New adhesive protocols as the foundation of long-term results in direct and indirect tooth-colored posterior restorations

Dr. Didier Dietschi

Why did we have to revisit conventional protocols:

An essential factor influencing the lifespan of all partial bonded restorations (class I & II fillings, onlays, overlays and veneers) is the stability of the adhesive interface, without which marginal and internal adaptation will degrade, leading first to margin discoloration (the first and sometimes only sign of this decaying process onset), followed by recurrent decays and also bulk-fractures, being the most frequent failure patterns, well documented in the literature (Fig. 1 & 2) (1,2) . If on the contrary, optimal adhesive and application protocols are being used, excellent restoration longevity is achieved with both direct & indirect tooth-colored restorations posterior (Fig. 3 A to D)

About Dr. Didier Dietschi

Dr Didier Dietschi was licensed in 1984 and got his doctoral and Privat Docent degrees in 1988 and 2004, respectively, at the University of Geneva, Switzerland. He also got a PhD degree in 2003 at the University of ACTA, Netherlands.

Dr. Dietschi has published over 125 clinical and scientific papers and book chapters on adhesive and aesthetic restorations; he also co-authored the book “Adhesive Metal-free Restorations”, edited in 1997 by Quintessence and translated in 7 languages. His new textbook entitled “TOOTH WEAR – Interceptive treatment approach with minimally invasive protocols” has been launched in June 2023 and which has become “best seller” of Quintessence Publishing in 2024.

He is since 1997 an Active Member of the EAED – European Academy of Esthetic Dentistry for which he will serve as President for the term 2025-2027. After being an Honorary Member of the AIC - Italian Academy of Conservative Dentistry , he has also been appointed Active Member since 2024.

Dr. Dietschi is internationally renowned for his theoretical and practical teaching programs on adhesive & aesthetic restorations.

Fig. 1

Fig. 2

Fig. 3a

Fig. 3b

Fig. 3c

Fig. 3d

The most common clinical problems encountered with indirect bonded posterior restorations are, once again, related to tissue conservation (creating an appropriate cavity design might lead to significant loss of sound tissue), impression taking and adhesive cementation (deep proximal preparations are a challenge and make working field isolation more difficult) and last but not least the interim restorations (the placement of conventional acrylic temporaries are time consuming and the cement contaminates the interface, while simplified “soft” light-curing temporaries get easily lost and trigger sensitivity after some time due to leakage and dentin contamination). An original and comprehensive treatment protocol was introduced by Dietschi and Spreafico in 1997 and 1998 (3,4), which after some initial skepticism, prompted a lot of research and obtained then confirmation from numerous studies. This new treatment approach embraces different concepts which answer satisfactorily the aforementioned clinical issues.

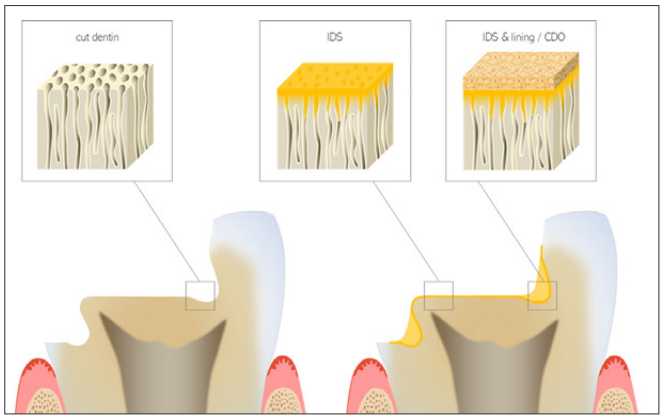

Fig. 4

Actually, the following treatment concepts/procedures (Fig. 4) address comprehensively each clinical problem related to the classical clinical protocol (table 1):

- Immediate Dentin Sealing (IDS) or Dual Bonding (DB) or
- Cavity Design Optimization (CDO)
- Cervical Margin Relocation (CMR) or Deep Margin Elevation (DME)
- Controlled Adhesive Cementation (CAC)

The first of these 4 concepts, the **"Immediate Dentin Sealing"** or **"Dual Bonding"**(Fig. 4) relate to the substrate treatment and was introduced first in 1997 by Paul and Schäerer for crown preparations (5), following the work of Pashley on dentin hybridization (6) and in 1997 & 1998 by Dietschi & Spreafico (4) and Dietschi and co-workers (7,8) for class II restorations. The concept of "Immediate Dentin Sealing" (IDS) was further investigated by Magne and Stavridakis (9,10) who explored new indications of this approach, such as in veneering techniques. The idea here is to seal the dentin surfaces with a full adhesive system while the cavity still is isolated (normally with a rubber dam); this will prevent further tissue dehydration (mainly when treating serial cavities), dentin contamination and then provides optimal tooth protection against sensitivity during the temporary phase while improving bond strength and stability of the adhesive interface.

The second concept **"Cavity Design Optimization"** (Fig. 4) was developed in parallel with the Immediate Dentin Sealing to overcome the unnecessary tissue removal when adapting inner cavity design to an indirect technique (parallel or slightly tapered). Following application of the DBA (and following DB or IDS concept), a flowable composite liner is applied to fill-in all undercuts and confer the cavity an ideal geometry. An ideal material consistency should ensure material's stability within undercuts while self-leveling to avoid further preparation and finishing; therefore, highly filled flowable composites are recommended. Actually, the use of products with a high viscosity (restorative composites) or very low viscosity (low-filled flowable composites) is feasible but application is less practical.

The third concept named **"Cervical Margin Relocation"** (fig 5. A to C) was also introduced by Dietschi and Spreafico (4) (and renamed "Deep Margin Relocation" by Magne and Spreafico (11) and is considered for deep proximal preparations (intra-sulcular) which complicates impression taking and cavity isolation during cementation. In this case, after proper positioning of a matrix in the cervical area, a first layer of flowable or restorative composite (or a combination of those two materials) is applied to reposition the margin. Actually, the use of a flowable composite is recommended up to 1-1.5mm only (12). Another critical condition is to grant perfect isolation of the cervical preparation for successful adhesive procedures; indeed, when respecting the true indication of this procedure (mainly intra-sulcular), the placement of rubber dam together with the matrix rarely is impossible.

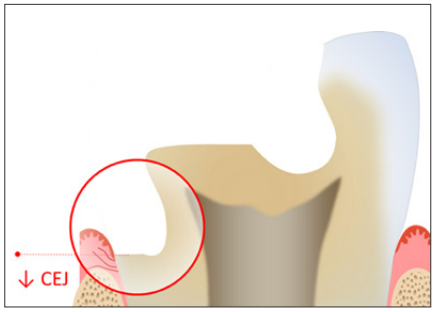

Fig. 5a

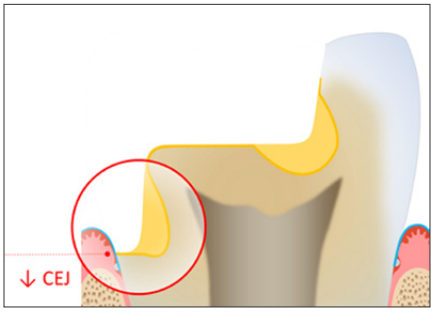

Fig. 5b

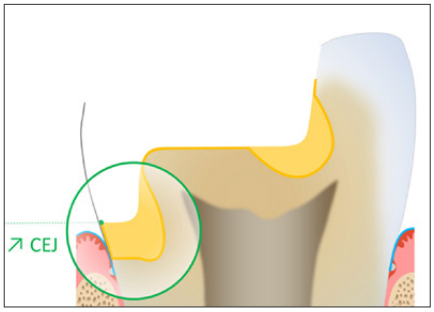

Fig. 5c

Last but not least, the use of a highly filled light-curing material for cementation ensures optimal working time and control, what is not the case with dual-curing adhesive cement (13). This concept shows also major advantage in complex cavity design and in combination with the Cervical Margin Relocation technique which grants visual margin sight; then, a proper removal of cement excesses becomes uncomplicated, offering unparalleled advantage. It is advisable to use a fine/micro-hybrid, whose viscosity is reduced at the time of placement using a special ultra-sonic or sonic cementation tips, which greatly facilitate restoration insertion. Of course, the possibility to bring enough light inside the cementing space for optimal composite conversion and mechanical properties has been researched; the results of different studies proved that proper light polymerization is feasible and in some conditions, even superior to what can be achieved with a dual-curing material in dark-curing condition (14) The Cavity Design Optimization concept also contributes to reduce and optimize restoration thickness and therefore favors proper light-transmission within the luting interface. Additionally, anesthesia during cementation procedures is virtually not needed anymore as dentin remains fully protected by the liner/base, what is another benefit of this technique (Fig 6. A to E).

Fig. 6a

Fig. 6b

Fig. 6c

Fig. 6e

Fig. 6d

CONCEPT & TERMINOLOGY	RATIONALE & BENEFITS	REFERENCES
Dual Bonding (DB)	Dentin sealing and protection before impression and provizionalization. Improved bond strength and adhesive interface quality	Dietschi & Spreafico, 1997 Dietschi & Spreafico, 1998 Dietschi & Herzfeld, 1998 Dietschi et al, 2002
Immediate Dentin Sealing (IDS)		Dietschi & Spreafico, 1998 Stavridakis et al, 2005 Magne, 2005 (BPR*) Magne et al, 2005 (BPR*)
Cavity Design Optimization (CDO)	Application of an adhesive base liner to: • Optimize cavity geometry • Fill undercuts Harmonize and limit restoration thickness • Protect exposed dentin during temporary phase • Improve restoration adaptation	"Dietschi & Spreafico, 1997 Dietschi & Spreafico, 1998 Dietschi et al, 2003"
Cervical Margin relocation (CMR)	Displace supra-gingivally an intra-crevicular cervical margin to facilitate and improve: • Impression procedures • Cementation procedures • Cleaning & finishing of margins • Restoration adaptation • Rubber dam placement (for cementation)	Dietschi & Spreafico, 1998 Dietschi et al, 2003
Deep Margin Relocation (DME)		Magne & Spreafico, 2012
Controlled Adhesive Cementation (CAC)	Luting partial restorations with highly filled light-curing restorative composite to: • Reduce luting cement wear • Control cement excess removal • Extend working time	Besek et al, 1995 Dietschi & Spreafico, 1998 Dietschi et al, 2003

Table 1 - Development of concepts for adhesive inlays & onlays, with original references

The procedures and principles described in the table 2 (revised protocol) also features the following clinical advantages:

- the absence of tissue removal for convenience, material's properties or technology limitations
- the gentle treatment of pulpo-dentinal complex during the preparation and eventually the temporary phase, by using systematically rubber dam, extensively water spray and isolating dentin immediately after preparation (with thick layer of DBA and adhesive base/liner)
- the long-term function and tooth-resistance through the use of a wear resistant, strong and "rigid" restorative materials (both restoration and cement)
- Strong and durable adhesive interfaces between the materials or substrate (dentin/enamel to adhesive, adhesive to base-liner, base-liner to composite cement and composite cement to restoration).

Preparation	• No specific isolation • Convenient marginal and internal design is required (taper)	• Under rubber dam, mostly under water spray • Only marginal convenient design
DBA application	At cementation	Just after preparation
Base/liner	Optional	Mandatory
Base/liner material	Composite or glass ionomers	Composite only (flow mainly)
Provisional restoration	Cemented provisional temporary recommended	Non-cemented, light-curing temporary
Luting material	Dual-curing composite cement	Light-curing restorative composite
Restoration insertion	Manual	Assisted with sonic/ultrasonic tip (eventually with heated material)

Table 2 - Description of the major differences between the "conventional" and "revised" preparation and cementation protocols for indirect adhesive class II restorations (according to Dietschi and Spreafico, 1997 & 1998)

Conclusion

Overall, the aforementioned concepts have been extensively evaluated in-vitro and there is strong, positive evidence toward this revised treatment protocol (15-19). In-vivo, the influence on restoration quality and longevity of a low-E modulus base-liner and its nature have been specifically investigated and largely validated as well. It is allowed to confirm today that aforementioned scientific and clinical evidences defined these protocols as the "Golden Standard" for indirect adhesive posterior restorations.

Figure Legends

Figure 1 & 2: Catastrophic failures of indirect ceramic onlays and direct fillings; the most likely reason for such failure to happen usually if a severe degradation of the adhesive interfaces, critical to the lifespan of any bonded restoration.

Figure 3: A) Direct fillings made with micro-hybrid resin composite, demonstrating the classical layering technique aiming to build-up first the proximal surfaces and contacts, before filling-up the occlusal volume, such as for a class I restoration. **B)** Post-treatment view after, respectively, 18Y (C) and 26Y (D) of clinical service. Apart from slight occlusal wear, the stability of adhesive interfaces promoted excellent behavior and longevity of restorations made with a direct technique.

Figure 4: Schematic representation of the IDS (Immediate Dentin Sealing) and Liner / Cavity design Optimization (CDO) which serve to enhance the interface quality and stability of indirect bonded restorations, while promoting tissue conservation when the CDO/Liner is being used to fill-up cavity undercuts.

Figure 5: A) Deep proximal preparations pose a true challenge to the clinician when attempting to isolate operation field, make the impression and later, to check the marginal, proximal fit and control cementation procedures. **B)** In such situation, the IDS and CDO protocols alone do not overcome aforementioned issues. **C)** The Cervical margin Relocation (CMR) is the key to make the whole procedure more reliable and efficient. One key condition remains of course to be able to place the rubber dam correctly, which necessitate to avoid deep biological width violation; this technique is better used for intra-sulcular margins, possibly also with only junctional epithelium involvement.

Figure 6: A) Failing direct class I & II restorations resulting from the improper behavior of a resin-modified glass ionomer base material. **B)** New indirect restorations were produced (in composite) following the application of the 3 novel protocols (IDS, CDO & CMR) (C). **D & E)** With help of these new clinical procedures, a formerly delicate situation (treating deep and large proximal cavities) became a highly reliable and simplified treatment with improved outcome.

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Disclosure: Dr. Didier Dietschi is a consultant for Kerr. The opinions and technique expressed in this article are based on the experience of Dr. Didier Dietschi. Kerr is a medical device manufacturer and does not dispense medical advice. Clinicians should use their own professional judgment in treating their patients. All trademarks and brand names are the property of their respective owners.