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Power density of lasers used in dental practice (add article review)

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Abstract :

The discovery of lasers is one of the most important innovations in the physics world, given the effectiveness of the laser beam that outstrips any of the technologies that are used today, Dentistry is a significant use the technology of laser. This survey the different applications of lasers in dentistry including types of lasers, laser-tissue interactions, treatment, and diagnosis. Laser in dentistry is ingoing a new age of legitimacy, fuelled by the adaptability and broad efficacy of the laser. and its applications work for multiple dental treatments and have become a necessary and important tool in the context of processing. Being more precise, faster, and less expensive, lasers have penetrated most dental specialties over the past half-century, including oral surgery, root canal treatment, periodontics, pediatric dentistry, prosthodontics, and orthodontics. In many ways, lasers revolutionized the diagnosis and treatment of diseases.

Key words: Laser Applications, Nd: YAG laser, Dentistry, Energy, Power.

كثافة القدرة لأشعة الليزر المستخدمة في التطبيقات السنية

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مستخلص:

يُعَدّ اكتشاف أشعة الليزر من أهم الابتكارات في عالم الفيزياء، نظرًا لفعالية شعاع الليزر التي تفوق أيّ من التقنيات المستخدمة اليوم. ويُعَدّ مجال طب الأسنان أحد أبرز المجالات التي استفادت من تكنولوجيا الليزر. تتناول هذه المراجعة مختلف تطبيقات الليزر في طب الأسنان، بما في ذلك أنواع أجهزة الليزر، وتفاعلات الليزر مع الأنسجة، إضافةً إلى استخدامه في العلاج والتشخيص. يعيش الليزر في مجال طب الأسنان عصرًا جديدًا من الاعتماد والشرعية، مدفوعًا بمرونته وكفاءته الواسعة، إذ أصبحت تطبيقاته أساسية ومهمة في العديد من إجراءات المعالجة السنية. وبفضل دقته العالية وسرعته وتكلفته المنخفضة، أصبح الليزر جزءًا لا يتجزأ من معظم تخصصات طب الأسنان خلال نصف القرن الماضي، بما في ذلك جراحة الفم، وعلاج جذور الأسنان، وطب دواعم الأسنان، وطب أسنان الأطفال، وطب التركيبات السنية، وتقويم الأسنان. وبطرق عديدة، أحدث الليزر ثورة في تشخيص الأمراض وعلاجها .

الكلمات المفتاحية : تطبيقات الليزر ، ليزر الياك ، طب الاسنان ، الطاقة ، القدرة.

Introduction

Light is a type of energy, and its fundamental unit is made up of molecules known as photons. Photons travel through waves whose velocity is the speed of light and whose amplitude is vertical gauge, It expresses the amplitude by raising the wave from the zero axis to the peak. The wave's energy is measured in millijoules, and the horizontal separation between two points is its length. The wavelength is measured in nanometers when it is considered to be on the wave. Lasers have numerous and diverse applications in dentistry today, depending on the energy used and the time of exposure to dental tissues, as well as wavelength absorption in soft or hard tissues. Laser light interacts with target tissues in four ways, depending on their optical properties: energy absorption and transmission, laser reflection, and laser scattering [1]. Monochrome and parallelism to a high degree. The output power and the method of the pulse, pulsed, Q-switched, or locked laser are the characteristics that affect the performance of the laser. For as long as the medium is excited, the laser mode emits a continuous beam of light. Only in impulses, ranging from femt to second to second [2]. The high power of the laser radiation allows for the power to be focused on small areas with sizes that are match the wavelength, and the focus of the high-energy pulsed laser radiation allows for two-photon spectroscopy. The tissue reaction is dependent on the wavelength and power density of the laser utilized. Photons must be coherent in order to constructively scan the electric field in the photomechanical mode of nanoscale or shorter pulses with very high spatial density [3]. The laser current appropriate of a particular use is determined by , the tissue needs to be destroyed because of its absorption properties, the range of the radiation's wavelength, The applied energy level , as well as the temporal parameters of the energy provided, continuous or impulse energy delivery, either direct or indirect touch with the target tissue, and rate of exposure[4,5]. The energy absorbed by tissue is precisely linked to laser technical parameters such as laser energy or power and pulse duration [6].

Both low with high power lasers are employed in dentistry for a variety of applications. Low-intensity lasers such as Helium neon laser and diode laser s can be used to detect tooth decay, treat pain and neuromuscular disorders, control inflammation, and accelerate healing. In surgical procedures, high intensity lasers such as erbium yag, neodmium yag, holmium yag, aegon, carbon dioxide, excimer and alexandrite are utilized, examples of procedures include soft tissue , removing dental caries,and resectioning bones [7]. Low-intensity laser therapy is widely used to treat pain associated with orthodontic movement and to speed up bone regeneration, whereas high-intensity laser therapy is primarily used for dental surgery and bio stimulation therapy [8]. In order to treat oral cancer, soft tissue surgery with laser power is advantageous. It is beneficial that laser surgery can seal blood arteries with a laser beam since it can be done without using blood, and it may also lower the quantity of cancerous cells present throughout the procedure [9]. The laser's capacity to close the lymphatics during surgery helps to lessen the edema that comes with the procedure [10]. Additional dental soft-tissue laser uses include vestibulopathy, soft-tissue crown lengthening, soft-tissue tuberosity reduction, frenectomies, incisional and excisional biopsies, and more. During oral and maxillofacial surgery, laser energy can be used to readily control many of the lesions that develop on the oral mucosa's surface, and it may be used to treat all of them [11,12].

This research will look at the various applications of laser energy in dentistry, such as laser types, laser interactions with tissues, treatment, and diagnosis.

Lasers in dentistry

In dentistry, different laser devices are used for different applications in dental treatment. Generally, The laser's effective medium, which includes diode, argon, helium-neon, and alexandrite, Co2, ErCr:YSGG, Ho:YAG, Er:YAG, Nd:YAG, and all Wavelength, power, repetition rate, energy per pulse, and energy density are among the parameters of a laser device. These specifications determine the context of the scientific application to control it well.

The dental applications are classified as follows:

1- **Laser effect on soft tissues**

Depending on the purpose of the treatment, low power and high power lasers both have the ability to be used on soft tissues Most layers of surface tissue are treated with low power lasers for healing purposes.. The use of this laser is appropriate for Pain and anti-inflammatory, and it can work in tissues inside the body [13], high power lasers remove lesions and cut soft tissue by absorbing light, coagulating, generating heat, drying, and evaporation [14]. The biological response is stimulated by wavelengths ranging from 632 to 1064 nm [15]. The benefits of low-level laser therapy can be obtained by employing different wavelengths and devices have different energies. Sapphire was the primary material used for laser that produced pulsed light at 694 nm. The helium neon laser, (0.1-0.5)W 632.8 NM gas laser, was one of its successors. A diode laser is a relatively inexpensive laser [16]. The GaAs laser diode (gallium arsenide, 904 nm) had a typical output power of 0.1-0. 4 W. GaAlAs (780-890 nm) was originally designed as a unit with 0.1 to 0.3 W and a maximum power of 5 W. InGaAlP (gallium and aluminum phosphide) lasers (630-700 nm) typically provide lasers ranging from 0.25 to 0.5 W, making them an alternative to He-Ne lasers for superficial wound dressing. To achieve the required biological effect in a reasonable amount of time, the GaAlAs laser must be at least 0.1 W. In adult patients receiving cell wavelength implantation treatment, a low level laser was used to prevent oral mucositis. Hematopoietic stem at 650 nm, 0.4 W, and per square centimeter of fabric capacity by 2 joule per square centimeter [13-18]. As it may be appealing to treatments, It appears that the diode laser is safe to use. The literature shows that it has both efficacy and safety, particularly when used during a twenty second root canal period at one point five watts in all operating modes and 3 watts in pulsed mode [19].

2- The effective of laser on hard tissue

The low-intensity laser is a relatively simple treatment that leads to a decrease in the solubility and dissolution of enamel, whereas the high-intensity laser can be used in mineral tissue to prevent tooth decay and improve area power, holes with cracks can be sealed by laser as a preventative measure by reshaping the surface and increasing fluoride ion penetration. The carbon dioxide The laser has the ability to alter the slit system to improve its efficiency,more resistant to future attack by either sealing the A change in the enamel protective fluoride content or rend.. A laser is used not only for the surgical removal of body tissue or dissolution, in addition, to alter the chemical makeup of the tooth's framework, resulting surfaces that are less prone to metal removal with thus less exposure to primary with extra necrosis.effectives are determined by the power used to area, in addition distance between laser and object, the spot size , and time.

Laser energies used in Oral surgery

A clinical investigation detailed the use of a potassium-titanyl-phosphate (KTP) laser (532 nm) with a low power factor (1 Watt-Cw) to measure pain both during and after surgery to remove lesions from the oral mucosa [23]. Oral leukoplakia has been treated with phototherapy using a pulsed dye laser. The optimal parameters were determined by the study to be an application time of 1.5 hours and a laser irradiance exposure of 8 J/cm with a pulse time of 1.5 ms [24]. A clinical report showed that the Er: YAG laser was effective in lowering symptoms and lymphocyte infiltration (OLP) in the case of oral lichen planus. 80–120 megajoules of energy, 6–15 Hz of frequency, and a non-contact handpiece were the characteristics that were employed. The pulse duration varies from 100 s (very short pulse) to 300 s (short pulse), with the spot's diameter measuring 0.9 mm. Fluency of 12.6–18.9 joules/cm^2. Moreover, water/air spray (ratio: 6/5) [25]. Both the diode laser and the Er: YAG laser at 1 watt remove gingival pigmentation with melanin [26]. There have been reports of treating lymphoma with a carbon dioxide laser. The application of the CO2 laser (focused CO laser beam, 10.600 nm) was carried out at 3 watts (watts), continuous wave (CW) [27]. Analyze the bone size removed following erbium drilling, operation duration, and temperature changes of the bone surface:

Er: YAG laser with a 1000 mJ pulse energy, 300 s pulse duration, and 20 Hz frequency [28]. In individuals undergoing bisphosphonate therapy, bisphosphonate-associated jaw bone necrosis following tooth extraction may be avoided with Nd: YAG laser treatment (1064 nm - power 1.25 W; frequency 15 Hz; fiber diameter: 320 m) [28,29].

Laser energies used in Endodontics

There have been numerous studies that show the impact of different laser energy on dental root therapy. Melcer and associates [30] demonstrated in beagles and primates that using a carbon dioxide laser at 2 watts for 2 seconds created new mineralized dentin without altering the cells of the pulp tissues. Dentinal hypersensitivity has been treated with helium-neon and Er: YAG lasers, which have an output power of only 6 mW (25 to 35 mJ per pulse). It permits a tiny quantity of energy to reach the pulp tissue but has no influence on the form of the enamel or dentin [31]. For 0.5 to 3 minutes, three gallium/aluminum/arsenic (diode) laser wavelengths (780, 830, and 900 nm) were employed in continuous wave radiation mode to cure dentinal hypersensitivity. utilizing a variety of power levels and both focused and unfocused laser modes, laser CO_2 applied to exposed pulp for (3, 10, 30 and 60 watts). Blowing, thrombophilia, and odontoblast degeneration occurred, but no damage occurred. On the exposed core tissues, The energy density of the CO2 and Nd: YAG lasers are 4 J/cm2 and 6.3 J/cm2, respectively, are used [32].

Laser energies used in Periodontics

Clinical applications of Nd: YAG and diode lasers, the lasers have been utilized in periodontal therapy without surgery to attain hemostasis,then Their application has led to the elimination of infections and the eradication of the sinuses' damaged epithelial lining. using radiation that includes an emission power of 2.0 watts (100 mJ/pulse and 20 Hz), 1.8 watts (30 mJ/pulse, 60 Hz) for 40 seconds, 0.6 or 0.4 watts for an electromagnetic wave, particularly a radio wave, with a constant amplitude, and then 0.6 watts for continuous wave power [33]. Removal of subgingival tartar using Er:YAG laser. At 40 mJ/pulse and 10 Hz, subgingival stones may be removed effectively without causing heat damage to the root surface, and at 100 mJ/pulse and 10 Hz, orthopedics [34].

Laser energies used in Pediatric dentistry

Use of lasers for cavity and caries removal in children, including the Er: YAG laser in pulse mode with energy in tooth decay (100-200) mJ, enamel (200-250) mJ, dentin (150-200) mJ, and drilling (30-50) mJ. For pulp residue removal, dental pulp diagnosis, direct pulp covering, access cavity preparation, canal preparation, laser therapy, peak lesions with sinuses, access lumen preparation, canal preparation, and wound healing, 2 watt Er, Cr: YSGG, and Nd: YAG lasers at 20 pulses/sec for 1 sec are recommended [35-37].

Laser energies used in Prosthodontics

The argon laser's energy has the highest absorption in hemoglobin, allowing for excellent coagulation, and efficient evaporation of the oral tissues. During a crown and bridge operation, these characteristics help in gum tissue retraction and coagulation in order to prepare an impression. When cutting fibrous tissue at high energies, a continuous wave and argon laser with a 1.0W power adjustment works incredibly well. With an argon laser calibrated to 1 to 2.25 W continuous wave delivery, these treatments effectively remove tissue in a bloodless field. Crown lengthening with osteotomy can also be done using an argon laser using 300 m fibers at 1.25 watts of power, 0.25 s pulse duration, and 10 s pulse interval to measure biological width. A CO laser typically has a power setting of 3 to 6 watts of indicated power, with the beam shifting between focus and out of focus as necessary. The following are the parameters of the 1064nm Nd: YAG laser: 150mJ of power, pulse, 3W of average power, and 45s of exposure time [38-40].

Laser energies used in Orthodontics

A power level between 1 and 1.2 watts can be used to achieve maximum actions. In regions of dense tissue, the power settings of a diode laser can be raised to 2 Watt. The lowest energy setting that can efficiently remove tissue is advised. By doing this, nearby tissues are protected from lateral thermal harm. Most diode laser procedures involve soft tissue excision at 1.0–1.5 Watt. Depending on the tissue's thickness, most periodontal operations may require 1.5 to 2.5 watts for a soft tissue excision. Using a solid-state laser (Nd: YAG, Er: YAG, or ErCr: YSGG) for coagulation requires a different setting, usually less than 1.0 watts instead. It should be mentioned that at about 4.0 to 5.0 watts, the solid-state laser will start to ablate solid tissue. Low level laser therapy uses laser energies ranging from (2-54) J to stimulate and accelerate tooth movement [41 -45]. Emphasis was also placed on applied science tests in research. These specifications are then summarized in Table (1) [46 -50].

Laser type	Wave length(nm)	Power(Watt)	Energy density (J/cm^2)	Laser time (sec)
He-Ne	630-700	0.1-0.5	2	2-5
Diode	780-980	0.1 - 5	90-199	2-8
Nd-YAG	1064	1.5-1.6	20-150	0.07-0.1
Er-YAG	2940	1.5-1.7	35-40	0.07
ErCr-YSGG	2780	0.1-0.5	2-8	0.08-0.1
CO_2	10600	0.5- 2	2-550	0.07

Conclusion

When using lasers in dental treatment, it is necessary to carefully study the selection of all parameters to accurately evaluate energy and energy density.One of the most promising areas of modern minimally invasive dentistry is dental laser. Thus, the use of laser technology during dental procedures is exciting for both the dental patient and the practitioner. They must modify behavior management techniques to accommodate new laser technologies and select the best one for each dental procedure. Despite the numerous benefits of dental lasers, dental practitioners should be aware of the harmful effects of the laser during therapeutic procedures in order to minimize the potential risks to patients, and the laser practitioner should be aware of the factors before beginning treatment if possible, so that they can choose the best treatment option. A suitable wavelength, beam diameter, focused or non-focal distance, energy pulse, and tissue cooling are all required. The proper combination of all of these parameters should result in an effective and beneficial outcome. Some procedures must be performed differently with laser energy than with conventional devices, but laser usage pointers continue to expand and improve patient care.

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