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Dentinal Temperature Rise During Photo-Activation of Restorative Composites †

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Oral Presentation:

Resin-based composites are introduced in conservative dentistry as a replacement of amalgama. Dental composites are made up of a resin matrix and an inorganic reinforcement.

The bulk fill composites recently introduced on the market are intended to complete the cavity dental with a single increment. The manufacturers of this new generation of composites claim that the bulk technology reduces contraction stress and maintains the degree of conversion from polymerization equally high. The objective is achieved through advanced formulations of the organic matrix coupled with a inorganic reinforcement which includes dispersions of nanometric particles. These formulations increase wear resistance and make an excellent material workability. The depth of polymerization is a problem that characterizes bulk-fill restorations: in a cavity deeper than 4 mm the light curing may be lower in a cavity deeper than 4 mm this problem is partially compensated by the index of refraction of these composites that allow to increase depth of photopolymerization. Detractors of the use of the bulk-fill techique affirm that a polymerization of such a large amount of composite into proximity of the pulp chamber can cause a thermal rise of the dental pulp; this sharp rise in temperature may cause an irreversible pulp damage with subsequent necrosis.

The doubts about the use of this procedure "bulk-fill", with respect to the incremental layers of composite resin, are shared by a good part of dental operators, especially with reference to the potential forces of contraction stress which generate and that would be in able to bring the restoration to an early failure.

This study aims to evaluate dentinal temperature rise in MOD restorations made with bulk-fill technique compared to conventional incremental technique. Two different types of bulkfill resins, SDR flow(DEnsply Sirona) and SFL (Kerr) are used.

They were selected 40 premolars obtained by orthodontic extractions. Each selected tooth was extracted two weeks before testing.

Teeth were subjected to mesio-occlusal-distal (MOD) cavity preparation.

The group of teeth was randomized into 2 groups (A and B). The samples belonging to group A were restored with SDR flow + (Sirona Dentsply, USA), while those belonging to Group B with SonicFill 2 (Kerr, USA). Each group was then divided into two subgroups (A1, A2 and B1, B2). Groups A1 and B1 were restored using bulk fill technique BT (4mm thickness), Groups A2 and B2 were restored using incremental technique IT (each increment 2mm).

For the bulk fill layering technique, no significant difference in the mean values of temperature increase for SDRB and SFLB have been observed (p=0.92). Similarly, no significant difference in the mean values of temperature increase for SDR and SFL2 have been observed (p=0.99). While for both RBCs, a significant difference ($p<0.05$) has been observed between temperature increase occurring during the first and the second light-curing steps.

Thermal stress represents an important issue related to temperature increase that can result in pulpal damage. Temperature increase in the pulp during light curing of RBCs is related to the exothermic reaction occurring with the polymerization process, and to the heat generated by the light-curing unit. Therefore, thermal injury thresholds represent the main limit to the power level which can be safely delivered. These temperature rise values would be detrimental for the pulp tissue. Fortunately, thermal conductivity of dentin effectively reduces temperature rise occurring into the pulp, in fact temperature levels recorded by the thermocouples placed 1 mm below the MOD cavity floor revealed that during light-curing temperature increase values are lower than 10 °C. In particular, for the bulk-fill layering technique temperature increase mean values for SFLB and SDRB are 7.7 °C and 8.5°C. However, difference between these mean values are not significant (p=0.92). For the incremental layering technique, temperature increase mean values for SFLI and SDRI (Figure 6) are 8.7 °C and 8.3 °C, but difference between the mean temperature rise values are not significant (p=0.99)

Irrespective of the bulk-fill RBCs and the layering techniques, temperature peak levels do not exceed 40 °C. Therefore, for both bulk-fill RBCs, the light curing modality can be considered safe for the integrity of the pulpal tissue if the thickness of the occlusal dentin is not lower than 1 mm. However, it must be pointed out that, for both RBCs and both composite layering techniques, the starting temperature level is about 30 °C, although the Thermoblock system used to mimic temperature levels occurring in the oral environment has been set at 35 °C. The reason is related to the rinsing and drying processes involved in the adhesive procedure that drastically reduces temperature level of the coronal tissues. Therefore, it is very important that the RBCs restorative procedure is performed soon after the adhesive procedure, otherwise the temperature base level of dental tissues may increase and the temperature increase occurring during photo-polymerization may largely exceed the temperature level of 40 °C, thus representing a thermal injury for the pulp tissue.

Based on the reported results the following conclusions can be drown:

- For the bulk fill technique, no significant difference in the mean values of temperature increase for SDR and Sonic Fill have been observed (p=0.92). Similarly, for the incremental layering technique, no significant difference in the mean values of temperature increase for SDR and Sonic Fill have been observed (p=0.99).

- For both bulk-fill RBCs and layering techniques, the light curing modality (1000 mW/cm2 for 20 s) can be considered safe for pulpal tissue if the thickness of the occlusal dentin is not lower than 1 mm.

Keywords: bulk-fill composites; temperature; pulpar damage; polymerization

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