Short Communication

Relative Hardness of Composite Buildups Polymerized with Two Different LED Lights

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The relative hardness (RH) of five composite materials was determined through polymerization via LED lights. Disk specimens were prepared by using composites composed of Artiste, an experimental glass fiber composite, Filtek Supreme, Z100, and LuxaCore. Specimens were polymerized for 10 and 20 seconds from the top surface only with two lights, Smartlite-IQ2 and DEMI LED, with light maintained 8 mm from the surface through a coronal section of the molar tooth. Knoop hardness numbers were determined for the top and bottom surfaces both immediately and 24 hours later. Ten RH values per group were calculated and data were statistically analyzed. Generally, RH increased with increasing polymerization time. The DEMI LED light resulted in RH values that were significantly higher than those obtained with Smartlite IQ2. Z100 had RH values of > 80% under most testing conditions and had the highest hardness values of all composites tested. Therefore, it is considered to be the most appropriate for core buildups. *Int J Prosthodont 2009;22:476–478.*

Improvements in the mechanical properties of composite resin and light polymerization devices have permitted their use in posterior teeth with greater reliability.[1] However, one of the problems encountered when using light-polymerized composites for core buildups is the risk of decreased light intensity as the light travels through the deep cavity.[2] Price et al measured the power density of light units at a distance of 0 to 10 mm and found it to vary significantly.[3]

It is thus important to determine the minimum light polymerization cycle and intensity required for sufficient polymerization of composites when used for core buildups. Therefore, the objective of this in vitro study was to determine the relative hardness (RH) of five composites when two LED lights were used with two polymerization cycles in a clinical simulation setup with increased cavity depth.

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Materials and Methods

Four light-polymerized and one dual-polymerized composites were examined in this study (Table 1). Two LED light-polymerization units were used, Smartlite-IQ2 (IQ2), with a light intensity of 700 mW/cm^2 (Dentsply), and DEMI LED (DEM), with a light intensity of 1,100 to 1,300 mW/cm^2 (Kerr). The light intensity of both units was verified using an LED light meter (Kerr). Disk specimens 2 mm thick and 3 mm in diameter were prepared from each material. Two groups of specimens were prepared and light polymerization was applied for 10 and 20 seconds from the top surface only. The light guide tip was maintained 8 mm from the surface by placing a spacer that was made of a coronal molar tooth section prepared with an endodontic access cavity (Fig 1). Two specimens were prepared for each test condition.

Table 1 Composite Materials Investigated

Composite resin core	Manufacturer	Shade	Lot number
Artiste	Pentron	A2	160958
Experimental glass fiber	StickTech	–	–
Filtek Supreme	3M ESPE	A2B	39105CA
Z100	3M ESPE	A2	80047PK
LuxaCore	DMG	A2	574223

– = not specified.

Fig 1 Specimen preparation with light applied through the coronal section of a molar tooth prepared with an endodontic access cavity. Light was applied from the top surface only.

Table 2 Descriptive Statistics and Test of Significance for the Effects of Material, Curing Lights, Curing Cycles, and Measurement Time on Relative Hardness

Curing cycles/ curing lights/ material	Immediate			24 h			
	Mean	SD	tk*	Mean	SD	tk*	*P*
10 s							
IQ2							
Artiste	0.19	0.017	h	0.21	0.021	m	NS
EGF	0.38	0.042	f	0.43	0.024	j	≤ .01
Filtek Supreme	0.41	0.047	f	0.44	0.036	j	NS
Z100	0.67	0.022	c	0.71	0.033	e	≤ .01
LuxaCore	0.18	0.031	h	0.20	0.009	m	≤ .05
DEM							
Artiste	0.37	0.029	f	0.39	0.030	k	NS
EGF	0.48	0.038	e	0.50	0.035	i	NS
Filtek Supreme	0.49	0.017	e	0.50	0.017	i	≤ .05
Z100	0.79	0.038	b	0.80	0.032	c	NS
LuxaCore	0.26	0.029	g	0.29	0.028	l	NS
20 s							
IQ2							
Artiste	0.18	0.025	h	0.23	0.024	m	≤ .001
EGF	0.56	0.066	d	0.61	0.024	g	≤ .05
Filtek Supreme	0.63	0.033	c	0.68	0.037	e	≤ .01
Z100	0.78	0.081	b	0.84	0.067	b	NS
LuxaCore	0.55	0.035	d	0.57	0.010	h	NS
DEM							
Artiste	0.39	0.025	f	0.43	0.024	j	≤ .001
EGF	0.54	0.061	de	0.65	0.028	f	≤ .001
Filtek Supreme	0.69	0.028	c	0.74	0.021	d	≤ .001
Z100	0.89	0.016	a	0.92	0.041	a	NS
LuxaCore	0.74	0.035	bc	0.78	0.053	b	≤ .01

SD = standard deviation; tk = results of the Tukey test; NS = not significant;
EGF = experimental glass fiber composite.
*Means with the same letter within each column are not significantly different at $P \leq .05$.

A hardness tester with a Knoop indenter and 50-g weight (Tukon 300, Acco Industries) was used for the testing of each specimen both immediately after polymerization and 24 hours after dry storage in the dark in an incubator at 37 ºC. Five Knoop hardness numbers (KHNs) were obtained from each surface of each specimen and 10 RH values were calculated per group. Data were statistically analyzed using analysis of variance (ANOVA) followed by the Tukey test at a significance of $P = .05$.

Results

ANOVA revealed significant differences in mean KHNs among the different curing cycle, light unit, and material groups ($P < .0001$) (Table 2). For all materials, RH increased with increasing polymerization time and greater light intensity. Mean KHNs and RH for Z100 were significantly higher than those of the four other materials under all test conditions.

Discussion

Determination of RH is considered to be the most frequently used method for estimating depth of cure for composite materials since it is closely associated with degree of monomer conversion.[1–5]

The effectiveness of polymerization cannot be assessed by top surface hardness alone. Bottom surface hardness is more critically affected by light intensity.[5] Irrespective of the light used, and as expected, bottom surface hardness values were lower than those of the top for all materials. This is not surprising since as light passes through the bulk of the composite, its intensity is reduced due to the scattering of light by the inorganic filler particles.[1] The 8-mm distance from the tip of the light guide to the top surface of the composite specimen, which is clinically relevant for core buildups, was detrimental to adequate polymerization. RH values for all groups were much lower than the ideal standard of ≥ 80%, even when the polymerization cycle was increased to 20 seconds (except for Z100) (Table 2).[1] This is in agreement with previously published studies.[3,5] In general, composite brand had a significant effect on KHNs, perhaps due to the variability in type, composition, size, and distribution of the inorganic fillers. It is possible that if IQ2 was used in a polymerization cycle longer than 20 seconds, RH values may have increased; however, more research is needed to explore this potential. It is interesting to note that for the dual-polymerized material, the desirable RH value of 80% was not reached even after 24 hours of storage and when the 20-second cycle was used.

Conclusions

Among the composite resins tested, Z100 had RH values > 80% under most test conditions and had the highest hardness values overall. Therefore, it is considered to be the most appropriate material for core buildups. DEM with an increased light intensity resulted in increased RH values for almost all five composites.

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Literature Abstract

Occlusal plane orientation: A statistical and clinical analysis in different clinical situations

This study evaluated the reliability of the hamular notch/incisive papilla plane (HIP) in establishing the occlusal plane. Ninety patients were included in this double-blind study. Sixty dentate and 30 edentulous casts were made from these patients using a Type III dental stone. A surveyor with three vertical pins mounted at a fixed position was used to determine the HIP for the dentate casts. The HIP for these casts was compared to the occlusal plane by measuring the vertical distance of the four points of the occlusal plane to the floor of the surveyor. Three metallic balls placed at the hamular notches and the incisive papillae were imbedded into a temporary record base. Using lateral cephalograms of the temporary record bases, the HIP was compared to the ala-tragal line and interpupillary line (occlusal plane) by using central bearing plates. A paired *t* test was used to compare the results. There was no statistically significant difference in both the dentate and the edentulous casts. Fifteen percent of the dentate casts showed absolute parallelism, with 75% within the range of ± 2 mm. As for the edentulous samples, the HIP showed a parallel relationship to the occlusal plane, established by the ala-tragal line and interpupillary line, especially when the central point of the tragus was used. Since the HIP tends to be parallel to the occlusal plane, it would be helpful to use it as a guide in determining the orientation of the occlusal plane. This will be most helpful when fabricating complete dentures for edentulous patients.

Jayachandran S, Ramachandran CR, Varghese R. *J Prosthodont* 2008;17:572–575. **References:** 22. **Reprints:** Dr Jayachandran Sivakumar, Division of Prosthodontics, RMDC&H, Annamalai University, 49 Sivam Nagar, Panagal Road, Tiruvarur, Tamilnadu 610002, India. Email: sivajsk@rediffmail.com—*Majd Al Mardini, Hamilton, Ontario, Canada*