The effect of Non-ideal illumination on the properties of new dental composite based filling materials

Naeem Sheikh M.Sheikh1@Newcastle.ac.uk

Introduction

- When suffering from dental caries, teeth need to be restored with a synthetic material to alleviate patient pain and to return the form and function of the tooth to approximately normal levels
- Dental amalgam has been the material most commonly used by dentists to restore teeth (Letzel et al. 1997)
- However, due to mercury being potentially phased out by 2030 due to environmental concerns (BDA, 2018), alternative materials are required
- Recently, a new class of dental composites has been developed, termed bulk-fill composites, which can potentially be used as an alternative
- However, much of the published data on these materials relies on *in vitro* studies conducted under laboratory conditions that rarely occur in clinical situations

Aims

- Measure **Hardness** (resistance to damage) of the bulk-filled composite - both at time of polymerisation and weekly after exposure to an environment mimicking the oral cavity
- Measure effect of distance and angulation on **Light Intensity** reaching the sample

Methods

Hardness Experiment

- Disc samples of composite were set at varying distances (0mm, 1mm and 2mm) and angulations (0^o, 20^o and 40^o) using a light curing unit
- Samples were kept in a phosphate-buffer solution (PBS) at 37^oC until testing between Weeks 0 – 4
- Hardness of both the top and bottom surfaces were measured

Light Intensity Experiment

- Disc samples of composite were set at varying distances (0mm, 1mm and 2mm) and angulations (0^o, 20^o and 40^o)
- Light intensity was then measured using a MARC Resin Calibrator

Results

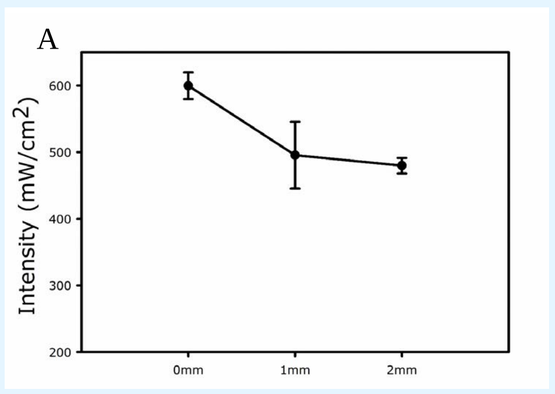

Figure 1: relationship between light intensity and A distance from sensor or B: light intensity and angle to the sensor

- Light intensity dropped significantly with increasing distance and angle (Figure 1)
- Hardness was always higher on the top surface compared to the bottom surface (Figure 2)
- Hardness decreased with increasing angle to the sensor
- In general, top and bottom surface hardness remained approximately constant over 4 weeks
- As angle to the sample increased, there was a greater decrease in hardness as time increased
- The increased variability at 2 weeks hardness for the top surface, and decrease in hardness at 1 week for the bottom surface, suggest that variable results are possible when trying to cure specimens with distances between the tip and specimen of 1 mm or more

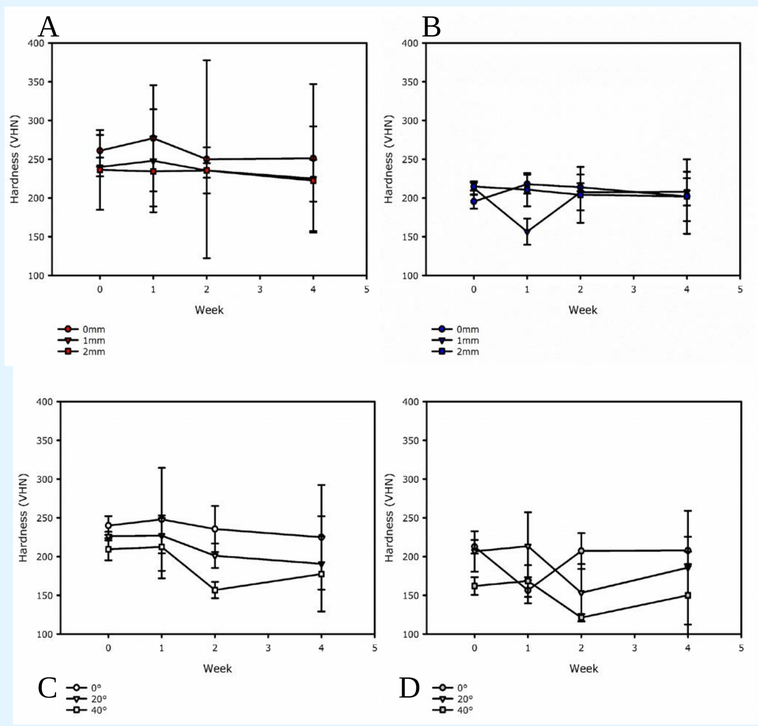

Figure 2: Change in hardness over time in PBS storage for A: Different light distance to the top surface, B: Bottom surface and C: Different angles to the top surface and D: bottom surface

Discussion

- As light intensity decreases, the potential for the composite to convert to a set state decreases leading to a high amount of unset composite monomers. These monomers are cytotoxic and a potential cause of post-operative pain.
- The lower the hardness, the lower the degree of conversion to a set state. This suggests that when the distance between the light curing unit and the sample surface is 1mm or more, there may be high levels of monomer within the material.
- The decrease in hardness with PBS storage exhibited by specimens made with the tip at an angle to the surface suggests that these specimens would become weaker over time. If these were restorations in a clinical setting, they may well fail prematurely, requiring a replacement restoration.
- Future work should investigate a number of different materials and measure whether there is a significant amount of water absorbed by the materials during water storage.

Conclusion

- Both distance away from the composite and angulation have a great impact on the light intensity reaching the sample and hardness of sample
- Hardness of composite generally decreases over time
- Clinical Impact: Clinicians must ensure that when placing a composite restoration, the distance and angulation away from the composite is as small as possible to increase its longevity

References
BDA (2018). Amalgam – British Dental Association. [Accessed 1st October 2018]. https://bda.org/amalgam
Letzel H, van't Hof MA, Marshall GW, Marshall SJ (1997). The influence of the amalgam alloy on the survival of amalgam restorations: A secondary analysis of multiple controlled clinical trials. J Dent Res. 76:1787–98

I would like to thank Dr Matthew German and Mr Anthony Townshend for their help and support during this project