



# Effect of direct peroxide bleach application to bovine dentin on flexural strength and modulus *in vitro*<sup>☆</sup>

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## KEYWORDS

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**Summary Objectives.** The objective of this study was to determine the effects of carbamide peroxide (CP) and hydrogen peroxide (HP) bleaching on the flexural strength (FS) and flexural modulus (FM) of dentin.

**Methods.** 2×2×20 mm bovine dentin specimens were immersed in the bleaching agents to simulate overnight (10 or 15% CP, 6 h daily, 2 weeks), exaggerated overnight (10% CP, 6 h/day, 5 days/week, 2 months), daytime (6.5 or 7.5% HP, 1 h daily, 3 weeks) and in-office (35% HP, 1 h/day, 2 days/week, 3 weeks) treatment protocols. Distilled water (DW) and a placebo gel acted as control immersion materials. After immersion, the specimens were rinsed and stored in DW. Mechanical testing was performed 24 h after the last treatment using an Instron Universal Testing Machine with a crosshead speed of 0.75 mm/min. The results were analyzed by ANOVA and Tukey's tests ( $p < 0.05$ ).

**Results.** There were significant reductions in the FS and FM of dentin after 2-week and 2-month exposures to CP. There were no significant differences in the FS or the FM of the dentin among the HP treatment and control groups.

**Conclusions.** Direct *in vitro* application of CP bleaches caused significant decreases in dentin FS and FM. Similar decreases were not observed among the HP-treated dentin groups, which were exposed to shorter treatment times. Further research is needed to determine the effect of CP and HP on dentin *in vivo*.

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## Introduction

Successful vital bleaching requires good whitening efficacy without tooth damage. Scanning electron microscopy (SEM) studies of the bleached enamel are equivocal with regard to surface morphology changes. Some SEM studies have shown no changes in the enamel morphology, but others have demonstrated increased surface porosity or roughness.<sup>1-7</sup>

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A fracture toughness assessment on the enamel surface, hardness assessments and abrasion studies on enamel imply further possible surface enamel changes that could occur as a result of bleaching.<sup>8-13</sup> The clinical significance of the reported enamel surface changes, however, is considered to be minimal and such effects may be reversed after the cessation of bleaching.<sup>1,7</sup>

Fewer studies have evaluated the biomechanical properties of the tooth beyond the enamel surface. The mechanical properties of dentin are of significant interest because dentin provides the base for both enamel and cementum and is largely responsible for the structural integrity of the entire tooth. Slight changes in surface morphology and hardness have been identified in dentin after bleaching.<sup>10,14</sup> Significant decreases in the ultimate tensile and micropunch shear strength of dentin were reported after an intracoronal bleach application of 30% hydrogen peroxide (HP).<sup>15</sup> This led the authors to conclude that the 30% HP bleach could weaken dentin enough to cause the tooth to fracture in function when there is extensive tooth structure loss. It is unknown whether this reported decrease in dentin mechanical properties is relevant to patient-applied bleaching techniques that use lower HP concentrations or carbamide peroxide (CP).

The patient-applied bleaching treatment protocol generally involves the application of a 10% CP (or HP equivalent) product by the patient to the surfaces of the teeth for several hours daily over several weeks. There has been a recent increase in the number of products available which contain a higher concentration of CP. Furthermore, it has been recommended that tetracycline-stained teeth should be bleached for a period of months as opposed to weeks.<sup>16-18</sup> The availability of over-the-counter bleach products increases the opportunity

for patients to bleach their teeth in an unsupervised manner for a protracted period of time. The safety and efficacy of higher concentration CP products or the prolonged use of bleaching products have not been fully evaluated. It is important to determine the physical effects of normal bleaching regimens and of prolonged or higher concentration peroxide bleaching treatments on bulk tooth structure.

The objective of this study is to determine the effects of CP and HP bleaching on the flexural strength (FS) and flexural modulus (FM) of dentin. The null hypothesis for this study is CP and HP materials have no effect on the FS and FM of dentin.

## Materials and methods

Dentin rectangular beams measuring 20 mm in length by 2 mm in width by 2 mm height were cut from the roots of previously frozen extracted bovine incisors. The thickest aspects of each root were selected for specimen preparation. The depth of the dentin in every specimen ranged from deep to superficial because the 2 mm by 2 mm thick specimen section utilized the bulk of the dentin circumferential to the canal space. The length of each specimen section ran parallel to the long axis of the root. A single root usually provided one or two dentin specimens. The mean height and width of the specimens were measured using a digital micrometer to an accuracy of 0.01 mm at three locations along the specimen length. The specimens were randomly divided into treatment groups ( $n=8$ ) and subjected to immersion in bleach or control treatments (minimum one millimeter of gel or liquid surrounding the specimen) as outlined in Tables 1 and 2. To simulate an overnight wear

**Table 1** Materials used for the carbamide peroxide treatment groups.

CP treatment group ( $n=8$ )	Bleach product/manufacturer	Treatment period	Immersion time (h/day)
Distilled water	-	2 weeks (daily)	6
Placebo gel	Ultradent Products Inc., South Jordan, UT, 84095	2 weeks (daily)	6
10% Carbamide peroxide	Opalescence/Ultradent Products Inc.	2 weeks (daily)	6
15% Carbamide peroxide	Opalescence/Ultradent Products Inc.	2 weeks (daily)	6
Distilled water	-	2 months (5 days/week)	6
Placebo gel	Opalescence/Ultradent Products Inc.	2 months (5 days/week)	6
10% Carbamide peroxide	Opalescence/Ultradent Products Inc.	2 months (5 days/week)	6

The immersion protocols are provided for the simulated overnight (2-week) and exaggerated overnight (2-month) treatments.

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