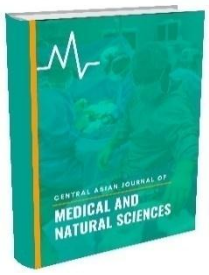
CENTRAL ASIAN JOURNAL OF MEDICAL AND NATURAL SCIENCES



Volume: 03 Issue: 03 | May- Jun 2022 ISSN: 2660-4159

http://cajmns.centralasianstudies.org

Lasers in Therapeutic and Orthopedic Dentistry

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Received 22nd Apr 2022,
Accepted 23rd May 2022,
Online 30th Jun 2022

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Abstract: Laser technologies are widely used in medicine. Depending on the principle of operation, dental lasers are: Nd: YAG with frequency doubling, pulsed, helium-neon, ruby, alexandrite, diode, neodymium, goldmine, erbium, carbon dioxide. Laser technologies are widely used in implantology, periodontology and orthopedic dentistry, which has a positive effect on improving the quality of treatment.

Keywords: Dentistry, laser radiation, dental lasers.

A laser is a device in which energy, such as thermal, chemical, electrical, is converted into electromagnetic field energy - a laser beam.

Lasers were created in 1955 by the Russian physicists A.M. Prokhorov and N.G. Basov and, independently of them, the American physicist Ch. Towns, for which they were awarded the Nobel Prize (1964).

The use of the latest generation of lasers opens up new opportunities, allowing the dentist to offer the patient a wide range of minimally invasive and virtually painless surgical interventions that meet the highest clinical standards of dental care.

Several types of lasers are used in dental practice: Argon laser (wavelength 488 nm and 514 nm), Diode laser (semiconductor, wavelength 792-1030 nm), Nd:YAG laser (neodymium, wavelength 1064 nm), He-Ne laser (helium-neon, wavelength 610-630 nm), CO2 laser (carbon dioxide, wavelength 10600 nm), Erbium laser (wavelength 2940 and 2780 nm).

Modern restorative dentistry provides the doctor with a full range of filling materials, and also allows you to create a completely different approach to the treatment of caries: using the most conservative methods, with minimal removal of infected and maximum preservation of healthy tissue.

Using rotating tools, such results are quite difficult to achieve, which is why there is an increased interest in other methods of preparing hard tooth tissues. The use of laser technologies allows you to achieve stunning results in aesthetic dentistry.

Of all the types of lasers that have been historically used to treat hard tooth tissue, the most researched and effective is the ErCr-YAG and Eg, Sg: YSGG laser. The mechanism of its operation is based on the fact that the wavelength of 2,780 and 2,940 nm is well absorbed by water. By absorbing laser energy, we can obtain instantaneous evaporation of water with a significant increase in its volume, resulting in the destruction of the crystal structure of the hard tissues of the tooth.

Erbium-based laser systems (Eg: YAG and Eg, Sg: YSGG) have become standardized tools for the treatment of hard dental tissues (Fig. 1). Their use has provided a reduction in thermal and mechanical stress and made it possible for precise preparation with high selectivity of caries removal. With the help of direct adhesion of composites to tooth tissues, it became possible to work even with very complex cavities and recesses. The second condition that allows for minimal preparation is the availability of tools that ensure selective removal of the affected tissue.

In the last few decades, there has been a constant improvement of dental equipment. The rotation speed of the turbine tips reaches 200,000 revolutions per minute or more, which makes it possible to perform the necessary manipulations faster and less painful than 20 years ago. However, the pain caused by pressure, vibration and temperature will never disappear, so the use of anesthetics during these manipulations is indicated. Despite the significant advantages of modern rotating tools, certain problems arise when using them: it is impossible to carry out minimally invasive removal or treatment of only the carious area with such tools; during operation, a lubricated layer with a thickness of 1-5 nm is formed, and it must be removed before applying adhesive technology.

A serious problem is the thermal effect, which increases during the drilling process. The temperature is mainly related to the speed of rotation, the applied pressure and the sharpness of the boron. The research results show that even with effective cooling, the temperature in the pulp increases by 15 ° C. A sharp temperature jump can cause pulpitis or pulp necrosis.

For several decades, the theory of "extension for prevention" formulated by Black has been used in dentistry. In recent years, the most important has been the application of the principle of minimal invasive intervention (micro-preparation), in which the preservation of healthy hard tooth tissue has become the most important factor. Today's requirement is selective removal of carious lesions, combined with very little, minimal possible tissue loss. With the advent of a number of adhesive systems and sealing materials, the first steps have been taken to implement this principle.

Laser systems based on erbium are widely used for the preparation of hard dental tissues. Due to their specific excision mechanism, the formation of microretence in the walls of the prepared cavity is ensured, which enhances the adhesion of the composite material to the cavity. This allows the use of adhesive materials without traumatic technologies and eliminates any side effects: excessive acid etching, the threat of damage, toxicity to the pulp, as well as pain caused by acid residues in the dentine tubules.

The laser is perceived positively by patients mainly due to non-contact processing and the absence of drilling sound compared to traditional instruments. In addition, due to the absence of pain from pressure and elevated temperature, anesthesia is very often not required. This is especially beneficial in the treatment of children, when it is necessary to use the gentlest techniques.

The radiation of the erbium laser is well absorbed by water. Due to the fact that enamel and dentin contain water, the penetration depth of the laser beam is quite insignificant. The property of high absorption of laser radiation by water is used to contain the temperature rise in the surrounding tissues during excision. Using an adequate amount of irrigation, thermal damage to the pulp can be avoided.

Water under the influence of a laser reaches the boiling point and causes a micro-explosion in the tissues of the tooth. This destroys the surrounding tissue into very small pieces and simultaneously throws them away. Since the explosion occurs in water, this method is called water-induced excision.

Laser treatment of enamel provides a more effective microretence than acid etching, since liquid adhesive penetrates into the micro-depressions formed during laser treatment, mechanically binding to the enamel. The chemical adhesion of the adhesive to the composite prevents the formation of an edge gap. The retention surface occurs as a result of evaporation of free inter-exchange water.

Laser conditioning is performed with a tip with a sapphire nozzle with an energy beam of 150 MJ and a pulse repetition rate of 12 Hz. The enamel surface to be treated is scanned, on which it is necessary to create a retention surface. To avoid excessive overheating of the tooth surface, it is necessary to use short-duration pulses, since the radiation of the erbium laser is very well absorbed not only by water, but also by hydroxyapatite. High-quality edge fit of composite fillings in all clinical cases in which etching of enamel is shown, it is provided by laser conditioning and does not require traditional etching technique.

With the laser method of enamel conditioning, the inorganic substance is not destroyed; there is no weakening of the tooth enamel, but, on the contrary, its compaction. Micromechanical adhesion in terms of tensile strength under laser action is comparable to adhesion by the acid etching method.

The laser can be successfully used for antibacterial treatment of the prepared dentin of the carious cavity, since organic matter evaporates during laser treatment. The effect of sterilization is achieved not only as a result of the action of the temperature factor, but also due to the wavelength of the erbium laser, tropic to the bacterial cell. Changes caused by laser irradiation can occur at a depth of up to 50 microns.

The effect of laser radiation on the dentin surface is at the macroscopic level, and it can be observed using a magnifying glass with a two- or three-fold magnification. Individual laser pulses should create during processing a dense network of zones of dentin that pass into each other, changed under the influence of laser radiation. In order to achieve a decrease in bacterial flora in the area of residual caries, it is quite enough to carry out laser treatment only of this section of dentin. If it is necessary that the effect of laser radiation on the dentin leads to the formation of a retention structure, sealing of the dentine tubules and desensitization, the entire exposed surface of the dentin is treated with a laser. After laser treatment, the dentin hardness is checked with a solid probe.

Before laser exposure, the treated tooth should be cleaned with an ultrasonic scanner or polishing tool from the decay products of tissues, since their presence can reduce the absorption of laser radiation. Then you should follow all the safety rules when working with the laser (safety glasses, checking the laser parameters)

After passing the enamel, the laser power should be reduced, since at the same time the thermal effect on the pulp decreases. It is possible to remove carious dentin at a lower power due to the higher water content in the affected dentin than in the enamel. If in the process of caries removal the cavity turns out to be too close to the pulp, accordingly, the energy power of the laser should also be reduced. During the preparation next to the pulp, the work should be intermittent, and the frequency should be reduced. The completeness of caries removal is checked using a probe or a caries indicator.

Thus, laser technologies in the treatment of diseases of the hard tissues of the tooth are increasingly being used due to a number of advantages over traditional methods of treatment with the use of rotating instruments. The laser beam allows processing non-contact, painlessly, minimally invasive, in sterile conditions, without the formation of a lubricating layer, creating a micro region surface that does not require etching. At the same time, the probability of secondary caries is minimized. It should be remembered that optimal treatment results are possible only with appropriate professional training and strict adherence to the laser treatment algorithm.

The scope of laser application in therapeutic dentistry is very diverse. In the prevention of caries — sealing of fissures. Since, most often, this procedure is performed for children, then, undoubtedly, the speed of manipulation (on average 5 seconds per tooth) and the lack of preliminary preparation of fissures.

Desensitization of hyperesthesia of the necks of teeth resulting from gum recession in periodontal diseases. Painful sensations pass once and for all, as the hard tissues of the tooth are "melted", thus sealing the nerve endings.

Direct overlap of the pulp is used when the horn of a healthy pulp is accidentally opened, which avoids unnecessary endodontic treatment and preserves the vitality of the tooth by producing tertiary dentin.

Restructuring of dentin in deep caries in patients whose diagnostic Rg images, cariously altered dentin presumably reaches the pulp, but clinically the pulp is intact.

In endodontic treatment, lasers are used for pulp ectomy - instant evaporation of the pulp without fear of breaking small instruments in the tooth canal, sealing the dentine tubules and the walls of the tooth canal, sterilization of the canal without the use of expensive bactericidal drugs.

In orthodontics, a laser is used to release retinated teeth, followed by the simultaneous installation of a bracket system.

Debond — removal of braces without negative consequences for the enamel.

Operculectomy is the elimination of gingival pockets with teething defects that occur, as a rule, in the lower molars and become inflamed when pericoronitis occurs.

Laser radiation can play an important role in the treatment of herpetic and aphthous stomatitis — very common diseases, the peculiarity of which is the appearance at the most inopportune moment. The laser carbonizes pathological elements and relapses never occur at this place.

The laser is used in various conditions; including diseases caused by a poor environmental situation and under the influence of external factors, such as, for example, radiation, traumatic and temperature damage. Excision of fibroids and epulis for surgeons is rather thankless operations, since very often relapses occur after operations. During laser treatment, all tumor cells die.

Currently, the advantages of using lasers in dentistry have been proven by practice and are indisputable: safety, accuracy and speed, absence of undesirable effects, limited use of anesthetics - all this allows for gentle and painless treatment, acceleration of treatment periods, and, consequently, creates more comfortable conditions for both the doctor and the patient. However, the use of lasers in dental practice, in a polyclinic, is difficult to achieve due to the high cost of laser equipment and the need to train specialists.

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