Various commercially & clinically used common Flowable Composites

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Abstract
Flowable composites are of low viscosity and a modification of small particle-filled and hybrid composites. They have reduced filler load and modified resin monomers which provide a consistency that allows the material to flow readily. They have better adaptability to cavity walls thus preventing microleakage. The various commercially available and clinically used low viscosity dental restorative materials, better known as ‘flowable composites’ that will be discussed in this article are VertiseFlow, Grandio Flow and PremiseFlowable composites.

Introduction
Restorative dentistry is going through a dynamic transition towards adhesive dentistry. A class of resin-composite systems known as ‘flowable composites’ has become an essential part of the restorative process since their introduction in the mid-nineties. These materials were developed in response to a demand from the clinicians for easy handling. They are characterized by having less filler load and greater portion of diluent monomers. Designed to be less viscous, and so the flowable composites offer a better adaptation to internal walls of the cavity, easier insertion and greater elasticity. Flowability of these materials allows them to be dispensed through injectable dispensers and simplifies easy placement procedures.

Present day dental composites exhibit excellent aesthetics. Thus, due to this increasing demand, this has leaded to significant developments in terms of bond strength, adequate working time, shorter curing time and ease of use.1 By the end of twentieth century, low-viscosity resin composite, generally known as flowable composites, were introduced amongst the variety of commercial commodities for restorative dentistry.2 These flowable composites show two desirable clinical handling characteristics that were not present in composites until very recently. Firstly the material does not stick to the instruments, so the material can be easily filled in the cavity and secondly fluid injectability.1 Flowable composites were formed by keeping the same particle sizes of traditional hybrid composites, and by decreasing the filler content thus permitting increased resin to reduce the viscosity of the mixture.1,3

PROPERTIES OF FLOWABLE COMPOSITES
Wide ranges of flowable composite with different percentage of fillers (50%-70%/wt) are available and can be classified into low, medium or high viscosity.4 Flowable composites are similar to traditional resin based fissure sealants. According to Sebastein, (2012) the former are said to have better mechanical and physical properties thus have been suggested to be used as pits and fissure sealants.5 Lower filler loading results in greater polymerization shrinkage and lower mechanical properties compared to other hybrid composites.6 Flowable composite also have low modulus of elasticity and their viscosity ranges from low to medium.6,6 This suggests that these materials modulus of elasticity in 24 hours ranges from 2.8-6.0 GPa and thus they are not able to withstand the occlusal forces when used in bulk.7 By decreasing the proportion of filler,
Flowable composites can easily adapt small cavity preparations. However their wear resistance is of major clinical concern as good wear resistance depends on increased filler load. Complex viscosities of flowable composites decrease with increasing shear rate, showing a non-Newtonian behavior. Flowable composites consist of less filler loading and the filler morphology is spherical due to which there is less shrinkage-strain values. Their shrinkage-strain values at 23°C are 2.61-6.25%, and at 37°C range between 3.88-6.56%. But in some flowable composite the spherical shaped filler particles have an advantage as they allow increased filler loading and enhance the fracture toughness value. According to some in vitro studies flowable composites decrease restoration microleakage and the occurrence of voids. This is mainly due to their ability to adapt well to the cavity walls and their stress-absorbing ability. Flowable composites, as concluded in the study of Attar et al. (2003) have approximately 50% of the rigidity (elastic modulus) of the regular composites and approximately 80% of the flexural strength.

In this article we will discuss the following flowable dental composites

**VERTISE FLOW**

Flowable composites were brought on the market in the mid-nineties and have proven to be serviceable in a wide variety of clinical conditions. The company Kerr (Kerr, Corp, U.S.A) has developed Vertise™ flow as its first self adhering light cure flowable composite for direct restorations. Its formulation incorporated “optibond” adhesion technology which eliminates the processes of, in no specific order; bonding, rinsing, priming and etching (Kerr, 2011). This belongs to the 7th generation of dental composites as mentioned in table 1, in which the triple mechanism i.e. etchant, primer and adhesive are mixed together into one syringe. The glycerol-phosphate-di-methacrylate (GPDM, introduced by Buonocore et al, 1956) between phosphate functional groups of GPDM monomer and calcium ions of enamel and dentine creates the bonding mechanism with the tooth structure where a chemical bonding is then attained as shown in Figure 1.13,14 Its composition includes GPDM and Hydroxyethyl methacrylate (HEMA) in the resin matrix and pre-polymerized barium glass filler, colloidal silica and ytterbium fluoride as filler constituents.

**Table 1 Classification of dental adhesives.**

<table>
<thead>
<tr>
<th>GENERATIONS</th>
<th>DENTAL ADHESIVES</th>
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<tbody>
<tr>
<td>1st Generation</td>
<td>Chelation between NPG-GMA; N-phenylglycine-glycidyl methacrylate (comonomer) and tooth surface resulting in bond between resin and dentinal calcium (Cervident from SS White)</td>
</tr>
<tr>
<td>2nd Generation</td>
<td>Polar interaction between negatively charged phosphate groups in resin with positively charged calcium in smear layer (Clearfil Bond System from Kuray&amp;Bondlite from Kerr)</td>
</tr>
<tr>
<td>3rd Generation</td>
<td>Retain and modify the smear layer thus allowing penetration of Phenyl-P or PENTA (acidic monomers) (Scotchbond 2 from 3M)</td>
</tr>
<tr>
<td>4th Generation</td>
<td>Multiple bottles: Etchant: 37% phosphoric acid, citric acid (10%)/calcium chloride (20%), oxalic acid Primer: NTG-GMA/BPDM, HEMA/GPDM 4-META/MMA, glutaraldehyde Adhesive: 2, 2-bis [4(2-hydroxy-3methacryloyx-propyloxy-phenyl)] (Bis-GMA) /TriethyleneglycolDimethacrylate (TEGDMA) Solvent: Acetone, ethanol/water.45</td>
</tr>
<tr>
<td>5th Generation</td>
<td>Single bottle but etchant needed separately. Etchant: Phosphoric acid Primer: PENTA, methacrylated phosphonates Solvent: Acetone, ethanol/water, solvent free.15</td>
</tr>
<tr>
<td>6th Generation</td>
<td>Two bottles Acidic primer-adhesive: Methacrylated phosphates. Solvent: Water.15</td>
</tr>
<tr>
<td>7th Generation</td>
<td>One bottle Acidic primer-adhesive: Methacrylated phosphates. Solvent: Water.15</td>
</tr>
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**Figure 1: GPDM bonding in Vertise™ FLow (Kerr, 2011, Provided by Kerr Corporation)**
This material offers high bond strength, high mechanical strength and other physical attributes when compared to other traditional flowable composites. It has multiple clinical implications and is available in nine different shades. It is a biocompatible and radiopaque product and bonds well to enamel, dentine, porcelain, metals, amalgams and composite.

HYDROXYETHYL METHACRYLATE (HEMA)

Hydroxyethyl methacrylate (HEMA) Figure 2 is a hydrogel; it is hydrophilic in nature and potentially biocompatible. Thus it’s of great interest in the field of biomaterial sciences and manufacturing soft contact lenses. Hydrogels being hydrophilic polymers, absorb 10-20% water, being a thousand times more than their dry weight. They are chemically stable, may degrade and finally breakdown and disintegrate. The elasticity of these hydrogels can be improved by altering their structure and by adding cross-linking agents. Most commonly used cross-linking agent is ethylene glycol dimethacrylate.

Figure 2: Chemical structure of Hydroxyethyl methacrylate

The nature of water in the hydrogel can determine the permeation of nutrients in and out of the gel. Hoffman described water absorption by HEMA as follows: A dry hydrogel starts to absorb water; this first water enters the matrix and hydrates the matrix with the most polar (hydrophilic group) resulting in ‘primary bound water’. These polar groups, after being hydrated swell and expose hydrophobic groups; these also interact with molecules of water leading to ‘secondary bound water’ (hydrophobically bound water). Total bound water is formed by the combination of primary and secondary bound waters. Equilibrium is reached when further swelling is opposed by covalent/physical cross-links, leading to an elastic network of retraction forces. This additional water that is imbibed becomes saturated and is called the ‘free’ or ‘bulk water’. It is this free water that occupies the gaps between network chains and voids. Thus HEMA being one of the important components of Vertise flow has made this material a subject to study.

GRANDIO FLOW

Grandio flow is a nano-hybrid flowable type of composite. When compared to general hybrid-resin, it has the highest filler load. Its resin to filler ratio is 1:6.7 (VOCO, Grandio Flow). Filler morphology of Grandio under the Scanning Electron Microscope showed higher irregular shaped particles. Fillers present in this material are two-thirds inorganic fillers and the resin part consist of Bis-GMA, TEGDMA and Hexan Ethyl Dimethacrylate (HEDMA).

Grandio flow offers various outstanding physical properties along with its less polymerization shrinkage that is 1.57%. Its properties include good wettability, high compressive and transverse strength, less cytotoxicity and good abrasion resistance. Moreover, the nano-particles create a network effect within the matrix that increases tensile strength, wear resistance and good flow properties. Vickers hardness test by the Durimet gave the result of 59.9VHN, which was higher than the Premise flowable.

PREMISE FLOWABLE

Premise flowable composite (Kerr, Corp. U.S.A) is a medium viscosity, light cured, nano-hybrid composite. This material is used after the application of ‘optibond/FL’ or ‘optibond solo plus’ in the cavity. The material also poses a unique property of releasing fluoride and radiopacity. It contains more regular spherically shaped filler particles. The percentage of filler content by weight in Premise flowable is 72.5%. Premise flowable contains the trimodal filler system which comprises pre-polymerised filler (it is an organic low shrinkage resin, 0.4 µm barium glass, and 20 nm the silica nano-filler) and resin part consists of ethoxylated bis-phenol-A-dimethacrylate.

Due to this technology, this material shows; less shrinkage, optimal handling, good polish, durability, good mechanical strength and good wear resistance compared to other flowable composites.

Discussion

The composites chosen for this study are marketed in the UK as low viscosity, self-adhering composites, suitable for pits and fissure sealants, repair of marginal defects, liners in deep cavities, class-v restoration and paediatric dentistry.

The company Kerr has formulated a self-adhering, low viscosity nano-hybrid composite known as Vertise TM Flow. It includes the Optibond technology and eliminates the steps of etching/priming/bonding. The bonding mechanism of this material with the tooth structure is a chemical bond achieved via the GPDM phosphate functional groups and calcium ions of the enamel and dentine. According to the company’s, this material offers high bond strength, high mechanical strength and other physical attributes comparable to
other traditional flowable composites. Vertise TM Flow is a biocompatible and radiopaque material and bonds well to different substrates including enamel, dentine, porcelain, metals, amalgam and composite.

Vertise TM Flow has been a subject of this study here due to its composition containing HEMA and low filler loading (compared with GrandioFlow and Premise Flow). HEMA is a hydrophilic monomer which absorbs water and higher water uptake could compromise the physiochemical properties of the materials and hence compromise the clinical lifetime.22

The other materials used in the study were GrandioFlow and Premise Flow. Both these are low viscosity flowable composites. The difference between them and Vertise TM Flow is that they do not contain HEMA. These are nano-hybrid composites, and their filler content by weight is 72.5% in Premise Flow and 80.2% in GrandioFlow. Data provided by Kerr Corporation and VOCO the Dentalists). They both have good physical and mechanical properties but Premise Flow has an added advantage of releasing fluoride thus creating a cariostatic action and having a higher radiopacity than GrandioFlow. These materials are in used in this study for comparisons purposes.

Flowable composites are of low viscosity and a modification of small particle-filled and hybrid composites. They have reduced filler load and modified resin monomers which provide a consistency that allows the material to flow readily. They have better adaptability to cavity walls thus preventing microleakage.

References