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Short communication

Selective masking for thin indirect restorations: Can the use of opaque resin affect the dentine bond strength of immediately sealed preparations?

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ABSTRACT

Purpose: Evaluate the dentine bond strength using different methods of application of opaque resins to mask dentine discoloration.
Materials and methods: Dentine was exposed on 21 extracted molars which were assigned to 3 groups: G1: immediate dentine sealing (IDS). G2: IDS + opaque. G3: IDS with adhesive resin mixed with opaque. After 1 week, teeth were restored and beams were fabricated for microtensile testing. Optical microscopy was used to analyse the failure mode.
Results: Bond strength mean values were statistically different: G1 55.20 MPa > G2 45.79 MPa > G3 18.96 MPa. Failure modes were mostly adhesive for G1 and G3. G2 presented mostly mixed failures.
Conclusion: The use of opaque resin to mask discoloured dentine results in a decrease of bond strength.

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1. Introduction/objectives

There has been an increased focus on dentine bonding agents in order to optimize their application techniques, understand their interaction with the dentine substrate, their possible antibacterial properties and degradation processes.[1–3] Exposure of dentine during the preparation for indirect bonded restorations presents additional challenges and requires the immediate dentine sealing (IDS) technique be applied prior to impression making.[7,10,11] Amongst the advantages of the IDS technique is: pulpal protection, improved dentine sealing and bond strength, and decreased postoperative sensitivity.[4–6,9,10] An additional aesthetic challenge is encountered in case of discoloured dentine under thin indirect veneer restorations. Such a situation requires selective intrinsic masking that can be applied to the restoration itself[8] (Fig. 1) or the use opaque resins onto the preparation, in

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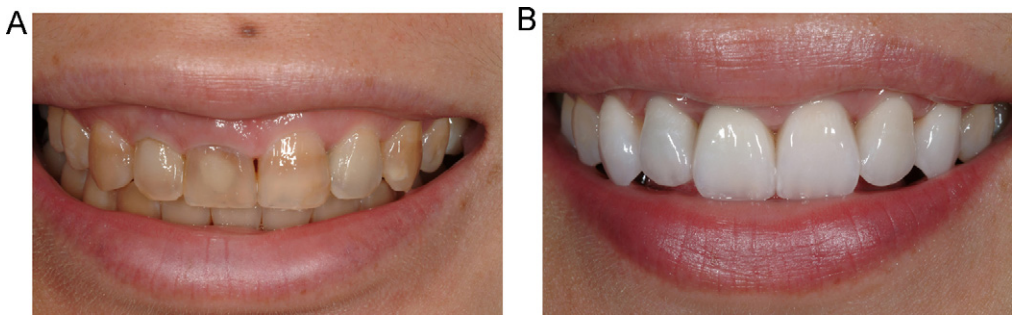

Fig. 1 – Clinical case before (A) and after (B) treatment using a combination of periodontal surgery, bleaching and porcelain veneers using the intrinsic selective masking technique.

Table 1 – Experimental groups.

Group	Treatment	Group name
1	Immediate dentine sealing (IDS)	Control
2	IDS + opaque resin	Separate layers
3	Etch + prime + adhesive resin mixed with opaque	Mixed layers

combination to IDS, before taking impression. However, the effect of the additional masking layer on the bond strength is not known. Therefore, the purpose of this study was to evaluate the dentine microtensile bond strength using different methods of application of opaque resins during IDS. This study tested the null hypothesis that no difference in bond strength would be found when using opaque resins on dentine.

2. Materials and methods

Twenty-one freshly extracted sound human molars were used. Flat mid-coronal dentine surfaces were created using a low–speed diamond saw (Isomet; Buehler Ltd., Lake Bluff, Ill). Any remaining enamel was removed by finishing with 600–1500-grit SiC paper (Gatorgrit; Ali Industries, Fairborn, OH) under water. The teeth were randomly assigned to 3 experimental groups (7 teeth each) which received different dentine treatments (Table 1).

In group 1 (IDS), a 3-step etch-rinse adhesive system (Optibond FL; Kerr, Orange, CA) was used according to the manufacturer's instructions.

In group 2 (separate layers), the dentine was sealed as in group 1. However, following light polymerization of the bonding agent, before application of the petroleum jelly, the dentine was covered with a single even layer of opaque resin (Kolor Plus A1 Opaque; Kerr, Orange, CA) and light-polymerized for 40 s at 600 mW/cm^2.

In group 3 (mixed layers), dentine was treated with 37.5% phosphoric acid for 15 s, followed by abundant rinsing, air drying for 5 s, application of primer with a light brushing motion for 20 s, and air drying for 5 s. A mixture of the adhesive resin (Optibond FL, bottle no. 2) and opaque resin (Kolor Plus A1 Opaque) was applied on dentine, with a gentle motion for 15 s and light-polymerized 40 s. The mixture ratio and application technique was pre-determined and standardized in a pilot study. To match precisely the amount of masking produced by the opaque resin in group 3, one microbrush load of adhesive resin and three microbrush loads of the opaque resin had to be used.

Polymerization of the last layer (adhesive or opaque resin) was always followed by the application of an air-blocking barrier (glycerin jelly) and 20 s of additional light exposure with the same light unit. The bonded surfaces were then isolated with vaseline. Teeth were restored with a provisional restoration material (Fermit; Ivoclar Vivadent; Liechtenstein), left in place for 1 week and immersed in distilled water. Following that delay, the provisional restoration was removed and the sealed dentine was cleaned by airborne-particle abrasion (Rondoflex; Kavo; Lake Zurich; IL and aluminium oxide 27 microns; Danville Materials; San Ramon; CA). One coat of adhesive resin was then applied and left unpolymerized until the application of the restorative material (Filtek restorative composite Z100; 3M-ESPE; St. Paul; MN) in three consecutive layers of 2 mm each which were light-polymerized for 20 s/each.

All restored specimens were stored in distilled water at room temperature for 24 h before testing. Preparation of the specimens and microtensile testing protocol are described elsewhere.[9] Eleven beams were prepared from each tooth. After testing, the failure mode of each beam was determined under stereoscopic microscope (×30). Failure was classified as: adhesive, mixed, cohesive in the dentine, or cohesive in the composite resin.

Bond strength data obtained from the 3 experimental groups were analysed with a Kruskal–Wallis test, with each tooth (mean microtensile bond strength from the 11 beams) used as a single measurement, yielding 7 measurements per group. Statistical significance was set in advance at the 0.05 level. Post hoc comparison was done using the Mann–Whitney *U*-test.

3. Results

All groups presented statistically different bond strength mean values ($P = 0.001$) (Table 2). Control IDS 55.20 MPa > separate layers 45.79 MPa > mixed layers 18.96 MPa. Failure modes indicated that most of failures were mixed for the

Table 2 – Microtensile bond strength mean values – MPa (n = 11/tooth) and failure mode for each group.

	IDS	Separate layers	Mixed layers
Mean	55.20[a]	45.79[b]	18.96[c]
Failure mode	90% adhesive	85% mixed	75% adhesive
	10% cohesive on dentine	15% adhesive	25% mixed

Mean values followed by the same superscript letter are not statistically different.

separate layers groups, whilst for control and mixed layers groups they were mostly adhesive failures.

4. Discussion/conclusions

Dentine bonding with a total-etch three-steps dentine bonding agent (DBA) is still the golden standard, reason for which it was used in this experiment. The clinical significance of this work is limited by the fact that only the early bond strength was measured and the experience was conducted in vitro. However, the present study is distinctive as there is no literature about the use of opaque resin and their effect on the performance of existing DBAs. The reason may be that skilled dental technicians usually take care of incorporating sufficient intrinsic opacity into the restoration (selective intrinsic masking by the restoration, Fig. 1).[8] Because opaque resins are usually unfilled and present limited mechanical properties, it is expected that they may affect the bond strength, and ultimately could influence negatively the long-term performance of the restoration. The main cause for the reduced bond strength, however, is more likely to be related to decrease of light intensity for polymerization because opaque resins intrinsically limit light penetration. As a result, insufficient light polymerization is to be expected, particularly at the bottom of the opaque layer in group 2. In the case of the mixed adhesive/opaque layer, it is also expected that the viscosity, hydrophilicity, and ability of infiltration to the etched dentine are modified, which adds to the problem of light penetration and explains the particularly poor bond strength obtained in group 3. The result of the present study is a confirmation that the IDS layer performs best when it is used alone and not covered with opaque resins, either as a separate layer or mixed to the adhesive resin. When indicated, opaque resin should be placed after IDS in a separate layer. Further research is needed to establish similar recommendations with other popular adhesive systems or systems including a dark cure initiator to resolve the problem of light penetration during polymerization.

The use of opaque resin during tooth preparation for indirect bonded restorations affects the dentine bond strength. When necessary, the use of a separate layer of opaque resin over IDS is recommended instead of mixing it with the adhesive resin.

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