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Polymerization Srinkage: Clinical Method Used to Counteract Polymerization Shrinkage

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Abstract: ***In general excellent results cannot be guaranteed when using resin-based composites for posterior restorations. This is due to polymerization shrinkage which can still be regarded as the primary negative characteristics of composites.Sevaral factors responsible for the polymerization shrinkage process may negatively affect the integrity of the resoration.The materials shrinkage is associated with dynamic development of elastic modules, creates stress within the material and its interface with the tooth surface. As a consequence operative sensitivity are clinical drawbacks of resin composite restoration.Evoling improvements associated with resin based composite materials ,dental adhesive, filling and light curing techniques have improved the predictability of such restorations.***

Keywords: flowable composite, layering technique, glass inomer cement

1. Introduction

Since their development in the late 1950's,resin composite represent a class of materials widely used in restorative dentistry. Composite resin has become an essential part of everyday dental practice with the improvement in dental adhesive systems, the increase in patient demands for aesthetics and more emphasis in preservation of tooth structure. Besides the acceptable aesthetic property resin composite can be directly bonded to the tooth structure without removing healthy tissue. Because of its bonding ability, by application of a previous adhesive treatment, the material has found increasing application in modern preventive and conservative dentistry. The abrasion resistance of dental composite has continued to improve since their introduction as dental restorative, enabling expanded use in posterior restorations with good longevity.However,the polymerization shrinkage and its associated stress still remains a major drawback of dental composite. Polymerization shrinkage causes stress at the interface between a tooth and a restoration as the elastic modulus of the composite increases during curing. Efforts have been made to increase inorganic fillers loading to develop a new resin matrix to reduce polymerization. Polymerization shrinkage can also be reduced by decreasing reactive sites per unit volume through increasing the molecular weight per reactive group. Clinical strategies to minimize shrinkage stress of composite include incremental filling technique to decrease the C-factor, measurement of cuspal deflection, flowable composite has been recomemded as a stress absorbing liner, Silorane based composite shows lower polymerization shrinkage compared to conventional methacrylate based composite, indirect methods such as microleakage and micro-tensile bond strength test are used to evaluate the clinical methods of polymerization shrinkage stress.

2. Clinical Method Used to Counteract Polymerization Shrinkage

a) Flowable Composite

Flowable composite were created by retaining the same small size of traditional hybrid composite but with a reduced filler content resulting in a reduced viscosity[3].Their low filler content causes them to develop high volumetric shrinkage[1].In spite of the low elastic modulus, seems to be the main cause for high contraction stress, this results means that the risk for of interfacial debonding for flowable composite due to the shrinkage stress which is similar[1].Primary benefit of any low viscosity composite could be to act as a stress bsorbing layer between the hybrid layer and the shrinkage of the resin composite by partially relieving the polymerization contraction stress[3].However the use of flow able composite to reduce polymerization shrinkage stress is still being debated and is not widely recommended[3].

b) Incremental Layering Technique

Many researchers have suggested the use of "incremental layering techniques" for resin composite restoration to reduce the polymerization shrinkage stress and cusp deflection. The rationale behind this incremental layering technique is that shrinkage may be less detrimental when there are fewer bonded cavity walls involved at each stage of the restoration procedure[5]. According to Park et al bulk filling technique yielded significantly more cuspal deflection in premolars than incremental filling techniques, concluding that cuspal deflection resulting from polymerization shrinkage can be reduced by incremental filling techniques. Incremental curing also enhances the degree of cure as a thin section undergoes high degree of cure due to lower light attenuation, thisn the degree of conversion is greater[4].In a class 1 caity, by using a single increment, the resin composite would polymerize within five bonding surfaces while free shrinkage would only occur in the upper surface, producing very high level of stress between the bonded surfaces[5].According to Loguercio et al, some evaluated effects of polymerization shrinkage such as a gap width, adhesive bond, strength and cohesive strength of the resin composite were not reduced by the filling technique under the different C-factor cavities[5].Despite all the controversy over the advantages of incremental layering technique of resin composite, this technique has been broadly recommended in direct restoration because it is expected to decreade the C-factor[3].

c) Light Curing And Self-Curing Composites

The contraction stress magnitude is highly dependent on the composite's viscous component. Stress reduction by viscous flow may occur in two ways. First, the unbonded composite allows the material to deform when shrinking (external flow). They develop different polymerization shrinkage stress due to two inrtrinsic factor which are velocity of polymerization and porosity[3].For all cements, the contraction stress in a dual cure mode was higher than a self-cure mode. The reduced stress in a self-cure mode may have been the result of two concruent factor[1].The main difference between the magnitudes of the internal stress of self and light-curing composites is the velocity of polymerization of light curing composite is much higher than self-curing composite. A lower velocity results in a better adaptation of the restoration to the cavity walls[2]. Alternative curing routines using stepped, pulsed, or ramped energy delivery have been developed to improve restoration interfacial integrity by reducing composite curing rate

d) Light-Curing Procedure

Diverse photoactivation protocols have been advocated to reduce the polymerization stress. Initial light exposure at lower irradiance values might lead to the formation of reduced number of polymer growth centers, reducing the reaction rate and decreasing stress development due to the increased opportunity for resin flow before the vitrification stage[3].There are many types of alternative light-curing methods. The “soft-start” protocol consist of initial light exposure with reduced irradiance for a certain period of time followed by full irradiance. Another protocol is “pulse-delay” method where the clinician may apply the initial exposure with reduced light irradiance for a very short period of time without irradiance[2].The flowability of a material, during extended preset stage, may have minimal consequences, because most shrinkage stress is develop during and after the vitrification stage. Therefore, oppourtunities for polymer relaxation would be restricted during the short period of light activation[3].

e) Glass-Ionomer Cement

The glass-ionomer composite or also known as the “sandwich technique” provides significant clinical advamtage. The Glass-Ionomer cement is used as a liner or base and offers several advantages. Glass ionomer cememt provides a relatively reliable form of adhesion to the dentin with little or no polymerization stress[2].

f) Stress Absorbing Layers With Low Elastic Modulus Liners

Flowable Composite are low-viscosity resin based restorative materials, which differ from conventional resin composites in their filler load. This material is less rigid and could have a modulus elasticity which is lower than conventional composite. The use of flowable composite of flowable composie as an intermediate thin layer has been suggested to overcome polymerization shrinkage stress based on the concept of an “elastic cavity wall”. According to this concept the shrinkage stress generated by the subsequent layer can be absorbed by an elastic intermediatery layer thereby reducing the stress at the tooth restoration interface.

g) Preheating

Recently, preheating resin composites to a temperature slightly greater than 37^{O}C has been advocated as a method to increase composite flow, improve marginal adaptation, and monomer conversion. The benefit of preheating involves the application of shorter light exposure to provide conversion values similar to those seen in unheated conditions. The reason for increased conversion are based on many factors. At raised temperature, in theory ,it would be possible to obtain higher degree of conversion before the vitrification point which causes decrease in magnitude stress, decreases viscosity and enhances radical mobility, resulting in additional polymerization and higher conversion.

3. Conclusion

The use of composite in daily clinical practice has increased since its production,but there is a problem of resin composite polymerization shrinkage and destructive shrinkage stress.There is no straight forward way of handling this problem. This is due to several aspects involved in the polymerization process and it cannot be controlled.

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