International Journal of Current Research and Review
DOI: http://dx.doi.org/10.31782/IJCRR.2020.12121

Review Article

IJCRR
Section: Healthcare
Sci. Journal Impact Factor: 6.1 (2018)
ICV: 90.90 (2018)

Marked Lasers in the World of Paediatric Dentistry – A Short Review

Sumit Rajewar[1], Mayur Bhattad[2], Runal Bansod[3]

[1]PG Student, Department of Pedodontics and Preventive Dentistry, Swargiya Dadasaheb Kalmegh Smruti Dental College and Hospital, Nagpur; [2]Reader, Department of Pedodontics and Preventive Dentistry, HSRSM Dental College and Hospital, Hingoli, [3]PG Student Department of Oral Medicine and Radiology, Swargiya Dadasaheb Kalmegh Smruti Dental College and Hospital, Nagpur.

ABSTRACT

Lasers are one fine classic *technology* ever invented. The implementation of lasers in the world of Paediatric dentistry implies a very child-friendly approach. Lasers used in dentistry surely win the race as they offer wide and various advantages over the other procedures, instruments and technologies which make the experience of the child to the dental clinic less traumatic and also help in *the proper behavioral management* of the child. Lasers also provide a stress-free environment and offer optimal and protective care to the patient. This article aims to briefly review the commonly used lasers and their applications in Paediatric dentistry.

Key Words: Lasers, Paediatric dentistry, Application of laser in dental field

INTRODUCTION

Paediatric dentistry is a unique specialty which not only encompasses a particular skill but also introspects various aspects of child growth and development[1]. Handling and working with a Paediatric patient requires appropriate and efficient skill, functioning & development. Since many years there has been a wave of advancement in the technology in the field of Paediatric dentistry. To such changing trends, it is very essential to adapt and involve some child-friendly approaches into dental care, thus raising the standards[1].

Laser is one of the finest technologies ever invented and is an acronym that stands for amplification of light by stimulated emission of radiation. Gordan Gould in 1959, first introduced lasers[2,6]. The concept and principle of lasers was first unfolded when physicist Albert Einstein described the theory of stimulated emission[2,7]. Theodore Maiman at Hughes Research Laboratories in 1960 first developed a working laser[2,8]. Lasers have become a household name. Dr. A.L. Schawlow in the early 1960s described laser as an "invention in search of an application" [3]. Nowadays, the laser has found myriad applications and uses in the field of medicine and surgery, thus replacing the scalpel and whine of handpiece in the field of dental surgery[3,9].

Mainly three types of lasers are being used as instruments for surgical intervention: Neodymium-doped Yttrium Aluminum Garnet (Nd:YAG), Argon (Ar), Carbon dioxide (CO_2).[3] Contemporary dentistry indulges the use of minimally invasive procedures, hence lasers can serve as a great alternative to drilling as they cause less pain, sound and vibration[4,10].

A dry environment inside the mouth provides a good field of working and view to the clinician which further results in better outcome[4]. The use of lasers in place of sharp instruments definitely adds a spark to the dentist's clinic and grabs the attention of the patients. However, with great efficiency comes the great cost, so are the lasers. Moreover, laser may be difficult to access and may not be applicable in all fields of dentistry. The laser is inefficient to remove the metal restorations and thermal damage to the soft tissues[4].

Paediatric dentists use different types of new lasers which provide them a minimally invasive environment for hard and soft tissue procedures with minimal patient discomfort and a painless pre and post treatment protocol[1]. Lasers have also minimized the use of injections, the smell of different materials in conventional dentistry. This was greatly appreciated by the parents and the children. Due to this marked advantage of lasers, the dental visits become stress-free and radiate

Corresponding Author:
Dr. Sumit Rajewar, Raigad nagar near MGM college Namaskar chowk Nanded, Maharashtra- 431605;
Phone: 7020625254; Email: drsumitpedodontist@gmail.com

ISSN: 2231-2196 (Print) **ISSN:** 0975-5241 (Online)
Received: 11.03.2020 **Revised:** 04.05.2020 **Accepted:** 05.06.2020

a positive and healthy dental attitude inside a child, thus adding a smile on their face[1].

Lasers can undoubtedly and successfully be used for diagnosis of oral and dental conditions and diseases, in treating the hard and soft tissues and also in preventing some rapidly progressing oral and dental conditions in children[4].

The latest advances in laser technology and research have set a base of revolution in Paediatric dentistry to provide optimal, preventive, interceptive and restorative dental care along with a stress-free environment. This paper briefly reviews and throws light on some laser applications in Paediatric dentistry[1].

HISTORY OF LASER

Laser was first developed by Theodore Maiman using a synthetic ruby crystal on May 16, 1960[4]. The laser was firstly applied for the diagnosis and treatment of skin diseases. Later it was used for various endoscopic surgeries and in ophthalmology. In dentistry, it was first applied and used for oral soft tissue surgeries[4]. Stimulation of a synthetic material inside a light chamber generates an intensified light and the energy is emitted uniformly and continuously towards the target organ without directly contacting it[4].

The Nd-YAG laser was produced in 1961 with a combination of 1%-3% neodymium along with yttrium –aluminium[2]. A year later; an argon laser was developed after the development of Nd-YAG laser. In 1963, the ruby laser was firstly used for the coagulation of retinal lesion[2]. A year later in 1964, CO_2 was built up by Patel at the Bell laboratories[2]. After the invention of diode laser, the application of laser became diverse and widespread in dentistry[4]. Lasers used in dentistry possess variable wavelengths and they run in a continuous wave, as well as run in a pulsed or running pulsed mode[4]. A range of 193-10600 nm of wavelength is applicable in medicine and dentistry. There are mainly 4 main groups of lasers based on their specific applications: solid state lasers, liquid lasers, gas lasers, semi-conductor lasers[4]. Gas lasers possess a simpler design as compared to the other types. Liquid lasers have a marked ability to change their frequency[4]. Human dental tissues are composed of a combination of apatite crystal, water, blood and tissue pigment; hence the dental practitioners must use the best laser for each treatment[3]. For soft tissue treatments, the dentist or the clinician can use any type of dental laser irrespective of its wavelength as all dental lasers are absorbed now and then by one or more of the soft tissue components[3]. But for hard tissues, the only lasers to be used are from the Er (Erbium) family as they use extremely short durations of pulse and easily ablate the layers of calcified tissue with minimum thermal effects[3]. Different laser wavelengths have different absorption coefficients when they come in contact with dental tissues due to monochromaticity of laser energy[3]. All biologic tissues contain water which finally absorbs the two Er wavelengths, including the CO_2 wavelength. The lasers with shorter wavelength like Ar (Argon), diode, and Nd: YAG are transmitted through water[3]. The structure of teeth and bone are formed by apatite crystals, which readily absorb CO_2 wavelength and to a lesser degree, those of the Er family[3].

Four types of interaction i.e, laser light absorption, transmission, reflection and scattering take place when a laser light hits the target tissue. These interactions are dependent on the optical properties of the target tissue and the wavelength of the laser light[2].

LASERS IN PAEDIATRIC DENTISTRY

Motivating a child for dental visit is very important in order to prevent oral and dental diseases or conditions[4]. The American Academy of Paediatric Dentistry has advised that parents must visit a dentist no later than 6 months after the eruption of first teeth or around their child's first birthday[3]. The biggest merit of the use of lasers in paediatric dentistry is due to its scrupulous and meticulous interaction with damaged tissues[5].

Lasers are a helping hand in achieving haemostasis during soft tissue procedures without the need for suture in numerous cases[5]. Due to this property, wound healing takes place more rapidly along with less patient discomfort both pre and post-operatively with a reduced need for analgesics[5].

Another fascinating advantage of lasers is the reduced operator chair time during soft tissue procedures with little or no local aesthesia in conjunction to it[5]. The technology of lasers gifts the dentist to easily perform micro dentistry thus removing only the diseased part and preserving the other healthy tissues or structures[3]. Lasers are proven and efficient in removing caries very effectively with minimal involvement of the surrounding tooth structure. The mechanism being the high H_2O content in caries affected tissue than a healthy sound tissue[5]. Lasers are soft gadgets and thus cause minimum noise and vibration as compared to the conventional high- speed dental handpiece, thus eventually reducing the pain and discomfort of patient and relaxing him. These conventional high – speed dental handpiece causes noise and vibration and to overcome this, the non-contact of Erbium Lasers with hard tissue totally removes or eliminates the vibratory effects of conventional handpieces, thus allowing comfortable teeth preparations and reduced anxiety of children[5]. The Erbium and Nd: YAG lasers have proven to have an analgesic effect on the hard tissues, thus totally prohibiting the use of local anaesthetics and injections during tooth preparations[5].

Table 1: Showing characteristics of various lasers[4]

Table 1. Characteristics of Dental Lasers

Laser Type	Wavelength	Mode	Application
CO_2	10 600 nm	Pulse or continuous-wave	1. Soft tissue ablation 2. Gingival contouring for esthetic purposes 3. Treatment of oral ulcerative lesions 4. Frenectomy and gingivectomy 5. Elimination of necrotic epithelial tissue during regenerative periodontal surgeries
Nd:YAG	1064 nm	Pulse	1. Root canal therapy: Helps eliminate pathogenic microorganisms and debris from the root canal 2. Extensive periodontal surgery and scaling to eliminate necrotic tissues and pathogenic microorganisms 3. Caries removal
Er:YAG	2940 nm	Pulse	1. Caries removal 2. Cavity preparation in enamel and dentin 3. Root canal preparation
Er,Cr:YSGG	2780 nm	Pulse	1. Enamel etching 2. Caries removal 3. Cavity preparation 4. Bone ablation without over-heating, melting or changing the calcium and phosphorus ratios 5. Root canal preparation
Argon	572 nm	Pulse or continuous	1. Polymerization of restorative resin materials 2. Tooth bleaching 3. Elimination of necrotic tissue and gingival contouring 4. Treatment of oral lesions such as recurrent aphthous ulcers or herpetic lesions 5. Frenectomy and gingivectomy
Diode	810 or 980 nm	Pulse or continuous-wave	1. Proliferation of fibroblasts and enhancing the healing of oral lesions or surgical wounds 2. Frenectomy and gingivectomy 3. Correcting the gingival contouring for esthetic purposes

Table 2: Enlisting different types of lasers[5]

Table. LASER BASICS IN PEDIATRIC DENTISTRY

Laser type	Wavelength	Applications
Diode	450 - 655 nm	1. Laser fluorescence – diagnostic applications, detection of occlusal caries, detecting calculus in periodontal pockets, detection of dysplastic cells during oral cancer screening
Diode	810 - 980 nm	1. Soft tissue ablation – gingival contouring for esthetic purposes, frenectomy, gingivectomy, operculectomy 2. Photobiomodulation – proliferation of fibroblasts and enhancing the healing of oral lesions (mucositis) or surgical wounds 3. Periodontal procedures – laser bacterial reduction, elimination of necrotic epithelial tissue during regenerative periodontal surgeries 4. Whitening
Er, Cr:YSGG*	2,780 nm	1. Hard tissue procedures – enamel etching, caries removal and cavity preparation in enamel and dentin 2. Osseous tissue procedures – bone ablation 3. Soft tissue ablation – gingival contouring for esthetic purposes, frenectomy, givectomy, operculectomy 4. Endodontic therapy – pulp cap, pulpotomy, pulpectomy, root canal preparation 5. Periodontal procedures – laser bacterial reduction, elimination of necrotic epithelial tissue during regenerative periodontal surgeries 6. Treatment of oral ulcerative lesions
Er:YAG**	2,940 nm	1. Hard tissue procedures – caries removal and cavity preparation in enamel and dentin 2. Endodontic therapy – root canal preparation
CO_2†	9,300 nm	1. Hard tissue procedures – caries removal and cavity preparation in enamel and dentin 2. Osseous tissue procedures – bone ablation 3. Soft tissue procedures – incision, excision, vaporization, coagulation and hemostasis
CO_2	10,600 nm	1. Soft tissue ablation – gingival contouring for esthetic purposes, frenectomy, gingivectomy 2. Treatment of oral ulcerative lesions 3. Periodontal procedures – elimination of necrotic epithelial tissue during regenerative periodontal surgeries

* Er, Cr:YSGG – erbium, chromium, yttrium, scandium, gallium, garnet. ** Er:YAG – erbium, yttrium, aluminium, garnet. † CO_2: Carbon dioxide.

DISCUSSION

Lasers for soft tissue treatments

1) Treating ankyloglossia

Children are subjected to the usual manner by using a local anaesthetic of operator's choice. The tongue is stabilized with the help of a haemostat and the frenum is revised. Great care should be taken to avoid the glands present on the floor of the mouth[3]. Laser settings of Er:YAG , 30 Hz, 50 mJ, no water is used for the treatment of tongue-tie with the use of safety goggles[1].

2) Frenectomy

A tight maxillary frenum may be a hindrance to proper latching during breastfeeding in a newborn. While in older children, high frenum attachment can cause midline diastema[1]. Laser setting for frenectomy are Er:YAG 30 Hz, 50mJ and laser energy is headed at the insertion of frenum and area between the two central incisors[1]. Sutures are usually not required and the postoperative period is uneventful[1].

3) Tooth exposure, an aid in eruption of tooth

Lasers expose the teeth without any damage to the tooth enamel thus, allowing better eruption of teeth[1]. Lasers with no absorption into the enamel are useful in exposure of teeth with a retarded eruption requiring operculectomy. Laser setting for such laser are Er:YAG 30h , 45mJ both in contact and non-contact mode can be used. The behaviour management of Paediatric patients becomes very easier with the help of the above technique[1].

4) Crown lengthening and gingival recontouring

Gingivectomy is done using CO_2 lasers. Secondly, it can also be used in surgical removal of soft tissue tumours in the oral cavity. Lasers provide a bloodless field and also reduce the microbial load exposed to laser radiation thus sterilizing the wound.

5) Laser in pulpotomy of deciduous teeth

Different wavelength lasers are used with a power of 0.5-1W for the preservation of pulp vitality[1]. For pulpotomy of deciduous tooth, a CO_2 laser can be used at a power of 1-4W in a non-continuous manner to avoid excessive exposure of laser energy to pulp tissue[1]. There may be formation of a carbonized layer on the root canal surface, this being the disadvantage, hence irrigation using 3% H_2O_2 and 5.25% NaOCl must be used to remove this layer[2]. Use of diode laser for pulpotomy of deciduous teeth showed a 100% success rate and was proven to be a better alternative than ferric sulphate and electrosurgery from the clinical as well as radiographical aspects[2].

6) Laser for direct and indirect pulp capping in deciduous teeth of Paediatric patients

Laser energy can cause closure of the dentinal tubule and also has a sedative effect on the inflamed pulpal tissue[2]. Laser used for indirect pulp capping has the same sedative effect as the effect of laser-produced in pulpitis[2]. For direct pulp capping a CO_2 laser is used as it controls the haemorrhage and facilitates proper and better placement of

calcium hydroxide paste at the site of exposure by sterilizing it[2].

7) Laser for diagnosing the vitality of pulp

The key to diagnose the vitality or non-vitality of the pulp is based on the changes in red blood cell flux in the pulpal tissue. This is done by a non-invasive method called Laser Doppler Flowmetry[2]. Stimulation of the normal pulp by a pulsed laser at 2W and 20 pulses per second at a 10mm distance from the tooth surface produces pain within a time range of 20-30 seconds and then pain disappears after a couple of seconds once the laser stimulation is stopped[1]. Laser Doppler Flowmetry uses helium, neon and gallium aluminium as a semiconductor diode laser to measure the changes in red blood cell flux in the pulp tissue[2].

Hard tissue interactions

1) Lasers for caries removal

The most effective laser for caries removal is Er:YAG. It is very effective in removing caries from both enamel and dentin without causing any thermal injury to the pulp tissue underneath[2]. The first use of this laser for removal of caries was done by Hibst & Keller in the 1980's in their study[1]. The affected layer is decontaminated using the antibacterial property of Er:YAG laser and the layer retains its remineralizing potential.

2) Pit fissure sealants

Sealing of enamel lesions with low viscous light-curing resins is a promising approach to non-operative dentistry. One such resin is the pit and fissure sealants[1]. In procedures like fissurotomy or cleaning and smoothening of the pits and fissures, a laser can be used before the sealant application[2]. For fissurotomy an erbium laser is used[2]. Although the need for acid etching is persistent and essential even after the application of a laser[2]. It's of utmost importance that the pit and fissure sealant is able to prevent the microleakage at its periphery failing which there is continuation of the carious process beneath the sealants[1]. The use of Er-Cr:YSGG laser for surface conditioning does not have any effect in the reduction of microleakage or the enamel sealant interface in deciduous teeth[2].

3) Combined laser and fluoride activated therapy for caries prevention

The tooth structures can be protected from the acid challenges by reducing critical pH[1]. This can be done by laser irradiation for the dissolution of enamel from 5.5 to 4.8[1]. The critical pH can further be reduced or decreased in the presence of fluoride in concentrations as low as 0.1ppm. Once the enamel is lased, it will not undergo any dissolution until the critical pH reaches a pH of 4.3[1].

4) Lasers for detection of caries and efficacy of diagnodent

Sometimes conventional methods may be too tricky and unapproachable to the diagnostic tool. Manual probing and radiographic evaluation may be two such methods as these methods may be inefficient in the detection of some enamel defects[1]. In cases of complex anatomy of fissure areas, radiographs may fail to detect early carious lesions although they are effective in detecting the early carious lesions[1]. For the detection of occlusal caries or any occult lesion in the deciduous or permanent teeth, a laser fluorescence at a wavelength of 625nm is very effective. One such device which uses laser fluorescence technology is the Diagnodent[2]. For the detection of demineralization, particularly in the interproximal surfaces, an argon laser at a wavelength of 488nm can be used as it is more effective in detecting caries in deciduous teeth[2].

5) Lasers for bleaching of tooth

The main content of a bleaching gel is the peroxide which when oxidised produces bleaching action. When laser light hits this bleaching gel, heat is generated thus accelerating the oxidation process[2].

6) Laser for preparation of Paediatric crown

The laser used is Biolase. The specifications are set at 5.5 W with 55% of water and 65% of air. The method used for the preparation of Paediatric crowns is the same as conventional method. The merit of these techniques is the increase in the micromechanical bonding with resin cement by producing roughness on the prepared tooth surfaces[2].

CONTRAINDICATIONS OF LASERS

1. Lasers should not be used in epileptic patients.
2. In patients having severe chest pain or arrhythmias.
3. In patients on pacemakers.
4. In pregnant women, lasers should not be used in and around the uterus area.
5. They should not be used on tissues showing some malignant potential or benign tumours having malignant tendencies.

THE SAFETY OF LASERS

Ocular hazards are very common, hence it is very mandatory to use a protective eyewear[2]. The operator or the clinician must be aware of the hazards caused by the use of lasers and about the accidental exposure to non-target tissue[2]. Several hazards such as tissue damage, fire and explosion, ocular hazards, combustion hazards, equipment hazards, respiratory hazards may be encountered by the clinician during his

dental practice. Hence awareness about the potential risks and hazards of lasers is very important for dental practioners[3].

CONCLUSION

Lasers are proof that fine technologies do exist. Despite some cost-related factors, lasers are one of the most adapted and accepted therapies both by the patients and the parents in Paediatric dental practice. The biggest merit of lasers being their minimal invasiveness, as a result of which Paediatric patients show great cooperation to the dentists. This being the sparkle factor, lasers are surely useful adjunct to regular Paediatric dental practice.

ACKNOWLEDGEMENT

Authors acknowledge the immense help received from the scholars whose articles are cited and included in references to this manuscript. The authors are also grateful to authors/editors/publishers of all those articles, journals and books from where the literature for this article has been reviewed and discussed.

CONFLICT OF INTEREST

Authors declare there is no conflict of interest.

SOURCE OF FUNDING

There is no source of funding.

REFERENCES

1. Shanthi M. Laser prescience in Paediatric dentistry. International Journal of Scientific Study. 2015;3(2):197-203.
2. Galui S, Pal S, Mahata S, Saha S, Sarkar S. Laser and its use in Paediatric dentistry: A review of literature and recent update. International Journal of Pedodontic Rehabilitation. 2019 Jan 1; 4(1):1.
3. I. E. Neena, P. Poornima, Ganesh Edagunji, K. B. Roopa, K. P. Bharath, "Lasers in Paediatric dentistry: A review," Int J Contemp Dent Med Rev, Vol. 2015; doi: 10.15713.
4. Nazemisalman B, Farsadeghi M, Sokhansanj M. Types of lasers and their applications in Paediatric dentistry. Journal of lasers in medical sciences. 2015; 6(3):96.
5. Council O. Policy on the Use of Lasers for Paediatric Dental Patients.
6. Gross AJ, Herrmann TR. History of lasers. World J Urol 2007; 25:21720.
7. Aoki A, Sasaki KM, Watanabe H, Ishikawa I. Lasers in nonsurgical periodontal therapy. Periodontol 2000 2004;36:5997.
8. Maiman TH. Stimulated optical radiation in ruby lasers. Nature 1960;187:493.
9. Evans D, Reid J, Strang R, Stirrups D. A comparison of laser Doppler flowmetry with other methods of assessing the vitality of traumatised anterior teeth. Endod Dent Traumatol 1999; 15:284-90.
10. Javan A, Bennette WR Jr, Herriot DR. Population inversion and continuous optical maser oscillation in a gas discharge containing a He-Ne mixture. Physiol Rev. 1961: doi: 10.1103.