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REVIEW

Immediate dentin sealing: current concepts, clinical workflow, and evidence-based applications

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Abstract

Immediate Dentin Sealing (IDS) has become an essential clinical protocol aimed at optimizing adhesive bonding in indirect restorations due to increasing demands for durable restorations, reduced postoperative complications, and improved patient satisfaction in restorative dentistry. This comprehensive review systematically examines the underlying principles, varied application techniques, and clinical implications associated with IDS. This narrative review was conducted by searching PubMed/MEDLINE, Scopus, and Web of Science databases for relevant in vitro and clinical studies, using the search terms: immediate dentin sealing, IDS, dentin bonding, indirect restorations, and adhesive dentistry. Current evidence from both in vitro and clinical studies is thoroughly reviewed, emphasizing the superior bond strength, enhanced long-term bond durability, reduced dentin permeability, and decreased postoperative sensitivity achieved with IDS compared to delayed dentin sealing. Various adhesive strategies, including etch-and-rinse and self-etch systems, as well as adjunctive methods such as the application of flowable resin liners, are critically evaluated. Clinical investigations consistently report favorable outcomes concerning patient comfort, restoration longevity, and structural integrity when IDS protocols are employed. The evidence suggests that IDS may offer meaningful clinical advantages, supporting its consideration as a reliable and promising approach in contemporary restorative dentistry; however, the evidence should be interpreted in light of existing methodological limitations, and further long-term clinical studies are warranted.

Keywords Immediate dentin sealing · IDS · Restorative dentistry · Bonded restoration · Adhesive system · Direct restoration · Indirect restoration · Resin composites

1 Introduction

Indirect adhesive restorations such as ceramic inlays, onlays, veneers, and partial crowns have become integral to minimally invasive dentistry. They offer superior control of polymerization shrinkage and enhanced physical properties through extraoral curing, along with precise anatomy and contacts (Magne and Belser 2002). A critical challenge with indirect techniques, however, is the exposure of dentin during tooth preparation. When a provisional restoration is placed, the cut dentin remains unsealed for days to weeks, allowing bacterial microleakage and sensitivity from thermal, chemical, and mechanical stimuli transmitted through open tubules (Pashley et al. 1992).

This can jeopardize pulpal health and compromise the quality of the final bonding. To address these issues, the technique of Immediate Dentin Sealing (IDS) was introduced in the 1990s, initially termed *dentin pre-hybridization* or the *dual bonding technique* (Pashley et al. 1992). IDS involves sealing freshly cut dentin with an adhesive bonding agent immediately after tooth preparation and before taking the impression, rather than waiting until final cementation. By sealing the dentin at the time of preparation, IDS aims to prevent contamination and allow the dentin bond to mature, thereby improving restoration outcomes.

Tooth preparation on dentin exposes an estimated 20,000 dentinal tubules in shallow cavities and up to 40,000 in deeper ones, creating open pathways for microbial access and thermal, chemical, and mechanical insults (Bekes 2015). Occluding these tubules at the time of preparation is therefore crucial to safeguarding pulpal health (Alghauli

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et al. 2024). Immediate dentin sealing (IDS) achieves this by forming a mature hybrid layer. Clinically, the prepared dentin is etched with 35% phosphoric acid for 15 s, gently air-dried under high-volume suction, and a hydrophilic primer is actively rubbed in. A filled adhesive resin is applied, air-thinned, and light-cured for 20 s. To eliminate the oxygen-inhibition layer, glycerin gel is placed and the surface is re-cured for an additional 10 s (Alghauli et al. 2024). Finally, the sealed surface is cleansed with low-pressure airborne abrasion and pumice slurry before definitive impression taking(Alghauli et al. 2024).

Although IDS markedly improves bond strength, reduces microleakage, and mitigates postoperative sensitivity, its multi-step protocol can challenge clinicians unfamiliar with the technique. Accordingly, this review synthesizes in-vitro evidence on bonding efficacy, sealing performance, hypersensitivity reduction, and long-term success of restorations placed with IDS, providing a clear clinical roadmap for its adoption in contemporary adhesive dentistry.

I summarize evidence from in vitro studies and clinical trials regarding bond strength, microleakage, post-operative sensitivity, and the longevity of restorations placed with IDS.I summarize evidence from in vitro studies and clinical trials regarding bond strength, microleakage, post-operative sensitivity, and the longevity of restorations placed with IDS.I summarize evidence from in vitro studies and clinical trials regarding bond strength, microleakage, post-operative sensitivity, and the longevity of restorations placed with IDS.

Therefore, this review aims to synthesize the current evidence on Immediate Dentin Sealing (IDS), outline a contemporary evidence-based clinical workflow, and critically appraise its applications in indirect restorative dentistry, including an assessment of the strengths and limitations of the available evidence.

2 Review methodology

A narrative review of the literature was conducted to synthesize current evidence on Immediate Dentin Sealing (IDS). Three major electronic databases were systematically searched: PubMed/MEDLINE, Scopus, and Web of Science. The search strategy employed the following key terms and their Boolean combinations: “immediate dentin sealing”, “IDS”, “dentin bonding”, “indirect restorations”, “adhesive dentistry”, “hybrid layer”, “dentin permeability”, and “resin cement”. No restriction was placed on publication date. Studies selected for inclusion comprised in vitro laboratory investigations, randomized controlled trials, prospective and retrospective clinical studies, and previously published systematic reviews and meta-analyses pertaining to the mechanisms, clinical protocol, and outcomes of IDS. Narrative synthesis was performed, and findings were organized thematically by topic area.

3 Historical background

The foundations for IDS can be traced to the work of Pashley and colleagues in the early 1990s (Pashley et al. 1992). They discovered that applying a dentin bonding agent immediately after tooth preparation significantly reduced dentinal permeability (Pashley et al. 1992). Paul and Schärer (Paul and Schärer 1997) later introduced a “dual bonding technique” in which the dentin was bonded twice: first at preparation and later at final cementation.

Pascal Magne popularized the term Immediate Dentin Sealing (IDS), systematically describing a workflow that improved the quality and reliability of the resin-dentin interface (Magne 2005). By the mid-2000s, IDS was recognized as an effective method to reduce microleakage, boost dentin bond strength, and minimize post-operative sensitivity.

Collectively, these early studies established the principle that sealing dentin at the time of tooth preparation could preserve bond integrity more effectively than waiting until the final cementation.

It is important to note, however, that these early investigations were predominantly laboratory-based and characterized by considerable methodological heterogeneity, including variation in adhesive systems, substrate preparation, and aging protocols. Clinical evidence during this formative period was sparse, sample sizes were often small, and universally accepted IDS protocols had not yet been established. These limitations should be borne in mind when interpreting the early literature and underscore the need for standardized, well-powered clinical trials (Pashley et al. 1992, Paul and Schärer 1997, Magne 2005).

4 Rationale and mechanisms of immediate dentin sealing

4.1 Fresh substrate and hybrid layer maturation

One of the main advantages of IDS is that it is placed on a freshly cut, uncontaminated dentin surface. When dentin is sealed immediately, the collagen network is exposed only briefly, facilitating optimal infiltration of primers and resins (Magne et al. 2005, Magne 2005). Moreover, because the adhesive layer polymerizes well before final cementation, there is additional time (“dark cure”) for the resin network to mature, thus improving its mechanical properties and interfacial stability (Magne et al. 2007).

4.2 Reduced microleakage and sensitivity

Unsealed dentin tubules allow fluid flow, bacterial byproducts, and thermal changes to irritate the pulp. By sealing the dentin at the time of preparation, IDS eliminates the exposure of tubules to provisional cement, oral debris, and moisture, reducing post-operative sensitivity (Hu and Zhu 2010). Multiple laboratory and clinical studies have confirmed that IDS groups show lower microleakage, less gap formation, and fewer reports of sensitivity compared to conventional delayed sealing (Samartzi et al. 2021, Perugia et al. 2013).

4.3 Stress modulation during luting

Delaying dentin bonding until final restoration placement subjects the bonding interface to high polymerization shrinkage stresses from the resin cement plus functional loads soon after. IDS decouples these events, dentin bonding layer has already polymerized, achieving a stronger and more mature hybrid layer. When the restoration is eventually bonded, the stress is partly absorbed by this pre-cured adhesive layer, minimizing interfacial strain (Magne et al. 2007). Laboratory data indicate that restorations with IDS are less prone to marginal gaps or adhesive failures under cyclic loading (Oliveira et al. 2014).

4.4 Overall restorative longevity

Clinically, IDS has been correlated with improved long-term success. The sealed dentin remains stable throughout the provisional phase, and the final bond to a resin-coated surface is typically stronger than to fresh dentin contaminated by temporary cements or moisture (Breemer et al. 2021). Moreover, a stable resin-dentin seal has been associated with decreased secondary caries and fewer debonding incidents over time (Gresnigt et al. 2019).

In summary, the mechanism of IDS can be understood as creating an immediate hybrid layer that is mature and stable by the time of final bonding. This hybrid layer serves as a dentin shield – preventing sensitivity and contamination, and providing a robust scaffold for the luting composite to bond to.

4.5 Hybrid layer degradation, MMPs, and adhesive aging

A critical yet underappreciated benefit of IDS relates to its protective role against progressive hybrid layer degradation. Matrix metalloproteinases (MMPs) — endogenous zinc- and calcium-dependent proteases present within dentin — are activated during the acid-etching step and contribute to the hydrolytic breakdown of collagen fibrils within the hybrid layer over time, a process termed 'adhesive aging.' By sealing the dentin immediately after preparation, IDS may reduce MMP activity and limit ongoing collagen degradation by providing a stable, early resin seal. This mechanism has important implications for long-term bond durability: restorations placed with IDS may be less susceptible to the gradual interfacial deterioration that characterizes delayed bonding strategies, where prolonged dentin exposure maximises MMP-mediated degradation (Tjäderhane et al. 2013, Mazzoni et al. 2007, Pashley et al. 2011). Hybrid Layer Degradation, Matrix Metalloproteinases (MMPs), and Adhesive Aging: A critical yet underappreciated benefit of IDS relates to its protective role against progressive hybrid layer degradation. Matrix metalloproteinases (MMPs) — endogenous zinc- and calcium-dependent proteases present within dentin — are activated during the acid-etching step and contribute to the hydrolytic breakdown of collagen fibrils within the hybrid layer over time, a process termed 'adhesive aging.' By sealing the dentin immediately after preparation, IDS may reduce MMP activity and limit ongoing collagen degradation by providing a stable, early resin seal. This mechanism has important implications for long-term bond durability: restorations placed with IDS may be less susceptible to the gradual interfacial deterioration that characterizes delayed bonding strategies, where prolonged dentin exposure maximises MMP-mediated degradation (Tjäderhane et al. 2013, Mazzoni et al. 2007, Pashley et al. 2011). Hybrid Layer Degradation, Matrix Metalloproteinases (MMPs), and Adhesive Aging: A critical yet underappreciated benefit of IDS relates to its protective role against progressive hybrid layer degradation. Matrix metalloproteinases (MMPs) — endogenous zinc- and calcium-dependent proteases present within dentin — are activated during the acid-etching step and contribute to the hydrolytic breakdown of collagen fibrils within the hybrid layer over time, a process termed 'adhesive aging.' By sealing the dentin immediately after preparation, IDS may reduce MMP activity and limit ongoing collagen degradation by providing a stable, early resin seal. This mechanism has important implications for long-term bond durability: restorations placed with IDS may be less susceptible to the gradual interfacial deterioration that characterizes delayed bonding strategies, where prolonged dentin exposure maximises MMP-mediated degradation (Tjäderhane et al. 2013, Mazzoni et al. 2007, Pashley et al. 2011).

5 Clinical protocol and materials selection

The immediate dentin sealing (IDS) procedure is incorporated into the indirect restoration workflow immediately after tooth preparation and prior to impression making.

The general steps include: (1) complete the desired cavity or crown preparation, (2) isolate the tooth adequately, (3) apply an adhesive bonding agent to all exposed dentin surfaces and polymerize, (4) treat the cured adhesive layer to prevent interference with impression/temporary materials, (5) take the impression of the sealed preparation, (6) fabricate and seat a provisional restoration using non-eugenol cement, and (7) at the cementation visit, clean and refresh the sealed dentin surface as needed, then lute the definitive restoration with resin cement. Each of these steps, along with relevant material considerations, is described below.

5.1 Tooth preparation

Complete the tooth preparation, removing all carious tissue and existing restorations to the desired form. Rinse thoroughly and dry gently, desiccation of the dentin must be avoided.

5.2 Isolation

Adequate moisture control is a fundamental prerequisite for IDS, as even minor contamination by saliva, gingival fluid, or blood substantially disrupts adhesive wettability, compromises polymerization, and weakens the hybrid layer (Alghauli et al. 2024). A properly positioned rubber dam is the preferred isolation method. Haemostatic agents must be completely rinsed away before adhesive application, since their residues can interfere with uncured monomers (Oliveira Bernades et al. 2014). Meticulous isolation therefore underpins the predictability and long-term success of IDS-assisted restorations.

5.3 Adhesive application

Both etch-and-rinse and self-etch adhesive strategies are compatible with IDS; however, application sequences differ between systems. Manufacturer instructions must be followed precisely. The general clinical steps for each approach are as follows.

Etch-and-rinse systems (2-step or 3-step):

(1) Apply 35–37% phosphoric acid selectively to the dentin for 15 s; enamel conditioning is unnecessary at this stage.
(2) Rinse for at least 15 s, then remove excess moisture with a gentle air pulse, maintaining a visibly moist dentinal surface.
(3) Apply the primer component (in 3-steps system); rub actively then air-dry gently until all solvent has evaporated.
(4) Apply bonding resin, spread into a uniform thin film, air-thin briefly, and light-cure for the recommended curing time.

Self-etch systems (2-step or universal):

(1) Apply the self-etching primer (in 2-steps) and scrub actively for 20 s to promote dentinal penetration.
(2) Air-dry until complete solvent evaporation is confirmed.
(3) Apply the bonding resin, air-thin, and light-cure per manufacturer specifications.

Regardless of adhesive system, the bonding agent must reach a fully cured state before any impression material contacts the prepared surface.

5.4 Thin resin coating (Optional)

For additional reinforcement—particularly with universal or two-step etch-and-rinse adhesives—a thin layer (~ 0.5 mm) of flowable composite is applied over the cured adhesive (Carvalho et al. 2021). The flowable material is light-cured to the radiant exposure specified by the manufacturer, creating a uniform and stable resin coating on the dentin surface.

This coating reinforces the hybrid layer and shields the adhesive from oxygen-inhibition effects or mechanical damage. When a relatively unfilled bonding resin was used, the flowable layer fills micro-voids and establishes a more stable substrate for subsequent steps.

Research has demonstrated that a flowable resin applied over the IDS adhesive improves bond strength and reduces microleakage compared to adhesive alone (Medina et al. 2014, Nikaido et al. 2018). A thermal cycling study further confirmed lower nanoleakage when a two-step self-etch adhesive was combined with a flowable coating (Ariyoshi et al. 2008). Although optional, this step is advisable, especially when the adhesive film is thin. When a filled adhesive (e.g., OptiBond FL) is used, the extra coating layer may be omitted, as the cured adhesive itself provides adequate strength.

5.5 Impression and provisional restoration

The outermost layer of the polymerized adhesive may remain incompletely cured due to oxygen inhibition, and impression materials can interact with this oxygen-inhibition layer (OIL), potentially causing adhesion or tearing during removal (Magne and Nielsen 2009). Eliminating the OIL prior to impression taking is therefore essential. Accepted removal methods include wiping the sealed surface with alcohol-soaked cotton pellets, pumice polishing, or applying glycerin gel followed by supplementary light-curing (Magne and Nielsen 2009).

Temporary restorative materials also require careful management. Contamination of the IDS surface by provisional cements can markedly reduce bond strength at the final cementation visit (Frankenberger et al. 2007). Resin-based temporaries in particular bond to the OIL and are difficult to remove completely. Applying a protective agent such as glycerin gel or petroleum jelly to the IDS surface before placing the provisional effectively prevents unwanted adhesion (Ribeiro da Silva et al. 2016).

5.6 Final cementation

At the cementation appointment, conventional temporary cement removal techniques may be insufficient to eliminate all surface contaminants, thereby compromising bond strength (Frankenberger et al. 2007). Conditioning protocols—including airborne-particle abrasion with aluminium oxide, phosphoric acid etching, pumice polishing, and tribochemical silica coating—have demonstrated effectiveness in managing residual contamination and improving adhesion when IDS is employed (Breemer et al. 2019). Of these, tribochemical silica coating increases surface area by depositing silica particles, potentially enhancing bond strength. However, aggressive conditioning (silica coating or intensive sandblasting) may inadvertently remove portions of the IDS layer and reduce bond strength (Breemer et al. 2019, Stavridakis et al. 2005). Clinicians are therefore advised to apply a thicker IDS layer using filled adhesive resins or flowable composites when tribochemical silica coating is anticipated (Stavridakis et al. 2005). The appropriate conditioning strategy should be selected based on the composition and thickness of the IDS material and the specific clinical context.

Regarding cement selection, self-adhesive resin cements have gained popularity because of their simplified handling and reduced postoperative sensitivity (Maravić et al. 2023); however, their bond strengths are generally lower than those of conventional resin cements (Miotti et al. 2020).

For the luting procedure, enamel margins are etched for 30 s, rinsed, and an adhesive is applied before the resin cement is loaded into the restoration. The restoration is seated and light-cured to complete polymerization. Recommended material guidelines and key clinical considerations for IDS are summarized in Table 1.

6 Discussion

The distinct anatomical and morphological properties of enamel and dentin necessitate tailored clinical approaches. Enamel predominantly comprises mineralized hydroxyapatite, whereas dentin possesses a higher organic content and is permeated by dentinal tubules connected to odontoblasts, mediating sensory and pain stimuli. Consequently, exposed dentin potentially facilitates microbial infiltration toward the pulp, jeopardizing tooth vitality. Clinical evidence underscores the necessity of effective dentin sealing, supported by findings identifying pulp vitality loss as a frequent biological complication associated with metal-ceramic crowns (Sailer et al. 2015).

The Immediate Dentin Sealing (IDS) technique has received strong support from extensive laboratory and clinical studies, clearly demonstrating its advantages over conventional delayed bonding methods(Magne 2005, Hu and Zhu 2010, Gresnigt et al. 2019, Nikaido et al. 2018, Magne and Nielsen 2009). Laboratory research consistently shows that IDS significantly enhances adhesive bond strength, with microtensile bond strength improvements typically ranging from 20% to 30% compared to delayed sealing approaches (Paul and Schärer 1997). These improvements in bonding performance are further validated by observations of enhanced marginal adaptation, which occur consistently regardless of whether total-etch or self-etch adhesive systems are used (Magne et al. 2007). Additionally, IDS is known for its resistance to common aging factors like thermocycling and prolonged water exposure, resulting in a more durable resin-dentin interface that effectively resists nanoleakage and hydrolytic degradation (Gresnigt et al. 2019, Frankenberger et al. 2007, Breemer et al. 2019).

Table 1 Material considerations and recommendations for Immediate Dentin Sealing (IDS) technique to achieve optimal bonding outcomes

Material Consideration	Recommendations	References
Adhesive Systems	- High-performance adhesives recommended (Three-step etch-and-rinse or two-step self-etch) for reliable seals.- Two-step etch-and-rinse and one-step “universal” adhesives acceptable, but multiple coats and Thin Resin Coating is highly recommended.	(Magne 2005, Choi et al. 2000, Samartzi et al. 2021)
Provisional Cement	- Use temporary resin cement or non-eugenol temporary cement to prevent inhibition of resin polymerization at the interface.	(Oliveira Bernades et al. 2014, Carvalho et al. 2021)
Surface Conditioning Before Cementation	- Light pumice, sandblast, and etching with phosphoric acid at the sealed surface to remove any debris.	(Samartzi et al. 2021, Carvalho et al. 2021)
Resin Cements	- Compatible with total-etch, self-etch, or self-adhesive resin cements.- For self-adhesive cements, selective etching recommended to achieve optimal bonding.	(Carvalho et al. 2021, Nikaido et al. 2018)

It is important, however, to interpret these findings with appropriate caution. A considerable proportion of the evidence supporting IDS derives from in vitro laboratory studies, which — while informative — do not fully replicate the complexity of the clinical oral environment. Laboratory conditions lack the biological variability inherent to clinical practice, including salivary contamination, pulpal fluid pressure, operator variability, and patient-specific factors. Furthermore, methodological heterogeneity across studies — including differences in adhesive systems, substrate preparation methods, aging protocols, and outcome measures — limits direct comparisons and the generalizability of findings. Clinicians should therefore apply a degree of critical judgement when translating in vitro data to clinical decision-making (Samartzi et al. 2021, Duarte et al. 2009, Leesungbok et al. 2015, Abo-Alazm and Safy 2022).

Regarding clinical outcomes, while the majority of trials report advantages with IDS, it is noteworthy that some randomized controlled trials have demonstrated comparable short-term outcomes between IDS and conventional delayed dentin sealing (DDS) protocols, particularly in relation to postoperative sensitivity (Breemer et al. 2019, Breemer et al. 2019). This observation suggests that the clinical benefit of IDS may be more pronounced in specific scenarios — such as preparations with extensive dentin exposure, deep preparations in proximity to the pulp, or cases where lengthy provisional phases are anticipated — rather than constituting an absolute advantage in all clinical situations. A balanced appraisal of both favourable and neutral findings is essential to avoid an overly optimistic interpretation of the current evidence base.

Biomechanically, IDS has demonstrated the ability to reduce cuspal flexure and improve fracture resistance, especially noticeable in large onlay restorations (Oliveira et al. 2014, Stavridakis et al. 2005). Early polymerization of the adhesive layer appears to evenly distribute stress across the restoration, contributing significantly to its structural stability and longevity (Nikaido et al. 2018, Maravić et al. 2023, Miotti et al. 2020).

Clinically, IDS has consistently been associated with reduced postoperative sensitivity, although the extent of this benefit has shown variability among clinical studies (Hu and Zhu 2010, Miotti et al. 2020). Despite this variation, the overall clinical evidence strongly supports adopting IDS. Randomized controlled trials and long-term cohort studies consistently show high survival rates for restorations placed with IDS—frequently exceeding 90% over long-term follow-up periods (Breemer et al. 2021, Gresnigt et al. 2019). Importantly, IDS tends to shift failure modes from adhesive failures to cohesive failures within the tooth or restoration itself, indicating improved bond quality and interface durability (Ariyoshi et al. 2008).

Nevertheless, practitioners should carefully consider several practical challenges associated with Immediate Dentin Sealing (IDS), including the technique's sensitivity, compatibility with different adhesive/cement systems, the influence of adhesive layer thickness in minimally invasive restorations, and the additional chairside time required. Despite these challenges, following precise clinical protocols can significantly mitigate potential drawbacks. Properly executed IDS has been shown to effectively reduce postoperative complications and streamline subsequent restorative procedures.

Successful implementation of IDS hinges on meticulous adhesive application, thorough surface preparation, correct resin cementation methods, and stringent isolation measures. Isolation is particularly critical, as optimal moisture control substantially influences adhesive bonding effectiveness and ultimately determines the success of IDS procedures. Although IDS presents certain technical sensitivities, its well-documented clinical and scientific advantages strongly support its routine adoption in modern restorative dentistry, ultimately enhancing patient outcomes (Tables 2 and 3).

The application of IDS to endodontically treated teeth warrants specific consideration. In non-vital teeth, the absence of pulpal pressure eliminates the outward dentinal fluid movement characteristic of vital dentin, which may modify adhesive interactions at the resin–dentin interface (Sauro et al. 2007). At the same time, endodontically treated dentin may be affected by procedural factors such as irrigant exposure and sealer contamination, both of which can influence bonding performance. Emerging evidence from recent studies on immediate pre-endodontic dentin sealing suggests that early sealing of freshly cut dentin may improve bond strength and may also favorably influence the structural behavior of endodontically treated teeth (Carvalho et al. 2025, Al-Rubaie et al. 2025, Ramos et al. 2025). Nevertheless, the evidence remains limited, and whether IDS provides the same magnitude of benefit in non-vital teeth as in vital preparations has yet to be established conclusively (Carvalho et al. 2025, Al-Rubaie et al. 2025, Ramos et al. 2025). Further studies, particularly well-designed clinical investigations, are needed to clarify the role of IDS in restorations placed on endodontically treated teeth. Clinicians should exercise caution and apply conservative surface preparation protocols in these cases, and further clinical studies specifically addressing IDS in pre or post endodontically treated teeth are warranted (Alghauli et al. 2024, Magne 2005).

Contemporary restorative dentistry is increasingly adopting fully digital workflows, incorporating intraoral scanners (IOS), CAD/CAM design software, and digitally milled or 3D-printed restorations. The integration of IDS within

Table 2 In vitro studies on immediate dentin sealing

Study	Design	Key Findings
Magne et al. (2007)	Microtensile bond strength test at different delays (2, 7, 12 weeks of provisionalization) with IDS vs. DDS. Compared a 3-step etch-and-rinse adhesive (OptiBond FL) and a 2-step self-etch adhesive (Clearfil SE) for dentin sealing.	After up to 12 weeks delay, IDS groups maintained high bond strength (~46–66 MPa) comparable to immediate bonding, regardless of delay. In contrast, unsealed (DDS) groups showed much lower bond strength, especially with the self-etch adhesive (~1.8 MPa after 12 weeks) Conclusion: sealing dentin immediately preserved bond efficacy even after months; IDS bonds were not affected by delay (up to 12 weeks)
Duarte et al. (2009)	Compared indirect restorations with and without IDS using two adhesives: a 2-step etch-and-rinse vs. a 2-step self-etch. Evaluated microtensile bond strength and marginal microleakage	IDS significantly increased bond strength for both adhesive types, with the etch-and-rinse system yielding higher bond values than the self-etch when both were used for IDS, however microleakage was similar to that obtained with Conventional cementation
van den Breemer et al. (2019a)	Applied IDS with different strategies: one vs. two layers of adhesive, or adhesive plus a flowable resin coat (versus no immediate sealing), then placed provisionals. After 1 week and 6 months water storage, tested microtensile bond strength; also tested different surface clean-up methods before final cementation (pumice vs. silica coating).	All IDS groups showed higher dentin bond strength than the non-sealed control, especially after 6-month aging. Using a flowable composite over the adhesive or a two-layer application tended to further improve bond durability. Notably, the method of provisional cement removal did not significantly impact bond strength – simple pumice cleaning was as effective as additional silica coating
Abo-Alazm et al. (2022)	Simulated clinical conditions with pulpal pressure: compared IDS vs. Delayed Dentin Sealing using a one-step self-etch (iBond) and a universal adhesive (GLUMA Bond Universal in self-etch mode). Measured microtensile bond strength after 24 h and 6 months, and assessed dentin permeability.	IDS under simulated pulpal pressure significantly increased bond strength at 24 h and after 6 months compared to delayed sealing After aging, IDS groups retained better bond strength than DDS. Dentin permeability was greatly reduced by IDS, with sealed dentin showing significantly lower fluid flow than unsealed dentin

Table 3 Clinical studies on immediate dentin sealing

Study	Design	Key Findings
Hu & Zhu (2010)	Randomized trial evaluating post-cementation sensitivity after full-coverage crowns. Patients received crowns with either IDS (dentin sealed immediately after prep) or the conventional approach (no sealing until cementation). Post-operative sensitivity was measured.	Hu and Zhu found that immediately sealing the dentin before temporary crown placement was effective in preventing post-cementation hypersensitivity, whereas the unsealed (DDS) group had significantly more sensitivity complaints
van den Breemer et al. (2019b)	Randomized controlled trial (RCT) – compared outcomes of indirect partial crowns (onlays) luted with IDS vs. without IDS. Evaluated patient-reported sensitivity shortly after cementation and patient satisfaction, with follow-ups in the first weeks and at 1 year.	No significant difference in short-term post-operative sensitivity was found between IDS and control groups in this trial Both groups had minimal levels of sensitivity at 1 week and 1 year, likely due to overall good bonding in both protocols. Patient satisfaction was high in both groups, and early post-op sensitivity was low across the board (the IDS protocol did not significantly alter the already low incidence of sensitivity in the control)
van den Breemer et al. (2019c)	RCT 3-year follow-up – same patient cohort as above; measured restoration survival and success over 3 years for lithium disilicate onlays with IDS vs. DDS. Success criteria included retention, marginal integrity, and absence of complications.	After 3 years in function, both groups showed high survival, but IDS onlays trended slightly higher. The IDS group had ~ 96–100% restoration survival vs. ~82–97% for the non-IDS group
Gresnigt et al. (2019)	Prospective clinical trial (11-year) – evaluated the long-term performance of porcelain laminate veneers placed with IDS. Dentin was immediately sealed in all cases (patients with substantial dentin exposure after tooth preparation). Outcomes (veneer survival, debonding, etc.) were assessed over 11 years.	high long-term success was observed with IDS-bonded veneers. Over an 11-year period, veneers placed with immediate dentin sealing exhibited minimal adhesive failures and excellent survival.

digital workflows introduces specific considerations. Proper surface preparation of the sealed dentin surface before scanning, such as elimination of the oxygen-inhibited layer by glycerin application followed by re-curing or by gentle pumice polishing, facilitates digital impression procedures and helps optimize scan quality. In this context, one of the traditional concerns associated with conventional impression materials—namely, their potential interaction with or bonding to the oxygen-inhibited layer—is no longer relevant in fully digital workflows. Although published evidence specifically addressing IDS in fully digital workflows remains limited, the biological rationale for IDS is inherently workflow-agnostic, and its principles are equally applicable to both conventional and digital impression protocols. (Magne 2005, Magne and Nielsen 2009, Stavridakis et al. 2005, Murata et al. 2018). Future research should specifically evaluate IDS outcomes in digitally driven restorative workflows.

In summary, substantial evidence highlights IDS as an effective clinical approach that enhances adhesive bond strength, improves restoration longevity, and maintains structural integrity of indirect restorations. Provided that careful clinical protocols are consistently followed, the benefits of IDS significantly outweigh its limitations, strongly endorsing its use as standard practice in contemporary restorative dentistry. These conclusions are further supported by both in vitro (Table 2) and clinical (Table 3) studies, which consistently demonstrate improved bond durability, reduced dentin permeability, decreased postoperative sensitivity, and excellent long-term clinical outcomes associated with IDS.

7 Conclusion

Successful implementation of IDS demands careful attention to practical challenges, including technique sensitivity, adhesive compatibility, management of adhesive thickness, particularly in minimally invasive preparations, and the additional chairside time required. Meticulous adhesive application, proper surface preparation, precise resin cementation procedures, and stringent isolation protocols are crucial. Effective isolation and moisture control are particularly important, significantly influencing adhesive bond strength and overall clinical success.

Despite these considerations, IDS appears to be a promising and reliable technique supported by a growing body of in vitro and clinical evidence. Its integration into contemporary restorative workflows should be considered on the basis of individual clinical context, with recognition of the existing limitations of the evidence base and the need for further long-term, adequately powered randomized clinical trials.

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Declarations

Competing interests The authors declare no competing interests.

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