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Interaction of immediate dentine sealing with different clinical procedures in aesthetic dentistry: review of literature

Interakcja natychmiastowego uszczelnienia zębiny z różnymi procedurami klinicznymi w stomatologii estetycznej: przegląd literatury

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Summary

Bonding to dentine in adhesive dentistry is a known challenge due to the unique characteristics of dentine. Dentine exposed during tooth preparation is vulnerable to bacterial infiltration and microleakage in the provisional phase, posing risks of post-operative sensitivity and pulp irritation in bonded restorations. To mitigate these issues, immediate dentine sealing (IDS) was introduced. This review explores the interactions between IDS and various treatment phases, from temporization to final assembly.

An extensive electronic search was conducted on PubMed Scopus, and Cochrane Library databases, focusing on in vitro studies and clinical trials published between 2005 and 2023. The search used specific keywords such as "immediate dentine sealing", "IDS", and "prehybridization", targeting studies on IDS applied to human teeth.

Forty-six relevant articles were identified and analysed. The findings consistently emphasize IDS's critical role in improving bond strength between dental restorative materials and dentine.

Streszczenie

Łączenie z zębiną w stomatologii adhezyjnej jest znanym wyzwaniem ze względu na unikalne właściwości zębiny. Zębina odsłonięta podczas preparacji zęba jest podatna na infiltrację bakterii i mikroprzeciek w fazie tymczasowej, co stwarza ryzyko nadwrażliwości pozabiegowej i podrażnienia miazgi w uzupełnieniach cementowych. Aby złagodzić te problemy, wprowadzono natychmiastowe uszczelnianie zębiny (IDS). W tym przeglądzie zbadano interakcje pomiędzy IDS w różnych fazach leczenia, od etapu początkowego do końcowego.

Przeprowadzono szeroko zakrojone elektroniczne wyszukiwanie w bazach danych PubMed Scopus i Cochrane Library, koncentrując się na badaniach in vitro i badaniach klinicznych opublikowanych w latach 2005–2023. W wyszukiwaniu wykorzystano określone słowa kluczowe, takie jak „natychmiastowe uszczelnianie zębiny", „IDS" i „prehybrydyzacja", ukierunkowane na badania dotyczące IDS stosowanego w zębach ludzkich.

Researchers support the localized application of an adhesive system whenever a significant portion of dentine is exposed during tooth preparation for indirect restorations. IDS has been shown to enhance bonding, provide superior water resistance, and reduce post-operative sensitivity. Experts recommend adding a layer of flowable resin and glycerin jelly, followed by a 10-second curing. Additionally, using polyether impression materials should be avoided, while micro-sandblasting is recommended to create surface roughness on the adhesive resin, followed by gentle cleaning with pumice.

Immediate dentine sealing requires meticulous attention but offers promising results in improving dentine bonding and reducing complications in bonded restorations.

Wyróżniono i przeanalizowano czterdzieści sześć artykułów. We wnioskach podkreśla się kluczową rolę IDS w poprawie siły wiązania pomiędzy dentystycznymi materiałami odtwórczymi a zębiną.

Naukowcy popierają miejscowe nakładanie systemu adhezyjnego w przypadku odsłonięcia znacznej części zębiny podczas przygotowywania zębów do uzupełnień pośrednich. Wykazano, że IDS poprawia wiązanie, zapewnia doskonałą wodoodporność i zmniejsza nadwrażliwość pozabiegową. Eksperci zalecają dodanie warstwy płynnej żywicy i galaretki glicerynowej, a następnie utwardzanie przez 10 sekund. Dodatkowo należy unikać stosowania polieterowych mas wyciskowych, zaleca się natomiast mikropiaskowanie w celu uzyskania chropowatości powierzchni żywicy adhezyjnej, a następnie delikatne czyszczenie pumeksem.

Natychmiastowe uszczelnianie zębiny wymaga szczególnej staranności, ale zapewnia obiecujące wyniki w postaci poprawy wiązania zębiny i ograniczenia powikłań przy uzupełnieniach cementowanych.

Introduction

Over the last two decades, significant advancements have occurred in the area of aesthetic and adhesive dentistry. Bonded ceramic restorations have emerged as a reliable and enduring treatment modality for restoring both tooth functionality and aesthetics.[1] The success of treatment involving bonded prostheses hinges on the strength and durability of the bonding interface, which encompasses the interconnection among three crucial components: the tooth surface, the bonding composite and the ceramic prosthesis.

Consequently, achieving optimal clinical outcomes in ceramic bonding necessitates meticulous attention to detail.[1] However, adhesive restorations come with challenges, notably the intricate task of ensuring water-tight bonding. This challenge is exacerbated by the susceptibility of this stage to moisture, such as gingival fluid, saliva and blood. Contamination during the bonding process can lead to bacterial leakage, postoperative sensitivity, recurrent caries, discoloration, and restoration failure.[2,3] Thus, the control of contamination during bonding procedures is pivotal for establishing stable short- and long-term adhesion.

The complexity of successful dentine bonding arises from the heterogeneous substrate of dentine, characterized by higher organic matter and water content compared to enamel. Preparing teeth for indirect bonded restorations, such as ceramic inlays, onlays and veneers, often exposes considerable area of dentine, necessitating protection of the dentine-pulp complex to prevent post-operative sensitivity and bacterial invasion.

The conventional cementation technique for indirect aesthetic restorations, known as the Delayed Dentine Sealing (DDS) technique, involves sealing just before the final restoration

is placed, following the provisional phase. Despite being widely utilized over the years, this technique has drawbacks, including inadequate sealing by temporary sealants, making exposed dentine vulnerable to bacterial microleakage, as well as chemical and mechanical stimuli during various procedural steps.[4]

To address these challenges and associated issues, *Pashley* et al. proposed a novel approach in the early 1990s – immediate dentine sealing. This technique involves applying a dentine bonding agent immediately after tooth preparation, prior to taking the impression. By doing so, bacterial invasion and dentinee sensitivity during the temporization stage are prevented.[5,6] Formerly known as "prehybridization", "double bonding technique", and "resin-coating technique", this procedure is now recognized as the "immediate dentine sealing technique".[7]

The aim of this review is to evaluate the effects of Immediate Dentine Sealing (IDS) on bonded partial restorations, assess its advantages and examine its interactions with various treatment steps, from temporization to final assembly, to establish its clinical implications and provide evidence-based recommendations.

Materials and Methods

Search Methodology

An electronic search was performed in three major scientific databases – PubMed, Scopus, and Cochrane Library – to identify studies related to the Immediate Dentine Sealing (IDS) technique. The search encompassed publications from January 2005 to December 2023.

Following an initial screening of the literature, the search terms included "immediate dentine sealing," "dual bonding technique," "resin coating technique," and "prehybridization." To supplement the electronic search, a manual search of relevant references was also conducted.

The initial search yielded 27,000 articles. Titles, abstracts and full-texts were screened progressively, and all eligible articles were independently evaluated by two reviewers (S.N. and I.B.).

Search Strategy

The search strategy incorporated the use of specific keywords, including "immediate dentine sealing", "IDS", and "prehybridization". Boolean operators (AND, OR) were applied to refine search results and retrieve relevant studies. The search was restricted to articles published in English, and additional filters, such as publication type, were applied to enhance specificity.

Eligibility Criteria (Tab. 1)

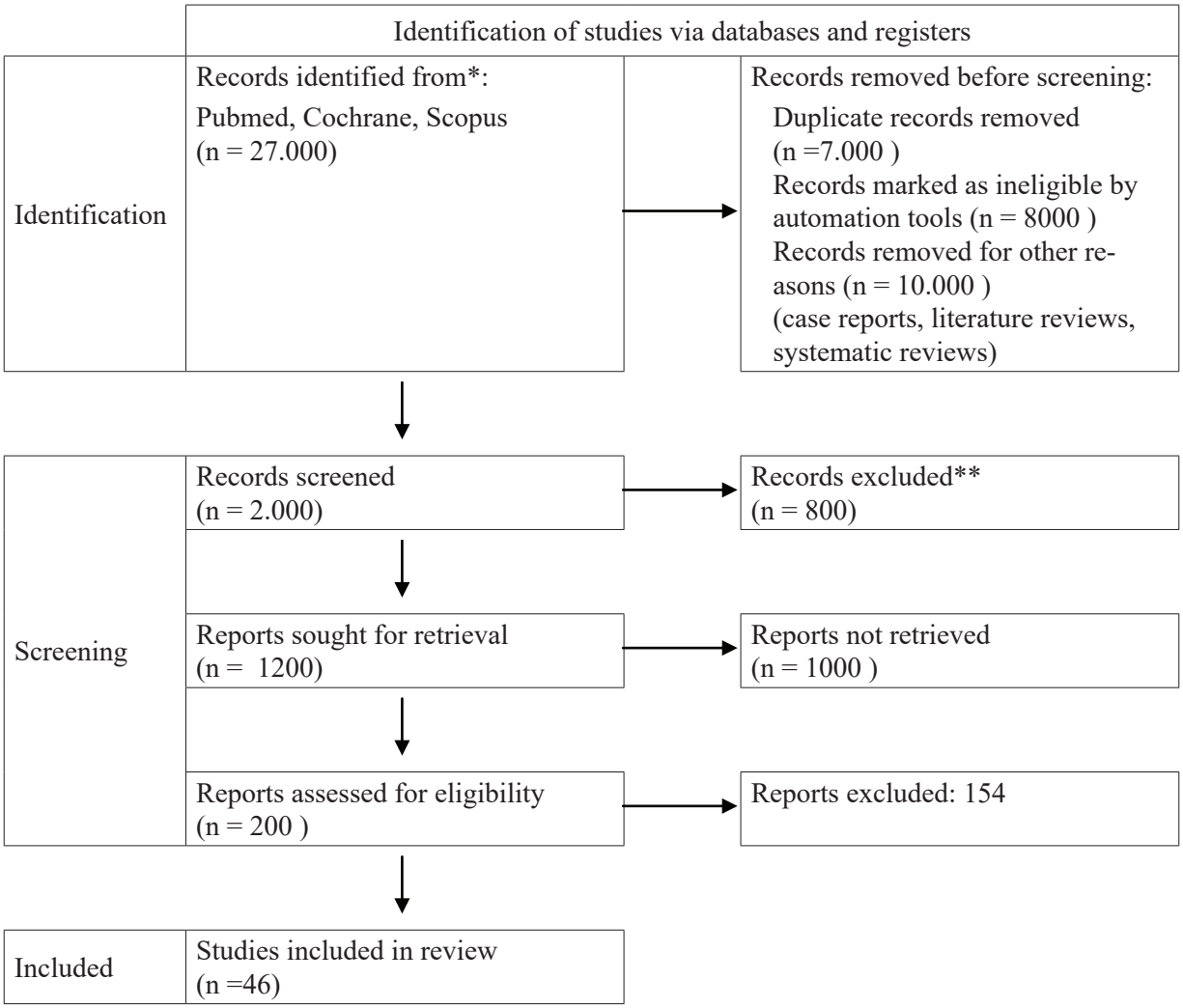
– Inclusion Criteria
  Articles published in English.
  Studies focusing on the application of the IDS technique to human permanent teeth.
  Both *in vitro* and clinical studies were considered.
– Exclusion Criteria
  Studies not published in English.
  Duplicate publications.
  Articles lacking relevance to the IDS technique.
  In vitro studies involving primary or bovine teeth.

Study Selection

Titles and abstracts were independently screened by two reviewers to determine eligibility. Full-text articles were subsequently retrieved and assessed against the inclusion and exclusion criteria. Discrepancies between reviewers were resolved through discussion or, when necessary, consultation with a third reviewer to minimize selection bias.

Data Extraction

Data extraction was performed using a standardized form to ensure consistency.



Extracted information included: study characteristics (e.g., authors, year, study design), population details, intervention specifics (e.g., IDS application protocol), outcomes of interest (e.g., bond strength, durability).

The extracted data were verified for accuracy and completeness to maintain the integrity of the review process.

Results

After excluding irrelevant or duplicate articles, a total of 46 studies were included in this review (Tab. 2). Details regarding the type of study, study design, and main findings are summarized in the tables provided in the appendix.

The included studies primarily focused on key topics such as bond strength, fracture resistance, tensile bond strength, survival rates and dentine hypersensitivity. These aspects were analysed to provide a comprehensive understanding of their clinical and scientific implications.

The main findings were that Immediate Dentine Sealing (IDS) consistently improves bond strength compared to Delayed Dentine Sealing (DDS), enhancing microtensile and shear strength as well as bond reliability in various restorations, including metal-free

onlays and zirconia. Pre-treatment with chlorhexidine further optimizes bonding. IDS also enhances fracture resistance in materials such as lithium disilicate, although its effects on resin composites are less consistent. In terms of survival rates, IDS improves outcomes for restorations with dentine exposure, though long-term clinical differences remain minimal. IDS significantly reduces postoperative hypersensitivity, particularly when combined with systems like Prime & Bond, although its clinical efficacy is not fully conclusive. Effective handling of impression materials is crucial, with air blocking and pumice cleaning recommended to avoid interactions. Furthermore, IDS strengthens bonds with temporary cements and protects freshly cut dentine, although sandblasting may reduce or remove the IDS layer, compromising its sealing effect. Conditioning with silicoated aluminum oxide or glycerine improves bond strength, and IDS also enhances adhesion to resin cement, leading to favourable long-term outcomes. Overall, IDS improves restoration durability and bond strength, though its effectiveness varies depending on the materials and techniques used.

Discussion

The investigation conducted by *Magne* et al.[8] strongly indicates a positive correlation between the Immediate Dentine Sealing (IDS) technique and enhanced bond strength in the final restoration. This augmentation in bond strength has been substantiated across applications involving both etch-and-rinse and self-etching adhesives.

The influence of adhesive prepolymerization on bond strength is noteworthy. In assessments of dentine adhesive bond strength, a prevailing practice involves the initial polymerization (prepolymerization) of the infiltrating resin and adhesive layer before the placement of composite increments. This sequential approach appears to yield superior bond strength compared to instances where adhesive and overlying composite undergo simultaneous polymerization. The rationale behind this superiority lies in the avoidance of potential collapse in the unpolymerized dentine-resin hybrid layer, induced by the pressure exerted during the placement of composite resin or restoration. This observation aligns coherently with the altered bond strength observed in the DDS group.[9]

The pre-curing of adhesive resin, particularly when employed during the cementation of indirect-bonded restorations, introduces practical challenges. Consequently, it is advisable to defer curing until after the restoration is fully seated. This precaution is rooted in the potential adverse effects on the cohesion of the adhesive interface, stemming from the pressure exerted by the composite luting resin during restoration placement, which can cause the demineralized dentine (collagen fibrils) to collapse. The theoretical consideration of thinning the adhesive layer to less than 40 μm for prepolymerization is nuanced by the inhibition layer characteristic of methacrylate resins, which can be up to 40 μm thick, posing a potential impediment to the polymerization of light-activated adhesives.[8]

Resolution to the aforementioned challenges is attainable through the immediate sealing of exposed dentine surfaces. Application and curing of adhesive immediately after dental preparations, before the final impression, has been validated as an effective strategy for generating superior bond strength and minimizing gap formation. This resulting interphase holds promise for sustained resilience under long-term exposure to thermal and functional loads, surpassing the performance of adhesive applied and cured concurrently with the restoration.[14]

The adhesive cementation of ceramic restorations has been empirically established to augment the fracture resistance of both restored teeth and the bonded ceramic restorations. *Spohr* et al.[44] conducted a study revealing that the Immediate Dentinee Sealing (IDS) procedure contributes to an increased fracture load in all-ceramic crowns. Recent investigations by *Gresnigt* et al.[28] have further elucidated the advantageous impact of IDS, showcasing enhanced adhesion and, consequently, improved fracture resistance in lithium disilicate veneers bonded to dentine surfaces in comparison to those bonded to all-ceramic crowns.

When contrasted with bonded restorations using the Delayed Dentinee Sealing (DDS) technique, the superior fracture resistance of posterior lithium disilicate inlay/onlay ceramic restorations has been substantiated through an *in vitro* study conducted by *van den Breemer* et al.[29] The IDS technique's potential to mitigate crack formation is attributed to its ability to alleviate polymerization shrinkage-induced stress concentrations at the adhesive interface, particularly at the ceramic subsurface. This nuanced understanding posits that the delayed final bonding and functional loading associated with the IDS technique enable the gradual development of the dentine bond without subjecting the restoration to undue stress, consequently minimizing the propensity for crack development.

The influence of dentine exposure on the debonding and retention of indirectly bonded restorations becomes evident when evaluating restorations with compromised conventional retention and strength. Numerous studies indicate a markedly lower survival rate for ceramic veneers with deeper preparations exposing dentine compared to those with intra-enamel preparations. It is acknowledged that ceramic laminate veneers bonded to dentine and teeth with preparation margins in dentine are more prone to failure than those bonded to enamel. Specifically, the failure rate for ceramic laminate veneers with preparation margins in dentine over a 12-year follow-up is notably high at 89.3%, whereas the rate for preparation margins in enamel is substantially lower at 3.1%. Additional consideration reveals that dentine exposure on axial surfaces due to preparation depth results in a failure rate of 31.9%, significantly surpassing the 1.3% failure rate observed for in-enamel restorations.

Recent findings by *Gresnigt* et al.[28] highlight the positive impact of Immediate Dentine Sealing (IDS) on the survival rate of ceramic laminate veneers. Their study reports an overall failure rate of 5% (19 out of 348 veneers placed). Intriguingly, for teeth with more than 50% dentine exposure, the IDS technique demonstrates a substantial increase in survival (96.4%), in contrast to a survival rate of approximately 81.1% for teeth bonded with the Delayed Dentine Sealing (DDS) technique. Conversely, *van den Breemer* et al.[22] found no significant difference in the survival rate of posterior ceramic inlays and onlays bonded with IDS and DDS after three years of operation. In a subsequent comprehensive investigation, the same group assessed the survival of 765 posterior inlays and onlays bonded using the IDS technique over an average observation period of 53 months (range 3 to 113 months). The estimated cumulative survival rate was impressively high at 99.6% after five years and 96% after seven years of function. Throughout this follow-up period, 9 out of 765 teeth required endodontic treatment, which was successfully carried out without compromising the integrity of the original restorations. Secondary caries occurred in one tooth, and delamination transpired in another, involving detachment.

The occurrence of detachment in one tooth and secondary caries in another underscores the disparities in the impact of IDS on the survival of distinct restorations. These findings

support the assumption that the enhanced bond strength of ceramic laminate veneers following the IDS technique assumes greater significance, primarily relying on the bonding to tooth structure rather than traditional tooth preparation characteristics of retention and strength. Furthermore, the suggested distinction in stress patterns during function – shear and tensile forces on anterior teeth versus axial loading on posterior inlay/onlay restorations – may contribute to the observed variations in the effect of IDS on the survival rates of ceramic laminate veneers and posterior inlay/onlay restorations.[29-31]

Post-bonding hypersensitivity manifests as a transient, acute pain sensation elicited by thermal and chemical stimuli upon exposure to the vital teeth of the abutment subsequent to the placement of a newly bonded crown or a fixed partial denture. While often self-resolving, this hypersensitivity can persist in certain instances. Notably, perceived sensitivity typically abates within a 24-month period post-cementation. The therapeutic approach to dentine hypersensitivity involves the modulation of mechanoreceptor sensitivity or the occlusion of dentinal tubules. A plethora of products and methodologies have been devised for the effective management of dentine hypersensitivity.[32]

Immediate Dentine Sealing (IDS) represents an innovative strategy for dentine sealing preemptive to impression taking, demonstrating efficacy in mitigating post-operative sensitivity. In a study conducted by *Jun Hu* et al.[34] it was demonstrated that prophylactic intervention using Prime & Bond, a 5th generation adhesive system amalgamating primer and adhesive in a single bottle, through the IDS technique significantly reduces hypersensitivity. The selection of the bonding system employed in the IDS procedure assumes critical importance in addressing dentine sensitivity. Self-etching systems exhibit reduced sensitivity to the technique and demonstrate a heightened qualitative and quantitative penetration capacity compared to conventional systems. This characteristic points towards a proclivity for minimizing post-operative sensitivity, underlining the significance of careful bonding system selection within the IDS framework.[32,33]

Contamination of the resin coating by the impression material remains a persistent challenge, as it has the potential to modify the bond between the existing resin coating and the bonding agent. The final impression of the resin-coated preparation surface presents difficulties, as adhesives form an oxygen-inhibiting surface layer upon light-curing.

To mitigate this issue, a glycerine jelly (air block) can be applied to the sealed surface, followed by an additional 10-second light polymerization step, a practice generally advocated in the IDS (Immediate Dentine Sealing) technique. This procedure aims to reduce the thickness of the inhibited oxygen layer.[15]

The resultant thinner inhibited oxygen layer leads to a thinner layer of inhibited impression material, which should not compromise the precise fit of restorations, particularly when a matrix spacer is employed for indirect restorations.

Magne and *Nielsen*[36] demonstrated that incompletely polymerized resin coating can impede the polymerization reaction of impression materials. Successful polyvinylsiloxane impressions on resin-coated surfaces can be achieved by air blockage and utilization of a pumice stone before impression-taking. Conversely, with polyether, attempts to block out air and sandblasting may result in impression defects due to adhesion and subsequent tearing of the impression material.

The presence of HEMA (2-hydroxyethyl methacrylate), a widely recognized hydrophilic monomer, in the resin adhesive, in conjunction with the high stiffness and low tear strength of

polyethers, may contribute to the development of these adhesions.

Ghiggi et al. (2014) evaluated the interaction between resinous materials utilized in the immediate dentine sealing technique and impression materials using two different techniques: additional polymerization with glycerine jelly and alcohol-soaked cotton pellet application to eliminate oxygen inhibition between resin materials and impression materials.[6]

Distinct interaction patterns were observed between resins and impression materials. For vinyl polysiloxane, unpolymerized impression material persisted on the resin materials due to the reaction of the monomers in the inhibited oxygen layer with the platinum salt. Conversely, with polyether, polymerized impression material remained adhered to the resin materials due to the reaction of the initiating agent of the polyether polymerization reaction with the free radicals of the monomers of the resin materials on the surface, rendering the use of polyether impractical.[6]

Given that most suggested techniques by various authors only mitigate the formation of the oxygen inhibition layer without complete elimination, it is advisable to thoroughly clean the resin-coated surface of the preparation using a low-speed diamond rotary cutting instrument or by abrasion of airborne particles immediately prior to bonding.[35]

However, the advent of digital impression techniques holds promise in resolving all issues associated with interactions between impression materials and cemented dentine surfaces.[31]

In the realm of temporary material and cement selection, it is imperative to avoid resin-based materials. Direct acrylic-based temporary materials lack the ability to hermetically seal preparations, thus leading to contamination of the IDS (Immediate Dentine Sealing) surface and subsequent loss of retention. Conversely, bis-acryl-based direct temporary materials and resin-based temporary cements exhibit strong adhesion to the IDS substrate, resulting in challenging removal processes that may necessitate cutting, thereby compromising dental preparation integrity. Despite thorough mechanical cleaning and conditioning with 37% phosphoric acid, studies utilizing scanning electron microscopy have consistently identified the presence of residual temporary material on dentine.

Given the confirmed presence of temporary material residues post-cleaning, an inquiry arises regarding their impact on bond strength, rendering bonding potentially inadequate. Some authors have noted reduced bond strength of resin materials only when using eugenol-containing cements, while others did not differentiate the type of provisional cement.[5,39-43]

Schoenbaum et al.[38] introduced the "reverse point bonding technique" for temporary cementation, which involves selectively bonding the temporary material in a limited area of the IDS-prepared tooth, away from the margins. This facilitates effective cleaning of the surface during cementation. A small quantity of fast-setting condensation silicone is strategically placed in the preparation, covering a specific portion of the sealed surface. Subsequently, a separating medium is applied to the entire surface, ensuring bonding only in the designated area, while the remainder of the sealed surface remains unbonded due to the presence of the separating film.

The risk of dentine re-exposure post-conditioning is notable and influenced not only by the conditioning method but also by the thickness of the IDS film. Optimal film thickness at the edge of the preparation is desirable to prevent exposure to the oral cavity and subsequent degradation. The use of a filled adhesive, such as Optibond FL, is recommended to mitigate dentine re-exposure after conditioning.[45]

The number of IDS layers significantly impacts its strength. Application of multiple adhesive layers (≤4 layers) enhances bond strength, with separate polymerization of each layer further improving adhesion quality to dentine. While a thicker IDS film contributes to improved stress distribution and higher bond strength, careful consideration of the ideal thickness is paramount, with adherence to manufacturer instructions being essential.[44]

Application of an additional layer of flowable resin post-adhesive application is advisable, particularly when using unfilled adhesives. This facilitates enhanced polymerization of the adhesive system and reduces adhesive permeability, thereby improving coupling with resin cement. Additionally, a low-viscosity resin serves as a protective layer for the underlying hybrid layer, mitigating resin cement polymerization-induced stress and modifying failure patterns. Notably, the selection of the type of low-viscosity resin may influence restoration performance.

IDS significantly influences resin cement bond strength, with variations observed among different cement types. While IDS enhances bond strength for certain resin cements, it may not affect others. Furthermore, IDS demonstrates compatibility with conventional light-cured composites, as evidenced by favourable medium-term prognosis in clinical studies.[21,30]

Practical recommendations for IDS implementation include light etching for differentiation between dentine and enamel, application of multiple adhesive layers with additional flowable composite for unfilled adhesive systems, utilization of glycerine jelly and light-curing for reducing the inhibited oxygen layer thickness, avoidance of polyether as an impression material, preference for eugenol-free temporary cements, and gentle cleaning of IDS-sealed surfaces prior to final restoration cementation.

Conclusion

The Immediate Dentine Sealing (IDS) technique demonstrates clear advantages in terms of bond strength, minimizing gap formation, reducing bacterial microleakage, and addressing dentine hypersensitivity. However, challenges related to its interaction with impression materials, the provisional restoration phase, and surface conditioning prior to cementation warrant further investigation. Importantly, there are no documented contraindications preventing clinicians from incorporating IDS into routine practice.

To optimize clinical outcomes, it is strongly recommended to apply a glycerin jelly layer followed by thorough light curing, perform micro sandblasting to achieve effective surface roughening, and ensure meticulous cleaning of the adhesive resin surface using pumice and a soft brush. Adherence to these guidelines, in conjunction with expert recommendations, ensures the best possible results with this technique.

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Appendix

Table 1. Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
Published in English	Not published in English
Focus on IDS technique applied to human permanent teeth	Duplicate publications
Includes in vitro and clinical studies	Not relevant to the IDS technique
	In vitro studies on primary or bovine teeth

Table 2. Results by adhesion strength criterion

	Authors and publication year	Study Type	Tested parameters	Principales conclusions
1	Magne et al 2005 [8]	In vitro	Bond strength	The application of Immediate Dentin Sealing (IDS) with a 3-stage rinse-and-etch adhesive before taking impressions enhances microtensile strength when compared to the Delayed Dentin Sealing (DDS) technique.
2	Choi et all 2010 [9]	In vitro	Bond strength	The Immediate Dentin Sealing (IDS) technique with Clearfil SE Bond resulted in higher shear strength compared to that achieved with Delayed Dentin Sealing (DDS).
3	Leesungbok et al 2015[1]	In vitro	Bond strength	Ceramic restorations are recommended to be cemented using resin cement within a one-week timeframe following the Immediate Dentin Sealing (IDS) procedure for optimal clinical outcomes.
4	Choi et al 2017 [10]	In vitro	Bond strength	The utilization of Immediate Dentin Sealing (IDS) incorporating adhesive and flowable resin composite has been observed to enhance dentin bond strength, mitigate patient discomfort, and thereby exert a favorable impact on the long-term survival of indirect bonded restorations.
5	Ishi et al 2017 [11]	In vitro		Immediate Dentin Sealing (IDS) not only enhances intra--cavity bond strength but also augments the bond reliability of metal-free onlays.
6	Augusti et al 2018 [12]	In vitro		Immediate Dentin Sealing (IDS) demonstrates efficacy in safeguarding freshly cut dentin from the deleterious effects of temporary materials. In instances where a temporary resin cement is employed, the use of glycine air abrasion is recommended.
7	Murata et al 2018 [3]	In vitro	Bond strength	Immediate Dentin Sealing (IDS) resulted in notable enhancements in microtensile strength, bonding reliability, and durability across the evaluated restorations. Notably, the slope-shaped group exhibited the most optimal performance.
8	Rigos et al 2019 [13]	In vitro	Bond strength	Bonding strategies for monolithic zirconia restorations may potentially derive benefits from Immediate Dentin Sealing (IDS), irrespective of the employed bonding agent system.
9	Van den Breemer et al 2019 [14]	In vitro	Bond strength	Dentin exposure during clinical procedures for indirect restorations is enhanced by the application of Immediate Dentin Sealing (IDS), as demonstrated by its association with increased bond strength. Notably, no significant difference was observed between dentin cleaning using pumice alone and a sequential approach involving pumice followed by a tribochemical silica coating.

Table 2. cont.

	Authors and publication year	Study Type	Tested parameters	Principales conclusions
10	Shafiei et al 2020 [15]	In vitro	Bond strength	Immediate Dentin Sealing (IDS), with or without proanthocyanidin treatment, exhibited a substantial enhancement in the strength of premolars featuring self-adhesive cemented inlays. Notably, the strength achieved with IDS alone, in conjunction with proanthocyanidin treatment, reached a level comparable to that of healthy teeth.
11	Carvahalo et al 2021 [16]	In vitro	Bond strength	Immediate Dentin Sealing (IDS) demonstrated a significant enhancement in bond strength, as measured by microtensile bond strength (μTBS), when utilizing a filled adhesive. In cases where unfilled or low-filled adhesives are employed, reinforcing them with a resin coating becomes imperative to optimize μTBS to dentin in the context of IDS.
12	Denise et al 2021 [17]	In vitro	Bond strength	Pre-treatment with chlorhexidine has been observed to enhance the bond strength between resin cement and dentin when Immediate Dentin Sealing (IDS) treatment is executed with a universal adhesive system.
13	Nabil et Zohdy 2021[18]	In vitro	Bond strength	The application of Immediate Dentin Sealing (IDS) treatment is recommended in scenarios characterized by high tensile stress, particularly when the refreshing of the tooth structure surface is performed using air abrasion. This method entails the utilization of air abrasion to refresh the surface of the tooth structure.
14	Nakazawa et al 2022 [19]	In vitro	Bond strength	The Immediate Dentin Sealing (IDS) accomplished through the synergistic application of an adhesive system and a flowable resin composite demonstrated superior bond strength and the utmost bond durability in terms of qualitative bonding performance. This efficacy persisted even under cyclic loading conditions designed to simulate clinical mastication.
15	Magne 2012 [20]	In vitro	Bond strength	The application of Immediate Dentin Sealing (IDS) with a 3-stage rinse-and-etch adhesive before taking impressions enhances microtensile strength when compared to the Delayed Dentin Sealing (DDS) technique.
16	Santana et al 2016 [21]	In vitro	Résistance à la micro- traction	Regardless of the simulated pulpal pressure conditions, the Immediate Dentin Sealing (IDS) technique yielded higher microtensile strength with certain adhesive systems (Panavia F, Clearfil SA, and RelyX Unicem), while exhibiting no discernible influence on the microtensile strength of others (Rely X ARC).

Table 2. cont.

	Authors and publication year	Study Type	Tested parameters	Principales conclusions
17	Van den Breemer et al 2017 [22]	In vitro		Immediate Dentin Sealing (IDS) demonstrated a statistically significant improvement in the fracture toughness of lithium disilicate, while exhibiting no significant effect on the fracture toughness of a multiphase resin composite.
18	Yassen et Haridy 2018 [23]	In vitro		Immediate Dentin Sealing (IDS) not only enhances intra-cavity bond strength but also augments the bond reliability of metal-free onlays.
19	Van den Breemer et al 2019 [24]	In vitro		IDS improves shear strength compared with DDS.
20	Hofsteenge et al 2020 [25]	In vitro	Aging and fracture strength	The implementation of Immediate Dentin Sealing (IDS) alongside overlay preparation contributes to an enhancement in overall fracture resistance. Notably, there is no significant difference in fracture resistance between inlays with IDS and overlays without IDS. Both inlays and overlays exhibit sufficient strength to withstand physiological masticatory forces.
21	Abdulrahman et Zohdy 2021 [26]	In vitro	Tensile Bond Strength	Immediate Dentin Sealing (IDS) is recommended in instances characterized by high tensile stress, as it exerts a beneficial impact on the bond strength of indirect restorations.
22	Gailani et al 2021 [5]	In vitro		The amalgamation of the Kerr three-stage etch-and-rinse protocol with universal adhesives from Dentsply, Ivoclar, 3M, and Coltene yielded the highest bond strength values. Notably, a majority of the microtensile strength values were either equal to or higher in Immediate Dentin Sealing (IDS) compared to Delayed Dentin Sealing (DDS).
23	Abo Alazm et Safy 2022 [2]	In vitro		The Immediate Dentin Sealing (IDS) technique, employing a self-etching universal adhesive, emerges as an efficacious strategy for enhancing the ultimate bond strength of composite resin restorations, concurrently mitigating dentin permeability.
24	Saadedine et al 2022 [27]	In vitro	Fracture resistance	The incorporation of Immediate Dentin Sealing (IDS) contributed to an enhancement in the fracture resistance of ceramic onlays..
25	Gresnigt et al 2019 [28]	Prospective clinical trial	Survival, success rate, patients satisfaction	Immediate Dentin Sealing (IDS) demonstrated a significant beneficial effect on teeth with more than 50% dentin exposure.

Table 2. cont.

	Authors and publication year	Study Type	Tested parameters	Principales conclusions
26	Van den Breemer et al 2019 [29]	Randomized clinical trial	Prognosis, Survival rate	Bonded ceramic partial restorations in vital molars exhibit a favorable prognosis. However, Immediate Dentin Sealing (IDS) revealed no discernible difference in success and survival rates after three years of functional use.
27	Van den Breemer et al 2021 [30]	Prospective clinical trial	Long term prognosis	Partial posterior glass-ceramic (pressed lithium disilicate) restorations, when bonded with a conventional light-cured resin composite and combined with the Immediate Dentin Sealing (IDS) procedure, demonstrate an excellent medium-term prognosis.
28	Vasluianu et al 2021 [31]	Clinical trials	Survival rate, resistance	Combining the IDS technique with bonded onlays in the treatment of extensive coronal lesions of molars helps to preserve their vitality, ensure their increased resistance over time, and preserve a stable occlusion and even periodontal protection through precise rendering of crown morphology, occlusal and interproximal contacts.
28	Vasluianu et al 2021 [31]	Clinical trials	Survival rate, resistance	Combining the IDS technique with bonded onlays in the treatment of extensive coronal lesions of molars helps to preserve their vitality, ensure their increased resistance over time, and preserve a stable occlusion and even periodontal protection through precise rendering of crown morphology, occlusal and interproximal contacts.
29	Sahin et al 2012 [32]	In vitro	Dentin permeability	Among the tested adhesives, only the G-Bond one-step self-etch system and the Clearfil Protect Bond two-step self-etch adhesive demonstrated greater effectiveness in sealing dentin compared to the original smear layer.
30	Luong et al 2020 [33]	In vitro	Hypersensitivity	Dentine desensitizer has been demonstrated to proficiently seal dentine tubules and facilitate mineral crystal growth on dentine and within tubuli during simulated body fluid storage. To achieve optimal bonding to desensitizer-treated dentin, it is advisable to utilize a two-stage self-etch system for dentin treatment.
31	Hu et al 2010 [34]		Hypersensitivity after bonding	Preventive treatment with Prime & Bond, employing the Immediate Dentin Sealing (IDS) technique, can significantly diminish post-cementation hypersensitivity.
32	Josic et al 2022 [35]	Clinical trials	hypersensitivity	There is low-certainty evidence indicating that Immediate Dentin Sealing (IDS) does not decrease post-operative sensitivity in teeth restored with indirect restorations.
33	Magne et Nielsen 2009 [36]	In vitro	Interaction with Impression Materials	The Immediate Dentin Sealing (IDS) protocol necessitates subsequent air blocking and pumice cleaning to achieve optimal impressions with A-silicone. It is advised to refrain from utilizing polyether in conjunction with IDS.

Table 2. cont.

	Authors and publication year	Study Type	Tested parameters	Principales conclusions
34	Ghiggi et al 2014 [6]	In vitro	Interaction with Impression Materials	Adhesives exhibited interactions with impression materials. The utilization of glycerine jelly and alcohol effectively mitigated the interaction between a self-etching adhesive (Clearfil CE Bond) and vinyl polysiloxane, as well as between flowable resin (Protect Liner F) and polyether. However, these treatments proved inadequate in completely preventing the interaction of Clearfil SE Bond with polyether or Protect Liner F with vinyl polysiloxane.
35	Sinjari et al 2019 [15]	In vitro	Interaction with Impression Materials	Surface cleaning protocols involving prophylactic paste and surfactant result in the mitigation of interactions with impression materials and the elimination of the inhibited oxygen layer.
36	Verma et al 2019 [37]	In vitro	Interaction with Impression Materials	The Immediate Dentin Sealing (IDS) procedure necessitates subsequent air blocking and pumice application to achieve optimal impressions with Aquasil (A-silicone). The combination of Impregum Soft (polyether) with immediate dentin sealing is not recommended.
37	Schoenbaum et al 2012 [38]	Clinical Technique	Temporary Prosthesis	The provisional restoration incorporating silicone and a separating medium demonstrated efficacy for a duration of up to six weeks.
38	Brigagao et al 2017 [39]	In vitro	Adhesion strength and provisional luting cement	Immediate Dentin Sealing (IDS) performed prior to the application of temporary luting cement resulted in the highest dentin bond strength values among the tested resin cements.
39	Augusti et al 2018 [5]	In vitro	Provisional cement	Immediate Dentin Sealing (IDS) has demonstrated effectiveness in preserving freshly cut dentin from the deleterious effects of temporary materials. The use of air abrasion is recommended for the removal of debris from temporary resin cements.
40	Hironka et al 2018 [40]	In vitro	Provisional cement and bond strength	The application of Immediate Dentin Sealing (IDS) before sealing led to a chemical interaction at the interface, manifesting in significantly elevated values for micro--tensile strength and diffusion zone thickness. Notably, intermediate sealing did not compromise the quality of the bond.

Table 2. cont.

	Authors and publication year	Study Type	Tested parameters	Principales conclusions
41	Hayachi et al 2019 [41]	In vitro	Temporary prosthesis and adhesion strength	Immediate Dentin Sealing (IDS) elicited an enhancement in bond strength, with temporary restoration exerting no discernible impact on it. IDS performed without temporary restoration yielded the highest bond reliability, achieving specific values for microtensile strength and durability against delamination.
42	Maciel et al 2021 [42]	In vitro	Provisional Cement and resistance to micro-tensile stress	Sandblasting with sodium bicarbonate emerged as the most effective method for achieving optimal micro-tensile strength while successfully removing temporary cement, without compromising the thickness of Immediate Dentin Sealing (IDS).
43	Guilardi et al 2022 [43]	In vitro	Provisional Cement and Bond Strength	The antecedent application of Immediate Dentin Sealing (IDS) preceding temporary sealing yielded superior outcomes in terms of bond strength.
44	Sphor et al 2013 [44]	In vitro	Thickness of adhésif	The thickness of the film generated by Immediate Dentin Sealing (IDS) materials is subject to variation based on the position under the crown, indicating a potential impact on the breaking load of crowns.
45	Kolvasky et al 2022 [45]	In vitro	Thickness of IDS	Sandblasting leads to a reduction in the thickness of the Immediate Dentin Sealing (IDS) layer, and in several instances, it is completely removed.
46	Falkensammer et al 2014 [46]	In vitro	Bond strength, conditioning method	Polishing and abrasion using silicoated aluminum oxide or glycerine emerge as effective methods for conditioning the surfaces of both immediate and delayed dentin sealants.