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Irradiation Parameters Influence on Micro Hardness Rate of Light-Cured Composite-Resins

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Objectives To assess the influence of irradiation parameters (type of lamp/radiation intensity, exposure time, distance of optical fibre from sample's surface, sample thickness) on composite-resin degree of polymerization by evaluating Micro Hardness Rate (MHR).

Methods Six light-cured composite-resins (colour A2) were studied: Filtek Z550 (3M ESPE), G-aenial Posterior (GC), Filtek Bulk Fill Posterior (3M ESPE), SDR (bulk-fill) (Dentsply), Filtek Ultimate Flow (3M ESPE), G-aenial Universal Flow (GC). Three LED polymerization lamps were used: lamp_1 (control)- Elipar FreeLight 2 LED (3M ESPE)- 1000 mW/cm², lamp_2-MiniLED Supercharged (Acteon)-2000/3000 mW/cm², lamp_3-FlashMax P3 460 4W (CMS Dental)-5000/6000 mW/cm². Cylindrical samples (2mm height-5mm diameter and 4mm height-5mm diameter, n=6) of each material were irradiated (distance 0, 2 and 4mm, time: 20s/lamp_1, 10s/lamp_2, 3s and 1s/lamp_3), stored (24h, 5ml water, 23°C); dried, subjected to microhardness testing, statistically analysed (Anova, U-Mann-Whitney, p<0,05). Degree of polymerization was assessed using MHR (lower to upper surface's microhardness ratio); greater than 0.80 indicates a properly polymerized lower surface.

Results For all materials: the highest MHR was obtained for control lamp exposure, no differences were observed in microhardness of each material's upper surfaces irradiated for 20 and 10s, all 4mm samples were not adequately polymerized at the bottom surface (MHR<0,80). All material's lower surfaces were less hard (MHR 0,94 to 0,00) than upper ones (MHR 1,0 to 0,13). Increased distance of optical fibre from sample's surface (>0mm) negatively impacted through-cure (MHR<0,80) of all materials. Acceptable polymerization of composite-resins (MHR>0,80) required light intensity 1000mW/cm², longest available exposure time (20s), and 0mm distance of optical fibre from sample's surface, 2mm thick.

Conclusions Irradiation with higher light intensity lamps causes deterioration of the polymerization degree. Short exposure time has the most significant negative impact on MHR of bulk-fill and flowable composite-resins. Sample's thickness above 2mm negatively affects MHR of all tested composite-resins, including bulk-fills.