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Lasers in Orthodontics – A Review

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Abstract

A laser is a collimated single wavelength of light that delivers a concentrated source of energy. Soon after different types of lasers were invented, investigators began to examine the effects of different wavelengths of laser energy on oral tissues, routine dental procedures, and experimental applications. Orthodontists, along with other specialists in different fields of dentistry, can now benefit from several different advantages that lasers provide during the treatment process, from the beginning of the treatment, when separators are placed, to the time of resin residues removal from the tooth surface at the end of orthodontic treatment. This article outlines some of the most common usages of the laser beam in orthodontics and also provides a comparison between laser and another conventional method that was the standard of care before the advent of the laser in this field.

Keyword: laser; orthodontics; applications

Introduction

While research in laser-supported therapies for dentistry is going slow, it is going steadily. There is no field of dentistry where progress took place at such a tearing rate in recent years as in the field of laser dentistry. In the beginning, it was in some branches of this scientific field that major therapeutic advantages were being yielded by traditional types of treatment, but by now, this advancement has already incorporated all branches of dentistry to support it and become integrated into the context of laser-assisted dental treatment.[1] An inexhaustible number of new completely different wavelengths of usage offers continuously new possibilities with continually refreshed and near-impossible-to-believe-in-competencies. All must incorporate laser incorporation into their treatment plan for dental care to propel the professional field and give dentistry the therapeutic edge of laser replacement.[2]

History

Laser' is an acronym for 'light amplification by the stimulation emission of radiation'. Its theoretical basis was postulated by Albert Einstein. In explaining the photoelectric effect, Einstein assumed that a photon could penetrate matter, where it would collide with an atom. Since all atoms have electrons, an electron would be ejected from the atom by the energy of the photon, with great velocity. Einstein also predicted in 1917 in Zur Theorie der Strahlung[1] (Theory of Wavelength), that when there exists the population inversion between the upper and lower energy levels among the atom systems, it was possible to realize amplified stimulated radiation, ie laser light. Stimulated electromagnetic radiation emission has the same frequency (wavelength) and phase (coherence) as the incident radiation. (Einstein, 1905, 1917) The laser was demonstrated for the first time in 1960 by Maiman.[1] This emission made the lasers possible. Charles Townes in 1954 demonstrated a working device using ammonia gas as the active medium that produced microwave amplification and the device was called the 'maser'. In 1958, Arthur Schawlow proposed the operation of optical and infrared masers, or 'lasers', a term first coined by physicist Gordon Gould in 1957. In 1960, the first laser was developed by physicist Theodor H Maiman.[1] Robert Hall in 1962 developed the first diode or semiconductor laser. The CO2 gas laser was invented by Kumar Patel in 1964. Paghidiwala tested the erbium-doped solid-state laser (Er: YAG) on dental hard tissue in the year 1985. In 1997, the Er: YAG solid-state laser for hard tissue surgery was approved by the USA Food and Drug Administration (FDA). In 1998, the first diode laser was approved for soft tissue surgery.

Components

There are three main components:

- The laser medium (sometimes referred to as a gain medium)
- The pump source
- The optical cavity or optical resonator

Laser medium

The laser medium is the 'active element' that can be a solid-state element (distributed in a solid crystal or glass matrix), or semiconductor (diode) a gas, dye (in liquid), and the medium dictates the wavelength of the laser.

Pump source:

The pump source stimulates the lasing medium until light-energy is emitted. For instance, pump sources include electrical discharges, flash-lamps, arc lamps, or chemical reactions.

Optical cavity or resonator

The laser optical cavity amplifies light energy. The optical cavity is a compartment of mirrors that contains the laser medium. Light-energy released from the laser medium is reflected by the mirrors back on to itself, where it may be amplified by stimulated emission before exiting the cavity.

Applications in Orthodontics

1. Enamel etching
2. The application of laser energy to a tooth surface allows for a localized ablation of the enamel by two mechanisms. The first is the micro explosion of entrapped water within the enamel, along with the micro explosion, there may also be some melting of the hydroxyl-apatite crystals. The second is the superficial micro explosion of the hydroxyl-apatite crystals. After laser irradiation, it often results in thermally induced changes on the enamel surface. The surface of the metal surface has the appearance of acid-etched enamel. It depends on the type of light source and the strength the light is applied to the surface. Therefore, laser application is more atraumatic and enables patient comfort than by the normal procedure.

3. Light curing lasers

An argon laser can be the initiator of the chemical reaction which is called polymerization and is employed with a reducing agent to denature the amine groups. A photoinitiator, in general, is a device that, when exposed to light, initiates a chemical reaction quickly and with minimal phototoxicity. In this particular case, it is light at a certain wavelength that is being used to cause the chemical reaction. The argon laser is made out of blue and green light as well as a monochromatic and emits light over a band of wavelengths in the blue & green spectrum (457.9-514.5 nm), making it suitable for polymerizing composite. Talbot et al.[3] has shown that argon lasers can be used to efficiently bind orthodontic brackets. In the analysis, the bond strengths of the final brackets were equivalent to those of the brackets bonded with a traditional light-curing resin.

4. Laser for de-bonding procedure

5. Laser technology has been commonly used in both acid etching and demolition of brackets. Lasers have proven their utility in the softening/demoulding of adhesive tape, WMPP, and PFA glue, with a decrease in the adhesive remnant index and a relatively slight rise in the temperature of the pulp after processing. Studies have shown that Nd: YAG and CO2 lasers have been useful in growing the temperatures of the pulp, which is a side effect usually considered negative for surgery. In the analysis by Strobet et al., the efficiency of using CO2 and Nd: YAG lasers were evaluated where the brackets (from the teeth) were removed. When compared to a traditional technique, the laser-assisted debonding technique greatly decreased the residual debonding power, the likelihood of damage to the enamel, and the failure rate during the de-bonding of teeth. Compared to dental "fewer tools," this less invasive approach has a lesser potential for enamel damage, which allows for a safer less stinging experience for the patient.

6. Lasers for clinical exposure of the impacted tooth

7. Laser (the method by which the surgeon makes soft tissue like tissue mutable) consists of exposing teeth in submucosal inclusion (a cavity or process found in the soft tissue around a tooth) and distal gingival resection (the removal of part of the gums) at the mandibular molars region (the eruptive (ossified mass) and recessive (Small cavity filled with the bone that makes up the areas under the two mandibular molars). Speeding up the process is almost bloodless and a field can be collected easily.[4]

8. Lasers for labial and lingual frenectomy

The appearance of a diastema between the upper central incisors can also be caused by a small girth of the upper lip incisors. To facilitate the closure of such space and to prevent post-treatment relapse, lasers may be used to perform deep resection of the frenulum along with incision of the transeptal fibers.[5] The laser permits simpler and rapid resolution without bleeding or the need for sutures. Treatments for this condition can occur over a few days to be without discomfort.

9. The normalisation of clinical crown exposure:

Several patients have an unpleasant gummy smile owing to an excessive gingival overgrowth that covers part of the frontal surfaces of the anterior teeth. In such cases, a simple aesthetic recontouring of the gum with a laser diode can be done to bring the exposure of the anatomical crowns back to normal.

10. Apthous ulcer management

Laser can be used to irradiate the apthous ulcer lesions for healing.

11. Laser holography

This can be used as a new tool for measuring tooth movement. Laser holography offers a precise, non-invasive method for determining movement in three dimensions. The stresses generated in the periodontal ligament when the crown of a tooth is subjected to different forces have important ramifications for the study of orthodontic tooth movement and periodontal disease.

12. Assessing patient pain during dental laser treatment: [6,7]

Many investigators have shown that Low-level laser therapy (LLLT) can produce analgesic effects in various therapeutic and clinical applications. Moreover, local CO2 laser therapy is effective in reducing the pain associated with orthodontic forces. Lim et al.10concluded that LLLT effectively controlled pain caused by the application of the first archwire, but it does not affect the pain beginning after the first archwire is placed and does not alter the most painful day.

13. Laser welding

Metal frameworks are joined frequently to create individual orthodontic appliances and to achieve efficient treatment procedures. A method employed recently for joining metal frameworks is laser welding to weld dental alloys, crystals of YAG, with added neodymium are used to emit laser beams. The benefits of laser-welding are -no solder, and hence no corrosion at the joint, smaller focus, and an argon shielding atmosphere which prevents the oxidation around the welding zone.

Laser safety

Dental practitioners should be aware of dental laser safety. [11] This includes not only an awareness of the potential risks and hazards related to lasers used but also recognition of existing standards of care and a thorough understanding of safety control measures.[12-14] The types of hazards that may be encountered within the clinical practice are an ocular hazard, tissue damage, respiratory hazards, fire and explosion, electrical shock, combustion hazard, equipment hazards.

Conclusion

For several clinical conditions, lasers, when used safely and ethically, maybe an outstanding treatment modality. A major benefit of laser devices is that it enhances the oral hygiene and gives you nice looking skin. Lasers are one of the developments, which have definite promise, but in the present date, a lot of work is still needed for both hard and soft tissue laser procedures to find a single laser that can fulfill the needs of all dental procedures. As an orthodontist who also has multiple EIP procedures, it was very important to my practice that I have the best combination of treatment for my patients, namely, coordination between the EIP procedures I provide, the laser I use in that layering, etc.

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