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Short communication

Presence of microbrush remnants on the adhesion surface: A microscopical analysis

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ABSTRACT

Objectives: the aim of this *ex vivo* report was to evaluate, on a microscopical analysis, the presence of microbrush remnants on ~~in~~ the adhesive surface in extracted teeth.
Methods: Twenty extracted teeth were divided into four groups. Half of the teeth were prepared as Class I cavities, whereas the other half as Class II cavities, according to Black classification. The teeth were conditioned with primer and bonding, both applied with microbrushes. Each of these groups was divided into halves, and the two sub-groups received a polymerization process or not, respectively. The teeth were then analyzed by scanning electron microscopy working in environmental mode.
Results: All of the analyzed surfaces (100%) showed the presence of residual bristles on the adhesion surface.
Conclusions: Microscopical analysis showed the presence of residual bristles in the 100% of the surfaces treated with Black Classes I and II cavities. Further studies are necessary to evaluate the influence of this factor on the adhesion strength and capacity.
Clinical Significance: Clinician should be aware of the realistic possibility of the presence of bristles belonging to disposable applicators in the adhesive interface of Black's class I and II cavities. The impact of these remnants has still to be ascertained.

1. Introduction

In the last decades, adhesive dentistry has undergone great progress. This approach promotes a conservative cavity design, basing its strength on the effectiveness of enamel-dentine adhesives, which is a strongly operator-dependent procedure [1], because of its several passages and great number of protocols [2–4].

The two (or single) components of the adhesive system can be applied using different devices, such as cotton pellets, tissue papers or disposable brushes. Previous studies [5,6] showed that the use of a microbrush as a carrier of the priming-adhesive solution is able to create a more uniform and micromechanically stable bonding mechanism than a standard brush for endodontic posts. These studies performed a microscopical analysis with Scanning Electron Microscopy (SEM), which investigated the presence of defects and adhesion alterations, but there are no studies in literature evaluating the presence of residual impurities on the adhesive surface. To confirm this trend, only few articles among the several analyzed by the authors, report the applicator brand. "Microbrush" is often preferred, meant as applicator with micro bristles.

The possible presence of any type of remnant (latex powder, microbrush bristles, impurities, etc.) may hamper the adhesive seal, mostly if present on the cervical margin.

2. Aim of the study

The aim of the present study was to evaluate the presence of impurities on the adhesive surface by an *ex vivo* SEM analysis.

3. Materials and methods

Twenty intact extracted molars were retrieved. All the dental elements were extracted for periodontal reasons and did not present any decay on their surfaces. Prior to extraction, patients were informed about the use of the molars for research purposes and written consent

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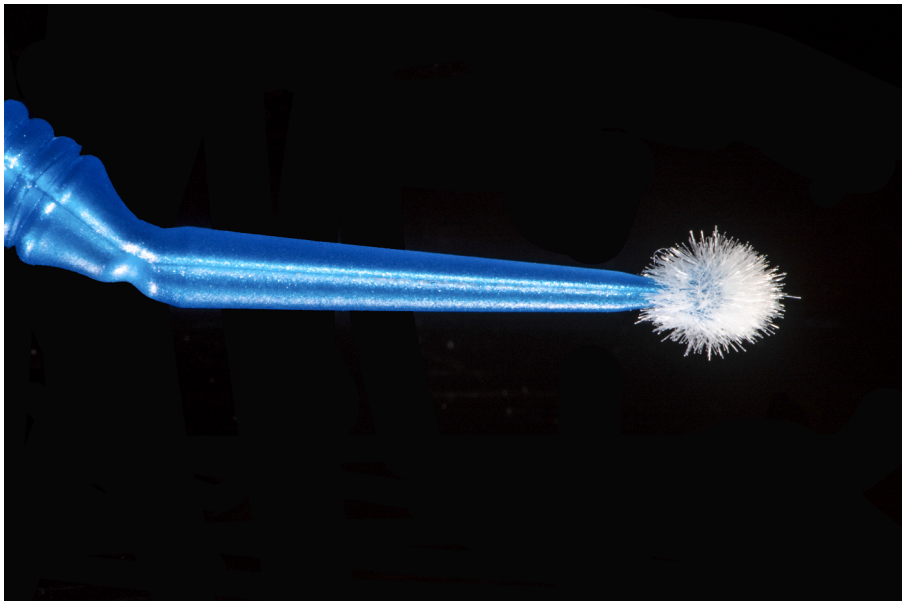

Fig. 1. Photography of the disposable applicator (Microbrush Tube Series Regular 2.0 mm, Blue, Microbrush International, Grafton, Massachusetts, USA) used for the application of the adhesive system.

was obtained. The study protocol was approved by the relevant Ethical Committee (C.E.U.R. Friuli-Venezia Giulia, Italy – n° 194/2019). Before preparation, the teeth were stored in sterile saline solution (NaCl 0.9% w/V) at 4 °C for a maximum of 30 days. Any macroscopic residual of calculus, staining or biological debris was removed with manual curettes.

3.1. Cavity preparation

The elements were divided into two groups and were prepared as Black Class I ($n = 10$) and Class II ($n = 10$) cavities. Cavities were prepared under copious irrigation with diamond and steel burs on low-speed handpieces (1:5 Red Ring and 1:1 Blue Ring) by a single operator (MZ) under 5x magnification. Cavities were carefully checked to eliminate sharp edges and obtain smooth margins.

Class I boxes were prepared following molar pits and fissures, with a depth of 3 mm, whilst class II cavities were prepared to obtain a 3 × 3 × 3 mm box on the interproximal surface.

3.2. Adhesive procedure

The prepared cavity was rinsed with sterile deionized water for ten seconds, then dried with gentle air blow. Each group (I and II) was then divided into two subgroups, according to the curing procedure, obtaining four subgroups: IA (class I cavity, one minute photo-polymerization); IIA (class II cavity, one minute photo-polymerization); IB (class I cavity, no photo-polymerization) and IIB (class II cavity, no photo-polymerization).

All the teeth underwent the application of a two-step self-etching system, using a primer agent (Clearfil SE Bond Primer, Kuraray Noritake, Tokyo, Japan) and a bonding agent (Clearfil SE Bond, Kuraray Noritake, Tokyo, Japan). Every agent was applied using a brand new disposable applicator (Microbrush Tube Series Regular 2.0 mm Blue, Microbrush International, Grafton, Massachusetts, USA) (Fig. 1). The primer was applied for 20 s and then gently dried; the bonding agent was then applied for one minute, following manufacturer's instruction. In IA and IIA group photo-polymerization was performed for one minute (Valo Led Cordless, Ultradent, South Jordan, Utah, USA).

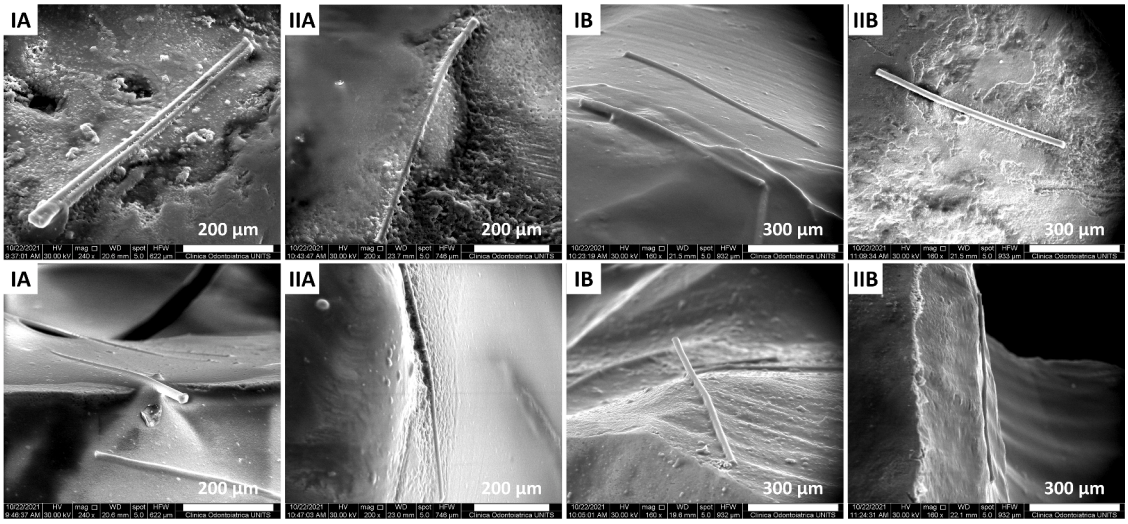

Fig. 2. Illustrative ESEM images of the samples: in columns, from left to right are depicted two examples per group IA, IIA, IB, IIB.

3.3. Microscopical analysis

Prior to microscopical analysis, all teeth were left under chemical hood for 72 h, under laminar flow at room temperature. Samples were then placed on aluminum stubs covered with double-side carbon tape, and observed using scanning electron microscope (Quanta250 SEM, FEI, Hillsboro, Oregon, USA) operating in environmental mode (ESEM), using an accelerating voltage of 30 kV.

4. Results

Microscopical analysis showed the presence of residual bristles ~~fibers~~ on the adhesive surface ~~interface~~ in 100% of the analyzed samples (at least one single bristle per sample) (Fig. 2). Polymerization seems not to influence the results.

5. Discussion

Surprisingly, no previous article ever reported the presence of applicator remnants. This can be explained by several hypotheses: i) SEM magnification for dental surfaces ranges between 500x and 5000x: any remnant can be missed or easily excluded from iconography, if detected as artifact or "foreign body" [7,8]; ii) dental surfaces may undergo different chemical processes as decalcification or acid treatment and replicas that can eliminate remnants [9,10]; iii) most of the recent restorative studies analyze adhesive interface more than adhesive surface, hampering the identification of possible bristle remnants and finally iv) an aphorism sometimes applied to the scientific research reads "What you find depends on what you are looking for. What you lose depends on what you neglect".

The use of disposable microbrushes for the application of bonding agents on teeth surface is widely spread. Literature has shown how, during the insertion of fiber posts, the use of microbrush creates a more uniform micromechanical bonding mechanism [5,6]. Nowadays, to the best of the authors knowledge, there are no studies analyzing the presence of residual brush bristles ~~fibers~~ on the adhesive surface of conservative or prosthetic restorations. This pilot *ex vivo* study showed how, after standardized application of bonding agents, microbrushes left remnants on the adhesive surface ~~interface~~. Several aspects could be affected by the presence of remnants such as adhesive forces, marginal seal integrity, formation of micro-gaps in the bonding layer, or alterations of polymerization process. Different applicators should have been tested. The reason why only Microbrush (Tube Series Regular 2.0 mm Blue, Microbrush International, Grafton, Massachusetts, USA) was tested resides in its widespread use. One of the most important worldwide healthcare companies declared that Microbrush represented the 76% of applicators sold in Italy in 2022 (report of the end of August 2022), corresponding to 211,000 packs out of 286,000 packs of sold applicators. Moreover, as abovementioned, most Authors report the generic term "microbrush" to define bonding applicator. Nonetheless, further studies are necessary for a systematic analysis of the possible impact of the presence of bristle ~~fiber~~ remnants and to determine the efficacy of different types of applicator. Finally, microbrushes are commonly used to distribute several types of adhesive systems in different procedures: endodontic posts, direct and indirect restorations and prosthetic rehabilitations. These all may be affected by bristle remnants and therefore deserve in-depth studies.

6. Conclusions

The present ESEM investigation showed that, in Black Class I and II cavities, the use of microbrush leaves bristle ~~fiber~~ remnants on the adhesive surface of all analyzed samples.

Further studies are necessary to evaluate the influence of these remnants in the adhesive interface on bonding strength.

CRediT authorship contribution statement

Federico Berton: Conceptualization, Methodology, Writing – original draft. **Antonio Rapani:** Software. **Matteo Zotti:** Methodology, Writing – original draft. **Claudio Stacchi:** Writing – review & editing, Supervision. **Tiziano Berton:** Conceptualization. **Davide Porrelli:** Resources, Visualization, Writing – review & editing.

Declaration of Competing Interest

All the Authors (Federico Berton, Antonio Rapani, Claudio Stacchi, Tiziano Berton and Davide Porrelli) confirm that this manuscript has not been published elsewhere, nor is it under consideration by another journal. The authors have no conflicts of interest to declare.

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