

Comparative Desensitization Effect of Vital Abutments Realized by Different Methods

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Vital abutments presents different degree of dentinal sensitivity (DS) after their preparation. Protective methods of dentinal wound have the purpose to fill up the dentinal tubules. The objective of the study was to assess the efficacy of three different desensitization methods applied to reduce the postoperative sensitivity of prepared vital abutments. The clinical trial included 65 patients with 251 vital abutments, divided into three groups: in the first group of 21 patients (82 vital abutments) the protection method was carried out by a desensitizer agent containing hydroxyethyl methacrylate and glutaraldehyde; in the second group of 22 patients (85 vital abutments), diode laser therapy was used; in the third group of 22 patients (84 vital abutments), associated protection method was applied, by using the same desensitizer agent and laser therapy. During the study, all selected patients used the same toothpaste for at-home desensitization, containing 5% calcium sodium phosphosilicate (CSPS). The evaluation of the painful intensity of DS in vital abutments after desensitization was realized by using a Visual Analogue Scales (VAS) and by evaluating the failure rate. The results of study showed that after desensitisation, the DS of vital abutments has decreased in all three groups, but the highest desensitization rate with the most reduced rate of failures was found in the third group of patients, with associated therapies. The efficiency of the applied desensitization methods have been confirmed.

Keywords: vital abutments, desensitization methods, comparative results

After their preparation, the open dentinal tubules of vital abutments can present different degrees of dentinal sensibility (DS) [1] and the lack of proper management of tooth vitality often requires the removal of dental pulp.

The dentin and the dental pulp form the biologic entity of dentin-pulp complex [2]. The sensory function of the pulp-dentin complex is one of his many functions [3]. Dentinal tubules contain the odontoblastic processes, which may extend from pulp to dentin-enamel junction, surrounded by dentinal fluid inside the dentin tubules. The dentinal fluid is an ultrafiltrate of blood from the dental pulp and represent the communication between the dental pulp through the odontoblastic layer and the outer regions of the dentin [4,5].

Three theories on dentinal sensitivity were formulated. The nerve theory postulates the direct stimulation of dentinal tubules and pulpar nerve terminals; the hydrodynamic theory of dentin hypersensitivity consider that external stimuli determine movements in the fluid of dentinal tubules, which induce nociceptive transduction

in adjacent pulpal nerve fibers; the odontoblastic theory postulates direct stimulation of odontoblast, and is based on the expression of several ion channels by these cells [6,7]. The theories are not mutually exclusive and cannot be considered separately because of the presence of nerves and odontoblast processes within the dentinal tubules, bathing in the dentinal fluid, and the close apposition of the odontoblasts to the dentinal or basal nerves terminals (fig. 1) [8,9].

The acute localized pain, which is reduced after the cessation of the stimuli, is called dentinal pain/dentinal hypersensitivity, and is described as one of the most painful affection of teeth [2,3,10]. The Canadian consensus document stipulate that dentinal hypersensitivity is defined as pain derived from exposed dentin to chemical, thermal, tactile or osmotic stimuli, and not explained by any other dental lesions [11,12]. The prevalence of DS varies from 4 to 57% [13,14].

The actually method in decreasing DS of vital abutments is represented by the sealing of dentinal tubules, by the

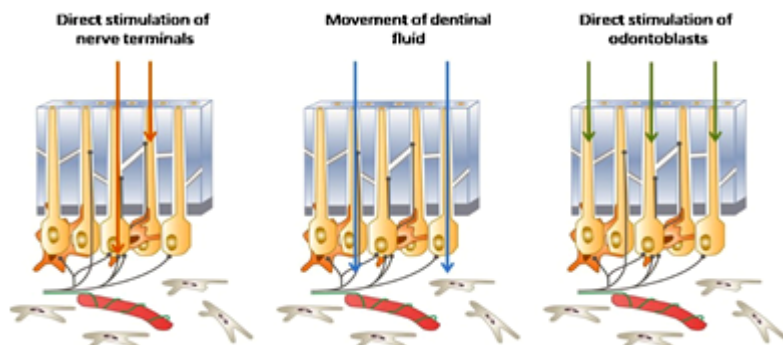


Fig. 1. Schematic representation of the three main theories explaining the dentin sensitivity [8]

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application of chemical and mechanical methods in dentin desensitization [15-17], before taking impressions.

Gluma Desensitizer (Heraeus Kulzer, Germany), a dental bonding agent with the specific purpose to treat DS [18], contain 35% hydroxyethyl methacrylate (HEMA) and 5% glutaraldehyde in purified water. HEMA forms deep resin tags and closes dentinal tubules, and glutaraldehyde causes protein coagulation inside of dentinal tubules, by its reaction with the serum albumin of the dentinal fluid [19,20]. The precipitation of plasma proteins determine the reduction of dentinal permeability, the occlusion of the peripheral dentinal tubules and the inhibition of the flow of fluid from the dentinal tubules. HEMA can react with dentin collagen due to its ester group and its hydroxyl group with collagen because of its hydrophilic nature [21]. Gluma Desensitizer (fig. 2) is a dental desensitizing agent, for in-office use [22]. Indications of Gluma Desensitizer are related with the reduction/elimination of pain in exposed cervical areas of teeth crowns that do not require restoration and the reduction/elimination of dentin sensitivity after the preparation of teeth for fixed prosthetic restorations [23].



Fig. 2. Aspect of Single dose Gluma Desensitizer, used in the study [24]

At-home desensitizing agents includes toothpastes and mouthwashes, which acts by occluding the dentinal tubules or by blocking the neural transmission [25]. Sensodyne Advanced Repair and Protect Toothpaste with NovaMin calcium formula (GlaxoSmithKline), is different from other Sensodyne toothpastes with his desensitizing technology, and act as reparative layer over exposed dentine and on the natural crystals of teeth structure. The active ingredient is represented by Sodium Monofluorophosphate 1.08% w/w (1450 ppm fluoride) [26].

NovaMin® is an inorganic amorphous calcium sodium phosphosilicate (CSPS) material based on bioactive glasses, formed by 45% SiO₂, 24.5% Na₂O, 24.5% CaO and 6% P₂O₅. Its chemical formula is CaNaO₆Psi [28,29]. The size of NovaMin particles are small and so they occlude the exposed dentinal tubules and prevent the fluid flow. When CSPS particles come into contact with saliva, appear an immediate release of sodium ions, leading to a localised pH increase due to cation exchange. Together with a release of calcium and phosphate ions, this facilitates the precipitation of an occlusive calcium phosphate hydroxycarbonate apatite-like layer over the exposed dentine [30]. It is dedicated for relief occasional dentin hypersensitivity that occurs when sensitive teeth are exposed to hot or cold substances [31].

Photobiostimulation with therapeutically laser is the use of low-energy laser light on tissues, to achieve a clinical effect. Biostimulation has been used clinically for pain reduction, wound healing and aid in physical therapy for temporomandibular joint disorders. The basic mechanism for biostimulation occurs at molecular level. Laser light penetrates through tissue and strikes a chromophore (photosensitive molecule), which is situated in mitochondria [32,33]. Mitochondrial cytochromes are

responsible for converting adenosine diphosphate (ADP) to adenosine triphosphate (ATP), thus supplying energy to the cell and driving cellular metabolism [34].

The ability of laser light to affect target molecules is dependent on the absorption spectra of biomolecules and tissue optics. With inflammation, the normal resting potential of nerve fibers is decreased, leading to hypersensitivity. Returning the resting potential to normal could decrease pain transmission. This area of biostimulation is clinically important in pain reduction. Biostimulation is also effective in increasing metabolism and cell replication in fibroblasts and endothelial cells [35-37].

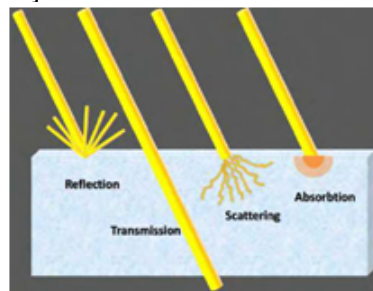
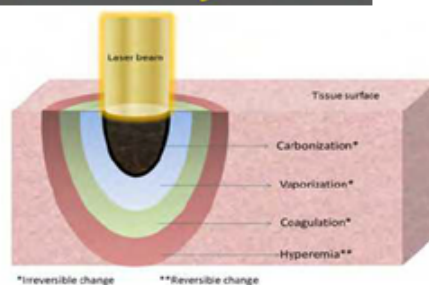


Fig. 3. Laser beam interaction with tissues [38]



Epic 10 diode lasers provide therapeutic and non-invasive way in treating pain and is used too for relief minor pain. The technical specifications of Epic 10 diode lasers are: laser classification IV; InGaAsP semi-conductor diode; 940 nm wavelength; 10 W peak power. The presentation mode of Epic 10 diode laser and of the handpiece, respectively the using mode of device in our study can be observed in figure 4 [39,40].



Fig. 4. The presentation mode of Epic 10 diode laser (A), and using mode (B)

Lasertherapy stimulate the microcirculation, acts on tissue repair to reduce edema and pain [41,42], and may increase intracellular ATP levels sufficient to maintain muscle physical effort [43]. In pain, it can use a laser source of low emission energy [44].

Visual analogue scale (VAS) is applied by the clinical researchers to assess the intensity of various subjective symptoms, including pain intensity, in mature populations and for the evaluation of the efficiency of different therapies [45,46]. The VAS for pain survey is a single-item scale which study the pain intensity and is comprised between *no pain* (score = 0) and *pain as bad as it could be* (score = 10) [47,48].

The objective of the study was to evaluate the efficacy of three different desensitization methods applied to reduce the postoperative sensitivity in vital abutments.

The null hypothesis of clinical trial was started from the premise that the efficacy of used desensitization methods in decreasing DS are not different.

Experimental part

Material and method

The randomized comparative clinical study was conducted in accordance with the ethical standards as laid down in the Declaration of Helsinki, according to the good practice and the ethical principles. The clinical study was realized in the period of 2016-2018, in the Dental Specialties Departments of Faculties. The dentists which have partake of this clinical trial have sustain trainings to ensure the coherence of examination, of diagnosis and of treatment.

Selection of patients was effectuated after finalisation of all dental, periodontal and pro-prosthetic treatments.

The inclusion criteria were: healthy adult patients, with no acute or chronic illness; age range of 31-50 years; partially edentations which required their restoration through dental bridges, without acute or chronic dental or/and periodontal sensitivity/pain; ability and goodwill to perform in-office and at-home desensitization of the vital abutments; patients that willingly participated to the program.

The exclusion criteria were: vital abutments with extended dental lesions; patients with dental or/and periodontal treatments within the studied period; anti-inflammatory therapy due to medical problems; adverse effects or allergic reactions after the use of desensitizing substances; antecedents with chronic, general or dental diseases; pregnancy and lactation.

In selected patients, the mean of age was 40.5 ± 9.5 years. The preponderance of females in the investigated groups was 52.31% (34 females of 65 participants) and of male was 47.69% (31 males of 65 participants).

The included patients (65, with 251 vital abutments) subscribed their written consents previously starting the research. The patients were divided into three groups:

-In the first group (**G**) of 21 patients with 82 vital abutments, the protection was carried out by Gluma Desensitizer - Heraeus Kulzer, a desensitizer containing hydroxyethyl methacrylate and glutaraldehyde. The methodology for the use of Gluma Desensitizer on vital abutments implicated soft cleaning, rinsing with water, isolation, gentle drying of vital abutment surfaces, application of Gluma desensitizer on the area with brushes, 1 minute waiting, rinsing of oral cavity. The desensitization was performed daily for a period of 5 days until the prosthetic restoration was inserted into the oral cavity. The first desensitization was performed immediately after grinding the vital teeth and before impression, and the last before inserting onto the vital abutments of the dental bridges.

-In the second group (**L**) of 22 patients and 85 vital abutments, laser therapy was realised with the Epic 10 diode laser, in non-contact mode, at a distance of 2 mm away from the vital abutment surface, for a period of 1 minute, in a scanning motion for covering the entire surface of the prepared vital abutment area (fig. 4B). The desensitization with laser therapy was accomplished daily, for a period of 5 days, until the prosthetic restoration was inserted into the oral cavity.

-In the third group (**G+L**) of 22 patients and 84 vital abutments, associated protection with Gluma desensitizer

agent and laser therapy was applied, likewise, daily for 5 days.

The distribution of the patients in groups in according with the used desensitising methods and after gender is presented in chart 1.

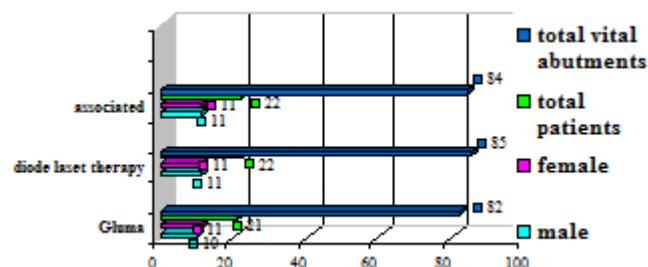


Chart 1. Distribution of patients in groups, after the used desensitizing methods and after gender

The used clinical protocol in all patients included the realization of professional oral hygiene, pre- and pro-prosthetic treatments, grinding the vital teeth for fixed metal-ceramic restorations (through high speed, by cooling, with proper rotary diamonds, without exceeding stress, etc.), laying of desensitizer substance or first laser therapy session, impression, instruction of patients for a suitable maintenance of oral cavity hygiene, daily desensitization for a period of 5 days.

All patients were given Sensodyne Advanced Repair and Protect Toothpaste with NovaMin calcium formula (GlaxoSmithKline) toothpaste containing 5% calcium sodium phosphosilicate (CSPS), for using twice daily.

The assessment of pain intensity degree after the desensitization was realized with Visual Analogue Scale (VAS) for 5 days starting with the second day after grinding. The assessments noted the patient's response at 22°C air stimuli of the dental unit, for 3 s, at 2 mm distance of vital abutments cervical area. The trial evaluated on visual-analogue scale (VAS), with range 0-10. The reference points used in our study were: VAS 0-1 = no pain; VAS 2-3 = mild pain; VAS 4-5 = moderate pain; VAS 6-7 = severe pain; VAS 8-9 = very severe pain; VAS 10 = the most intense pain possible.

The patients were monitored during the period of April 2016 - March 2018 in the Dental Clinics of the Dental Medicine Faculties for evaluation of the failure rate, in 6 sessions.

Results and discussions

The intensity of DS determined after the application of desensitizing agents, according to Visual Analogue Scale (VAS) used in the study, are summarized in table 1.

The values highlight the fact that the reported DS in the vital abutments decreased as following:

-In Ist batch (**G**), in first determination the maximum severe pain (VAS = 10) was reported in 6 vital abutments (= 7.31%), but in the next determinations decreased, and in 5th determination, the minimum no pain VAS (= 0-1), was founded in 32 vital abutments (= 39.02%), respectively VAS (= 2-3), was founded in 33 vital abutments (= 40.24%);

-In IInd batch (**L**), in first assessment the maximum severe pain (VAS = 10) was reported in 7 vital abutments (= 8.23%), but in the next determinations decreased, and in 5th determination, the minimum no pain VAS (= 0-1), was founded in 34 vital abutments (= 40.0%), respectively VAS (= 2-3), was founded in 37 vital abutments (= 43.52%);

-In IIIrd batch associated therapy (**G+L**), the maximum severe pain in first determination (VAS = 10) was founded

Table 1
REPORTED DS ACCORDING TO VISUAL ANALOGUE SCALE (VAS) USED IN THE STUDY

Batch	I st Batch Gluma Desensitizer (G) 82 vital abutments (21 patients)						II nd Batch Diode laser therapy (L) 85 vital abutments (22 patients)						III rd Batch G+L 84 vital abutments (22 patients)					
VAS	0-1	2-3	4-5	6-7	8-9	10	0-1	2-3	4-5	6-7	8-9	10	0-1	2-3	4-5	6-7	8-9	10
1 Det	-	-	33	35	8	6	-	-	35	35	8	7	-	-	34	35	8	7
2 Det	-	12	31	33	5	4	-	15	32	29	4	5	-	21	35	23	3	2
3 Det	1	19	35	21	3	3	1	21	32	25	3	3	7	29	28	17	2	1
4 Det	17	29	21	11	1	2+1F	18	30	21	12	1	2+1F	26	32	21	4	-	1F
5 Det	32	33	14	-	-	3F	34	37	11	-	-	3F	51	24	8	-	-	1F

*Det = determination

in 7 vital abutments (= 8.33%), and in the next sessions were reduced, also in 5th determination, the minimum "no pain" VAS (= 0-1), was noted in 51 vital abutments (= 60.71%), respectively VAS (= 2-3), was founded in 24 vital abutments (= 28.57%).

A significant reduction in level of sensitivity after all types of treatments occurred in the level of painful sensitivity, beginning with the first day to the fifth day of desensitization treatments. The reduction of painful sensitivity of the vital abutments in the first batch compared with the second batch of patients was not significantly different. VAS values of the Ist (G) and IInd (L) batch of patients were highest than in the third batch of patients, so, we underline that VAS values were the lowest in the patients of IIIrd batch, with associated therapy (G+L).

We emphasize the fact that after the 5th session, the fixed prosthetic restorations were cemented temporarily on the vital abutments. According to the quantified responses on the VAS scale, the insertion and cementation of restorations determined the reduction of the painful intensity in the investigated vital abutments.

The failures rate at the end of VAS determinations, which imposed the effectuation of endodontic treatments, was as following (chart 2):

-In Ist batch (Gluma, G) = 3.57 %, 3 abutments of 82 vital abutments;

-In IInd batch (Laser therapy, L) = 3.52 %, 3 abutments of 85;

-In IIIrd batch associated therapy (G+L) = 1.19 %, only 1 abutment of 84.

The rate of failures at the end of the research (March 2018), which included the failures observed after the VAS determinations, was (chart 2):

-In Ist batch (Gluma, G) = 6.09 %, 5 vital abutments of 82 required vital extirpation;

-In IInd batch (Laser therapy, L) = 4.70 %, 4 vital abutments of 85 have imposed their vital extirpation;

-In IIIrd batch associated therapy (G+L) = 2.38 %, only 2 vital abutments of 84 needed endodontic treatments at the end of the research.

The results of study revealed that DS was decreased in all three groups, but the highest rate of desensitization was

in the vital abutments of third patients group, with associated desensitization methods/therapies.

Preserving the vitality of pulp have the purpose to keep the functionality of dental pulp tissues [49]. Vital abutments become extremely sensitive after their preparation to stimuli as warmth, cold, pressure, and brushing may become painful [50]. Usually one the therapeutically strategies for post- operative sensitivity is the prescription of analgesic medication, aiming to ameliorate or eliminate the pain [51]. The general scientific consensus is that through occluding the exposed dentinal tubules, effectively is relieved the occasional pain of affected teeth and of vital abutments [52]. Numerous studies in the specialty literature presents the effects of different products for diminishing the vital abutments painful sensitivity, but the individual reactivity of patients differ, and till now, it has not been developed the ideal the product [53].

The researches of Qin et al. [54], suggest that Gluma Desensitizer (Hereus Kulzer) acts as a desensitizer by two reactions. First, glutaraldehyde reacts with the serum albumin in dentinal fluid, which induces albumin precipitation, and then a second reaction of glutaraldehyde with albumin induces HEMA polymerization. Electron microscopy images (SEM), shows that Gluma Desensitizer leads a homogeneous hybrid layer on the dental surface [18]. Gluma Desensitizer penetrate the exposed dentinal tubules up to 200µ depth, induce the restructuration of collapsed collagenous fibbers, and the apparition of multiple layers of protein septas, the hermetic sealing of dentinal tubules (fig. 5), and through that, acts as a microbial barrier, and inhibit bacterial growth [55-58].

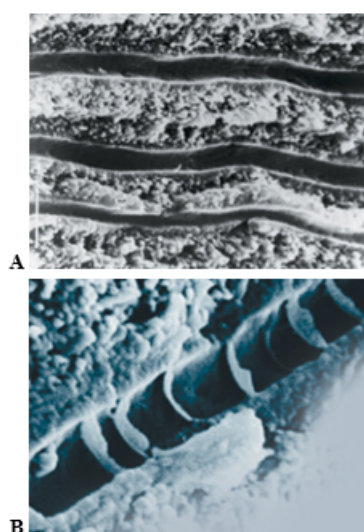


Fig. 5. SEM of Gluma Desensitizer action [59]:
A: Dentinal tubule before application of Gluma;
B: Protein septas following application of Gluma

A: Dentinal tubule before application of Gluma; B: Protein septas following application of Gluma

Some theories claiming that the use of laser therapy decreases dentin hypersensitivity by decreasing the adhesion of dentinal tubules, by dissolution or dentin recrystallization, by evaporation of dentin fluid, or analgesic

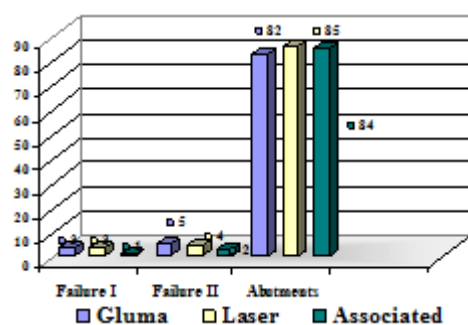


Chart 2. Rate of failures in batches at the end of VAS determinations (Failure I) at the end of the research (Failure II)

effect which is connected with depressed nerve transmission or by obliteration of dentinal tubules with tertiary dentin. Irradiation with the GaAlAs laser with maximal dose of 60 mW does not affect enamel or dentin surface morphologically. However, a small amount of laser energy of 830 nm wavelength passes through hard tissues in the pulp and therefore immediate analgesic effect is seen as a consequence of depressed transmission through nerves, probably by blocking afferent C fibers. Yilmaz et al [60] reported that one dose of irradiation with Cr YSGG (30 seconds, 0.25 W, 20 Hz, =% water and 10% air) or with GaAlAs laser (60 s, 8.5 J/cm²) was efficient in decreasing dentin hypersensitivity, which was confirmed in other studies [61-63].

After the studies of Mason et al [64], dentifrice containing 5% CSPS improved dentinal hypersensitivity. The researches of Wang et al [65], respectively Zhong et al [66] demonstrated that the use of new Novamin bioglass-containing Sensodyne toothpaste decrease the permeability and seal the dentinal tubule after teeth brushing (fig. 6).

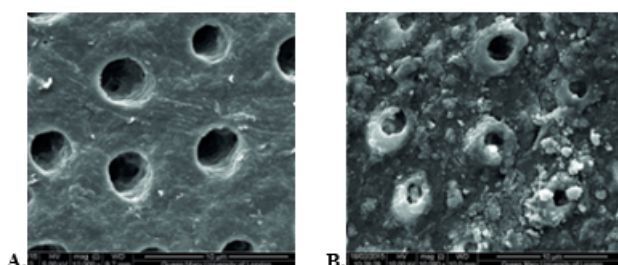


Fig. 6. SEM aspects of dentinal tubules: A. before brushing with bioactive glass; B. after brushing [67]

Biocompatibility of dental materials is of great significance for the patient, clinician, technician, nurse and manufacturer. A dental biomaterial for oral use should be harmless when is in contact with oral and dental tissues [17, 68].

Conclusions

The benefits of all used desensitization agents and technique in the study were confirmed.

The use of Gluma Desensitizer is time saving, but the results are not so beneficial like in associated therapy.

Associated therapy, represented by desensitizing agent deposition, laser therapy and dentifrice containing 5% CSPS, had the best action.

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