International Journal of Applied Pharmaceutics

ISSN - 0975 - 7058 Vol 12, Special Issue 2, 2020

Research Article

COMPARISON OF VOLUMETRIC SHRINKAGE OF COMPOSITE RESIN NANOCERAMIC AND NANOFILLER

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Received: 08 July 2019, Revised and Accepted: 29 April 2020

ABSTRACT

Objective: The main cause of failure of composite resin restorations is volumetric shrinkage. The aim of this study was to analyze and compare volumetric shrinkage in nanohybrid and nanoceramic composite resins.

Methods: A total of 32 (3 cm×3 cm× 2 mm) cavities were analyzed for volume using micro-CT. The samples were divided randomly into two groups: 16 cavities that were restored using nanohybrid composite resin and 16 cavities that were restored using nanoceramic composite resin. The composite resin volume was analyzed using micro-CT.

Results: The difference in volumetric shrinkage between nanohybrid composite resin 245,866.5 mm^3 (3%) and nanoceramic composite resin 3,470,175.13 mm^3 (5%) was not significant (p=0.585).

Conclusion: Nanohybrid and nanoceramic composite resins have the same volumetric shrinkage rate.

Keywords: Composite resin, Nanohybrid, Nanoceramic, Volumetric shrinkage.

 DOI: http://dx.doi.org/10.22159/ijap.2020.v12s2.OP-02

INTRODUCTION

One of the disadvantages of composite resin is the volumetric shrinkage that occurs at the time of the polymerization that causes attraction in the interface between the cavity wall and the composite resin. This can cause adhesion failure, the formation of microleakage that can create sensitivity after restoration, and secondary caries [1]. Factors influencing volumetric shrinkage during polymerization are filler particles, degree of conversion, elastic modulus, water absorption, thermal expansion coefficient, light intensity, and cavity configuration factor (factor-C) [2].

To reduce volumetric shrinkage during polymerization, the proportion of monomers and filler particles is changed by adding more fillers and less resin Sandelin B, Afaag, 2015 [3]. Nanosized filler particles are currently being developed to minimize shrinkage, improve mechanical properties, and increase wear resistance [4]. In 2003, nanoceramic composite resin began to be combined with methacrylate-modified polysiloxane, with 76% of the total weight being glass particles with a size of 1.1–1.5 μm. To increase, mechanical strength is combined with polyurethane-methacrylate and also bis-EMA and TEGDMA. Combining this photoinitiator system increases the durability of the methacrylate resin matrix. Nanoceramic filler particles are spherical mixtures and pre-polymerized SphereTEC™, which contain barium non-agglomerated glass and ytterbium fluoride with filler loads ranging from 77% to 79% by weight (59%–1% by volume) [5].

The main difference between nanohybrid and nanoceramic composite resins is that nanohybrid composite resins have an irregular filler particle shape, whereas nanoceramic composite resins are spherical and contain both large and small submicron particles so that the gap filled with matrix is reduced and there is less polymerization shrinkage. The authors are interested in conducting this study because they want to know, whether nanohybrid and nanoceramic composite resins undergo volume shrinkage during polymerization and whether the two composite resins differ in terms of volume shrinkage. We analyzed and compared the volumetric shrinkage of nanoceramic and nanohybrid composite resins. Our reasons for doing so are explained in this paper.

METHODS

Sixteen extracted premolar teeth were cleaned under running water. Cavities with a depth of 3 mm, a buccolingual width of 3 mm, and a gingival wall width of 2 mm were made on the mesial and the distal sides of the teeth using a cylindrical diamond bur.

Each cavity was numbered and, before being filled with composite resin, was analyzed in respect of volume using a micro-computed tomography (CT) SkyScan 1173 (Bruker, Belgium) device at a high-resolution level (1 pixel = 29.8 micrometers), 130 kV, 60 Ma, and 0.1° rotation step. The scan lasts 5 h. All slices were then reconstructed using NRecon and Data Viewer software (Bruker, Belgium) and analyzed using the CT analyzer (CT-An) (Bruker, Belgium). All cavity samples were divided into two groups, each consisting of 16 cavities. In Group I, the teeth were restored using nanohybrid composite resin (IPS Empress, Ivoclar Vivadent) to 3 mm depth, whereas, in Group II, the teeth were restored using nanoceramic composite resin (Ceram-X, SphereTEC™ Dentsply) to 3mm depth.

Before being filled with composite resin, all cavity samples had the same adhesive system, Single Bond 2 (3M-ESPE), applied using a micro-brush, according to the manufacturer's protocol. Composite resin was added in increments by placing the first layer at a slant on one of the upright walls, followed by polymerization for 20 s, then placing the next layer at a slant on the other wall, followed by polymerization for 20 s, and finally using the last layer to fill the remaining space up to the surface of the cavity. This was followed by finishing and polishing. Then, the volume of composite resin was measured using micro-CT and CT-An. The samples were scanned with SkyScan 1173 micro-CT (Bruker, Belgium) at high resolution (1 pixel = 29.8 micrometers), 130 kV, 60 Ma, and rotation steps of 0.1°.

microns, whereas nanoceramic composite resins have a total filler content of 59%–61% (volume). Thus, nanohybrid and nanoceramic composite resins have similar total volumes of fillers. According to Julian *et al.*, the shrinkage stress value is generally lower for composites with spherical filler particles than for those with irregular filler particles [13].

CONCLUSIONS

Although the technology used in making nanoceramic and nanohybrid composite resins differs, both composite resins undergo volume shrinkage during polymerization. The volume shrinkages of the nanoceramic and nanohybrid composite resins are almost the same.

AUTHORS' CONTRIBUTIONS

All the authors have contributed equally.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

FUNDING

Nil.

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