

## A Review on Marginal Deterioration of Composite Restoration

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**Abstract:** Dental treatment procedures are increasingly governed by factors such as biocompatibility of restorative materials, patients demands for esthetics and a conservative approach to minimize loss of tooth structure. G.V Black was the first person to describe the ideal cavity form to restore carious lesions. G.V Black followed "EXTENTION FOR PREVENTION" as ideal principle for cavity preparation. Such classical cavity forms and principles remained appropriate and largely unchallenged for a period of 50 years using Amalgam. However amalgam cavities require uniform depth, particular wall forms with excessive tooth damage to ensure retention of amalgam. So patients demand for tooth coloured restoration, with minimal sacrifice of sound tooth structure was increased and it depends mainly on adhesion of the restorative material that provide strong and durable bonding to the remaining sound enamel and dentin. This led to the introduction of aesthetic restorative material known as Composite Resins which has taken dentistry a step closer to the goal. Dental composites are highly cross linked polymeric materials reinforced by a dispersion of glass, crystalline, or resin filler particles and short fibers bound to the matrix by silane coupling agents. The predictors of marginal deterioration has been reviewed in this article.

### I. Introduction

An ideal restorative material must not only establish effective seal between the restoration and the tooth but also should strengthen the tooth and maintain aesthetics. Despite the improvement of many restorative materials the marginal integrity of the restoration remains a challenge for dentistry. The marginal integrity of composite restoration refers to its marginal fit and marginal adaptation thereby increasing the longitivity of the restorative material. The marginal deterioration refers to poor marginal adaptation which may produce marginal discoloration, post operative sensitivity and secondary caries. These are the most frequent reasons to replace or repair an adhesive restoration. The marginal failure of composite resin restoration is related mainly to the quality of bonding to the dental structures and the stress generated on the restoration [1] When the resin composite is bonded to tooth structure using adhesives the initial and residual polimerization stresses that are present along the cavity walls results in gap formation, micro leakage which leads to recurrent caries and pulpal irritation [2] The detrimental effect of marginal gap formation cannot be offset even with the use of flouride releasing adhesives or restorative material that prevent the demineralization along cavity margins[3] Thus only hermetic sealing of restorations guarantees clinical success [4] The accurate evaluations of margin qualities are important for identification of the risk of future failure of composite restorations. The clinical evaluation of marginal deterioration can be done using modified USPHS criteria which includes evaluation of marginal adaptation, marginal discolouration, secondary caries. The loss of marginal adaptation and the presence of secondary caries are predictors of the failure of composite resin restorations and being the main reason for the replacement of restorations [5] Marginal fit is assumed to affect the restoration longevity by either encouraging or discouraging microleakage and development of secondary or marginal caries.[6]

### II. Modified USPHS Evaluation Criteria[7]

Marginal Discoloration	Alfa:No Discoloration
	Bravo:Acceptable mismatch
	Charlie:Unacceptable mismatch
Marginal Adaptation	Alfa:Closely adapted, no visible crevice
	Bravo:Visible crevice,explorer will penetrate
	Charlie:Crevice in which dentin is exposed
Secondary Caries	Alfa:No caries present
	Charlie:caries present

### **III. Predictors Of Marginal Deterioration**

#### **MARGINAL ADAPTATION[3.1]**

The dental explorer has been used for the diagnosis of caries and for marginal evaluation. A proper marginal sealing is essential to improve the longevity of composite resin restoration [8][9][10] Marginal adaptation in composite restorations is related to some factors like type of dentin adhesive, restoration technique, band accuracy in finishing restoration.[11] The most of the clinical studies evaluating the performance of an adhesive system considers the C-factor. The C-factor of the cavities impairs the composite resin flowing during the polymerization shrinkage, increasing the stress over the bonding interface [12][13] Composite restoration, stresses submitted on the restoration can disrupt the bonding and lead to the formation of gaps. Thus the proper bond of an adhesive to the dental tissue contributes to avoid marginal microleakage. [14] [15] Bonding to enamel is predictable and stable because of the substrate's high mineral content. [16] In contrast with the enamel, dentin is a more heterogeneous substrate, consisting of hydroxyapatite, collagen fibrils and water. The acid conditioning of the dentin widens the opening of the dentinal tubules exposing a layer of mineral-depleted collagen fibrils and increasing water content.[17] The presence of the organic content and water impairs proper bonding. The presence of solvents and hydrophilic components in the adhesive layer of the self-etching adhesive can compromise the adhesive's proper polymerization.[18][19]. On the other hand, the Clearfil SE bond presents a hydrophilic adhesive that is applied on the etched dentin by a self-etching primer. This explains the lowest gaps observed in the margins of the dentin when the Clearfil SE is used when compared to self-etching adhesive.[20][21] Thus, the more stable bonding to the dental substrate contributes to maintain margin sealing. Moreover, 60% of marginal fractures have been found in cavity preparations which have widths of more than two-thirds of intercuspal distance.[22]

#### **SHRINKAGE AS THE PREDICTOR OF MARGINAL DETERIORATION.[3.2]**

**POLYMERIZATION** Composite restorations are subjected to polymerization shrinkage which occurs due to the affiliation of the resin molecules with one another and formation of chemical bonds which reduce the material bulk[23] The C-factor plays a major role in determining the amount of shrinkage. C factor is defined as the ratio between the bonded and unbounded cavity surfaces. Increasing this ratio also increases the stress from polymerization shrinkage.[24] Shrinkage of composites results in stresses, cuspal deflection which in turn leads to enamel cracks, hypersensitivity, marginal degradation, microleakage. It also includes potential debonding of the tooth-composite interface.[25] The amount of shrinkage and stresses varies with the composite filling material used.[26][27]. It is influenced by material flow, chemistry, curing dynamics and the size and shape of the preparation, hygroscopic expansion. The intensity and duration of curing have been found to affect polymerization.[28] Polymerization shrinkage stress of composite resin is about 13-17 MPa. Therefore, adhesive agents should have a good bond strength higher than this amount.[29][30] Polymerization shrinkage of composites can lead to microleakage which can cause an immediate inflammatory reaction in pulp.[31][32][33]. Three different strategies to reduce polymerization stress include modification to placement technique, altered curing schemes, use of a resilient liner on dentin.[34][35]

#### **MICROLEAKAGE[3.3]**

When composite resin is placed on dentin or cementum, a high potential exists for marginal gap formation.[36] This gap predisposes the restorative margin to microleakage, secondary caries and marginal discoloration.[37][38] Marginal leakage can be defined as the passage of fluids, bacteria or molecules between a cavity wall and the restorative material because of the presence of micrometric spaces.[39] Marginal leakage is a cause of failure of composite resin restorations as a result of lack of the lack of adhesion, which is responsible for marginal discoloration.[40] Marginal staining is mentioned as a clinical sign of microleakage.[41][42]. Major reported that the relatively high proportion of marginal discoloration suggests inadequate acid-etching of the enamel prior to placing the resin-based composite restorations and/or inadequate fabrication of the restoration in addition to the inherent problems associated with polymerization shrinkage. The increase in etched surface area results in stronger enamel to resin bond, which increases the retention of the restoration and reduces marginal leakage and marginal discoloration.[43][44]. The marginal staining of the restoration also depends on proper shade selection, finish of the margins of restorations and oral hygiene of the patient.

#### **SECONDARY CARIES[3.4]**

Secondary caries has been consistently found to be the most common reason for replacement of restorations. It is also known as marginal caries which refers to the carious lesions found adjacent to existing restoration margin.[45] The high incidence of secondary caries associated with the resin composite restorations may be explained on the basis of microbiological findings.[46] Secondary caries is thought to be associated with marginal gaps, voids and openings along the margins of existing restoration. A significantly higher proportion of

streptococcus mutans was found at the cavity margins of the resin composite restorations than for the other materials.[47] Recurrent caries may arise from remnants of infected dentine, incompletely removed during cavity preparation or more commonly from oral microorganisms which gain entry via leaky filling margin. All composites shrink during curing. It is important to minimize the effect of composite shrinkage by incrementally placing and curing materials.[48]

#### **IV. Silorane-Based Posterior Restorations.**

Silorane is derived from combination of siloxane and oxirane and has compact ring structure that unlinks during polymerization. It reduces polymerization shrinkage and associated stresses, which would also reduce microleakage and postoperative sensitivity while demonstrating other physical properties comparable to leading composites.[49]

#### **V. Conclusion**

Increasingly composite are being placed in preference due to patient demands for esthetics as well as the clinical desire to do minimal preparation where possible and provide patients with bonded esthetic restorations. However composite restorations fails mainly due to polymerization shrinkage. Further investigations are required at reducing polymerization shrinkage to increase the longevity of restoration and reduce the potential for failure.

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