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IMMEDIATE DENTIN SEALING FOR INDIRECT BONDED RESTORATIONS- A LITERATURE REVIEW AND CURRENT CONCEPTS

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ABSTRACT Resin-bonded indirect restorations are fabricated by clinicians by usually preparing the tooth, making an impression, and cementing a provisional restoration at an initial appointment. A few weeks later, after the definitive restoration has been tried in and adjusted, it is bonded with some combination of adhesive and resin cement. The tooth preparation for indirect bonded restorations can result in significant dentin exposures. Immediate application and polymerization of the dentin bonding agent to the freshly cut dentin, prior to impression making is therefore recommended by some authors. This procedure is known as "Immediate Dentin Sealing". Several advantages have been cited for immediate dentin sealing. Prominent among those are reduction in tooth sensitivity during the provisional phase and the potential for better bonding of the restoration to dentin. Also reducing gap formations and decreasing bacterial leakage. It has also reported to have a positive influence on tooth structure preservation, patient comfort and long term survival of indirect bonded restorations. This systematic review updates the understanding of concept of using immediate dentin sealing, its protocol and advantages over delayed dentin sealing.

KEYWORDS : cementation, immediate dentin sealing, indirect bonded restorations, resin sealing, tooth sensitivity, vital tooth preparation.

INTRODUCTION:

Dental adhesive technology has evolved in the past decades towards complex formulations with simplified clinical procedures.[1] It is a process dependent on several factors, such as the type of substrate, type of adhesive substance(s), humidity of the environment, and operator's ability in performing the bonding procedure. With regard to the dental substrates, adhesive procedures are usually performed to achieve bond to dental enamel and dentin.[2] Since the advent of adhesive dentistry, the composition of the materials and the clinical methods used for adhesion has changed.[3]

When clinical procedures are considered, most prosthodontic restorations require a provisionalization phase. A considerable reduction in bond strength after adhesive cementation has been identified with eugenol-free formulations. This has been related to the occlusion of dentin tubules with provisional luting agent (PLA) residues and the reaction of zinc oxide remnants with the acidic primer of some adhesive system to avoid resin tag formation. Therefore, elimination of PLA from the tooth surface is crucial. There have been different attempts to accomplish complete removal of PLA. Residual PLA was evident on dentin surfaces after cleaning with pumice and water.[4]

Applying dental adhesive before definitive impression making, the so-called immediate dentin sealing (IDS) technique provides adhesion to a freshly cut and uncontaminated dentin, which is considered ideal for bonding. The IDS technique provides higher values for bond strength, and the adhesive layer applied before impression making does not interfere with the complete seating of the restoration. When the adhesive is applied only at the moment of definitive cementation, the approach is known as delayed dentin sealing (DDS).[5]

The primary advantage of this technique is to protect the tooth from the consequences of micro leakage by sealing the dentin tubules that are vulnerable to bacterial invasion immediately after completion of the preparation. Sealing of the dentin tubules also reduces sensitivity by preventing hydraulic fluid flow within the dentin tubules, which is associated with post-operative sensitivity and limited need of anesthesia during definitive restoration placement, thus improving patient comfort. It has been shown that cements can be forced into dentin tubules before the luting agent sets and microorganisms and their by-products can penetrate into the patent dental tubules post-operatively.[4] Therefore, the early sealing of dentin tubules also may prevent collapsing of collagen fibrils and occlusion of dental tubules by provisional luting agent remnants. Moreover, by using adhesive containing fillers in IDS, more stable and homogeneous dentin-resin hybrid layer was acquired, resulting in improved bonding strength.[5] The dentin bond develops progressively with time. Immediate dentin sealing allows stress-free dentin bond development by delayed placement of the restoration and postponed occlusal loading.[6]

IMMEDIATE DENTIN SEALING TECHNIQUE

As per the instructions given by Magne P [7] steps involved in IDS are:

a. Dentin Identification:

The first technical step for the application of IDS is the identification of exposed dentin surfaces. A simple but efficient method is to proceed to a short etching (2–3 s) and thorough drying of the prepared surfaces. Dentin can be easily recognized because of its glossy aspect, whereas enamel is frosty.

b. Preparation Depth:

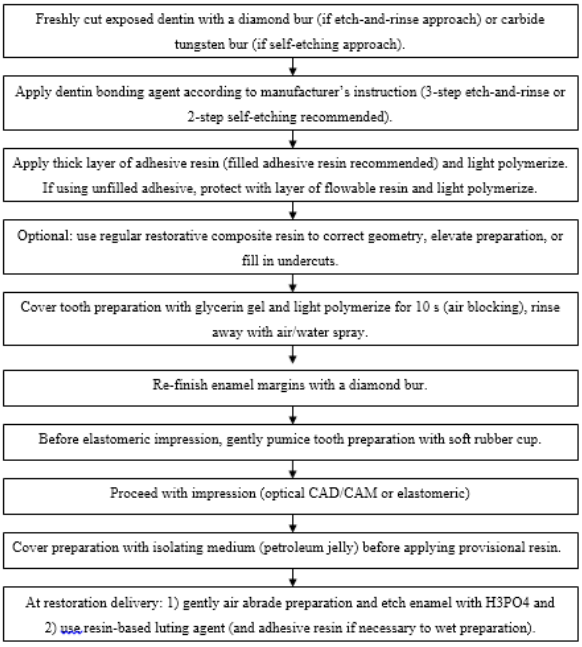
When using IDS, the additional adhesive layer can sometimes negatively affect the thickness of the future restoration. This is particularly evident in the case of porcelain veneers and in the presence of gingival margins in dentin. When margins terminate in dentin, a marked chamfer (0.7–0.8 mm) is recommended to provide adequate margin definition and enough space for the adhesive and overlaying restoration.

c. Adhesive Technique:

The technique described focuses on the use of the total-etch technique (also called "etch and rinse"), which can include either three-step (separated primer and resin) or two-step (self-priming resin) dentin adhesives.

d. Caution with Provisionalization:

Sealed dentin surfaces have the potential to bond to resin-based provisional materials and cements. As a result, retrieval and removal of provisional restorations can prove extremely difficult. Tooth preparations must be rigorously isolated with a separating medium during fabrication of the provisional restoration. It is strongly suggested to avoid resin-based provisional cements. It is recomme nded to keep the provisionalization period reduced to a maximum of 2 weeks.



REVIEW

The majority of studies are in vitro investigations.[3,6,9-43,47] They mainly concentrate on effect of IDS on the bond strength or adaptation of definitive restorations [3,6,9-16], interaction of IDS with impression materials [17-27] and post-cementation hypersensitivity.[38-43]

A. BOND STRENGTH

It has been shown that the bond strength of resin cements depends, among other factors, on the type and quality of dentin and the preparation depth. All bonding agents and resin cements achieve the highest bond strength values on freshly ground, uncontaminated dentin. Yet, after tooth preparation for a fixed restoration, the prepared tooth is covered with a provisional restoration, which is cemented with provisional cement. Unfortunately, complete removal of the cement remnants with pumice or a cleaning paste before final cementation is difficult.

The contamination of dentin with provisional cement has been reported to significantly reduce the bond strength values of resin cements to dentin. To retain the high bond strengths of freshly ground dentin during the provisional treatment phase, the dual bonding technique for the sealing of dentin was developed.[16]

Magne et al. [11] evaluated the differences in micro tensile bond strength (MTBS) to human dentin using IDS technique compared to delayed dentin sealing (DDS). They concluded that MTBS improved on using IDS technique.

Duarte et al. [12] determined effectiveness of IDS using total-etch (adper single bond) or self-etch dentin adhesives (adper prompt-L pop) on MTBS. They concluded that both adhesive had high bond strength.

Sahin et al. [13] tested etch-and-rinse and self-etch bonding agents for their ability to block the permeability of previously infused dentin. They concluded that only one-step self-etch bonding agent (G-Bond, GC) and two-step self-etch bonding agent (Clearfil protect bond, Kuraray) were more effective than original smear layer.

Lee et al. [14] evaluated the effect of three variables on the shear bond strength (SBS) of indirect bonded restorations: IDS, thinning of dentin adhesive by air blowing before cementation and light polymerization of the dentin adhesive before cementation. They concluded that SBS improved on using IDS technique.

Dietschi et al. [15] studied four variables: rigidity of the restoration substrate set up, cement thickness, adhesive configuration (enamel-dentin ratio and bonding agent) and luting agent influencing marginal and internal seal of bonded restorations. They concluded that adhesive configuration plays an important role.

Sailer et al. [16] evaluated the efficacy of dentin desensitizing or sealing methods on the SBS of self-adhesive resin cements (RelyX Unicem, 3M) and conventional resin cements (Variolink II and Panavia 21). They concluded that there were beneficial effects on bond strength of self-adhesive resin cement.

Stavridakis et al. [10] evaluated the thickness of pre-polymerized DBA used for IDS of onlay preparations. They concluded that filled DBA (OptiBond FL) presented a more uniform film thickness than unfilled one (Syntac classic).

Brigagao VC et al. [3] evaluated the microtensile bond strength of 2 different resin cements (conventional and self-adhesive) with or without previous dentin sealing and effect of interim cement. They concluded that the application of dental adhesive immediately after tooth preparation (immediate dentin sealing) and before the use of an interim cement promoted the highest values of bond strength to dentin with the resin cements tested.

B. INTERACTION WITH IMPRESSION MATERIAL

A problematic step in the procedure is the final impression of the resin-coated preparation surface, since dentin bonding agents show a superficial oxygen-inhibition layer (OIL) when they are light polymerized. The OIL has a thickness of up to 40 µm and is due to an increasingly low conversion rate of the resin because of the oxygen inhibition of the radicals that normally induce the polymerization reaction. The OIL may in turn inhibit the polymerization of vinyl polysiloxane (VPS) impression materials, depending on the type of DBA. It has been reported that the formation of the OIL can be prevented by the application of a glycerin jelly during polymerization ("air blocking"), which is usually recommended in the IDS technique. Yet there are anecdotal reports and findings that popular DBAs and impression materials still display inhibition phenomena or adhesion and tearing.

Magne and Nielsen [24] Assessed possible interactions between two impression materials (Extrude-PVS, Impregum Soft-PE) and resin coated tooth surfaces using two DBAs (Optibond FL & Clearfil SE Bond). They concluded that air-blocking using glycerine jelly prevents interaction of PVS with sealed dentin. PE is not recommended in combination with IDS.

Ghiggi et al. [25] evaluated interaction between the resin (CSE & PLF) used in IDS techniques and impression materials (Express XT-PVS, Impregum-PE) using two different techniques to eliminate OIL (Glycerine Jelly, Alcohol Swabbing). They concluded that glycerine Jelly and alcohol are equally efficient in preventing interaction with impression materials.

Bruzi et al. [26] evaluated the interaction between adhesive resins/liners (Optibond FL, Scotch bond universal, Optibond XTR & Filtek LS) and impression materials (Express STD-PVS & Imregum F-PE) when using IDS. They conluded that liner resolved issues of any interaction with impression materials.

Magne et al. [27] evaluated the dentin bond strength using different methods of application of opaque resin to mask dentin discoloration. They concluded that bond strength decreased on application of opaque resin.

C. INTERACTION DURING PROVISIONALIZATION

C.1 Type of provisional cement

Altinas et al. [31] evaluated the effect of three provisional cements:

Calcium hydroxide provisional cement and cleaning with a dental explorer are advisable. Eugenol-free provisional cement (Cavex), calcium hydroxide (Dycal) and light-polymerized provisional cement (Tempbond clear) and two cleansing techniques: dental explorer and air water spray or a cleaning bur (opticlean) on shear bond strength of porcelain laminate veneers. They concluded that calcium hydroxide provisional cement and cleaning with a dental explorer are advisable.

Fonseca et al. [32] evaluated the effect of provisional cements: calcium hydroxide (Dycal), ZOE containing cement (Provy), zinc oxide eugenol-free cement (Tempbond NE) and cleaning techniques: hand scaler for 10 s, pumice–water slurry for 10 s, aluminium oxide sandblasting for 10 s on MTBS of final restoration. They concluded that calcium hydroxide provisional cement demonstrated lowest bond strength values of final restoration.

Sailer et al. [16] tested the effect of provisional cement on the bond strength of dentin luted with self-adhesive (RelyX Unicem, 3M) and conventional resin cements (Variolink II & Panavia 21). They concluded that contamination of dentin with provisional cement has no influence on the bond strength of self-adhesive resin cement (RelyX Unicem).

Riberio da Silva et al. [47] evaluated the effect of resin based provisional material (RBPM) on the tensile bond strength to human dentin developed using DDS and IDS procedures. They concluded that adhesion to dentin was reduced by use of RBPM with IDS prior to placement of definitive restoration.

C.2 Conditioning methods

Dillenburg et al. [33] evaluated the effect of surface treatments (aluminium oxide, 37% phosphoric acid or combination of two) of the pre-polymerized adhesive layer in the IDS technique on MTBS of two-step etch-and-rinse adhesive systems. They concluded that aluminium oxide alone or associated with 37% phosphoric acid gave high MTBS.

Rocca et al. [34] evaluated the influence of different surface treatments (soft air abrasions vs sandblasting) on marginal and internal adaptation of class II indirect composite restorations after simulated occlusal loading. They concluded that soft air abrasion represents a potential alternative to airborne particle abrasion for treating cavities before cementation.

Falkensammer et al. [36] evaluated the bond strength and surface configuration of immediate and delayed dentin sealing surface after applying different conditioning methods: polishing with fluoride-free pumice paste, air borne particle abrasion with silicoated aluminium oxide, glycin and calcium carbonate. They concluded that polishing and air borne particles abrasion with aluminium oxide and glycin are efficient methods.

C.3 Provisionalization period

Magne et al. [23] determined difference in MTBS to immediately sealed dentin when comparing 2, 7 & 12 weeks delay until restoration placement. They concluded that optimal bond strength can be achieved even up to an extended provisionalization phase of 12 weeks.

D. PLACEMENT OF FINAL RESTORATION

Just before the cementation of definitive restoration, it is recommended to roughen the existing adhesive resin using a coarse diamond bur at low speed or by micro-sandblasting. Surfaces sealed with an unfilled dentin bonding agent should be cleansed gently with a soft brush and pumice only.[5]

E. POST SENSITIVITY

Hu et al. [40] investigated the effect of prime and bond adhesive on preventing post-cementation sensitivity of immediately sealed vital abutment teeth. They concluded that preventive treatment with prime and bond using IDS technique significantly reduces post-cementation sensitivity.

Feilzer et al. [43] in their study established that the film thickness of the luting resin governs the wall-to-wall contraction of the same which in turn affects the stability of the adhesive interface. Therefore, authors recommend that to decrease post-cementation sensitivity manufacturer recommendations for film thickness of luting resin be followed.

DISCUSSION

The immediate dentin sealing protocol has been proposed as an effective technique that may be used for enhancing the bond strength of final restoration and also sealing the dentinal tubules which prevents or reduces bacterial contamination and tooth sensitivity during the provisionalization phase.[5] The studies strongly suggests that the IDS technique improved the bond strength of the final restoration both total-etch and self-etch dentin bonding agents.[11–13] In addition to bond strength, factor that requires consideration is the film thickness of the bonding agent and its influence on the fit of the final restoration. Studies have shown that DBA thickness can reach several hundred micrometres when applied to concave areas.[13,44,45] Stavridakis et al. [10] demonstrated that the filled DBA presented a more uniform film thickness compared to the unfilled one. The thickness of dentin bonding agent may affect the seating of restoration. Just before the placement of final restoration a layer of unpolymerized DBA (preferably filled) can be applied to the dentin surface and then luting cement and both can be polymerized at same time. For self adhesive resin cements, use of unpolymerized DBA is not necessary after removal of temporary restoration.[3] One more factor to be considered is the unfavourable interaction of OIL with elastomeric impression materials especially polyether.[24] To reduce the unfavourable interaction due to OIL, it has been suggested to use glycerine gel with additional polymerization for 10 s (Air-blocking) as part of IDS protocol.[5,11,23,24,44] Another alternative involves swabbing the sealed dentinal surface with a cotton pellet pre-soaked in 70% ethyl alcohol for 10 s [25] or covering the IDS surface with a liner (flowable composite) if space permits.[26] It has been suggested that tooth preparation must be isolated with a separating medium like petroleum jelly or PRO-V COAT (Bisco) during direct fabrication of provisional restorations and resin based provisional cements must be avoided because the resin restoration and resin cements will bond to teeth making it difficult to remove during final restoration [11] also the direct fabrication of resin bonded provisional material reduced the bond strength of definitive restoration.[47] Proper cleaning of the abutment teeth prior to final cementation is important regardless the use of conventional or resin cement. It has also been found that soft-air abrasion [34], air borne particle abrasion with aluminium oxide [11,23,33], fluoride-free pumice paste systems [5,12,35], silicoated aluminium oxide and glycin [36] and use of rotary cutting instruments at low speed [11] are some of the efficient methods of cleaning the IDS surface. Dillenburg et al. [33] found that additional etching with H3PO4 was effective in conditioning of IDS surface and helps to remove all kinds of contaminants. The major problem of IDS technique is that most studies on IDS are lacking randomized controlled trials. The efficient execution of all steps of the IDS protocol in a clinical scenario involves techniques that do not have adequate literature backing. There are no guidelines provided for techniques that are recommended to remove OIL or for cleaning the abutment prior to final cementation include the use of pumice or rotary cutting instruments at low speed. The verification of sealed dentin not been removed in the process are also unavailable. OIL related errors in elastomeric impressions cannot be detected by routine visual examination. This may lead to compromised restorations. The IDS protocol assumes that the procedure/ technique is followed under complete isolation, although achieving the same may not be possible in every clinical situation. Despite these shortcomings studies [6,8,9,11–16] have demonstrated that IDS might provide a better long term bonding to the dentin than that provided by the resin cement alone. These studies have shown better results with IDS technique despite employing procedures that raise concerns. In the extensive literature regarding advantages of using IDS technique significant differences have been shown when compared to delayed dentin sealing. Although more research is required in this field, presently there are NO scientific reasons not to recommend IDS in routine practice.[46]

CONCLUSION

A thorough review of literature suggests the need for a revised protocol for dentin bonding when placing indirect bonded restorations. IDS technique recommends to immediately sealing the dentin after tooth cutting and prior to taking the impression. This technique helps to achieve improved bond strength, fewer gap formations, decreased bacterial leakage and reduced dentin sensitivity. It also helps to improve patient comfort and in long term survival of indirect bonded restorations. Thus, it might be suggested to the clinicians and researchers to develop newer protocols and materials which would help to achieve better results and also more randomized control trails of IDS technique should be encouraged.

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