International Journal of Dental Research
www.dentaljournal.net
Online ISSN: 2664-9055, Print ISSN: 2664-9047
Received: 12-11-2023, Accepted: 7-11-2023, Published: 13-12-2023
Volume 5, Issue 4, 2023, Page No. 20-24

Immediate dentin sealing -A systematic review

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Abstract
The purpose of this review is to know in depth about Immediate Dentin sealing. Immediate Dentin sealing is a procedure done in Indirect restorations immediately after cavity preparation .This study aimed to assess the effect of immediate dentin sealing v/s delayed dentinal sealing

Keywords: Immediate dentin sealing, direct restorations, delayed dentinal sealing

Introduction
Immediate dentin sealing (IDS) is a procedure where an adhesive system is applied directly to the fresh cut dentin preceding the placement of the provisional phase in indirect restorations.
Introduced in the early-1990s by Pashley *et al*.
Also referred to as "prehybridization", "dual bonding technique", and "resin coating technique

Objective
The purpose of the present study was to assess the effect of immediate dentin sealing on tooth restoration compared to delayed dentinal sealing

Materials and Methods
The Following systematic review was registered in PROSPERO (ID -446375)
This study followed the PRISMA statement guidelines.
The following PICOS framework was used:
Population- indirect restorations
Intervention- IDS
Control- DDS
Outcomes-bond strength, Microleakage, Post op sensitivity
Study design-*In vitro* studies and clinical studies
The research question was: Effect of Immediate dentin sealing on Indirect Restorations?

Study selection
Two reviewers independently assessed the titles and abstracts of all documents.
The titles and abstracts of all reports identified through the electronic searches were read.

Inclusion criteria
Clinical and *In vitro* studies regarding Immediate dentin sealing

Exclusion criteria
Animal studies and studies in primary dentition, studies in languages other than English languages

Data Extraction
For each of the identified studies included, the following data were then extracted on a standard form, when available:
These data comprised the study and year of publication, the type of study, parameters tested (Bond strength, Hyper sensitivity, Dentin permeability, Film thickness, Fracture resistance)
Search strategies
An electronic search of articles published from January 2010 to Dec 2022 in the following databases: PubMed/Medline, Web of Science, Cochrane, Scopus. and Google Scholar .
Independent electronic search by 2 investigators yielded 2350 titles.Records screened according to the title and selected (n=745)Records after duplicates removed n=75.Full text articles assessed for eligibility n=50.Full text articles excluded with reasons 21,Review article,Articles in language other than English .Studies included in qualitative synthesis 29(22 –*In vitro*,7 -Clincal)
Search was conducted by using combinations "Immediate dentin sealing", "dual bonding technique", "resin coating technique", and "prehybridization" "Bond strength" were used as key words. Supplementary manual research was also conducted.

Results
Search criteria: Immediate Dentin Sealing, Dual Bonding, Prehybridization, Indirect Restorations, Bonding, Bond Strength

Author/year/type of s tudy	Study design	Tested Parameters	Main Findings
Choi *et al* 2010 *In vitro*	Assessed the variations in shear bond strength to dentin utilising IDS (Clearfil SE Bond, Adapter	Bond strength	IDS combined with Clearfil SE Bond produced a stronger shear bond than

	Single Bond 2) in contrast to DDS		DDS alone.
Hu and Zhu 2010 Split-mouth clinical study	evaluated how sensitively 25 male patients felt one week, one month, six months, twelve months, and twenty-four months following the cementation of a three-unit fixed restoration.	Hypersensitivity	After using IDS, postcementation hypersensitivity was considerably lessened.
Magne *et al* 2011/ *In vitro*	Assessed the wear resistance of damaged teeth repaired using CAD/CAM composite resin inlays and onlays (Model MZ100) with or without fiber-reinforced IDS (Ribbond)	Fatigue strength	For teeth with a compromised cusp, there was no benefit to utilising fibre reinforcement; the best course of action was to use onlay to protect the cusp.
Gregory Gillespie 2012/*In vivo*	Clinical	Hypersensitivity	The benefits of immediate dentin sealing outweigh the drawbacks for both the patient and the practitioner in terms of long-term "clinical success
Sahin *et al*/ 2012/ *In vitro*	Dentin permeability was tested using five DBAs (Single Bond 2, Adper Prompt L-Pop, Clearfil Protect Bond, Clearfil S3 Bond, G Bond), as well as a dentin desensitizer (Gluma).	Dentin permeability	The only two-step self-etch Clearfil Protect Bond and one-step self-etch Gbond offered better sealing than the initial smear layer.
Spohr *et al* /2013 *In vitro*	Assessed the impact of the material's thickness on the fracture load of the restorations during full-crown preparations using IDS (Clearfil SE Bond, Clearfil SE Bond + Protect Liner F).	Film thickness	The thickness of the film was influenced by the position beneath the crown and could raise the restoration's fracture load.
Ghiggi *et al*/ 2014 *In vitro*	Assessed the interactions between the IDS materials (Clearfil SE Bond, Clearfil SE Bond + Protect Liner F) and the impression materials (Express XT, Impregum), as well as the results of further glycerin jelly polymerization and alcohol treatment..	Interaction with impression materials	The interactions between Clearfil CE Bond and Express XT and Protect Liner F and Impregum were inhibited by the application of glycerin jelly and alcohol; however, these treatments were unable to totally stop the interactions between Clearfil SE Bond and Impregum or Protect Liner F with Express XT.
Oliveira *et al*/ 2014 *In vitro*	Examined the impact of IDS (Clearfil SE Bond/Clearfil SE Bond + Protect Liner F) on the fracture resistance and cuspal deflection of teeth with composite resin inlay.	Cuspal deflection, Fracture resistance	The fracture resistance was unaffected by IDS. Cuspal deflection was comparable to that of a healthy tooth when IDS and Clearfil SE Bond were used alone; LVR addition did not lessen the cuspal deflection.
Falkensammer *et al* 2014/*In vitro*	Assessed changes in the bond strength*In vitro* with the use of several conditioning techniques (polishing with fluoride-free pumice paste, APA with silicon-coated aluminium oxide, glycine, or calcium carbonate).	Bond strength, Conditioning method	Effective conditioning techniques included polishing and APA with aluminium oxide or glycine. APA with aluminium oxide resulted in notable surface changes, and calcium carbonate was not advised.
Leesungbok *et al* 2015/*In vitro*	The impact of IDS (All Bond II) on the bond strength of ceramic restorations was tested over a range of thermocycling times (one, two, seven, and fourteen days).	Bond strength	Ceramic restorations need to be cemented within a week following IDS.
Özcan 2015 *In vitro*	Analysed the impact of air-particle and mechanical cleaning methods (APA with 50 μm at 2, 3.5 bar/30 μm at 2, 3. 5 bar/prophylaxy paste/pumice-water slurry at 1500 rpm for 15 sec) on the surface of the interim cement on IDS.	Bond strength	The easiest way to remove temporary cement remains from the IDS surface would be to use air-abrasion cleaning techniques for a brief 5-second duration..
Gresnigt *et al* 2016 *In vitro*	Examined the impact of IDS (Optibond FL) and DDS on the fracture strength of lithium-disilicate laminate veneers.inate veneers.	Fracture strength	Upon bonding laminate veneers to a sizable dentin substrate, IDS enhanced the bonding and, consequently, the fracture toughness.
Santana *et al* 2016 *In vitro*	Examined how four resin cements (RelyX Unicam, Clearfil SA Luting, RelyX ARC, and Panavia F) and simulated pulse pressure (Clearfil SE Bond) affected the TBS of indirect composite restorations.	Bond strength	Regardless of the simulated pulse pressure, IDS strengthened the bonds between Panavia F, Clearfil SA Luting, and RelyX Unicam, but had no effect on RelyX ARC.
Da Silva *et al* 2016 *In vitro*	compared the impact on TBS of a resin-based temporary material (Clip F) to human dentin created using DDS and IDS.	Bond strength	When a resin-based temporary material was used in the IDS method, adhesion to dentin was adversely affected; isolation using a water-soluble gel was advised.
Belleflamme *et al* 2017	Retrospective clinical study	Evaluated documented cases of endocrowns performed using IDS.	The study validated the use of IDS, which helped to explain the high debonding success rate (2%).
Leite *et al* 2017	Clinical study	marginal fit, marginal infiltration and postoperative Sensitivity.	IDS integration improved marginal fit, decreased marginal infiltration, and lessened postoperative sensitivity in indirect restorations.

Brigagao *et al* 2017/ *In vitro*	Assessed the impact of IDS (Scotchbond Universal) and interim cement on the bond strength of self-adhesive RelyX U200 and conventional RelyX ARC resin cements.	Bond strength, Interim cement	When a DBA was applied right away before to interim cement, the maximum bond strength was observed in both tested resin cements.
Ferreira-Filho *et al* 2018 *In vitro*	Assessed the water-storage behaviour of four DBAs used for IDS (Xeno V, Clearfil SE Bond, XP Bond, and Optibond FL) both immediately and over a three-month period.	Bond strength	With the exception of XP Bond and Clearfil SE Bond, IDS groups produced greater TBS after 7 days than the control group (without IDS). After 3 months, there was no discernible difference between the IDS groups and the control group.
Murata *et al* 2018 *In vitro*	Examined the impact of several IDS applications (thin layer, slope-shaped, base-shaped) on the loading-induced bond strength of CAD/CAM ceramic inlays.	Bond strength	The slope-shaped group produced the best results, and IDS increased TBS as well as the bonding durability and dependability of the evaluated restorations.
van der Breemer *et al* 2019Randomized clinical trial	Examined, after three years of operation, the survival, success rate, and quality of survival of partial ceramic restorations (IPS e.max) in essential molars bonded utilising IDS (Clearfil SE Bond + Clearfil Majesty Flow).	Survival, success rate, and quality of survival of partial ceramic restorations	After three years of operation, there were no changes in the success or survival rates of ceramic restorations with IDS.
Khakiani *et al* 2019/ In vito	Examined how two imprint materials (Impregum Soft/Aquasil) interacted with IDS (Adper Single Bond 2/Clearfil SE Bond) either separately or in conjunction with pumicing.	Interaction with Impression materials	Polyether was not advised when using IDS; instead, silicone imprints should be used together with air-blocking and pumicing.
Rigos *et al* 2019 *In vitro*	Assessed the strength of the bond between dentin and pretreatment monolithic zirconia using two self-adhesive resin cements (Permacem Dual Smartmix and Panavia F2.0) and IDS (Optibond FL).	Bond strength	IDS may be advantageous for bonding techniques for monolithic zirconia restorations, independent of the adhesive luting agent method employed.
Gresnigt *et al* 2019 Prospective clinical trial	Assessed the longevity, success rate, and patient satisfaction with the laminate veneers received by 104 patients who underwent IDS after 11 years of use..	Survival, success rate, patient satisfaction	Teeth with >50% dentin exposure responded greatly with IDS.
Cesca *et al* 2020 *In vitro*	Comparing indirect resin composite copings for periodontal overdentures that were luted with either Syntac+Variolink II/Tetric Ceram or DDS.	Tensile load	IDS group produced a tensile load that was noticeably higher.
Sag and Bektas 2020/*In vitro*	A comparison was conducted between the bond strengths of various resin cements (RelyX Ultimate/RelyX Unicem) on an indirect composite (Solidex) and a resin-nanoceramic CAD/CAM block (Lava Ultimate) with or without IDS (Clearfil SE Bond+ Filtek Ultimate)..	Bond strength	IDS improved bond strength of indirect restorations.
Ashy *et al* 2020 *In vitro*	Examined the internal application and marginal adaption of ceramic inlay restorations bonded with DDS or IDS (All-Bond Universal).	Marginal adaptation and internal adaptation	When compared to when employing DDS, luted ceramic inlays showed a better marginal adaptation right after cementation and a better internal adaptation after thermocycling; nevertheless, there was no discernible difference in the marginal adaptation following thermal cycling between the two techniques.
Hofsteenge *et al* 2020*In vitro*	examined how age, fracture strength, failure mode, and repairability affected lithium-disilicate inlays and onlays in connection to either DDS or IDS (Optibond FL).	Aging and Fracture strength	The fracture strength was impacted by the application of IDS and the preparation design, respectively; IDS did not interact with the effect of the preparation design on fracture strength.
van der Breemer *et al* 2021 Prospective clinical trial	Clinical performance	Assessed the clinical performance of 765 partial glass–ceramic posterior restorations (IPS e.max) luted with a conventional photo-activated resin composite in conjunction with IDS (Clearfil SE Bond).	The medium-term prognosis for partial glass-ceramic posterior restorations treated with IDS was favourable.
Nader Saadeddin Manar Ali 2022/*In vitro*	evaluated the fracture strength of human premolars. Following the completion of the preparation, the dentin surfaces of the IDS group	Fracture Strength	The strength of ceramic onlays' fracture was influenced by dentin sealing; onlays bonded with an immediate dentin

	were sealed using a flowable composite (Te-Econom Flow) and a bonding system (ALL-BOND 3®, ALL-BOND 3® RESIN). Impressions were made, and temporary restorations were made using PRO-V FILL®. The specimens were thermocycled after bonding the final restorations with resin cement (Variolink N).		sealing technique exhibited a higher fracture strength than those bonded with a delayed dentin sealing technique.

With a dentin bonding agent (DBA) immediately following tooth preparation, before taking impression.

Rationale for IDS

Freshly cut dentin is the ideal substrate for dentin bonding.
Pre curing the DBA results in a better bond strength.
Immediate dentin sealing allows stress-free dentin bond development
IDS reduces fluid and bacterial penetration. (Pascal Magne)

Clinical procedure

Etch freshly cut dentin with Phosphoric acid. Etching time may vary from 10 seconds for normal dentin to 20 seconds for sclerotic dentin Rinse and remove excess water (Select a technique as per manufacturer instructions depending on the type of adhesive being used) Application of primer-Apply either a three step system or self priming resin (two step system) using a slight brushing motion resulting in spread of resin beyond exposed dentin surface.

Application of DBA- Apply adhesive resin followed by removal of excess solvent using suction/gentle air drying depending on type of adhesive being used and light polymerization Air Blocking-Apply a layer of glycerine jelly to limit formation of oxygen Inhibition layer to the adhesive and slightly beyond followed by additional polymerization for 10 seconds 3 step etch and rinse and 2 step self-etch provided superior bond strength, durability and aging as they formed more hydrophobic resin coating (Magne *et al* and Duarte *et al*) Interaction with the provisional restorations where minimal after Application of a separating medium combined with reverse spot bonding (Schoenbaum *et al*) Before placement of final restoration the IDS surface was conditioned with either air-borne particle abrasion (APA) with aluminum oxide (Magne et al) or with additional etching with phosphoric acid (Dillenburg *et al*)provided better cleansing, superior mechanical retention enabled chemical co polymerization of resin based cement with IDS Bond strength increased after application of multiple layers of adhesive (≤4 layers) (Hashimoto *et al*, Ito *et al*).A thicker IDS film contributes to better distribution of stress, yields a superior bond strength, and provides more stable bonding and elimination of undercuts becomes easier.

IDS improved the bond strength of self adhesive and conventional resin cements even when stimulated pulpal pressure negatively affected the quality of resin -dentin interfaces due to better stress absorption against shrinkage of resin cement. Another technique that has been suggested to reduce or eliminate the OIL is to wipe the sealed surface with a cotton pellet soaked in 70% ethyl alcohol for 10 s (9). or covering the IDS surface with a liner (flowable composite) if space permits.(10).Polyether is not recommended (Impregum Soft).The OIL may in turn inhibit the polymerization of vinyl polysiloxane (VPS) impression materials, depending on the type of DBA.(11)Air blocking and pumicing was the best method to reduce the effect of OIL.(12).Sealed dentin surfaces have the potential to bond to resin-based temporary cements/materials. Usage of non-resin-based cements is recommended. (Non-eugenol ZnO and Calcium hydroxide).Cover tooth preparation using a separating medium (e.g petroleum jelly or Pro-V coat) to avoid locking of restorations.(13)Early sealing of dentin tubules provided by the IDS technique seems to reduce sensitivity during the provisional phase and after cementation (Up to 1 week and one month after cementation)-(Hu and Zhu)

IDS favors delayed restoration placement for ≤12 weeks.(Magne)

IDS provided high success rate of endocrowns in terms of debonding with >50% of dentin exposure, laminate veneers benefit significantly from IDS.

IDS reduced microleakage and improve marginal adaptation and internal adaptation after thermocycling (Ashley *et al*)

Conclusion

Immediate application and polymerization of the dentin bonding agent to the freshly cut dentin, before impression taking, is recommended. The immediate dentin sealing appears to achieve improved bond strength, fewer gap formations, decreased bacterial leakage, and reduced dentin sensitivity.

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