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Evaluation of desensitizing agents for the control of sensitivity in conventional fixed restorations

Avaliação de agentes dessensibilizantes para o controle da sensibilidade em restaurações fixas convencionais

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ABSTRACT

Objective: To evaluate and compare the effectiveness of the desensitizing agents Shield Force Plus, Fluor Protector S and Mi Paste Plus, in reducing post-tooth preparation sensitivity in conventional fixed restorations. **Material and Methods:** A randomized single-blind, controlled clinical experimental study was conducted with 32 participants requiring fixed metal-ceramic restorations. The participants were divided into four groups: SF (Shield Force Plus), FP (Fluor Protector S), MP (Mi Paste Plus), and Control. The desensitizing agents were applied three times: one day after tooth preparation, during the metal framework trial, and during the bisque trial. Sensitivity was assessed using a visual analog scale (VAS) by applying blasts of cold air in four visits at two-day intervals. To compare the perception of sensitivity between the quotes, the Friedman test was used followed by the Nemenyi Post hoc Test. Decreased sensitivity between desensitizing agents was assessed with the Kruskal-Wallis test, followed by Dunn's post hoc test. The level was set at 5%. **Results:** Shield Force Plus reduced tooth sensitivity similarly to Fluor Protector S ($p > 0.05$) in teeth prepared for fixed prostheses. Additionally, Shield Force Plus was statistically more effective in reducing tooth sensitivity compared to Mi Paste Plus ($p < 0.05$). Significant differences in tooth sensitivity were noted between the evaluation sessions for all desensitizing agents ($p < 0.05$). **Conclusion:** In this study, Shield Force Plus was the most effective desensitizing agent for reducing post-tooth preparation sensitivity, followed by Fluor Protector S.

KEYWORDS

Desensitizing agents; Fixed restoration; Tooth sensitivity; Visual analogue scale; Vital dental preparation.

RESUMO

Objetivo: Avaliar e comparar a eficácia dos agentes dessensibilizantes Shield Force Plus, Fluor Protector S e Mi Paste Plus na redução da sensibilidade pós-preparo dental em restaurações fixas convencionais. **Material e Métodos:** Um ensaio clínico experimental controlado, randomizado e simples-cego foi conduzido com 32 participantes que necessitavam de restaurações fixas metalocerâmicas. Os participantes foram divididos em quatro grupos: SF (Shield Force Plus), FP (Fluor Protector S), MP (Mi Paste Plus) e Controle. Os agentes dessensibilizantes foram aplicados três vezes: um dia após o preparo dental, durante a prova da infraestrutura metálica e durante a prova da cerâmica. A sensibilidade foi avaliada utilizando uma escala visual analógica (EVA) através da aplicação de jatos de ar frio em quatro visitas com intervalos de dois dias. Para comparar a percepção da sensibilidade entre as avaliações, o teste de Friedman foi utilizado, seguido pelo teste post hoc de Nemenyi. A diminuição da sensibilidade entre os agentes dessensibilizantes foi avaliada com o teste de Kruskal-Wallis, seguido pelo teste post hoc de Dunn. O nível de significância foi definido em 5%. **Resultados:** Shield Force Plus reduziu a sensibilidade dental de forma semelhante ao Fluor Protector S ($p > 0,05$) em dentes preparados para próteses fixas. Além disso, Shield Force

Plus foi estatisticamente mais eficaz na redução da sensibilidade dental em comparação com Mi Paste Plus ($p < 0,05$). Diferenças significativas na sensibilidade dental foram observadas entre as sessões de avaliação para todos os agentes dessensibilizantes ($p < 0,05$). **Conclusão:** Neste estudo, Shield Force Plus foi o agente dessensibilizante mais eficaz para reduzir a sensibilidade pós-preparo dental, seguido por Fluor Protector S.

PALAVRAS-CHAVE

Agentes dessensibilizantes; Restauração fixa; Sensibilidade dental; Escala visual analógica; Preparo dental vital.

INTRODUCTION

Effective pain management during and after dental treatment is crucial for both the patient and the clinician. Properly addressing dentin sensitivity can significantly enhance the psychological acceptance of dental procedures, leading to increased patient satisfaction and an improved quality of life [1]. Modern dentistry employs minimally invasive techniques, which reduces the likelihood of dentin sensitivity [2,3]. However, traditional prosthetic treatments, such as crowns and bridges, are still commonly performed. It is noted that tooth wear from these treatments can expose one to two million dentinal tubules to the oral environment [4], increasing the risk of bacterial leakage and potential sensitivity following tooth preparation [5].

Various studies have demonstrated the effectiveness of desensitizing agents in cases of gingival recession [6], tooth whitening [7], and periodontal therapy [8]. However, due to the limited documentation reported so far, its use in dental preparations for fixed restorations still requires further investigation. In a clinical trial conducted by Sayed et al. [9], the effectiveness of three desensitizing agents in dental preparations for fixed restorations was evaluated. The trial involved three separate applications of the agents at different times, and the results showed that both Gluma Desensitizer and Shield Force Plus were more effective from their first application. Another study by Abdollahi and Jalalian [10] reported that fluorinated varnish (Bifluride 10) effectively reduced sensitivity in teeth prepared for fixed restorations, with the effectiveness lasting even after the cementation process.

The scientific literature strongly supports the use of fluoride varnishes to control dentin sensitivity. Nardi et al. [11] highlight the prolonged effectiveness of these varnishes, noting positive results 30 and 90 days after application. In their study, the Fluor Protector S product showed superior efficacy compared to other desensitizing agents.

On the other hand, there are also remineralizing products that contain potassium nitrate (KNO3) or casein phosphopeptide-amorphous calcium phosphate (CPP-ACP). Mahesuti et al. [12] demonstrated the effectiveness of these compounds in reducing dentin sensitivity, with effects lasting between 30- and 60-days post-application. Similarly, Yassin and Milly [13] corroborated this efficacy using the Mi Paste Plus agent, observing a significant decrease in postoperative sensitivity after teeth whitening procedures, with favorable results noted just three days after application.

The sensitivity experienced after placing fixed prostheses is one of the most common issues encountered during the first three years of follow-up. This is often accompanied by recurrent caries and periodontal problems [14]. These findings emphasize the importance of implementing preventive strategies to ensure the longevity of these treatments. However, access to effective desensitizing agents for fixed prostheses is limited in several Latin American countries. This limitation highlights the need to explore alternative solutions that can achieve similar outcomes in managing post-treatment sensitivity.

Therefore, the current study aimed to assess the effectiveness of two desensitizing agents, Fluor Protector S (Ivoclar Vivadent, Schaan, Liechtenstein) and Mi Paste Plus (GC Corporation, Tokyo, Japan), in comparison to Shield Force Plus (Tokuyama Dental America Inc., San Diego, CA, USA) for use in dental preparations for conventional fixed prostheses.

MATERIAL AND METHODS

Ethical considerations

This study adhered to the CONSORT guidelines [15]. The study received approval from the Research Ethics Committee of the Faculty of Health Sciences at the Private University of Tacna (FACSA-CEI/070-07-2023). It was conducted in

accordance with the ethical principles outlined in the Declaration of Helsinki and the guidelines proposed by Emanuel et al. [16].

All participants who agreed to take part in the study signed an informed consent form that detailed the associated risks of their participation.

Study design

This research was conducted using a randomized, single-blind, parallel-controlled exploratory clinical experimental design.

Participants

The number of participants was calculated using a one-way fixed effects ANOVA model with the G*Power software version 3.1.9,7 (Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany). We considered an effect size of 0.87 calculated from the results of a previous study [9], an $\alpha = 0.05$, and a power of 90%. The minimum calculated sample size was 24 participants, providing a power of 91.2%, with six participants required for each group.

Additionally, a 20% adjustment for participant loss was considered, resulting in a final minimum sample size of 31 participants. To maintain the same number of subjects in each study group, the sample was set at 32 participants (n=8 per each group).

Participants of both sexes, aged between 20 and 55 years, were included in the study [17], who required single fixed partial restorations or three-piece bridges (metal-ceramic) in the maxilla, with vital teeth, without periodontal compromise and without previous direct restorations that will involve more than 50% of the tooth surface. Participants with systemic conditions or diseases, presence of macroscopic oral lesions, allergy to lidocaine, history of adverse reactions to local anesthetics, pregnant women, and people who would participate in other clinical studies were excluded. This information was evaluated through a medical history and an oral clinical examination during recruitment.

Participant recruitment

The study was conducted in accordance with the established eligibility criteria, beginning on July 24, 2023, and concluding on September 19, 2023. Advertisements on social networks and information brochures were used to recruit participants, which contained a summary of the study and the contact details of the principal investigator [18]. After arranging interviews, additional information about the study was provided, and a medical history was taken along with an oral clinical examination. This process was finished once the minimum required number of participants who had signed an informed consent form was reached before starting any intervention.

Distribution and masking of participants

Participants were randomly assigned to four groups in this study. The study was single-blind, meaning only the participants were unaware of their assigned group. The allocation of participants was based on whether they received a desensitizing agent or were placed in the control group. The Research Randomizer Form 4.0 software (Social Psychology Network, Middletown, CT, USA) was used for randomization. The distribution was as follows: SF Group with Shield Force Plus (n=8), FP Group with Fluor Protector S (n=8), MP Group with Mi Paste Plus (n=8), and Control Group (control) with the application of glycerin (n=8).

Sensitivity evaluation

Sensitivity was assessed using a Visual Analog Scale (VAS), which featured a 100 mm straight line marked from 0 to 10, with 0 signifying no sensitivity and 10 denoting very intense sensitivity. This methodology is widely used in clinical trials to measure pain in various clinical situations, including its application in dentistry [19-21].

Clinical interventions

The desensitizing agents were applied following the manufacturer's instructions (Table I). All clinical experimentation began on September 23 and ended on November 2, 2023. All clinical experiments were closely supervised by the principal investigator, both in person and by phone, to ensure that participants encountered no issues during the process. Additionally, the experiments were conducted within the established timeframes after obtaining informed consent from the participants.

First session: Local anesthesia was administered using 2% lidocaine with epinephrine (1:80,000), delivering 1.80 ml per tooth to be treated. With walls prepared at a convergence

Table I - Description of desensitizing agents used in the study

Desensitizing Agent	Composition	Mechanism of action	Indications for use
Shield Force Plus (Tokuyama Dental America Inc., San Diego, CA, USA) Batch: 140E22	Resin matrix 10-30% 2- (HEMA), 10-30% dis(2-hydroxypropoxy) bisphenol A dimethacrylate, 10-30% phosphoric acid monomer, 30-60% propan-2-ol, 5-10% triethylene glycol dimethacrylate, 5-10% water	Double locking mechanism: the calcium in the tooth substance and the adhesive monomer react to form the first block. The volatilization and photoactivation of the agent act as a second block at the level of the dentinal tubules (50 µm), forming resin tags.	After cleaning the tooth surface, apply Shield Force Plus directly to the exposed dentin with a micro-applicator. Air dry for 5 seconds and light cure for 10 seconds. Make sure you cover all sensitive areas.
Fluor Protector S (Ivoclar Vivadent, Schaan, Liechtenstein). Batch: Z04C0Z	Contains 1.5% ammonium fluoride in a varnish base with ethanol and water as solvents. The fluoride content is equivalent to 0.77%, or 7700 parts per million (ppm) in Solution, this increases after application pH: 5.0-6.5	Control of demineralization and remineralization is achieved by depositing a layer of calcium fluoride. This hinders acid demineralization and blocks open dentinal tubules. Thanks to its low viscosity, the material penetrates up to 10 µm into the tubules, effectively blocking their entrances.	It is applied in a thin layer to clean and dry tooth surfaces with a soft brush or applicator. Let the varnish settle independently, and avoid eating or drinking for at least 30 minutes after application.
Mi Paste Plus (GC Corporation, Tokyo, Japan) Batch: 230214G	Contains RECALDENT™* with incorporated Fluoride (CPP-ACPF). The Fluorine level is 0.2% by weight (900ppm)	CPP–ACP molecules bind to biofilm, plaque, bacteria, hydroxyapatites, and adjacent soft tissue. Induces remineralization. Reduces hypersensitivity by occluding open dentinal tubules.	Apply a small amount of Mi Paste Plus to your teeth and let it sit for 3 minutes. Spit out excess without rinsing, and avoid eating or drinking for 30 minutes.

angle of 12°. The occlusal surfaces were reduced to 1.5 mm, and the axial surfaces to 1 mm, utilizing truncated conical diamond burs (850-010 MDT, Afula, Israel) with a high-speed handpiece (NSK Pana-Max, Tochigi, Japan) with abundant irrigation. To control wear, a Zeta Labor silicone matrix (Zhermack SpA, Badia Polesine, Italy) was used, obtained before tooth preparation [22-24]. The provisional restoration was made with Primma Art (FGM Dental Group, Joinville, Santa Catarina, Brazil) and was cemented with CharmTemp NE (Dentkist Inc., South Korea). The participant was scheduled for a follow-up session two days later to conduct the first sensitivity measurement of the prepared tooth. This timing was chosen to account for the varying duration of local anesthesia effects, which can differ among patients. The decision was made to refrain from performing the measurement during the initial session in order to prevent any potential biases.

Second Session: During this session, the first sensitivity measurement of the previously prepared tooth was conducted. The provisional restoration was removed, and gentle bursts of cold air were applied using a triple syringe. The air was directed at a distance of 1 cm, with a flow rate of 5 L/min, for 2 to 3 seconds over the entire surface of the single abutment tooth. To minimize measurement bias, the examiner covered the adjacent teeth with their index and middle fingers. Dental sensitivity was recorded using a visual analog scale (VAS), allowing the participant to indicate their level of discomfort. After this, the desensitizing agent corresponding to each experimental group was applied. A final impression was taken using addition silicone (I-Sil, Spident Co. Ltd., South Korea) following the one-step impression technique [25]. Once the procedure was completed, the provisional restoration was cemented, and the next appointment was scheduled for two days later.

Third session: The provisional restoration was removed, and gentle bursts of cold air were used to take a second measurement of dental sensitivity, utilizing VAS. Then, the metal structure trial was performed, and its proper adaptation was confirmed. Following this, the desensitizing agent relevant to each experimental group was applied for the second time. After completing this procedure, the provisional restoration was cemented back in place, and the participant was scheduled for the next session in two days.

Fourth session: The provisional restoration was removed, and gentle bursts of cold air were applied to obtain the third measurement of dental sensitivity using VAS. After validating

the bisque trial based on the aesthetic and functional parameters, the third application of the desensitizing agent corresponding to each experimental group was carried out. Once the procedure was completed, the provisional restoration was replaced and the next session was scheduled for two days later.

Fifth session: The provisional restoration was removed, and gentle bursts of cold air were applied to assess dental sensitivity. This assessment was recorded using VAS. After this information was collected, the final restoration was permanently cemented using Ketac Cem (3M, St. Paul, Minnesota, United States).

The same methodology was applied to the control group, using glycerin as placebo instead of desensitizing agents.

Statistical analysis

Statistical analysis was performed with STATA 17 (Stata Corp LP, College Station, TX, USA) and R studio V. 3.6.1 software (R Foundation for Statistical Computing, Vienna, Austria). The descriptive analysis included frequency measures and measures of central tendency and dispersion. The Friedman test for repeated measures, followed by the Nemenyi Post Hoc test, was used to contrast hypotheses. The relationship between age and dental sensitivity was examined using Spearman's rank correlation coefficient. Comparison of dental sensitivity based on sex was assessed with the Mann-Whitney U test. To evaluate whether there are differences between the different desensitizing agents, the Kruskal-Wallis test was used. A significance level of 5% was set for all tests.

RESULTS

Initially, 38 potential participants were evaluated, but six were excluded for not meeting the selection criteria. A total of 32 participants were included in the study: 20 women and 12 men, with an average age of 35.53 ± 9.91 years (ages ranging from 22 to 55). Participants were allocated randomly to the study groups (Figure 1). The characteristics of the participants in each study group are presented in Table II.

The Friedman test indicated significant differences in dental sensitivity based on the type of desensitizing agent used during measurement appointments ($p<0.05$). For Shield Force Plus, significant differences were observed during the third and fourth measurement compared to the first reading. In the case of Fluor Protector

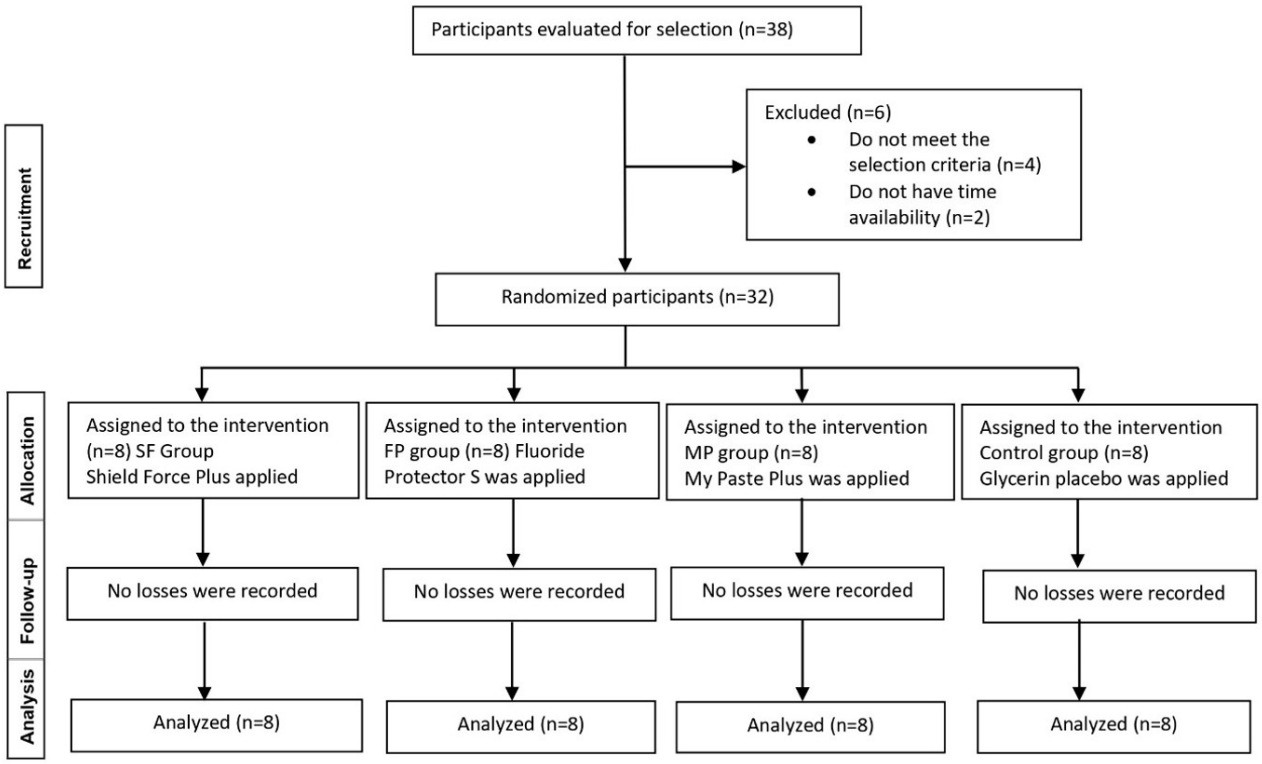

Figure 1 - Flowchart of the participants in the clinical trial according to CONSORT.

S, there was a significant difference during the fourth reading compared to the first and second measurement ($p<0.05$). At the same time, there was no significant difference compared to the third measurement ($p>0.05$). Regarding Mi Paste Plus, a significant difference was found during the fourth measurement compared to the first and second reading ($p<0.05$). In the Control Group, no significant difference was observed across all measurements. These findings are summarized in Table III.

Furthermore, the correlation between age and dental sensitivity as reported by participants during the evaluation sessions was analyzed. The results indicated that the correlations observed in all cases were weak and not significant ($p>0.05$) (Table IV).

Table V presents a comparison of dental sensitivity based on the sex of the participants. The results indicated marginally significant differences between men and women in the MP group during the first and second evaluation appointments ($p=0.048$). Similar differences were also observed in the FP group during the second and third evaluation appointments ($p<0.05$).

Table II - Characteristics of the participants (n=32)

Variable	Desensitizing Agent			
	SF Group n(%)	FP Group n(%)	MP Group n(%)	Control Group n(%)
Sex				
Female	6(75.0)	6(75.0)	3(37.5)	5(62.5)
Male	2(25.0)	2(25.0)	5(62.5)	3(37.5)
Age*	35.2±9.9	34.6±11.9	35.6±9.1	36.7±10.4
Age by sex*				
Female	32.5±6.7	31.2±10.8	42.5±6.7	35.0±10.3
Male	43.0±16.9	45.0±11.3	31.4±8.0	39.6±12.2
Segment				
Anterior	4(50.0)	3(37.5)	3(37.5)	3(37.5)
Posterior	4(50.0)	5(62.5)	5(62.5)	5(62.5)

*Expressed as mean ± standard deviation.

Table III - Perception of sensitivity during appointments according to desensitizing agent

Desensitizing Agent	Dental sensitivity measurements (VAS)				
	First	Second	Third	Fourth	p-value*
	Median (IQR)	Median (IQR)	Median (IQR)	Median (IQR)	
SF Group	10(0.5)^{a}	9(1)^{ab}	6(1)^{b}	3(1.5)^{c}	<0.001
FP Group	10(0)^{a}	10(1)^{a}	8(1.5)^{ab}	7(2)^{b}	<0.001
MP Group	10(0.5)^{a}	10(0.5)^{a}	10(1)^{ab}	9(1)^{b}	<0.001
Control Group	10(0)	10(0.5)	10(1)	9.5(1)	0.066

IQR: Interquartile range; VAS: Visual analog scale. *Friedman test followed by Nemenyi post hoc test. Different superscript letters in rows indicate significant differences in dentin sensitivity between appointments.

Table IV - Correlation between age and dental sensitivity

Variable	Desensitizing Agent	Dental sensitivity measurements (VAS)			
		First ρ (p-value)	Second ρ (p-value)	Third ρ (p-value)	Fourth ρ (p-value)
Age	SF Group	-0.65(0.077)	-0.22(0.581)	-0.49(0.211)	-0.01(0.975)
	FP Group	-0.58(0.100)	-0.22(0.574)	-0.24(0.559)	-0.35(0.381)
	MP Group	-0.50(0.202)	-0.50(0.202)	-0.35(376)	0.05(0.890)
	Control Group	0.41(0.376)	0.25(0.547)	0.03(0.947)	0.15(0.703)

ρ: Spearman's rank correlation coefficient.

Table V – Comparison of dental sensitivity according to sex between the participants

Desensitizing Agent	Sex	Dental sensitivity measurements (VAS)							
		First		Second		Third		Fourth	
		Median (IQR)	p-value*	Median (IQR)	p-value*	Median (IQR)	p-value*	Median (IQR)	p-value*
SF Group	Male	9(2)	0.275	7.5(3)	0.210	6(0)	1.000	3(2)	0.860
	Female	10(0)		9(1)		6(2)		3(1)	
FP Group	Male	9.5(1)	0.083	9(0)	0.048*	6.5(1)	0.039*	5(0)	0.067
	Female	10(0)		10(0)		8.5(1)		7(0)	
MP Group	Male	10(0)	0.048*	10(0)	0.048*	10(0)	0.168	9	0.860
	Female	9(1)		9(1)		9(2)		9(1)	
Control Group	Male	10(0)	0.438	10(0)	0.236	10(1)	0.730	9(1)	0.744
	Female	10(0)		10(1)		10(1)		10(1)	

IQR: Interquartile range. *Mann–Whitney U test. p<0.05.

Table VI - Multiple comparisons between desensitizing agents on decreased sensitivity

Dunn´s multiple comparison test		Differences in rank sum	p-value
FP Group	SF Group	1.630207	0.309
	MP Group	2.169118	0.090
	Control Group	3.017903	0.008*
MP Group	SF Group	3.799324	<0.001**
	Control Group	0.848785	1.000
SF Group	Control Group	4.648110	<0.001**

* p<0.01, ** p<0.001.
Note. p-value adjusted by the Bonferroni method.

The Kruskal-Wallis test revealed significant differences in sensitivity reduction between the first and last measurements among the groups (p<0.001). Dunn's post hoc test showed that sensitivity decrease observed in the Shield Force Plus group was similar to that of the Fluor Protector S group (p=0.309). However, it differed significantly from the Mi Paste Plus group (p<0.001). The Fluor Protector S group displayed a decrease in sensitivity comparable to the Mi Paste Plus group (p=0.090). No significant differences were observed between the Mi Paste Plus group and the control group (p=1.000). These findings are summarized in Table VI.

DISCUSSION

In this study, the evaluated desensitizing agents demonstrated varying levels of effectiveness in reducing dental sensitivity, with Shield Force Plus proving to be the most effective. This effectiveness can be attributed to its chemical composition, which includes a resinous matrix, phosphate monomer, bisphenol A-glycidyl methacrylate, triethylene glycol dimethacrylate and 2-hydroxyethyl methacrylate, in addition to its double-blocking mechanism: the first block occurs when the adhesive monomer reacts with dental calcium, while the volatilization and photoactivation of the agent provide the second blockage at the level of the dentinal tubules (50 μm), creating resin tags [26].

Considerations for including alternative desensitizing agents in this investigation were based on results from previous studies demonstrating the effectiveness of all three desensitizing agents in various clinical settings [11,13,27,28]. However, our study was mainly based on the findings of Sayed et al. [9], who evaluated the effectiveness of three desensitizing agents in dental preparations for fixed restorations, pointing out that Shield Force Plus showed outstanding effectiveness against thermal (cold) and electrical stimuli. This study was conducted over three appointments, with 15-day intervals between visits. During these appointments, three sensitivity measurements were taken using a visual analog scale (VAS), and desensitizing agents were applied three times.

A verbal telephone evaluation was conducted fifteen days after cementation. Our study utilized a different methodology compared to previous research. It involved five appointments, during which we applied the desensitizing agent three times and assessed sensitivity to cold air four times, using a Visual Analog Scale (VAS) at two-day intervals. This approach more closely resembles standard clinical practices in conventional prosthetic treatments, where appointments are typically not spaced so far apart. This allowed us to evaluate the effectiveness of desensitizing agents in a clinical setting that accurately reflects the actual timeframe required for these treatments. Savithqa et al. [29] conducted a study on the effects of cold air on prepared tooth surfaces for full crowns. They evaluated the tooth sensitivity at five different intervals: before preparation, after preparation, after the application of desensitizers, just before cementation, and again after a 30-day follow-up period, though they did not specify the exact time between appointments. Likewise, Gupta et al. [30], determined the effectiveness of three desensitizing agents before and after the cementation of complete dental crowns. Their study assessed sensitivity levels at four intervals: one week after applying the desensitizing agent, immediately before cementation, and at five minutes, one day, and one-week post-cementation. Their study assessed sensitivity levels at four intervals: one week after applying the desensitizing agent, immediately before cementation, and at five minutes, one day, and one-week post-cementation.

Participants using Fluor Protector S showed decreased sensitivity levels after the second application, with more significant reductions observed after the third and fourth applications. Some researchers attribute this effect to its composition, which contains 7700 ppm of fluoride, and its ability to create a thin layer on the substrate surfaces. A study indicates that its mechanism of action involves the formation of fluorapatite, which effectively seals the dentinal tubules and promotes the development of secondary dentin [11].

The use of fluoride varnishes in dental preparations for fixed restorations has not been extensively studied. Abdollahi and Jalalian [10] evaluated the effectiveness of a fluoride varnish and another desensitizing agent after tooth preparation for full crowns. Their study demostrated a significant reduction in sensitivity between appointments, which aligns with the results obtained in our study using Fluor Protector S. Additionally, immediate pain was reported after applying fluoride varnish followed by an air spray, a sensation that several participants in our study also experienced until the second application.

The effectiveness of Mi Paste Plus in reducing sensitivity was almost nonexistent, even after three applications. This could be because its formulation, based on the CPP-ACP complex, is primarily designed to remineralize tooth enamel. This agent is most effective in remineralizing early lesions, such as white spots, by providing calcium and phosphate that integrate into damaged enamel, which may help reduce sensitivity at that level [31]. However, dentin does not respond similarly to this remineralizing process, and there is no documented evidence of its effectiveness in clinical situations involving dental preparations for fixed restorations.

Therefore, Using the desensitizing agents evaluated in this study, which have proven efficacy, can significantly enhance the outcomes of fixed prosthetic treatments in everyday clinical practice. Additionally, it has been noted that repeated applications can further increase their effectiveness.

This study assessed the effectiveness of desensitizing agents with various mechanisms of action, comparing them to a well-known product recognized for its efficacy, such as Shield Force Plus. Additionally, the findings indicate that age and sex do not influence perceptions of dental sensitivity. Despite using a randomization process to assign participants to different groups, the small sample size influenced the distribution of participants by sex, so the findings should be interpreted with caution. Although it has been suggested that sex may be a confounding variable in assessing pain, other studies have concluded that sex is not a significant factor in dentin sensitivity [32,33]. Additionally, since age is related to dental sensitivity, an age range was considered to minimize its impact on the results, as suggested by other researchers [17].

There are some limiting factors that need to be considered in this clinical trial. Firstly, although the Visual Analogue Scale is generally recognized for its validity and reliability [34], the subjective nature of self-reporting can influence the results. This is largely because pain intensity is evaluated based on each participant's personal perception, which may be influenced by both physiological and emotional factors. Secondly, in this investigation, it was not possible to follow-up

dental sensitivity after the cementation of the crowns. This was primarily due to the treatment and prosthetic coverage applied, which are factors that tend to diminish symptoms. However, the literature indicates that sensitivity in teeth with fixed prostheses can emerge up to two years after cementation [14].

The inclusion of placebo controls was an important strength of this trial. It provided a reference point for evaluating the relative effectiveness of Shield Force compared to the other treatments. This approach ensured the internal validity of the study design and helped establish the clinical margin of equivalence.

CONCLUSION

Among the desensitizing agents analyzed, Fluor Protector S effectively reduced tooth sensitivity, although its effectiveness was lower than that of Shield Force Plus. In contrast, Mi Paste Plus showed results similar to those of the control group, indicating that it was not effective in reducing post-preparation sensitivity.

Repeated applications of desensitizing agents during each session proved to be more beneficial than a single application. This suggests that the frequency of use can significantly impact their effectiveness.

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Author's Contributions

JGTB: Conceptualization, Methodology, Resources, Validation, Investigation, Writing – Original Draft Preparation, Supervision, Project Administration. MAST: Resources, Validation, Formal Analysis, Investigation, Data Curation, Writing – Review & Editing, Visualization. NABKG: Resources, Supervision, Investigation, Writing – Review & Editing. ADZM: Investigation, Resources, Writing – Original Draft Preparation. WGEO: Methodology Supervision, Project Administration, Investigation, Writing – Review & Editing, Visualization.

Conflict of Interest

The authors have no conflicts of interest to declare.

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Regulatory Statement

This study was carried out according to all the provisions and policies of the Research Ethics Committee of the Faculty of Health Sciences of the Private University of Tacna, following the recommendations of CONSORT and the Declaration of Helsinki (revised in 2000). The approval code for this study is FACSA-CEI/070-07-2023.

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