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Immediate dentin sealing: the dentin shield –a review

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ABSTRACT
Indirect bonded restorations own a major share of aesthetic and restorative dentistry with its minimally invasive techniques.Dentin bonding is a never-ending discussion topic in this field. Immediate dentin sealing (IDS) provides solution to some of the concerns associated with bonding of indirect ceramic restorations. Better bond strength and reduced post operative sensitivity are the major milestones of this somewhat recent technique.
Keywords: Dentin bonding, indirect restorations, immediate dentin sealing, oxygen inhibited layer, reverse spot bonding.

I. INTRODUCTION

Dr Buonocore paved the way to strong enamel bonding. However, similar success bonding to dentin still remained challenging. The major problems being the composition and nature of the two substrates. Enamel is inorganic, composed primarily of hydroxyapatite with very low water content. While the chemical structure of dentin involves both inorganic and organicmaterials, and it features a highly complex physical structure that varies towards its depth.(1)

Composite resins and adhesive systems gained popularity with its ability to bond to toothstructure and its similar elastic modulus as that of dentin. Improved bonding protocols, newer adhesive options and improved operative techniques made composite the restorative choice in aesthetic dentistry. They are generally used with direct restorative technique for both anterior and posterior teeth. Although it is technique sensitive,it requires only minor toothpreparations.(2)

However, direct composite restoration poses challenges like polymerization shrinkage, marginal leakage and inadequate prosthetic contacts especially in case of large restorations. As a substitute indirect restoration such as inlays and onlays presented a better result in terms of proximal contact, occlusal anatomy and marginal adaptation as their manufacturing and polymerisation are done externally. Bonding of indirect restorations have a highly predictable level of clinical success with the currently available dentin bonding agents.(3)

Hybrid layer

Bonded porcelains as an enamel or DEJ substitute relies mainly on dentin hybridisation which simulates the DEJ andthis opened abundant opportunities for the biomimetic restorative dentistry. (6) The hybrid layer mechanism means certain resins can infiltrate the dentin and combine with the collagen and hydroxyapatite to form a new material that is neither tooth nor resin but a hybrid of the two. True hybridisation results in dramatic increase in bond strength. The hybrid layer acts as an acid resistant envelope that seals the dentin, preventing hypersensitivity and secondary caries.(1)

During tooth preparation application of dentin bonding agent (DBA) on exposed areas of dentin is recommended.(4) Exposed dentinal tubules act as open channels for microorganisms to reach the pulp , thus endangering the tooth vitality.(5)

To compensate these issues and protect the pulp , Pashley et al in early 1990s suggested immediate application ofDBA after tooth preparation and before impression making for indirect restorations.(6) This concept, which is also referred to as “prehybridization”, “dual bonding technique”and “resin coating technique”, was later entitled with the term “immediate dentin sealing” (IDS).(7)

Immediate dentin sealing (IDS)

Immediate dentine sealing (IDS),(4) also known as dual bonding,(8) is a relatively new concept for bonding indirect adhesive restorations and has been associated with promising clinical results.
The IDS technique relies upon four principles-

a) only fresh-cut, contaminant-free dentin provides the optimum substrate for bonding. Otherwise, the bond strength is inferior.
b) if the DBA and overlaying composite are light-cured together, the hybrid layer may collapse due to the pressure from the composite or restoration placement. Thus, precuring the DBA is required for a better bond strength.

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c) IDS and delayed restoration placement permit maturation of the dentin bond in an environment free of occlusal forces and overlaying composite shrinkage.
d) IDS reduces fluid and microbial penetration[9]

IDS is done before impression making. This allows maturation of the bond. The IDS is usually reactivated during cementation by using air particle abrasion (APA). Either pumice or roughening using a coarse diamond rotary cutting instrument at low speed, can also be used to promote the bond to the sealed dentin.[10] An efficient resin-to resin bond between the existing resin coating and the new luting composite resin is the cornerstone step in luting.

IDS Protocol

Immediate dentin sealing (IDS) involves application of an adhesive to dentin directlyafter tooth preparation, before impression. This can be considered as an alternative to delayed dentin sealing(DDS), which involves hybridization following the provisional phase and justbefore the indirect restoration luting phase.[11]

According to Magne,[12]the first step of IDS is to differentiate dentin from enamel. For this purpose, a preliminary etching of 2–3 s is done over the whole tooth surface. After thorough rinsing, enamel gain a "frosty" appearance, whereas dentin appearsmore "glossy". Then, with a diamond bur (in etch-and-rinse systems) or a carbide tungsten bur (in self-etch systems), a fresh layer of dentin is exposed, over which a thick layer of a DBA is applied and light cured according to manufacturer guidelines. With unfilled adhesive, an additional layer of low viscosity resin (LVR) is recommended.Alternatively, a regular composite to correct geometry, eliminate undercuts, or elevate the preparation can be used. Later, the DBA is polymerized additionally through a layer of glycerine gel to reduce the oxygen-inhibition layer (OIL) and rinsed with air/water spray. To remove excess adhesive, enamel margins may need corrections with a diamond bur.

In case of conventional crown preparations, combined with glass ionomer or modified-resin cements, IDS can result in significantly increased retention, reduced marginal leakage, and improved bond strengths. IDS is believed to provide better retention for short clinical crowns and excessively tapered preparations.

Oxygen- inhibited layer and impression materials

A superficial oxygen inhibited layer (OIL)of approximately 40 microns is associated with light curing of DBAs. OIL can inhibit the polymerisation of elastomeric impression materials.[13],[14]According to Magne and Nielsen application of IDS without surface treatment leaves an unpolymerized resin layer.[13]Ghiggi et al,[14]observed incomplete polymerisation of silicone impression materials ; while polyether materials showed adherence to the resin layer ; difference explained on the basis of their variant chemical composition.

In case of vinyl polysiloxane, the monomers present in the OIL may react with the platinum salt resulting in anunpolymerized portion of impression material over the resin materials. While for polyethers, the initiator agent is cation that can react with the free radicals of unpolymerized IDS surface. High stiffness, low tear resistance and high hydrophilicity accounts for the adhesion of polyethers to the resin surface. Thehydrophilic monomer hydroxyethyl methacrylate, that is present in theadhesive resin of some DBAs, has also been suggested of causing residual inhibition.[13]

To reduce these interactions, certain cleaning protocols need to be done following IDS, before impression making. According to Magne and Nielsen[13]an additional step of polymerisation of the DBA through a layer of glycerine gel (prevents formation of OIL)and pumicing (application of a mix of pumice and water using a soft rubber prophy cup in a slow-speed handpiece at 500 rpm speed).

Conditioning of IDS substrate

Selection of an appropriate conditioning method is crucial for optimum bonding. Magne et al[15] employed air-borne particle abrasion (APA) with aluminium oxide, whereas Dillenburg et al[16]showed that additional etching with phosphoric acid had a positive impact on conditioning sealed dentin. As per anotherstudy,[17] polishing using fluoride-free pumice paste and APA with silicoatedaluminum oxide or glycinshowed equal efficiency, whereas APA with calcium carbonate was contraindicated due to its higher roughness and inferior bond strength. Cleaning with pumice or pumicing with an additional tribochemical silica results an unchanged bond strength as quoted by van den Breemer et al[18,19]

Adhesive system for IDS

A filled adhesive system such as Optibond FL treated with airborne-particle abrasion is considered a better option for IDS than an unfilled DBA because of its ability to produce a more

uniform resin coating. The filled adhesive that is visibly detectable, makes the evaluation of the DBA during placement easier, as well as after surface cleaning prior to final cementation. Polymerised resin thickness may vary on different surface geometries- 60-80 µm on a smooth convex surface and 200-300 µm on concave surfaces. This might interfere with the seating of final restoration if cured just before final placement.It is recommended that the adhesive resin be kept unpolymerized before the restoration is fully seated.[10]

According to Magne, conventional three-step total-etch DBA is considered to be the most reliable long-term option for IDS.Literature also suggests that, older three-step etch- and-rinse systems and two-step self-etch systems are superior to single-step systems in terms of durability, aging, and bond strength. Also, older adhesives form a more hydrophobic layer , which is desirable for IDS efficacy.[10] Another invitro studydemonstrated significantly higher bond strength following IDS with both total-etch adhesives and self-etch adhesives as compared traditional DDS method.[20]

While Ferreira-Filho et al,[21]compared the behavior of four adhesive systems (one-step self-etch Xeno V; two-step self-etch Clearfil SE Bond; two-step etch-and-rinse XP Bond; three-step etch-and-rinse Optibond FL),and mentioned no variations in microtensile bond strength among the tested adhesives and the control group- without IDSfollowing 3 months of water storage.

Provisional restoration and reverse spot bonding

Resin -based provisional restorations or cements might bond to the resin -coated dentin surface which complicates the removal of the provisionals.Schoenbaum et al [22]put forward the "reverse spot bonding technique" for provisional cementation. Technique involves the placement of a small portion of fast-setting condensation silicone in the middle of the preparation away from the margins, covering 2–3 mm of the sealed surface. Followed by application of a separating medium on the entire surface of the preparation. Removal of the silicone increment provides a small area for bonding of the provisional; while the rest of the surface is covered with separating medium.Advantage being better cleaning of the substrate during the final cementation procedure and also easy removal of the provisional.[9]

Advantages of IDS

(1) Better bonding to dentin,the clinician can focus on bonding to dentin while enamel bonding can be performed separately at thefinal stageof definitive restoration.

(2) Sealed dentin is protected from fluid and bacterial leakage during the provisional restoration stage, thus preventing sensitivity and secondary caries.

(3) Chances for post cementation sensitivity is reduced.

(4) Cementation of the definitive restoration and occlusal adjustments if needed requires only limited or no anaesthesia.[10]

Disadvantages of IDS

Although, there are no obvious demerits enumerated under the protocol; some challenges need to be addressed. More studies are needed in relation to

1) Type of adhesives to be used
2) Activation of IDS surface
3) Provisionalisation
4) Interaction with impression materials

II. CONCLUSION

IDS with strictly maintained isolation gives a predictable durability to the indirect bonded restorations. However, research is still needed to improve its performance in terms of conditioning, temporization, impression making etc. Considering the improving pace of research in adhesives and bonding, better results can be expected in the future.

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