SCT Proceedings in Interdisciplinary Insights and Innovations. 2025; 3:411
doi: 10.56294/piii2025411

Category: Applied Research in Health and Medicine

ORIGINAL

Marginal microleakage at the tooth-material interface with different types of sealants. Application of the ultrasonic sealant technique

Microfiltración marginal en la interfase diente-material ante distintos tipos de selladores. Aplicación de la técnica sellante con ultrasonido

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Cite as: González RC, Saldaña J. Marginal microleakage at the tooth-material interface with different types of sealants. Application of the ultrasonic sealant technique. SCT Proceedings in Interdisciplinary Insights and Innovations . 2025 Jan. 1;3:411. DOI: https://doi.org/10.56294/piii2025411

Submitted: 12-09-2025 **Reviewed:** 27-11-2024 **Accepted:** 03-01-2025 **Published:** 05-01-2025

Editor: Emanuel Maldonado

ABSTRACT

Introduction: Pit and fissure sealants are the most effective method of prevention, since they act as a physical barrier preventing the entry of microorganisms into these hard-to-reach areas during brushing and self-cleaning carried out by saliva. The effectiveness of sealants depends mainly on retention on the tooth surface and microleakage is the factor most linked to their failure. Microleakage is defined as the passage of molecules, bacteria or fluids between the cavity walls and the restorative material and is the result of an inadequate application protocol, tooth preparation techniques, the chemical composition of the material and shrinkage due to polymerization. The most commonly used sealant materials are resin-based, since in theory they present less microleakage than ionomers. The most recent ones have incorporated nanometric inorganic filler particles (0.005 - 0.01 microns) in their composition in order to improve their physical-mechanical properties and reduce polymerization shrinkage.
Objectives: To evaluate the degree of microleakage of the tooth-material interface in premolars and third molars using the ultrasound technique with three different materials. Sealer, Vitreous Ionomer and Fluid Resin.
Materials and methods: An in vitro, comparative and transversal study was carried out on 30 dental pieces (premolars and third molars), randomly divided into 3 study groups of 10 pieces each, sealed with different types of materials. The groups were divided into A (sealant), B (vitreous ionomer) and C (flow composite) in order to evaluate the degree of microleakage of the different materials used. For the cavity preparations, the enamel surface was etched with 37% phosphoric acid propelled with a micromotor and a dental pneumatic cavitator tip with a small rubber band and a k 10 file for 15 seconds. Subsequently, they were sealed with different types of materials to evaluate the degree of microleakage, analyzed by direct observation.
Group A: Sealer (Conseal f and Conseal)
Group B: Vitreous Ionomer (Riva Light Cure)
Group C: Flow Composite (Flow Wave)

The materials used during the investigation are SDI brand.
Results: The material that showed the highest degree of microfiltration was the one used in group B (vitreous ionomer) with 2 out of 10 pieces filtered. Group A (sealant) and group C (flow composite) obtained better results: 1 out of 10 pieces filtered in both cases. Direct observation showed that all three groups presented marginal microleakage, to a lesser or greater degree. It could not be determined that the permanence of the materials depended on the morphology of the dental pieces, since it was mixed, that is to say, they were detached in premolars as well as in third molars.
Conclusion: In comparison with groups A and C, the marginal microleakage observed was significantly higher in group B (vitreous ionomer). However, marginal microleakage was present in all three groups, to a lesser or greater degree. Therefore, we estimate that there will always be a percentage probability of this occurring.

Keywords: pit and fissure sealants; microfiltration; vitreous ionomer; composite Flow; ultrasonic etching.

RESUMEN

Introducción: Los selladores de fosas y fisuras son el método de prevención más eficaz, ya que actúan como barrera física evitando el ingreso de microorganismos a estas zonas de difícil acceso durante el cepillado y la autolimpieza llevada a cabo por la saliva. La efectividad de los selladores depende principalmente de la retención en la superficie dental y la microfiltración constituye el factor más vinculado a su fracaso. La microfiltración se define como el paso de moléculas, bacterias o fluidos entre las paredes de la cavidad y el material restaurador y es el resultado de un inadecuado protocolo de aplicación, de técnicas de preparación dentaria, de la composición química del material y de la contracción derivada de la polimerización. Los materiales selladores más utilizados están elaborados a base de resina, ya que en teoría presentan menor microfiltración que los ionómeros. Los más recientes han incorporado partículas inorgánicas de relleno nanométricas (0.005 - 0.01 micrones) en su composición con el fin de mejorar sus propiedades físico-mecánicas y disminuir la contracción por polimerización.
Objetivos: Evaluar el grado de microfiltración de la interfase diente – material en premolares y terceros molares utilizando la técnica de ultrasonido con tres materiales distintos. Sellador, Ionómero Vitreo y Resina fluida.
Materiales y métodos: Se efectuó un estudio in vitro, comparativo y transversal de 30 piezas dentarias (premolares y terceros molares), divididas en 3 grupos de estudio de forma aleatoria, de 10 piezas cada uno, selladas con distintos tipos de materiales. Los grupos se dividieron en A (sellador), B (ionómero vítreo) y C (composite flow) con el objetivo de evaluar el grado de microfiltración de los diversos materiales empleados. Para las preparaciones cavitarias se realizó el grabado de la superficie de esmalte con ácido fosfórico al 37 % propulsado con micromotor y punta de cavitador neumático odontológico con goma elástica pequeña y lima k 10 durante 15 segundos. Posteriormente, fueron selladas con distintos tipos de materiales para evaluar el grado de microfiltración, analizado por observación directa.
Grupo A: Sellador (Conseal f y Conseal)
Grupo B: Ionómero Vítreo (Riva Light Cure)
Grupo C: Composite Flow (Flow Wave)
Los materiales utilizados durante la investigación son de la marca SDI.
Resultados: El material que demostró mayor grado de microfiltración fue el utilizado en el grupo B (ionómero vítreo) con 2 de 10 piezas filtradas. El grupo A (sellador) y el grupo C (composite flow) obtuvieron mejor resultado: 1 de 10 piezas filtradas en ambos casos. Mediante la observación directa

se advirtió que los tres grupos presentaron microfiltración marginal, en menor o mayor grado. No se pudo determinar que la permanencia de los materiales dependa de la morfología de las piezas dentarias, ya que fue mixta, es decir, se desprendieron tanto en premolares como en terceros molares.
Conclusión: En comparación con los grupos A y C, la microfiltración marginal observada fue significativamente mayor en el grupo B (ionómero vitreo). Sin embargo, en los tres grupos se presentó microfiltración marginal, en menor o mayor grado. Por consiguiente, estimamos que siempre va a existir un porcentaje de probabilidad de que esto ocurra.
Palabras clave: selladores de fosas y fisuras; microfiltración; ionómero vítreo; composite Flow; grabado con ultrasonido.

INTRODUCTION

Historically, advances in caries prevention have been marked by the introduction of new techniques and materials. In the past, caries treatment focused on the mechanical removal of the affected tooth structure, which often involved the loss of healthy tissue. With the introduction of the acid etching technique in 1955 by Buonocore, the foundations were laid for developing pit and fissure sealants, a less invasive and more tissue-preserving approach. Initially based on resins such as BIS-GMA, these materials have evolved significantly, incorporating properties such as fluoride release and better adaptation to enamel.

Dental sealants have proven effective in preventing caries on occlusal surfaces by creating a physical barrier that prevents the accumulation of microorganisms and facilitates cleaning. However, their effectiveness depends on several factors, including proper patient selection, application technique, and the quality of the material used. In addition, adherence to regular checkups is essential to ensure sealant integrity and prevent complications such as microleakage, which can compromise dental health.

Numerous clinical and experimental studies evaluating their cost-benefit and efficacy in different contexts have supported developing and applying pit and fissure sealants. Research such as that of Leverett et al. has highlighted the cost-effectiveness of sealants in patients with active caries. At the same time, other studies have explored the influence of socioeconomic factors on their use. Despite their proven efficacy, sealant use remains limited in many populations, underscoring the need for educational and health promotion strategies to increase adoption.

In the field of materials used as sealants, the variety available makes it possible to tailor the choice to each patient's profile and clinical conditions. Sealants can be classified according to their composition (fluoride or non-fluoride), texture (filled or unfilled), and presentation (self-curing or light-curing). Each type of sealant has advantages and limitations that the practitioner should consider at the time of application. For example, sealants with fluoride offer the additional benefit of releasing this ion, contributing to the remineralization of the surrounding enamel, while sealants with a filler present more excellent resistance to mechanical wear.

Techniques have evolved in sealant placement to maximize effectiveness and minimize associated risks. From conventional occlusal sealing to more advanced techniques, such as opening with fistulotomy drills or the use of ultrasonic devices, the aim is to ensure optimal adhesion and complete coverage of vulnerable surfaces. In addition, complementary procedures such as angioplasty have proven helpful in modifying the morphology of fissures and improving their accessibility to preventive measures.

The effectiveness of sealants is also influenced by factors related to the application technique, such as adequate tooth isolation, pre-cleaning of the occlusal surface, and adequate enamel etching. The absence of an effective marginal sealant can lead to microleakage problems, which increase the risk of recurrent caries and other complications. Therefore, the training and experience of the dental professional are crucial to ensure successful treatment.

In conclusion, pit and fissure sealants are essential in caries prevention, combining technological and technical advances with a comprehensive preventive approach. Their proper use, together with

complementary strategies such as fluoride application and the promotion of oral hygiene habits, can contribute significantly to reducing the carious disease burden in the population. This theoretical framework provides a solid foundation for understanding the implications of sealants in dental practice and guiding future research and clinical applications.
Overall Objective.
To evaluate the degree of microleakage of the tooth-material interface in premolars and third molars. Using the ultrasound technique and three different materials: sealant, vitreous ionomer, and flowable resin.

METHODS

Method: An experimental and comparative study was carried out.
Use of the ultrasound sealant application technique.
Selection of the groups to be analyzed.
Preparation of the dental piece and sealing technique.
Staining with methylene blue.
Cross section of the piece.
Evaluation: observational.
Materials:
Sealer (Conseal f and Conseal SDI).
Vitreous Ionomer (Riva Light Cure SDI)
Flow Composite (Flow Wave SDI)
37% phosphoric acid
KMD Micromotor with Denimed motor.
Brush and pumice stone.
Cavitator tip
Ultra One Scale Pneumatic Dental Cavitator
Small rubber band
File k 10
Woodpecker Led H lamp
Carborundum discs
Methylene blue
The iPhone 14 Pro is a second-generation camera with a 2556 x 1179 pixels resolution at 460 ppi.
Inclusion criteria
Dentures with 100% preserved coronal integrity.
Premolars
Third molars
Teeth with deep pits and fissures
Permanent teeth. Without incipient or non-cavitated caries lesion.
Procedure
An in vitro, comparative, and cross-sectional study of 30 teeth (third molars and premolars) was conducted.
The sample was randomly divided into three groups of 10 teeth each, sealed with different types of materials to evaluate the degree of microleakage of the various materials. Sample preparation was performed using an ultrasonic tip and a K 10 file for conditioning, and then the sealant was applied.
Group A: Sealant (Conseal f and Conseal) Group B: Vitreous Ionomer (Riva Light Cure) Group C: Flow Composite (Flow Wave)
The materials used during the investigation are the SDI brand.

https://doi.org/10.56294/piii2025411

On 16/6/22, the research began at 8 a.m. in the UAI clinical room located in Salta 980. With the help of Florencia Magnoli and under the tutoring of Julieta Saldaña, we selected the pieces to be used and divided the groups of premolars and third molars randomly, forming groups A, B, and C with a total of 10 teeth each. These teeth were preserved in 100% water hydration.

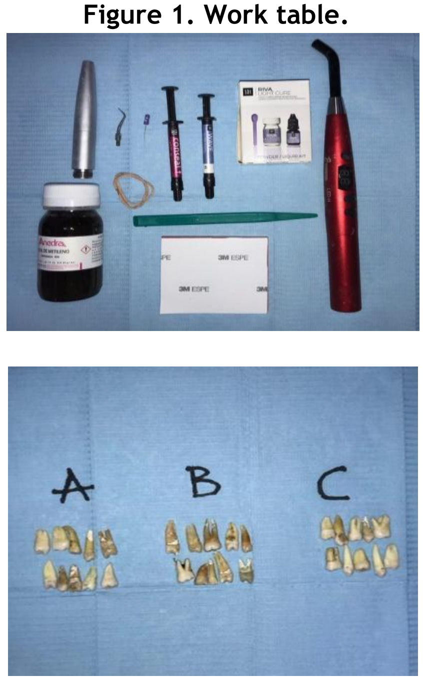
For the cavity preparations, the enamel surface was etched with 37% phosphoric acid propelled with KMD Micromotor with Denimed motor and Ultra One Scale dental pneumatic cavitation tip with a small rubber band and k 10 file for 15 seconds. After etching, we wash and dry with the triple syringe of the dental chair. Subsequently, we began to make the sealants: we started with group A of 10 dental pieces sealed with a sealant (Conseal f and Conseal); we continued with group B - 10 dental pieces sealed with glass ionomer (Riva Light Cure) -, and we finished with group C of 10 dental pieces with flow composite (Flow Wave), applying the protocols indicated by the manufacturer of each of the materials. Once the 30 sealants were completed, we prepared methylene blue with an approximate dilution of 10%. We submerged the teeth entirely and left them to act for 21 days.

On 15/9/22, we proceeded to assemble the blocks with modeling compound and made the transversal cut of each dental piece with carborundum discs and a Denimed-mounted handpiece.

We observed the microleakage of the sealants by taking pictures and zooming in to evaluate the results correctly.

Procedure

Figure 1. Work table.



Source: Own elaboration.

https://doi.org/10.56294/piii2025411

Figure 2. Acid etching.

Source: Own elaboration.

Figure 3. Placement of sealing material.

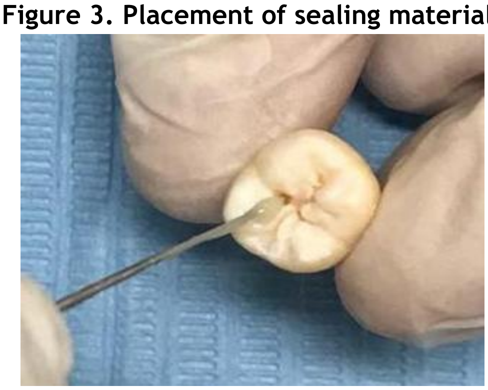


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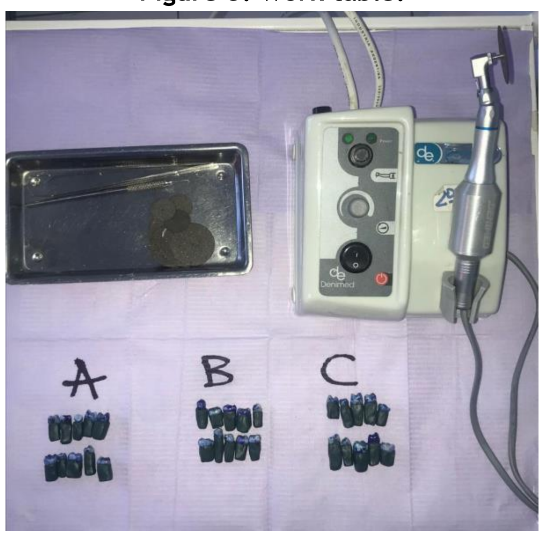
Figure 4 Light curing.

Source: Own elaboration.

Figure 5. Work table.



Source: Own elaboration.

Figure 6. Cutting of the dental piece with carborundum disc.

Source: Own elaboration.

https://doi.org/10.56294/piii2025411

Conseal f and Conseal

They are very low-viscosity sealants with excellent flowability, allowing for superb homogeneous penetration. The low shrinkage of SDI's unique resin system produces a more compact seal, which optimizes mechanical retention. Conseal f contains high fluoride release and clinically combines SDI's patented sealant technology with intensive initial fluoridation linked to long-term fluoridation treatment.

Conseal'f'snique filler is

Conseal's fescue filler is composed of a blend of particles with a high surface-area-volume ratio, which allows it to increase fluoride release.

Indications

It is in teeth with healthy areas but is vulnerable to pits and fissures.

In teeth with minimal pits and fissures caused by caries.

Contraindications

Do not apply in areas with caries.

Do not apply in areas without etching.

Some people may experience skin irritation from this product. In such a case, discontinue use and seek medical attention.

Instructions for use

Using an oil- and fluoride-free prophylaxis paste, clean the occlusal surface of teeth that have healthy areas but are vulnerable to pits and fissures. Remove cavities from pits and fissures with a low-speed handpiece using small circular burs. Do not extend into healthy parts of the fissure system. Rinse thoroughly with water. Isolate the tooth.

Dry the surface to be etched with clean, dry, oil-free air.

Etch the occlusal surface - at least 30 seconds and no more than 60 seconds - with 37 % phosphoric acid.

Rinse thoroughly with water.

Completely dry the tooth with clean, oil-free air for 15 seconds.

Apply a sealant. Place the tip against the surface to be veneered and gently apply the sealant.

Light cure the sealant for 20 seconds using an SDI Radii Plus LED Light or any other available light-curing device (with a wavelength of 440 - 480 nm). Additional magnification can also be applied as long as adequate isolation is maintained and the area is dry. Remove the inhibited oxygen layer and ensure that no bubbles are left behind.

Riva Light Cure

An ideal, radiopaque, resin-reinforced glass ionomer restorative material. Riva Light Cure is useful for many restorative applications with excellent dental adhesion, prolonged fluoride release, high compressive strength, and a high

and controlled setting. It is available in A1, A2, A3, A3.5, A3.5, A4, B2, B3, B4, C2, C4 and bleach shades, in capsules and powder-liquid kits.

Preparation

Clean and isolate the tooth.

Note: A conservative cavity should be prepared using standard instruments and techniques. Abrading is not necessary.

In cases where it is necessary to protect the pulp surface using a calcium hydroxide base.

Conditioner/etchant

Apply Riva Conditioner to prepared surfaces and leave in the cavity for 10 seconds.

Apply Super Etch 37% Phosphoric Acid to the prepared surfaces and leave the cavity for 5 seconds.

Rinse thoroughly with water.

Remove excess water, keep it moist, and avoid contamination. IMPORTANT: Do not dry the surface completely; it must be shiny.

Powder-liquid mixture
Dosage of powder - liquid: 1 level scoop per two drops Ratio of powder - liquid: 0.22 g/ 0.07 g (3.1:1)
Recommended mixing time: 30 s. Light curing time: 20 s.
Light curing depth (A3) 1.8 mm
Lightly tap the Riva Light Cure canister in your hand.
Dispense a scoop of powder onto the paper or glass mixing pad. Replace the lid and close tightly.
Dispense two drops of liquid onto the paper or glass mixing tile near the powder. Quickly replace the lid and close tightly.
Divide the powder into two equal parts.
Using a plastic spatula, mix the liquid with one part of the powder for 10 seconds, then add the second part and mix for another 15 to 20 seconds.
Placement Procedure:
Place Riva Light Cure in the cavity, being careful not to trap air underneath or in the restoration. For cavities deeper than 2 mm, use a layering technique.
Light cure for 20 seconds using the SDI Radii curing light or any visible light curing device (470 nm wavelength). Place the light source as close to the cement surface as possible.
Finish the restoration using conventional techniques.
Instruct the patient not to eat for at least one hour after treatment.
Exposure to intense light during the mixing and placement may reduce the setting time.
Flow Wave Composite
It is a fluoride-releasing, light-curing, radio-opaque, flowable composite. The wave is injected directly into the cavity preparation, maximizing adaptation to the preparation.
Instructions
Clean and isolate the tooth.
Clean all surfaces to be acid etched with an oil-free, fluoride-free paste, pumice, and water.
Rinse with plenty of water.
Shade selection.
Isolation.
Acid etching
Carefully dry the surface to be etched with dry, oil-free air. Etch the tooth surface with Super Etch 37 % phosphoric acid.
Enamel only. Etch the surface for at least 20 seconds.
Dentin and enamel are prepared using the “total e"ch” technique, which involves etching the ionomer glass surface for at least 20 seconds.
Enamel subject to fluoridation should be etched for 90 to 120 seconds.
Wash with plenty of water.
Remove excess water. Keep moist. Avoid contamination (e.g., saliva).
Apply Stae enamel/dentin adhesive, saturating all internal surfaces or bonding agents according to the instructions.
Blow gently with oil-free air for 2 seconds to evaporate the solvent. Leave a glossy surface.
Light cure for 20 seconds.
Directly inject Wave in increments of 2 mm or less in:
Class V restorations,
Tunnel preparations,
Spot and fissure sealants, minimal Class I, II, III, and IV restorations. Or other indications.
The variables analyzed will be:
Microleakage in parts with sealant.Microleakage in parts sealed with a vitreous ionomer.Microleakage in parts sealed with flowable or flow resin.

https://doi.org/10.56294/piii2025411

Possible confounding variables:
Time the piece has been out of the oral cavity.
The general condition of the piece: pieces in good condition.
How do we measure the results?
The results will be measured by clinical diagnosis and direct observation—examination of already treated teeth.
Measuring instrument
Measured by direct observation.
Experimental group
Experimental group: Premolars and third molars are divided into groups according to the materials used.
Group A: premolars and third molars sealed with Sealer.
Group B: premolars and third molars sealed with Vitreous Ionomer. Group C: premolars and third molars sealed with Composite Flow.
Measuring instrument
The following were measured by direct observation.
Experimental group
Experimental group: Premolars and third molars are divided into groups according to the materials used.
Group A: premolars and third molars sealed with Sealer.
Group B: premolars and third molars sealed with Vitreous Ionomer. Group C: premolars and third molars sealed with Composite Flow.

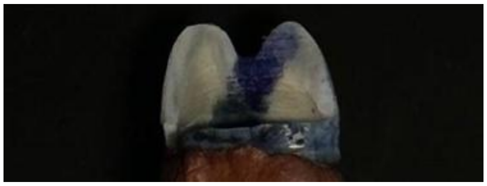
RESULTS

The material that showed the highest degree of microfiltration was used in group B (vitreous ionomer) with 2 of 10 pieces filtered. Group A (sealant) and group C (flow composite) obtained better results with 1 of 10 pieces filtered in both cases. Direct observation showed that the three groups presented marginal microleakage, to a lesser or greater degree, and it could not be determined that the permanence of the materials depended on the morphology of the teeth since it was mixed, that is, they were detached in premolars as well as in third molars.

Figure 7. Sealer (consejal F and consegal)

Source: Own elaboration.

Figure 8. Vitreous Ionomer (Riva Light Cure)



Source: Own elaboration.

https://doi.org/10.56294/piii2025411

Figure 9. Composite flow (Flow wave)

Source: Own elaboration.

The present in vitro study analyzed the behavior and efficacy of two sealant techniques regarding the degree of microleakage and evaluated the sealing capacity. The comparison was made between the conventional sealant technique proposed in the work of Lucila Espina, "Microleakage at the tooth-sealant interface before different types of sealants. Efficacy for extension work" (8), and the ultrasonic sealant technique based on the application of three different materials (sealant, glass ionomer, and flow composite). In the technique applied with ultrasound, it was observed that the marginal microleakage of the sealants was lower than in the research work of Lucila Espina, who performed the sealant technique with conventional etching.

After analyzing the results, and in spite of the different techniques of enamel etching, both concluded that the material that showed the greatest marginal microleakage was group B (Riva light Cure vitreous ionomer), with 3 of 10 pieces filtered in the study of sealants with efficiency for extension work and 2 of 10 pieces filtered in the present study with the ultrasound technique.

Kersten (9) observed that ultrasonic vibration treatment of the tooth during the etching procedure increased the quality of the fissure sealing process and allowed the acid gel to penetrate deeper into the enamel structure. Our results are consistent regarding the technique used and pit and fissure sealing quality.

Butail (10) evaluated the marginal microleakage and penetration depth of different materials used as pit and fissure sealants in an in vitro study. As in our study, the highest microleakage corresponded to the glass ionomer-based sealant, followed by the flowable composite, and finally, the sealant registered the lowest.

On the other hand, our results coincide with those of Kim (11), who, through an in vitro investigation, evaluated three techniques (conventional, heat, and sonic vibration) and concluded that the sonic vibration technique for applying material shear had the most significant influence on penetration.

Although the results of the microfiltration of the materials in the conventional technique of Lucila Espina's work coincide with the ultrasound technique of our research, the number of microfiltrations using the ultrasound technique was lower.

CONCLUSIONS

Ultrasonic sealant treatment performed better than conventional preparation and could ensure better sealant retention.

The marginal microleakage observed was significantly higher in group B (vitreous ionomer) compared to groups A and C. Although marginal microleakage occurred in all three groups, to a lesser or greater extent, we conclude that there will always be a percentage probability of this occurring. Periodic checks of sealants are essential to prevent sealant failure, which results in counterproductive practices.

https://doi.org/10.56294/piii2025411

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FINANCING

None.

CONFLICT OF INTEREST

None.