more effective as hardtissue lasers with limited application on soft tissues because of poor hemostasis.[6,8]

Application of Lasers in Clinical Practice

Use of lasers can be divided among four phases:
- Pre-surgical
- Surgical
- Post-surgical
- Prosthetic.

Pre-surgical

Preparation of surgical site

This is the first step of implant surgery which includes disinfection of surgical site and degranulation of extraction sockets. Lasers have bactericidal effects and can cause sterilization of implant site. The erbium and diode lasers can accomplish decontamination and can remove granulation tissue from the extraction site. CO_2 lasers are non-contact lasers; therefore, it increases the spot size. The CO_2 lasers are also applicable in removing soft-tissue tags and decontaminating the bony surfaces.[3,13]

Lateral window sinus lift

CO_2 and erbium lasers can be used to create incision without compromising the bone integrity. In sinus lift procedure, graft material is placed between bone and Schneiderian membrane, so integrity of this membrane is necessary. Although piezoelectric devices have promising results, lasers can also be used if used with expertise.[3,9]

Surgical

Flap incision

Dental lasers provide advantages of soft-tissue ablation, hemostasis and thus can also be used to make soft-tissue incisions. In comparison to surgical blade, it provides great hemostasis. Various lasers that can be employed for this purpose are diode lasers, CO_2 lasers, and erbium lasers difference being in their wavelength and depth of penetration. Wavelength offering water cooling mechanism reduces the thermal effects and keeps the visual field clean.[13,14]

Osteotomy

Erbium lasers can be used effectively in bone ablation as well, therefore, are effective in producing osteotomies.[13,15] Use of drills causes anxiety and discomfort to patients, so lasers can be of advantage. The major advantage of using erbium lasers is during the preparation of initial guide hole as bur may slip over

irregular bony surfaces.[13] Kesler *et al.* concluded that erbium lasers are safe option in osteotomy procedures.[16]

Decortication for guided bone regeneration - During placement of dental implants, implant site may require bone augmentation in either horizontal or vertical direction. Erbium family of lasers can be utilized for decortication of bone and research suggests that using laser is advantageous compared to bur.[8,13] Kesler *et al.* showed that a higher level of platelet-derived growth factor is produced by erbium lasers compared to bur, and therefore, it enhances early healing.[17]

Post-surgical

After the placement of implant fixture, minute remodeling of hard and soft tissues can be performed by erbium lasers to assist in placement of ideal prosthetic components such as healing abutment.[13] Furthermore, the advent of low-level laser therapy which provides increased biostimulation and bioinhibition can enhance faster bone formation and improves bone implant interface strength and osseointegration.[13,18,19]

Uncovering implants

Uncovering of dental implants in two stage surgery can be accomplished by various methods as described in the literature which includes traditional use of scalpel and later on electrosurgery both having their limitations, e.g., bleeding edge leading to post-operative sensitivity and delay in taking impressions and thermal effects due to electrosurgery. As an alternative to these, establishment of lasers in last decade has been useful.[20,21] Using the laser for uncovering implants have advantages such as sterilization, depolarization of nerves, analgesia, and hemostasis.[22] Diode lasers and erbium lasers can best be used for this purpose. This can be accomplished either in a circular fashion or with a buccal roll technique depending on the presence of attached and keratinized tissue.[21,22] Use of lasers can allow for taking impressions on the same day and also assists in abutment seating.

Prosthetic phase

Recontouring of soft tissues around implants may be required after surgery for prosthesis to fit in, for this all tissue erbium lasers, CO_2 lasers n diode lasers can be used. This can assist in both initial placements of final prosthesis and recementation.[22]

Use of Lasers in Treatment of Peri-implantitis

Peri-implantitis is multifactorial in nature, which affects both hard and soft tissues around it. It can be managed in either surgical or nonsurgical manner. Non-surgical treatment includes the use of lasers to decontaminate the implant surfaces and then treating peri-implantitis. CO_2, erbium, and diode lasers are used for this with erbium lasers having higher potential. Research shows that surgical treatment is better accomplished using erbium family of lasers as it can remove contaminated titanium layers from implant surface and shows most promising results.[22-24]

Conclusion

The literature suggests that lasers have promising results in implant dentistry. Clinicians should have a proper knowledge of basic laser physics, its properties, and its tissue interactions for its significant benefits in dentistry. Proper training is necessary for using lasers precisely with the use of appropriate wavelengths for its best outcome in implant dentistry. Despite of various effects of lasers of a particular wavelength on different hard and soft tissues, advantages and disadvantages of laser primarily depends on the clinician's expertise. Proper knowledge about lasers will help promote future of implants to a higher level successfully with better treatment options.

References

1. Romanos GE, Gupta B, Yunker M, Romanos EB, Malmstrom H. Lasers use in dental implantology. Implant Dent 2013;22:282-8.
2. Martin E. Lasers in dental implantology. Dent Clin North Am 2004;48:999-1015, viii.
3. Julian J. Principles and Practice of Laser Dentistry. St. Louis, MO: Elsevier; 2011. p. 114-38.
4. Romanos G. Laser surgical tools in implant dentistry for the long-term prognosis of oral implants. Int Congr Ser 2003;1248:111.
5. Kreisler M, Götz H, Duschner H. Effect of Nd:YAG, Ho:YAG, Er:YAG, CO_2, and GaAIAs laser irradiation on surface properties of endosseous dental implants. Int J Oral Maxillofac Implants 2002;17:202-11.
6. Romanos GE, Gutknecht N, Dieter S, Schwarz F, Crespi R, Sculean A. Laser wavelengths and oral implantology. Lasers Med Sci 2009;24:961-70.
7. Deppe H, Horch HH, Henke J, Donath K. Peri-implant care of ailing implants with the carbon dioxide laser. Int J Oral Maxillofac Implants 2001;16:659-67.
8. Van As G. Erbium lasers in dentistry. Dent Clin North Am 2004;48:1017-59, viii.
9. Oyster DK, Parker WB, Gher ME. CO2 lasers and temperature changes of titanium implants. J Periodontol 1995;66:1017-24.
10. Romanos GE, Everts H, Nentwig GH. Effects of the diode (980 nm) and Nd: YAG(1064 nm) laser irradiation on titanium discs. A SEM examination. J Periodontol 2000;71:810-5.
11. Sasaki KM, Aoki A, Ichinose S, Yoshino T, Yamada S, Iahikawa I. Scanning electron microscopy and fourier transformed infrared spectroscopy analysis of bone removal using Er: YAG and CO_2 lasers. J Periodontol 2002;73:643-52.
12. Romanos G, Crespi R, Barone A, Covani U. Osteoblast attachment on titanium disks after laser irradiation. Int J Oral Maxillofac Implants 2006;21:232-6.
13. Van As GA. Lasers in implant dentistry, Part I. Dent Today 2015;34:134, 136-9.
14. Parker S. Surgical laser use in implantology and endodontics. Br Dent J 2007;202:377-86.
15. Parker S. Surgical lasers and hard dental tissue. Br Dent J 2007;202:445-54.
16. Kesler G, Romanos G, Koren R. Use of Er: YAG laser to improve osseointegration of titanium alloy implants – A comparison of

bone healing. Int J Oral Maxillofac Implants 2006;21:375-9.
17. Kesler G, Shvero DK, Tov YS, Romanos G. Platelet derived growth factor secretion and bone healing after Er: YAG laser bone irradiation. J Oral Implantol 2011;37 Spec No:195-204.
18. Carroll JD, Milward MR, Cooper PR, Hadis M, Palin WM. Developments in low level light therapy (LLLT) for dentistry. Dent Mater 2014;30:465-75.
19. Tuner J. Principles and Practice of Laser Dentistry. St. Louis: Elsevier; 2011. p. 263-86.
20. Wilcox CW, Wilwerding TM, Watson P, Morris JT. Use of electrosurgery and lasers in the presence of dental implants. Int J Oral Maxillofac Implants 2001;16:578-82.
21. Kurtzman GM, Mahesh L. Implant uncovery and soft-tissue modification utilizing a diode laser. Int J Oral Implantol Clin Res 2015;6:20-5.
22. Van As GA. Lasers in implant dentistry, Part 2. Dent Today 2015;34:94, 96-9.
23. Kalra T, Nagrath M, Kalra G. Lasers in prostshodontics - Part I: Implantology. Int J Laser Dent 2014;4:49-53.
24. Raffetto N. Lasers for initial periodontal therapy. Dent Clin North Am 2004;48:923-36, vii.

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