Laser Therapy Evaluation in Complications of Restorations by Total-Etch Technique

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The aim of this study was to evaluate the efficiency of laser therapy in post-operative sensitivity by Visual Analogue Scale (VAS) to the 57 patients after restoration with two different resins composite. In the first group (28 patients, 30 teeth) it was restored the cavity class I Black with micro-hybrid composite Filtek Z250 - Adper Single Bond (3M/ESPE). In the second group (29 patients, 30 teeth) it was restored the cavity class III Black with nano-hybrid composite Ceram X One Sphere Tec-Prime and Bond One (Etch & Rinse) (Dentsply). The restorative treatments were performed by the same practitioner on posterior and anterior teeth diagnosed with mid-sized chronic carious lesions. Total etch (etch and rinse) strategy of adhesion was used for both composite resins. The laser treatment was performed in 2 sessions at 48 hours and after 7 days, for both study groups using laser Whitening Lase II (DMC Dental). Mean scores for VAS indices decreased significantly at 48 hours and 7 days, following laser treatment for all the investigated parameters (materials, sex, age) ($p < 0.05$).

Keywords: low-level laser therapy, mid-sized chronic carious lesions, resin composite, total etch strategy, Visual Analogue Scale

The increasing demand for aesthetic adhesive restorations have significantly changed the restorative dental procedures, by more conservative restorative approaches and the use of the restorative adhesive materials [1]. The success of composite restorations relies on the material properties and restorative technique as well as on the knowledge and practical abilities of the dental practitioners. However the composite restorations may present marginal discoloration, microleakage, and postoperative sensitivity, which can lead to patients' discomfort and restoration failure. Also the postoperative sensitivity can cause restoration replacement and the additional loss of tooth structure [2]. The technique sensitivity, cavity size as well as the residual stress from polymerization shrinkage is strongly related to debonding and the onset of post-operative sensitivity [3]. Other factors related to the onset of the post-operative sensitivity are the individual profile of patient, the shape and extension of the cavity preparation and the quality of protection of the dentin–pulp complex in deep cavities [4, 5]. Regarding the mechanisms involved, the deficient seal of the tooth/restoration interface exposes the openings of the dentinal tubules and generates the flow of fluids towards the gap when it receives the cold thermal stimulus, leading to the stimulation of the pulp nerve fibbers, and causing the sensitivity [6].

Usually one the therapeutically strategies for post-operative sensitivity is the prescription of analgesic medication, aiming to ameliorate or eliminate the pain in the next week.

For more than 40 years, low-level laser therapy (LLLT) has been employed in medicine and dentistry because of its analgesic, biostimulative, and anti-inflammatory effects and its great benefits in accelerating the healing process. Due to these effects LLLT is also recommended for the treatment of dentin hypersensitivity and post-operative sensitivity [7].

Experimental part

Materials and methods

The study was performed on 30 teeth from 28 patients (13 males, 15 females; age 25-45) with shallow/mid-size class I micro-hybrid composite resin restorations (Filtek Z250-Adper Single Bond (3M/ESPE) and 30 teeth from 29 patients (12 males, 17 females; age 25-45) with shallow/mid-size class III nano-hybrid composite restorations Ceram X One Sphere Tec-Prime And Bond One (Etch & Rinse) (Dentsply) (table 1). The patients reported, 24 h post restorative treatment, post-operative sensitivity (sharp/dull pain of short duration that appears with hot and cold foods or liquids and it disappears when the stimulus is removed). The restorative treatments were performed by the same practitioner on posterior and anterior teeth diagnosed with mid-sized chronic carious lesions of different ethiologies [8-17]. The teeth with restorations placed in deep cavities were excluded due to the need for cavity liners for pulp protection. The manufacturer's instructions to use were respected both for the restorative materials and adhesive systems. Total etch (etch and rinse) strategy of adhesion was used for both composite resins.

The inclusion criteria of sample were as follows: age under 50; good health status; shallow and mid-sized cavities; reported sensitivity 24 h after placement of restorations; no analgesic medication.

The intensity of post-operative sensitivity was assessed using Visual Analogue Scale (VAS) that divides the pain feeling, on a scale from 1 to 10, as mild (VAS 1-3), moderate (VAS 4-7), and high (VAS 8-10). The recording of VAS indices was performed at baseline, after 48 h, and after 7 days, using a questionnaire and asking the patients to indicate the pain intensity accordingly to VAS scale (fig. 1). The laser treatment was performed in 2 sessions for both study groups using laser Whitening Lase II (DMC Dental) (figs. 2 and 3). The nominal wavelength was 660 nm, blue, nominal

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power of 35 mW. The deposited energy density was 4 J/cm² per dental element with exposition time of 60 s in continuous emission form. The first session was performed when the post-operative sensitivity was diagnosed and second session at 48 h after first laser session.

Data were analysed, using Mann-Whitney and Wilcoxon signed-rank tests. The significance level of the tests was set at $p < 0.05$.

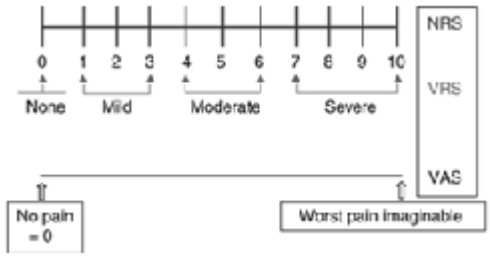

Fig. 1. VAS scale [18]

Table 1
FILTEK Z250 AND CERAMX COMPOSITION AND MANUFACTURER'S INSTRUCTION TO USE

MATERIALS	CATEGORY	COMPOSITIONS	MANUFACTURER INSTRUCTION
Filtek Z 250 XT 3M ESPE Dental Products, St. Paul, USA	Universal microhybrid composite	BIS-GMA and Low-viscosity resin TEGMA .Blend of UDMA and Bis- EMA in place of TEGDMA. . Z250 is filled to 60% by volume with zirconia/silica particles having a size range of 0.01-3.5 microns and an average size of 0.6 micron..	Application of composite in layers less than 2 mm in thickness and cure with LED lamp Demetron for 40 seconds each layer of composite resins.
Scotch Bond Etchant (gel, pH = 0.6) **Adper Single Bond 2** (pH = 4.7) 3M ESPE Dental Products, St. Paul, USA	Adhesive system total etch	35% phosphoric acid, colloidal silica, water, ethanol, HEMA, dimethacrylates, methacrylate functional copolymers of polyacrylic and politaconic acids, (Bis-GMA), silica nanofillers and photo initiator	Etching for 15 s, rinse for 10 s, blot excess water using a mini-sponge (surface should appear glistening without pooling of water; immediately after blotting 2 consecutive coats of adhesive were applied for 15 s with gentle agitation using a fully saturated applicator; gently air thin for 5 s to evaporate solvents; light cure for 10 s.
Ceram X Spheretec One Dentsply de Trey Gmbh Germany	Universal nano-hybrid ceramic composite	Poly-urethanemethacrylate, Bis-GMA, TEGDMA, prepolymerized fillers perfectly round spheres <1 µm, non-agglomerated submicron barium glass and ytterbium fluoride. (59-61% by volume)	Application of composite in layers less than 2 mm in thickness and cure with LED lamp Demetron for 40 seconds each layer of composite resins.
Prime & Bond Select Dentsply de Trey Gmbh Germany	Adhesive system etch and rinse	Carboxylic acid modified dimethacrylate (TCB resin), Phosphoric acid modified acrylate resin (PENTA), UDMA, TEGDMA, HEMA, Butylated benzenediol (stabilizer), Ethyl 4(dimethylamino)benzoate,Camphorquinone, Functionalised amorphous silica, Tertiary butanol	The enamel and dentine were etched with 36% phosphoric acid for 15 seconds. Rinse for 10 s; blot excess water using a mini sponge; application of prime&bond® one Etch&Rinse adhesive using the applicator tip for 20 seconds; solvent evaporation by thoroughly drying with clean, dry air from a dental syringe for 5 seconds (surface should have a uniform glossy appearance); cure prime&bond® one Etch&Rinse adhesive for 10 seconds 2 using a curing light.

Fig. 2. Whitening Lase II (DMC Dental) (660 nm)

Fig. 3. Laser session in postoperative hipersensitivity

Results and discussions

The changes of VAS indices, in relation to the type of composite resin, following laser treatment, are presented in figure 4. For Filtek Z250 restorations, VAS indices decreased from 8.8 to 5.1 (at 48 h), and 1.7 (at 7 days). For Ceram X restorations, VAS indices decreased from 7.3 to 4.4 (at 48 h), and 0.3 (at 7 days). The changes of VAS indices, in relation to genre, are presented in figure 5. For males, VAS indices decreased from 8.4 to 5 (at 48 h), and 1.4 (at 7 days). For females, VAS indices decreased from 7.7 to 4.5 (at 48 h) and 0.5 (at 7 days). The changes of VAS indices, in relation to age, are presented in figure 6. For age group 25-35, VAS indices decreased from 7.7 to 4.5 (at 48 h) and 0.5 (at 7 days). For age group 36-45, VAS indices decreased from 8.7 to 5 (at 48 h) and 1.8 (at 7 days).

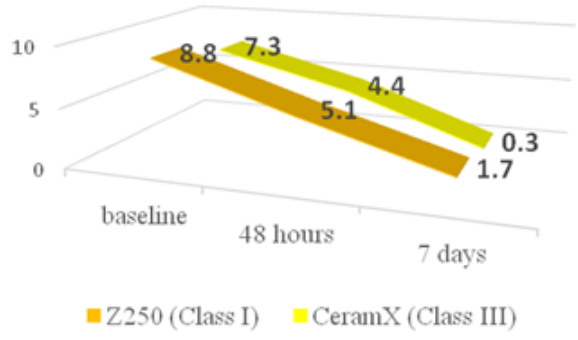

Fig. 4. VAS indices changes related to restorative material

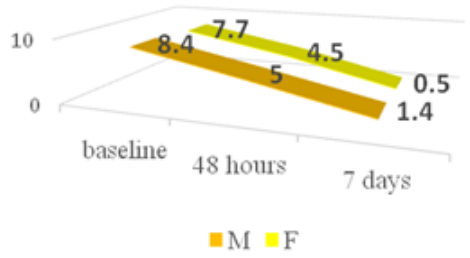

Fig. 5. VAS indices changes related to genre

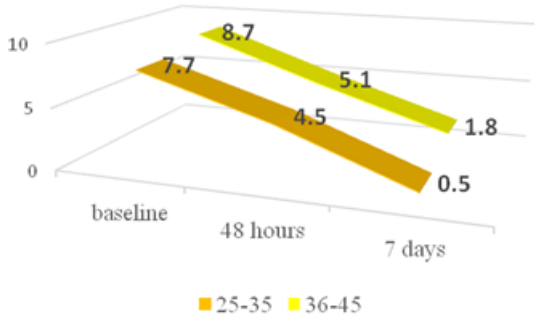

Fig. 6. VAS indices changes related to age

In the current study mean scores for VAS indices decreased significantly at 48 h and 7 days, following laser treatment for all the investigated parameters (materials, sex and age) ($p < 0.05$) (table 2). Thus, the mean of VAS values at 7 days after laser treatment, had a more significant decrease in Ceram X restorations (0.20) than those with the Filtek Z250 (1.70). In the tabel 2 we observed the mean VAS values lower in women (0.45), compared to men (1.56), at 7 days after laser treatment. Treatment of post-operative sensitivity, after 7 days, was more effective in age group 25-35 (0.46) compared to group 36-45 years (1.86).

In the table 3, the Mann-Whitney test presents comparisons of VAS changes at 48 h and 7 days between materials (Z250 vs. Ceram X), sex (males vs. females), and age groups (25-35 vs. 36-45). Significantly changes of VAS indices were observed at 48 hours between Filtek Z250 and Ceram X ($p < 0.005$).

Despite the absence of a desensitising agent to treat post-operative sensitivity, very few studies investigated the effectiveness of the post-operative sensitivity therapy by laser biostimulation. To reduce the influence of various factors on the laser sessions effectiveness in the treatment post-operative sensitivity, the same practitioner performed restorative therapy on similar cavities size, working conditions, and techniques. The intensity of pain was recorded using visual analogue scale, a subjective method of pain assessment. VAS scale was used due to the advantages as follows: high test-retest reliability and repeatability, internally consistent measures of clinical and experimental pain, sensitivity to variables that increase or decrease pain and capacity to measure multiple dimensions of pain [19, 20]. Some limitations of VAS system are given by the involvement of many steps (with potential of errors) as well as the need for careful explanation and reinforcement for the patients to be used accurately.

In our study VAS indices were lower at baseline for Ceram X (7.3) than composite Z250 (8.8). This difference was maintained after 48 h (5.1 for Ceram.X; 4.4 for Filtek Z250) and 7 days (1.7 for Ceram.X; 0.3 for Filtek Z250). These differences can be explained both by different composition and interaction with dentine of the adhesive systems and by different polymerisation shrinkage of the two composites due to their structure (Filtek Z250 is a microhybride composite, Ceram X is a nanohybrid composite).

The checking of light source output is critical to ensure a proper and complete photopolymerisation and to avoid the polymerisation shrinkage of the composite resins [21]. In our study, the power of light source was measured previously, and light activation technique was performed gradually and the resin was inserted in small increments. An important factor, that influences the occuring and the evolution of post-operative sensitivity, is the quality of the adhesive strategy. The proper formation of a bond interface that minimizes or prevents the entry of bacterial fluids avoid failure in dental tissue hybridization that could results in marginal leakage, resin discoloration and post-operative sensitivity [22]. Considering these data, the photo-curing was meticulously performed by practitioner for all subjects included in study. Total-etch technique (etch-and-raise) was performed for both types of composite restorations.

Table 2

COMPARED VAS INDICES VALUES AT BASELINE WITH 48 h AND 7 DAYS, MEAN, STANDARD DEVIATION FOR ALL PARAMETERS INVESTIGATED

	Filtek Z 250		Ceram X		Male		Female		Age group 25-35		Age group 36-45	
Baseline	48 h	7 d	48 h	7 d	48 h	7 d	48 h	7 d	48 h	7 d	48 h	7 d
N	30	30	30	30	27	27	33	33	39	39	21	21
Mean	5.10	1.70	4.40	0.20	5.00	1.56	4.55	0.45	4.54	0.46	5.14	1.86
S.D.	±1.470	±1.822	±0.814	±0.407	±1.593	±1.987	±0.794	±0.666	±0.756	±0.643	±1.769	±2.151
p	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

h – hour; d – day; SD - std.deviat; $p < 0.005$

Table 3

MANN-WHITNEY TEST. COMPARISONS OF VAS VALUES AT 48 h AND 7 DAYS, FOR MATERIALS, SEX AND AGE

	Filtek Z250/ Ceram X		Male/Female		Age group 25-35/36-45	
Baseline	48hours	7days	48hours	7days	48h	7days
Mean Rank	39.35/21.65	30.80/30.20	33.11/28.36	28.00/32.55	27.85/35.43	31.77/28.14
p	**0.0001***	0.881	0.240	0.256	0.074	0.385

FZ-Filtek Z250; CX-Ceram.X; M- Male; F-Female; *$p < 0.005$

In a study, Iovan G. et al. [23] observed that total-etch technique ensures a thicker hybrid layer and more frequent resin plugs comparing to self-etch technique. On the other hand, total-etch adhesive systems, through over-etching, can result in a demineralised, unimpregnated dentin, susceptible to damage the pulp [24].

Ghiorghe CA et al. [25] found a higher microleakage for coronal restorations with Filtek Z250 to the gingival margins than coronal restorations with Zmack Comp. These results can be explained by different polymerization shrinkages for the investigated composite resins [26].

When using total-etch technique, the quality of the resin-dentin adhesion can be greatly affected by the degree of dentinal surface wetness and the duration of the acid-etching process [27]. The self-etching systems should provide less post-operative sensitivity considering that ensure reduced technique sensitivity by the absence of a separate etching step and uniform penetration of resin into the etched dentin [28]. The presence of post-operative sensitivity more frequently in restorations placed using total-etch adhesives than in restorations placed using self-etch adhesives is demonstrated by Yousaf A. et al. [29]. Other factors like cavity depth, and the presence or absence of calcium hydroxide liner had no statistically significant influence on the occurrence of sensitivity [30]. In our study these factors were controlled by the standardisation of cavity depth (shallow and medium cavity depth) and the absence of liner.

In a study, Say E.C. et al. [31] observed that to reduce post-operative sensitivity, dentists can use desensitizing agents based on hydroxyethyl methacrylate (HEMA), chlorhexidine fluoride and gluconate after teeth preparation for composite restorations. Fluoride present in dentinal desensitizers seals dental tubes with the main incorporation of HEMA, which increases the infiltration ability of primers. HEMA, due to its hydrophilic properties, is incorporated into many adhesives and increases the adhesion to dentin collagen [32, 33]. The adhesives containing glutaraldehyde /HEMA also have water in the composition, which acts as a refill. Their use in the total-etch bonding procedures, on a demineralised dentinal collagen, will increase the surface energy and facilitates the diffusion of the hydrophilic resin monomer into the dentin [34]. Glutaraldehyde has the ability to create a coagulation plug inside the dentinal tubules and can reduce or completely eliminate tooth sensitivity [35, 36].

Both types of adhesives used in our study have nanofillers incorporated, more precisely colloidal silicate fillers, which forms an uniform and stable adhesive layer. Adper Single Bond 2 requires 2-3 successive adhesive coats while Prime & Bond only one coat. Regarding solvents, Adper Single Bond 2 has in its composition ethanol and Prime & Bond tertiary butanol. Adhesives that use tertiary butanol solvent have shown a stronger bond strenght than those using ethanol and claim that the dentine humidity is a less sensitive factor of adhesion ensuring a complete infiltration of the resin. Regarding the application technique of the two types of adhesives, the difference is that in the case of Adper Single Bond 2, it is recommended to apply two or three successive coats, and in the case of Prime & Bond One Etch & Rinse, only one application is required. Thus, it can be explained that post-operative hypersensitivity was lower at baseline in patients with Ceram X restoration.

Our study demonstrated that two 660 nm laser sessions, with an interval of 48 hours between them, are enough to provide significant pain reduction after first therapeutical session and further diminishing or the elimination of the sensitivity after second laser session. Also, Ladalardo T.C. et al. [37] found the 660 nm diode was more effective than other wavelenghts in the treatment of dentinal hypersensitivity. The results of our study sustains the conclusions of the systematic review performed regarding the effectiveness of laser biostimulation in dentinal hypersensitivity [38].

The effects of low-level laser therapy in the treatment of sensitive teeth can be explained by the blockage of nerve activity at the level of the pulp-dentin complex, preventing the pain transmission to the central nervous system [39].

Ferreira A.N. et al. [40] also found that laser therapy of the teeth after cavity preparation presented less inflammatory reactions and more reactionary dentinogenesis compared with control. The biomodulation effects of low-lasers are responsible for the producing of tertiary dentine that serve as a barrier against thermal stimuli as well as for the elimination of pulp inflammation created through the cavity preparation process.

The stimulation of pulp repair processes by low-level laser therapy was demonstrated by a few in vivo studies. Godoy B.M. et al. [41] demonstrated that one 670nm laser session following cavity preparation accelerated the recovery of dental structures involved in cavity preparation in the pre-dentin region. The pain control following low-level laser therapy can be explained by the stimulation of the analgesia mechanisms. Considering these data, low-level laser therapy has benefits in the therapy of postoperative sensitivity by pain control, inflammatory modulation and the stimulation of repair processes.

Further studies with greater sample size are requested to compare the effects of low-level lasers with diode lasers as well as the influence of other factors on the effectiveness of laser therapy (various materials and adhesives, depth cavity, liners).

Conclusions

The intensity of post-operative sensitivity in microhybrid and nanofilled composite restorations decreases significantly at 48 hours and 7 days following two sessions of laser therapy (660 nm). The pain intensity following laser therapy decreases significantly both for males and females as well as age group 25-35 years and 36-45 years. The analgesic effects of laser biostimulation are significantly higher, after 48 hours, for CeramX restorations comparing to Z250 restorations, but no significant differences were found after 7 days of laser therapy.

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