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Dr. Hage Monju
MDS Third Year,
Department of Pediatric and Preventive Dentistry,
Government College of Dentistry, Indore,
Madhya Pradesh, India

Dr. Anuradha Agrawal
Associate Professor,
Govt. college of Dentistry,
Indore, Madhya Pradesh, India

Dr. Shikhar Pratap Chauhan
Assistant Professor, Department of pedodontic, GDC Indore,
Madhya Pradesh, India

Corresponding Author:
Dr. Hage Monju
MDS Third Year,
Department of Pediatric and Preventive Dentistry,
Government College of Dentistry, Indore,
Madhya Pradesh, India

Journey of lasers in dentistry and its role in pediatric dentistry

Dr. Hage Monju, Dr. Anuradha Agrawal and Dr. Shikhar Pratap Chauhan

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Abstract
Lasers have drawn a lot of interest and are now widely used in dentistry. The primary benefits of laser systems have drawn the attention of many practitioners and have begun to displace conventional therapy. The discipline of dentistry now has access to more advanced and modern tools that can assist dentists and patients in receiving dental care. New technology project the present day paradigms of dental exercise and could cause good sized shifts in future remedy modes. Laser generation can be used as a diagnostic device for caries detection, resin curing, hollow space coaching, tender and difficult tissue surgical operation and to cope with dentin hypersensitivity. Lasers provide superior results over conventional methods and may help clinician to carry out procedures which may not be possible with routine therapy with good results. This article highlight the basic scientific and review on lasers in dentistry with special emphasis on applications in Pediatric Dentistry.

Keywords: Carbon dioxide laser, diode laser, water lase, erbium laser

Introduction
"Light Amplification with the Aid of Stimulation Emission of Radiation," or "LASER," is an abbreviation. Various oral diseases such dental caries, gingivitis, and periodontal disease have been observed over time. The employment of conventional methods has been used to regulate pulp treatment, small surgical procedures such operculectomy, biopsy, surgical publicity of teeth for orthodontic treatment, frenectomy, etc. All of those methods call for the use of local anaesthesia, a needle, and rotational devices that make noise and vibrate. They take more time to consume and may need more than one sitting. Anxiety, fear, and the uncooperative behaviour of the baby patient in toddlers and children make those procedures tiresome for paediatric dentists.
However, with evidence-based dentistry and ongoing research in the field of laser technology, laser therapy may eventually advance conventional treatment.

History
Many images that are likely defined as modern living come to mind when people hear the word "laser." When it comes to generation, the adjectives "effective," "precise," and "innovative" add to our understanding of the industry. The fields of medicine and dentistry have, however, been using lasers for a long time. The modern dental lasers are the result of years of research and have their roots in sound quantum mechanics theories, which were first put forth by Danish physicist Niels Bohr in the early 1900s. Schawlow and Townes discovered LASER in 1958, and Maiman of the Hughes Research Laboratories built the first operational laser, a pulsed ruby apparatus, in 1960 [1].

Classification
In dentistry, various laser types were used. Traditional classifications for lasers include: 1) The wavelength 2) The method of laser production (e.g., gas, solid-state, liquid, or semiconductor diode) 3. Tissues on which it is presently used: supple and challenging tissues 4) The degree of risk to the skin or eyes after unintentional exposure. 5) The type of lasing medium (such as Erbium, yttrium aluminium garnet, etc. [2].

Table 1: Types of LASER according to Wavelength

Laser type	Wavelength	Application
CO2 (Pulse or continuous wave mode)	10 600 nm	1. Ablation of soft tissues 2. The contouring of the gingiva for cosmetic reasons 3. Oral ulcerative lesions treatment 4. Gingivectomy and frenectomy 5. Removal of dead epithelial tissue Regenerative periodontal procedures
Nd-YAG (Pulse mode)	1064 nm	1. Root canal therapy helps clean the root canal of debris and infectious bacteria. 2. Extensive periodontal surgery and scaling to get rid of disease-causing germs and necrotic tissues 3. Caries eradication
Er-YAG (Pulse mode)	2940 nm	1. Eliminating caries 2. Preparing the enamel and dentin for cavities 3. Root canal cleaning
Er,Cr-YSGG (Pulse mode)	2780 nm	1. Etching Enamel 2. eliminating caries 3. Preparing the cavity 4. Ablation of bones without melting, overheating, or altering the calcium or phosphorus ratios 5. Preparation of the root canal
Argon (Pulse or continuous wave mode)	572 nm	1. Polymerization of materials made of restorative resin 2. Tooth whitening 3. The removal of dead tissue and shaping of the gingiva. 4. Therapeutic management of oral lesions, such as persistent aphthous ulcers or hepetic lesions 5. Gingivectomy and frenectomy
Diode (Pulse or continuous wave mode)	810 or 980 nm	1. Fibroblast proliferation and improved healing of surgical wounds or oral lesions 2. Fenectomy as well as gingivectomy 3. Gingival contouring correction for aesthetic reasons
HO-YAG (Pulse mode)	2100 nm	1. Contouring Gingival elongation 2. Oral lesions treatment 3. Gingivectomy and frenectomy

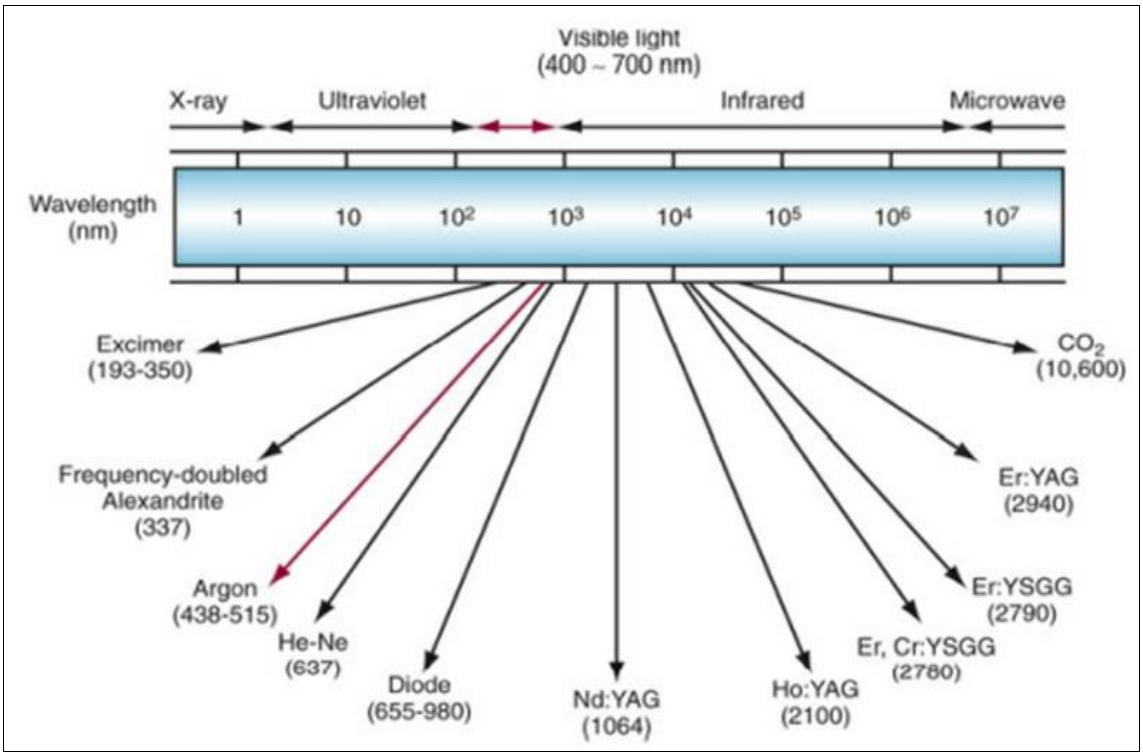

Fig 1: wavelengths of lasers. Each laser has a wavelength spectrum that is entirely distinct from another, resulting in exact absorption properties. Most of the lasers used in dentistry and periodontics have a wavelength that is within the red and near infrared spectrum [3].

Mechanism of action

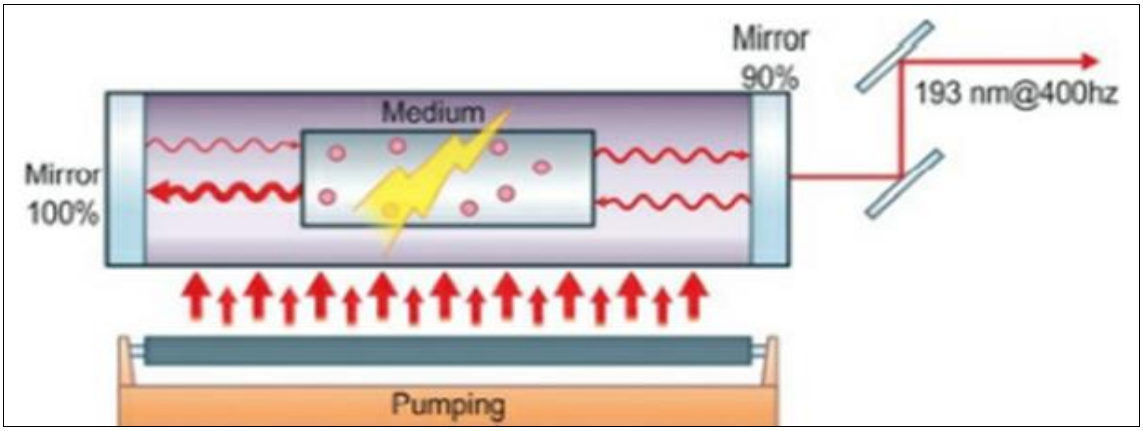

Fig 2: Presenting the main components of a laser tool through a diagram. To produce an output monochromatic power beam, lasers need a medium, an optical chamber or laser tube, and an externally supported power supply

A medium, an optical chamber or laser tube, and an externally operated power supply are required for the creation of an emitting monochromatic power beam from a laser. Electrons are "stimulated" to a better power orbit when power is applied to the medium. Upon returning to their normal orbit, a photon (a mild particle) is released. The laser beam is "coherent" because all of the photons have the same wavelength. The wavelength of a laser is dependent on the medium, which could be a semiconductor, a solid, or a gas. Lasers acquire their name from the energetic component (s) that, when stimulated, produce the power beam. Argon, gas (diode), Nd: YAG, Er: YAG, Er, Cr: YSGG, and CO_2 lasers are frequently used in dentistry. Both non-stop, pulsed (gated), and walking pulse waveforms can be used to add wavelengths [4].

Laser transport machine

The transport device can be a quartz fiber-optic, bendy hole waveguide, articulated arm, or hand piece housing the laser unit that is currently used in low powered laser dentistry, depending on the wavelength. A positive power density is produced by the laser beam's diameter, whether or not it comes into contact or not with the tissue. The smaller the beam, the higher the power density.

Laser tissue interplay

There will be 4 unique interactions between the laser light and the target tissue.

First: The laser energy is absorbed with the help of the targeted tissue. The amount of energy that is absorbed by the tissue depends on the tissue's properties, such as its pigmentation and water content, as well as the laser's wavelength and emission mode.

Second: The rapid transfer of laser energy through tissue without having an impact on the target tissue, which is the opposite of absorption. This effect is very reliant on the laser light's wavelength. While tissue fluids easily absorb the erbium own circle of relatives and CO2 on the outer floor, water is extremely visible to shorter wavelengths like argon, diode, and Nd: YAG. As a result, there is little power communicated to surrounding tissues.

The Third Option is mirrored image, in which the beam reflects off the ground without striking the tissue it is intended to reach. The considered light is used by a caries-detection laser equipment to gauge the degree of healthy enamel structure. The light under consideration should either remain collimated in a narrow beam or become more diffuse. As the distance from the hand piece rises, the laser beam often diverges more.

At distances more than three meters, the beam from a few lasers will have sufficient strength. This reflected image could be dangerous because the power is being directed at the eyes and an unexpected target, which is a major safety concern for laser operation.

Fourth: Dispersion of the laser light, which reduces the intended strength and probably has no beneficial biological effects. The laser beam should scatter, causing heat to switch to the tissue next to the surgical site and causing injury. However, a beam diverted according to specific rules is advantageous for speeding up the cure of composite resin or for securing a vast area.

Soft tissue management

1. Treatment for ankyloglossia

Ankyloglossia is a very common condition that affects the newborn population and accounts for a sizable share of breastfeeding issues. In a study of more than 350 children, Kotlow L. A. (2004) [5] found that ankyloglossia may be seen in 3.2% of paediatric patients. He asserts that the odd attachment of the lingual frenum is one of the most frequently misdiagnosed and ignored congenital defects seen in children. He developed helpful diagnostic criteria that are useful for treating and evaluating the lingual frenum [5].

2. Diagnosis and remedy for maxillary frenum

Normally In severe situations, the maxillary frenum may stretch between the important incisors and into the palate in toddlers, inserting it into the alveolar ridge. This may result in a diastema between the valuable incisors in the front region and may lead the lip to become wedged between them, interfering with oral hygiene practises.

A good maxillary frenum may also interfere with the newborn's ability to latch on correctly and cause breastfeeding issues, according to Ballard J, Khour J C *et al*., (2002) [6]. Kotlow L. A. (2004) [5] claims that between the ages of eight and 18 months is when a cure is most likely to take place. Er: YAG 30 hz, 50 mj and Er, Cr: YSGG 20 hz, 50 mj, each without water, are the laser settings he suggests for ankyloglossia. The frenum insertion and the area between the two anterior teeth are the focus of the laser's energy. There is

no need for sutures. If necessary, medication such as ibuprofen may be used [5].

3. Exposure of tooth

The enamel will be seen using a variety of laser frequencies, but the best one is an erbium laser. There is no need for local anaesthetic when only delicate tissue needs to be removed. Kotlow LA (2004) [5] recommended Er: YAG 30 hz, 45 mj and Er, Cr: YSGG 20 hz, 70 mj for laser settings, both in touch and noncontact mode [5].

4. Gingival recon touring and gingivectomies

Guelman *et al*. (2003) advised doing laser treatment to restructure gingiva in cases of gingival hyperplasia or gingival development caused by utilizing medications like dilatin sodium. Lasers can remove the gingival tissue to make room for a recovery without experiencing bleeding problems. Most of those procedures can be completed without local anaesthetic and with quite minimal postoperative pain [7].

Pericoronal flap troubles related to erupting enamel

Children who have newly or already erupted enamel frequently complain of pain, swelling, or infection in the tissue beneath the new or already erupted enamel.

Lasers can be used in a noncontact way to vaporise the anxious tissue and reveal the worried enamel's scientific crown. Most of the time, laser therapy can be performed without the need for local anaesthesia**.** Kotlow L. A. (2004) [5] advised using an Erbium laser in a noncontact mode without water with settings of 20–30 hz and 45–55 mj [4].

5. Treatment of aphthous ulcers and herpetic lesions

One of the most straightforward and effective methods for treating aphthous ulcers or recurrent aphthous ulcers is laser therapy, which has been supported by Parkins *et al* (1994) [8].

6. Pulp remedy in number one tooth

In the past, formocresol and other root canal medications were used to treat the pulp of the first and permanent tooth. However, Kotlow LA (2004) studied more than 150 teeth over the course of two years and found that using the Erbium laser has comparable to or better results than using traditional formocresol. According to him, the laser will be set at 20 to 30 hz, 50 to 70 mj, and can easily the pulp chamber in 10 to 20 seconds when applied to a vital tooth. He came to the conclusion that it provides enough hemostasis and leaves some important tissue at the peak. The completion rates of the laser and conventional pulpotomy techniques are comparable in nonvital teeth. When a fistula is present, the same settings are utilised to incise it, but the success rate is substantially lower [5].

Laser approaches for hard tissue

1. Lasers are thought to be a safe procedure since they are effective at removing cavities from enamel's tough tissue. Nd: YAG laser wavelength was recommended by White J. M. *et al*. (1993) for the removal of superficial pigmented caries. The best laser for removing cavities from deep teeth, dentin, and other materials is an Erbium-based laser from its own family [9].

In their study, Hadley J *et al*. (2000) found that the Er, Cr: YSGG laser machine is effective for training of type I, III, and V cavities and resin restorations are preserved utilising lased enamel surface [10].

According to Kotlow L. A. (2004) [5], laser treatment avoids micro-fractures that appear frequently following standard drilling. In most cases, local anaesthetic is not necessary. He examined the successful removal of caries using erbium laser. He came to the conclusion that the most important thing is to put the least amount of effort into achieving a successful outcome. Higher treatment is no longer guaranteed by more energy. The water and fluoride content of the target tissue, the laser settings, including power, pulses per second, and water spray pattern, the end material, shape, and diameter, and the appropriate suctioning technique to remove the water and ablated particles, all affect the laser's ability to remove difficult tissue. Correct isolation should be carried out during laser treatment with the help of a rubber dam. Because a clamp must be held lightly on gingival tissue but not subgingivally, local anaesthetic is not necessary [5].

2. **Removal of amalgam and different restorations:** Although Kotlow L. A. (2004) [5] no longer recommends using a laser machine to remove damaged amalgam restorations, it can still be used to remove secondary cavities that have formed underneath amalgam restorations. If eliminating the current amalgam recovery is required for caries ablation, the laser tip must be pointed at the neighbouring teeth to create a tiny trough. Metal can be removed with hand tools. Lasers can be used to remove bad glass ionomer and composite cements [5].

3. **Sealant placement:** Since its invention in 1955, the use of sealants in children has gone mostly ignored. Almost 70% of molars develop occlusal floor caries within three years after the eruption of the enamel, according to Feigal R. (2002). The dentist can easily, sterilise, and unquestionably see the grooves in the teeth thanks to the laser. After etching, enamel indicates unique types of fashions. Studies conducted with the help of Visuri S. R. *et al*., (1996), confirmed that the properties of erbium-etched teeth are similar to those of acid-etched teeth [11, 12].

4. **Tooth preparation:** Kotlow L. A. (2004) praised the erbium laser for eliminating caries and claimed that it does so effectively. Because of the low water content in the fluorosis condition, the ablation process may also proceed slowly. Here, a turbine with an excessive speed can be used. He demonstrated that for optimal cutting efficiency, the laser tip must be perpendicular to the enamel surface. He also demonstrated that once the teeth have been removed, power must be reduced for the dentin and carious lesions since they contain more water than teeth and can be easily removed [5].

Apicoectomies and removal of impacted teeth under the bone will be carried out using an Erbium laser, special laser tips, settings, and water spray, as determined in a study carried out with the aid of Sasaki K *et al* (2002) [13]. A comparison of the retention of pit and fissure sealants applied using traditional acid etching and Er, Cr: YSGG laser etching reveals that Er, Cr: YSGG laser etching has retention and patient acceptance characteristics similar to those of acid etching [14].

Use of laser treatments is contraindicated [15]:

1. In the uterus region in pregnant women, or with prudence in pacemaker patients
2. In those who have epilepsy or frequently

3. Patients with a history of chest discomfort or an arrhythmia
4. Tumorous tissues or benign tumours having a predisposition to become malignant
5. On glands, such as the thyroid gland
6. Lupus patients or sufferers who used medications safe for light

Miscellaneous application of lasers [16]

Throughout many years of development up to the present, laser generation has demonstrated to be an excessively refined field for both hard tissue and soft tissue surgery, and upgrades can also be created. The laser has the aforementioned additional dental applications:

1. The effects of the lasers' analgesia
2. Regeneration and restoration of nerves
3. Pain following surgery
4. Sinusitis (n. 4)
5. Proliferation of stem cells:
6. Hypertonia/xerostomia
7. Periodontitis:
8. Sterilization of challenging tissue
9. Interphase healing after bone implants
10. Lasers are effective treatment options for mucositis and ulcers.

Advantages of lasers [17, 18, 19]

1. No need for sutures
2. Does not need anaesthetic anymore
3. Patients experience less bleeding
4. 4.Reduced postoperative discomfort
5. Patient compliance is improved
6. Viral and bacterial infections are reduced since the high-power laser sterilizes the area being worked on.
7. Decreased swelling, postoperative trauma, and scarring. The technique significantly reduced haemorrhage and edoema by sealing up the small blood vessels and lymphatics.
8. Tissues may regrow and wounds heal more quickly.
9. Shorter surgery time.
10. Laser may be precisely controlled to remove thin layers of tissues,
11. Lymphatic closure minimises tumour cell dispersion.

There is no longer a need for sutures because haemostasis allows for secondary intention wound healing. Only a select few authors, including Kopp and St Hilaire (2004), have used sutures after using a CO2 laser [20].

Unlike when using a rotational instrument, the patient no longer feels any pressure, vibration, or contact from the optical fibre at the enamel.

Lasers appear to be more kid-friendly because they don't have the dental drill's frightening sound or vibrations. They treat the laser like a toy and are very comfortable around it [21].

Disadvantages of lasers [15]

1. Laser use results in no tactile feeling.
2. No single wavelength can effectively treat all tooth diseases.
3. Three. Sometimes using it can be difficult.
4. The CO2 laser will diminish a lot of tissues, including the assistant's finger, since it is absorbed with the help of water molecules.
5. The price of the gadget.
6. The inability to remove defective metal and solid porcelain restorations.

The use of a dental laser is governed by numerous safety regulations. The most important ones are:

1. The presence of a selected security guard.
2. A location with minimal reflected surfaces and restricted access.
3. The surgical team, the patient, and any observers must wear safety goggles.
4. Compliance with contamination control

The various dangers that may arise during clinical dental management can be divided into the following categories.

1. **Ocular Injury:** Potential injury to the eyes may result from either direct laser emission or the mirrored image of a specular (mirror-like) floor.
2. **Tissue damage:** The heat interaction of radiant energy with tissue proteins can result in laser-induced damage to skin and other non-target tissue.
3. **Three) Environmental risks:** Another type of risk is the potential for inhaling airborne biologically dangerous compounds that laser surgery may release.
4. **Combustion dangers:** In the presence of flammable materials, lasers may furthermore provide a number of substantial concerns. If exposed to a laser beam, flammable liquids, solids, and gases utilised in surgical settings may easily catch fire.
5. **Electrical Risks:** Elegance IV lasers frequently employ very high currents and high voltage energy sources, both of which have the potential to be fatal. Laser electrical threats can be divided into three categories: explosion risks, electric surprise risks, and electric hearthplace risks.

Laser hazard control measures

In the context of dental lasers, management measures have been divided into four categories.

Engineering controls, first Protective housing, Interlocks Beam enclosures, shutters, provider panels, and warning systems for devices are required for this.

2) Personnel safety equipment

A) Eye Protection

Everyone exposed to a minimal risk should wear adequate eye protection, such as safety goggles or screening devices.

Control of airborne contaminants can be accomplished using either a recirculating air filtering equipment or the proper air flow evacuation.

Procedures and administrative controls:

A laser protection officer is a person who oversees all administrative tasks related to ensuring the safe functioning of lasers. The responsibilities of ISO include

1. In-room evaluation and identification of hazards.
2. Determining if a sector is capable of posing a threat or not.
3. Developing well-liked working techniques.
4. Ensuring that all staff have the proper laser protection.
5. Implementing programmes for accident files and clinical surveillance.

Environmental measures: These include the physical environment where the laser is being used.

Discussion

Pediatric dentists deal with several clinical circumstances on a

daily basis, and laser therapy is a very effective mode of treatment. Kotlo LA (2004) claims that modern laser technology has made treating children with laser therapy more effective than using more conventional methods [5].

In many areas of the industry, laser generation still requires attention. Among contrast to developing nations like India and other Asian nations, it has earned a respectable reputation in the western countries.

According to an American Dental Association poll, 31% of patients believe it is absolutely necessary for a dentist to have a laser and 30% believe it is necessary as of July 24, 2019. The use of lasers is prohibited in India due to the high cost of laser devices and a lack of attention. Laser safety has been a concern, but in the hands of professionals, especially expert dentists, lasers are fairly secure. In order to improve the reputation of laser dentistry, dental surgeons need to be encouraged to use dental lasers [22, 23].

With the help of coverage groups, several surgical procedures carried out with the aid of lasers are included in western countries. This suggests more advanced dental techniques, and as a result, lasers may eventually take the role of traditional dental hand pieces in dental offices.

The other laser literature makes clear that, in addition to understanding the numerous applications for lasers, it's also crucial to pick the proper wavelength, comprehend how lasers interact with tissue, and avoid too embracing laser dentistry before the technology is well-suited for it.

Although laser dentistry may be a novel concept to many, it's a well-supported and least invasive way to safely care for your child. This kind of treatment can frequently help to ease your child's anxiety over dental visits.

Erbium lasers are now thought to be appropriate for dental treatment due to recent advancements in laser technology [24] (Rajan JS, *et al*. 2021). This is because of its dual ability to ablate tough and fragile tissues with little damage.

Periowave TM

A photodynamic disinfection device that, following scale and root planning, uses a photosensitizer mixed with a low-depth laser to destroy microorganisms and pollution.

Periodontal Water lase MD

It uses Er, Cr, and YSGG to provide green periodontal attachment stage recovery by minimally invasive surgical periodontal laser therapy. Goal software dental restoration, aesthetic procedures, oral surgery, root canal cleaning, dental implants, and periodontal treatments are all examples of restorative care.

A full, partial, or break up thickness flap, a tender tissue curettage, the removal of diseased, infected, inflamed, or necrosed tender tissue inside periodontal pockets, an osteoplasty, an osseous recon touring, an ostectomy, or an osseous crown lengthening procedure are all indicated uses for water lase C 100. Target software: Early periodontal treatment, extraction, and restorative techniques

Photoacoustic streaming carried about by photons: The use of Di Vito EE, which generates effective shockwaves at sub ablative degrees to make disinfectant irrigants easy to apply, has led to a recent advancement in root canal treatment.

Piezosurgery uses ultrasonic vibration as an ultrasound tool for techniques like osteotomy and osteoplasty. Additionally, it can be employed for root canal, ridge augmentation, ridge expansion, enamel extraction, and orthodontic treatments that require retrograde coaching.

Osseo densification

A novel method of biomechanical bone coaching for placing dental implants that uses protective bone mass and accelerates recovery.

Conclusion

There are specific wavelengths of lasers available for specific types of packaging. Lasers are now being used in practically all dental specialties. With more laser companies entering the field and offering the profession more options of smaller, less expensive devices, it's sure to gain popularity over conventional approaches in the years to come and makes the baby's visit to the dentist simpler, much less stressful, and make your baby's visit a whole lot greater great and enjoyable!

Conflict of Interest

Not available

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Not available

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