



Review Article

Different applications of laser in the field of orthodontics: A review

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ABSTRACT

In today's time laser has been used widely in various fields of dentistry, out of all one is in the field of orthodontics and proved to be as useful equipment. Specific lasers such as soft tissue lasers can be used in the treatment of exposure of the tooth surgically with its prime advantage of very less bleeding as well as little bit of swelling it is also helpful in reducing the potential of post reducing pain. Along with all this the other applications of lasers in the field of orthodontics are, they are helpful in etching the superior most surface of the tooth i.e. enamel as well as helpful in bonding of the bracket to the enamel and vice versa i.e. debonding of the bracket from the superior most surface of the tooth i.e. enamel. Lasers are also helpful in tooth movement along with reducing the pain threshold.

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1. Introduction

Term laser denotes “light amplification by stimulated emission of radiation”. A device which is capable of transforming electrical form of energy in to the optical form of energy and results in light formation is known as a laser. Lasers produced monochromatic light of beam and which is coherent and is absolutely opposite to the lights which are ordinary.¹ The basic concept of lasers were derived from the quantum theory of radiation which was given by sir Einstein.² The maser technique which was studied by towns ultimately resulted in infrared along with optical region, which ultimately resulted in the invention of lasers.³ and the first laser was developed by maiman in the year 1960.⁴ lasers were introduced in the field of medical by goldman.⁵

The first effect of lasers over the dental caries were demonstrated by goldman in the year 1964, and revealed that lasers are helpful equipment in the reduction of dental caries.⁶ When the enamel is exposed to ruby laser energy tooth respond in different manners like there are

crater formation along with dentine fusion along with disappearance of dental caries, some other authors respond with the same results.^{7,8} laser technique were extended to both the hard and soft tissues in the oral cavity with the invention of neodymium doped yttrium aluminum garnet (Nd:YAG) laser and carbon dioxide (CO₂) laser in the year of 1964.⁹ in the year of 1980 Nd:YAG laser was used first timely in the oral cavity, for the prevention of dental caries by the researcher. Between the year 1970 and 1980 various researches over the different applications CO₂ lasers on the hard and soft tissue were tested.^{9,10} After 1990 various newer types of lasers were invented and used over hard and soft tissue in the oral cavity like Holmium: YAG, Erbium:YAG, Argon, Erbium yttrium scandium gallium garnet.

The basic theory quantum of physics were firstly described by neils bohr.¹¹ the smallest unit of energy i.e. photon is released after another photon is absorbed by the atom. This is known as spontaneous emission phenomenon. This theory were further developed by sir Einstein. He added to the basic theory that, a single excited atom is being able to absorb energy quantum and then released

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two photons instead of one which result in formation of a single coherent wave in two photons travel. By these identical photons more atoms will get excited and results in emission of further identical photons, which ultimately results in light energy that is amplified totally and finally results in production of laser beam.¹²

1.1. Different properties of laser

1. **Coherency** : Stated that all the different types of light waves are identical in laser light.
2. **Collimation** : The beam which is present in a laser light should have a unique or straight direction as well as size and shape when compared to the conventional light, which gets diverged in all the direction.
3. **Monochromaticity** : The light which is produced by a laser is of narrow wave length when compared to the conventional light. That's why laser light is having single color.

The laser is basically made up of three components i.e. resonant optical, which is made up of mirror, semi-conductor which act as an active medium and the most importantly the energy source.

There are basically two different types of laser beam delivery system,

1. Interior mirror with hollow tube like wave guide: In this the beam of laser is being reflected by the mirrors along the wave guide and exit through the hand piece. In this there is no direct contact of the laser with the tissue, basically carbon dioxide type of laser used this technique.
2. Optic cable along with glass fiber: This cable is available in different sizes ranging from 200 microns to 1000 microns. It is enclosed in a sheath and is very fragile and it can't be bent to any sharp angle. This type of laser can be used in both the types i.e. with the direct tissue contact and without the direct tissue contact, this type of laser is used most commonly in direct tissue contact type fashion.

Light energy is being emitted by the laser in three different modes, i) when the laser beam is emitted in continuous power level it is known as ii) in second mode there is alteration in the power of the energy like on and off types and is known as gate pulsed mode. Iii) And the last type is known as free running pulsed mode in which major amount of energy is released for short duration of time.

1.2. Effect of laser

Whenever the laser came in contact with the oral tissue, for different types of interactions occur between the laser and the oral tissue. When there occur no effect over the target site and the laser beam gets reflected away from the tissue

site, known as reflection. Second type is, when the laser beam or energy is transmitted through the tissue and show no effect in the target site or the target tissue is known as transmission. The third is when heat being produced by the laser site and is transferred to the adjacent site is known as scattering. The most important and prime effect of laser is when it hits the target site or the target tissue in the oral cavity and produced its effect over it is known as the absorption of the laser energy.

2. Different applications of lasers in the field of orthodontics

Different types of abnormalities related to soft tissue might occur during the time or before or after the orthodontic treatment. Basically there are three different types conditions that may occur with respect to orthodontic treatment i.e. abnormal growth of the gingival soft tissue,¹³ abnormal attachment of frenum, or impacted tooth.^{14–18} Minor surgical procedures such as gingivectomy, frenectomy, can be performed with the help of lasers. Lasers can also be used in surgical exposure of the tooth. Diode, CO2 and Nd:YAG, are the most commonly used one lasers but recently Er:YAG and Er,Cr:YAG achieved more attention by their use in the field of soft tissue surgery.^{19–21} Clinicians found difficulty in placing the brackets in enlarged or irregularly contoured gingiva which may lead to change or alter the height of the crown which may alter the tooth proportion.²² So for the gingivectomy or gingivoplasty procedure carbon dioxide lasers are used most commonly because of its wavelength is well absorbed by the soft tissue and is composed of water. After the year of 1980 these carbon dioxide based lasers are being used by periodontists to remove the irregularly shaped or enlarged gingiva for aesthetic reason as well as for the functional reason.^{23,24}

Another laser known as Nd:YAG and diode lasers were also used in as a treatment modality for the procedure of frenectomy and clinicians found satisfactory results with the same lasers when compared to carbon dioxide lasers.^{25,26} These lasers work on the principle of continuous or interrupted continuous wave mode. The dental hard tissues are not being able to well absorb the wave length of the laser. The only possible drawback of this type of laser is production of thermal heat and this could be the only possible reason that this type of lasers cannot be used in direct contact with the hard tissue i.e. alveolar bon.²⁷

Literature revealed that Er:YAG laser induced mild analgesic effect.²⁸ This laser works on a principle of pulse waved manner and simultaneously absorbed well by dental hard tissue as well as water and it results in minimal thermal effect over the hard tissues and is well tolerated. This laser can be used in conjunction with Nd:YAG or diode lasers for the process of frenectomy.

Laser technique can be used in the surgical exposure of impacted tooth at the bone level or at mucogingival level. When the exposure of the impacted tooth is by the help of lasers, it is clean, painless, and very quick. A totally dry field is achieved when the tooth is exposed by laser, and this could help in easy placement of bracket over the exposed tooth surface.²⁹ However literature revealed the occurrence the sub cutaneous emphysema after the tooth is surgically exposed with the help of lasers.³⁰ Erbium laser gained popularity in the field of surgical exposure of impacted tooth because it is well tolerated by hard and soft tissues. This laser is also helpful in etching the outer surface of the tooth i.e. the enamel and facilitate in bonding of the orthodontic bracket to the tooth surface.³¹ The bond strength of the tooth i.e. etched via laser is found to be same to other tooth surface that is etched with the help of acid.³² The phosphate to calcium ratio of the enamel can be altered after irradiation with the use of lasers which ultimately leads in formation of stable acid proof compound.³²

With the use of ceramic brackets in orthodontics there are higher chances of fracture of enamel because of high bond strength of the ceramic brackets. It can be overcome by the process of laser irradiation, it softens the resins when the brackets are heated and thus helps in reducing the force required for debonding. Basically two principles are used in laser debonding i.e. photoablation and thermal softening.^{33,34} Literature revealed that low level laser therapy is very much helpful in reducing in pain threshold in tooth movement cases in first 5 to 7 days of the tooth movement. Some investigated pain relief with CO2 laser after the first wire was placed, while others studied pain relief after separators placement with gallium-aluminum arsenium and CO2 lasers.³⁵

Low-level lasers can accelerate the opening of the mid-palatal suture and improve bone regeneration during and after rapid maxillary expansion according to several studies.

Safety from dental laser is very much required, laser can affect retinal damage can cause cataract, so one should wear proper eye protection from the wavelength of the laser. Lasers can cause blistering and burning sensation to the skin, the clinician should cover the full body while working with lasers. Lasers may also cause coughing, nasal congestion by emission of fumes containing noxious elements. So the clinician should wear masks and high volume evacuation during the use of lasers.

3. Conclusion

Lasers are becoming very useful in the treatment modality of orthodontics. Use of lasers provide good hemostasis, reduced post operating pain as well as swelling enhanced wound healing and total control over the incision. One should follow strict rules while using the lasers.

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5. Conflicts of Interest

There are no conflicts of interest.

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