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The Biological Effect of Laser on Dental Hard Tissues Review

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Abstract

Laser absorption in biological tissue is mostly owing to the existence of free water molecule, protein, pigment and other macromolecule. Absorbed laser can have three different consequences: photothermal, photomechanical and photochemical. The effect of laser on enamel at a low energy density may become more resistant to acid dissolution. While laser was used on dentine to limited thermal effect and reduce dentine sensitivity with energy irradiation. However, the laser irradiation result in more extensive pulp damage and reparative dentinogenesis was delayed . Root specimens have exhibited higher rates of inhibition of caries like lesion progression and resistance to acid dissolution than those seen in enamel specimens, after combined laser fluoride treatment.

Key words: laser absorption, hard tissues, acid dissolution

Introduction

Light Amplification by Stimulated Emission of Radiation (laser) is an acronym for Light Amplification by Stimulated Emission of Radiation (1,2). Lasers were brought into the realm of clinical dentistry with the hopes of alleviating some of the difficulties associated with traditional dental procedures (3).

The absorbed laser energy can cause one of three outcomes: photothermal, photomechanical and photochemical effects (4) .

History of lasers

When scientist Albert Einstein described the theory of relativity in 1917, it became known as the laser principle stimulating the emission of radiation(5). Several engineers were working on harnessing energy using the principle of stimulated emission around the beginning of the 1950s (6). Patel in 1964 developed first continuous wave carbon dioxide laser. This type of laser was found to be completely absorbed by most histological tissues and was found useful in ablating volumes of tissues their thermal effect(7).

Properties of laser

Laser light has certain distinct features that aren't found in other types of light. These are (4,8): directionally, monochromaticity, coherence , radiance , intensity and short pulse duration capability.

Types of laser:

Laser system can be classified using many different criteria (9): gas laser (10), solid state laser (11) and liquid laser (12).

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Laser tissue interactions:

Light propagation in biological tissues. When laser energy interacts with a target material or tissue, four basic interactions can occur: absorption, scattering, transmission, or reflection (13).

Absorption occurs primarily in biological tissue due to the presence of free water molecules, protein, pigments, and other macromolecules (14).

Optical Processing of Tissue

The use of lasers for diagnostic purposes is based on scattered or reemitted light. Light absorption is required for surgical and therapeutic purposes. The absorbed laser energy can cause one of three outcomes:

Photothermal effect, photomechanical effect and photochemical effect (4).

Photothermal effect: This effect is a rise in tissue temperature that occurs when laser energy is absorbed, and it is determined by two factors: the tissue volume in which the energy is deposited and the time in which the energy is deposited via the thermal relaxation time and this is used for surgical application(15).

Photomechanical effect: Localized absorption of high-intensity laser radiation can result in extremely huge temperature gradients, causing massive pressure waves and localized photomechanical disruption. This effect is used for breaking stones in the kidney or urethra(4).

Photochemical effects: For laser irradiation at a power level where no appreciable increase in temperature occurs, temperature of tissue the Photo thermal and photomechanical effects are not possible. In such a situation, only Photochemical effects can take place and these effects cause electronic excitation of biomolecules which can be either endogenous or externally injected (16,17).

Biological effect of laser on dental hard tissue:

-The effect of laser on hard tissue:

A-Dental enamel : It has been demonstrated that enamel lazing can improve dissolve resistance and reduce the rate of subsurface demineralization (18,19).

B-Dentine : dentine becomes more enamel- like, more resistant to demineralization (20).The effect of laser irradiation on carious dentine causes an increase in temperature due to absorption of energy by high water content in lesion, volatilization of lesion occur (21,22,23).

The low energy laser irradiation has been used to reduce or limit dentine sensitivity (24). One of mechanism of dentine sensitivity is the surface sealing of dentinal tubules (22).

Pulp: histological studies using ruby laser and Nd : YAG laser revealed that pulpal damage occurred characterized by hemorrhage, coagulation, necrosis and loss of orientation of odontoblast edema and inflammation cell infiltration(25,26).clinically when using of Nd : YAG laser irradiation result in more extensive pulp damage and reparative dentinogensis was delayed(26). The application of excessive energy densities and has been shown to result in significant damage to pulp tissue and in particular to odontoblast(17).

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The use of acidulated phosphate fluoride in combination with CO_2 laser produced significantly higher rates of inhibition of caries- like lesion progression and better resistance to acid dissolution, than those seen when sodium fluoride was used in combination with CO_2 laser(27). When use of Argon laser with fluoride application could significantly increase in resistance of root surface to caries like lesion application. The chemical analysis done in AL-Sayyab study have demonstrated that laser irradiation of specimens lead to increase in the permeability and to reduce solubility of tissues ,also, the analysis of the carbonate content of the dematerializing solution taken from root specimens, has demonstrated reduce concentration of carbonate when compared with non-lased root specimens (7,27,28,29,30). Nd-YAG laser causes vaporization of granulation and necrotic tissues as well as reduction and delay recolonization of sub gingival bacterial flora .

Application of erbium lasers are used to treat periodontal disease, and this type of laser can be used as an alternative to root surface debridement since it can ablate calculus without causing significant heat damage to the surrounding tissue (31,32).

Laser applications in dentistry :

A range of lasers is now available for use in dentistry. The laser of choice for specific indications in laser dentistry as following (33, 34):

1.They may be used to discover cavities in the teeth early.
2.Tooth can be safely viewed by using Optical Coherence Tomography.
3 .The reshape the bone and crown lengthening .
4 .They avoid the use of local anesthetic and the use of a typical turbine drill.
5 .They are used in the bleaching process
6 .The use of laser dentistry to treat the tempromandibular joint can help to reduce inflammation and pain.
7 .Dental lasers reduce sensitivity by sealing the tubules found on the tooth's root

Advantages and Limitation of Laser in dentistry:

Laser is one of newest development dental field . This method of treatment reduces pain and healing time. Due to the coagulation of exposed blood vessels caused by a high-energy laser beam, bleeding during dental procedures is reduced and blood loss is successfully controlled. It sterilizes the area to be treated also during the laser procedure, the surrounding tissue is less damaged. The tissues renew, and wounds heal more quickly (34) .

On the other hand dental laser lasers cannot be used to fill cavities between teeth, around existing fillings, or large cavities prepared for a crown. Lasers also cannot be used to remove silver fillings, defective fillings, or defective crowns, or to prepare teeth for bridges (35).

Conclusion

Absorbed laser can have three different consequences: photothermal, photomechanical and photochemical. The effect of laser on enamel at a low energy density may become more resistant to acid dissolution. While laser was used on dentine to limited thermal effect and reduce dentine sensitivity with energy irradiation. However the laser irradiation result in more extensive pulp damage and reparative dentinogenesis was delayed.

Conflict of Interests.

There are non-conflicts of interest .

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التأثير البيولوجي لليزر على الأنسجة الصلبة للأسنان "عرض للمؤلفات"

الخلاصه:

أن امتصاص الأنسجة البيولوجية (لليزر) يرجع بشكل أساسي الى وجود جزيء الماء الحر، البروتين، الصبغة وجزيء كبير خريمكن ان يؤدي الليزر الممتص بشكل عام الى ثلاث تأثيرات منها الضوئية الحرارية والضوئية الميكانيكية والضوئية الكيميائية. أن تأثير الليزر على المينه عند كثافه الطاقة المنخفضة تصبح اكثر مقاومه للانحلال الحمضي بينما استخدم الليزر على طبقة العاج لكي يقلل تأثير الحراري ويقلل حساسية العاج مع تشعيع الطاقة . مع ذالك يؤدي تشعيع الليزر الى تلف شديد باللب وتعويضه تأخر تكوين الاسنان. أظهرت العينات الجذرية ارتفاع معدلات تثبيط تسوس الاسنان مثل تطور الافه ومقاومة انحلال الحمض الموجودة في عينات المينا، بعد الجمع بين العلاج بالفلورايد والليزر.

الكلمات المفتاحية: امتصاص الليزر، الانسجة الصلبة، الانحلال الحمضي