Original Article

The influence of CO2 LASER irradiation and Calcium Oxalate on the occlusion of dentinal tubules: in vitro SEM study

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ABSTRACT

Introduction & Objective: Increased clinical dentin hypersensitivity is seen among 30-40 year olds. This complication is directly related to the size of the dentinal tubules. Therefore, considering the importance of dental sensitivity control and finding newer and more mundane ways to control it, the purpose of this study was to investigate the effect of bioglass 45 s5 and calcium oxalate(gluma) for covering the dentinal tubules in dental sensitivity was done. **Methods:** In this experimental and laboratory study that was conducted in 1398, After obtaining permission from the Ethics Committee of the Army Medical University The study was conducted at the Army Dentistry School. For this study, 45 premolar and healthy molars were collected in the surgery department of the Army Dentistry School. The teeth lacked any restorations, caries or cracks. Samples were randomly assigned to three equal groups using the random numbers table. A group treated with bioglass, a group treated with gluma (calcium oxalate) and a group was also a control group. After collecting data from the sample, the questionnaire, the information was encrypted and entered into the computer. Then, using SPSS software, one-way analysis of variance was used to analyze the data. Normality analysis of mean distribution was performed using Kolmogorov-Smirnov test. In all tests, the level of significance was considered to be 0.05. **Results:** Both gluma and bioglass materials were effective and significantly compared to the control group Dentin tubules fill up and thus can effectively reduce dental sensitivity. On the other hand, the results of this study were the result of this study Biologas has been more effective and meaningful than gluma it causes dentinal tubules to fill up. So, in SEM images, Bioglass was closed in a few samples close to all dentin tubules, Therefore, it seems to be more effective in reducing dental sensitivity. **Conclusion:** According to our results, both bivalve cells and gluma had a significant effect in dentin tubules, it is more than the control group Bioglez is a more effective anti-allergic agent than gluma.

Keywords: Bioaccumulation Glass, 45S5, Calcium Oxalate, Dentin Tubules, Dental Sensitivit

Introduction

Dental hypersensitivity (DH) is one of the problems that often cause discomfort and complaints in patients. Following thermal, tactile and evaporative stimuli occur in dentin exposed to cervical tooth. DH has long been troublesome symptoms that affecting many patients with higher prevalence in 20-30 years old and lower prevalence in 30-40 years old [1, 2]. DH occurs more frequently in the cervical area of the teeth because the enamel in these areas is very thin and has little resistance to mechanical loading. Many factors, such as abrasion, erosion, attrition, and scaling and root planning (SRP) which causes gingival recession, play an important role in causing DH due to exposure of dentinal tubules to the oral cavity. Also, there are some other factors, including age, sex, occlusion incompatibility, oral PH, local bacterial plaque, and the oral hygiene can also affect DH [3]. The major symptom of DH is characterized by sharp and brief pain that occurs in response to thermal and tactile or osmotic and chemical evaporative stimulations [1, 4].

Occluding of exposed dentinal tubules is generally considered the most effective strategy to treat hypersensitivity [5, 6]. Various treatments have been developed, including types of tubular sealants (such as Ammonium Hexafluorosilicate, Arginine 8%

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with Calcium Phosphate, etc.) and materials such as Calcium Oxalate, Strontium Chloride, Potassium Nitrate and Fluoride varnishes in desensitizing toothpastes [7-15].

Despite the remarkable success of these substances in reducing sensitivity, most of them have a temporary and unpredictable effect. In addition, it sometimes takes several weeks to take effect. Therefore, it is necessary to use new treatment methods that are effective for longer periods and at the same time do not have the mentioned side effects [16, 17].

Recently the clinical use of LASERs has increased and now LASERs are employed frequently for hypersensitivity treatment in all the world. Energy from long wavelength, non-penetration type CO2 LASER and Er: YAG LASER is absorbed by water and used as a surgical application in dentin hypersensitivity and root canal therapy. It has been reported that CO2 LASER irradiation is useful for treatment of cervical DH [2]. Many different studies have compared the occluding effects of LASER with conventional methods such as fluoride therapy. Studies that compare the advantages of using LASER as a desensitizing treatment with non-LASER methods. These include greater patient satisfaction, early response and greater durability, and predicting the effects of LASER desensitization, as well as ease of use. Recently, the use of various LASERs, including CO2, has been proposed as a potential alternative to DH treatment [18, 19].

Due to limited studies comparing the effectiveness desensitizing of LASER therapy with substances such as Calcium Oxalate, the aim of this study was to compare the microscopic effect of CO2 LASER with Calcium Oxalate in reducing the diameter of dentinal tubules.

Materials and Methods

In this randomized, controlled, single-blind in vitro trial study, 20 extracted human third molars were collected. The specimens which were detected caries on crown or root, restoration or fillings, tooth cracks or fractures, pulp or periapical diseases before extraction or a necrotic pulp, dentin sclerosis, and past history of hypersensitivity or exposure of dentin, particularly in cervical sites, were excluded.

Any remaining soft tissue was removed by dental scaler (sonic flex 2000, KaVo, Germany). then all of the specimens brushed until all debris were completely removed.

Then each tooth was divided vertically (buccolingually) into two equal parts by a diamond disk (Diatec, Germany) and 40 specimens were obtained. The tooth enamel was removed up to Dentin-Enamel Junction (DEJ), respectively, using a high-speed plain cut tungsten carbide bur with water coolant.

All specimens left in the normal saline buffer for 24 hours. Then, all cavity was etched with Phosphoric acid 37% for 20 seconds and then acid rinsed with 40 seconds water spray. The specimens were divided into two groups:

Group 1: LASER treatment (n=20)

A CO2 LASER DS40U (Lancet, Russia) (wavelength: 10,600 nm, energy density: 1.27 J/ Cm2, power: 50 W, pulse duration: 50 ms, interval: 0.07 s, irradiation mode: ultra-pulse mode, spot size: 500 microns, time: 1 s, distance: 1cm (focal point);) that provided a constant beam of coherent, continuous monochromatic was used in this study.

Group 2: Calcium Oxalate treatment (n=20)

Calcium Oxalate (Sigma-Aldrich, USA) applied to each specimen according to manufacturer instruction with a micro brush. all regions of etched dentin applied 2 layers of oxalate gently and after each layer, oxalate dried with airflow of the dental unit for 20 seconds and then another layer applied.

Scanning electron microscopy examination:

After these processes, specimens were evaluated by a specialist blinded to experimental condition, under stereomicroscope (Olympus Optical Co, Japan) with a magnification of 24, with a view to any defect, crack, or any other significant surface structures that may have detected after LASER irradiation. Then, after coating specimens by a 100A8 thick gold layer in a Bal-Tec coater device (Switzerland), they were evaluated under an XL30 SEM (Philips, Netherlands) with magnification of 250, 500, 1000, and 2000 in a scanning manner. For each LASER, mean values of tubular diameters were determined twice, by a specialist blinded to experimental condition, using ''Scale-bar'' (Phillips) which was the software running on the SEM. A practitioner carried this out on control sites of all specimens. Raw data were first entered into the SPSS statistical program (Version 25) and then analyzed with a One Sample Kolmogorov-Smirnov test to confirm normal distribution. Afterwards, mean tubular diameter was calculated for each of the two groups. These values were compared statistically using an independent t–test and $P<0.05$ was considered as significant.

Result

The independent student t-test showed that the rate of reduction in dentinal tubule diameter in CO2 LASER treated group (Group 1) (Figure 1) was significantly higher than the Calcium Oxalate treated group (Group 2) (Figure 2, Figure 3).

Figure 1: SEM view of sealed dentinal tubules treated by CO2 LASER magnification 2000x

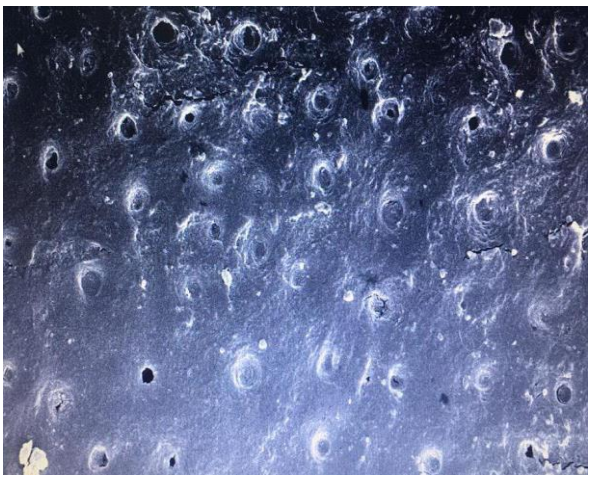

Figure 2: SEM view of dentinal tubules after treatment of Calcium Oxalate magnification 2000 x

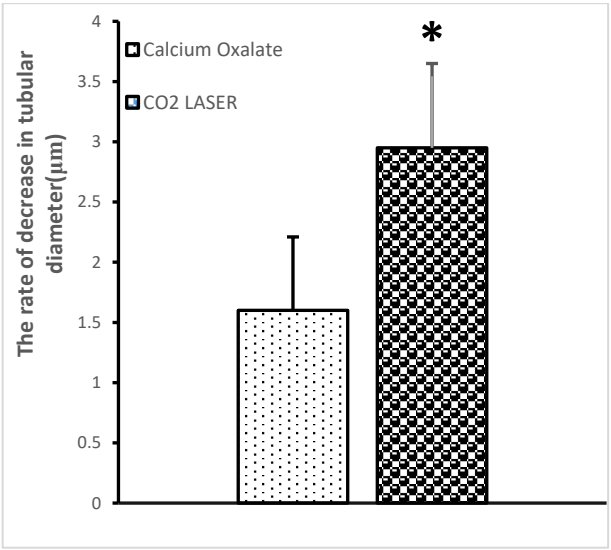

Figure 3: Comparison between group 1 and 2 in the rate of decrease in tubular diameter

Discussion

Exposed dentinal tubules have been considered as the main cause of DH and numerous treatment suggestion methods is based on occluding of exposed tubules. These methods could be classified as physical and chemical methods [1, 2, 4]. Chemical agents included strontium chloride, sodium fluoride, ferric oxalate, calcium oxalate, ferric phosphate, potassium nitrate and physical agents such as resins [20]. Because these materials don't bind to tooth walls, after daily brushing, mastication, and with oral fluids, these agents abraded and lost. Therefore, their effect is short-lived [20, 21]. CO2 LASER irradiation is capable of occluding dentinal tubules. This occluding effect is proportional to the duration of irradiation. the main advantage of the LASER is an immediate effect after a single treatment session [2, 5, 20, 21].

This infrared LASER has known by its low penetrating depth, maximum water absorption and has more maximum hydroxyapatite absorption than erbium LASERs. Therefore, it can modify enamel and dentin structure, especially when applied in high powers, non-continuous irradiation mode, and very short pulse width. In this study, we aimed to compare the microscopic effect of CO2 LASER with Calcium Oxalate in reducing the diameter of dentinal tubules.

As a result, the rate of reduction in dentinal tubule diameter in CO2 LASER treated group (Group 1) was significantly higher than the Calcium Oxalate treated group (Group 2). As you can see in Figure 1, most of the tubules melted down and we rarely can see an exposed tubule, but in the figures 2, many tubules are exposed and calcium oxalate only occluded few tubules.

Kantola in a study in 1972, used the CO2 LASER to modify craters in dentin. Micro radiographic and analysis showed that there were more fusion and recrystallization minerals in the dentin walls of the grooves. They attributed this to the burning of dentin organic components by the LASER beam energy [22]. Further parallel studies also confirmed this theory [23, 24].

Moritz and Bonin, concluded that dentin tubular occlusion and penetrability reduction can be achieved when CO2 LASER is used in moderate energy densities [25, 26].

LASER treatment should be done carefully because of thermal damage to pulp. According to the study of Zach and Cohen, 5.5 degrees temperature rise in pulp, have minimal effects [27]. Also, Namour et al., in their study demonstrated that temperature rise after water bath is 5 degrees decreased. furthermore, in in vivo conditions temperature rise is lower than in vitro.

To reduce the destructive effect of temperature damage, we used ultra-pulse radiation mode with a high-power peak (50 W) and a very short pulse duration (50 ms), which did not lead to any carbonization due to greater tissue thermal relaxation time. It should be noted that CO2 LASER desensitization due to analgesic ability is questionable [26] and requires many more controlled trials.

based on our result CO2 LASER can be recommended as an ideal tool for the clinical seal of tubules but because of expensively of the LASER device and easier application of chemical treatments such as calcium oxalate we suggested that further studies require to improve beneficial effect and sealing time of chemical agents and compare in in vivo condition.

Conclusion

Based on the results of the study, it can be concluded that the use of CO2 LASER has a stronger, faster and longer effect than chemical treatments such as Calcium Oxalate.

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