Influences on Flexural Strength And Deformation Behavior of Led Cured Microhybrid And Nanofilled Dental Resin Composites

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Background: A major modern application of engineering materials is to support biological tissues. Mechanical tests that closely simulate the real world activity on these materials are the most reliable way of predicting their service performance under load bearing activity. Flexural strength is an important property for characterizing brittle materials because the test generates complex tensions by combining tensile stress, compression and shear. In general, high flexural strength is desired for restorative materials that support the occlusal forces of posterior teeth. Several factors such as curing time and strain rates as well as the constituents of the dental resin composites affect the flexural strength. Deformation behaviour of restorations, such as shrinkage and shearing from curing and mastication, have also been a major concern for clinicians because of void and crack formations in restored tooth structure which affects the mechanical properties of the resin composites.

Objective: Hence, the aim of this study is to investigate the effects of varying curing times during polymerization, varying strain rates during loading of cured composites, resin matrix composition, filler particle sizes and filler volumes on the flexural strength. The deformation behaviour of composites under uniaxial tensile loading condition was also studied.

Materials, Specimen Preparation and Testing: Two commercially available dental resin composites, Filtek Z250 A3 Compules, a universal microhybrid restorative, and nanofilled light cured Universal Fine Hybrid Nano Composite were molded into sixty (60) samples of rectangular bar shaped specimens of 2mm X 2.5mm X 8mm dimension. The composites were polymerized by illuminating the filled aluminum molds with the Flashlite 2.0, of $\mathbf{900}\boldsymbol{mW/cm^2}$ light intensity at ten (10) different curing times and were tested according to ASTM D7264 standards on the ElectroForce 3200 testing instrument at ambient (room) temperature (30^0C). Flexural strength at different curing times was determined by carrying out 3-point bending test. This test was also carried out at varying strain rates. MSCR Test in accordance with ASTM D7405 – 08 standards was carried out to determine the material model behaviour.

Six commercially available dental resin based composites were also tested and used to investigate the effects of the material composition; Bis-GMA, UDMA, TEGDMA, and filler volumes and sizes on flexural strength.

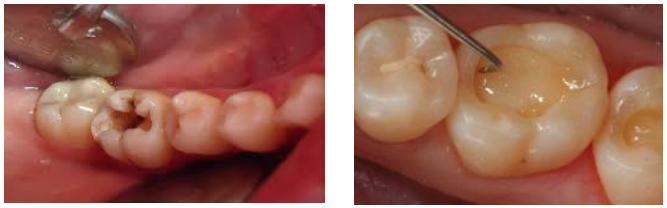

Figure 1 Samples of decay and restored teeth

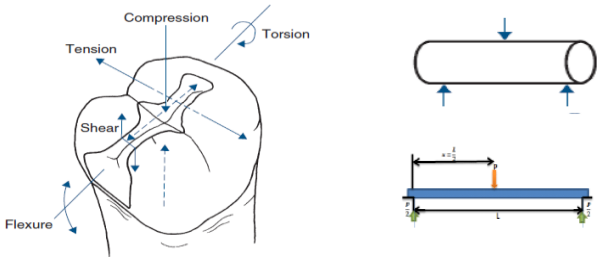

Figure 2 Direction of flexure loading of the tooth structure

Experimental Results:

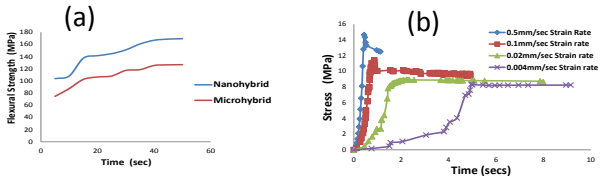

Figure 3(a) Flexural strength of microhybrid and nanohybrid dental resin composites at different curing times, (b) Effects of strain rate on the stress

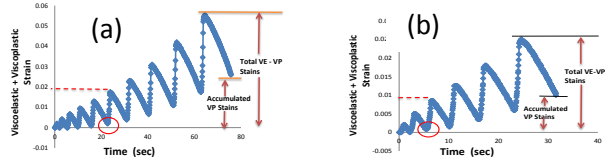

Fig. 4 MSCR test for total strain versus time for (a) microhybrid cured with LED (b) Nanohybrid cured with LED

Results and Discussion: Figure 3 shows the flexural strength of the two samples at varying curing times. Though the response of both materials is a non-linear one, the nanohybrid when compared with the microhybrid, shows a higher flexural strength. At five seconds cure time, the difference of 14.53 MPa is observed; also, at twenty-five seconds cure time, a difference of 18.36 MPa, while at maximum cure time, a difference of 21.37 MPa is apparent. This shows that the nanohybrid does not only possess a greater strength but that its rate of strength growth as the cure time is increased is much greater than that of the microhybrid.

It was also observed that, a hybrid with filler volume of 56% and only bis-GMA showed the lowest flexural strength but the best tensile strength amongst the group. Also, a nanohybrid with filler volume of 76.5% and bis-GMA, TEGDMA, UDMA showed the highest flexural strength and relatively low tensile strength. Micro hybrid showed relative balance in both cases. Nano hybrid showed better flexural strength in the group. Worthy of note also is that the second best flexural strength was a hybrid this confirms with the works of Moezzyzadeh (2012) and Hamouda *et al (*2012) that states that hybrid show better compressive strength than micro hybrid. The clinical relevance of flexural strength is its use for prediction of restorative ability to resist occlusal load without failure (cracking). Therefore, high flexural strength values are desired in restorative materials.

Conclusions Within the limitations of this study, the nanohybrid material showed a higher flexural property. The flexural strength of dental resin composites was found to be dependent on the resin matrix type, the filler particle size and the filler volume in that order. At low stress values, rate dependent irreversible strains were absent in all the tested samples but at high stress values they were observed. An increase in the strain rate resulted in an increase in the flexural strength of the resin composites. Similarly, as the curing time increased, the flexural strength increased up to a curing time of fifty (50) seconds.

References

1. Moezzyzadeh M. (2012) "Evaluation of the Compressive Strength of Hybrid and Nanocomposites". *Journal Dental School* 2012; 1:24-29

2. Hamouda, I.M., Elkader, H.A., (2012) "Evaluation of the Mechanical Properties of Nanohybrid Composite Resin Restorative Material". *Journal of Biomaterials and Nanobiotechnology*, 2012, 3, 238-242