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COMMENTARY

FLEXURAL STRENGTH AND MODULUS PROPERTIES OF CARBAMIDE PEROXIDE-TREATED BOVINE DENTIN

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Tam and colleagues deserve special credit for trying to sort out some of the potential problems of bleaching regimes on the structural integrity of tooth structure. This study is well-organized, diligent in including appropriate controls, and carefully conducted. That said, it also begs a couple of other unresolved questions that should be emphasized: (1) What is the best model for testing undesirable bleaching effects on tooth structure? (2) What is the best laboratory test for detecting these changes?

Dentin is a wonderfully complex and resilient tissue often distinguished from enamel as being connected to the pulp through odontoblastic processes. As such, it is capable of responding to challenges by remodeling itself. In a practical sense, this means that structural problems that arise during function or exposure to challenges such as bleaching might be repaired. That is good. Since we do not understand the way that might happen or how fast it might happen, one might be tempted to overreact to any negative changes that arise in laboratory tests that would not include considerations of actual physiologic recovery.

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When choosing a technique for detecting small effects, it is often much easier to test conditions that are well below and well above the actual clinical conditions so that you can reveal the actual trend. For example, if you are trying to detect the difference between conditions at 23°C and 37°C, it is often easier to measure conditions at 10°, 20°, 30°, 40°, and 50°C so that you can define the temperature relationship more discretely and then report the differences with much more confidence. This is true of all concentration-time studies as well. To understand bleaching effects, it might be more useful to look at low, medium, and high concentrations or short, long, and very long times of exposure. Another advantage of testing extremes is that it increases your confidence about insignificant changes since you can then state that you tested extreme conditions.

No one really has demonstrated the actual molecular mechanism of interaction of bleaching materials with components of dentin that produce the color change. However, it seems plausible that it is related to the diffusion of the reactive components through enamel and into dentin. Different authors hypothesize potential reactions with collagen and/or hydroxyapatite. There is some potential confusion here. Hydroxyapatite molecules exist between the ends of the fibrils in collagen fibers (within collagen), but this is a very small contribution to the overall hydroxyapatite content of dentin. Most hydroxyapatite exists as crystals that are dispersed between the collagen fibers and are considered a separate phase. When authors talk about affecting hydroxyapatite, it is crucial to carefully define the actual proposed target.

Ideal laboratory models for testing clinical situations are static tests that have good predictability for actual dynamic events and that are easy to conduct. They do not have to be perfect replicas of the clinical situation. The authors of the current study have selected a good first approximation of such a test. They chose a single material to test, an acceptable storage or test solution, and a property to test as an indicator of any change. But consider that last part in a little bit more detail.

Generally, mechanical properties of any system or structure can be related to the rule of mixtures and the interactions of the various phases involved. Dentin by volume is 47% hydroxyapatite (in between collagen fibers), 27% collagen, 21% water, and 5% noncollagenous proteins.[1] During laboratory experiments, it is hard to ensure that there is no loss of noncollagenous proteins during storage in water solutions. During diffusion experiments, the water content may change as well. Small changes in water content would be totally sufficient to affect the flexural strength and modulus of specimens. Several research teams have demonstrated ample evidence of these effects.[2–6]

Another interpretation of the current results of Tam and colleagues is that small changes occurring between some control (DW) and test (CP) specimens within test groups are really only minor differences and may simply reflect small water content differences. What is more important to focus on is the change among groups (1, 2, 3, and 4) owing to treatment differences (dentin, enamel + dentin, dentin + saliva, dentin + NaF + saliva). Although artificial saliva and/or NaF may be hypothesized to have reparative effects for dentin, they may also cause concentration differences that lead to water exchanges in dentin. If the water content changes (and we do not know at this point whether the effect is due to gain or loss of water), then the mechanical properties could change. As the authors have demonstrated with their careful controls (CP vs DW), the intragroup differences are consistently small or nonexistent. Thus, one might argue that real differences among all the groups (all CP or all DW groups) could be explained simply by the differences in water content of the dentin. This certainly deserves further investigation.

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