Review Article

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Dentistry Section

Flowable Resin Composites: A Systematic Review and Clinical Considerations

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ABSTRACT

Background: Little is known about flowable composite materials. Most literature mentions conventional composite materials at large, giving minimal emphasis to flowables in particular. This paper briefly gives an in depth insight to the multiple facets of this versatile material.

Aim: To exclusively review the most salient features of flowable composite materials in comparison to conventional composites and to give clinicians a detailed understanding of the advantages, drawbacks, indications and contraindications based on composition and physical/mechanical properties.

Methodology: Data Sources: A thorough literature search from the year 1996 up to January 2015 was done on PubMed Central, The Cochrane Library, Science Direct, Wiley Online Library, and Google Scholar. Grey literature (pending patents, technical reports etc.) was also screened. The search terms used were "dental flowable resin composites".

Search Strategy: After omitting the duplicates/repetitions, a total of 491 full text articles were assessed. As including all articles were out of the scope of this paper. Only relevant articles that fulfilled the reviewer's objectives {mentioning indications, contraindications, applications, assessment of physical/mechanical/biological properties (in vitro/ in vivo /ex vivo)} were considered. A total of 92 full text articles were selected.

Conclusion: Flowable composites exhibit a variable composition and consequently variable mechanical/ physical properties. Clinicians must be aware of this aspect to make a proper material selection based on specific properties and indications of each material relevant to a particular clinical situation.

Keywords: Composite, Fracture toughness, Microleakage, Polymerization shrinkage

INTRODUCTION

The early 1990s hallmarked the use of composite materials in dentistry. The initial composites were usually quartz-filled with large filler particles, making restorations rough and difficult to polish. With polish ability being a major aesthetic concern, a variety of newer materials have emerged in response to the ever growing needs expressed by dental practitioners. Composite resins derive their physical properties/handling characteristics from the reinforcing filler particles and viscosity from the resin matrix. A majority of direct restorative composite resins fall into one of the following categories: hybrid, nano-filled, microfill, packable and flowable composites [1].

The purpose of increasing the filler load is to improve the resistance to functional wear and physical properties. Viscosity increases with increase in filler loading. Most direct restorative composite have a putty like consistency which is desirable for clinical situations but there is a need to have a less viscous composite resin for better adaptability with the cavity wall. For this reason, a new class of "flowable composite resins" was introduced in late 1996 [2].

Flowable resin-based composites are conventional composites with the filler loading reduced to 37%-53% (volume) compared to 50%-70% (volume) for conventional minifilled hybrids. This altered filler loading modifies the viscosity of these materials. Most manufacturers package flowable composites in small syringes that allow for easy dispensing with very small gauge needles. This makes them ideal for use in small preparations that would be difficult to fill otherwise [3].

Most literature discusses conventional composite materials at large, giving minimal emphasis to flowables in particular. The sole objective of this paper was to exclusively review the most salient features of flowable composite materials and to give clinicians a detailed insight to the advantages, drawbacks, indications and contraindications based on composition and physical/mechanical properties. Clinicians are able to correlate this knowledge during case selection, manipulation and placement for better longevity of restorations.

METHODOLOGY

(i) Eligibility Criteria: Eligible for inclusion in this review was articles published in English, dated from the year 1996 to January 2015. The articles selected had to include the search terms either in the title or abstract. Full text articles and literature reviews were preferred. Unpublished articles in press, pending patents, personal communications, manufacturer advertisements, etc were screened and excluded. Our intent was to be broad in scope to ensure the inclusion of as much relevant existing data as reasonably possible.

(ii) Data Sources: A thorough literature search was done on PubMed Central, The Cochrane Library, Science Direct, Wiley Online Library and Google Scholar. The search terms used were "dental flowable resin composites".

(iii) Search Strategy: After omitting the duplicates/repetitions, a total of 491 full text articles were screened. Literature reviews were hand searched for prominent references.

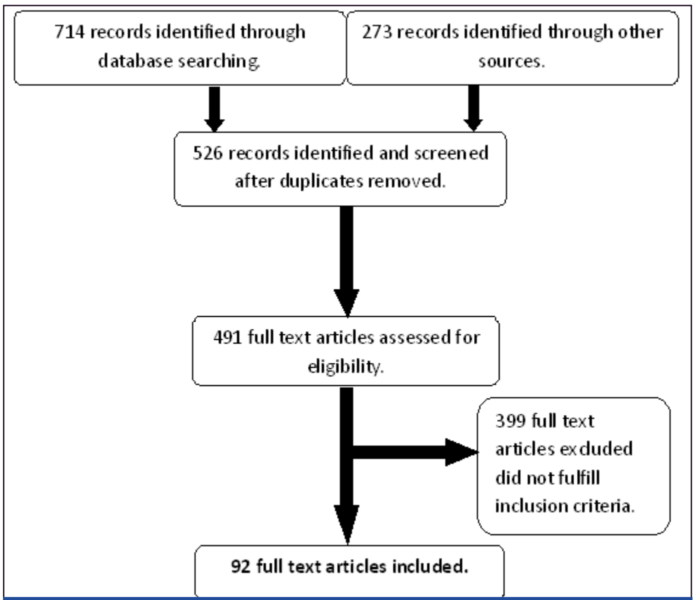
(iv) Data Extraction: As including all articles were out of the scope of this paper. Only relevant articles that fulfilled the reviewer's objectives {i.e. mentioning indications, contraindications, applications, assess -ment of physical/mechanical/biological properties (in vitro/ in vivo / ex vivo)} were considered.

RESULTS

From our search strategy we found only 8 review articles on the PubMed database related to our search terms. However, none explained flowable composites alone except one article by Unterbrink et al., [4]. Hence, the authors were convinced to solely make a one of a kind review on flowables that would update all aspects of the material in detail. Following a strict qualitative analysis, a total of 92 full text articles were selected as summarized in [Table/Fig-1].

DISCUSSION

The sole purpose of this broadly inclusive review was to give clinicians an in depth insight to the various facets of flowable composite materials. Which brings us back to our question?



[Table/Fig-1]: Flowchart of the review process

Why use flowable composites?

At a first glance, they are not highly filled and are more susceptible to wear in stress-bearing areas and hence, may not be a clinician's first choice. However, there are a few areas that require composite in injectable form rather than its packable consistency. [Table/Fig-2] summarizes the advantages and drawbacks of flowable composite materials that need to be considered during case selection.

MAJOR CLINICAL INDICATIONS OF FLOWABLE COMPOSITES

(i) Preventive Resin Restorations (for minimally invasive occlusal Class I):

Flowable composite resin materials are ideal to restore what have been termed, "Preventative Resin Restorations" (PRR's) because these are the most minimal of the Class I types and the needle tip placement into these small preparations assures a well-adapted restoration. Nonetheless, angled incremental deposition is important in order to minimize the contraction force from the setting composite [5]. According to a survey conducted by Savage et al., flowable composites are one of the most widely used restorative materials for PRR's with more than 30% of paediatric dentists using a flowable composite or a combination of flowable and packable composite [6].

(ii) Pit and Fissure Sealants:

According to evidence based review done by Jean et al., flowables are the first choice of materials for pit and fissure sealants [7]. However, for effective placement and long-term retention of these materials proper cleaning of pits and fissures, appropriate acid etching of surfaces and maintaining a dry field uncontaminated by saliva until the sealant is placed and cured is mandatory. Jafarzadeh et al., compared the retention of flowable composites with conventional resin based sealants and concluded that flowable composites had better retention when used as pit and fissure sealants [8]. Dukic et al., concluded that flowable composite resins should be used in combination with dentine bonding agents as they can improve the strength of the adhesive bonding to enamel in fissures and reduce marginal microleakage and improve retention rate [9].

Advantages	Drawbacks
• High wet ability of the tooth surface, ensuring penetration into every irregularity; • Ability to form layers of minimum thickness, so improving or eliminating air inclusion or entrapment • High flexibility, so less likely to be displaced in stress concentration areas (cervical wear processes and cavitated dentine areas); • Radio-opaqueness • Availability in different colours.	• High curing shrinkage: due to lower filler load, and • Weaker mechanical properties

[Table/Fig-2]: Advantages and drawbacks of flowable composite materials

(iii) Cavity Liners

There is a growing trend of using flowable composites as cavity liners. However, postoperative sensitivity is still a major concern [10]. Although many clinicians have been successful in reducing postoperative sensitivity, clinical research shows no difference in postoperative sensitivity between solely using an adhesive as compared to just using a flowable composite as a liner [11]. Payne et al., concluded that flowable composites are a good choice as cavity liners [12]. They adapt well to the microstructural irregularities of the cavity preparation prior to restorative composite placement. Rainer et al., evaluated the use of flowable composite liners in large extended class I restorations and concluded that large Class I restorations without dentin support showed high amount of marginal enamel fractures [13]. Lining with flowables improved the initial marginal integrity.

(iv) Minimally invasive Class II restorations and inner layer for Class II posterior composite resin placement in sealing the gingival margin to avoid deficiencies:

For conservative preparation of Class II interproximal caries with only initial caries on the proximal surface and no caries on the occlusal surface, a facial approach for the cavity preparation will leave the marginal ridge intact [14]. Flowable composites are also ideally suited for such facial approach Class II cavity preparations [12]. Another use for flowable composites is in conjunction with placement of viscous packable composites. Leevailoj et al., evaluated packable composite resin placement with and without a flowable composite and found that there was significantly less microleakage in teeth restored with the flowable composite resin as the first increment in the proximal box [15]. Hence, the placement of an inner layer of flowable composite below the final restorative packable material can reduce microleakage at the gingival margins [16].

(v) Class V abfraction lesions

These are small angular Class V lesions attributed to the forces of tooth flexure. When restored with a stiff hybrid composite resin, the clinical success rate was only 70% [17]. The high failure rate was attributed to the stiffness of the composite used. Thus, using a flowable composite resin with a lower biaxial flexural strength than traditional hybrid composites was assumed to improve the clinical success of these restorations. A one year clinical study evaluating Class V restorations using a flowable composite demonstrated that all restorations were intact and showed no signs of postoperative sensitivity after one year [18]. Many studies have concluded that the use of flowable composites for non-carious Class V lesions is a good choice [19].

OTHER APPLICATIONS OF FLOWABLE COMPOSITES INCLUDE

i. Bonding of orthodontic brackets [20] and lingual orthodontics retainers [21].

ii. Splinting fractured and mobile teeth (post-trauma or periodontal involvement) [22].

iii. Emergency reattachment of fractured anterior tooth segment [23].

iv. Repairing temporary restorations and adding to margins of temporaries fabricated using bis-acryl composite resins.

v. Opaquing metal substrates for example, porcelain fused to metal (PFM) repairs.

vi. Denture repairs: many companies offer different shades of pink [24].

vii. Repair of ditched amalgam margins [25].

viii. Repair of crown margins and composite restoration margins [26].

ix. To block out small undercuts in indirect cavity preparations [27].

x. Repair of small porcelain fractures in non-stress-bearing areas

xi. Minimally invasive Class III restorations [28].

xii. Luting porcelain and composite resin veneers [29].

xiii. According to Helvey et al., flowable composites when used as luting agents form an acid base resistant zone (ABRZ) in dentine also termed as super dentine, which helps in preventing secondary caries [30].

xiv. As a protective base in non-vital dental bleaching [31].

xv. Bonding of fibre posts in the restoration of endodontically treated teeth [32].

PROPERTIES OF FLOWABLE COMPOSITES

(i) Strength & Fracture Toughness

Visible Light Cured flowable resin-based composites have a filler loading of 37%-53% by volume in comparison with 50%-70% by volume for conventional minifilled hybrids [2]. Bayne et al., evaluated the filler percent, wear, compressive strength, diametral tensile strength [26], indented biaxial flexure strength and toughness of eight flowable and two hybrid composites. Mechanical properties were about 60 to 90 percent than those of conventional composites. Thus, concluding that flowable materials should be used with caution in high-stress bearing areas. Nuray et al., evaluated the flexural strength of eight flowable composites and concluded that the control composite had the highest mean value for flexural strength in comparison with the flowable composites [33]. Estaban D. Bonilla et al., compared the resistance to crack propagation of 9 flowable composites as measured by their fracture toughness and found no significant difference among 7 of the 9 composites tested [34]. Also, there was no correlation between the filler content by volume and the fracture toughness of these flowable composites.

Kusai Baroudi et al., evaluated in vitro the failure-forces of flowable composites at different distances from an interface edge of a bulk material [35]. Seven materials were investigated. Two modes of failure were observed cracking and chipping. The edge-strength was used to differentiate between the materials and predict their clinical marginal performance. It was found that the edge-fracture resistance of flowable composites was lower towards the margins than towards the center of a restoration. Burke et al., reported marginal fracture of 18% and bulk fracture of 7% as the most prevalent reasons for replacement of restorations when using resin-composite materials [36]. From most of the available literature it can be concluded that the main drawback of flowable composite resins is low strength compared to conventional composite resin, attributed to a low amount of filler, necessary for achieving low viscosity and ease of handling. Hence, Sebastian Balos et al., conducted a study to improve the mechanical properties of flowable composite resins by adding a small amount of nanoparticles [37], which would not compromise handling properties. A commercially available flowable composite material was mixed with 7nm of after treated hydrophobic fumed silica and cured by a UV lamp. Flexural modulus, flexural strength and micro hardness were tested. Adding a small amount of nanosilica was more effective in improving mechanical properties without affecting handling characteristics of the composite. More such studies are needed to better understand the strength of flowable composites without altering its flow characteristics.

(ii) Wear Resistance & Polishability

In vitro abrasion wear tests have produced contradictory results [38] and the clinical wear resistance of flowable composites has yet to be determined. However, because of the decreased filler content and reduced physical properties, it is recommended that flowables only be used in low-stress areas, or very conservative occlusal restorations. Even studies evaluating the alterations in surface morphology of flowables have attributed increased wear due to reduced filler loading [39]. Fernanda et al., measured the mass loss and surface roughness changes of different brands of flowable resin composites in comparison with conventional micro filled composites after a simulated toothbrushing test [40]. Flowable composites proved to be inferior to the control groups. Linilin et al., evaluated the morphological changes of the surfaces of flowable resins eroded by orange juice and alcoholic drinks [41]. Surface degradation was observed for the specimens immersed in acidic and alcoholic drinks, and it was thought that lower the filler percentage, the greater was the surface degradation. Decomposition of the matrix resin and fallout of the fillers were observed in flowable resins that were eroded with acidic and alcoholic drinks. Thus, based on the few studies evaluating surface abrasion it can be concluded that the reduced filler content increases better polish ability but reduces the overall wear resistance of flowables.

(iii) Flow

The fluidity of flowable composites is a characteristic property of this material. The amount of fluidity varies significantly from one product to another [1]. Hence, the viscosity and flow characteristics of flowable resin composites can have a potential influence on their clinical behaviour during handling and thus on their clinical indications [42]. Bayne et al., measured the flow of 5 flowables and found that the most fluid had 5 times the flow of the least fluid [26]. As a result of differences in viscosity, flowable composites vary considerably in polymerization shrinkage, stiffness, and other physical properties. Moon et al., compared the variation in viscosity of flowable composites using the ADA Flow Test and measured film thickness with a test to simulate flow during cementation [43]. Flow characteristics were divided into high flow, medium flow and low flow groups. The film thickness measurements agreed with the ADA flow test, except for two exceptions.

According to Sebastein Beun et al., flowable composites are non-Newtonian, shear-thinning materials which showed a decrease in viscosity as the shear rate increased [44]. Another study by the same author concluded that flowable composites have by far better mechanical properties than pit and fissure sealants [45]. Kusai Baroudi et al., evaluated the creep behaviour of flowable composites in relation to their filler fraction and postcure period [46]. Flowables that had the highest percentage of filler produced the lowest creep strain. The creep response decreased with 1 month of preload storage. Clinically, the finding of this study suggests that flowable composites are unsuitable for stress-bearing areas. Hence, when the flowability increases the filler loading is reduced which affects the overall strength of flowables.

(iv) Polymerisation Shrinkage & Modulus of Elasticity

Dimensional stability of dental resin-composites is essential for the longevity and function of the restoration. Dental composites consisting of dimethacrylate resins filled with inorganic filler particles undergo volumetric shrinkage when cured. This shrinkage results in corresponding stresses which may cause mechanical failure at the composite/tooth interface, de-bonding, microleakage and secondary caries in addition to enamel fractures [47,48]. Most flowable composites have an average volume polymerization shrinkage rate of 5% [49]. Kusai Baroudi et al., concluded that the polymerization shrinkage-strain of flowable composites should be taken into consideration in combination with their filler-fraction [50], which highly influences their shrinkage behaviour. Lower filler loading materials, are more likely to be highly fluid. Even though these materials exhibited substantial polymerization shrinkage, they might be successfully used in microconservative occlusal cavities, as the consequences of polymerization shrinkage would be low because of the limited volume of the material used. However, in deep bulk-filled cavities fractures along the cavosurface enamel margin and cracks along the enamel wall have been detected [51].

Ichiro Ikeda et al., evaluated the marginal integrity and wall adaptation in 1- and 2-mm-deep cavities restored with a high filler-loaded flowable composite in comparison to a flowable composite with lower filler content and a conventional hybrid composite [52]. No differences in marginal integrity and wall adaptation were observed for 1 mm deep cavities. For 2 mm deep cavities, outcome with the higher filler loaded flowable composite was similar to that of the conventional hybrid composite when restored with the bulk technique. Incremental technique gave a superior result when compared to bulk fill in 2 mm deep cavities.Although manufacturers of bulk fill flowable composites advocate filling layers of 4mm, it should be suggested that the standard 2mm layer increments still be used because of the high shrinkage values [53]. The literature also showed that in general the higher the monomer content and the more flowable, the higher the shrinkage [54-56] and the faster the conversion rate to the gel phase [57-59].

Toshiki et al., evaluated the influence of power density on contraction stress of composite materials during photopolymerization [60]. Six flowable composites were compared with a hybrid resin composite. The study concluded that the higher the power intensity of the curing unit the higher was the contraction stress. Janaina et al., compared the linear polymerization shrinkage (LPS) [61], flexural strength (FS) and modulus of elasticity (ME) of low-viscosity resin composites with a well established conventional micro-hybrid composite as a standard. When compared with low viscosity composites, conventional resin presented significantly lower LPS associated with high FS and ME.

According to Labella et al., the magnitude and kinetics of polymerization shrinkage [62], together with elastic modulus, may be potential predictors of bond failure of adhesive restorations. The authors concluded that, flowable composites generally showed higher shrinkage than traditional non-flowable composites. The elastic moduli of hybrid composites showed the highest values, while the flowable composites were in the low-medium range and the microfilled the lowest. The higher shrinkage of flowable composites over that of hybrids may indicate a potential for higher interfacial stresses. However, their lower rigidity may be a counteracting factor. From literature it can be concluded that many factors might have an influence on the volumetric shrinkage of a material i.e., filler content, filler size, type of monomers, monomer content, organic matrix type, organic matrix conversion factors, power intensity of the curing unit, thickness of the material/depth of the cavity and technique of placement of the material [63].

(v) Marginal Integrity (Microleakage)

Majority of restorative materials show variable levels of marginal microleakage due to changes in dimension and a lack of good adaptation to the cavity wall [64]. This lack of adaptation is partly due to polymerization contraction and extreme temperatures in the oral cavity, which may break the adhesion between the adhesive system and the cavity walls [65]. Clinical consequences of marginal microleakage are pulpal pathology, secondary carious lesions, post operative pain and sensitivity leading to potential failure of the restoration [66]. The degree of polymerization contraction is also influenced by the amount of resin matrix. Flowable composites have a higher percentage of resin matrix than their traditional hybrid counterparts. Thus, it could be thought that they could contract more during polymerization and create more tension in the union agents than the traditional composites, resulting in greater microleakage [63]. However, flowable composites are recommended for the initial increments that serve as cavity liners in proximal boxes of Class II restorations as the material adapts itself to the internal irregularities of the preparation. A posterior composite is then placed on top to provide strength and wear resistance. In vitro microleakage and gap formation studies on this technique are contradictory [67,68]. However, the use of flowable composite as a liner under hybrid and packable composite has shown a trend towards less leakage compared to hybrid and flowable composite alone [69].

Malmstrom et al., evaluated class II restorations located supra CEJ (with gingival margins in enamel) with 2 mm thick flowable resin gingival increments which demonstrated significantly less leakage than those with 0.5 mm thickness [70]. When the margin of the restoration was located sub-CEJ (in dentin/cementum), neither the thickness nor the presence of flowable resin as a gingival increment significantly influenced the marginal leakage. According to Conte et al., a newer category of bulk fill composites recommend 4 mm thick increments [71], which reduces the shrinkage stresses during polymerization. Kwon et al., determined if flowable composites can be used as pit and fissure sealants without bonding agents and found that the flowable composites and filled sealants showed a similar resin tag formation pattern [72]. However, the use of a filled sealant was more effective in sealing mechanically prepared occlusal fissures in comparison to flowable composites.

Ascension et al., evaluated the effects of thermo-cycling on microleakage beneath brackets bonded with orthodontic composite and different flowable materials [73]. Some degree of microleakage was found in all the groups investigated. However, flowable resins showed a poorest performance. When evaluating the influence of different light curing units and modes on microleakage of flowable composite resins. The authors concluded that flowable composite resin leakage was material dependent [74]. From the various studies comparing the microleakage of flowables in cervical cavities (class V) it was found that, flowable composites were similar or slightly poorer to hybrid composites [75,76], similar or slightly superior to compomers but far better than glass ionomer restorations [77,78]. Hence, the marginal integrity of flowable composites is still questionable and more clinical trials need to be performed to confirm their performance.

(vi) Radiopacity

Radiopacity is an essential property which allows the dentist to distinguish radio graphically, existing restorations and primary caries, to evaluate contours, overhangs, and major voids in restorations, and to assist in the identification of recurrent caries [79]. According to the International Organization for Standardization ISO-4049 [80], flowable composites should have a radiopacity value equal to or greater than that of the same thickness of aluminum. According to Bayne et al., the low filler content of flowable composites (41-53% by volume and 56-70% by weight) is a reason for their low radiopacity compared to the traditional hybrid composites. Radiographic assessment is important to detect interstitial and recurrent caries. It is difficult to distinguish a material with a low radiopacity from secondary caries [26]. To improve their clinical detection, the minimum radiopacity level of composite resin restorations should be higher than that of dentine or slightly in excess than that of enamel [81]. However, the results of previous studies have suggested that a number of commercially available flowable composites lack the necessary radiopacity [82,83]. In clinical practice, it is not unusual to encounter patients who have flowables of low radiopacity present in their mouths. For this reason clinicians should be careful in selecting the material as not many exhibit a radiopacity equal to or greater than that of enamel [84].

(vii) Colour Stability

The colour stability of flowables is an important factor to maintain the longevity of these restorations relating to aesthetic concerns. However, only a few studies have been reported evaluating colour stability. Bin et al., evaluated the optical properties such as colour, translucency and fluorescence of flowable resin composites, and compared them with the corresponding shade of universal resin composites of the same brand [85]. The authors concluded that the optical properties of flowable and universal resin composites were significantly different; therefore, differences in colour, translucency and fluorescence between the flowable and the corresponding universal resin composites should be considered for clinically acceptable colour matching. According to Yonca et al., effects of aging on colour of flowable composites were shade dependent [86]. Translucency was not affected by accelerated aging. In another study, the influence of fluoride-containing solutions on the translucency of flowable composite resins was evaluated. It was found that fluorides altered the inherent translucency of the materials tested. Flowables have a composition with lower load particles than micro-hybrid and micro particle resins. Thus, there is a higher proportion of matrix resin, which can benefit dye retention from various intraoral solutions used [87].

(viii) Biocompatibility

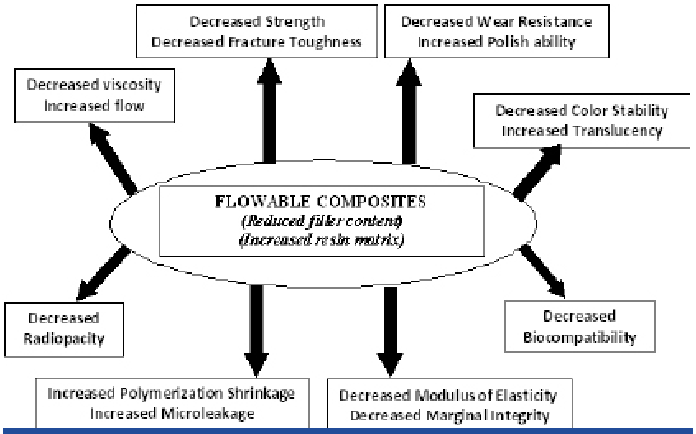
Flowable composites are known to produce a higher level of cell toxicity compared to their conventional counterparts. This increase in toxicity has been attributed to the presence of increased resin diluents that are added to achieve higher flow [88].According to a recent in vitro study done by MN Hegde et al., it was concluded that a significant release of BisGMA and TEGDMA resin was released from the flowable composite materials tested [89]. However, Muhammet Yalcin et al., evaluated the cytotoxicity of six different flowable composites and found them to be less toxic [90]. More future studies need to be performed to confirm these results. Kusai Baroudi et al., investigated the pulpal temperature rise induced during the polymerization of flowable and non-flowable composites using light-emitting diode and halogen light-curing units and concluded that flowable composites exhibited higher temperature rises than non-flowable materials [91]. Their lower filler loading and higher resin content increases the exothermic reaction. Several previous investigators have concluded that a change in exotherm was caused by differences in a materials composition [92].The highly exothermic nature of the setting reaction of flowable composite produced a substantial temperature rise which could cause pulpal damage in deep restorations. Hence, it is important to maintain caution when using flowable composites in deeper restorations.

Correlating the Ideal Properties of Flowable Composite Materials with Their Clinical Significance and Clinical Considerations

Now that, we have a detailed understanding of the various properties of flowable composites it is important for a clinician to correlate this knowledge clinically during case selection, manipulation and restoration. [Table/Fig-3] summarizes the influence of reduced filler content on the various properties of flowable composite materials and [Table/Fig-4] summarizes the correlation between the ideal properties of flowables with their clinical significance and clinical indications.

CONCLUSION

Flowable composites form an inhomogeneous group of materials. They exhibit a wide variety in their composition and consequently a variety in mechanical and physical properties. Clinicians must be aware of this variability, thus selecting the most appropriate material based on a particular clinical situation. Flowables are relatively newer members to the family of conventional composites and clinical studies still do not provide conclusive results of their performance in the oral environment, suggesting that long term clinical trials are necessary. Within the limitations of this review, the authors would like to conclude that flowable composites, once thought to be a passing fad, have become a versatile workhorse in various aesthetic dental procedures. They surely do claim to be a promising material for the future.



[Table/Fig-3]: Summarizes the influence of reduced filler content on the various properties of flowable composite materials

Ideal Property	Clinical Significance	Clinical Indications
Flow ability	for easy manipulation and adaptability to cavity	• Minimal occlusal class I cavities • Preventive Resin Restorations • Pit & Fissure sealants • Minimally invasive Class II proximal boxes • Cavity Liners • Minimally invasive class III restorations • Class V abfraction lesions • Bonding of orthodontic brackets/ lingual orthodontics retainers • Splinting fractured and mobile teeth • Emergency reattachment of fractured anterior tooth segment • Repairing temporary restorations • Denture repairs • Repair of ditched amalgam margins • Repair of crown/composite restoration margins • To block out small undercuts in indirect cavity preparations • Repair of small porcelain fractures in non-stress-bearing areas • Luting porcelain/composite resin veneers • As a protective base in non-vital dental bleaching • Bonding of fibre posts in the restoration of endodontically treated teeth
Increased strength	for better wear resistance and fracture toughness	
Low shrinkage	for reduced microleakage and better marginal adaptation	
Radiopacity	to differentiate between the material and secondary caries	
Shades corresponding to conventional composites	colour adaptative qualities when used in combination with conventional composites	
Polishability and long-lasting shine	for better aesthetics	
Colour stability	for better aesthetics	
Bio-compatibility	less toxic to the pulp and surrounding soft tissues	

[Table/Fig-4]: Summary of the ideal properties of flowable composites with their clinical significance and clinical indications

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