



REVIEW ARTICLE

The Stipulation of Dental Cavity Lining Under Composite Resin Restoration: A Myth or Reality?

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Abstract

Excavation of carious lesions and restoration of the resulting cavities is a therapeutic activity older than the pyramids of Giza. A better understanding of the biological aspects of this procedure and the materials used has led to a silent revolution in the dental restorative materials and techniques. The fact that complete removal of caries is undesirable in deeper lesions is an intriguing concept. This paradigm shift in restorative dentistry has fueled parallel research in the utility of 'liners' underneath restorations. Liners that were traditionally used subjacent to dental amalgam restorations were extrapolated to be used under composite resin restorations also, albeit with glass ionomer cement (GIC), flowable resin composite, or resin-modified glass ionomer cement (RMGIC). Later research shows unclear evidence of any benefit of the use of any liner under dental composite material, whether in cavities devoid of caries or in cavities with residual caries. This article seeks to present the evidence that makes the step of applying a liner redundant in a concise manner for the benefit of restorative dentists who may be sitting on the fence on this issue.

Keywords: Calcium hydroxide; Composite resin; Dental caries; Dental cavity lining; Zinc-oxide eugenol cement.

Introduction

The application of resin composite restorations (RCRs) in the posterior teeth have immensely grown over the last decade.¹ This upsurge may be ascribed to several factors such as improvement in material properties, development in adhesive technology, decreased concerns about the longevity of resin composites and patient demand of tooth-colored restorations. Furthermore, the resin composite is now considered as a material of choice

for the restoration of posterior teeth, as concluded by a consensus report among the faculty in the field of operative dentistry in the UK and Ireland.² This trend has prompted the clinicians to simplify the placement of composite restorations with a demand to plummet the number of steps in cavity restoration. Therefore, in the recent years, the cavity liner has gained a reputation of an additional and unnecessary step while restoring teeth with composite resin.³

Traditionally the 'Cavity Liner' is defined as the material that coats the floor of the prepared cavity in a thin layer to protect the dental pulp from the noxious stimuli.⁴ The lining is thought to provide insulation from thermal, chemical, or electrical (galvanism) injury and may also have a therapeutic role.⁵ It could be described as 'Indirect Pulp Capping Agent' when used for medicinal purpose and as a 'Base' material when used in a thick layer to replace lost dentin.⁶

The concept of liners and varnish (sealer) originated for the application below dental amalgam restoration to prevent microleakage and provide thermal insulation.⁷ However; there is a lack of convincing evidence that the use of lining under dental amalgam restoration provides any benefit in reducing postoperative sensitivity or improves overall restoration success.⁷ The layer of lining under composite resin restorations in deep cavities is widely taught in dental schools with documented variations in the selection of lining materials.² A survey conducted among general dental practitioners (GDPs) in the UK reported that 82 % of respondents preferred to use lining in deep cavities under composite restorations, whereas for moderately deep cavities, only half of the respondents favored a liner.⁸ Conventional glass-ionomer cement (GIC), flowable resin composites, resin-modified glass-ionomer cement (RMGIC), and setting calcium hydroxide cement were found to be favored lining materials among dental practitioners in the same study. With an ongoing trend of lining below resin composite, there is now emerging evidence that lining under composite resin may not be beneficial as once thought. A recent systematic review concluded that lining under occlusal and occluso-proximal restorations appears to have no advantages in terms of reducing postoperative sensitivity or avoiding restoration failure as compared to no lining.⁹ Hence, the routine use of lining materials under resin composite restorations can be questioned on scientific grounds.

OBJECTIVES: The objective of this review was to assess the biological and mechanical consequences of omitting dental cavity liners in the placement of

resin-based composite restorations in permanent teeth of children and adults. We shall also discuss the paradigm shift in the management of deep carious lesions and its impact on the use of cavity liners under resin composite restorations.

SEARCH METHODS: PubMed, Web of Science and Cochrane Oral Health's Trials Register databases were searched to retrieve the relevant articles in English without any year restriction.

Paradigms shift for the treatment of deep carious lesions and the role of liners

The understanding of approaches to carious tissue removal is a prerequisite to discussing the role of lining material under resin composite restorations. Traditionally, the treatment protocols for the management of deep carious lesions are based on the amount of decayed dental tissue removed from the cavity.¹⁰ Recently, a group of cariologists reviewed the literature and questioned the reliability of the previous 42 terms used to describe these treatment philosophies.¹¹ They argued that the existing terminology such as 'incomplete,' 'partial,' 'ultra-conservative,' or 'complete' caries removal might convey a diverse meaning to different clinicians. Moreover, these terms lack a clear description and criteria on the level (demineralized, discolored, or soft dentine) to which carious tissue removal is attempted. Therefore, the authors suggested the following three approaches to operative caries management depending upon the extent of the lesion.

1. Selective removal to soft dentine
2. Selective removal to firm dentine
3. Stepwise removal

These minimal intervention approaches to caries removal allow the preservation of viable odontoblasts necessary for laying down reactionary dentine. Furthermore, it should be remembered that reparative odontogenesis is a natural process triggered by growth factors released from dentine matrix dissolution resulting from bacterial acids, cavity preparation, and dentine conditioning.¹² Therefore, the use of lining material for the sole purpose of initiating reactionary dentine may not

be justified under the current recommendations of selective caries removal. Stepwise caries removal approach requires a calcium hydroxide lining material to be placed at the stage one of the procedure. However, a recent randomized controlled trial comparing stepwise caries removal technique with or without calcium hydroxide liner found no differences in the outcome measured (pulp vitality).¹³ Moreover, a systematic review concluded that ‘single step’ selective caries removal (partial caries removal) procedure appears to preserve the pulp vitality better than stepwise caries excavation.¹⁴ There is also some support from the literature that liners may have a remineralizing effect on residual caries, especially where selective or stepwise caries removal was attempted before restoration placement.¹⁵ Nevertheless, these claims are contested by studies that show mineral gain might be attributed to the pulp, and the application of liners may not be required.¹⁶⁻¹⁷ It can, therefore, be assumed that stepwise caries removal and placement of lining material unnecessary delays the final restoration that may have biological and financial implications.

Consequences of leaving caries beneath a restoration without a lining material

Microbes leftover in the residual caries are of considerable concern to the practitioners as it may lead to irreversible pulpal damage if caries continues to progress. This fear does not seem to be hypothetical as it is still unclear if the remaining bacteria sealed in the cavity or infected dentine left close to a pulp without any lining material poses any danger to a pulp.¹⁸ Thus, the use of lining material appears to be inevitable under resin composite restorations. Also, there is some evidence that the lining materials such as calcium hydroxide and zinc oxide eugenol cements significantly reduce the bacterial load as compared to a restoration without lining.¹⁵ However, the same authors concluded that the evidence is weak or insufficient to make any recommendations for specific cavity treatment before placing a restoration.

On the other hand, numerous literature reviews concluded that there is substantial evidence that

caries left during selective caries removal techniques in asymptomatic, vital teeth do not endanger the pulp.^{10,14} Moreover, Thompson and colleagues stated that the caries process arrests and results in a decrease in the bacterial count if early dentine lesion is sealed in non-cavitated carious lesions.¹⁹ To further support the relatively benign nature of the residual bacteria left in the cavity, the study by Mertz and colleagues is worth mentioning.²⁰ In a 10-year prospective clinical trial, cavitated lesions with sound enamel at the periphery when bonded and sealed using resin composite and dental amalgam restorations successfully arrested the progress of the carious lesion clinically and radiographically. Hence, the fear of dentists about leaving caries beneath restorations and not providing a lining appears to be unfounded.

Effect of remaining dentine thickness and lining materials on the survivability of odontoblast cells

The odontoblast cells are responsible for secreting the dentine matrix, and their destruction will affect the quantity and quality of tertiary dentinogenesis (reactionary/reparative). When the odontoblasts survive the trauma of cavity preparation and restorative procedure, they synthesize a new dentine matrix called reactionary dentine.¹² However, when the injury is more severe, it results in the death of odontoblast cells, and new odontoblasts-like cells are recruited from pulp tissue to lay down dentine matrix, which is called as reparative dentine.¹² Multiple variables may affect the survival of odontoblasts such as heat generation from rotary instruments, depth of cavity preparation, pulp inflammation, remaining dentin thickness (RDT) and restorative materials including lining materials.²¹ Nevertheless, odontoblasts survival appears to be most sensitive to the remaining dentine thickness and restorative materials used as they determine the extent of pulp inflammation.²¹

With the continuous decrease in RDT, the number of odontoblasts significantly decreases, so does the capacity of dentin to repair. A reduction of about 50% in odontoblasts numbers below shallow and very deep cavity preparation types was reported.²² Similarly, RMGIC and dentine adhesives in deep

cavities are associated with a significant decline in the odontoblasts numbers.²² Furthermore, the uncured monomer from dentine adhesives has the tendency to diffuse towards the pulpal side in cavities with reduced RDT which may result in irreversible pulp damage.²³ The cumulative effect of reduced RDT and cytotoxic lining material may contribute to sustained pulp inflammation leading to hypersensitivity and pulp necrosis. Pulpitis of moderate to severe nature may further destroy the odontoblasts with subsequent delay or failure to form reparative dentine.

Calcium hydroxide(Ca(OH)₂) appears to be less damaging and preserves the maximum number of odontoblasts.²² It is also associated with more significant areas of reactionary dentine formation.²² However, it should be remembered that if used as a lining material, it has the propensity to wash away if restoration is not well sealed.²⁴ Likewise, if RMGIC is used to protect Ca(OH)₂ lining, it may disrupt the lining by pulling it away during polymerization forming micro gaps leading to post-operative sensitivity.²⁵ Hence, efforts should be made to minimize the injury to odontoblasts by shallow cavity preparations and the use of biocompatible restorative materials. It should be further stated if the dentine bonding agents are appropriately applied, they provide an effective shield against microleakage and render dentine insensitive.²⁴

Post-operative sensitivity and the use of lining materials

Post-operative sensitivity is an infrequent occurrence following the restoration of teeth with resin composites.²⁶ Some studies have reported a higher percentage of post-operative discomfort in a range of 10% to 20% that may persist at one week and one-month follow-up visits.²⁷⁻²⁸ Clinically, it may appear in a variety of ways such as sharp/dull pain after drinking cold or hot drinks, discomfort on chewing/mastication, or sensitivity to sweet/sour foods.²⁹ It may also result in the replacement of recently placed restoration or, in some cases, intentional endodontic treatment if the pain remains unresolved. Therefore, the lining is often recommended on the floor of the cavity to prevent

post-operative discomfort subsequent to composite resin restoration.³⁰

Traditionally, various theories were put forward to help explain the mechanism of dentin sensitivity. However, the most generally accepted (hydrodynamic) theory of dentine sensitivity proposed that the sudden fluid movement within dentinal tubules in response to an external stimuli (hot/cold,air,sweet,chewing) is responsible for the excitation of sensory nerve endings and perceived pain.³¹ It may help to explain dentine sensitivity arising from open cavities to the oral environment. But what causes the dentine sensitivity following the restoration of the cavity with a bonded resin composite seems to be poorly understood.³²

Polymerization shrinkage occurring in resin composites are often held responsible for the post-operative discomfort experienced by the patient.³³ It may help to explain the phenomena of post-operative sensitivity using fluid movement theory. The elevated shrinkage stresses generated within the composite material during polymerization may surpass the local adhesive bond or strength of the remaining tooth structure resulting in microscopic gap formation between the restoration and the tooth structure. This gap formation may be localized or generalized and may result in post-operative sensitivity in two ways.³³ First, it may favor microleakage and influx of bacteria that may be responsible for postoperative discomfort. Secondly, the gap formation may be limited to the floor of the cavity that will allow the accumulation of fluids from pulpal flow between the restoration and the floor of the cavity. The composite materials being relatively less stiff (low modulus of elasticity) than adjacent tooth structures will deform during mastication or chewing, driving the fluid towards the pulpal side and irritation of sensory nerve endings.²⁹ The sensitivity to chewing or mastication should be delineated from the discomfort due to hyperocclusion after the restoration. The chewing sensitivity is often accompanied by cold or hot discomfort, mild or no tenderness to percussion, minimal or no resolution after occlusal adjustment, and may resolve once the gap at the cavity floor is

eliminated by replacement of the restoration with a good sealing material such as glass polyalkonate cement.³³ On the other hand, in hyperocclusion, the offending tooth is usually tender during clenching, and occlusal adjustment will result in a complete resolution of the symptoms.

The association between polymerization shrinkage and post-operative sensitivity appears to dictate the routine application of lining material beneath composite resins. However, this relationship can be challenged on various grounds, so does the need for a liner. Firstly, there is no direct evidence from the literature that polymerization contraction stresses are associated with an increased restoration failure.³³ Secondly, the adverse effects (marginal discrepancies, microleakage, post-operative sensitivity), which are often linked to the setting shrinkage of composite, seem to be of considerable concern only in-vitro studies. The clinical evidence of the deleterious effects of stress generation during the setting of composite appears to be lacking.³³ Thirdly, the problems associated with polymerization stress are actually the consequences of adhesive failure. Therefore, efforts should be focused to optimize the adhesion by preserving enamel as substrate, suitable isolation of cavity preparation, incremental placement of composite, judicious use of bulk-fill resin composites and proper curing protocols.³²⁻³³ This will obviate the need for lining material. Lastly, the studies comparing the presence and absence of lining under composite resin restorations have failed to demonstrate any benefit of a liner in preventing post-operative sensitivity.^{26,34} Furthermore, there might be a certain number of patients that may develop unexplained dentinal sensitivity during restorative treatment regardless of the depth of the cavity and may be independent of the lining material used or not.³²

Survival of resin composite restorations with or without a liner

The longevity of the restoration is an important criterion to judge the credibility of any material or the technique employed. Hence, the discussion about cavity liners may not be completed without

mentioning its effects on the longevity of resin composite restorations. The long term studies assessing the influence of lining materials on the longevity of composite restorations are lacking. The study by Opdam and colleagues evaluating the reasons for the failure of complex posterior composite restorations with or without liner is worth mentioning in this regard.³⁵ They found higher fracture rates of composite restorations performed using RMGIC lining as compared to those restored using the total-etch technique alone. Similarly, more recent studies have also failed to demonstrate any beneficial effect of the intermediate layer of RMGIC on the longevity of resin composite restorations.^{36,37} Therefore, the claims of RMGIC underneath composite for preventing caries and ultimately increasing the lifespan of restoration may be viewed with skepticism.

Discussion

Clinicians frequently use lining materials under the composite resin restorations in an attempt to evade the microorganisms, stimulate reactionary dentine, avoid post-operative sensitivity, and protect the dental pulp from the harmful effects of various restorative materials.¹⁵ It not only prolongs the restorative procedure but also, is often an ambiguous matter among the clinicians, as there is no agreement on the best type of lining material to be used.²⁴ When such cases are encountered where a decision is required about a lining material, the dentists are influenced by senior clinicians, teachers and the concept they were taught in dental school, which may or may not be evidence-based. Furthermore, the concept of lining under a dental restoration and fear of leaving microbes in the cavity is so intensely ingrained among dentists that even with the available evidence in favor of selective caries removal¹⁰ and no lining material under composite resin restoration,⁹ its implementation seems to be a challenge.³⁸

The advantages of not using a lining under composite resin restoration far exceed any worries the practitioners may have. It has been shown to reduce post-operative sensitivity, restoration failure, and overall operative time. The lining material appears

to be an unnecessary step when selective caries removal treatment approaches are adopted, and the cavity is bonded and sealed using composite resin restoration. The residual bacteria left in the sealed cavity isolates them from their nutrient supply, and they remain dormant or die.¹⁹ Most dentists understand this concept, but fear of the unknown, compromises their beliefs which results in the needless removal of the tooth structure and lining under the restoration. Those who still doubt the sterile nature of the remaining bacteria sealed in the cavity must look into recent endodontic literature, where root canals when obturated and restoration of sufficient integrity is provided, results in healing of periradicular tissues even though disinfection procedures do not guarantee sterile canals.³⁹

The popularity of calcium hydroxide as a lining material in deep cavities reflects its biocompatibility and excellent antibacterial properties.¹⁵ There is no doubt that calcium hydroxide induces more significant areas of reactionary dentine formation and preserves the maximum number of odontoblasts in deep cavities, but it is not clear if perceived theoretical advantages are of any clinical significance or not. A recent systematic review assessing the requirement of calcium hydroxide in deep cavities found that it did not influence the clinical success of treatment in both primary and permanent teeth.⁴⁰ It must be highlighted that these conclusions were derived from only two studies on permanent teeth and 17 studies on primary teeth. However, the included studies on permanent teeth were both randomized controlled trials of adequate quality.

Some authors recommend using calcium hydroxide in only deep cavities and should be covered by a layer of RMGIC before the final composite restoration. Before adopting this approach, a question must be asked in the first place; why the cavity has to be extended so close to the pulp when evidence endorses minimal caries removal techniques. Moreover, it is a well-established fact that one factor that had been consistently associated with more failures in indirect pulp capping procedures is the cavity depth.³¹ Therefore, the evidence dictates that efforts should be concentrated on minimizing the extent of cavity preparation and optimizing

the adhesion rather than relying on the calcium hydroxide lining miracles.

Conclusion

It is apparent from the literature review that an intermediate layer of lining material between the floor of the cavity and resin composite should be discouraged. The various reasons given by the practitioners for applying a lining material are not endorsed by the literature and any doubts they have appear to be baseless. The clinicians should strive for evidence-based dental practice for decision-making regarding the use of liners, rather than being rigid on older concepts. The cavity, whether shallow, moderate, or deep in depth not only depends on the extent of caries but also on the clinician's attempt to remove it. Being conservative in caries removal would result in shallow to moderate cavities and will avoid the unevidenced-based thought to use liner under resin composites.

Conflicts of interest

None.

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