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Hardness of celluloid strip-finished or polished composite surfaces with time

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Statement of problem. An in vitro study revealed that a celluloid strip–finished composite surface discolored more than the polished composite surface. Thus, the celluloid strip–finished composite surface may not cure enough compared with the polished composite surface.
Purpose. This study tested the hypothesis that the celluloid strip–finished composite surface did not cure enough compared with the polished composite surface.
Methods and material. The composite was placed in a 1.5-mm thick aluminum mold and the upper surface was covered with a celluloid strip. Composite was light cured for 60 seconds, then a layer of approximately 200 μm thick was ground away from the lower surface and polished. The hardness of the upper composite surface that was polymerized under a celluloid strip and the polished lower surface were measured with Vickers hardness measuring instrument 15 minutes, 6 hours, and 6 days after light curing. The hardnesses of polished and celluloid strip–finished surfaces were compared using a paired *t* test. One-way ANOVA and Tukey was used for tests for the significant differences in hardnesses between 15 minutes, 6 hours, and 6 days after light curing for a given surface.
Results. Microhardness of the celluloid strip–finished composite surface was 380.6 N/mm^2 at 15 minutes, 442.5 N/mm^2 at 6 hours, and 519.2 N/mm^2 at 6 days after light curing. Microhardnesses of the polished composite surface was 476.6 N/mm^2 at 15 minutes, 511.7 N/mm^2 at 6 hours, and 535.0 N/mm^2 at 6 days after light curing. The hardness of the celluloid strip–opposed composite surface was significantly lower than that of the polished surface 15 minutes and 6 hours after light curing ($P<.001$). There was no difference in hardness between the celluloid strip–opposed surface and the polished surface on the sixth day.
Conclusion. The hardness of the celluloid strip–opposed composite surface was lower than that of the polished surface at 15 minutes and at 6 hours after light curing. However, there was no difference in microhardness in 6 days. (J Prosthet Dent 2000;83:660-3.)

CLINICAL IMPLICATIONS

In this study, the celluloid strip–finished composite surface did not cure enough when compared with the polished surface in the early postcuring period. Thus, the patient, whose teeth are finished with celluloid strip, should be instructed to avoid chemical or mechanical stress in the early postcuring period.

The smoothest composite surface that is important in esthetic restorations can be obtained with a celluloid strip.[1] However, a discoloration study revealed that composite surfaces polymerized under matrix discolored more than surfaces polished after 48 hours of light curing.[2] Higher tendency of discoloration on the celluloid strip–covered composite surface, even though it has a smoother surface, may be related to lower physical property on the surface.

A previous study showed microhardness of the celluloid strip–finished composite to be lower than the polished subsurface,[3] and the celluloid strip–covered composite surface showed lower conversion than the composite bulk.[4] Thus, it was recommended that composites should be finished and polished, despite the smooth finish of the celluloid strip.[5-8] However, from a clinician's point of view, he is reluctant to polish the celluloid strip–finished composite surface with an instrument, especially when an esthetic result is the prime concern to the patient.

It would be helpful for the clinicians to find a way to minimize the drawbacks of celluloid strip–finished composite surface. Discovering the physical properties of the celluloid strip–finished composite surfaces would be the first step in minimizing these disadvantages. In the composite, the physical property is closely related to the degree of conversion, and the hardness measurement is an effective way to evaluate the degree of composite cure.[9]

The purpose of this study was to evaluate the changes in the microhardness of composite surface over time, which was cured under celluloid.

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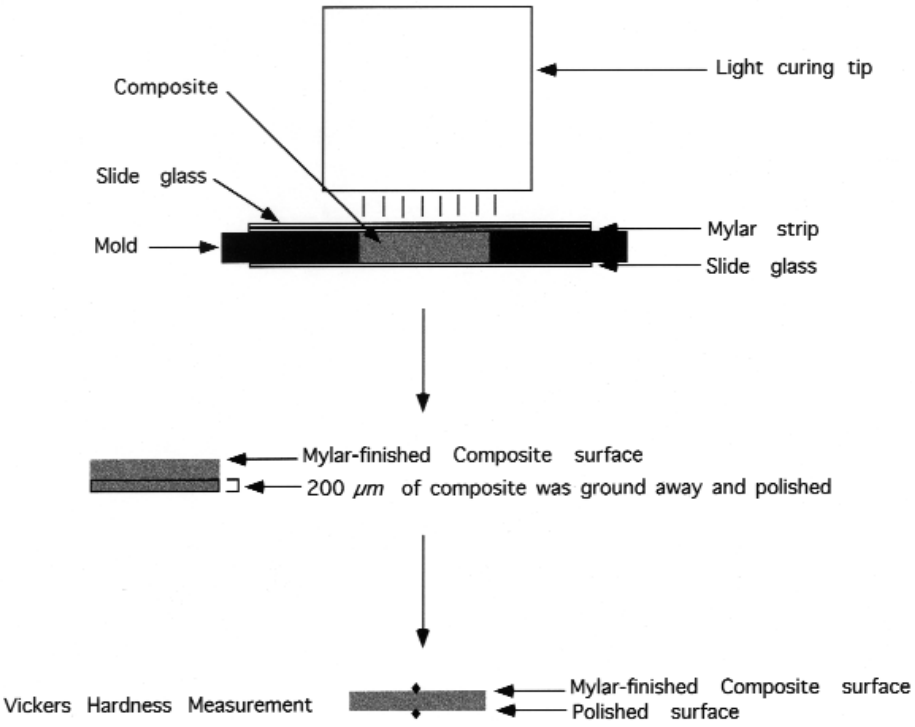

Fig. 1. Schematic illustration of experimental design.

MATERIAL AND METHODS

Tetric Ceram material (Vivadent AG, Schaan, Liechtenstein) was used. A 6-mm diameter cylindrical hole was made in a 1.5-mm thick aluminum plate, and a glass slide was positioned along the lower side of the hole. Titanium-coated instruments (Composite Instrument, Coltene, Alstatten, Switzerland) were used to place the composite in the mold. A celluloid strip (Hawe Striproll, Hawe Neos Dental, Gentilino, Switzerland) and a slide glass were placed on top of the composite and then pressed. The light intensity of the light-curing unit (Optilux 500, Demetron/Kerr, Danbury, Conn.) was measured to be 990 mW/cm^2 by the installed radiometer. The light-curing unit was positioned as close as possible to the slide glass and then the composite was light cured for 60 seconds (Fig. 1). When light curing was completed, the composite was removed from the mold, and the upper portion of the composite marked with a pen.

A layer of approximately 200 μm was ground away from the lower surface and polished with SiC paper. Twenty-five samples were assigned. The hardness of the celluloid strip–covered upper surface and the polished lower surface were first measured after 15 minutes with an Optidur Vickers hardness measuring instrument (Göttfert Feinwerktechnik GmbH, Buchen, Germany). Samples were then stored in a dark, 100% humid condition, at a temperature of 25°C. The second measurement was performed 6 hours after light curing was carried out, and the next measurement was recorded on the sixth day.

The hardnesses of the polished and celluloid strip–finished surfaces were compared by using a paired *t* test. One-way analysis of variance (ANOVA) with Tukey test was used to determine the significant differences in hardnesses of the polished or celluloid strip–finished composite surface for the time intervals 15 minutes, 6 hours, and 6 days after light curing. From a pilot study, it had been confirmed that there was no difference in the hardness between the upper and lower surfaces of 1.5 mm thick composite, which had been light cured in the same mold for our study. This is consistent with a previous study.[10]

RESULTS

Vickers hardness values of the celluloid strip–finished composite surfaces and the polished composite surfaces are presented in Table I. The hardness of the celluloid strip–opposed composite surface was significantly lower than that of the polished surface at 15 minutes and at 6 hours after light curing ($P<.001$). There was no difference in hardness between the celluloid strip–opposed surface and the polished surface on the sixth day. For the celluloid strip–opposed surface, there was a significant increase in hardness between 15 minutes and 6 hours after light curing ($P<.05$) and between

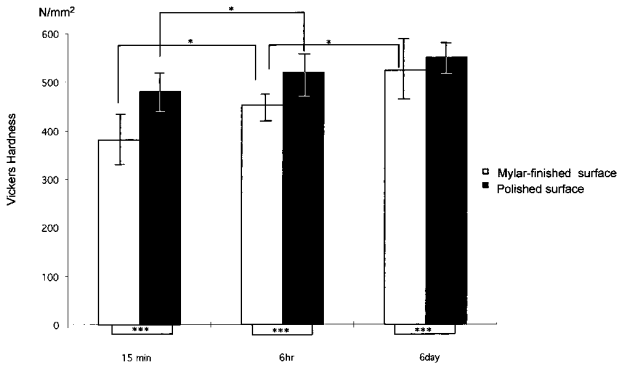

Fig. 2. Vickers hardness values for celluloid strip–finished and polished composite surfaces with time (n = 25). *$P<.05$; ***$P<.001$.

6 hours and 6 days after light curing ($P<.05$). For the polished surface, there was a significant increase in hardness between 15 minutes and 6 hours after light curing ($P<.05$). The difference in hardness between 6 hours and 6 days after light curing was not significant (Fig. 2).

DISCUSSION

The hardness value of polished surface in this study was within the range of values of another study.[11] In our study, the celluloid strip–finished surface achieved the same hardness as polished surface after 6 days of light curing, even though it had a lower hardness value compared with the polished surface in the early postcure period. Thus, if chemical or mechanical stress occurred in the early postcuring period, the celluloid strip–finished surface would have exhibited less resistance to discoloration or wear. If the restoration is to be finished with the celluloid strip, the patient should be advised to avoid disclosing food, chemicals, or mechanical stress on the composite in the early postcuring period. In a discoloration study by Hachiya et al,[2] the composite surfaces polymerized under a matrix discolored more than the surfaces polished 48 hours after light curing. In our study, the early exposure of the celluloid strip–covered surface to the disclosing solution may have affected the results. If the exposure of the celluloid strip–covered surface to the disclosing solution was delayed to 7 days after light curing, the result would be different. However, further study about the discoloration of composite surface will be needed to support this postulation.

In visible light-cured composite, the prevailing part of the increase in hardness was observed in the first few minutes after irradiation, even though the optimum hardness of the light-cured composite is achieved 1 day after light curing.[12,13] In our study, the microhardness of the celluloid strip–finished composite surface increased more progressively. The finding is in partial agreement with the observation of Helvatjoglou et al,[3] who reported a progressive increase of microhardness of the celluloid strip–finished composite surface at 4 weeks.

Table I. The Vickers hardness (N/mm^2) of the celluloid strip–finished and the polished composite surfaces

	Mylar-finished surface	Polished surface
15 minute	380.6 (54.6)	476.6 (34.2)
6 hour	442.5 (27.2)	511.7 (46.4)
6 day	519.2 (53.5)	535.0 (24.2)

The values in parentheses are SDs.

In a study that measured the shear bond strength between precured composite with various surface properties and a newly cured composite increment, Li[14] found that the surface that had been cured against a cover glass resulted in a significantly higher bond strength than any other preparation. It has also been shown that when composites are cured against a plastic matrix or a cover glass, they have the same interlayer bond strength as those cured in air.[15-17] It was concluded that the unreacted double bond on the celluloid strip–covered surface, which occurred because of the oxygen inhibition, functioned as a bonding medium between 2 increments of dental composites.[14] From our study, the shear bond strength between the celluloid strip–finished composite surface and a newly cured composite increment would be different, depending on the maturity of the celluloid strip–finished composite. That is, if the increment is added to the aged, celluloid strip–finished composite over 6 days, the surface would not function as a bonding medium any more because the surface cured completely. This postulation is in agreement with a previous study that reported that the interfacial bond strength between composite increments was lower when second increments are made of matured composite than that found with fresh composite.[16]

In our study, the hardness of the celluloid strip–finished surface increased with time. Thus, it is assumed that the oxygen inhibition, which occurs under the celluloid strip, would be different from the inhibition that occurs in the composite surface when it is cured in contact with air. When the composites cure in air, oxygen diffuses into the composite surface, whereas it is likely to be entrapped into the composite when the composites cure under the matrix. Thus, it is postulated that the radicals, which reacted with oxygen that was entrapped in the composite under the celluloid strip, reacted with the unreacted monomer and polymerized with time. Considering the half-life of radicals,[18] additional polymerization may continue to occur until a few days after light curing.

Another possible explanation for the lower microhardness of the celluloid strip–finished composite surface in the early postcuring period is that restriction in monomer movement between the celluloid strip and the composite surface may hinder the polymerization of the celluloid strip–covered composite surface.[2] With time, as the tension on the surface releases, the additional cure may occur.

CONCLUSION

The results of this study revealed that the hardness of the celluloid strip opposed to the composite surface was lower than that of the polished surface 15 minutes and 6 hours after light curing. However, there was no difference in microhardness in 6 days.

REFERENCES

1. Bauer JG, Caputo AA. The surface of composite resin finished with instruments and matrices. J Prosthet Dent 1983;50:351-7.
2. Hachiya Y, Iwaku M, Hosoda H, Fusayama T. Relation of finish to discoloration of composite resins. J Prosthet Dent 1984;52:811-4.
3. Helvatjoglou-Antoniadi M, Papadogianis Y, Koliniotou-Kubia E, Kubias S. Surface hardness of light-cured and self-cured composite resins. J Prosthet Dent 1991;65:215-20.
4. Park SH. The relative degree of conversion of the composite resin surface [abstract]. J Dent Res 1997;76:1973.
5. Wilson GS, Davies EH, von Fraunhofer JA. Micro-hardness characteristics of anterior restorative materials. Br Dent J 1980;148:37-40.
6. von Fraunhofer JA. The surface hardness of polymeric restorative materials. Br Dent J 1971;130:243-5.
7. Peterson EA 2d, Phillips RW, Swartz ML. A comparison of the physical properties of four restorative resins. J Am Dent Assoc 1966;73:1324-36.
8. Hannah CM, Smith GA. The surface finish of composite restorative materials. Br Dent J 1973;135:483-9.
9. Rueggeberg FA, Craig RG. Correlation of parameters used to estimate monomer conversion in a light-cured composite. J Dent Res 1988;67: 932-7.
10. Rueggeberg FA, Caughman WF, Curtis JW Jr, Davis HC. Factors affecting cure at depths within light-activated resin composites. Am J Dent 1993; 6:91-5.
11. Willems G, Lambrechts P, Braem M, Vanherle G. Composite resins in 21st century. Quintessence Int 1993;24:641-58.
12. Leung RL, Adishian SR, Fan PL. Postirradiation polymerization of visible light-activated composite resin. J Dent Res 1985;62;363-5.
13. Hansen EK. After polymerization of visible light activated resins: surface hardness vs. light source. Scand J Dent Res 1983;91:406-10.
14. Li J. Effects of surface properties on bond strength between layers of newly cured dental composites. J Oral Rehabil 1997;24:358-60.
15. Boyer DB, Chan KC, Torney DL. The strength of multilayer and repaired composite resin. J Prosthet Dent 1978;39:63-7.
16. Lloyd CH, Baigrie DA, Jeffrey IW. The tensile strength of composite repairs. J Dent 1980;8:171-7.
17. von Beetzen M, Li J, Nicander I, Sundström F. Factors influencing shear strength of incrementally cured composite resins. Acta Odontol Scand 1996;54:275-8.
18. Burtscher P. Stability of radicals in cured composite materials. Dent Mater 1993;9:218-21.

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