

## Effect of two different bleaching techniques on fracture toughness of two bulk fill composite materials: an in vitro study

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### ABSTRACT

#### Aim

The aim of this study is to evaluate the effect of two different bleaching techniques on fracture toughness of two bulk fill composite materials.

#### Materials and Methods

Seventy two disks shaped specimens (10mm x 4 mm) of two bulk-fill resin composites: FiltekBulkFill Posterior (3M ESPE, St. PAUL, MN, USA) and Tetric N-Ceram Bulk Fill (IvoclarVivadent, Schaan, Liechtenstein) each group contains 36 samples were used. Fracture toughness was evaluated after the application of both bleaching protocols. In-office bleaching opalescence boost 40% (hydrogen peroxide) and home bleaching opalescence 20% (carbamide peroxide). Data collected were analyzed using the Statistical Package for the Social Sciences (Version 23.0, SPSS, Chicago, IL, USA).

#### Results

There was no statistically significant difference in fracture toughness between office bleaching (hydrogen Peroxide) and home bleaching (carbamide peroxide)( $p > 0.05$ ). Fracture toughness was not affected after bleaching (at home or in office).

#### Conclusions

Filtek had a significantly higher fracture toughness value than the Tetric N-Ceram. Bleaching had a significant effect in increasing the fracture toughness value on Filtek Supreme Plus but not on the Tetric N-ceram. The practice of bleaching after placement of the composite restoration does not compromise the fracture toughness of the resin composites tested.

### INTRODUCTION

In the last couple of decades, the concern of white teeth has been increased and teeth bleaching has been considered the most applicable and cost-effective modality of treatment for teeth or tooth discoloration. Research has shown that the outcome of bleaching on the vital and non-vital teeth is successful if it has done under controlled conditions. Different bleaching modalities have proved to be safe on hard dental tissues.<sup>1</sup> Moreover, macroscopic and clinically visible alterations due to bleaching procedure have not been documented.<sup>2</sup> Studies have been documented some microscopic

alterations to hard dental tissue in histology and chemical composition with significant decrease in surface microhardness due to the use of either hydrogen peroxide or carbamide peroxide for teeth bleaching.<sup>3</sup>

Composite resins are being widely used over the years due to their superior esthetic properties, and the continuous improvement of their physical and mechanical properties.<sup>4</sup> Some of the physical properties of the restorative materials such as microhardness, flexural strength, and fracture toughness could affect the quality and durability as well as the longevity of restorations. The mechanical properties shows that fracture toughness is considered to be a reliable indicator of the ability of dental

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materials to resist failure under load.<sup>5</sup>

Fracture toughness is the measure of a material's ability to resist crack propagation. It is considered to be a reliable indicator of the ability of dental materials to resist failure under load.<sup>6</sup>Bonilla et al. assessed the fracture toughness of different resin composites, glass ionomers, and amalgam. The fracture toughness of titanium-reinforced resin composite, resin core with fluoride, and spherical amalgam alloys showed comparable fracture toughness values. They concluded that, with the exception of the glass ionomer core materials, all were able to withstand occlusal loads when used as a core material.<sup>7</sup>

In another study Bonilla et al. used the same method and found a packable resin and a universal resin showed the highest fracture toughness values. On the other hand, other packable resin composites were found to range in the mid-range with the other universal resin composites. The microfilled resin composite and the microhybrid composite had the lowest fracture toughness values of all the resin composites included.<sup>8</sup>The aim of this in vitro study is to evaluate the effect of two different bleaching techniques on fracture toughness of two bulk fill composite materials.

### Methods

Seventy two disks shaped specimens (10mm x 4 mm) of two bulk-fill resin composites: FiltekBulkFill Posterior (3M ESPE, St. PAUL, MN, USA) and Tetric N-Ceram Bulk Fill (IvoclarVivadent, Schaan, Liechtenstein) each group contains 36 samples were used. For the baseline control reading (no bleaching) was used. The A1 or equivalent shade was selected for each composite resin cured using Elipar deep cure-S LED single wave (3M ESPE, St. Paul, MN, USA) and Sapphire plasma arc light (Lompoc, USA) at 1mm distance. Fracture toughness was evaluated after the application of both bleaching protocols. In-office bleaching opalescence boost 40% (hydrogen peroxide) two sets of application each one for 20 minutes separately and home bleaching opalescence 20% (carbamide peroxide) for two weeks and 4 hours/day for the first week every day, then the next week

was be day on day off .

Twenty four disks shaped specimens of Tetric N-Ceram bulk fill composite with two different kind of bleaching, as well as twenty four Filtek bulk fill posterior with the two different kind of bleaching. In addition, twenty four two different kind of the bulk fill (control) without any kind of bleaching.

A special custom fabricated mold (10 mm in diameter and 4 mm depth) was used. Materials were placed in 4 mm bulk in the mold over the glass slab. After the materials were inserted into the mold, a glass plate with 1mm thickness was secured over it to be flattened surface.

Polymerization was carried out following the manufacturer's recommendation. The tip of the curing light was placed at 1 mm distance from the top surface of the specimens. Subsequently, specimens were stored in water for 24 hours at 37°C in a dark chamber. The composite discs were polished with polishing discs (Sof-Lex, 3M ESPE, USA).<sup>2</sup>

All the specimens were subjected to compressive loading with a crosshead speed of 3 mm/min in an Instron universal testing machine (Zwick, Germany) using a steel bar (4.5 mm in diameter) which was placed central to top surface of the disks. Load was applied until failure and the force at which the disks fractured. The results were recorded in Newton as the fracture resistance. Failure mode of each of the specimens was evaluated under a stereomicroscope  $\times 10$ .

The recommended sample size for each group was twelve with a sample power of 0.9. Data collected were analyzed using the Statistical Package for the Social Sciences (Version 23.0, SPSS, Chicago, IL, USA). All p-values  $\leq 0.05$  were considered statistically significant.

### Results

Two bulk fill materials Filtek bulk fill posterior and Tetric N-Ceram bulk fill were tested in this study under two different bleaching regimes (home bleaching and office bleaching). The mean (standard deviation) in HV/0.54 for Filtek bulk fill were 2016.90 (229.66), 2104.51 (223.50), and 2095.22 (205.71) for control, home bleaching, and office

bleaching groups respectively (Figure 1 and Table 1). On the other hand, the mean (standard deviation) in HV/0.54 for Tetric N-Ceram bulk fill were 1677.99 (174.57), 1697.18(153.04), and 1733.20(130.86) for control, home bleaching, and office bleaching groups respectively (Figure 2 and Table 2). There was no statistically significant difference in fracture toughness between office bleaching (hydrogen Peroxide) and home bleaching (carbamide peroxide). Fracture toughness was not affected after bleaching(at home or in office).

### Discussion

Tooth whitening is a widespread esthetic dental treatment. However, there are still concerns about the different side effects and various investigations into the probable effects of bleaching agent to cause morphological changes in enamel and the fracture toughness is one of them. It can also cause reduction of young's modulus, hardness, and 'fracture toughness' $K^{(IC)}$  after bleaching with 38% of hydrogen peroxide due to its undermining effect on nano-mechanical properties of teeth and the acidity of hydrogen peroxide is responsible for the morphological changes and demineralization accompanied with organic matter damage is the reason behind the loss of microhardness of teeth.<sup>9</sup>

Bulk fill composites are newly introduced composite resins that promise dentists faster results optimum function and esthetics. However, in 2019 Leprince et al. concluded that due to the reduction of time and improvement of convenience associated with bulk-fill materials, their mechanical properties were compromised when compared with more conventional commercially-available nano-hybrid composite resins.<sup>10</sup>

In the current study, we evaluated the effect of polymerization time of in office and at home bleaching techniques on the fracture toughness of two bulk-fill composites (Filtek and Tetric N-Ceram). Control groups of Filtek showed significantly higher fracture toughness values in comparison with the Tetric N-Ceram. Fracture toughness of Filtek have showed no significant differences between control group, home bleaching and office bleaching, so did the Tetric N-Ceram. Post

bleaching whether at home or in office, there were no statistically significant changes on fracture toughness between them. However, in the Feltiktest group higher values were observed. The most significant improvement in fracture toughness values was seen when bleached with in office bleaching on Filtek, but it was much lower in Tetric N-ceram.

Cho et al. have observed that Esthet-X composites post exposure to 35% hydrogen peroxide had increased fracture toughness, although Permase had lower fracture toughness. With the 45% hydrogen peroxide bleaching concentration, ESX Esthet-X had significantly higher fracture toughness values than that of the other composites tested. However, with the 20% bleaching concentration, there were no significant differences among the composites. Similar effect reflected in the results of the current study the Filtek supreme groups showed a significant increase in fracture toughness values after bleaching when compared with the Tetric N-ceram group.

### Conclusion

Of the nano filled resin composites included in the current study, Feltik had a significantly higher fracture toughness value than the Tetric N-Ceram. Bleaching had a significant effect in increasing the fracture toughness value on Filtek Supreme Plus but not on the Tetric N-ceram. The practice of bleaching after placement of the composite restoration does not compromise the fracture toughness of the resin composites tested. Within the limitations of our study, we recommend that further studies should be done focusing on these two bulk fill materials (Filtek and Tetric N-Ceram) to investigate their mechanical properties. Moreover, sample size should be increased to get more reliable results.

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