# The Effect of Some Manipulation Variables on Gap Formation of Resin Based Direct Esthetic Restoratives

***Thesis***

***A thesis Submitted to the Faculty of Dentistry***
***Ain Shams University in partial fulfilment of the requirements of the master Degree in Conservative Dentistry***


***By***

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***B.D.S***
***Faculty of Dentistry***
***(Ain Shams University), 2002***


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***Under supervision of***

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***Professor of Operative Dentistry and Vice Dean for Education & students***

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The introduction of resin composite to restorative dentistry was one of the most significant contributions to dentistry in the last century. One advantage of bonded restorations include conservation of sound tooth structure, reduction of microleakage, prevention of post operative sensitivity, marginal staining and recurrent caries, transmission and distribution of functional stresses across the bonding interface to the tooth. Bonded restorations also offer the potential for tooth reinforcement, cosmetic restoration and recontouring of teeth with little or no preparation, and diminished need for use of liners and bases. (29)

Tooth-colored restorations, mainly, direct-placement, resin-based composite (RBC) are increasingly being used for restoration of posterior teeth, often as replacements for failed or unaesthetic restorations in dental amalgam. Currently available formulations of these materials are now recommended for a wide variety of clinical situations. Meta-analysis, published in 1994, has demonstrated promising clinical performance. It is likely that currently available resin composite materials, which have been developed since the publication of the meta-analysis, may perform similarly, or even better. (25)

The achievement of an optimal marginal seal is a key factor for the success in restorative dentistry, as presence of marginal deficiencies has been reported to be one of the main reasons for restoration's failure (35). Gap formation can be attributed to shrinkage of resin during polymerization and/or poor adhesion of dentin bonding agents between dentin and composite material. Consequences such as discoloration of the restoration, marginal breakdown, recurrent caries, pulpal inflammation and postoperative sensitivity, can affect the longevity of the restoration and ultimately the vitality of the dental pulp. (62)

Good marginal adaptation requires adequate physical and mechanical properties of the filling material and its careful manipulation [29]. Furthermore, efforts to minimize stresses from polymerization shrinkage have been directed towards improving placement techniques, material and composite formulation, and curing methods. [19]

Therefore, the present study aimed to investigate the effect of some manipulative procedures for restoring teeth with class V cavities, on the marginal seal of packable composite resin restoration versus polyacid-modified composite restoration (compomer).

The continued development of esthetically acceptable adhesive restoratives has made a variety of tooth colored materials available for clinical use. Currently the clinician has resin composite, polyacid modified composite, resin modified glass ionomer and conventional glass ionomer restoratives as options for direct restorations. The main drawback of resin-based restoration is microleakage, which results from gap formation at the junction of restoration and cavosurface margins of tooth structure.

Gap formation can be attributed to shrinkage of resin during polymerization and/or poor adhesion of dentin bonding agents between dentin and resin based materials. Gap formation can result in many clinical consequences such as marginal discoloration of restoration, marginal breakdown, recurrent caries, pulpal inflammation and postoperative sensitivity. Such consequences can affect the longevity of restoration and ultimately the vitality of dental pulp.

Direction of curing shrinkage, depth of cure and polymerization contraction stresses are some of the shortcomings of the curing pattern of light-cured resin composites, which may compromise the achievement of a perfect seal at the cavity wall. Composite resin systems shrink considerably during setting. The contraction before the moment of gelation is not regarded as having clinical relevance. The rigid contraction, however, has received much attention in dentistry and is often assigned as the cause of marginal defects. [(89), (6), (8)]

**Carvalho RM, Pereira JC, and others, 1996**; [(11)] Reported that polymerization shrinkage of resin composite can create contraction forces that may disrupt the bond to cavity walls. This competition between mechanical stress in polymerizing resin composites and bonds of adhesive resins to the walls of restorations is one of the main causes of marginal failure. This results in subsequent microleakage that is observed with composite restorations. Moreover, **Jensen and Chan, 1985**; [38] Concluded that Polymerization shrinkage stresses have the potential to initiate failure of the composite-tooth interface (adhesive failure), which may cause microleakage and secondary caries. Furthermore, **Lai and Johnson, 1993**; [45] Reported that polymerization shrinkage stresses can also initiate micro cracking of the restorative material (cohesive failure), while polymerization contraction stresses transferred to the tooth cause deformation of the tooth. The resulting coronal deformation may result in post-operative sensitivity and may open pre-existing enamel micro cracks [38]. Moreover, the tooth-restoration complex is in a pre-stressed state even before occlusal stresses that result in further coronal deformation. [65]

On the other hand **Segura and Donly, 1993;** [67] reported that stress relaxation through water absorption is evident in mature composites this occurs over a long period, well after post-gel polymerization is complete. **Kohler B, and others in 2000;** [42] reported that secondary caries, due to microleakage, has become the most frequent indication for removing resin-based composite restorations. It is difficult to differentiate clinically between secondary caries and marginal discoloration. [53] Therefore, to diminish recurrent caries due to microleakage, caused by incompletely sealed margins, especially at resin cementum interface, several efforts were made to develop new monomers [7], to improve resin-dentin bond strengths [17], and even by regulating the forces of polymerization shrinkage. [11]

**Smith AT, Overton JD, and others, 1997**; [70] reported that up until now none of the available resin based restorative materials have met all clinical demands. There is no low or non-shrinkage restorative materials being able to prevent microleakage. Other efforts are made to improve and facilitate handling of resin-based composite materials by means of packable restorative materials, or to return to the easier use of metal matrix systems for posterior composite restorations. Another interesting attempt was the use of flowable resin composites underneath the first resin composite layer**.** Those materials perform as a kind of stress-breaker and seem to be able to wet the cavity surfaces more completely than a conventional sticky resin based restorative material does [(57)]. **Moszner N, Salz U, 2001;** [(55)] stated that "several researchers have thought for techniques and materials to overcome composite's undesirable curing effects"

**Taylor MJ, Lynch E, 1992;** [(74)] reported that many different techniques may be used to evaluate microleakage: air pressure, bacterial studies, radioisotope studies, neutron activation studies, scanning electron microscopy, chemical tracers, dye penetration studies, and electrochemical studies. Moreover **Torstenson B, and Brännström M, 1998**; [(76)] carried out a study demonstrated that a fluorescent resin would penetrate the gap after the composite had set.

**Unterbrink GL, and Muessner R, 1995;** [(78)] conducted a study to investigate the Influence of light intensity on two restorative systems regarding four properties: polymerization shrinkage (density method), flexural modulus and strength (IS0 4049), hardness profiles after post-cure (Vickers), and marginal adaptation in dentine cavities (quantitative margin analysis using electron microscope). It was concluded that the variation in light intensity did not significantly affect curing contraction or post-cure hardness profiles to a depth of 4.5 mm for either resin composite. Significant differences were found in flexural modulus with both restoratives: only one material demonstrated a light intensity-related influence on flexural strength.

Marginal gap formation increased in each bonding agent/resin composite pair with increased light intensity, which was attributed to increased shrinkage stress.

**Mehl A, Hickel R, and Kunzelmann K.H, 1997**; [52] studied the effect of light initiated prepolymerization at low intensity followed by a postlight-cure at full intensity (softstart-polymerization) on physical properties of light cured composite resin, like flexural modulus, flexural strength and Vickers microhardness of different composites. Additionally, an in vitro study was carried out to investigate the influence of different initial cure conditions on marginal quality of composite restorations in class V cavities totally bordered by dentine. In this study, initial cure with reduced intensity followed by final cure with full intensity (softstart polymerization) is a reliable method to combine better physical properties with increased marginal integrity of composite fillings at the dentin-composite junction.

**Stephen C Bayne & others, 2002**; [72] stated that "composite is a physical mixture of materials, the parts of the mixture generally are chosen with the purpose of averaging the properties to achieve intermediate properties. The organic matrix is mainly polymethyl methacrylate (PMMA) or methyl methacrylate (MMA) supplanted by bis–GMA or UDMA which are extremely viscous so they are diluted with another difunctional monomer of much lower viscosity (TEGDMA)"

The current most popular fillers are silicate glass, barium, zinc and yttrium modified silicate glasses. Dental composites are highly cross-linked polymeric materials reinforced by dispersion of glass, crystalline or resin filler particles and/or short fibers bound to the matrix by silane coupling agent. [40]