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Flowable Composite Resin: A Versatile Material

Dr. Saraswati Sachan[1], Dr. Isha Srivastava[1], Dr. Manish Ranjan[2]
[1.] *Post Graduate Student, Department of Conservative Dentistry and Endodontics, Sardar Patel Post graduate institute of dental and medical sciences, Lucknow*
[2.] *Senior Lecturer, Department of Conservative Dentistry and Endodontics, Saveetha Dental college and hospital, Chennai.*

Abstract
Aesthetic dentistry can promote a beautiful smile that parents and their children desire. We are fortunate to have dental materials and devices that provide us the opportunity to perform aesthetic dentistry. Many different composite resin products have found their way into dental practice.Composite consists of inorganic fillers chemically embeddedin a resin matrix. A newer type of composite known as "flowable composite" came into existance because of its low viscosity and ability to be syringed into a cavity preparation with a needle tip.There are many application of a composite resin that will flow into tight areas such as repairing crown margin or repairing porcelain.This article focuses on materials aspects, composition,properties and application of flowable composite

I. Introduction

Composite resin is a tooth coloured material and commonly used for aesthetic restoration of anterior and posterior teeth. Composite resins are polymer matrix filled, tooth coloured restorative that derives their physical properties and handling characterise from loading with reinforcing filler particles and the viscosity of the resin matrix.

With the introduction of adhesive bonding,the types of dental resins have increased over time.The earliest composite resins were usually quartz filled with reasonably larger filler particles making restoration difficult to polish. Due to recent advances resins are now available with smaller filler particle for better polish ability. One of the primary reasons for the increased loading of fillers in composite is to improve physical properties and resistance to functional wear.As filler loading increased, so did composite resin viscosity

Most direct restorative composite resins have a puttylike consistency. While the putty like consistency of packable composite resins was a desirable characteristic for most clinical uses, it was desire to have a less viscous composite resin but none was that runny as dental sealants. For this reason a new class of composite resins known as flowable composite was introduced to the dental profession in late 1996. Flowable composite has principle characteristic like a low viscosity that allowed them to be injected into a cavity preparation .The development of flowable composite was based upon its flowable viscosity and not on the type of filler used.The majority of flowable are filled between 41-53% by volume which translates into 56-70% by weight.[(1)]Most manufactures packaged these flowable composite in small syringe that allow for dispensing with very small gauge needles.The application of flowable composite through small needles made them ideal for use in small preparation that would be difficult to fill with more conventional composite resin

Classification

Composite resins can be classified by filler size and per cent filler loading as well as by viscosity of the composite.The majority of direct restorative composite resins fall into one of the following categories: hybrid, nano-filled or micromatrix hybrid, microfill, packable composites and flowablecomposites[(14)]

year	Name	Resin matrix	Filler	% and size of filler
1962	Conventional Type I	Polymethyl methacrylate	Quartz	30-70% by wt,25-30 um
1968	Conventional Type II	BisGMA/Bisphenol/Glycidyl methacrylate replaces PMMA	Quartz Barium added in traces	30-70%by wt,7-10um
1975	Microfilled	BisGMA	Silica replaces quartz	30-70%by wt,0.05um
1978	Organic	BisGMA	Quartz	10%by wt,20-30
1989	Hybrid	UGDMA/TEGDMA	Silica	50-70%by wt,20-30um and 0.05um
1996	Flowable	TEGDMA	Silica	60%by wt,0.8um
1996	Packeable	Urethane Modified BisGMA	Fumed Silica and Bariumfluroalumino borosilicate	82%by wt ,0.8um

Properties

Mechanical Properties-The mechanical property of flowable composite are poorer than those of the hybrid composite .but they have a higher fracture toughness due to their lower modulus of elasticity. Hence they are indicated in low stress bearing areas where increased flow of the composite resin is desirable.

Flexural Modulus-

Different mechanical properties determine the durability of the restoration .one of the mechanical property is a flexural modulus, which is defined as the amount of stress required to create deflection of the material. High flexural modulus of a material means that the material is stiffer than one with a lower flexural modulus. Materials with low filler loading have greater mechanical problems and greater polymerization shrinkage. A material with a higher flexural modulus needs to be balanced with high bond strength in order to avoid a failure at the resin tooth interface.[(15)]

Polymerization Shrinkage-

Flowable composite resin have polymerization shrinkage in between 2 -3.5%.It is an intrinsic property of the resin matrix.in which upon light curing ,the single resin molecules move toward each other and are linked by chemical bonds to form a polymer network , a reaction that leads to a significant volume contraction .The main value of high bond strength is the conservation of the marginal seal during polymerization.[(2)] The stresses that develop as the composite contracts can be transferred to the bonded margins of the preparation creating two potential causes for post-operativesensitivity: gap formation and cusp deformation[(3)].This can be minimized by increasing the ratio of non-bonded to bonded surface of c factor. In the oral environment, bond failure can result in micro leakage, which is the main cause for failure of the restoration.[(15)]

Gap formation occur when the contraction force is stronger than the bond strength of the resin to the tooth force .The gap creates a nidus for bacterial colonization and recurrent caries with its subsequent irritating action on the dental pal. Cusp deflection occurs when the contraction force of curing composite causes the tooth to bend, creating internal stress or implosion fracture[(4)]. That's why polymerization shrinkage is considered to be a significant factor which must be considered before placement of restoration.

Lower Viscosity

Flowable composite are simply a low viscosity composite with less filler than universal composite .Because of low viscosity they exhibit lower mechanical properties than universal composite, but at the same time it is 2 to 3 times more flexible than universal composite. Because of its flexibility ,it has become material of choice for abfraction ,erosion and class 5 restoration .Since they have higher resin content than universal or packable materials, they are highly polish able. Having more resin means they incur more polymerization shrinkage, but many studies have shown that when used in small, thin amounts, such as a cavity liner, the shrinkage is negligible since the flowable does not bridge any axial walls together.[(16)]

Elastic Modulus

Flowable composite have lower elastic modulus which compensate for the higher shrinkage. It is an important property, which can yield useful data related to the material behaviour. It describes the relative stiffness or rigidity of a material and it is measured by slope of the elastic region of the stress.[(5)]

Uses Of Flowable Composite

- Cavity liner
- Preventive resin restoration
- Pit and fissure sealant
- Class I and V Restoration
- Class II restoration
- Liner under a routine core build up
- Use as acore build up to treat vertical fracture
- orthodontic retainers
- Repairing small,direct,and indirect restoration

Cavity Liner

Cavity liners such as calcium hydroxide have been historically used to protect the pulp by providing the deposition of reparative dentin and by neutralizing dentin and by neutralizing acids[6]. Calcium hydroxide is highly soluble and has low compressive strength causes long term failures. Liners are used to decrease sensitivity and to counter polymerization shrinkage of the overlying composite and also to improve adaptation, and also to impart better wettability of the cut dentin surface.

The most popular use of a flowable composite is as a thin, highly adaptive cavity liner .But at the same time it is used to build up cavity preps, to block out small undercuts and also to use as an indirect or direct pulp cap[15].In vitro studies have shown that use of a flowable composite reduces restoration micro leakage and the occurrence of voids that may cause postoperative sensitivity[16].

Other useful materials for liners can be resin modified glass ionomercement, which are self-adhesive and has a lower flexural modulus than flowablecomposite, but unfortunately also have lower bond strength than dentin .So while the flowable composite require a higher bond strength to counter the 15-17MPa contraction force coming from the polymerization shrinkage[7],this requirement is routinely achieved with the appropriate bonding agents. Its ability to adapt to the prepared tooth structure allows it to create an intimate union with microstructural defects of cavity preparation prior to placing the restorative composite.[8]

Preventive Resin Restoration

Flowable composite resin materials are ideal to restore what have been termed, preventive resin restoration because these are the most minimal of the class I types and needle tip placement into these small preparations assures a well-adaptedrestoration[15]. In recent data by Savage, et al it was reported that flowable composite was the most widely used restorative material for the PRR among those paediatric dentist surveyed in this study.It was found that flowable composite can be useful in those cases also where sealant has failed and incipient caries was detected.[17]

Pit And Fissure Sealant

Flowable composite is used as pit & fissure sealants on occlusalenameloplasty[18] ,because of their low filler loading ,which promotes an appropriate consistency that permits the resin to flow into the fissure ,enhanced wetting of the tooth surface ,and a low modulus of elasticity.[9]

Class I And V Restoration

Flowable composite are often utilized as a liner under composite restoration. The highest C factor occur in class I and V preparation because in each case there are5 bonded surfaces and only one unbounded surface. On the other hand, a liner that is placed only on the pulpal floor has C factor of 1,thus reducing the C factor of the entire restoration .The lower the C factor ,the less the chances of gap formation or cusp deflection because the composite is not pulling against as many preparation walls during polymerization.[15]

Class Ii Restoration

Flowable composite is an excellent material to use in the proximal boxes in class II preparation because of its strength as well as its superior adaptation to the matrix and to the confines of the preparation. When used as the initial incremental in the proximal boxes,it was found to have reduced micro leakage at the enamel margin. [10]

Liner Under A Routine Core Build Up

Core build ups have become routine in restorative clinical practice, and, often a heavy bodied light cured core material is used because of its ease and speed of placement. The flowable composite liner improves the quality of the restoration by its improved adaptation to the cut dentin surface, minimizing the effect of the polymerization shrinkage of the light cured build upmaterial[15].

Uses As A Core Build Up To Treat Vertical Fracture

Flowable composite can be used as core build up material for treating vertical fractured tooth. The heavy filler content present in flowable composite gives the strength that is necessary to hold fractured tooth fragments together.[15]

Orthodontic Retainers

Tabrizi ,et al found that flowable composite provided satisfactory shear bond strength comparable to a standard orthodontic resin and therefore may be used for direct bonding of lingual retainers[11]. Foek ,et al studied the adhesive properties of bonded orthodontic retainers to enamel ,utilising flowable composite, with both stainless steel wire versus fibre –reinforced composites[12].

Repairing Small,Direct,And Indirect Restoration

One of the many advantageous properties of flowable composite is their ability to repair previously placed composite restoration. Papacchini ,et al evaluated the effect of various intermediate resin agents on composite to composite bond strengths. The flowable composites showed good interfacial quality to the adhesives. Also, the application of flowable composite resulted in statistically superior tensile strength[13].

II. Conclusion

Flowable composite can be used successfully for our child & adolescent patients for aesthetic restoration Flowable composite are versatile restorative material suitable for a variety of applications.When flowable composite resins were first introduced, they appeared to be one-dimensional restorative materials with very limited uses.Over the last few years, the usefulness of flowable composite resin has been demonstrated. Most flowables have a variety of shades to manage most aesthetic clinical situations. There is variability in the viscosity of these restorative materials, which gives option to the different flowable composite with different viscosity at different areas.

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