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Role of Lasers in Composite Restorations

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Abstract

The term LASER is an acronym for 'Light Amplification by the Stimulated Emission of Radiation'. The first laser was introduced in the 1960's by Miaman. Laser is used to treat a number of various dental conditions like composite restorations etc.. It is most commonly used in restorations for treating hypersensitivity, tooth decay, gum diseases and whitening teeth. Various kinds of lasers such as ND:YAG, Er:YAG, Er:Cr:YSGG are used in various dental procedures. Laser seems to be made for effective removal of dentine and enamel with only minor side effects such as thermal damage. The capability of Er:YAG lasers for the removal of hard tissues in dentistry was exhibited as of now in 1989, Er:YAG (erbium-doped yttrium aluminum garnet) lasers have been progressively utilized in dental practices and are turning out to be increasingly more an agreeable technique for caries evacuation for patients, as conventional cavity drilling may cause noise and pain. Laser received FDA approval for caries removal and cavity preparations. The use of laser therapy also seems to be promising from many recent researchers. Laser therapy induces surface roughness or even improves bond strength or decreases marginal leakage. There seems to be a general consensus on the fact that Er:YAG is one of the best suited types of lasers because it's efficiency in dentine is very good without any damage of pulp. Er:YAG lasers are a lot utilized in small scale blasts that may bring visible irregularities. In addition, pain reduction in comparison to bur assisted preparation of cavities has been clearly demonstrated.

***Keywords**: Lasers, composite restorations, Er:YAG lasers, compositional changes, Dentistry.*

Introduction

The term LASER is an acronym for 'Light Amplification by the Stimulated Emission of Radiation'. The first laser was introduced in the 1960's[1,2] by Theodore Miaman. Maiman, at the Hughes Research Laboratories in Malibu, CA, built the first functioning laser by using a mixture of helium and neon. In 1961, a laser generated from crystals of yttrium-aluminum-garnet treated with 1-3% neodymium (Nd:YAG) was developed. It is used for nonsurgical sulcular debridement in periodontal disease control and the Laser Assisted New Attachment Procedure (LANAP). In 1962, the argon laser was developed, whereas, the ruby laser became the first medical laser to coagulate retinal lesions, when it was used in 1963. In 1964, Patel at Bell Laboratories developed the CO_2 laser. It has a very high affinity for water, resulting in rapid soft tissue removal and hemostasis with a very shallow depth of penetration. Lasers have been used in dentistry since 1994 to treat a number of dental problems. Yet, despite FDA approval, no laser system has received the American Dental Association's (ADA) Seal of Acceptance as an alternative to more traditional treatment. The use of lasers in dentistry has increased over the past few years. Because of their many advantages, lasers are indicated for a wide variety of procedures [3,4]. It is most commonly used in restorations for treating hypersensitivity

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and tooth decay. Nowadays, diode lasers are being extensively used in the field of dentistry. Diode lasers are used in some kind of procedures like aesthetic gingival recontouring, soft tissue crown lengthening, exposure of soft tissue impacted teeth, removal of inflamed and hypertrophic tissue, frenectomies, and photostimulation of the aphthous and herpetic lesions. Lasers seem to have been made for effective removal of dentine and enamel with only minor side effects such as thermal damage. The potential of Er:YAG (erbium-doped yttrium aluminum garnet) lasers for ablation of hard tissues in dentistry was demonstrated already, Er:YAG lasers have been increasingly used in dental practices and are becoming more and more a comfortable method for caries removal for patients, as conventional cavity drilling may cause noise and pain. The repair and the extension of composite restorations is an everyday task for dentists. However, the existing composite restoration may have been in the oral environment for a long, and often unknown, period of time, and in many cases the dental clinician is unaware of which product has been used to create the restorations [5,6,7]. During repair of a composite restoration, the prepared cavity usually exposes enamel and dentine [8,9,10]. For that reason, the usage of lasers is required to obtain adequate bond strength to the tooth structure. Many studies have been carried out to investigate the usage of lasers bonding between composites/ enamel and composite /dentine and it gives acceptable tensile strength and shear bond strength (SBS) between the composite and the tooth [11,12]. Thus the main aim of this study is to know about the role of lasers and various laser types in composite restoration procedures.

LASERS IN COMPOSITE RESTORATIONS:

At present days, there are numerous lasers which can be used efficiently in restorative dentistry for various procedures as the results yielded by employing lasers are promising. Various kinds of lasers can be employed in composite resin restorations such as Er:YAG, Nd:YAG (neodymium-doped yttrium aluminum garnet) , Diode lasers, CO_2 lasers, Er:Cr:YSGG (erbium/chromium-doped yttrium scandium gallium garnet)[13,14] etc..

Er:YAG Lasers:

Er: YAG lasers are a lot utilized in small scale blasts that may bring about tiny and plainly visible irregularities. Safe utilization of lasers likewise [15,16] be the fundamental objective of proposed or future laser treatment. Laser beam cutting with Er:YAG lasers are suitable for short pulse duration and have low mean beam power, high laser beam intensity. Er:YAG lasers have a tissue applicability used on hard and soft tissues[17]. Hard tissue lasers which were developed during the 1990s have the capability to prepare enamel for restoration and reduces, eliminates the audibility of drills and reduces the micro fractures [18,19]. Low power Er:YAG lasers which have 100 milliwatts could operate the middle opened infrared region with the cape of hard and soft tissues [20–22].

Nd:YAG Laser:

These lasers have a wide range of utilizations in the procedures such as laser spectroscopy and composite restorations. Nd:YAG laser is a four-level laser framework, which implies that the four vitality levels are associated with lasers of composite resin restoration activity. These lasers work in both beat and ceaseless mode. Nd:YAG laser produces laser light usually in the close infrared locale of the range at 1064 nanometers (nm). It likewise emanates laser light at a few unique frequencies including 1440 nm, 1320 nm, 1120 nm, and 940 nm. Nd:YAG laser fluorescence which helps in the detection of dental decay could demonstrate the presence of lesions and calculus [23,24].

Diode Lasers:

The dynamic mode of the diode laser is a strong state semiconductor made of aluminum, gallium, arsenide, and infrequently indium, which produces laser frequencies, running from roughly 810 nm to 980 nm. All diode frequencies are ingested fundamentally by tissue shade (melanin) and hemoglobin. They are inadequately consumed by the hydroxyapatite and water present in the finish. Explicit strategies incorporate tasteful gingival reshaping, delicate tissue crown, frenectomies, and photostimulation of the aphthous and herpetic sores.

Argon Lasers:

Argon lasers are a unique laser used specifically in composite restorations. It was invented by William Bridges at the Hughes Aircraft Labs in 1964. The argon laser doesn't employ the use of filters. Rather, it produces one frequency of blue light (i.e., the light is monochromatic) having a band width of just 40 to 45 nm. Furthermore, the brilliance of the light can be set to the producer's details for ideal effectiveness, one of a kind for each brand of composite pitch. Thoroughness and the depth in composite restorations are increased using the argon lasers. Argon lasers in composites are used to improve shear bond strength in both enamel and dentine.

MORPHOLOGICAL CHANGES ON TOOTH UPON LASERS:

Er:YAG laser irradiation may cause morphological changes in the enamel causing the formation of rough surfaces, cracks, prone to bacterial accumulation[25]. Laser action with temperature rise causing morphological alterations that are directly related to frequency increment, causing demineralization of sound dentine[26]. Er:YAG lasers have potential treatment of dental decay cause alteration to the conventional drill may reduce mechanical damage and can remove the hard dental tissues. Thus, Er:YAG lasers cause extensive cracking lines in dentine surfaces with a smear layer with sound dentine[27]. It reduces the mechanical damage and removes the hard tissue. Cavity walls and borders disclose typical morphological aspects after ablation Er:YAG laser treatment. The smear layer is efficiently removed. Neither knoop hardness nor Ca/P ratio evaluation on the cavity floor revealed any significant difference between laser and bur treatment. If any, only minimal thermally induced changes of dental hard tissue composition is produced by Er:YAG and only minimal local thermal damage follows Er:YAG irradiations. The surface morphology and the chemistry of dentine may influence the bond strength to dental restoration materials. Enamel acid etching after laser treatment increases the etching depth if evaluated with the help of X-ray tomography.

COMPOSITIONAL CHANGES:

The degree of compositional changes helps in the retention of tissues to diminish or expand its dissolvability lighted to finish or dentine (CO_2, Nd:YAG lasers). Laser illumination can build the CA or P structure which may result from the evaporation of organic compounds. This causes the adjustment in warm reactions Er:Cr:YSGG laser light with CA:P proportion stays unaltered [28,29]. Corrosive carving causes substance changes and expands the dentine penetrability, dentin, wetness and furthermore builds the potential for mash crabbiness [30,31]. Laser application may cause comparative corrosive carving that causes the high unpleasantness without any dental damage in deep underlying tissues.

BOND STRENGTH:

Mean modified shear bond strength for light and laser groups ranges from 10.80 MPa to 13.31 MPa which are recommended for orthodontic treatment and also for both curing modalities[32]. Laser irradiation causes surface modification by increasing its bond strength in resin cements. Er:YAG laser irradiation causes adhesion of resin to dentine that improves bond strength of acid etching and increases tensile strength highly for acid etched human dentine[33]. Thus, irradiation by the Er:YAG laser at 450 mJ has bond strength ($p<0.05$) level. Many authors found similar tensile bonds to acid etching samples. If Er:YAG treatment was combined with acid etching, higher bond strength was found than with laser treatment alone. If the tensile bond strength on dentine was not adversely affected by different water flow cooling rates, it was of importance to optimise the water flow on enamel to prevent the formation of non appetite CaP phases on the enamel surface, which may compromise adhesion. For composites repair, Er:YAG lasers as the conditioning method showed a significant improvement in tensile bond strength in comparison to classical methods such as air abrasion, salinization, hydrofluoric acid and their combination, reaching mean values of 22.92MPa [34].

ENERGY SOURCES:

Energy sources for the lasers for etching the tooth surfaces derived from blue coloured halogen curing lamps. Infrared CO_2 lasers, blue coloured plasma arc lamps, cool blue argon lasers used and 980nm GAA1As (Gallium-Aluminum-Arsenide) lasers are used which are capable with different energy sources [35,36]. Enamel and dentine surfaces can be etched utilizing Er:YAG lasers with 2.94 miniaturized scale frequency for 250 small scale beat terms which can be achieved with 300 mJ for enamel and 250 mJ for root surfaces[37,38]. Camphoroquinione initiation with blue light of frequency running of 400 to 500 na have an expansive pinnacle of 480 nm. Argon lasers improve the tear bond quality for the lacquer and dentine [39,40,41].

ADVANTAGES:

Dental lasers which emit energy convey end cutting by methods altered for specialists' clinical technique. Erbium lasers can expel unhealthy tooth structure,carious sores with higher water content cause solid tissues may cause an end of microfracture. It brings down pulpal temperature and causes quicker recovery.

CONTRAINDICATIONS:

Lasers can't be used for teeth already filled and also for performing dental procedures involving removal of old fillings. In tooth preparations, the Erbium family of lasers are unable to remove gold and vitreous porcelain and have no interaction with the restorative material and also in most composite restoration.

Conclusion

There seems to be a general consensus on the fact that Er:YAG is one of the best suited laser types for cavity preparation because it's efficiency, especially in dentine, is very good without any danger of pulpal damage if working under sufficient water cooling. In addition, pain reduction in comparison to bur assisted preparation has clearly been demonstrated making it possible to work without local anaesthesia in most instances. Er:YAG is also efficient in removing composite restoration, however, little is known on its ability to ablate dental ceramics, GIC and gold. Ablation of amalgam should be avoided because it is not efficient and because it leads to mercury evaporation. Thus, the role of lasers in composite restorations adds to major use in dental procedures.

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