

# Time-dependent Variation in Compressive Strengths of Three Posterior Esthetic Restorative Materials: An *in vitro* Study

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## ABSTRACT

**Aim:** To compare the compressive strengths of composite resins and resin-modified glass ionomer cements (RMGICs) at different times.

**Materials and methods:** A total of 36 samples were prepared, 12 samples of each group, composite resins Filtek Z 250, Filtek Z 350, and resin-modified glass ionomer cement. Compressive strengths of specimens were measured after 1, 24 hours, and 7 days. Test was carried out on a "Universal Testing Machine" with cross-head speed of 5 mm/min.

**Results:** There was a significant difference between all the three restorative materials. Analysis of variance showed that mean compressive strengths of Z 250 after 1, 24 hours were higher than Z 350 and RMGIC ( $p < 0.05$ ). The mean compressive strengths were reduced after 7 days in all the three groups, but after 7 days, the values of Z 250 when compared with the Z 350 and RMGIC were higher.

**Conclusion:** The study demonstrated that compressive strengths of hybrid composite resins (Z 250) were significantly higher than that of nanocomposites (Z 350) and RMGIC.

**Keywords:** Filtek Z 250, Filtek Z 350, Hybrid composite, Resin-modified glass ionomer cement.

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**Conflict of interest:** None

## INTRODUCTION

With the increase in esthetic demand and the development of adhesive techniques, resin composite has become

the material of choice for posterior tooth restoration. Mechanical properties of restorative materials have an important role in the efficacy and longevity of the tooth and restoration.<sup>1</sup>

The tooth needs to be restored with a suitable restorative material, which can resist complicated forces of mastication.<sup>2</sup> As the majority of masticatory forces in the posterior region are particularly compressive, tooth should bear these kinds of forces.<sup>3-5</sup> It is said that compressive strength is the most important mechanical property of restorative materials. A material with lower compressive strength than the tooth tends to fail, fracture and it ends with periodontal problems or extraction of the tooth.<sup>6-8</sup>

Composite resins and resin-modified glass ionomer cement (RMGIC) are improving day-by-day because of their chemical ingredients, bonding ability, conservative preparation, preservation of tooth structure, and esthetics. The aim of this study was to compare the compressive strength of two commercially available composite resins and one RMGIC at different time intervals.

## MATERIALS AND METHODS

A total of 36 samples were prepared, 12 samples of each group, hybrid composite resins Filtek Z 250 (3M ESPE, USA), nanocomposite Filtek Z 350 (3M, ESPE, USA), and RMGIC (GC, USA). Compressive strengths of specimens were measured after 1, 24 hours, and 7 days. In each group, a total of 12 samples were measured, 4 each at 1 to 24 hours, and 7 days. The details of the each group are presented in Table 1.

## Specimen Preparation

Square-shaped specimens were prepared with dimensions of 10 mm length, 10 mm width, and 2 mm thickness. A two-part stainless steel multi-square mold was used to prepare the specimens (Fig. 1). Composite resins were applied in 2-mm layer thickness to fill the mold. For the last layer, a mylar strip was placed. For light-cure composite resins specimens, light curing was done for 40 seconds per layer, in order to have maximum curing. Each specimen was again cured for 60 seconds in all the directions. Modified glass ionomer cement is a light-cured

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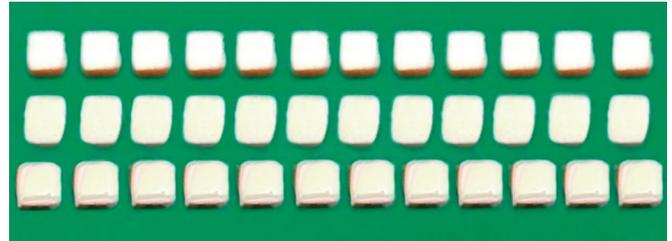
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**Table 1:** Different groups with different time periods and total sample

Groups	Material	Time period			Total number of samples
		1 hour (number of samples)	24 hours (number of samples)	7 days (number of samples)	
I	FILTEK Z 250 hybrid composite resin	4	4	4	12
II	Filtek Z 350 nanocomposite resin	4	4	4	12
III	Resin-modified glass ionomer cement	4	4	4	12
	Total	12	12	12	36

**Fig. 1:** Two-part stainless steel multisquare mold**Fig. 2:** Samples prepared for testing compressive strength

universal restorative material, which was mixed according to manufacturer's instruction and light cured for 40 seconds. After preparing the sample (Fig. 2), they were stored at  $37 \pm 1^\circ\text{C}$  in an incubator to simulate the oral temperature, for different times prior to testing.

### Measurement of Compressive Strength

Compressive strengths of specimens were measured after 1, 24 hours, and 7 days. Test was carried out on a universal testing machine (Instron Corp., Canton, MA) with cross-head speed of 5 mm/min. The ultimate compressive strength (UCS) was calculated from the formula  $UCS = F/b^2$ , where F is maximum applied load (Newton) and b is the size of the square specimen in mm. The data were represented as mean  $\pm$  standard deviation. One-way analysis of variance (ANOVA) was used to compare means between groups.

### RESULTS

The mean compressive strengths of all the groups after 1, 24 hours, and 7 days are listed in Table 2.

There was a significant difference between all the three restorative materials. The ANOVA showed that the mean compressive strength of Filtek Z 250 after 1 hour was higher (368.50) than Filtek Z 350 (271.50) and RMGIC (251.80). The mean compressive strength of Filtek Z 250 after 24 hours

was higher (392.70) than Filtek Z 350 (277.80) and RMGIC (259.70) ( $p < 0.05$ ). The mean compressive strengths were reduced after 7 days in all the three groups, but after 7 days, the values of Filtek Z 250 (232.90), when compared with the Z 350 (87.80) and RMGIC (67.30), were higher.

### DISCUSSION

Compressive stress testing is used for evaluation of the mechanical properties of restorative materials. Since most of the masticatory forces fall into the category of compressive forces, assessment of the durability of restorative materials in such conditions is of great importance. Progresses made in the field of nanotechnology have greatly impacted the composition of composite resins. Compressive strength is one of the most important mechanical properties of posterior restorative material. It should have the same mechanical properties as tooth structure. A material with a higher or lower amount of a property must adversely affect the longevity of the restoration and the tooth structure, and premature failure of each will happen. The results of this study revealed that the compressive strengths of all the composites resins increased with time from 1 to 24 hours.<sup>9-12</sup> It seems that the compressive strength is related to the type of composite resin. Z 250 had the highest compressive strength at all the times. The results show that volumetric percentage

**Table 2:** Mean compressive strengths of all the groups after 1, 24 hours, and 7 days

Sl. no.	Groups	Time period			p-value
		1 hour (mean $\pm$ SD)	24 hours (mean $\pm$ SD)	7 days (mean $\pm$ SD)	
1	Filtek Z 250	364 $\pm$ 3.72	384.88 $\pm$ 7.33	229.35 $\pm$ 2.65	<0.0001
2	Filtek Z 350	266.55 $\pm$ 3.60	274 $\pm$ 3.75	85.68 $\pm$ 1.92	<0.0001
3	Resin-modified glass ionomer cement	246.52 $\pm$ 6.62	256.40 $\pm$ 3.44	65.88 $\pm$ 0.79	<0.0001

SD: Standard deviation

of fillers in these composite resins is not the only factor to affect the compressive strength.

Composite resins with almost the same filler content did not have the same compressive strength. It seems that there are other factors, such as degree of conversion, filler matrix bond, type of polymerization, polymerization shrinkage, and many other factors which affect the mechanical properties of composite resins. The polymerization pattern of composite resin is important for mechanical properties too. Patterns are not only associated with the volumetric or linear shrinkage of the materials. They are also related to the material capacity to flow during the initial polymerization stage and its flexibility in the later polymerization stage where the composite starts presenting a solid-material characteristic.

But even after 24 hours, neither of the two composites nor RMGIC reached the amount of compressive strength of the tooth, which is 384 MPa for enamel and 297 MPa for dentin. After 7 days, when all three materials had been compared, the compressive strength of Filtek Z 250 was higher and nearer to the compressive strength of the tooth structure. Hence, this difference in result may be due to the differences in chemical ingredients of the materials and the operator's variability, such as packing of material inside the mold using incremental technique and polymerization shrinkage.

## CONCLUSION

Within the limitation of the study, the compressive strength of hybrid composite resins (Z 250) was significantly higher than that of nanocomposites (Z 350) and

RMGIC. Hybrid composite resins will be a good treatment option in cases where posterior restorative materials with increased strength are required.

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