LASERS in Orthodontics

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ABSTRACT
Dentistry is an ever changing field and there has always been a quest to find procedures and techniques that are fast more effective, convenient and patient friendly. The introduction of light amplification and stimulated emission of radiation technique in both medicine and dentistry has brought a sea change in these fields. Lasers have numerous applications in orthodontics, including enamel etching, debonding, curing composite gingivectomy, frenectomy, operculectomy, papilla flattening, uncovering temporary anchorage devices, ablation of aphthous ulcerations, exposure of impacted teeth, and even tooth whitening. As an adjunctive procedure, laser surgery has helped many orthodontists to enhance the design of a patient’s smile and improve treatment efficacy. Also introduction of laser guided holography has increased the spectrum of the field. Before incorporating lasers into clinical practice, the clinician must fully understand the basic science, safety protocol, and risks associated with them. The purpose of this article is to provide an overview regarding applications of lasers in orthodontics.

Keywords: Dentistry, light amplification and stimulated emission of radiation, orthodontics

Introduction:
In this modern era where technology is bringing a sea changes in all field, dentistry and orthodontics is no exception. Such technological advancement has led to the introduction of LASER technique in both medicine and dentistry. LASER is abbreviated as ‘light amplification by stimulated emission of radiation’. Laser beam is a focused source of electromagnetic radiation, or light energy which travels in a specific direction, and all wavelengths of the laser light travel in single phase.

Historical perspective
Albert Einstein a pioneer theoretical physicist in 1917 first gave the theory of ‘stimulated emission’. 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. 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.

PROPERTIES OF LASER:
- Monochromatic
- Directional
- Coherent

COMPONENTS:
Mainly three 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 determines the wavelength of the laser.

**Pump source:**
Pump source ‘stimulates’ the lasing medium until light-energy is emitted. Eg. pump sources include: electrical discharges, flash-lamps, arc-lamps, or chemical reactions.

**Optical cavity or resonator:**
The laser optical cavity amplifies the light energy. The optical cavity is a compartment of mirrors that contain 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 exciting the cavity.

**LASERS IN ORTHODONTICS-CLINICAL APPLICATIONS:**

**Enamel etching**
Application of laser energy to an enamel surface causes localized ablation. Enamel etching results from the micro explosion of entrapped water in the enamel, in addition to micro explosion, there may be some melting of the hydroxyl-apatite crystals. Laser irradiation mostly causes thermally induced changes on the enamel surface. The surface looks similar to that of acid-etched enamel. It also depends on the type of laser and the energy applied to the surface. Therefore, laser application is more atraumatic and safer (less risk of enamel damage) for the patient.

**Light curing lasers**
Argon laser is used mainly used along with initiator such as camphoroquione and a reducing agent such as a tertiary amine to initiate polymerization. This photoinitiator system is very sensitive to light in the blue region of the visible light spectrum having peak activity centered around 480 nm. The argon laser is monochromatic and emits light over a band of wavelengths in the blue & green spectrum (457.9-514.5 nm), making it ideally suited to polymerize composite. Talbot et al. has concluded that argon lasers can be used to bond orthodontic brackets, to achieve bond strengths comparable to those attained with conventional light curing resins.

**Laser for de-bonding procedure**
Lasers have been used in both acid etching and de-bonding of brackets. Lasers have shown efficiency for de-bonding, with a decrease in the adhesive remnant index and a relatively small increase in pulp temperature. In particular, application of Nd: YAG and CO2 lasers have shown satisfying results, and minimal side effects from the increase in pulp temperature. Strobet al. studied on the efficiency of using CO2 and Nd: YAG lasers in de-bonding ceramic brackets from the enamel surface. Laser aided debonding technique was found to significantly reduce the residual de-bonding force, the risk of damage on enamel and the incidence of failure when compared with the conventional de-bonding techniques. Therefore, this method has the potential to be less painful and safer (less risk of enamel damage) for the patient.

**Lasers for clinical exposure of impacted tooth:**
There are various ways by which a laser can help in the manipulation of soft tissue like exposure of teeth in submucosal inclusion to expose the clinical crown for disimpaction of the tooth. Distal gingival resection at the mandibular molars region for the eruption of second molars in the arch. There procedure is rapid and almost bloodless field can be obtained.

**Lasers for labial and lingual frenectomy:**
The presence of diastema between the upper central incisors may frequently be due to insertion of the upper labial frenum. To facilitate the closure of such space and to avoid post-treatment relapse, lasers can be used to perform deep resection of the frenulum along with incision of the transeptal fibres. The laser permits simpler and rapid resolution without
bleeding or the need for sutures. Healing by secondary intention occurs within a few days, without pain.

**Normalisation of clinical crown exposure:**
Many patients have an unpleasant gummy smile owing to an excessive gingival overgrowth which 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.

**Aphthous ulcer management:**
Laser can be used to irradiate the aphthous ulcer lesions for healing eg. diode laser

**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.

**Assessing patient pain during dental laser treatment:**
Many investigators have shown that Low-level laser therapy (LLLT) can produce analgesic effects in various therapeutic and clinical applications. Many researchers have reported that Nd: YAG, He-Ne, and Ga-Al-As diode lasers have analgesic effects for reducing orthodontic pain. Moreover, local CO2 laser therapy is effective in reducing the pain associated with orthodontic forces. Lim et al. concluded that LLLT effectively controls pain caused by the application of the first arch wire, but it does not affect the start of pain after the first arch wire is placed and does not alter the most painful day.

**Laser welding:**
Metal frameworks are joined frequently to create individual orthodontic appliances and to achieve efficient treatment procedures. Recent method employed for joining metal frameworks is laser welding to weld dental alloys, crystals of YAG, with added neodymium are used to emit laser beams. The advantages 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.

### CLASSIFICATION BASED ON WAVE LENGTH AND USE:

<table>
<thead>
<tr>
<th>Laser type</th>
<th>Wavelength</th>
<th>Clinical application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argon</td>
<td>488, 514 nm</td>
<td>Curing, soft tissue desensitization</td>
</tr>
<tr>
<td>Diode</td>
<td>800-830, 950-1010</td>
<td>Soft tissue, periodontics</td>
</tr>
<tr>
<td>Nd: YAG</td>
<td>1064 nm</td>
<td>Soft tissue, periodontics, desentization, analgesia, tooth whitening, and endodontics</td>
</tr>
<tr>
<td>Er: YSGG</td>
<td>2.79 μm</td>
<td>Hard tissue</td>
</tr>
<tr>
<td>Er: YAG</td>
<td>2.94 μm</td>
<td>Hard tissue</td>
</tr>
</tbody>
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Laser safety
Dental practitioners should be aware of dental laser safety. 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. The types of hazards that may be encountered within clinical practice of dentistry may be grouped as follows:
• Ocular hazard
• Tissue damage
• Respiratory hazards
• Fire and explosion
• Electrical shock
• Combustion hazard
• Equipment hazards.

A danger zone should be created around the surgical area with a sign reading: Warning: Visible and Invisible Laser Radiation. Avoid Eye or Skin Exposure to Direct or Scatter Radiation. Class IV laser product (fig:1)

Conclusion
Lasers are considered as “light in the end of the tunnel” in dentistry. When used effectively and ethically, it can be an exceptional modality of treatment for many clinical conditions. There are many advantages of laser which includes improved oral hygiene and esthetic finishing. Lasers are one of the advances, which have definite potential, but in the present date, a lot of effort is still required for both hard and soft tissue laser procedures to find a single laser that can satisfy the needs of all dental procedures. As an orthodontist being committed to provide the best possible service; an adjunctive procedure such as lasers can dramatically enhance the entire procedure in one’s dental office.

REFERENCES:
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