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Comparison of two video-imaging instruments for measuring volumetric shrinkage of dental resin composites

Amer Tiba[a], David G. Charlton[a,*], Kraig S. Vandewalle[b], James C. Ragain Jr[c]

[a]*Applied Clinical Sciences Department, Naval Institute for Dental and Biomedical Research, 310A 'B' Street, Bldg 1H, Great Lakes, IL, USA*
[b]*USAF Dental Investigation Service, Great Lakes, IL, USA*
[c]*Recruit Treatment Branch Dental Clinic, Recruit Training Command, Great Lakes, IL, USA*

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Summary *Objectives*: The purpose of this study was to measure the polymerization shrinkage of three dental resin composites using two commercially available video-imaging devices to determine if the devices produced equivalent results.
Methods: Small, semi-spherical specimens of a microhybrid (Venus), microfill (Filtek A110), and flowable (Esthet•X Flow) resin composite were manually formed and light activated for 40 s using a light-curing unit. The volumetric polymerization shrinkage of fifteen specimens of each brand of resin composite was measured using the AcuVol and the Drop Shape Analysis System model DSA10 Mk2 (DSAS) video-imaging devices. Mean volumetric shrinkage values were calculated for each resin composite and equivalence was evaluated using the two one-sided tests approach. Differences between the means that were less than approximately 5% of the observed shrinkage were considered indicative of clinical equivalence.
Results: Mean volumetric shrinkage values measured for the resin composites were: Venus (AcuVol, 3.07±0.07%; DSAS, 2.90±0.07%); Filtek A110 (AcuVol, 2.26±0.10%; DSAS, 2.25±0.09%); and Esthet•X Flow (AcuVol, 5.01±0.17%; DSAS, 5.14±0.11%). Statistical analysis revealed that the two imaging devices produced equivalent results for Filtek A110 and Esthet•X Flow but not for Venus.
Conclusions: Video-imaging systems provide an easy method for measuring volumetric shrinkage of resin composites. As with other methods for measuring volumetric shrinkage, however, they are best used to comparatively measure different materials within the same laboratory.
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* Corresponding author. Tel.: +1 847 688 5647x148; fax: +1 847 688 4279.
E-mail address: dgcharlton@nidbr.med.navy.mil (D.G. Charlton).

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Introduction

Visible-light-activated resin composites are increasingly being used to restore both anterior and posterior teeth. Their growing popularity is the result of many factors, from aggressive marketing on the part of dental manufacturers to the public's desire for a cost-effective and esthetic alternative to amalgam and other restorative materials. These materials appeal to dentists as well because they can be bonded to tooth structure and possess command set with a curing light, which helps reduce chair time.

Although resin composites have been refined in their composition and serve well with proper case selection and placement technique, they possess several disadvantages inherent to their composition. One of the most serious is polymerization shrinkage.[1-3] Free volumetric polymerization shrinkage of dental resin composite is a function of the amount and types of diluents, oligomers, and other methacrylates in the composite's composition, as well as type of filler, filler loading, and degree of cure.[4-7] Shrinkage occurs during curing as monomers are converted from a mass of freely flowing molecules to a rigid structure of crosslinked polymer chains. During polymerization, as polymer chains form through covalent bonding, volumetric contraction occurs. This shrinkage creates polymerization stresses in the tooth structure and strains the interfacial bond between the tooth and resin composite.[6] This, in turn, may lead to the formation of a small gap that can allow marginal leakage of saliva.[8,9] Over time, leakage can result in marginal staining, postoperative sensitivity, caries, pulpal inflammation, and necrosis.[1,10] Polymerization stress is also detrimental to resin composite restorations because it can exceed the tensile strength of enamel and cause stress cracking and enamel fracture along the interface.[11,12]

Because of the potential adverse effects of resin composite polymerization shrinkage, researchers and dental product manufacturers carefully measure shrinkage and attempt to formulate new products with minimal shrinkage. Shrinkage claims made by dental manufacturers, some substantiated and some unsubstantiated, abound for dental resin composites, and certain products are heavily marketed based on their purported small degree of shrinkage. It is important, therefore, that straightforward and simple methods be found to accurately measure resin composite polymerization shrinkage. Several methods have been used, such as: mercury dilatometry;[13-15] water dilatometry;[16-19] strain gauge,[20] linear contraction,[21,22] and density measurements;[7,23] and video imaging.[3,24]

A simple and easy method has recently been developed to measure volumetric shrinkage of resins using video imaging (AcuVol, Bisco, Schaumburg, IL, USA). This technique, in addition to having several practical advantages, has been shown to yield results comparable to those observed using mercury dilatometry.[3] Unfortunately, because it is a relatively new piece of equipment, few laboratories have an AcuVol. They may, however, have drop shape analysis instrumentation that uses video imaging to measure contact angles of liquid drops. This study was undertaken to determine if a commercially available contact angle-measuring device could be used to measure volumetric shrinkage of resin composites. This study measured the polymerization shrinkage of three dental resin composites using the two imaging devices to determine if they produced equivalent results.

Materials and methods

The resin composites used in the study are listed in Table 1. Each represents one of three different categories of composites—microhybrid, microfill, and flowable. The two methods chosen to measure the volumetric polymerization shrinkage were a video-imaging device specifically developed for shrinkage measurement (AcuVol), and a contact angle-measuring device (Drop Shape Analysis System, model DSA10 Mk2, Krűss America, Charlotte, NC, USA) (DSAS).

To measure shrinkage using the AcuVol, approximately 10 μl of the resin composite was manually shaped into a semi-sphere and placed on

Table 1 Resin composites used in the study.

Product	Manufacturer	Type	Lot number	Shade	Filler content (vol%/wt%)
Venus	Heraeus Kulzer Armonk, NY 10504	Microhybrid	010024	OA2	61/NA*
Filtek A110	3M ESPE St Paul, MN 55144	Microfill	20030228	A3D	40/56
Esthet•X flow	Dentsply/Caulk Milford, DE 19963	Flowable microhybrid	030804	A2	53/61

*NA, not available.