Review Article

EFFICACY OF IONOSEAL AS A LINING AND SEALING AGENT IN DENTAL RESTORATIONS: A SYSTEMATIC REVIEW

*Saud Ahmed Aleidi[1], Naif Saud Alosaimi[1], Sultan Mohammed Aljumah[1], Riyadh Abdulmunim Alabdulmunim[1], Badr Alhussain[2]**

[1]*Private Dental Clinic, Riyadh, Saudi Arabia.*
[2]*Department of Consultant Restorative, PSMMC, Riyadh, Saudi Arabia. bader.hussain@riyadh.edu.sa*

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ABSTRACT

This systematic review investigated the efficacy and clinical properties that make Ionoseal a successful sealing and lining agent during dental restorations. The study relied on secondary data compilation and analysis; thus, PRISMA meta-analysis and systematic review were adopted as the ideal methodology approaches. The research design procedure involved the identification of relevant inclusion and exclusion criteria for article screening and using the Cochrane risk of bias assessment for risk analysis. Tabulation of results, criteria, and results is used for a better presentation of the content. Procedural PRISMA analysis was used to screen many articles before settling on 15 peer-reviewed and scholarly articles based on the set inclusion criteria. The result showed that Ionoseal had a higher comprehensive strength of 226 MPa and transverse strengths of 95 MPa. The empirical findings supported this statistic from a different perspective. Ionoseal is an effective sealing and lining agent because it has high comprehensive and transverse strengths, great acid resistance, microorganisms' leakage preventer, high bonding and flexural strengths, and esthetic dentistry.

Key words: Dental restoration, Ionoseal, Efficacy, Clinical properties, Sealing, Lining agent.

Introduction

Efficacy is essential in all aspects of health practices and procedures because it determines the quality of service. Similarly, health practices or procedures have underlining clinical properties used to establish suitability. In dental restoration procedures, lining and sealing agents are used, and Ionoseal is one of the many agents. Conventionally, bases and liners have been used under restorations, particularly in cases involving substantial subtraction of dentin for cavity preparation [1]. Dentists consider a cavity liner and base necessary for protection against the toxic pulp effects. Nonetheless, studies have confirmed that the pulpal inflammation is due to the microorganisms' leakage [1]. Direct or indirect restorations are applicable for different conditions. This systematic review uses empirical findings from various peer-reviewed and scholarly studies published within the last three years to establish Ionoseal's clinical properties and efficacy as a sealing and lining material in dental restorations.

Toxic effects of dental materials and the leakage of the microorganisms are concerns that dentists must address during restoration [1]. Appropriate lining and base agents are vital to safeguard the pulp tissue from harmful effects [2]. Today, many pulp capping agents are used besides the traditional poly-carboxylate cement and glass ionomer cement. These current pulp capping agents are resin-modified glass ionomer cement (RMGIC), resin-modified calcium silicate cement (TheraCal LC), bioactive dentine substitutes (Biodentine), and mineral trioxide aggregate (MTA). They are applicable as dental compomer restoratives for primary teeth restorations [2]. Ionoseal is one of the RMGIC appropriate for leakage prevention during dental restorations. It is a Light-Curing Radiopaque Glassionomer (LCRG) composite cement liner with smaller lesions and extended fissure sealing [2-4]. The systematic review concentrates on the clinical properties of Ionoseal that increase its efficacy in leakage prevention in dental restorations.

According to VOCO Dental's (2020) findings, Ionoseal is delivered in NonDripping-Technology (NDT) that prevents loss of expensive materials or substitute dripping or running syringes. NDT is applicable in plunger design, of which, after pressure application, it pulls back. This concept is improved in Ionoseal's formula for efficacy [3]. High compressive and transverse strength is Ionoseal's proven properties sustained, whereas its viscosity has improved substantively. The properties facilitate accurate application into cavities and hidden areas while enhancing wetting of the restoration surface. Dentists and scholars agree that Ionoseal is the best lining agent for composite, ceramic, and amalgam restoration. For more than a decade and a half, it has been clinically certified and is currently available in improved formula and application [3]. In 2020, a study conducted by Karadas and Atıcı showed that Ionoseal RMGIC had the highest microleakage scores due to its polymerization shrinkage stress leading to weak adhesion and marginal gap. The findings require further studies to substantiate and

demonstrate the efficacy and clinical properties of Ionoseal RMGIC. Hence, it is reasonable to say that a knowledge gap exists for this study to complete. Significantly, this systematic review builds on existing knowledge because no primary data is collected to test existing theories or concepts.

Materials and Methods

The primary investigator uses systematic review and PRISMA meta-analysis to complete this study. Collecting secondary data is effective when pre-specified eligibility criteria are set to respond to the study question [5]. It is essential that a researcher specifies the study question, identifies inclusion and exclusion criteria, conducts comprehensive research, identifies relevant data, extracts, and synthesizes the results [6]. In this review, PRISMA guidelines assist in screening and extracting 15 relevant studies on the efficacy and clinical properties of Ionoseal.

Inclusion and exclusion criteria

Systematic review relies on inclusion and exclusion criteria for screening of eligible studies. The requirements are vital for collecting studies and records that best fit the current topic of discussion. This systematic review's inclusion and exclusion criteria are based on the content, publication period, and quality **(Table 1)**.

Table 1. Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion criteria
○ Studies analyzing Ionoseal ‘s properties as a Lining and Sealing Agent ○ Peer-review and scholarly literature ○ Recent publications, 2019 to 2021 ○ English publications ○ Full-texts articles	○ General description of Ionoseal ○ Non-peer-review or non-scholar articles ○ Outdated studies 2018 and below ○ Non-English ○ Abstract-only search

PRISMA Guideline

Studies have shown that Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline is vital for screening studies or records until the most applicable ones are selected for appropriate topic analysis. According to UNC (2021), PRISMA is an evidence-based flowchart or tool that allows orderly documentation of records or studies gathered for a systematic review and meta-analysis [7]. Researchers use this tool to improve the documentation of researched databases and collected articles [7]. According to Page *et al.* (2021), PRISMA assists researchers in reviewing the reports with relevant information [8]. The researcher extracted data from selected studies based on systematic review protocols and standards [9]. The flowchart in **Figure 1** outlines systematic annotation or analyses based on PRISMA guidelines and the inclusion and exclusion criteria of the study.

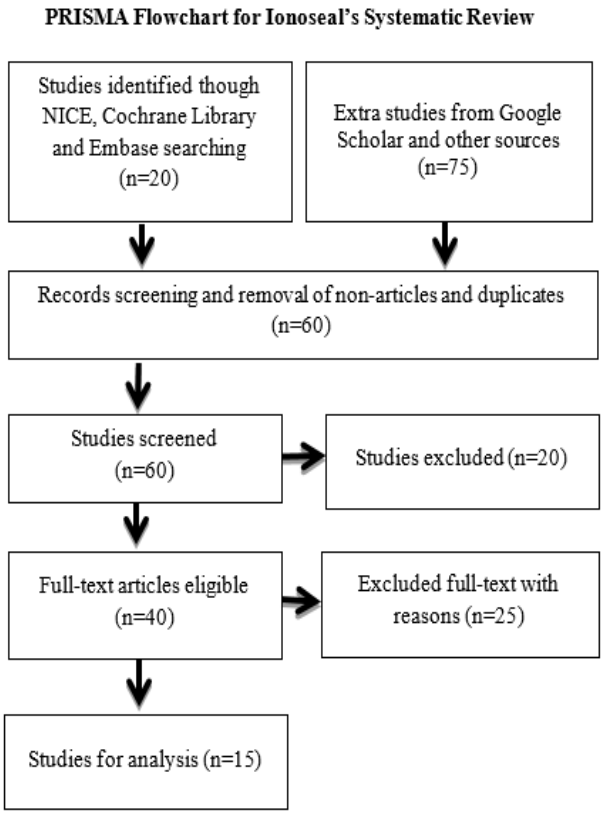


Figure 1. PRISMA Flowchart
Source: [7]

Cochrane risk of bias assessment

Cochrane systematic reviews (CSRs) use a risk of bias (RoB) to assess the accuracy of the articles' findings used for a review. According to Farrah *et al.* (2019), systematic reviews in health discipline integrate evidence from different sources apart from the randomized controlled trials (RCT). Non-randomized study (NRS) sources have gained interest; however, they are susceptible to bias compared to RCT. Fortunately, the Cochrane RoB tool uses a standardized method for evaluating the bias of extracted studies [9]. Cochrane's standard RoB tool is based on seven concepts or metrics for bias analysis [10]. The first metric is selection bias caused by random sequence generation that evaluates biased to interventions measures. The second is selection bias due to allocation concealment. The third is performance bias associated with participant blinding. The fourth is detection bias linked to blinding of result assessment and level of knowledge of the assigned interventions [10]. The fifth is attrition bias associated with incomplete outcome data. The sixth metric is reporting bias due to selective documentation or presentation of results. The seventh is "other bias" linked to any other bias apart from the six metrics [10]. **Table 2** presents the guideline of the current systematic review's RoB.

Table 2. Cochrane RoB Table

Study Authors	Bias	Judgment	Explanation/Comment
Ertuğrul and Ertuğrul, F. 2021.	Detection bias	High	Comment: handling of temperature changes exhibit some inconclusive outcome for comprehensive statistical analysis
VOCO Dental. 2020.	Attrition bias	Low	Comment: Comparisons of outcome data is incomplete
Arandi and Rabi 2020	Reporting bias	High	Comment: the systematic review exhibits selective outcome reporting based on findings generated by other researchers.
Karadas & Atıcı, 2020	Selection bias	Unclear	Comment: the study is unclear on the generation of a randomized pattern
Oliveira *et al*. 2020	Selection bias	High	Comment: participants and resources allocation exhibit some level of concealment
Torres *et al*. 2020	Performance bias	Unclear	Comment: blinding of participants
Mohammed *et al*. 2020	Selection bias	High	Comment: biased allocation of resources to interventions because the cohort of a randomized pattern is incomplete
Perera *et al*. 2020	Reporting bias	High	Comment: selective outcome reporting
Younis & Alaa 2020	Selection bias	Low	Comment: some level of inadequate concealment
Menezes-Silva *et al*. 2020	Detection bias	Unclear	Comment: unclear blinding of result assessment
Yao *et al*. 2020	Reporting bias	Low	Comment: Minimal selective result reporting
Novin & Jordehi 2020	Others	Low	Comment: ideal apart from a few additional challenges
Barrantes 2020	Reporting bias	Low	Comment: selective outcome reporting
Spinola *et al*. 2021	Attrition bias	Unclear	Comment: unclear comparison of outcome
Aggarwal *et al*. 2019	Detection bias	High	Comment: blinding of result evaluation

Results and Discussion

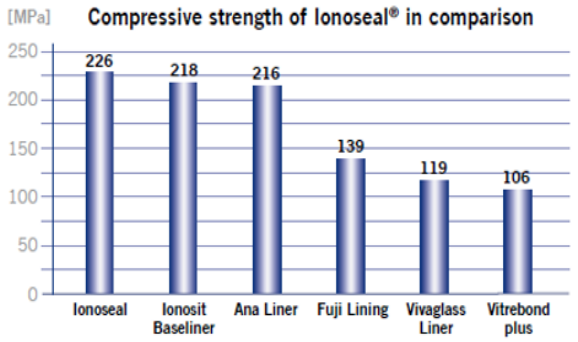
The primary investigator used search criteria to find 95 relevant articles. After screening based on duplicates, non-articles, abstract-only, publication duration, and peer-reviewed measures, 15 articles were found to be eligible and included for the systematic review. **Table 3** presents a summary of articles used for topic evaluation. The research question is: "what are the efficacy and clinical properties of Ionoseal as a sealing and lining agent?

Table 3. Summary of Article's Findings

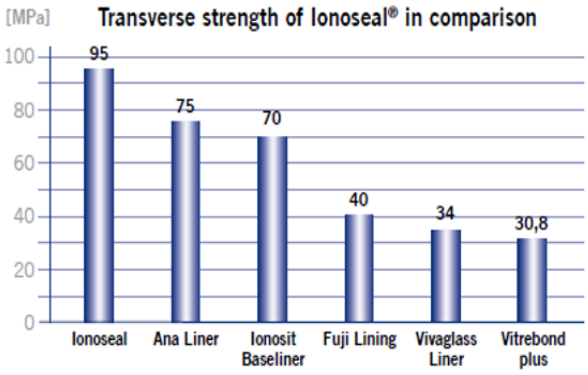
Author	Year	Inclusion criteria	Aim	Results
Ertuğrul and Ertuğrul	2021	Full-text peer-reviewed	Investigated the efficacy of pulp capping materials (PCM) in comparison to intrapulpal temperature increases (ITI).	Self-cured agents are ideal for PCM
VOCO Dental	2020	Full-text Scholarly	Explored the improvements of Ionoseal.	Ionoseal has high compressive and transverse strength due to suitable chemico-physical properties
Arandi and Rabi	2020	Full-text peer-reviewed	Reviewed cavity bases, particularly, RMGI and zinc oxide eugenol (ZOE) roles	RMGI showed better results as a protective base seal due to calcium hydroxide (CH) liners
Karadas and Atıcı	2020	Full-text peer-reviewed	Evaluated pulp-capping materials' shear bond strength (SBS) and internal marginal adaptation	The bond strength showed lower gap formations significantly.
Oliveira *et al*.	2020	Full-text peer-reviewed	Investigated the compressive strength of RMGIC mixing methods	Ionoseal exhibited the highest compressive strength values ($p<0.001$) and increased mechanical manipulation properties as resin-modified GIC.
Torres *et al*.	2020	Full-text peer-reviewed	Evaluated the effect of a liner on the clinical productivity of deep restorations.	Fisher's statistical analysis (5%) revealed no significance on properties or postoperative sensitivity.
Perera *et al*.	2020	Full-text peer-reviewed	Compared the behavior and dissolution of glass ionomer cement (GIC) agents when exposed acids versus ultrapure deionized water.	Recent GIC agents showed augmented acid resistance compared to earlier GIC materials.

Mohammed *et al.*	2020	Full-text peer-reviewed	Compared the retention between resin sealant and a resin-modified glass ionomer sealant.	Resin-modified glass ionomer sealant showed better performance in clinical retention.
Younis and Alaa	2020	Full-text peer-reviewed	Explored and contrasted flexural strength and elasticity modulus lining materials	Activa Bioactive-improved RMGIs as Ionoseal glass revealed a lower modulus of elasticity and higher flexural strength.
Menezes-Silva *et al.*	2020	Full-text peer-reviewed	Evaluate the compressive strength (CS), flexural strength (FS), Knoop microhardness (KH), diametral tensile strength (DTS), and traditional restorative GICs concerning mechanical properties (MP).	GICs with stable chemical bonds structure have stronger values predicting the strength tested.
Yao *et al.*	2020	Full-text peer-reviewed	Investigated self-adhesive composite hybrid onto a flat (FLAT) bonding efficacy.	New self-adhesive bulk-fill has favorable bonding performance.
Novin & Jordehi	2020	Full-text peer reviewed	Explored the effects of unlike viscosities, shades, and thicknesses on bulk-fill composites.	Properties of shade and viscosity influence sealing depths and light-curing.
Barrantes	2020	Full-text peer reviewed	Explored clinical significance of dental restorations.	Tooth fragment restoration through micro-hybrid composite resin and fiberglass post better results
Spinola *et al.*	2021	Full-text peer-reviewed	Assessed the effect of multi-walled carbon nanotube (MWCNT) integrated by glass ionomer cement's diametral tensile and compressive strengths.	The MWCNTs reduced compressive strength while increasing diametral tensile strength.
Aggarwal *et al.*	2019	Full-text peer-reviewed	Compared and evaluated the depth of treatment of Resin-based composites (RBC) for posterior application.	RBCs showed new dimensions of aesthetic and conservative dentistry.

The review concentrated on analyzing the clinical properties and efficacy of Ionoseal as a sealing and lining agent. The study revealed that comprehensive strength, acid resistance, transverse, tensile, and elasticity strengths were vital in assessing the clinical properties of Ionoseal. Empirical findings demonstrated that chemico-physical properties of Ionoseal contribute to its efficacy [3]. **Figure 2** exhibits comprehensive and transverse strengths of 226 MPa and 95 MPa, respectively. These strengths make Ionoseal the most stable lining under cement, amalgam, and composites whether a patient has shallow cavities [3]. Ionoseal is completely acid-resistant with a radiopacity rate of 200 %Al for a clear distinction between tooth substance and lining [3]. Oliveira *et al.* (2020) support the above findings by demonstrating that Ionoseal exhibits the highest compressive strength values [11]. However, mechanical manipulation for resin-modified GIC and traditional GIC had no statistical difference [11]. An exemption could have been a "protective base" of RMGI after calcium hydroxide (CH) liners for deep cavities.



a)



b)

Figure 2. High Compressive and Transverse Strength Source: VOCO Dental. 2020.

Ertuğrul and Ertuğrul's (2021) findings showed that Ionoseal RMGIC avoids leakage, protecting the pulp from harmful heat consequences of vital processes [2]. Therefore, it is reasonable to report that Ionoseal is the ideal PCM.

The bonding strength is another property that makes Ionoseal effective as a lining and sealing agent. According to Arandi and Rabi (2020), bonded RMGIs make ideal cavity sealing agents and substitute zinc oxide eugenol seals [1]. The dentin condition of the patients did not influence the bond strength filling and lining agents. The materials showed lower gap formations for better outcome and appearance [4]. GICs with elongated chemical bonds have augmented strength value for better performance [12]. Favorable bonding productivity of new self-adhesive return better results while lower bond strength has high C-factor cavity-bottom dentin [13]. The bonding factor gives Ionoseal a stable clinical property as a lining and sealing agent.

Apart from the bonding strength, the aesthetic, biological, and functional properties demonstrated the clinical efficacy of the agent. Torres *et al.*'s (2020) finding shows no postoperative sensitivity, and the liner did not influence the clinical procedure of deep restorations with composite [14]. Perera *et al.*'s (2020) results confirm that the more recent GIC agents have boosted acid resistance and supported their application in hostile environments [15]. This result depicts that Ionoseal RMGIC is effective for different conditions and environments. Effective sealants prevent dental caries lesions and show enhanced clinical retention [16]. Younis and Alaa (2020) showed that the flexural strength of Ionoseal and Bioactive-enhanced RMGIs is comparable with a lower modulus of elasticity [17]. In addition, empirical findings demonstrated that resin-based composites (RBCs) are effective restorative dental agents with a new dimension to traditional and esthetic dentistry [18]. On the other hand, shade and viscosity influence the sealing and lining of bulk-fill composite's 4mm thickness [19]. For high-viscosity glass ionomer agents, the tensile strength values are lower than compressive ones [20]. Other scholars found aesthetic fiberglass post and micro-hybrid composite resin effective for sealing and lining [21]. There are inconclusive results that need further studies to investigate the efficacy and clinical properties of Ionoseal as a restorative agent.

Conclusion

The systematic review has identified high comprehensive and transverse strengths, bonding strength, flexural strength, esthetic dentistry, acid resistance, and microorganisms' leakage prevention as clinical properties of Ionoseal boosting efficacy as a lining and sealing agent. The primary investigator extracted and synthesized 15 recent articles to compile and tabulate findings' visual presentation. Comparison of Ionoseal against other agents revealed that the former material had undergone advanced improvement to increase its efficacy as a restorative material.

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Conflict of interest: None

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Ethics statement: This study fulfilled all the ethical requirements including data collection and confidentiality of study participants.

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