

LASER IN DENTISTRY

Laser technology has become an integral part of modern dentistry by providing a minimally invasive, precise, and patient-friendly alternative to many conventional dental procedures. The term LASER stands for Light Amplification by Stimulated Emission of Radiation. The concept of stimulated emission was proposed by Albert Einstein in 1917, and the first functional ruby laser was developed by Theodore H. Maiman in 1960. Laser light is characterized by being monochromatic, coherent, and collimated, enabling controlled interaction with oral tissues for cutting, ablation, coagulation, vaporization, or photobiomodulation depending on the wavelength and tissue properties.^{1,2}

The biological effects of lasers are determined by several operating parameters, including wavelength, power output, pulse duration, exposure time, energy density (J/cm^2), and tissue chromophores. Different wavelengths exhibit selective absorption by water, hydroxyapatite, haemoglobin, or melanin, thereby determining their clinical applications. Er:YAG (2940 nm) and Er,Cr:YSGG (2780 nm) lasers are highly absorbed by water and hydroxyapatite, making them ideal for hard tissue procedures such as cavity preparation, caries removal, enamel etching, and bone surgery. In contrast, diode (810–980 nm) and Nd:YAG (1064 nm) lasers are preferentially absorbed by pigmented tissues, making them suitable for soft tissue surgery, periodontal therapy, and bacterial decontamination. CO₂ lasers (10,600 nm) exhibit high absorption by water, allowing rapid soft tissue incision with excellent haemostasis and minimal postoperative edema.^{1,3}

In routine dental practice, diode lasers are commonly used at 1–3 W for soft tissue incision and 0.5–2 W for coagulation, while CO₂ lasers are generally operated at 2–10 W for soft tissue excision and vaporization. Nd:YAG lasers are used at 2–6 W for soft tissue procedures and periodontal therapy.³ Hard tissue procedures using Er:YAG lasers are typically performed at 100–400 mJ with 10–20 Hz (approximately 1–6 W) under continuous water spray to minimize thermal injury. Low-Level Laser Therapy (LLLT) or Photobiomodulation Therapy (PBMT) employs significantly lower power outputs (50–500 mW) delivering 4–10 J/cm^2 , producing non-thermal effects that stimulate cellular metabolism, reduce inflammation, accelerate wound healing, relieve pain, manage oral mucositis, and reduce dentinal hypersensitivity.^{4,5}

Lasers are currently used in almost every branch of dentistry, including caries detection and prevention, cavity preparation, periodontal pocket debridement, gingivectomy, frenectomy, operculectomy, crown lengthening, soft tissue biopsy, oral lesion excision, implant uncovering, peri-implantitis management, root canal disinfection, dentinal hypersensitivity treatment, dental bleaching, photobiomodulation therapy, management of oral mucositis, and fluorescence-based diagnosis. Compared with conventional instruments, laser-assisted procedures generally result in reduced bleeding, decreased postoperative pain and swelling, superior haemostasis, reduced bacterial contamination, minimal need for sutures, faster wound healing, and improved patient acceptance.² However, successful clinical application depends on proper case selection, appropriate wavelength selection, correct operating parameters, adequate operator training, and strict adherence to laser safety protocols, including wavelength-specific protective eyewear. With continuous technological advances and increasing scientific evidence, lasers have become an indispensable adjunct in modern dentistry, enhancing precision, clinical outcomes, and patient care.^{6, 7}

Dr. Kumar Singh

Paediatric Dentist

Junior Resident

References

1. Brugnera Junior A, Namour S, editors. *Laser Dentistry: Current Clinical Applications*. Irvine (CA): Universal Publishers; 2018 .p. 1-48
2. Heidari M, Paknejad M, Jamali R, Nokhbatolfoghahaei H, Fekrazad R, Moslemi N. Effect of laser photobiomodulation on wound healing and postoperative pain following free gingival graft: A split-mouth triple-blind randomized controlled clinical trial. *Journal of Photochemistry and Photobiology B: Biology*. 2017;172(1):109-114.
3. Van As G. Erbium lasers in dentistry. *Dental Clinics*. 2004;48(4):1017-1059.
4. Olivi G, Genovese MD. Laser restorative dentistry in children and adolescents. *European Archives of Paediatric Dentistry*. 2011;12(2):68-78.
5. De Freitas LF, Hamblin MR. Proposed mechanisms of photobiomodulation or low-level light therapy. *IEEE Journal of selected topics in quantum electronics*. 2016;22(3):348-364.
6. Kikuchi T, Mogi M, Okabe I, Okada K, Goto H, Sasaki Y, Fujimura T, Fukuda M, Mitani A. Adjunctive application of antimicrobial photodynamic therapy in nonsurgical periodontal treatment: a review of literature. *International journal of molecular sciences*. 2015 Oct 13;16(10):24111-24126.
7. Freitas AC, Campos L, Brandao TB, Cristófaró M, Eduardo FD, Luiz AC, Marques MM, Eduardo CD, Simoes A. Chemotherapy-induced oral mucositis: effect of LED and laser phototherapy treatment protocols. *Photomedicine and Laser surgery*. 2014 ;32(2):81-87.