Concept and clinical application of the resin-coating technique for indirect restorations

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The resin-coating technique is one of the successful bonding techniques used for the indirect restorations. The dentin surfaces exposed after cavity preparation are coated with a thin film of a coating material or a dentin bonding system combined with a flowable composite resin. Resin coating can minimize pulp irritation and improve the bond strength between a resin cement and tooth structures. The technique can also be applied to endodontically treated teeth, resulting in prevention of coronal leakage of the restorations. Application of a resin coating to root surface provides the additional benefit of preventing root caries in elderly patients. Therefore, the coating materials have the potential to reinforce sound tooth ("Super Tooth" formation), leading to preservation of maximum tooth structures.

Keywords: Resin-coating technique, Resin cement, Bonding to dentin, Indirect restoration, Acid-base resistant zone

INTRODUCTION

With the improvement of adhesive materials and their greater reliability, adhesive materials and technology have been accepted in the clinic and have revolutionized clinical procedures in dentistry, especially in operative dentistry, prosthodontics, and orthodontics. The resin-coating technique is a successful bonding technique used for indirect restorations. The clinical application of the resin-coating technique was proposed in the early 1990s by Japanese clinicians who were experts in adhesive dentistry. The dentin and enamel surfaces exposed after cavity preparation are coated with a thin film of a coating material or a dentin bonding system combined with a flowable composite resin. Magne *et al.*^{1,2)} reported a similar idea, immediate dentin sealing (IDS), to seal the exposed dentin using a coating material. However, IDS focuses only on the dentin surface but not on the enamel surface. In the resin-coating technique, the exposed enamel and dentin surfaces after preparation should be totally covered by the coating layer. The technique can be applied not only to vital teeth but also to non-vital teeth after endodontic treatment.

The adhesive resin coating applied to dentin surfaces provides protection for dentin and pulp³⁻⁵⁾ through the formation of a hybrid layer⁶⁾ because of the superior acid resistance of resin as compared to tooth substances.

Previous studies have demonstrated that the resin-coating technique improves resin cement-dentin bonding when restorative materials are subsequently placed on tooth crowns in an indirect restoration procedure⁷⁻¹⁰⁾. A resin coating applied to the exposed dentin surfaces has an additional advantage of significantly reducing pain caused by external physical stimuli because it seals dentinal tubules and, thus, remarkably decreases dentinal permeability¹¹⁻¹³⁾.

The concept and clinical applications of the resin-coating technique are reviewed in this paper using the previous literature.

PROTECTING AND FORTIFYING TOOTH SUBSTANCES

Leaving undercuts in the cavity after the removal of carious lesions is unacceptable with conventional indirect restorations, including inlays and onlays. Therefore, the undercuts are commonly eliminated by removing sound tooth structure. In contrast, the undercuts are filled with a flowable composite resin as a blockout procedure in the resin-coating technique, thereby avoiding excessive removal of tooth substances¹⁴⁾. Sound dentin exposed in the interior of a cavity needs to be blocked against external stimuli. It has been reported that adhesion between a self-adhesive resin cement and tooth substance is generally lower than the adhesion achieved by direct resin composite

Color figures can be viewed in the online issue, which is available at J-STAGE.

Received Jul 23, 2017; Accepted Aug 21, 2017

doi:10.4012/dmj.2017-253 JOI JST.JSTAGE/dmj/2017-253

Fig. 1 Morphological differences in three types of restorations after acid-base challenge.

(B: bonding resin, D: dentin, H: hybrid layer, R: Restorative material)¹⁵⁾

Left: Conventional restoration without an adhesive system; A wall lesion (white arrow) is created along the interface between a restorative material and the dentin, indicating the formation of secondary caries in the clinic. Center: Composite restoration with an acid etch adhesive system; A hybrid layer is created at the interface, which prevents the formation of secondary caries in the clinic. Right: Composite restoration with a self-etch adhesive system; A hybrid layer and the ABRZ are created at the interface. Formation of the ABRZ is beneficial to prevent secondary caries and also enhances dentin around the restoration from the acid attachment.

restorations⁷⁻¹⁰⁾. Consequently, the resin-coating technique is used to protect the dentin-pulp complex^{12,13)}. Additionally, the use of self-etching systems produces an acid-base resistant zone (ABRZ) immediately below the hybridized dentin (Fig. 1)¹⁵⁾, thereby not only providing a cariostatic effect on dentin but also reinforcing the tooth substance itself¹⁶⁾. Recently, an enamel ABRZ has also been recognized at the self-etch adhesive–enamel interface after acid-base challenge^{17,18)}. The ABRZ was formed following the application of some acidic monomers, especially phosphoric-acid ester methacrylates incorporated into a few self-etching dental adhesives^{17,19)}. We proposed that the diffusion of such acidic monomers beyond the classic hybrid layer and their ion-exchange interactions with the available hydroxyapatite could result in formation of stable organic-inorganic complexes, and that the structures should be termed “super tooth”, as they would in concept withstand major causes of dental caries and tissue degradation²⁰⁻²²⁾.

It is highly likely that the application of a coating that combines a bonding system with a flowable resin composite improves adhesion to dentin. The coating not only reduces pain in patients but also enhances resin cement-dentin bonding⁷⁾ as well as the peripheral sealing performance of restorations^{16,23)}.

SELECTION OF RESIN-COATING MATERIALS

The desired combination that will ensure optimal adhesion and polymerization with a resin-coating layer is one that combines a two-step self-etching system with a low-viscosity resin composite (Table 1)²⁴⁾.

On the other hand, it is also possible to use one-step self-etching systems or materials specifically for coating²⁵⁾; however, these may result in the unsuccessful formation of an even coating film unless a certain level of thickness is achieved. Hence, they may not exert a blocking effect against external stimuli or a powerful bond strength. Although the maximum thickness of the coating layer achievable by one-step adhesive systems is 15 μm , even if laminated with a coating material, it has been found that the adhesion of resin cements to dentin is markedly improved by dual application²⁶⁾ (Fig. 2).

CLINICAL PROCEDURE FOR THE RESIN-COATING TECHNIQUE

The procedures for applying a coating by a combination of a two-step self-etch system and a low-viscosity composite resin are illustrated in Fig. 3.

1) Cavity preparation

Characteristics of the smear layer created on the surface of tooth substances by bur cutting are affected by the type of bur used for the preparation²⁷⁾. Application of a coating material to the dentin surface prepared only by a coarse diamond point bur does not produce adequate bond strength because a coarse smear layer has been created on the bonding interface. The dentin surface should be finished as smoothly as possible using a steel round bur for removing caries and a fine diamond point finishing bur for preparing an abutment tooth.

Table 1 Materials used in the resin-coating technique

	Applicable materials	Features
Bonding systems +Flowable resins	Combination of an adhesive with a flowable resin composite A two-step self-etch adhesive system selected as the most reliable dentin bonding system A flowable composite resin selected for easy handling property	<ul style="list-style-type: none"> • High bond strength to dentin identical to that of a direct resin composite • Suitable for inlay cavity preparation • Thick coating layer unsuitable for crown restorations
Thin film coating materials	A one-step self-etch (all-in-one) adhesive and a thin coating material based on an all-in-one adhesive technology To create a thin coating layer by double coating of the material	<ul style="list-style-type: none"> • Bond strength lower than that of a two-step self-etch adhesive • A thin coating layer created (<15 µm) • Coating for abutment teeth for crowns

Fig. 2 Two strategies of the resin-coating technique for indirect restorations.

Left: A combination technique, including a dentin bonding system and a flowable resin composite, is recommended for indirect restorations, such as inlays and onlays. Right: Double coating technique of an all-in-one adhesive creates a thin coating layer for crown preparation.

Fig. 3 Clinical procedures of indirect restoration using the resin-coating technique.

2) Moisture control

Maximum moisture exclusion should be ensured by a rubber dam or an intraoral vacuum suction device. In an internal cavity after the application of self-etching primer, the solvent tends to collect in concave angles. Therefore, sufficient air blowing should be applied²⁸⁾.

3) Coating treatment

A bonding material and a low-viscosity composite resin, applied using a syringe applicator and a disposable applicator brush, are then adequately light cured.

4) Removal of excess resin

The low conversion layer on the resin-coated surface should be wiped and removed with an alcohol cotton swab. Overhangs projecting over the cavity margin should be removed using a

fine diamond point finishing bur, or something similar, to clearly distinguish the margin.

5) Provisional sealing

The prepared cavity should be temporized, not with resin-based filling materials but with a water-setting temporary sealing material. When fabricating a provisional restoration using autopolymerizing resin, it should be produced after applying a water-soluble separator to the interior of the cavity, and it should be temporarily placed using non-eugenol or polycarboxylate cement¹⁴⁾.

6) Placement of a restoration

The cavity and restoration should be pretreated individually in accordance with the method indicated by the manufacturer. The restoration should then be placed using self-adhesive resin cement.

Fig. 4 Application of the resin-coating technique to an endodontically treated tooth.

a: conventional cavity for metal core build-up, causing risk of coronal leakage; b: application of the resin-coating technique to protect coronal leakage.

Thus, the resin-coating technique is a very effective procedure in clinical settings for reinforcing dentin and protecting pulp¹⁴. The technique also helps protect against secondary caries because the dentin remains protected by the coating material should the restoration fall off⁽²⁹⁻³¹⁾. Thus, the resin-coating technique is efficacious for improving the long-term prognosis of restorative treatments, since it helps reduce the risk of caries adjacent to restorations^{32,33}.

APPLICATION TO TEETH TREATED BY ROOT CANAL

The resin-coating technique is effective for teeth treated by root canal as well (Fig. 4)³⁴. For the additional purpose of preventing coronal leakage, it is highly effective to apply a resin coating to root canal dentin after preparing the cavity for restoration. When applied to a tooth treated by root canal, a resin-coating material for vital teeth should be used³¹.

ROOT SURFACE COATING

Root dentin is more prone to bacterial invasion and caries than is enamel³⁵. In view of the population's rapid aging, applying a resin coating to root surfaces provides the additional benefit: it prevents root caries in older adults (Fig. 5). In fact, previous studies have reported that a thin root coating of as little as 10 μm inhibits the demineralization of root surfaces^{36,37}. The root dentin surface covered by the application of an adhesive coating material can also prevent bacterial attachment and accumulation³⁵. Toothbrush abrasion tests have also demonstrated the excellent durability of thin film coating materials³⁸. Thus, the resin-coating

Fig. 5 Protection of the root dentin surface by a root surface coating.

The root dentin surface is covered by the application of an adhesive coating material to prevent bacterial attachment and accumulation and also to enhance the acid resistance of root dentin from bacterial acid attack (super dentin).

technique, when used on the surfaces of exposed roots of older adults and sound teeth, helps not only protect but also reinforce tooth substances (super tooth), thereby promising broader application to preventive dental care in the future.

CONCLUSION

When restoring a missing tooth's structures by an indirect restoration technique, the resin-coating technique not only improves pulp protection and bond strength but also reduces pain during the insertion and removal of a provisional restoration or restorative material. It also facilitates the removal of temporary bonding material adhering to the side of the abutment tooth. The resin-coating technique is also effective for self-adhesive cement, which has become more widely used in recent years³⁹. In Japan, where society is aging rapidly, the problem of root caries needs to be addressed; the resin-coating technique may be useful for this purpose in clinical applications. Additionally, as a variety of coating agents are available on the market, it is essential to select appropriate materials, as well as self-adhesive resin cements for bonding, on the basis of scientific data.

ACKNOWLEDGMENTS

This study was partly supported by a grant from the Japanese Dental Science Federation, JDSF-DSP1-2016-000-1 and a grant from the Japan Society for the Promotion of Science, KAKENHI, Grant Number 15K11105.

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