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Review Article

Assessment of Ionoseal's Performance as a Lining and Sealing Material in Dental Restorations: A Comprehensive Review

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ABSTRACT

This systematic review evaluated the efficacy of Ionoseal as a sealing and lining material in dental restorations by analyzing its clinical performance. The study used secondary data collection and analysis, using the PRISMA guidelines for systematic reviews and meta-analyses as the chosen methodological framework. The research process involved defining exclusion and inclusion criteria for article selection and using the Cochrane risk of bias tool for evaluating potential biases. Data presentation was enhanced through a structured tabulation of findings and criteria. A procedural PRISMA approach facilitated the screening of multiple studies, ultimately narrowing the selection to 15 peer-reviewed scholarly articles that met the pre-specified inclusion criteria. The findings showed that Ionoseal demonstrated a compressive strength of 226 MPa and a transverse strength of 95 MPa. These values were further confirmed by empirical research from different perspectives. Ionoseal proves to be a reliable lining and sealing agent due to its high compressive and transverse strengths, resistance to acidic environments, ability to prevent microbial penetration, strong bonding, and flexural properties, and suitability for esthetic dental applications.

Keywords: Lining agent, Dental restoration, Efficacy, Ionoseal, Clinical properties, Sealing

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Introduction

Effectiveness plays a crucial role in all healthcare procedures, as it directly impacts service quality. Likewise, clinical properties serve as fundamental criteria for assessing the appropriateness of medical practices. In dental restoration, sealing and lining agents are essential, with Ionoseal being one of the commonly utilized options. Traditionally, liners and bases have been placed beneath restorations, especially in cases where significant dentin removal is required during cavity preparation [1]. Dentists often use cavity liners and bases to safeguard against potential toxic effects on the pulp. However, research has shown that pulpal inflammation primarily results from microbial infiltration rather than direct toxicity [1]. Depending on the condition, either indirect or direct restorations may be employed. This systematic review synthesizes data from multiple peer-reviewed and scholarly studies published within the last three years to analyze the clinical characteristics and effectiveness of Ionoseal as a sealing and lining agent in dental restorations.

Dentists must address both the potential toxicity of dental materials and the infiltration of microorganisms during restorative procedures [1]. To shield the pulp from harmful effects, selecting the right base and lining agents is crucial [2]. While traditional options like glass ionomer cement and poly-carboxylate cement have been widely used, newer pulp-capping materials have emerged. These include resin-modified glass ionomer cement (RMGIC), bioactive dentine substitutes (Biodentine), resin-modified calcium

silicate cement (TheraCal LC), and mineral trioxide aggregate (MTA), commonly utilized in restorative treatments for primary teeth [2]. Among these, Ionoseal, a type of RMGIC, plays a key role in preventing leakage during dental restorations. As a light-curing radiopaque glass-ionomer (LCRG) composite cement liner, it is particularly effective in sealing minor lesions and deep fissures [2-4]. This review examines the clinical attributes of Ionoseal that contribute to its ability to prevent leakage in restorative dentistry.

VOCO Dental's [3] research highlights that Ionoseal utilizes non-dripping technology (NDT), a system designed to prevent material waste and eliminate issues associated with dripping or uncontrolled syringe flow. This technology is integrated into the plunger mechanism, which retracts after pressure is applied, optimizing material control. Ionoseal's formulation has been refined to enhance its overall effectiveness [3]. It maintains superior compressive and transverse strength while demonstrating significant improvements in viscosity. These characteristics ensure precise placement within cavities and hard-to-reach areas, improving surface wetting for restorations. Experts in dentistry widely recognize Ionoseal as a highly effective lining material for composite, ceramic, and amalgam restorations. Having been clinically approved for over 15 years, it continues to evolve with advancements in formulation and application methods [3]. However, a 2020 study by Karadas and Atıcı revealed that Ionoseal RMGIC exhibited the highest microleakage scores, attributed to polymerization shrinkage stress, which compromises adhesion and leads to marginal gaps. These findings indicate the need for further research to validate and clarify Ionoseal RMGIC's clinical properties and effectiveness. Consequently, this study identifies an existing knowledge gap that requires further exploration. Notably, this systematic review contributes to the existing body of knowledge without collecting primary data to evaluate established concepts or theories.

Materials and Methods

The lead researcher employs a systematic review and PRISMA meta-analysis to conduct this study. Utilizing secondary data proves effective when clearly defined eligibility criteria are established to address the research question [5]. A well-structured approach requires specifying the study question, setting exclusion and inclusion criteria, performing an extensive literature search, identifying pertinent data, and systematically extracting and synthesizing findings [6]. In this review, PRISMA guidelines play a crucial role in screening and selecting 15 relevant studies that examine the efficacy and clinical properties of Ionoseal.

Inclusion and exclusion criteria

A systematic review depends on well-defined exclusion and inclusion criteria to filter relevant studies. These criteria are essential for selecting research and records that align closely with the topic under investigation. In this review, the inclusion and exclusion parameters are determined based on content relevance, publication timeframe, and study quality **(Table 1)**.

Table 1. Inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
○ Research focusing on Ionoseal's characteristics as a Lining and Sealing Agent	○ Broad overviews of Ionoseal
○ Scholarly and peer-reviewed sources	○ Articles that are neither peer-reviewed nor scholarly
○ Publications from 2019 to 2021	○ Studies published in 2018 or earlier
○ Articles published in English	○ Non-English publications
○ Full-text studies	○ Searches are limited to abstracts only

PRISMA guideline

Research has highlighted the importance of the preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines in ensuring a structured process for selecting the most relevant studies for analysis. PRISMA, as described by UNC (2021), is an evidence-based framework that provides an organized method for documenting the studies or records included in a systematic review and meta-analysis [7]. It helps researchers maintain clear and thorough records of the studies and databases used [7]. As stated by Page *et al*. [8], PRISMA aids in the systematic review of reports containing key information. Data was extracted from the chosen studies following established systematic review protocols [9]. **Figure 1** displays a flowchart that outlines the analysis process, adhering to PRISMA

guidelines and the exclusion and inclusion criteria of the research.

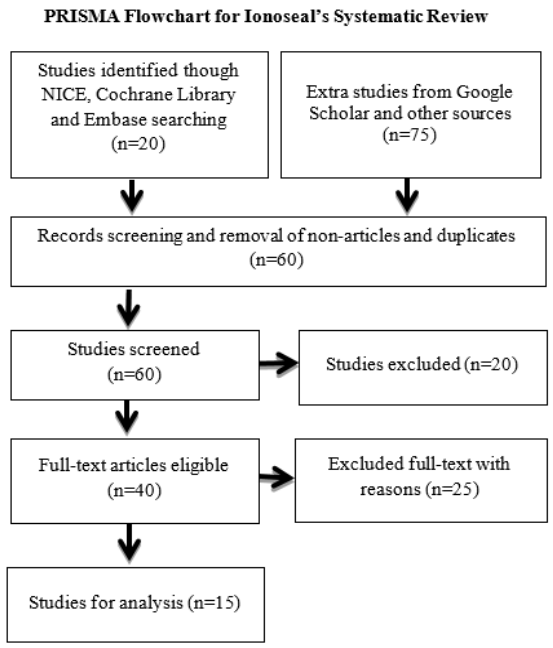


Figure 1. PRISMA flowchart [7].

Cochrane risk of bias assessment

Cochrane systematic reviews (CSRs) apply the risk of bias (RoB) tool to determine the validity of findings in the studies used for a review. As stated by Farrah *et al.* [9], health discipline systematic reviews incorporate evidence from a range of sources, not limited to randomized controlled trials (RCTs). Non-randomized studies (NRS) are increasingly considered, but they are more likely to be influenced by bias than RCTs. Fortunately, the Cochrane RoB tool provides a consistent method for assessing the bias in the studies included in a review [9]. The Cochrane RoB tool relies on seven main factors to evaluate bias [10]. The first is selection bias, which stems from random sequence generation and can introduce bias into intervention measures. The second is selection bias related to allocation concealment. The third focuses on performance bias, which is linked to participant blinding. The fourth is detection bias, concerning blinding during outcome assessment and the awareness of assigned interventions [10]. The fifth metric, attrition bias, addresses issues related to incomplete outcome data. The sixth is reporting bias, which arises from selective reporting or presentation of findings. The seventh, "other bias," includes any bias not captured by the previous six categories [10]. **Table 2** provides the RoB guidelines for the current systematic review.

Table 2. Cochrane RoB table

Reference	Bias	Judgment	Explanation/Comment
Ertuğrul and Ertuğrul [2]	Detection bias	High	Comment: The handling of temperature variations shows some unclear results, making it difficult to conduct a thorough statistical analysis.
VOCO Dental [3]	Attrition bias	Low	Comment: Data comparisons are incomplete.
Arandi and Rabi [1]	Reporting bias	High	Comment: The systematic review demonstrates a tendency to selectively report outcomes based on results from other studies.
Karadas and Atıcı [4]	Selection bias	Unclear	Comment: The process for generating a randomized pattern remains unclear.
Oliveira *et al.* [11]	Selection bias	High	Comment: There is some level of concealment in the allocation of participants and resources.
Menezes-Silva *et al.* [12]	Detection bias	Unclear	Comment: The blinding of result assessments was unclear.
Yao *et al.* [13]	Reporting bias	Low	Comment: There was minimal selective reporting of results.
Torres *et al.* [14]	Performance bias	Unclear	Comment: Participants were blinded.
Perera *et al.* [15]	Reporting bias	High	Comment: Outcome reporting was selective.
Mohammed *et al.* [16]	Selection bias	High	Comment: There was biased resource allocation to interventions due to an incomplete randomized cohort.
Younis and Alaa [17]	Selection bias	Low	Comment: There was some degree of insufficient concealment.
Aggarwal *et al.* [18]	Detection bias	High	Comment: The evaluation of results lacked blinding.
Rooz [19]	Others	Low	Comment: The approach was nearly ideal, except for a few challenges.
Spinola *et al.* [20]	Attrition bias	Unclear	Comment: The comparison of outcomes remains unclear.
Barrantes [21]	Reporting bias	Low	Comment: There was selective outcome reporting.

Results and Discussion

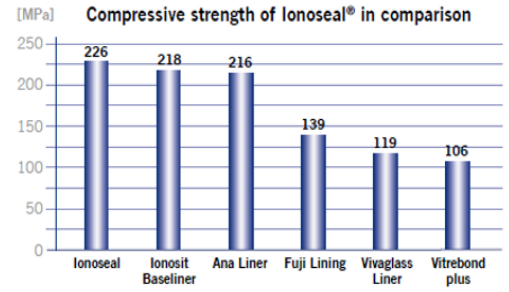
The lead investigator applied specific search criteria to identify 95 potentially relevant articles. After removing duplicates, non-articles, and abstracts-only, and considering publication timeframes and peer-review status, 15 articles were selected for inclusion in the systematic review. A summary of these articles is presented in **Table 3** for evaluation of the topic. The research question addressed is: "What are the clinical properties and efficacy of Ionoseal as a sealing and lining agent?"

Table 3. Summary of the article's findings

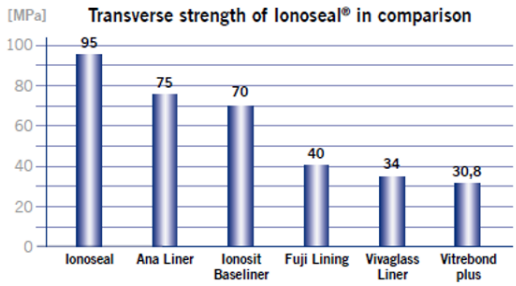
Author	Year	Inclusion criteria	Aim	Results
Ertuğrul and Ertuğrul	2021	Full-text peer-reviewed	Examined the effectiveness of pulp capping materials (PCM) concerning intrapulpal temperature rises (ITI).	Self-curing agents are optimal for use in pulp capping materials (PCM).
VOCO Dental	2020	Full-text Scholarly	Investigated the advancements in Ionoseal.	Ionoseal demonstrates excellent compressive and transverse strength due to its favorable chemico-physical properties.
Arandi and Rabi	2020	Full-text peer-reviewed	Reviewed the functions of cavity bases, particularly resin-modified glass ionomer (RMGI) and zinc oxide eugenol (ZOE).	RMGI proved to be more effective as a protective base seal, especially when used with calcium hydroxide (CH) liners.
Karadas and Atıcı	2020	Full-text peer-reviewed	Assessed the shear bond strength (SBS) and internal marginal adaptation of pulp-capping materials.	Bond strength was associated with significantly reduced gap formation.
Oliveira *et al*.	2020	Full-text peer-reviewed	Analyzed the compressive strength of various RMGIC mixing techniques.	Ionoseal exhibited the highest compressive strength ($P < 0.001$) and enhanced mechanical properties as a resin-modified GIC.
Torres *et al*.	2020	Full-text peer-reviewed	Evaluated how liners affect the clinical outcomes of deep restorations.	Fisher's statistical analysis (5%) indicated no significant difference in properties or postoperative sensitivity.
Perera *et al*.	2020	Full-text peer-reviewed	Compare the behavior and dissolution of glass ionomer cement (GIC) when exposed to acids versus ultrapure deionized water.	Recent GIC formulations showed improved acid resistance compared to older GIC materials.
Mohammed *et al*.	2020	Full-text peer-reviewed	Compare the retention of resin sealant with resin-modified glass ionomer sealant.	Resin-modified glass ionomer sealants demonstrated superior clinical retention performance.
Younis and Alaa	2020	Full-text peer-reviewed	Investigated and compared the flexural strength and elasticity modulus of different lining materials.	Activa Bioactive-enhanced RMGIs, such as Ionoseal glass, displayed lower elasticity modulus and higher flexural strength.
Menezes-Silva *et al*.	2020	Full-text peer-reviewed	Evaluated the mechanical properties (MP) of traditional restorative glass ionomer cement (GICs), including compressive strength (CS), flexural strength (FS), Knoop microhardness (KH), and diametral tensile strength (DTS).	GICs with stable chemical bond structures exhibited greater strength, as predicted by strength tests.
Yao *et al*.	2020	Full-text peer-reviewed	Investigated the bonding effectiveness of self-adhesive composite hybrids on flat (FLAT) surfaces.	New self-adhesive bulk-fill composites showed excellent bonding properties.
Novin and Jordehi	2020	Full-text peer-reviewed	Explored how varying viscosities, shades, and thicknesses influence bulk-fill composites.	The shade and viscosity of materials significantly affect sealing depths and light-curing efficiency.
Barrantes	2020	Full-text peer-reviewed	Investigated the clinical relevance of dental restorations.	Micro-hybrid composite resin and fiberglass posts for tooth fragment restoration yielded better outcomes.
Spinola *et al*.	2021	Full-text peer-reviewed	Assessed the impact of multi-walled carbon nanotube (MWCNT) incorporation	MWCNTs reduced compressive strength but increased diametral tensile strength.

			on the diametral tensile and compressive strengths of glass ionomer cement.	
Aggarwal *et al*.	2019	Full-text peer-reviewed	Compare the treatment depth of resin-based composites (RBC) for posterior use.	Resin-based composites (RBCs) introduced new possibilities in aesthetic and conservative dental treatments.

The focus of this review was to assess the clinical efficacy and properties of Ionoseal as a sealing and lining material. The study identified that key factors such as compressive strength, acid resistance, transverse strength, tensile strength, and elasticity are critical in evaluating Ionoseal's clinical performance. The empirical data affirmed that the chemico-physical characteristics of Ionoseal contribute significantly to its effectiveness [3]. **Figure 2** highlights Ionoseal's compressive strength of 226 MPa and transverse strength of 95 MPa, which make it highly stable when used beneath cement, amalgam, and composites, even in shallow cavities [3]. Furthermore, Ionoseal is fully resistant to acids and features a radiopacity rate of 200% Al, ensuring clear visibility of the tooth and lining interface [3]. Support for these findings comes from Oliveira *et al*. [11], who observed that Ionoseal exhibited the highest compressive strength values. However, there was no significant statistical difference between the mechanical handling of resin-modified GIC and traditional GIC [11]. A potential exception might be the use of RMGI as a "protective base" after calcium hydroxide (CH) liners in deep cavity preparations.



a)



b)

Figure 2. High compressive and transverse strength [3]

Ertuğrul and Ertuğrul [2] concluded that Ionoseal RMGIC effectively prevents leakage, safeguarding the pulp from the damaging effects of heat during vital procedures. This highlights Ionoseal as an optimal pulp capping material (PCM). Another key characteristic contributing to its effectiveness as a sealing and lining agent is its bonding strength. Arandi and Rabi [1] noted that resin-modified glass ionomer cement (RMGICs) offer excellent bonding properties, making them suitable substitutes for zinc oxide eugenol seals in cavity sealing. The bond strength of filling and lining agents was not affected by the condition of the patient's dentin. These materials demonstrated minimal gap formation, resulting in improved outcomes and aesthetics [4]. Glass ionomer cement with more robust chemical bonding exhibited greater strength and enhanced performance [12]. Additionally, newer self-adhesive materials showed better bonding capabilities, though lower bond strength was noted in cavities with a high C-factor at the bottom of dentin [13]. The bonding quality of Ionoseal reinforces its reliability as a sealing and lining agent in clinical applications.

The biological, aesthetic, and functional aspects of Ionoseal, in addition to its bonding strength, demonstrate its clinical effectiveness. Torres *et al*. [14] found no postoperative sensitivity, and the use of the liner didn't impact the clinical procedure for deep composite restorations. Similarly, Perera *et al*. [15] confirmed that newer GICs exhibit improved acid resistance, supporting their use in challenging conditions. This suggests that Ionoseal RMGIC performs effectively across different clinical settings. Effective sealants like Ionoseal help in preventing dental caries and enhancing clinical retention [16]. Younis and Alaa [17] observed that Ionoseal and Bioactive-enhanced RMGIs exhibited comparable flexural strength, though with a lower modulus of elasticity. Moreover, studies have shown that resin-based composites (RBCs) are valuable for restorative procedures, contributing significantly to both esthetic and traditional dentistry [18]. However, the thickness, shade, and viscosity of bulk-fill composites have a considerable impact on their sealing and lining properties [19]. For high-viscosity glass ionomers, tensile strength was found to be lower than compressive strength [20]. In addition, researchers have shown that aesthetic fiberglass posts and micro-hybrid composite resins are effective for sealing and

lining [21]. Despite these findings, there are still gaps in the evidence, and further studies are needed to better understand the clinical properties and efficacy of Ionoseal as a restorative material.

Conclusion

The systematic review highlighted several clinical properties of Ionoseal that enhance its effectiveness as a lining and sealing agent, including its high comprehensive and transverse strengths, flexural strength, bonding strength, acid resistance, prevention of microorganism leakage, and its role in esthetic dentistry. The primary investigator reviewed and synthesized findings from 15 recent studies, presenting the results visually in a tabulated format. A comparison between Ionoseal and other materials showed that Ionoseal has been significantly improved to enhance its performance as a restorative agent.

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Conflict of Interest: None

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Ethics Statement: The study adhered to all ethical guidelines, including ensuring confidentiality and proper data collection from participants.

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