Original Article

Analysis of depth of cure in photo-activated dental composite resins using different methods: In-vitro study

Dr.Swapn Rai[1], Dr.Vipul Srivastava[2], Dr.Shally Mahajan[3], Dr Abhinav Kumar[4]

[1]Assistant Professor, Department of Conservative Dentistry and Endodontics
[2,4]Professor
[3]Associate Professor

[1,4]Chandra dental College and Hospital, Safedabad.
[2,3]Saraswati Dental College and Hospital

ABSTRACT

Aim of study: The aim of the study was to evaluate depth of cure of light cured composite resin using three different modes of light curing systems a) Continuous mode b) Exponential mode c) Intermittent mode.

Materials & Method: The materials used were light curing system such as curing light 3M 2500 & Astralis7. The composite material used for testing was micro-filled hybrid composite material A3 shade. The apparatus used in test are Vicat polymer softening apparatus & composite curing test fixture.

Statistical Analysis Used: Statistical analysis of the data was done using the Tukey' s test.

Results: The result of depth cure showed that intermittent method had highest depth of cure. The lowest depth of cure was showed by continuous mode of photo polymerization & had highly significant result when compared to intermittent & exponential. Intermittent versus exponential showed statistically significant result. No uncured resin was found in control group samples.

Conclusions: The study evaluates the depth of cure of micro hybrid composite resin used in different photo activation techniques. The result of study showed that depth of cure is strongly affected by photo activation methods.

Key words: Photo-activation methods, Composite resin, Light curing systems, Depth of cure

INTRODUCTION

The light activated composite resins were brought into practice in the 1970s, they introduced expressive changes that made their satisfactory application in restoring teeth possible[1]. However characteristics such as composition, light intensity and exposure time can modify the final properties of material and thus restricts the clinical application[2]**.** The type, size, quantity and refractive index of fillers into composite exert an influence upon light transmission across the material and consequently light attenuation and depth of cure can be altered[3]. A higher degree of conversion can be obtained by using a high light intensity [4]. However, this higher intensity may result in greater polymerization shrinkage and thus greater marginal leakage.

Correspondence: ***Dr Shobha Rodrigues,****; e-mail:* ***ereldiaz@yahoo.com***

Thus, new photo-activation techniques have been proposed, such as the programmed use of low and high intensities that have shown to be more effective in decreasing the stress generated by polymerization shrinkage, while maintaining a high degree of conversion[5].

MATERIALS & METHOD

The light curing systems used are as follows

. Curing light Satelec

. Composite curing test fixture

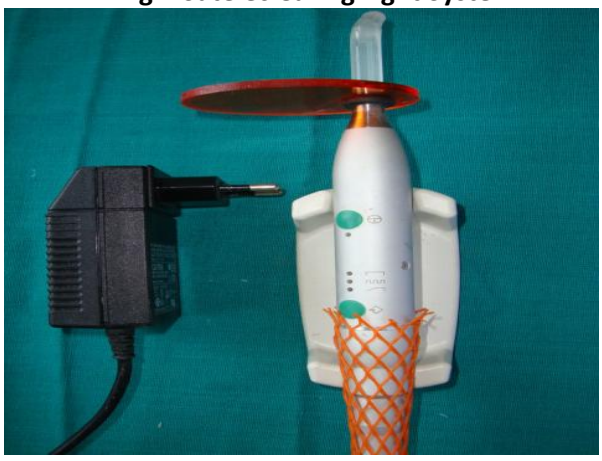
- The composite material used for testing was Micro-filled hybrid composite material A3 shade
- The apparatus used in the test - Vicat polymer softening apparatus.

Satelec Curing Light System

The 3 different modes of curing

1. Continuous Mode
2. Intermittent Mode
3. Exponential Mode

Fig.1 Satelec Curing Light System



Different Types Of Photo Activation Methods

1. Continuous mode: When the same light intensity is used throughout the photo-polymerization process for a period of 40 sec.

2. Exponential mode: When the light intensity is gradually increased from power output of 150 mw/cm^2 to 750 mw/cm^2 during the photo-polymerization process for a period of 40 sec.

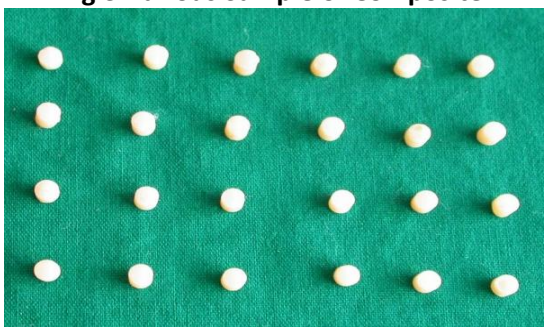
3. Intermittent mode: When the photo-polymerization for the first 30 sec is done at a power output of 400mw/cm^2 with a gap of 2 sec after each 10 sec duration. The photo-polymerization for the last 10 sec is done at a power output of 750mw/cm^2.

Composite Curing Test Fixture & **Micro-Filled Hybrid Composite A3 Shade**

The composite curing test fixture contains an aperture of dimensions 5mm, 4mm, 3mm and 2mm in depth and 4 mm in diameter.

Fig.2 Composite Curing Test Fixture

Fig.3 Various Sample of Composite



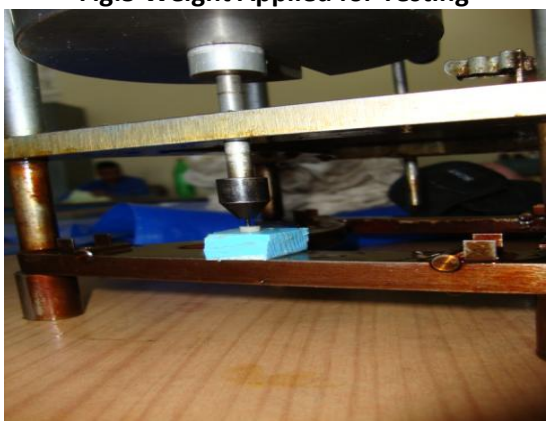
All the samples were cured keeping a constant distance from composite curing test fixture. The total time of cure for each mode was 40 seconds. After each sample is cured for 40 sec, the side of resin away from the light source was marked with a marker for identification. In total 3 groups of 6 samples each of height 5 mm and 1 control group of 6 samples each of height 2 mm was cured by all 3 modes of curing amounting to total of 24 samples. The samples were then immediately taken to Department of Metallurgy and Material Science. (Central Institute of Plastics Engineering & Technology, B-27 Amausi industrial area, Lucknow)

Vicat Softening Apparatus

The apparatus is used for measuring depth of cure in composite resins The apparatus contains a needle, weight and a dial measuring the depth of penetration. The weight applied for testing is 1250 gm. Vicat softening apparatus have a Depth **Measuring Dial** consists of 100 divisions each division measuring 0.01. mm The sample is kept under a needle with the uncured side facing the needle. The position just before the penetration of needle is noted on the measuring dial. Every sample is kept under the needle for 10 minutes. The final position of the dial is noted after 10 minutes.

Fig.4 Vicat Softening Apparatus

Fig.5 Weight Applied for Testing



The Depth Of Uncured Sample

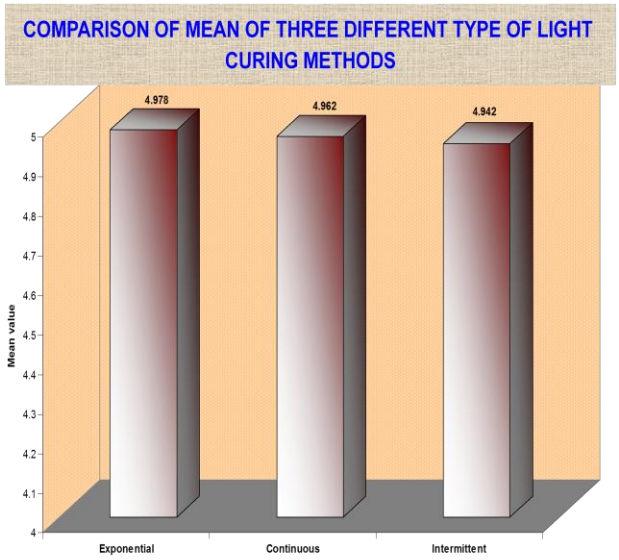
Final Position Of Measuring Dial- Initial Position Of Measuring Dial

The Depth Of Cured Sample

5mm (Original Height Of Sample) - Depth Of Uncured Sample

RESULTS

The results of depth of cure showed that intermittent method had the highest depth of cure. The lowest depth of cure was showed by continuous mode of photo polymerization and had highly significant results when compared to intermittent and exponential. Intermittent versus exponential showed statistically significant results. No uncured resin was found in control group samples.



	N	Mean	Standard Deviation
Intermittent	6	4.977500	0.0154110
Exponential	6	4.962500	0.0052440
Continuous	6	4.941667	0.0060553

DISCUSSION

The development of new technologies of photo-activation of restorative composite resins caused great interest among researchers. However the real advantage of these techniques is not yet totally known. This study evaluated the depth of cure of micro-hybrid composite resins used in different photo activation techniques. The results of study showed that depth of

cure is strongly affected by photo-activation methods[1]. The intermittent light demonstrated the highest depth of cure and was statistically different from other methods[2]. The factor that has influenced the depth of cure and caused difference between intermittent and exponential methods is total amount of energy supplied to the composite for polymerization[7]. The intermittent method of photo- polymerization may have provided highest amount of energy to the material which explains higher depth of cure values[7] . The photo activation methods provides depth of cure values that fulfilled required for ISO 4049. However, there were differences observed between the methods at depths greater than 2 mm. The difference observed between the methods was probably due to characteristics of each method such as light intensity, exposure time and heat generated[8]. To conclude, ideal situation as per ISO 4049, 2 mm still remains maximum thickness of composite to be cured[9] . However, when need arises to cure greater depths, the intermittent technique of curing can be used. Further studies on the polymerization and polymerization shrinkage with this technique needs to be done.

CONCLUSION

Depth of cure showed that intermittent method had the highest depth of cure while the lowest depth of cure was showed by continuous mode of photo polymerization.

REFERENCES

1. Rueggeberg FA, Caughman WF, Curtis Jr JW, Davis HC. Factors affecting cure at depths within light-activated resin composites. Am J Dent 1993; 6:91-95.
2. Rueggeberg FA, Caughman WF, Curtis Jr JW. Effect of light intensity and exposure duration on cure of resin composite. Operative Dent 1994; 19:26-32
3. Feilzer AJ, Doreen LH, de Gee AJ, Davidson CL. Influence of light intensity on polymerization shrinkage and integrity of restoration cavity interface. Eur J Oral Sci 1995;103:322-326.
4. Correr Sobrinho L, de Lima AA, Consani S, Sinhoreti MAC, Knowles JC. Influence of curing tip distance on composite Knoop hardness values. Braz Dent J 2000; 11:11-17.
5. Lovell LG, Lu H, Elliott JE, Stansbury JW, Bowman CN. The effect of cure rate on the mechanical properties of dental resins. Dent Mater 2001;17:504-511.
6. Fan PL, Schumacher RM, Azzolin K, Geary R & Eichmiller FC (2002) Curing light intensity and depth of cure of resin based composites tested according to international standards. Journal of the American dental association 2002; 133 (4) 429-434
7. Obici A.C, Sinhoreti M.A.C et al.Evaluation of depth of cure and knoop hardness in a dental composite photo activated using different methods. Braz Dent J (2004) 15(3) : 199-203.
8. Aravamudhan K, Rakowski D & Fan PL. Variation of depth of cure and intensity with distance using LED curing lights. Dent Mater 2006; 22 (11) 988-994
9. Depth of cure of dental resin composites: ISO 4049 Depth and microhardness of types of materials and shades. Oper Dent 2008; 33-4, 408-41