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In Vitro Evaluation of ZerofloX™ an Innovative Applicator Brush

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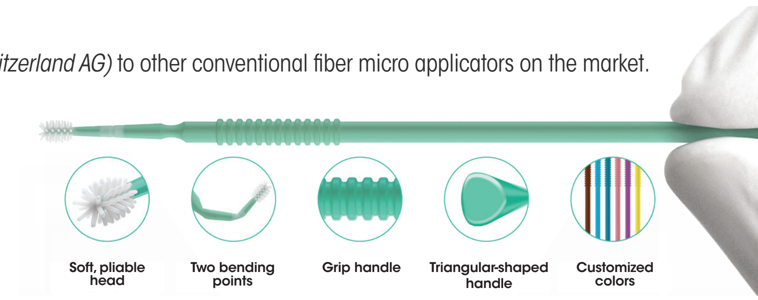
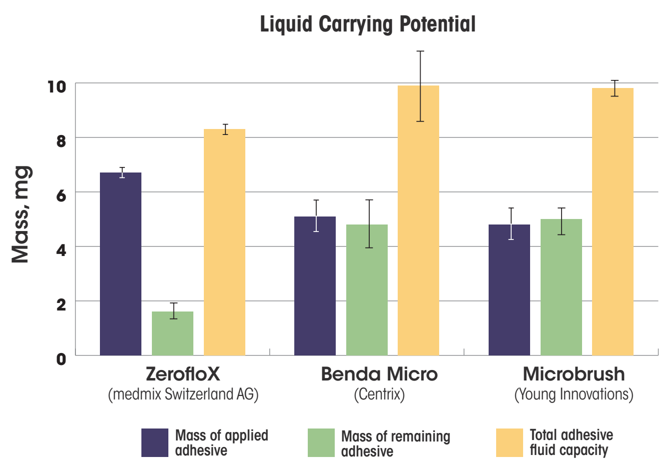
INTRODUCTION:

In this study we compared a new disposable applicator brush, ***ZerofloX™** (medmix Switzerland AG)* to other conventional fiber micro applicators on the market. ***ZerofloX*** differs from other applicators on the market by using fiber-free elastomer bristles rather than the common fiber flocking with most applicator brushes. This change may allow less loss of adhesively-fixed fiber flocks, which could remain in the final restoration as debris. The ***ZerofloX*** may also provide more consistent performance by having the same uniform shape for every brush compared to other applicators which may vary in the exact number of fibers and shape of the brush. To test these claims, we examined the liquid carrying potential of the brushes, how much the comparable fiber applicators shed bristles, and then tested the bonding performance of the brush to ensure it has no problems during use.



Liquid Carrying Potential

To measure the extent that the applicator brushes adsorb liquid adhesive onto the surface, the brushes were weighed before and after being dipped into an excess of ***iBond Universal** (Kulzer)**,*** and then spread onto a large flat tooth preparation and reweighed. The tooth preparation was cleaned and reused for all test replications for consistency. This allowed us to measure how much liquid it picked up, placed, and remained on the brush. Interestingly, the ***ZerofloX*** adsorbed less overall liquid but then applied nearly all of that liquid onto the surface, compared to the fiber brushes which still retained approximately half of the liquid rather than applying it. The ***ZerofloX*** also had more consistent measurements for every replication due to the variable nature of exactly how many fibers are on the microbrushes compared to the consistent shape of the ***ZerofloX***. The end result is that the ***ZerofloX*** is more efficient by wasting less adhesive that is left on the brush after application, and a more predicable vehicle for moving adhesive from a mixing well and applying it to a surface. This would allow less adhesive required to be dispensed into a mixing well for small tooth preparations, or more precise application to multiple preparation sites.



Fiber Applicator Shedding

One of the primary reasons that ***ZerofloX*** was invented was to eliminate the loss of adhesively-fixed fiber flocks on the tooth preparation/surface. We measured the extent that fiber microbrushes tend to shed fibers during application by wetting them in a solvent common to adhesives and rubbing them on a glass slide for 20 seconds to simulate an adhesive application in a bonding procedure. We found that on average, the ***Microbrush** (Young Innovations)* shed an average of 3.5 bristles per application and the ***Benda Micro** (Centrix)* brush shed 4.2 bristles with a maximum of 6 bristles lost with either brush. The potential concern with bristles being shed onto prepared surfaces is that it can create a weak spot in the adhesive interface which may serve as the initiation site for debonding; or it can be carried by the solvent toward the margins increasing the chance for microleakage or unesthetic fibers showing on the surface which may appear as a defect at the margin. Overall, this may not be a major contributing factor for restorative failure, but this is difficult to study and hasn't been assessed to our knowledge.

Fig 1. Example of bristles on microscope slide

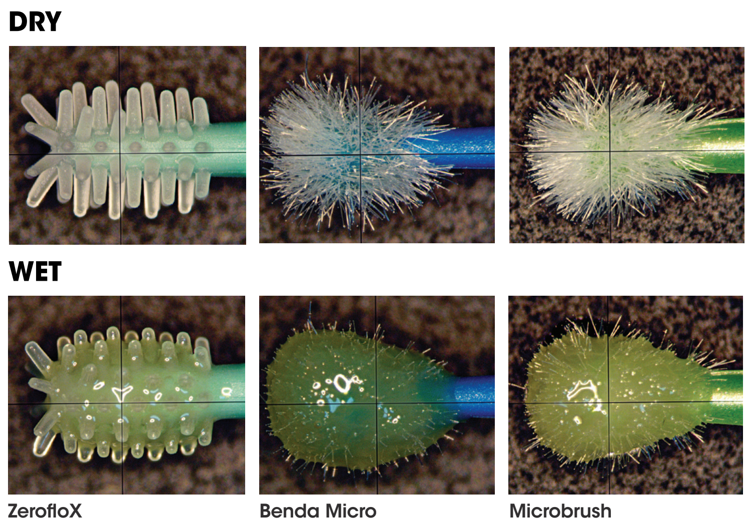
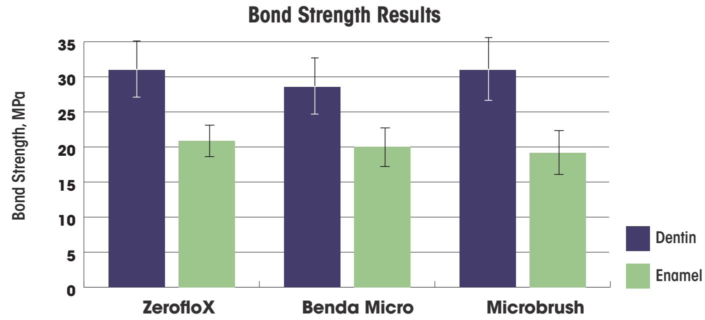


Fig 2. Brushes shown before and after immersion in ***iBond Universal***

Bond Strength Performance

Given this is a new kind of brush with different adsorption characteristics to other common brushes, we thought it would be a good idea to test the bonding performance compared to the other fiber brushes tested. We used the common Ultradent shear bond strength method (ISO 29022) to both measure the bond strength and look at the bonding interface for appearance of voids or abnormalities on dentin and enamel surfaces. Overall, there was no significant difference in the bonding performance in terms of bond strength or failure mode between the different groups. We did find a few fibers in the bonding interface of the test specimens for the fiber applicator groups, and those specimens had a lower bond strength than the average for those groups. However, fibers were only found in the bonding interface of 4/40 total specimens due to the large area being applied (~78.5 mm^2) compared to the relatively small specimen sizes (4.5 mm^2); examination of the unbonded adhesive on the surface confirmed fibers were shed during application. While the presence of the fibers didn't particularly affect the overall average bond strength values due to the small sample size, it serves as proof of concept that the fiber at the interface may create a weak point in the bonding interface.



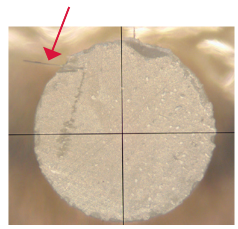


Fig 3. Example of a fiber found at the bonding interface

Pit and Fissure Application

We also examined the ability of the ***ZerofloX*** to be used for their indications of applying flowable composites such as in pit and fissure restorations, either as a means of pushing flowable into crevices or removing excess. We then sectioned the specimens and examined the margins using a Scanning Electron Microscope to see if any defects were detected.

In one test group, we treated teeth for sealant placement with ***Fit SA*** (Shofu USA), a self-adhesive light-cured composite, by cleaning and etching the surfaces with 37% phosphoric acid followed by placement and modification by the brushes.

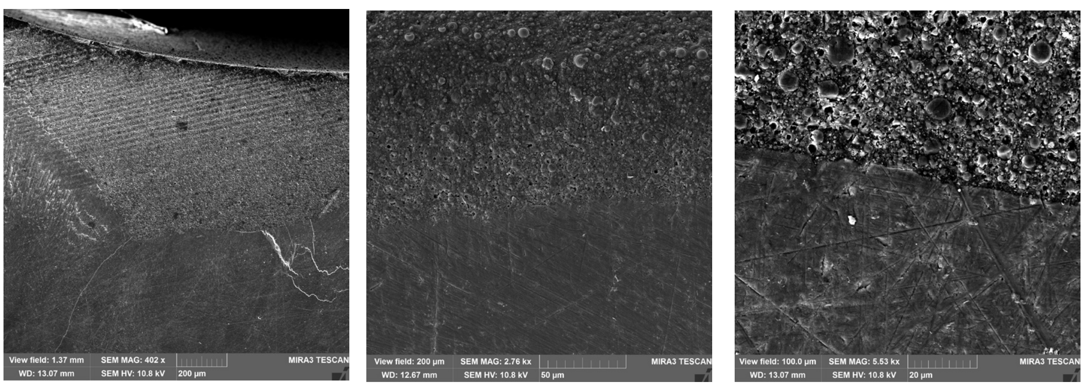


Fig 4. Representative examples of the margins of ***Fit SA*** applied with ***ZerofloX***

Results

There was no significant differences found between the ***ZerofloX*** groups and the ***Microbrush*** group in the number of voids, or thickness of the bonding layer. Excellent marginal adaptation was achieved with use of the ***ZerofloX*** applicator with these flowable composites and adhesives.

In another case, we treated teeth with surface caries by minimally preparing the teeth with a diamond bur and treated the teeth with ***3M Scotchbond Universal Plus*** and ***3M Filtek Supreme Flowable Restorative***.

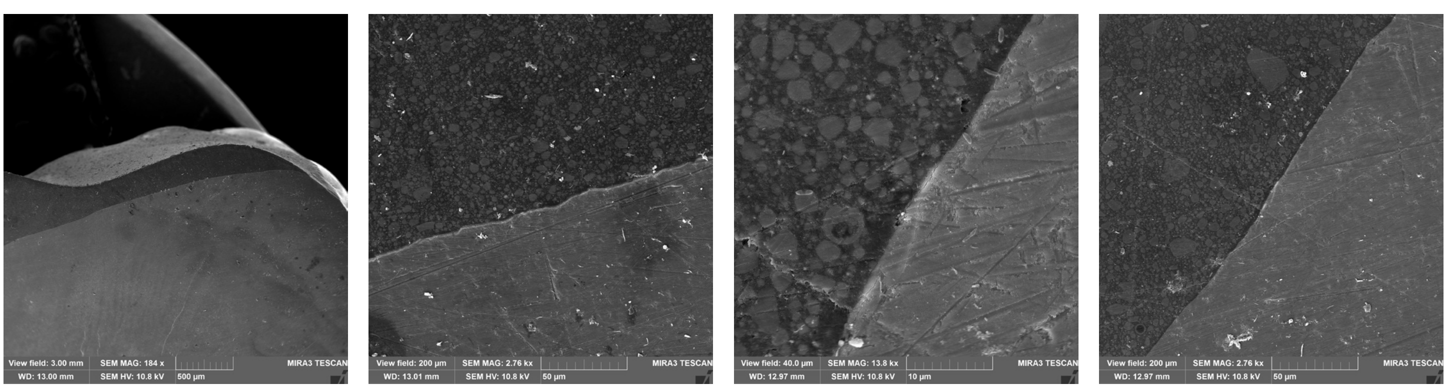


Fig 5. Representative examples of the margins of ***3M Scotchbond Universal Plus*** and ***3M Filtek Supreme Flowable Restorative*** an applied with ***ZerofloX***

