Laser: From Fundamental Principles to Applied Pediatric Dentistry - Review

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Research Article

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Abstract

Over the past two decades, the use of lasers in dentistry has progressed significantly. While soft tissue lasers were first introduced, they are now commonly used on dental hard tissue as well, thanks to the advent of new generation lasers. Commonly used laser in dentistry includes neodymium-yttrium aluminum garnet (Nd:YAG) Glaser, erbium: yttrium aluminum garnet (Er:YAG), CO2, erbium chromium: yttrium scandium gallium garnet (Er,Cr:YSGG), holmium:yttrium aluminum garnet Ho:YAG), and diode laser. Treating a pediatric patient with a laser for oral and dental procedures is advantageous because it reduces the child's anxiety and improves parental acceptance. Children become more patient when a clinician uses the laser for a surgical or pulpal operation, which improves clinical outcomes. In children, laser is used for caries prevention, early diagnosis, cavity repair, traumatized tooth management, and minor oral surgical procedures. While the use of lasers may pose some risks and necessitate some precautions, its use in pediatric dentistry appears to be on the verge of becoming the gold standard. Clinicians should prepare themselves for the new era of laser especially in pediatric dentistry by knowing laser basics, classification of different types of lasers, possible hazards and means of protection against these hazards, and advantages and limitation of laser which is the aim of this review.

Keywords: Different laser application in dental field, laser, laser in pediatric dentistry, laser therapy, Microshear bond strength; Self-adhering flowable composite; Pit-and-fissure sealants, Systematic review, Meta-analysis, Remineralization, Nanoleakage.

Introduction

The acronym LASER stands for light amplification by stimulated emission of radiation, and it was coined by Gordon Gould, a Columbia University graduate student, in a 1959 report [1]. The concept of the laser was revealed in 1917, when physicist Albert Einstein described the theory of stimulated emission [2]. Theodore Maiman of Hughes Research Laboratories developed the first working laser in 1960 [3]. Lasers were first used in medicine for soft tissue procedures in the mid-1970s. In the 1980s, oral and maxillofacial surgeons began using the carbon dioxide (CO2) laser to remove oral lesions [4] [5].

The Nd:YAG laser, developed in 1987 and authorized by the US Food and Drug Administration in 1990 [6], was the first laser designed specifically for dental use. Patel at Bell Laboratories developed the CO2 laser in 1964 [1], however, it was only introduced in oral surgery for the removal of soft tissue lesions in the 1980s [4] [2].

The argon laser was created one year after the Nd:YAG laser, and the ruby laser was first used for the coagulation of retinal lesions in 1963[1]. Patel designed a CO2 laser at Bell Laboratories in 1964, and Weichman and Johnson documented the use of infrared CO2 laser for apical foramen sealing in an in vitro study in 1971 [7]. After the invention of the diode laser, the use of lasers in dentistry became widespread. The Nd:YAG) laser was designed originally for dental procedures in 1987, and it was approved by the Food and Drug Administration in 1990 [8].

The American Dental Laser did not become commercially available until 1989, paving the way for laser dentistry. Various laser forms (Diode laser, Nd:YAG, Er,Cr:YSGG, Er:YAG, CO2) with corresponding wavelengths (810 - 890 nm, 1064 nm, 2780 nm, 2940 nm, 10600 nm) became available to dentists in the mid-1990s, allowing them to meet their needs for hard and soft tissue procedures. Due to relatively deep highly localized tissue heating, soft tissue lasers (near infrared lasers) are distinguished by a high absorption of chromophores (hemoglobin and melanin) found in soft tissue (Fig. 1), resulting in excellent soft tissue incision, ablation, and coagulation efficiency as well as antimicrobial effectiveness. Hard tissue lasers (Fig. 2) in the mid and far-infra red region of spectrum are highly absorbed in (carbonated) hydroxyapatite and water chromophores and are thus able to finely ablate hard tissues without heating of the surrounding tissue [9].

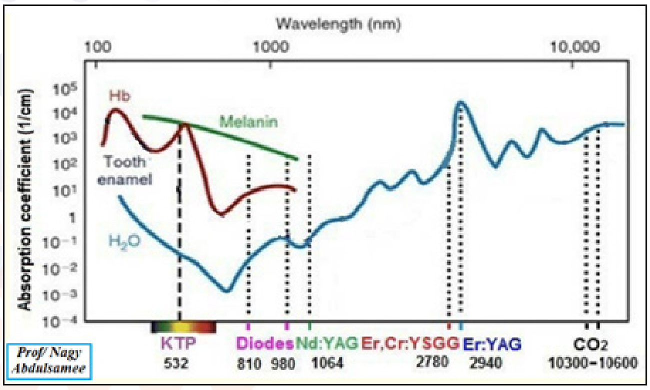

Figure 1: Different laser wavelengths in the electromagnetic spectrum and the relative absorption in soft tissue chromophores

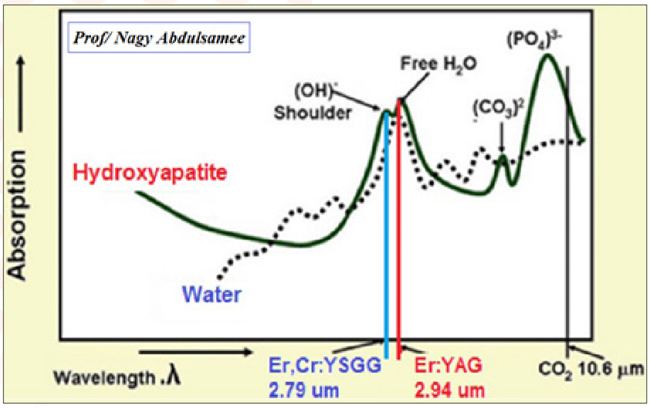

Figure 2 : Relative absorption of far infra-red spectrum including erbium and CO_2 wavelengths in hard tissue chromophores. The absorption peaks reflect the molecule's component radicals (hydroxyl, free-water, carbonate, phosphate).The dotted line represents the absorption of laser energy in whole water.

Since then, laser technology has improved dramatically, with applications in periodontics, pediatrics, endodontics, oral surgery, restorative dentistry and dental hygiene, cosmetic dental whitening, and temporomandibular joint pain control. While lasers were originally used for soft-tissue procedures, they are now commonly used on dental hard tissue as well, thanks to the invention of new generations of lasers. Hard tissue lasers are a good alternative to traditional drilling because they offer a safer working field for the clinician, resulting in better results and patient outcomes. Sharp dental instruments, grinding sounds, and vibration may also be prevented during dental procedures, which can be beneficial in pediatric dentistry [10]. With recent advancements in laser technology, it can now be used to diagnose, prevent, and treat dental caries as well as perform minimally invasive procedures [11]. The American Academy of Pediatric Dentistry [12] also recommends the rational use of soft tissue and hard tissue lasers for various oral procedures in babies, teenagers, and adolescents.

Laser basics

While a detailed description of how lasers work is beyond the scope of this document, it is important to understand the basics of laser physics prior to selecting a laser for dental treatment [13] which includes:

Classification of laser

Laser light is a monochromatic light with a single wavelength released when a synthetic material is stimulated [14]. The active medium (which can be a gas, a crystal, a solid state, or a semiconductor) that emits photons of energy when stimulated is also known as a laser. Different lasers have different wavelengths, which dictates their clinical applications [15]. Because of water's preference for mid- and far-infrared wavelengths [16], specifically Er,Cr:YSGG at 2,780 nm and Er:YAG at 2,940 nm, now known as erbium family lasers, these are actually the only two wavelengths capable of being greatly absorbed inside dental tissues and bone when used with healthy and recognized clinical parameters [17][18].

Laser properties

The common unique properties to all laser beam types are:

a) collimation means that all waves are parallel to one another with little divergence or convergence. Collimation allows laser light to travel long distance without loss of intensity, b) monochromaticity means that it is formed from single wave length. The clinical significance of this monochromatic property of laser light allows it to target specific chromophores, such as water, hemoglobin, and melanin, and allows for specific clinical applications, and c) coherence mean that the amplitude and frequency of all the waves of photons are identical. This results in the production of a specific form of focused electromagnetic energy (Fig. 3) [19].

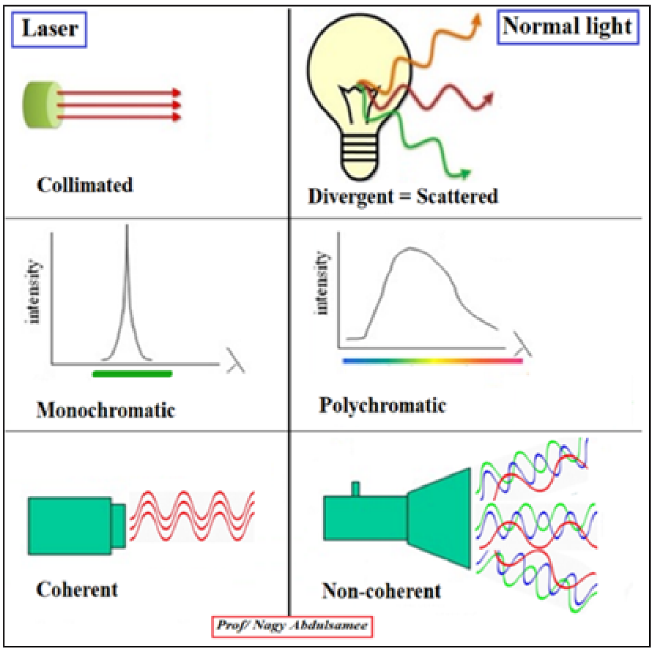

Figure 3 : The characteristic properties of laser and their difference from that of normal light.

Laser-tissue interaction

As laser light is shone on target tissue, a photo thermal reaction occurs, resulting in heat generation and an increase in tissue temperature [20]. When this temperature is above 60°C, it causes protein coagulation within the tissue however, when the temperature rises above 100°C, it causes vaporization of water molecule and soft-tissue ablation [4]. Above 200°C temperature is required for hard tissue procedure [21]. As laser light strikes target tissue, four different types of interactions occur, depending on the target tissue's optical properties and the laser light's wavelength. These interactions are as follows (Fig. 4).

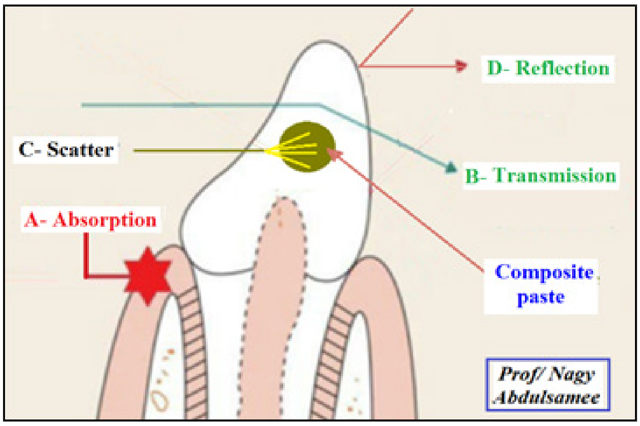

Figure 4: Laser tissue interaction

Absorption

The absorption of laser light is caused by the presence of chromophore within the target tissue [21]. The chromophore or light-absorbing pigments used in oral and dental hard tissue are responsible for absorbing laser energy of a specific wavelength [13] [21] [22].

1. Melanin
2. Hemoglobin
3. Water
4. dental hard tissues (Water and Hydroxyapatite) and
5. Photosensitive materials in visible light cured polymeric materials (Camphorquinone and Diketone) are the main chromophores in intraoral soft tissue [23].

The wavelength of a dental laser is what determines how much of the laser energy is absorbed by the target tissue. The presence of the chromophore or laser-absorbing elements of the tissue affects the tissue's affinity for particular wavelengths of laser energy [13] [24] [25]. Oral hard and soft tissues have a distinct preference for absorbing particular wavelengths of laser energy. As a result, the practitioner's decision on which laser unit to use is based on the type of tissue he or she wants to treat. Inside target tissues, the primary effect of a laser is photo thermal [25]. Water vaporizes when the temperature of a target tissue containing water is elevated above 100 degrees Celsius, resulting in soft tissue ablation [1]. Excision of soft tissue begins at this temperature because soft tissue is made up of a high proportion of water. At this temperature, hard tissue made up of hydroxyapatite crystals and minerals is not ablated, but the water portion is vaporized, and the resulting steam expands and disperses the surrounding material into tiny particles [21]. The clinical abilities of a laser are influenced by operating parameters such as strength, frequency, emission mode, thermal relaxation time, and the use of air or water as a coolant. Furthermore, the laser unit's delivery mechanism as well as the tissue concentration of the chromophore have a significant impact on laser tissue interactions. Different wavelengths of laser light have different coefficients of absorption with hard and soft tissue components such as mineral, water, blood component, and pigment. Blood components and tissue pigments absorb shorter wavelength laser light, which is mostly between 500 and 1000 nm, whereas longer wavelength laser light has a greater affinity for hydroxyapatite crystals and water molecules [8].

Transmission

Laser light can pass through target tissue without having any damage, and this property is largely determined by the wavelength of the laser light. As laser energy from argon and Nd:YAG reaches tissue fluids, it is absorbed well, while laser energy from the Erbium family and CO2 laser is transmitted to the adjacent tissue [8].

Scattering of laser light

Scattering of laser light results in heat transfer and damage of tissue adjacent to the target area. It also decreases the favorable clinical outcome. However, this property is beneficial when the clinician is intended to treat an aphthous ulcer or cure a composite resin restoration [8].

Reflection

It is possible that laser light would be transmitted from the target tissue without having any effect on it. This unintended reflection can be harmful to your eyes. This property, on the other hand, is used by caries detection lasers to assess sound tooth structure.

Laser application in pediatric dentistry

It is helpful to treat a pediatric patient with laser for oral and dental procedures because the child is less afraid and the parents are more accepting [26]. Children become more patient and the clinical result improves when clinicians use the laser for surgical or pulpal procedures [20]. It is used in many areas of pediatric dental practice, including caries prevention, early diagnosis, cavity reconstruction, traumatized tooth management, and minor oral surgical procedures, and it appears to be on its way to being the gold standard [27].

Soft-Tissue Applications of Laser

Gingival recontouring and crown lengthening

Gingivectomy is performed with a CO_2 laser [28]. It is also used to remove soft tissue tumors in the mouth surgically [29]. Clinicians now tend to recreate gingival aesthetics as part of intensive orthodontic treatment, thanks to the invention of the diode laser [30] [31]. The use of a laser in gingivectomy and gingival recontouring has the benefit of offering a bloodless field while also sterilizing the wound by reducing the microbial load exposed to laser radiation [20].

Exposure of unerupted tooth

Laser is used to uncover an unerupted or partially erupted tooth for the placement of orthodontic brackets or buttons (Fig. 5.a). Since the laser-assisted surgical area is relatively bloodless

(Fig. 5.b, c), bracket or button positioning can be performed right away (Fig. 5.d). The most popular materials used for this are Er:YAG, Nd: YAG, and Er,Cr: YSGG [32].

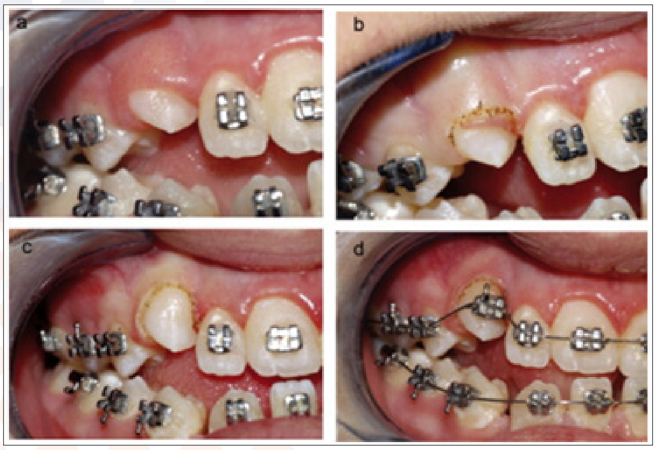

Figure 5: Canine exposure performed with diode laser

Pulpotomy of primary teeth using laser

Lasers with varying wavelengths and a power of 0.5–1 W are used to preserve the vitality of the pulp. To stop coagulation, they are used in pulse mode without water at a low frequency for 10 seconds [33]. A CO_2 laser with a power of 1–4 W can be used for pulpotomy in primary teeth, but it should be used in a noncontinuous manner to prevent unnecessary laser energy exposure to the pulp tissue. [20]. A limitation of using multiple laser exposures for full pulp tissue removal is the formation of a carbonized crust on the surface of the root canal, which can be dissolved by irrigation with 3 percent H_2O_2 and 5.25 percent NaOCl [20]. In 1989, Ehihara reported improved wound healing in amputated pulp tissue after Nd:YAG pulpotomy [20]. Jeng-fen Liu et al. tested the effects of laser pulpotomy in primary teeth in 1999 and found that, with the exception of one tooth, all of the teeth that received laser irradiation were clinically effective in a 6-month follow-up visit [20].

In dentistry, the diode laser is commonly used to treat soft tissues. A research looked at the clinical and radiographic outcomes of diode laser pulpotomy and formocresol pulpotomy on human primary molars. Pulpotomies on primary molars were performed on healthy two- to eight-year-olds as part of their routine dental care. The pulpotomy teeth were divided into two classes at random. Diode laser treatment was given to the experimental group, while 1:5 dilution formocresol (FC) treatment was given to the control group, 45 teeth were treated with a diode laser and 45 teeth with FC in 70 healthy children. Clinical success rates for laser and FC were 92.9 percent and 90.9 percent, respectively, after a 12-month follow-up, and radiographic success rates were 78.6 percent and 72.7 percent for laser and FC, respectively. Finally, there was no significant difference in clinical and radiographic success rates between diode laser and FC pulpotomy in human primary molars followed for 12 months [34].

Frenectomy and treatment of ankyloglossia

When the labial frenum is hyperactive, a laser-assisted frenectomy with an Er: YAG laser may be used to try to close the diastema [35].

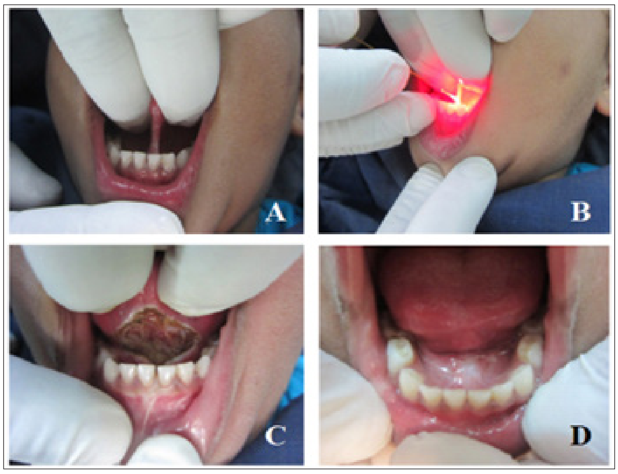

Figure 6: A) Tongue tie, B) Laser cutting, C) Immediate post op., and D) One week post op. complete healing.

The tongue was retracted upwards and posteriorly for laser assisted lingual frenectomy (Fig. 6). For better visualization, the frenum was grasped and strengthened by positioning the operator's fingers (index and middle) as near to the base of the tongue as possible and retracting the tongue's ventrum. In contact mode between the laser tip and the tissue surface, the fiber optic tip was held perpendicular or oblique to the frenum. Cutting above and down, avoiding the vessels and glands in the mouth's floor, completed the operation. The surgical site was cleaned with a regular saline wet cotton roll after the laser exposure was done (Fig. 6 A, B, C, and D). The patients were given verbal orders after surgery, including not consuming hot, spicy, citrus, or hard foods for a few days, as well as soft diet instructions. During the postoperative phase, do physio-exercises like separating the lip from the gingival tissue by moving the tongue upwards and laterally several times a day, and commit to follow-up appointments on the exact date [36].

Direct and indirect pulp capping of young permanent teeth using laser

The CO_2 laser is used for direct pulp capping because it reduces bleeding and sterilizes the exposure site, allowing for better positioning of calcium hydroxide paste and a better clinical outcome [20]. The laser is normally irradiated at a power of 1–2 W [20]. On inflamed pulpal tissue, laser energy has an abundant and sedative effect, and it can also close the dentinal tubule. It is thought that the mechanism by which it aids indirect pulp capping is similar to the sedative effect created by laser in pulpitis [35].

Laser in wound healing

Gingival fibroblasts are transformed into myofibroblasts by low-level laser treatment (LLLT), which aids wound contraction. This effect can be observed as soon as one day after laser treatment [37]. A low dose of 2 J/cm^2 stimulates fibroblast proliferation, while a higher dose (16 J/cm^2) suppresses it [38] [39]. LLLT is used to treat recurrent aphthous ulcers, mucositis, and radiation-induced oral ulcers because it promotes wound healing [40].

After inferior alveolar nerve block anesthesia (IANBA), a study was conducted to report a procedure for using low-level laser therapy (LLLT) to treat a traumatic ulcer in the lower lip secondarily to the IANBA. An indirect pulp capping in tooth # 74 was performed under the IANBA on a 9-year-old male patient with carious lesions. The procedure was completed without intercurrences, but on next day, the child presented extensive traumatic ulcer in the left lower lip, with complaint of pain. Two LLLT applications were applied in punctual mode under pressure around the lesion in a two-step process. After one week, the mother reported significant improvement. The lesion was absolutely healed after 30 days. Finally, LLLT resulted in rapid analgesia and healing, making it a viable treatment option for traumatic ulcers following troncular anesthesia [41].

Removal of mucocele

Mucocele is the most common minor salivary gland condition. Dental professionals can find it difficult to handle. A 10-year-old female patient was diagnosed with lower lip mucocele. A conventional excision surgery was performed. Two months later, the patient reported discomfort and swelling at the same operative site. The lesion had recurred. A diode laser with a wavelength of 980 nm, a 300-meter initiated fiber optic tip, continuous mode, and a power setting of 2 Watts was used to eradicate the mucocele. Without bleeding, the operation was done quickly. The patient was followed-up after 2 weeks and 6 months. After two weeks and six months, the patient was re-evaluated. There was no postoperative discomfort or pain, the wound did not become infected, and there was no recurrence. The researchers concluded that using a diode laser to treat mucocele in children is an accurate, simple, bloodless, and well-accepted technique [42].

Laser in disinfection of root canal

During root canal operation, pulsed Nd:YAG and Er:YAG lasers are used to disinfect the canal, and irrigation with 5.25 percent sodium hypochlorite or 14 percent ethylenediaminetetraacetic acid (EDTA) is performed during laser irradiation [20]. The Er, Cr: YSGG laser should be used in conjunction with standard disinfection and debridement procedures, not as a replacement. Endodontic patient results following the use of the Er, Cr: YSGG laser require further clinical randomized trials [43].

Laser in diagnosing pulp vitality

Laser Doppler Flowmetry is a noninvasive technique for assessing the vitality of the pulp. It uses a semiconductor diode laser with helium, neon, and gallium aluminum with a power of 1–2 mW to calculate changes in red blood cell flux in the pulp tissue [44].

Hard Tissue Application

Removal of caries, old restoration, and cavity preparation

The Er: YAG laser will remove caries from both enamel and dentin without causing thermal damage to the underlying essential pulp tissue [45]. It also employs ablation to remove old glass ionomer and restore composite resin [46]. Except for the non-smooth floor, the LLLT prepared cavity is similar to the aerator's [47].

The removal of dental caries and the preparation of restorative cavities are two of the most popular laser applications of dentistry. The morphology and wettability of laser-prepared surfaces vary from those prepared using traditional methods, potentially affecting the adhesive potential of bonding agents in these surfaces. For orthodontic purposes, 60 primary second molars from humans were extracted and divided into three equal classes (n = 20). Dentin surface preparation using a bur; dentin surface preparation using a laser with a 300 mJ energy level; dentin surface preparation using a laser with a 400 mJ energy level. The teeth were divided into two subgroups by chance in each of the main groups. The total-etch adhesive system was used to bind subgroups A1, B1, and C1, while the self-etch adhesive system was used to bond subgroups A2, B2, and C2. The shear bond strength of composite restorations was measured in MPa after the samples were thermo-cycled. After analyzing the results, it was found that group A2 and group C2 had the highest and lowest shear bond strength values, respectively. In terms of shear bond strength to dentin, Single Bond and Clearfil SE Bond adhesive agents performed adequately in primary tooth dentin prepared by Er: YAG laser with energy levels of 300 and 400 mJ and frequency of 10 Hz [48].

Over time, dentistry has progressed from the traditional 'Extension for Prevention' approach to minimally invasive caries removal methods. The sound and vibration of typical rotary instruments are the most common causes of dental phobia and anxiety in children. Lasers are important for both minimally invasive dentistry and lowering patient dental anxiety. The ability to extract caries without causing harm to the patient has a major effect on dental care delivery. Erbium lasers use the concept of thermomechanical ablation to remove carious tooth structure selectively. In addition to minimizing dental phobia, these lasers may be used for laser analgesia, decontamination, and significantly enhancing the properties of adhesive restorations. A review of the literature on the use of erbium lasers for caries removal conducted over a 20-year period aimed to provide a detailed understanding of the properties and applications of erbium lasers in pediatric dentistry [49].

Laser in pediatric crown preparation

Biolase is used in the preparation of pediatric crowns. It's set at 5.5W, with 65 percent air and 55 percent water, and crowns are prepared according to the same guidelines as the traditional form. This method eliminates the need for local anesthesia, enabling patients to relax more. It also strengthens resin cement micromechanical bonding by creating more roughness on prepared tooth surfaces [50].

Pit and fissure sealants

Laser may be used for fissurotomy, cleaning, and conditioning of pits and fissures before applying sealant [16]. Fissurotomy is the most common technique for which the Erbium laser is used. The use of a laser does not negate the need for acid etching before applying a sealant [51]. The development of enamel cracks and subsequent micro leakage at the sealant enamel interface are drawbacks of this process, which can be avoided by curing the sealant material with an argon laser [52].

Surface conditioning with the Er,Cr:YSGG laser has no effect on minimizing micro leakage at the sealant enamel interface in primary teeth [53].

Advances in flowable composite construction have been made in recent years, and self-adhering composites that do not need a bonding agent have recently hit the market. The aim of this study was to compare the microshear bond strength (SBS) of a self-adhering flowable composite to primary enamel treated with a graphite disc containing silicon carbide particles (SIC) and laser irradiation to that of a traditional flowable composite. To the enamel of primary teeth, the SBS of the traditional flowable composite was higher than that of the self-adhering flowable composite. The SBS of self-adhering flowable composites is increased when the enamel surface is treated with laser irradiation [54].

The clinical effects of laser preparation versus other types of chemical or mechanical tooth surface preparation used in fissure sealant placement were compared in a systematic study. Up until January 2019, PubMed, Scopus, Medline/EMBASE via OVID, and the Cochrane library were all used to perform a search. Only randomized controlled trials were considered for this study. The meta-analysis included three articles, while the systematic review included five. As a contrast to lasers, both of the experiments used acid etching. The overall probability of bias introduced by performance bias was rated as high in all of the included studies. Three research looked at the clinical effects of fissure sealants that were etched with acid or lasers, one compared acid etching to laser combined with acid etching, and one looked at the effect of lasers on objective and subjective stress parameters during sealant application in kids. The meta-analysis found no significant difference between laser preparation and conventional acid-etching preparation at 3, 6, and 12-month follow-ups. According to one analysis, using a laser to prepare the surface before acid etching improved the retention quality. There was no substantial difference in the occurrence of caries. The conclusion was that the present limited evidence suggests that lasers could be an effective pretreatment method. The retention rate was similar to that of conventional acid etching. However, the included studies had an overall high risk of bias and more rigorously designed research is needed [55].

DIAGNOdent and caries detection

For caries detection, laser fluorescence is used, which provides a near-perfect result as well as a faster clinical diagnosis. The detection of occlusal caries, invisible caries, and occult lesions in primary and permanent teeth using laser fluorescence at a wavelength of 655 nm is successful [35]. DIAGNOdent is a laser fluorescence-based machine that is commercially available. An Argon laser with a wavelength of 488 nm is used to detect quantitative demineralization, especially in interproximal surfaces. For primary teeth, it is more effective in detecting caries [56].

Prevention of dental caries

The use of an erbium or CO_2 laser to treat the enamel surface of a newly erupted tooth improves caries resistance. For this, a CO_2 laser with wavelengths of 10,600, 9600, and 9300 nm is used. [57] Erbium lasers with wavelengths of 2940 and 2780 nm show the same result. It's also possible to use an argon laser. Argon laser combined with topical fluoride application significantly decreases caries attack compared to argon laser alone [58]. Laser application in dentistry has been a research topic for the past 30 years, and it has recently gained popularity. Laser irradiation of hard dental tissue changes the calcium:phosphorus ratio, decreases the carbonate:phosphate ratio, and allows the development of more stable and acid-resistant compounds, decreasing the susceptibility to acid attacks and caries [59].

Increasing resistance against erosion of teeth enamel

Tooth mineral depletion is also caused by erosion. The use of lasers in combination with fluoride has been suggested as a novel method for preventing enamel demineralization. Within the study's limitations, Er:YAG laser irradiation in combination with fluoride application did not prevent erosion in permanent and primary enamel during the erosive phase [60].

Remineralization of primary teeth

The effectiveness of a 980-nm diode and 10.6-m CO_2 laser combined with tricalcium phosphate-5 percent sodium fluoride (fTCP) and casein phosphopeptide-amorphous calcium phosphate (CPP-ACP) for the remineralization of primary teeth was investigated in a study. 117 extracted primary anterior teeth were randomly divided into eight experimental and one control classes:

1. control (polished enamel)
2. fTCP varnish
3. fTCP + diode laser
4. fTCP + CO_2 laser
5. CPPACP
6. CPP-ACP + diode laser
7. CPP-ACP + CO_2 laser
8. diode laser, and
9. CO_2 laser.

The micro hardness of 12 samples in each group and the enamel porosity of one sample in each group were measured before and after demineralization, as well as 28 days after remineralization. The data was analyzed, and substantial differences in micro hardness and percentage of remineralization after remineralization were found among the material groups, with the CPP-ACP group having the highest mean. The laser groups had no major differences in micro hardness or the percentage of remineralization after remineralization. In all groups, porosities increased after demineralization and decreased slightly after remineralization; the fTCP group had the greatest reduction in porosity among the material groups, and the CO_2 group among the laser groups. The effect of materials and lasers interacting was not important ($P > 0.05$). After remineralization with CPP-ACP, the highest micro hardness was achieved, the efficacy of the diode and CO_2 lasers was comparable, and no synergistic effect between materials and lasers was discovered [61].

Cavity disinfection, in addition to routine caries removal procedures, is recommended to remove the microorganisms. A study compared the effects of various systems Er,Cr:YSGG lasers, diode lasers, and FotoSan, as well as agents Corsodyl; Cervitec and Cervitec Plus, and Fluor Protector—on the Nano leakage of composite restorations when used for cavity disinfection. A total of 40 intact human deciduous molar teeth with Black V cavities (321.5 mm) on the buccal and lingual surfaces parallel to the cementoenamel junction were randomly divided into eight groups using cavity disinfection methods. The antibacterial agents and systems were used exactly as instructed by the manufacturer. A compomer was used to complete the restorations. The restored teeth were then thermocycled for 500 cycles at 5°C and 55°C with a 30 second dwell time in a water bath. After the thermocycling procedures, 1-mm sticks were collected from the center of each cavity to prepare for the nanoleakage examination. The teeth were sectioned and submerged for 24 hours in a 50 percent ammoniacal silver nitrate solution before being immersed in photo-developing solutions for 8 hours under fluorescent light. A scanning electron microscope was used to analyze the samples (SEM). The Er,Cr:YSGG laser group had substantially less nanoleakage than the other groups, according to the findings. The nanoleakage in the diode laser, Fluor protector, and FotoSan groups was close to that in the control group. Nanoleakage was substantially higher in the Corsodyl and Cervitec groups than in the control group. The researchers concluded that Er,Cr:YSGG laser irradiation, which resulted in lower nanoleakage scores in both the control and test classes, can be recommended for cavity disinfection, and that diode laser and FotoSan, which have antibacterial effects but no negative effect on leakage, can also be used for cavity disinfection [62]. However, there have been no definitive research on the efficacy of lasers as a means of preparing the enamel surface prior to sealant application. According to a review and meta-analysis of the literature based on in vitro research, pretreatment with phosphoric acid resulted in lower micro leakage in occlusal sealants than Er: YAG laser and air abrasion [63].

Laser etching of enamel

Erbium lasers trigger thermomechanical wear of the tooth structure, as well as physical and macroscopic structural changes in the hydroxyapatite matrix [64] [65]. They also provide a rough surface for composite resin bonding. The use of the Waterlase Er,Cr:YSGG laser, which has advantages over the Er:YAG laser [55], was one of the study's advantages. Since water in dentinal tubules and enamel prisms evaporates rapidly when the Er:YAG laser is used, enamel hydroxyapatites absorb less energy and the efficacy of fast tissue ablation by the laser decreases, resulting in more tissue damage. The Waterlase laser hand-piece, on the other hand, never makes contact with the tooth structure, so vibrations are minimized and microscopic cracks and tissue damage are avoided [66].

Contraindications of Laser Use and its Limitations

- Laser should be used with caution in patient having cardiac pacemaker
- It is also not advised to use in cardiac patient with a history of anginal chest pain and arrhythmia
- Use of laser in dental practice requires intensive training and minute precision [8] [35].
- The high cost of laser armamentarium is also a disadvantage in developing country.
- The cost-effectiveness of laser treatment is debatable; additionally, different wavelength lasers are needed for different oral and dental procedures [8, 35].
- It should be used with precaution in patient with immunocompromised state as there is a potential chance of disease transmission through aerosol during the laser procedure [67, 68].

Laser hazards and safety precautions

Using lasers produces a laser plume, which is a mixture of gases and debris. Since the vaporized aerosol can contain infective tissue particles, it is important that the doctor and auxiliaries follow infection prevention procedure and use high-speed suction while using dental lasers [5, 69]. When treating viral lesions in immunocompromised patients with soft tissue therapy, the practitioner should use sound clinical judgement because there is a risk of disease transmission from laser-generated aerosol [67, 68]. To prevent viral transmission, palliative pharmacological therapies may be more appropriate and efficient in this group of patients. Unprotected skin or eyes can be harmed by reflected or scattered laser beams. During laser use, wavelength-specific protective eyewear should be given and worn by the dental staff, patient, and all observers in attendance at all times [5].

The operator must be careful about accidental exposure to nontarget tissue and the operating area should have restricted accessibility for other persons to mitigate its hazardous effects [70]. Protective eyewear is needed because it creates ocular hazards, and the operator must be cautious about accidental exposure to nontarget tissue. The presence of flammable materials in the laser surgery room should be avoided because they can cause fires. When laser surgery is planned under general anesthesia, the use of explosive anesthetic gases is prohibited [20]. Furthermore, it must be assured that the laser is in good working order and that all safeguards are in place.

Advantages of lasers in pediatric dentistry

One of the benefits of laser use in pediatric dentistry is the selective and precise contact with diseased tissues [5]. Electrosurgical instruments cause more thermal necrosis of surrounding tissues than lasers [71]. In most cases, hemostasis can be achieved without the use of sutures during soft tissue procedures [72]. Wound healing can be accelerated with hemostasis during soft tissue procedures, resulting in less post-operative pain and a lower need for analgesics [37]. Most soft-tissue treatments need little or no local anesthesia [73]. When soft tissue procedures are performed using lasers, the operator chair time is reduced [37]. Lasers have been shown to have decontaminating and bacteriocidal effects on tissues, reducing the need for antibiotics after surgery [21]. Lasers can relieve the pain and inflammation associated with aphthous ulcers and herpetic lesions without the use of drugs [24]. Lasers can effectively extract caries with limited involvement of surrounding tooth structure because caries-affected tissue has a higher water content than healthy tissue [5, 69]. The traditional high-speed dental hand piece's noise and vibration have been blamed for causing irritation, pain, and anxiety in children during restorative procedures [74, 75]. Since erbium lasers don't make contact with hard tissue, they don't have the vibratory effects of a traditional high-speed hand piece, making tooth preparations more relaxed and less stressful for kids and teenagers [76]. The analgesic effect of Nd:YAG and erbium lasers on hard tissues has been demonstrated, removing the need for injections and local anesthesia during tooth preparation [77].

Limitations of lasers in pediatric dentistry

The use of lasers in pediatric dentistry has several drawbacks. Since numerous soft and hard tissue procedures require different wavelengths, the practitioner can require more than one laser [5]. For the various clinical applications and types of lasers, additional training and education is needed [77]. To purchase the equipment, introduce the technology, and invest in the appropriate education and training, high start-up costs are required [37]. The majority of dental instruments cut from both sides and ends. Modifications in clinical technique, as well as additional preparation with high-speed dental hand pieces, may be needed when using lasers to complete tooth preparations [74].

Conclusion

Recognizes the use of lasers for soft and hard tissue dental procedures in babies, teenagers, teens, and people with special health care needs as an alternative and complementary process. Dental practitioners should receive additional didactic and experiential laser education and training before using lasers on pediatric dental patients, according to advocates. Encourages dental practitioners to conduct analysis, introduce, and use the most suitable laser for the treatment at hand. Endorses the use of laser-specific protective eyewear by the dental staff, the patient, and observers during care [12].

Despite some expense and preparation drawbacks, the use of laser therapy in pediatric dental procedures is well received by the patients and their parents. Patients in the pediatric age group behave cooperatively during dental procedures due to the procedure's limited invasiveness. While its efficacy in the diagnosis of dental caries, caries prevention, endodontic management of deciduous and permanent teeth, and various soft-tissue procedures is well known, further research on its efficacy in pediatric dental procedures is still needed [78].

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Conflicts of interest

The Authors declare no conflicts of interest.

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