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COMPARING THE DEPTH OF CURE OF LIGHT CURE AND DUAL CURE RESINS

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Abstract:

Aim: To determine the depth of cure of light cure and dual cure resins.

Objective: To compare the depth of cure of light and dual cure resins.

Background: Dental composite resins are types of synthetic resins which are used in dentistry as restorative material or adhesives. Light cure resins are polymers that cure and harden in the presence of specific light spectrums. Dual cure resins use both light and chemical initiators to activate the process of polymerisation. The depth of cure of light activated resin is limited by the attenuation of light passing through the material and has to be given in layers whereas the dual cure can be given in bulk and is less time consuming. In this research the depth of light cure and dual cure resins will be studied using Attenuated Total Reflectance Fourier Transform Infrared (ATR-FTIR) spectroscopy.

Reason: This study is done to find the depth required for light and dual cure resins and to find the better off the two.

Keywords: Resins, Polymerisation, Depth, Curing.

Introduction

Resin cements have an increasing application in the cementation of fixed prostheses (1), since they exhibit enhanced mechanical, physical and adhesive properties, compared to conventional luting agents (2). Further, they provide adequate stability (3,4) and increased fracture resistance of overlying all ceramic restorations (5,6), together with an optimal esthetic result. However, the fact that they are technique-sensitive materials (7)complicates clinical procedures and makes the cementation time-consuming and susceptible to manipulation errors. In an attempt to simplify procedures, a new group of resin cements, the self-etching, self-adhesive resin

cements, have been introduced. These products are self-adhesive, including acidic and hydrophilic monomers in their composition, which simultaneously demineralize and infiltrate enamel and dentin, resulting in strong bonding. Therefore, they require no conditioning or priming pre-treatment's of tooth substrate. (8,9,10,11) Thus resin cements are polymerised via chemical, light or both mechanism(dual). Successful bonding of polymer matrix composite is essential for decrease marginal leakage with improved apical seal, increases failure resistance compared with conventional cementation and retention. The cure of the resin cement is established by the conversion of the carbon double bonds into carbon single bond that can be measured through degree of conversion(12).The purpose of this study is to evaluate the depth of cure of light cure vs dual cure by FTIR analysis.

Material and Method

In order to evaluate the %DC of the light cure and dual cure, 5 specimens (1.8mm×4mm×4mm) of both materials(Dual cure-Paracore dentin shade; Light cure-Ivoclar viva dent) were prepared. Plastic molds were placed on glass microscope slides, covered with transparent celluloid matrix and overfilled with resin cement. The five samples of both light and dual cure were irradiated for 30s,35s,40s,45s and 50s respectively . The light curing device used was a halogen curing light in a standard irradiation mode, emitting light intensity 850mWcm−2. Then, the specimens were left undisturbed for 5min,for the completion of the polymerization reaction. The whole procedure took place at room temperature (23±1)◦C. The method used for the assessment of the %DC was the micro-attenuated total reflectance Fourier transform infrared spectrometry operated under the following conditions: 4000–500cm−1 range, 4cm−1 resolution, 20 scans co addition, 2mm diameter diamondATRcrystal, ZnSe lenses, depth of analysis ~2mat 1000cm−1. The specimens were placed one at a time in the sample holder of the device and spectra were recorded. A small amount of uncured resin cement from each material was also scanned and its spectrum was used as unpolymerized reference.(13)

Result

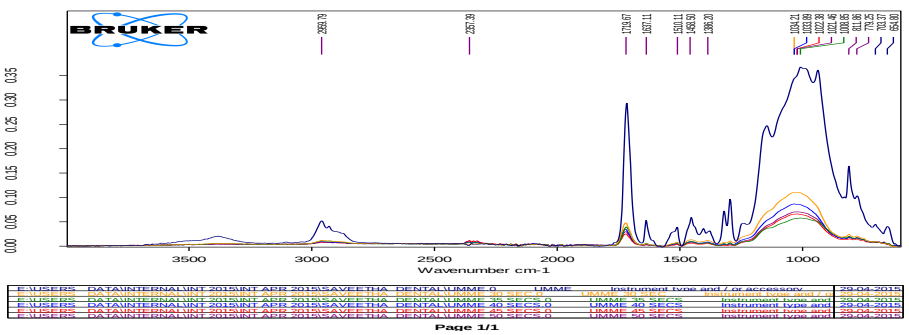

Figure1: Graph representing the FTIR spectra of an uncured and cured dual cure resin at 30,35,40,45 and 50secs using ATR-FTIR.

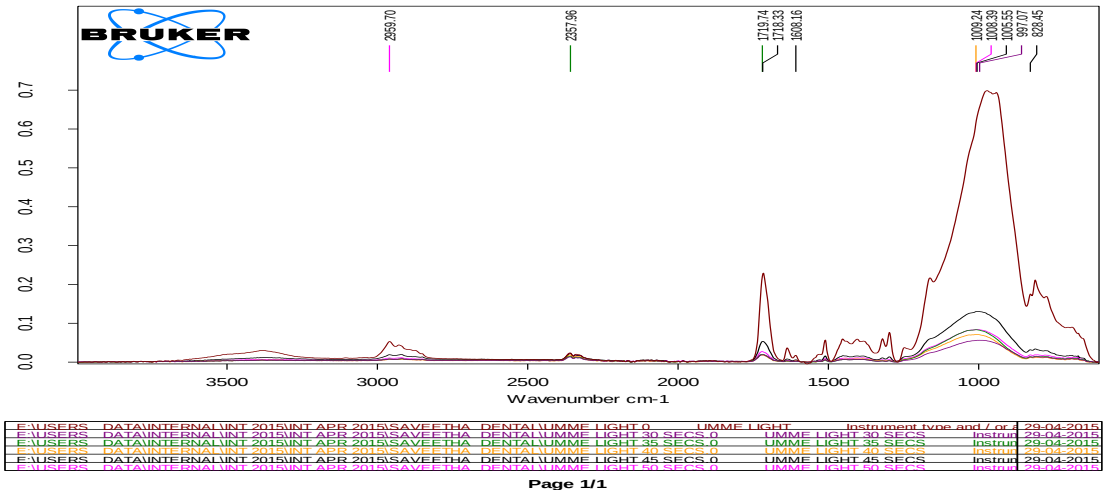

Figure-2: Graph representing the FTIR spectra of an uncured and cured light cure resin at 30,35,40,45 and 50 seconds using ATR-FTIR.

From the above graph of light cure and dual cure, it can be seen that the degree of conversion is more stable and higher for dual cure whereas for light cure it gradually keeps decreasing.

Discussion

Dental resin based composites are structures composed of three major components :a highly cross linked polymeric matrix reinforced by a dispersion of glass, mineral or resin filler particles and/or short fibers bound to the matrix by coupling agents. Resin composites are broadly classified into: chemically activated(self cure), photochemically activated(light cure) and dual cure resins. Resin polymerisation occurs in three processes namely, initiation, propagation and termination. During polymerization, dental resin composites transform from plastic viscous through a rubbery visco-elastic into an elastic glassy stage.(14)

Light curable dental composites are available in pastes(consisting of photosensitiser and an amine initiator) contained in a syringe. As long as the components in the paste are not exposed to light ,they do not interact. However exposure to light in the blue region produces an excited state of the photosensitiser which then interacts with the amine to form free radicals that start the polymerisation. Light cures composites have substantial limitations. Light cured composites offer a longer working time than self cured ones, but there is a possibility of incomplete polymerization especially in a deep cavity due to the limited depth of light transmission(15). They must be placed in increments when the bulk exceed 2-3mm because of the limited depth

of penetration. Other drawbacks include; cost of light curing unit, need for eye protection, complicating factors associated with light sources, heat generation, high marginal stress build-up etc,.

In order to overcome the limits of light cure system, dual cured systems, that combined favourable properties of both self cured and light cured systems, have been widely used. Dual cure resins consist of two light curable pastes, one containing benzoyl peroxide and other containing aromatic tertiary amine accelerator.(16) They are formulated to set up very slowly. The major advantage of this is assurance of completion of cure throughout. Dual cure materials are intended for any situation that does not allow sufficient light penetration to produce adequate monomer conversion -in case of cementation of bulky ceramic inlays.

The depth of cure is the depth or thickness of a resin that can be converted from a monomer to a polymer when exposed to a light source under specific conditions. The degree of conversion is a measure of the percentage of carbon-carbon double bonds that have been converted to single bonds to form a polymeric resin. The higher the DC, the better the strength, wear resistance and other properties essential to resin performance. Major shortcomings of resin-based composites are inferior conversion and its intrinsic polymerization shrinkage. Curing shrinkage arises as the monomer is converted to polymer and the free space it occupies reduces. In turn the polymerization shrinkage produces unrelieved stresses in the resin after it reaches the gelation point.(17) The polymerisation shrinkage and resultant stress can be affected by 1)the total volume of composite material 2)type of composite 3)polymerization speed 4)ratio of bonded/unbounded surfaces or configuration of the tooth preparation(C factor). In light cured materials, curing shrinkage leads to substantially greater stress buildup and leakage at the margins, in turn leading to staining, sensitivity and secondary caries. The internal pores in dual cure act to relax residual stress that build up during curing(the pores enlarge during hardening and reduce the concentration of stresses at the margins). Also the slower curing rate of dual cure activation allows a larger portion of the shrinkage to be compensated by internal flow among the developing polymer chains before extensive cross linking occurs. After the gel point, stresses cannot be relieved. (18,19)

Conclusion

The success of resin restoration depends on many factors including the technical difficulty of the procedure, isolation-the degree of moisture control, effects of polymerisation shrinkage, type of resin and how well the resin is cured. From the above study made between the variation in degree of conversion between light cure vs dual cure, it can be concluded that dual cure is better than light cure in terms of degree of polymerisation and

depth of cure. For better future scope of resin based composites, intensive research and development efforts are currently in progress to develop resins with low shrinkage and low thermal expansion.

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