



## Review Article

# Utility of lasers in orthodontics

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### ABSTRACT

Lasers have increased the treatment efficacy by many folds in the field of dentistry. Incorporating lasers in the orthodontic treatment leads to better patient as well as operator's comfort. First developed almost a century ago, lasers were instigated in dental practice in 1989. The motive of this review paper is to discuss the utility of dental lasers in the speciality of Orthodontics.

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## 1. Introduction

The name "LASER" stands for "Light Amplification by Stimulated Emission of Radiation". A laser can produce light by transforming electrical energy into optical energy. To generate laser light, atoms must be excited to a higher energy level and release their energy in phase.

Laser, as defined by 3 properties is monochromatic, directional and coherent. These properties are different from ordinary light which is non-coherent and diffuse.<sup>1</sup>

Albert Einstein was the first who proposed the theory of "Stimulated emission" as early as 1917. Physicist Theodore H. Maiman in 1960 was the first to develop the first laser to use visible light which used a ruby medium<sup>2</sup> after the theoretical study by Einstein, Townes, Prokhorov and Basov.<sup>3</sup>

The range of the wavelength of lasers employed in dentistry is 488 nm and 10,600 nm. (Figure 1).<sup>4</sup> The lasers used in dentistry are the:-

1. CO<sub>2</sub> laser
2. Argon laser

3. Neodymium-doped Yttrium Aluminum Garnet (Nd:YAG) laser
4. Erbium lasers [Erbium-doped solid state lasers].
5. Diode laser

These lasers are termed according to their suspension state and active medium content.<sup>5</sup>

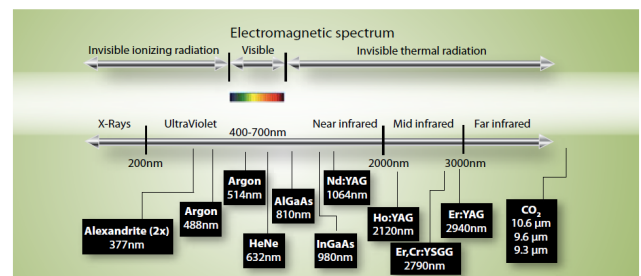


Fig. 1: Wavelengths of dental lasers

## 2. Advantages of Laser Excision vs. Scalpel Surgery

Compared to conventional scalpel surgery there are numerous advantages of laser. The most significant of them all is the clear field provided by it due to coagulation of

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blood vessels and sealing off lymphatics during ablation. Also the cut by the laser is more accurate also laser has an additional benefit of sterilizing the surgical field while ablation. Laser surgery is performed using only compound topical anaesthetic or light anaesthetic studies also suggest that less scar tissue is produced with laser as compared to scalpel. Shorter operating time with lasers is an undeniable advantage for the busy practitioner. Discomfort and pain experienced by the patients post surgically is significantly less when the procedure is done with laser.<sup>6</sup>

### 3. Lasers for Soft Tissue Procedures

The most commonly used soft tissue lasers include the:<sup>6,7</sup>

1. CO<sub>2</sub> (10,00 nm),
2. Diode lasers (800–980 nm)
3. Argon laser
4. Erbium solid state lasers (Erbium-doped yttrium-aluminium-garnet [Er:YAG] laser (2,940 nm).
5. Neodymium-doped yttrium-aluminium-garnet [Nd:YAG] laser (1,064 nm)
6. Potassium, Titanium and Phosphate [KTiOPO<sub>4</sub>, KTP] laser (532 nm)

### 4. Clinical Application of Laser in Orthodontics

Numerous common applications of lasers in orthodontic practice includes accelerated tooth movement, ceramic brackets debonding, etching of enamel prior to bonding and pain alleviation post orthodontic force and prevention of demineralization of the enamel, frenectomy, operculectomy, minor aphthous ulceration ablation, tooth and mini-implant exposure etc.<sup>8</sup>

### 5. Etching of Enamel Prior to Bonding

After laser irradiation, changes such as recrystallization and melting take place in enamel, leading to the occurrence of innumerable pores and bubble-like inclusions.<sup>9</sup> Due to this, laser radiation is a suitable method for etching of enamel. Additionally, it is reported that etching by laser results in the fractured, open dentin tubules and uneven surface, which is ideal for adhesion.<sup>10</sup>

### 6. Aesthetic Laser Gingival Recontouring

Dental aesthetic procedures like papilla flattening or aesthetic crown can be technically demanding tasks as gingival margins sometimes need very minor recontouring that needs a higher degree of precision that is difficult to be attained with a scalpel blade, regardless of the operator's skill level. Diode lasers offer the accurate incision control because of reduced bleeding and a clear dry field during surgery.<sup>11</sup> (Figures 2 and 3)<sup>11</sup>



**Fig. 2:** Preoperative image showing gingival hyperplasia at 22<sup>12</sup>



**Fig. 3:** Post-operative image following local infiltration with 2% lidocaine. Carbonisation is seen at laser gingivectomy site<sup>12</sup>

### 7. Enamel Decalcification Reduction

As suggested by numerous studies, laser can be used to avert decalcification of enamel at the subsurface by changing its crystalline structure, permeability and acid solubility<sup>13–16</sup> although it should be used at low intensity to prevent the enamel disintegration. Richard et al.<sup>14</sup> studied the efficacy of Argon laser irradiation to lessen the demineralization and loss of structure of tooth in vivo. In the mentioned study, a 250 mW argon laser at 12 J/cm<sup>2</sup> is used on the experimental teeth before banding and they showed a reduction of 29% in demineralization in comparison to the control teeth.

### 8. Alleviating Pain Post Orthodontic Force Application

Pain and discomfort is felt by the patient for two to four days after application of orthodontic force “Low-level laser therapy (LLLTT)” can be used as an analgesic management for orthodontic treatment. LLLTT also acts on biostimulating

process of repairing the tissues. In this, the output of energy is low enough to intercept the temperature rise above 36.5°C in the target tissue.<sup>17–19</sup>

### 9. Soft-Tissue Applications of lasers for Orthodontic Treatment

During soft-tissue incision, dental lasers allow convenience and precision. Lasers:

1. Cause least damage of tissue,
2. Provide hemorrhage control
3. Post-operative pain reduction.

Soft tissue applications of dental lasers associated with orthodontic treatment include exposing partially erupted and unerupted teeth, gingival contouring, hypertrophic or inflamed tissues removal, frenectomy and management of aphthous lesions.<sup>20</sup> Other uses include aesthetic contouring of the gingiva, creating proper tooth proportionally before bracket bonding, crown lengthening procedure, managing asymmetry of crown height or gingival margins and interdental margins contouring.<sup>21</sup> Nd solid state lasers are used particularly for soft-tissue uses such as flattening of papilla, frenectomy, gingivectomy etc.

### 10. Accelerating Orthodontic Tooth Movement

As compared to other methods like corticotomy of pharmacologic interventions, lasers provide the better alternative with reduced side-effects for accelerating orthodontic tooth movement to achieve faster completion of the treatment. “low level laser therapy” is used for this purpose. It induces the biostimulatory response in the adjacent periodontal ligament tissue. The most important factor which determines the tooth movement is the bone remodelling in the periodontal tissue affected by various factors. LLLT enhance the movement by stimulating the OPG/RANK/RANKL.<sup>22,23</sup>

### 11. Debonding of Ceramic Brackets

Due to brittle nature, high bond strength and lower fracture toughness of ceramic bracket, debonding of these brackets leads to enamel fracture. Therefore debonding of ceramic brackets is difficult as compared to metal brackets. To conveniently debond the ceramic brackets, lasers can be used as they change the bond strength between the bracket and the tooth. The adhesive is softened with laser irradiation and hence debonding can take place in 1-5 seconds. Neodymium and erbium solid state laser, diode laser and CO<sub>2</sub> lasers are efficient for the purpose of debonding of polycrystalline and monocrystalline ceramic brackets.<sup>24</sup>

### 12. Other utility of the Laser for Soft Tissue Procedures in Orthodontics

Numerous other soft tissue procedures that can be done with the help of lasers include:<sup>3,21,25</sup>

1. Frenectomy
2. Uncovering the ‘temporary anchorage devices’ (TADs)
3. Operculectomy
4. Uncovering impacted tooth
5. Management of minor aphthous ulcers

### 13. Requirements and Recommendations for Laser Safety<sup>4</sup>

1. Warning sign representing the laser is in use.
2. Using protective goggles by patient as well as the operator
3. Reflective surfaces like table, jewellery or belt should be minimized
4. High-volume suction should be used
5. Sterilization protocols should be followed
6. Presence of laser safety officer
7. Informed consent
8. Adequate training of the user
9. Potential fire hazards should be considered

### 14. Conclusion

Incorporating lasers in the field of orthodontics leads to efficacy in the overall management of the patient. Reduced pain and discomfort following the treatment is the major factor for the patient’s overall comfort. Also patient can be benefitted by minimizing the total treatment time. Reduced blood and clear visibility of the surgical field during the procedure helps the operator in providing much precise treatment and aesthetically laser pleasing results. Reduced treatment time also helps to increase the efficiency of the practitioner. However inherent risks should be recognized so that to avoid any potential injury.

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None.

### 16. Conflict of Interest

The authors declare no conflict of interest.

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