

## ORIGINAL PAPER

**Possibilities in alleviation of dentin sensitivity in vital abutments**

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**Abstract**

The preparation of vital abutments, in absence of an adequate management of their vitality, may impose their pulp extirpation.

The aim of this clinical study was to evaluate the alleviation of dentin sensitivity (DS) in vital abutments after the application of desensitizing biomaterials on the exposed dentin surfaces.

The randomized controlled clinical trial included 93 patients (312 vital abutments), divided in three groups. The vital abutments of the first group (30 patients, 102 vital abutments) were protected in-office with Gluma® Desensitizer (Kulzer). The second group of 31 patients (105 vital abutments) used at-home Sensodyne® Advanced Repair & Protect with Novamin™ toothpaste and Sensodyne® Mouthwash for Sensitive Teeth (GlaxoSmithKline). For the alleviation of the dentin sensitivity in the third group (32 patients, 105 abutments), both in-office and at-home desensitizing substances were used, as an associated method. The trial evaluated the DS of vital abutments on the visual-analogue scale (VAS), with range from 0 to 10, in 8 sessions, under cold thermal agent, after the use of desensitizing agents.

The results of the study revealed that DS decreased in all three groups, but the highest rate of desensitization was found in the vital abutments of the third patients group.

The benefits of all desensitizing agents used were confirmed.

**Keywords:** vital abutments, desensitizing agents, desensitization.

**Introduction**

After the preparation of vital abutments, by opening the dentinal tubules the apparition of different degrees of dentin sensibility (DS) can be induced.

Preparation of the teeth for full crowns can induce drying of the dentin, pulpal inflammation or even burn lesions after the reduction of the odontoblastic layer. Clinical researches demonstrated that the preparation of vital teeth for full coverage fixed prosthetic restorations can determine sharp, transient pain as a result of DS [1].

The hydrodynamic theory of dentin hypersensitivity (DHS) suggests that external stimuli determine movements in the fluid of dentin tubules, which induce nociceptive transduction in adjacent pulpal nerve fibers [2-4]. Dentinal tubules contain the odontoblastic processes, which may extend from the pulp to the dentino-enamel junction. The odontoblastic processes are the extensions of odontoblasts and they are surrounded by dentinal fluid inside the dentin tubules. The dentinal fluid is an ultrafiltrate of blood from the dental pulp and represents the

communication between the dental pulp through the odontoblastic layer and the outer regions of the dentin [5,6].

DS is characterized by a short and sharp pain, with a rapid onset. DS occurs after the removal of the protective smear layer, which determines the opening of dentinal tubules and the exposure of the odontoblastic processes to chemical, thermal, tactile or osmotic stimuli [6,7,8]. Great variations were observed in the prevalence of DS, which varies from 4% to 57% [9,11].

Sealing the dentinal tubules represents a current method in decreasing DS [11]. The therapeutic approach of closing the dentinal tubules, in order to impede the fluid shifts from the dentinal tubules, is represented by the application of chemical and mechanical methods in dentin desensitization. Significant advancement in the understanding and in treatment of DH, have been developed, respectively in the use of various methods and desensitizing agents [8,12].

Gluma® Desensitizer is used in-office, for dentin desensitizing [13]. Its formula contains of 5% [glutaraldehyde](#) and 35% HEMA

([hydroxyethyl methacrylate](#)) in purified [water](#) [14]. Its effect is obtained by the precipitation of plasma proteins, which 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. It is indicated in cases of pain in thermal, osmotic or tactile stimuli [15]. 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 [16].

At-home desensitizing agents include toothpastes or mouthwashes, which act by occluding the dentinal tubules or by blocking the neural transmission [6]. Sensodyne® toothpaste uses one of the two main ingredients for treating DS: potassium nitrate and stannous fluoride. Potassium nitrate acts by numbing the pain by soothing the prolongations of pulp nerves. Stannous fluoride acts by closing the open dentinal tubules by forming a protective barrier and heaving remineralization properties. Both methods are effective ways to treat sensitivity, and Sensodyne® features a range of toothpastes using each ingredient [17]. Sensodyne® Repair and Protect toothpaste (GlaxoSmithKline), contains stannous fluoride and is used for decreasing occasional DS in sensitive teeth exposed to hot or cold substances. Sensodyne® Repair and Protect Toothpaste with advanced Novamin™ calcium formula (GlaxoSmithKline), is different from other Sensodyne® toothpastes with its desensitizing technology, acts as a reparative layer over the exposed dentine and on the natural crystals of the teeth structure, and contains Sodium Monofluorophosphate 1.08% w/w (1450 ppm fluoride) [18,19]. Sensodyne® Oral Care for Sensitive Teeth Mouthwash (GlaxoSmithKline), contains potassium chloride which prevents pain due to sensitive teeth [20].

Visual analogue scale (VAS) is a measurement instrument for epidemiologic studies and clinical researches, and measures the intensity /frequency of different symptomatology in mature populations. The

VAS for pain survey is a single-item scale which studies the pain intensity and is comprised between “no pain” (score of 0) and “pain as bad as it could be” (score of 10) [21-23].

The purpose of the clinical study was to evaluate the alleviation of dentin sensitivity (DS) in vital abutments after the application of desensitizing agents on the exposed dentin surfaces. The null hypothesis of study was that the effectiveness of used desensitizing agents would not be different in reducing DS.

### Materials and methods

The clinical trial was accomplished according to the good practice and the ethical principles. The participating dentists followed trainings in order to assure consistency of clinical examination, diagnosis and treatments. The clinical trial was conducted during the period of 2015-2017, in the Dental Clinics of Dental Medicine Faculties.

The patients were selected after a detailed anamnesis, were informed about the research requirements, and were attended only by those that entered voluntarily in the research program. The selection of the patients was performed after the completion of all dental, periodontal and proprosthetic treatments.

The inclusion criteria in this clinical trial were represented by following patients: healthy adults demonstrating good general health with no history of chronic illness; age range of 36-55 years; different classes of partial edentations, which necessitate restoration by bridges, but without acute or chronic dental or/and periodontal sensitivity/pain; capability and willingness to effectuate in-office desensitization; brushing teeth at least 2 times a day for 5 minutes and cleaning the oral cavity with desensitizing agents used in the study; established DS diagnosis after the abutments preparation.

The exclusion criteria were represented by the patients: which received odontal or/and periodontal treatments within the period of the trial; bridge abutments with extended dental hard tissue lesions; participants with anti-inflammatory treatment due to medical problems; adverse effects/intolerances/allergic reactions at the used desensitizing agents; acute or chronic, general or dental

diseases (e.g. gastritis, digestive ulcer, gastrointestinal haemorrhages, liver- and renal disturbances, etc.) in personal history; use of a desensitizing agent in the 3 months prior to the study; being pregnant or nursing.

The selected patients signed the written informed consent prior to the beginning of the research. Out of 99 eligible patients, the number of patients participating in the study until the end of the research was 93. The 6 dropout patients were not included in the final results. The mean ( $\pm$ SD) of selected patients' age was  $45.5 \pm 9.5$  years. We noticed that the prevalence of females in the analysed batches was 60.21% (56 females of 93 participants) and of male patients was 39.78% (37 males of 93 participants).

This randomized controlled clinical trial compared the effectiveness of Gluma® Desensitizer, Sensodyne® Repair and Protect Toothpaste with advanced Novamin™ calcium formula and Sensodyne® Oral Care for Sensitive Teeth Mouthwash in DS reduction.

The clinical protocol used for all the selected patients consisted by the sanitation of the oral cavity, preparation of the vital teeth for mixed metal-ceramic restorations in proper conditions (grinding by cooling with water, with proper rotary diamond instruments, without excessive pressure, etc.), application of desensitization agents, impression, training the patient to ensure proper oral hygiene and the list with indicated beverages. The in-office method for desensitization involved gentle cleaning of vital abutments, rinsing with water, isolation and gentle drying of vital abutments, application of Gluma® desensitizing agent on the vital abutments strictly on the area to be protected by using pellets or brushes, it's maintaining for 30–60 seconds, rinsing. For the use at-home of desensitizing agents, we gave the patients Sensodyne® toothpaste, tooth brush and mouthwash, and the written instructions regarding their at-home use. The determinations of DS intensity in vital

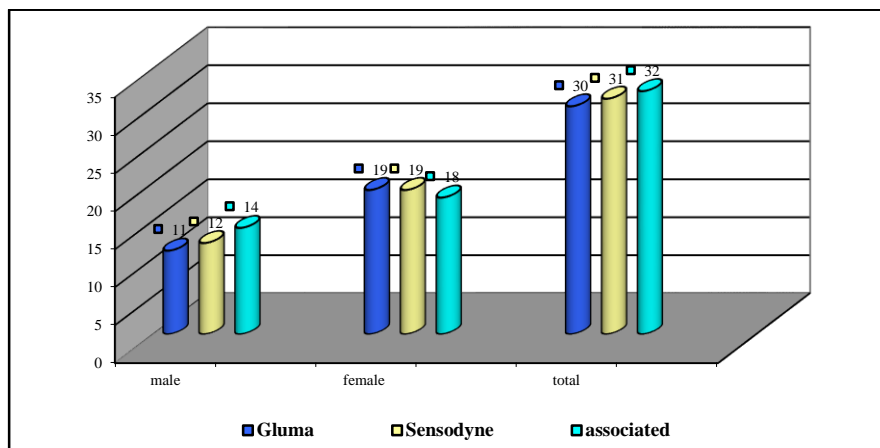
abutments were realized by the patient's response to air-blast stimuli, applied with the air syringe of the dental unit, for 3 s, at a distance of 2mm from the cervical area of labial/buccal surfaces. The temperature was of 22°C. The neighbouring teeth were protected with dental gauze and/or the operator's hand. Patients were then asked about the level of sensitivity they experienced.

The selected patients were randomized by the lottery method in three batches:

- The first batch (G) of 102 vital abutments (30 patients, 19 females and 11 males), were in-office protected with Gluma® Desensitizer (Kulzer), 5 daily applications; the first application was realized after the preparation of vital abutment and the impression, and the last application before the insertion of final prosthetic restoration on the abutments.
- The second batch (S) of 105 vital abutments (31 patients, 19 females and 12 males) were at-home protected with Sensodyne® Advanced Repair & Protect with Novamin™ toothpaste and Sensodyne® Mouthwash for Sensitive Teeth (GlaxoSmithKline), performed twice a day, in the morning and evening, for 5 days.
- The third batch (G+M) of 105 vital abutments (32 patients, 18 females and 14 males) benefited by the associated in-office with Gluma® Desensitizer (5 applications, effectuated daily), and at-home protection, with Sensodyne® Advanced Repair & Protect with Novamin™ toothpaste and Sensodyne® Mouthwash for Sensitive Teeth (performed twice a day, in the morning and evening, for 5 days).

The patients were monitored during the period of 2012-2018 in the Dental Clinics of the Dental Medicine Faculties.

The distribution of the patients in batches, by the used desensitising agents and gender is depicted in graph 1.



Graph 1. Distribution of patients in batches, by used desensitizing agents and gender

The duration of the clinical trials assessing the efficacy of the desensitizing agents was developed in 8 sessions, for 3 months: first assessment of patients (baseline) was effectuated after the preparation of vital abutments and the impression; 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup>, and 5<sup>th</sup> assessments, before the application of Gluma® desensitizer; 6<sup>th</sup> assessment before the insertion of the bridges on the vital abutments (the 7<sup>th</sup> day after the baseline); 7<sup>th</sup> assessment 2

weeks later; 8<sup>th</sup> assessment 3 months after the baseline. The trial evaluated on the 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 VAS scale used in this study is presented in figure 1.

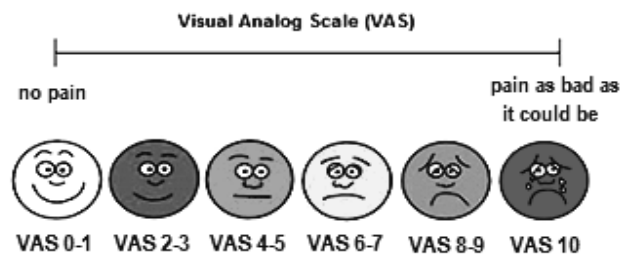


Figure 1. Visual analogue scale (VAS) used in study

## Results

The intensity of DS determined after the application of desensitizing agents is summarized in table 1.

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

- In the Ist batch (G) of in-office desensitization, in the first assessment the maximum "severe pain" (VAS = 10) was reported in 4 vital abutments (= 3.92%), in the 5th assessment and in the 8th assessment, the minimum "no pain", VAS = 0-1, was found in 42 (= 41.17%), respectively in 92 vital abutments (= 90.19%).
- In the IIInd batch (S) of at-home desensitization, in the first assessment the maximum "severe pain" (VAS = 10) was reported in 5 vital abutments (= 4.76%), in the 5th assessment and in the 8th assessment, the minimum "no pain", VAS = 0-1, was found in 30 (= 28.57%), respectively 80 vital abutments (= 76.19%).
- In the IIIrd batch (G+S) of in-office and at-home desensitization, in the first assessment the maximum "severe pain" (VAS = 10) was reported in 5 vital abutments (= 4.76%), in the 5th assessment and in the 8th assessment, the minimum "no pain", VAS = 0-1, was found in 49 (= 46.66%), respectively 101 vital abutments (= 96.19%).

- In the 7th, and 8th assessments, vital abutments of all 3 batches presented a visible decrease of DS, due to the

protection offered by the cemented restorations on their surface.

Table 1. Reported DS according to used Visual Analogue Scale (VAS)

Batch	I <sup>st</sup> Batch Gluma® Desensitizer (G) 30 patients, 102 vital abutments						II <sup>nd</sup> Batch Sensodyne® (S) 31 patients, 105 vital abutments						III <sup>rd</sup> Batch G+S 32 patients, 105 vital abutments					
	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 Ass	-	-	42	48	8	4	-	-	44	48	8	5	-	6	61	35	3	5
2 Ass	2	18	42	35	3	4	1	13	39	41	7	4	6	32	32	30	2	3
3 Ass	6	34	42	15	2	3	2	24	36	35	4	4	19	42	29	11	2	2
4 Ass	35	37	20	6	2	2	21	26	31	21	2	4	42	42	15	4	1	1
5 Ass	42	36	16	4	2	2	30	33	23	13	2	4	49	41	11	2	1	1
6 Ass	62	28	6	3	1	2	49	33	11	7	1	4	71	27	4	1	1	1
7 Ass	81	21	-	-	-	2	68	24	9	-	-	4	92	12	-	-	-	1
8 Ass	92	8	-	-	-	2	80	21	-	-	-	4	101	3	-	-	-	1

\*Ass = assessment

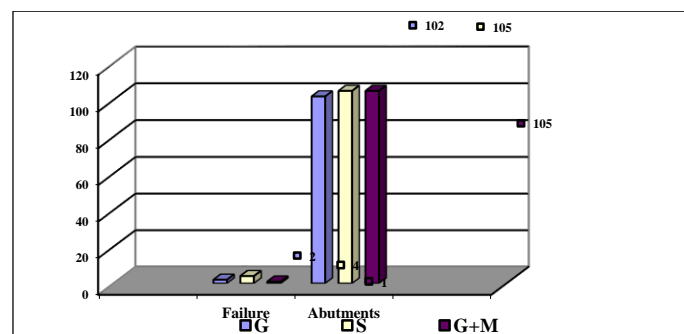
We emphasize the fact that after the 5<sup>th</sup> assessment, the fixed prosthetic restorations were cemented temporarily on the vital abutments. According to the quantified responses on the VAS scale, the insertion and cementation of restorations determined the reduction of the painful intensity in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

We also underline that VAS values were the lowest in the patients of the III<sup>rd</sup> batch (G+S), thus patients who received associated in-office and at-home desensitization, followed by VAS values of the I<sup>st</sup> batch of patients (G), which benefited only by in-office desensitization. VAS values in the II<sup>nd</sup> batch (S) with only at-home desensitization, were higher than in the other two batches. The yellowish color of the

boxes in table 1 indicate the maximum number of vital abutments, and the pink color of the boxes emphasizes the number of vital abutments which have required endodontic treatment.

The rate of failures in the batches (graph 2) was as following:

- In the I<sup>st</sup> batch (Gluma®, G) = 1.96%, and 2 vital abutments of 102 required vital extirpation.
- In the II<sup>nd</sup> batch (Sensodyne®, S) = 3.80%, and 4 vital abutments of 105 have imposed their vital extirpation.
- In the III<sup>rd</sup> batch (G+S) = 0.95%, and only 1 vital abutment of 105 needed endodontic treatment.



Graph 2. Rate of failures in batches of vital abutments

The results of the study revealed that DS decreased in all three groups, but the highest rate of desensitization was in the vital abutments of the third patients group, with in-office and at-home desensitization.

We recorded no side effects in the use of desensitizing agents.

## Discussion

Maintaining vitality of the pulp has the purpose to keep and treat the functionality of dental pulp tissues [24]. The treatment of dentinal wounds in vital abutments is different versus the resulting wound of a cavity preparation, because the varnishes and the liners used in cavities are covered and protected by the temporary or permanent fillings. The same materials, used for the protection of vital abutments, are dissolved by the oral fluid, and they will prejudice the quality of permanent cementation of fixed prosthetic restoration.

In their researches, Jackson et al [25], show that 5.7% of 603 analysed vital abutments required root canal therapy after the prosthetic restorations were cemented.

Goodacre et al [26] identified the incidence of complications associated with single crowns and fixed prosthetic restorations and the need for endodontic treatment appeared to be situated between in 3%-11%, by the type of prosthetic restoration used to restore the functionality of oro-facial system.

Favourable conditions for the healing of the pulp tissues after oral exposure demand a free of bacteria environment, absence of severe haemodynamic changes and absence of severe inflammatory cell infiltration. The degree of the defence reaction is in interdependence with the healing answer of the dental pulp tissues or with the extension of pulp inflammation [27].

Requirements of actual biomedical researches are to find new possibilities in recovering the dentin-pulp complex. Regenerative treatment in mild dentin lesions is applied to stimulate the constitution of peritubular dentin, to have effect in biosynthetic activity of odontoblasts, and to provide their survival [28].

Schüpbach et al [29], demonstrated that the glutaraldehyde of Gluma® desensitizer can intrinsically obturate the dentinal tubules by the genesis of deposition, which may counteract the hydrodynamic mechanism of dentin sensitivity.

The literature underlines that Gluma® Desensitizer components react with the albumin serum of the dentinal liquid, precipitate the protein, and that induces polymerization of HEMA. Gluma® Desensitizer has proven to penetrate the exposed dentinal tubules up to 200µ depth, which induces the restructuration of collapsed collagenous fibers, the apparition of multiple layers of protein septas, the hermetic sealing of dentinal tubules, and through that, acts as a microbial barrier, and inhibit bacterial growth (figure 2) [30-33].

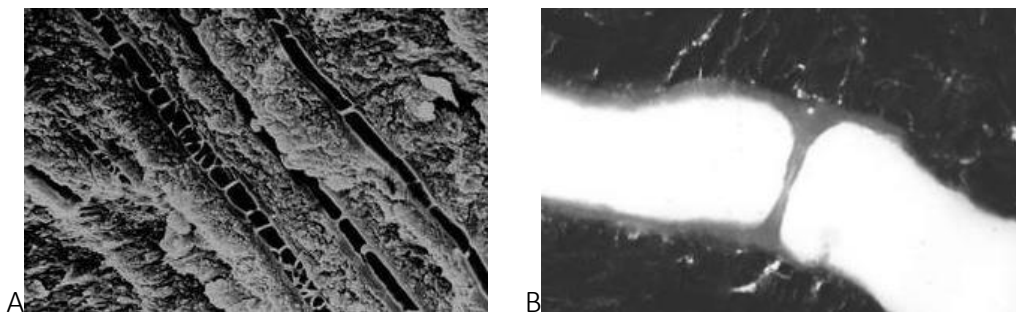


Figure 2. SEM of Gluma Desensitizer action: A. Gluma®-induced septa in dentinal tubuli; B. SEM magnification of a single Gluma®-induced septum in dentinal tube [34]

Sensodyne® repair and protect toothpaste which contains Novamin™ desensitising and concentrated calcium which is activated in contact with saliva, helps in repairing the

exposed dentine by building protective mineral layers over the sensitive areas [22].

The researches of Wang et al [35], respectively Zhong et al [36] demonstrated that

the use of new Novamin bioglass-containing Sensodyne toothpaste decrease the permeability and seal the dentinal tubules after teeth brushing.

In order to prevent the stimulation of the area with DS, patients have the tendency to avoid cleaning those teeth, particular drinks and food of their nourishment [37,38]. This attitude induces a vicious circle, which, unfortunately, often has an unpleasant end, represented by the loss of vitality of those teeth / vital abutments, and thus the failure of the therapy for maintaining the pulp organ vitality.

For a valuable management of DS condition, dentists should be open not only in DS detection, but also in the necessity of pertinent and correct diagnosis, for elimination of confounding factors from other oro-facial pain conditions [41].

Currently there are a lot of biomaterials for in-office or/and at-home use in reducing the DS, but none of the products represent the “gold standard” in the long term therapy of pulp vitality maintenance [39,40].

### Conclusion

- The benefits of the desensitizing agents used in the study was confirmed.
- The least invasive and cost effective therapy in the maintenance of pulp tissue vitality is represented by the use of desensitizing agents, both in-office and at-home.
- Controlled clinical trials and multicenter studies are necessary for implementation at-home use of the desensitizing agents in their daily utilization.

**Conflict of interest:** None to declare.

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