Poster 90

Leaching of monomers from bulk-fill composites

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Background: Bulk-fill composites have gained increased interest during the past years. The intention of bulk-fill materials is to restore a cavity in only one layer, preferably, but often a capping layer of a universal composite is required to ensure adequate aesthetic and mechanical properties. The layer thickness of bulk-fill materials is often claimed to be 4 mm.

Purpose: This study investigated the leaching of monomers from bulk-fill composites, as well as the depth of cure and the polymerization shrinkage of the materials.

Conclusions: The leaching of monomers increased when a distance was introduced from the light tip of the curing lamp to the surface of material. This indicates that a clinical curing situation may give insufficient curing of the materials resulting in a lower biocompatibility. A prolonged curing time may be necessary in clinical situations in order to retain an optimal performance of the material.

MATERIALS

Five commonly available bulk-fill materials were included and purchased from Norwegian distributors: Filtek Bulk fill (flowable), Smart Dentin Replacement (SDR, flowable), Tetric EvoCeram Bulk Fill, Venus Bulk Fill (flowable), x-tra base (flowable).

METHODS

- The materials were cured according to the instructions for use of the respective manufacturer (Table 1).
- Leaching of monomers from composite specimens cured a 0 mm distance and at 6 mm distance from the light tip was analysed using gas and liquid chromatography/mass spectrometry (Figure 1 and 2).
- The depth of cure was determined according to ISO 4049:2009 Dentistry - Polymer-based restorative materials (Figure 3).
- Polymerization shrinkage was measured using the buoyancy principle as described in ISO 17304:2013 Dentistry - Polymerization shrinkage: Method for the determination of polymerization shrinkage of polymer-based restorative materials (Figure 4).

Material	Filtek Bulk Fill	SDR	Tetric EvoCeram Bulk Fill	Venus Bulk Fill	x-tra base
Manufacturer	3M ESPE	Dentsply	Ivoclar Vivadent	Heraeus Kulzer	Voco
Capping layer recommended	Yes	Yes	No	Yes	Yes
Curing time (s)	**10**	**20**	**10**	**20**	**10**

Table 1: Materials and curing times used. Curing device: bluephase 20i High Power mode (1560 mW/cm^2 over the wavelengths 400-515 nm, measured at the Norwegian Radiation Authority).

RESULTS

LEACHING INTO ETHANOL

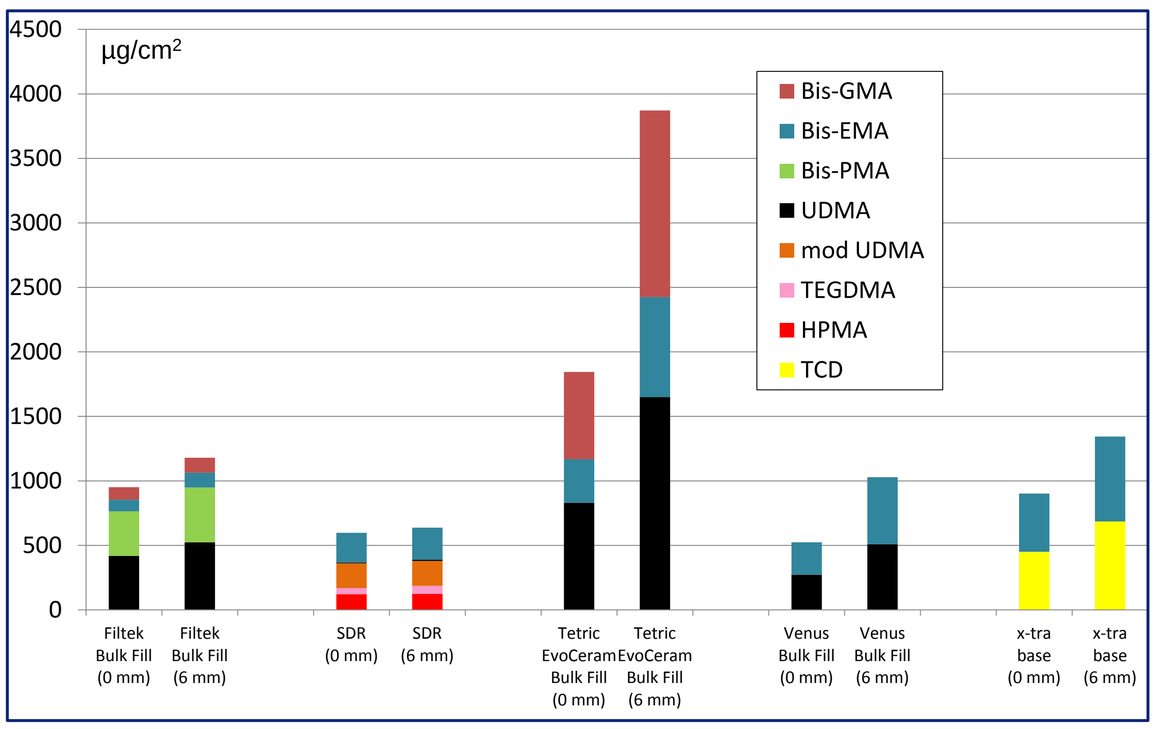

Figure 1: Leaching into 75 vol% ethanol of monomers from bulk fill materials cured with 0 mm or 6 mm distance from the light tip, measured after 24 h at 37 ºC, in micrograms per surface area.

LEACHING INTO WATER

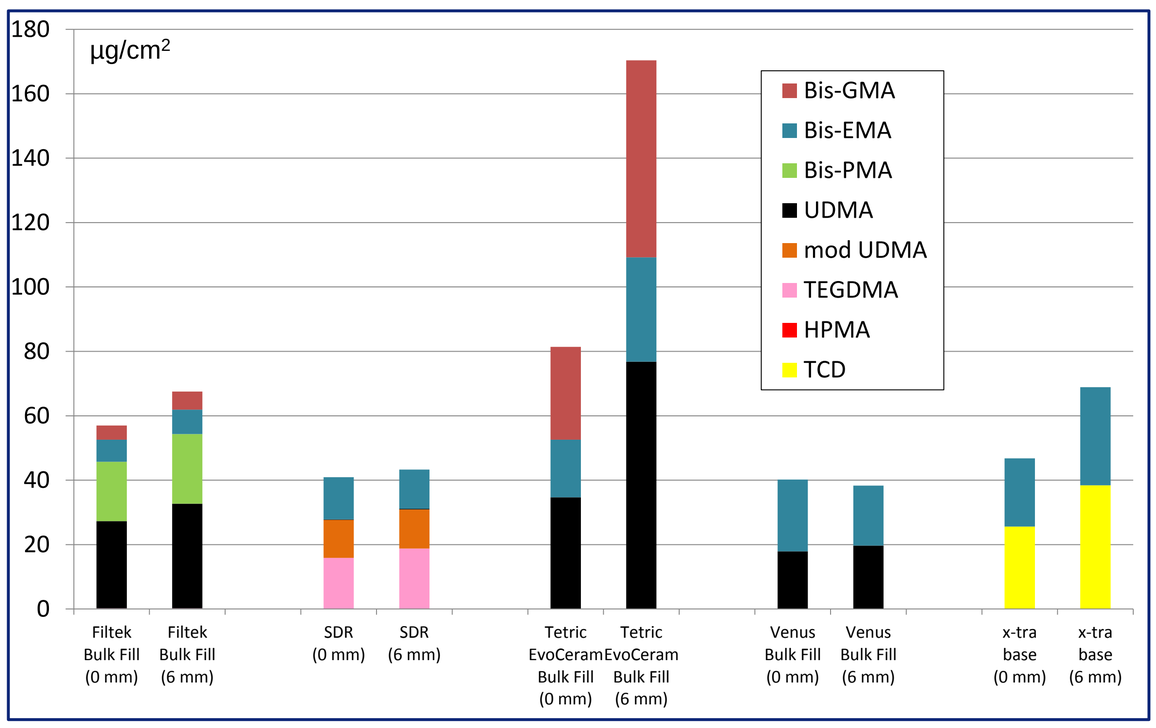

Figure 2: Leaching into water of monomers from bulk fill materials cured with 0 mm or 6 mm distance from the light tip, measured after 24 h at 37 ºC, in micrograms per surface area.

DEPTH OF CURE

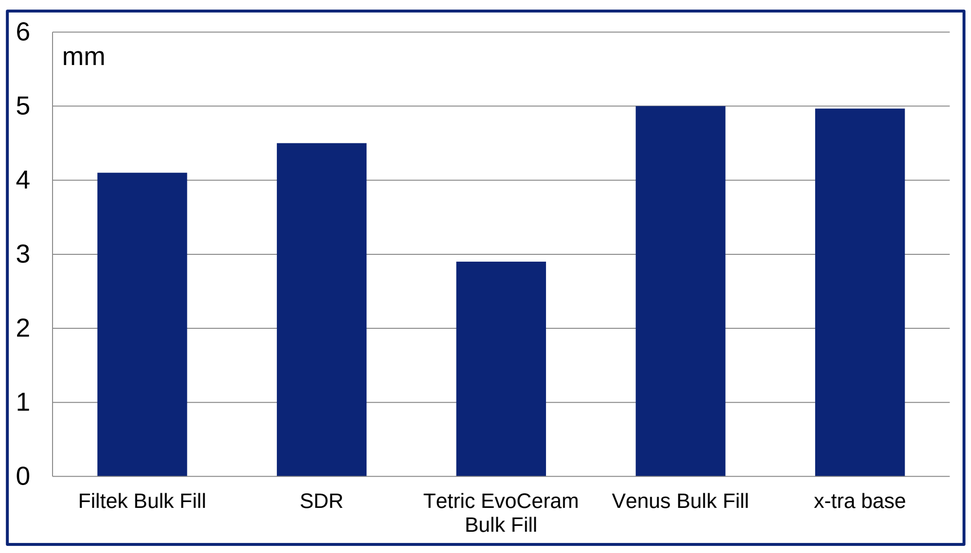

Figure 3: Depth of cure according to ISO 4049, in millimetres.

POLYMERIZATION SHRINKAGE

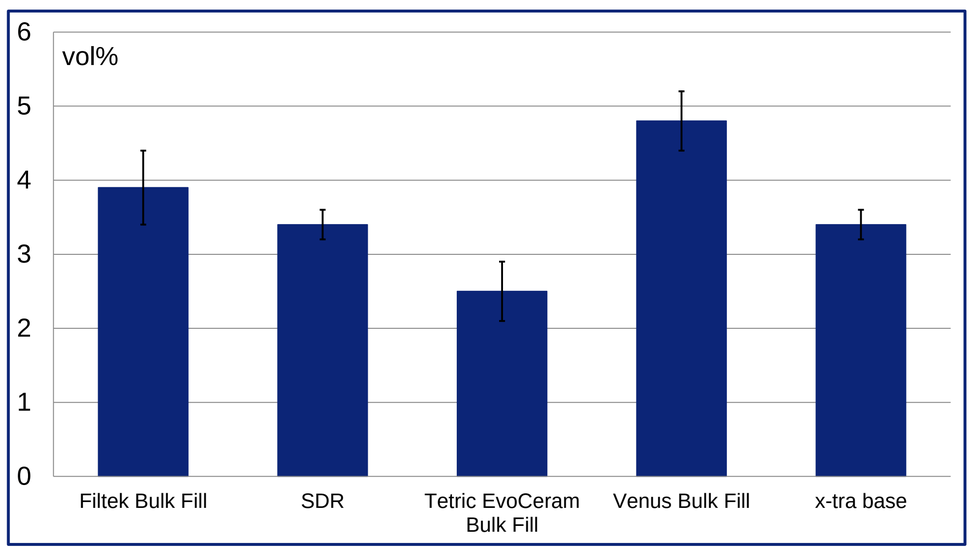

Figure 4: Volumetric shrinkage according to ISO 17304, in volume-percent.

DISCUSSION

- The total leaching of monomers was about 10-20 times as high in 75 vol% ethanol, representing a worst-case scenario, than in water. As well, the increase in leached monomers when increasing the distance from the material to the light curing tip ranged from 7 % (SDR) to 110 % (Tetric EvoCeram Bulk Fill), indicating a reduced degree of polymerization when increasing this distance.
- The depth of cure was above 4.0 mm for the four flowable materials and was thus within the claim of the manufacturers of a 4 mm layer thickness. This was determined when cured with 0 mm distance to the light tip, according to ISO 4049. Depth of cure for the material Tetric EvoCeram Bulk Fill was found to be 2.9 mm, more than 1 mm below the claimed value by the manufacturer.
- The polymerization shrinkage of the flowable bulk-fill materials in this study was found to be in the range 3.4 - 4.8 vol% which is similar to traditional flow-composites. One material (Tetric EvoCeram Bulk Fill) had a lower shrinkage (2.5 vol%), which was similar to traditional universal composites.

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REFERENCES

1. ISO 4049:2009 Dentistry - Polymer-based restorative materials. International Organization for Standardization, Geneva, Switzerland
2. ISO 17304:2013 Dentistry - Polymerization shrinkage: Method for determination of polymerization shrinkage of polymer-based restorative materials. International Organization for Standardization, Geneva, Switzerland