ivoclar

Scientific Report

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English

Ivoclar Universal Adhesives

Adhese® 2
Adhese® Universal
Adhese® Universal DC



Making People Smile

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Foreword



Thorsten Bock
Director R&D Organic Chemistry

In recent years, adhesive dentistry has shown remarkable momentum - new classes of materials, innovative monomers, functional additives and streamlined protocols have collectively transformed restorative therapy. Within the realm of universal adhesives, Ivoclar not only accompanied this change but played a pivotal role in shaping the quality-standards of this product group with the introduction of Adhese® Universal in 2014. Its broad market acceptance, supported by numerous studies demonstrating excellent bond strength, marginal integrity and long-term clinical success, provide compelling evidence. Adhese Universal has become one of the gold standards of daily dental practice.

Adhese® 2 continues this legacy, with a one-component delivery system suitable for direct and indirect indications, all etching techniques and curing protocols.

Adhese 2 further advances adhesive cementation through the use of catalytically-coated brushes and VivaPen® tips. These innovative applicators allow the universal adhesive to polymerize together with self-curing resin cements like Variolink® Esthetic DC, without any need for light-activation - eliminating concerns of the cured adhesive layer affecting fit.

Adhese 2 demonstrates high tolerance to both moist and dry surfaces, high bond strengths, and excellent marginal quality. It can be stored at room temperature, and presents with a low risk of postoperative sensitivity. These advancements have been made possible with a carefully balanced formulation of hydrophilic and hydrophobic monomers, combined with an innovative cross-linking molecule, enabling effective wetting of both moist dentin and hydrophobic composite substrates. The proven MDP adhesive monomer, in synergy with an optimized polyacrylic acid-based polymer, delivers excellent adhesion and marginal integrity. A newly developed rheology additive also affords precise modulation of flow and wetting characteristics, facilitating the application of a uniform, ultra-thin layer, optimizing both function and esthetics.

A further determinant of clinical success is ease of application. Adhese 2 is offered in three dispensing formats: Free Stand® Single Dose, bottle and VivaPen – whereby the ergonomic, cost-effective VivaPen offers up to 4x more applications per millilitre than many bottled adhesives.

Designed to meet the highest standards of direct and indirect restorative dentistry, Ivoclar has introduced a new generation of universal dental adhesive with Adhese 2. This Scientific Report summarizes the results of the most relevant investigations with the Ivoclar Universal Adhesives: Adhese Universal, Adhese Universal DC and Adhese 2.

As lasting customer satisfaction is our highest priority, we genuinely appreciate feedback and look forward to hearing from you.

Ivoclar Universal Adhesives

Adhese Universal

Introduced in 2014, Adhese Universal was the first "universal" adhesive from Ivoclar. It is a **light-curing**, single-component dental adhesive for enamel and dentin that is compatible with all etching techniques: etch & rinse, self-etch and selective-enamel-etch. Suitable for bonding both direct and indirect restorations, it is available in bottle and VivaPen form.





Adhese Universal DC

Adhese Universal DC can be used in the same way as Adhese Universal with the added possibility of **dual-curing** indirect restorations – in situations with limited light access. Available in Free Stand Single Dose units, the co-initiator to boost chemically-induced curing is pre-coated on the applicator brushes, which are available in Regular size and Small/Endo size for endodontic procedures.



Adhese 2

Universal bonding newly defined: The Ivoclar VivaPen is more universal than ever with Adhese 2, a newly formulated, **dual-curing**, single-component dental adhesive for enamel and dentin, compatible with all etching techniques: etch & rinse, self-etch and selective-enamel-etch. Suitable for bonding both direct and indirect restorations, it is available in bottle, VivaPen® and Free Stand® Single Dose form – with special coated cannulas and applicators for dual-curing procedures.



Product characteristics and indications

	Adhese Universal	Adhese Universal DC	Adhese 2
Characteristics & use			
Composition	HEMA, Bis-GMA, D3MA, MDP, ethanol, water, methacrylate-modified polyacrylic acid, silicon dioxide, camphor-quinone, ethyl p-dimethyl aminobenzoate, 2-dimethyl aminoethyl methacrylate	HEMA, Bis-GMA, D3MA, MDP, ethanol, water, methacrylate-modified polyacrylic acid, silicon dioxide, camphor-quinone, ethyl p-dimethyl aminobenzoate, 2-dimethyl aminoethyl methacrylate, potassium hydroxide	HEMA, TUDMA, D3MA, MDP, ethanol, water, methacrylate-modified polyacrylic acid, silicon dioxide, camphor-quinone, ethyl p-dimethyl aminobenzoate, 2-dimethyl aminoethyl methacrylate, potassium hydroxide
Etching techniques	Etch & Rinse Self-Etch Selective-Etch	Etch & Rinse Self-Etch Selective-Etch	Etch & Rinse Self-Etch Selective-Etch
Curing mode	Light-curing	Dual-curing*	Dual-curing*
Compatible composites	Light-curing Self-curing Dual-curing	Light-curing Self-curing Dual-curing	Light-curing Self-curing Dual-curing
Delivery forms			
Delivery form	VivaPen Bottle	Free Stand Single Dose	VivaPen Bottle Free Stand Single Dose
VivaPen cannulas	LC	n/a	Blue DC Black LC
Bottle applicators	LC	n/a	Blue DC Black LC
Free Stand Single Dose applicators	n/a	DC	Blue DC
Indications			
Direct restorations	✓	✓	✓
Indirect restorations	If light-curing is possible	✓	✓
Endodontic & light-limited restorations	✓	✓	✓

*Light curing possible and self-curing in combination with dual-curing luting composites

Scientific Insights

Universal Adhesives

Adhesive dentistry has undergone profound evolution, playing a pivotal role in shaping the principles of minimally-invasive restorative dentistry. Early systems in the 1960s were limited to enamel-etching only, followed in the 1980s and 1990s by the introduction of multi-step total-etch and selective-etch adhesives. By the late 1990s, self-etch adhesives emerged, progressively streamlining application protocols from multi-bottle to single-bottle systems around 2000. The latest milestone came around 2011, with the development of "universal" adhesives, designed to combine the advantages of previous generations while simplifying clinical application.

The term "universal" has differed between manufacturers and over time, but primarily universality has referred to the ability to condition enamel and dentin as the clinician wishes. That is: phosphoric acid etching of both the enamel and dentin (etch & rinse/total-etch), phosphoric acid etching of the enamel only (selective-enamel-etch) or conditioning with the (acidic) adhesive alone without utilizing phosphoric acid etching (self-etch).

Ivoclar's Adhese range of universal adhesives (notably Adhese 2), represents the current state of the art in modern dental adhesives. The German evidence-based and consensus-backed clinical practice guidelines on composites from 2024 – S3-Leitlinie Zahnmedizin (2024), unanimously named universal adhesives as a benchmark in dental bonding. The 2024 Berlin Quintessenz Expert Hearings (2024), intended to provide clear statements and guidance for the modern dental practice, also referred to universal adhesives as the new "gold standard", concluding that universal adhesives achieve the best clinical effectiveness to date and in terms of bond strength and marginal integrity, their clinical efficacy is at least equal to that of traditional multi-bottle systems.

Universal adhesives are now approaching true, evidence-based universal acceptance

Adhesive monomers

Monomers have transformed modern dentistry, forming the basis of numerous materials such as composite resins, adhesives, and luting composites. Common monomers include Bis-GMA (bisphenol A-glycidyl methacrylate), HEMA (2-hydroxyethyl methacrylate), TEGDMA (triethylene glycol dimethacrylate), UDMA (urethane dimethacrylate) and MDP (10-methacryloyloxydecyl dihydrogen phosphate). They can be blended to balance hydrophilic and hydrophobic properties and possess the ability to bond with one another – generating a cross-linked polymer network when activated by light, heat or chemical initiators.

Bis-GMA has long been a cornerstone-monomer in dental materials, valued for its favourable mechanical properties and polymerization behaviour. However, because it is synthesized from BPA (bisphenol A), a compound associated with endocrine disruption, it has become the focus of growing concern within the public health community.

Any contribution to BPA exposure from dental materials is minor compared to dietary sources. Definitive safety and clinical-significance conclusions are also problematic due to the established non-monotonic dose-response relationship with the substance (Tichy et al. 2025) - referring to the situation whereby a biological response to a substance is expressed in a non-linear fashion. Nevertheless, there has been an ongoing industry-shift away from the use of BPA-related materials.

Adhese 2 formulation: Adhese 2 was developed without Bis-GMA, utilizing instead, a next-generation, proprietary, BPA-free, tricyclic urethane-based dimethacrylate (TUDMA). UDMA-type monomers are usually known for their low viscosity, and reduced polymerization shrinkage. (Barszczewska-Rybarek 2020). This new monomer however behaves similarly to Bis-GMA. It exhibits a higher viscosity than standard UDMA-monomers, offers stable mechanical properties and low polymerization shrinkage.

Reliable efficient bonding

Adhesives are bonding-agents, and their purpose is to establish a link between a dental restoration, whether direct (e.g. composite) or indirect (e.g. glass ceramic) and the natural tooth substance. Historically, the breakthrough in dentin bonding came with the multi-/three-step systems, which bridged the gap between the hydrophilic (wet) tooth substance (dentin) and the hydrophobic (dry) resin or ceramic restorative. This was achieved via the sequential application of the components. In essence, the multi-component systems meant that each bonding issue could be dealt with in turn enabling the practitioner to achieve a transition between the hydrophilic dentin and hydrophobic restoration. Syntac/Ivoclar remains a classic example of this older generation of adhesives. After etching and rinsing, the hydrophilic Syntac Primer is applied to the entire cavity (enamel and dentin) followed by the hydrophilic Syntac Adhesive followed by a layer of the hydrophobic Heliobond. These conditioning, wetting and bonding steps remain as biologically relevant as ever, but can now all be managed in one step (if desired and compatible with the clinical situation) by universal adhesives. The following table indicates the separation of steps for Syntac, Adhese Universal and Adhese 2. Adhese 2 is both light-curing and self-curing i.e. dual-curing.

Working step	Enamel conditioning	Dentin conditioning	Wetting	Bonding	Light-curing	Self- curing
Syntac	Total Etch (H_3PO_4)	Syntac Primer	Syntac Adhesive	Heliobond	✓	–
Adhese Universal	Adhese Universal				✓	–
Adhese 2	Adhese 2				✓	✓

Bonding steps with various Ivoclar adhesives

Bonding with Adhese 2: Building on the proven efficacy of Adhese Universal, the composition of Adhese 2 is similar but incorporates the monomer TUDMA in place of Bis-GMA. It also features improved film-formation properties due to the incorporation of a new thixotropic silicone dioxide agent. The following table illustrates its amphiphilic nature (both hydrophilic and hydrophobic) and the adhesive functions of the various monomers used in Adhese 2. Each works in tandem but fulfils a distinct role in establishing a reliable bond:

Monomer	Type	Adhesive mechanism
MDP Methacryloyloxydecyl dihydrogen phosphate	Phosphoric acid methacrylate	Forms strong bond to hydroxyapatite surfaces. Promotes adhesion to tooth surface by formation of non-soluble Ca^{2+} salts.
MCAP Methacrylated carboxylic acid polymer	Methacrylate-modified polyacrylic acid	Carboxylic acid functional polymer reacts with and bonds to hydroxyapatite. The presence of many carboxylic acid groups along a polymeric backbone/chain allows multiple bonds to the tooth surface.
HEMA Hydroxyethyl methacrylate	Hydrophilic mono-functional methacrylate	Promotes wetting of polar / inorganic and moist surfaces. Assists penetration of liquid filled dentinal tubuli.
TUDMA Tricyclic urethane dimethacrylate	Relatively hydrophilic multi-functional crosslinking urethane	Contributes mechanical strength, reduced water sorption and improved hydrolytic stability of the adhesive layer. Compatible with both hydrophilic (HEMA) and hydrophobic (D3MA) monomers in the presence of water.
D3MA Decandiol dimethacrylate	Hydrophobic crosslinking dimethacrylate	Enables the reaction of the adhesive with the less polar monomers of the filling or luting composite.

Type and purpose of monomers in Adhese 2

Bonding with Ivoclar's Universal Adhesives: All the Adhese products achieve predictable high bond strengths to both enamel and dentin when used with e.g. Variolink Esthetic DC – regardless of the etching technique. Numerous in vitro investigations were carried out with the materials on enamel and dentin with varying etching and curing protocols. The results of these investigations are summarized in the In vitro section of the Studies chapter, and show that the newly formulated Adhese 2 offers the proven bonding performance of Adhese Universal and comparable values to other universal adhesives and traditional multi-component systems.

The dual-cure function of Adhese 2 and Adhese Universal DC, i.e. the addition of self-curing to light-curing, (described in detail later) also provides the potential for a better degree of conversion in situations where light accessibility is insufficient. Improved conversion can in turn lead to improved marginal integrity and therefore bond quality.

Hypersensitivity and Desensitization

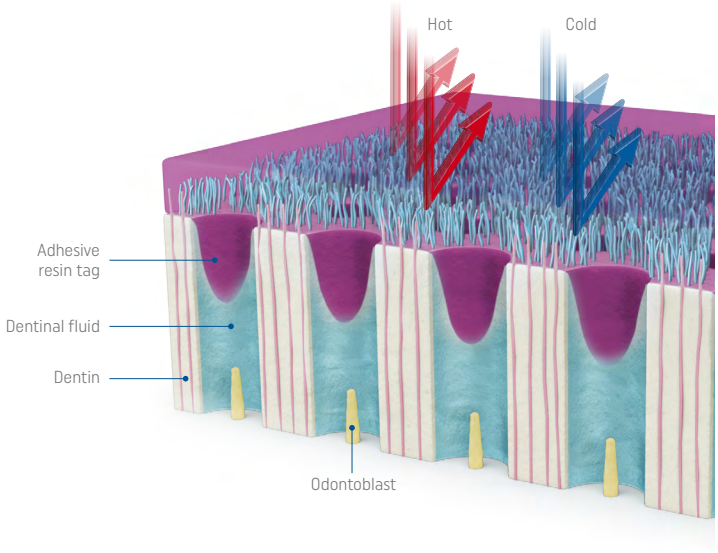
Dentin hypersensitivity is a common condition, notably following dental restorative work. It is generally agreed that hypersensitivity occurs as a result of fluid movements within the dentin tubuli - in response to stimuli such as cold, warmth or osmotically active substances like sugar. (Brännström et al. 1967). Brännströms hydrodynamic theory posits that this fluid-flow stimulates the odontoblasts – elongated cells which line the outer edge of the dental pulp. Odontoblasts have long processes called Tomes' fibres which extend into the tubuli. Fluid movement causes mechanical deformation of these processes – activating nearby nerve endings in the pulp which send pain messages to the brain. (Shibukawa et al. 2015). This process and in turn the sensation of hypersensitivity can be prevented by sealing dentinal surfaces.

Desensitization with Adhese 2: Adhese 2 is scrubbed into the dentin for at least 20 seconds to maximize enamel and dentin contact with the acidic monomers. During this step the hydrophilic solvents (water and ethanol) and HEMA optimize the wetting, priming and infiltration of the hydrophilic resin monomers into dentin tubuli and collagen network. This facilitates the creation of a homogenous adhesive layer with defined resin tags extending into the tubuli.

The acidic monomers MDP and MCAP also precipitate as insoluble calcium salts in the dentinal fluid. This provides further blockage, helping to prevent the movement of fluid within the dentin tubuli and any (post-operative) sensitivity associated with that movement.

Desensitization with Ivoclar's Universal Adhesives:
Each Adhese product functions similarly with regard to desensitization. Their integrated desensitizing properties minimize the risk of post-operative sensitivity, patient dissatisfaction and associated recalls.

The universal adhesives form a mechanical barrier that reliably seals dentin tubuli – eliminating the need for a separate desensitizing agent.



Application of Ivoclar "Adhese" adhesives to exposed dentin, blocking dentin tubuli

Effective polymerisation

Light-curing: Dental adhesives traditionally include photoinitiators such as camphorquinone plus an amine co-initiator like Lucirin TPO to initiate light-curing.

Self/Dual-curing: Dental adhesives require additional chemical-cure additives to enable polymerisation in areas that light cannot easily reach e.g. to achieve self/dual-curing in deep cavities, through very opaque restorations or during endodontic treatment.

The classic chemical-cure mechanism or "redox" (reduction-oxidation) initiator-system involves a peroxide e.g. hydro or benzoyl peroxide which acts as an oxidizing agent plus a reducing agent such as tertiary amine (for peroxide) or thiourea (for hydroperoxide). When mixed these components initiate free radical polymerization – without the need for light.

Light-curing and dual-curing with Adhese 2

Black LC cannula when light access is assured
The black uncoated LC cannula is ideal for light-curing applications, such as direct restorative procedures, when sufficient light polymerisation is guaranteed.

Blue DC cannula for extra clinical flexibility in light-limited situations
Adhese 2 enables reliable self/dual-curing directly from the VivaPen (in combination with self/dual-cure composites), thanks to the innovative blue DC cannula, coated with an integrated chemical/self-curing co-initiator.



Cannula and applicator overview





	DC cannulas/applicators *	LC cannulas/applicators
Direct restorations (light-cured)	✓	✓
Indirect restorations (light-cured)	✓	✓
Indirect restorations (self-cured)	✓**	–
Endodontic treatment (self-curing)	✓**	–

All cannulas are bendable for optimal use in all quadrants and cavity sizes.
* Blue applicator brushes are available in Regular and Small/Endo sizes.
** With etch & rinse technique or in combination with Variolink Esthetic DC.

The interchangeable LC and DC cannulas/applicators therefore ensure that Adhese 2 is suitable for adhesive bonding with or without a light source i.e. with all manner of direct and indirect restorations. In light-curing applications, both the LC and DC cannulas offer comparable performance and results.

Light-curing application: Adhese 2:

Adhese 2 is applied in a thin transparent layer and is light-cured via a combination of camphorquinone and a tertiary amine co-initiator. Adhese 2 can be light-cured with conventional polymerisation lamps with a light intensity of between approximately 500 mW/cm² and 3300 mW/cm². A 10 second curing time is suitable for light intensities of between 500 and 1,300 mW/cm² and 5 seconds is suitable for higher intensities of between 1,800 and 2,200 mW/cm². Rapid curing can be achieved in as little as 3 seconds for Class I/II permanent posterior composite restorations when light-curing is unobstructed from the occlusal aspect, using the Bluephase PowerCure (2,700 – 3,000 mW/cm²) curing light. If the diameter of the light guide is smaller than the width of the restoration, an overlapping polymerization procedure should be followed. The black LC cannulas and standard applicators are used with Adhese 2 for light-curing purposes. Light-curing is suitable in the following conditions:

Light-Cure* Application / Indication	Curing mode of restorative-composite or core build-up	Etching technique	
		Etch & Rinse	Self-Etch & Selective-Etch
Direct restorations, indirect translucent single tooth restorations and core build-ups	Light-curing or dual-curing	✓	✓
Sealing, desensitization, immediate dentin sealing	–	✓	✓

*when the adhesive is applied in light-cure mode i.e. light-cured directly

Light-curing application: Ivoclar Universal Adhesives:

Adhese Universal and Adhese Universal DC contain the same photoinitiators as Adhese 2 and are cured according to the same principles and procedure.

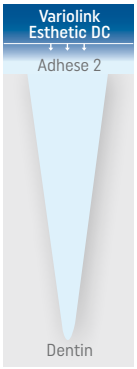
Dual-curing application: Adhese 2:

Dual-curing (DC) refers to the addition of self-curing properties to the light-curing properties of Adhese 2. These chemical self-curing properties are enabled when Adhese 2 is used for indirect restorations in combination with e.g. the luting composite Variolink Esthetic DC/Ivoclar and the blue DC-applicators (bottle/Free Stand Single Dose) or blue DC cannulas (VivaPen).

When placing an indirect restoration with limited light access, Adhese 2 is applied together with the coated blue DC cannulas or applicators. These are coated with special vanadyl salts which mix in with the Adhese 2 liquid and are rubbed thoroughly into the tooth substance during application.

Touch-cure effect

The adhesive is then followed by the placement of the restoration which is coated with a dual-curing luting composite e.g. Variolink Esthetic DC.



When Variolink Esthetic DC comes into contact with Adhese 2 a "touch-cure" polymerization effect takes place. Hydroperoxide (indicated by the arrows) diffuses from the luting composite into Adhese 2 (combined liquid + vanadyl salt adhesive).

The vanadyl salts (from the coated brushes) are co-initiators, which act as catalysts for the generation of free radicals in a "redox" reaction, as described previously. Vanadyl oxalate accelerates the polymerization started by the hydroperoxide diffusion, which is favourable for an improved bond, notably to dentin. More radicals are formed in a shorter amount of time, thus their penetration into the dentin tubuli is also faster. Furthermore, if this process were to occur slowly, water from the tubuli could dilute the adhesive – hindering reliable polymerization.

The radicals trigger the polymerization of methacrylate groups in the adhesive, allowing the material to cure without any need for light activation. Co-polymerization of both the adhesive and the luting cement therefore occurs – starting at the interface of the two materials.

With indirect restorations, the etching technique is also decisive regarding polymerization. If the etch & rinse technique is used, self-curing of Adhese 2 is possible with all dual-cure luting composites - independently of how they are cured (dual or self-cured). This is because the surface-roughening effect of etching creates adequate mechanical retention areas. If however the self-etch or selective etch technique is chosen, self-curing of Adhese 2 is only possible if the luting composite is dual-cured (light+self), or if Variolink Esthetic DC is used.

Self-Cure* Application / Indication	Curing mode of luting composite (cement) or core build-up composite	Etching technique	
		Etch & Rinse	Self-Etch & Selective-Etch
Adhesive cementation of indirect restorations and endodontic posts	Dual-curing	✓	✓
	Self-curing	✓	Only in combination with Variolink Esthetic DC

*when the adhesive is applied in light-cure mode i.e. light-cured directly

Stated the other way around if dual-curing an indirect restoration (with Adhese 2) is possible then any etch technique can be employed. With self-curing alone, Variolink Esthetic DC is necessary if a self-etch/selective-etch technique is chosen.

Dual-curing application: Ivoclar Universal Adhesives:

Adhese Universal is light-cured. Adhese Universal DC (in Free Stand Single Dose), though differently formulated, follows the same principles and procedure as Adhese 2

Precise fit for esthetic results

Adhesive layer thickness is an issue when seating indirect restorations. All Ivoclar universal adhesives are "thinned out" with compressed air during application to form a thin layer. Thixotropic silica based fillers included in all products also aid ideal film-formation.

Fit with Adhese 2:

Thanks to its low layer-thickness of approximately 10 µm, Adhese 2 enables the precise fit and integration of esthetically demanding indirect restorations. As a dual-curing adhesive, Adhese 2 avoids potential (post-light cure) pooling problems as there is no rigid pre-cured adhesive layer to accommodate and the adhesive and luting composite are cured together post-placement – with or without light.

The fit-advantage of dual-cure universal adhesives over multi-bottle systems (which require prior curing), was also highlighted in the Quintessenz Expert Hearing Statements (2024) on universal adhesives.

Adhese 2 also incorporates a new thixotropic silicone dioxide agent to further optimize homogenous film formation.

More universal than ever

Adhese 2 is a truly universal DC adhesive that helps dentists to bond different materials and restorations in different ways - easily, efficiently and safely.

Adhese 2 extends the current application-areas of the VivaPen.

Studies

In vitro studies: SBS – Direct & indirect restorations

Evaluation of Adhese 2 and Adhese Universal: Direct and indirect applications

Study location: Omaha, Nebraska, USA
Study release: November 2025
Study author(s): M. Latta, M. Seibert

Objective:

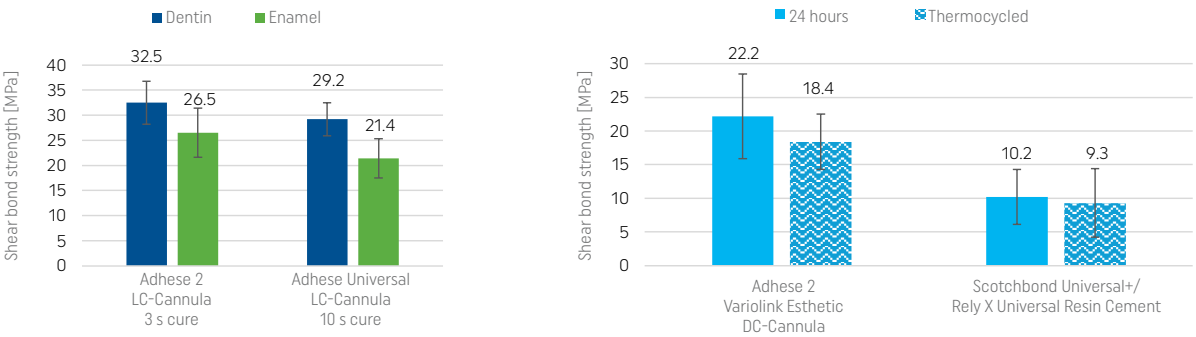
To evaluate the performance of Adhese 2 and Adhese Universal in direct and indirect applications via shear bond strength (SBS) testing.

Method:

Direct bonding: Flat bonding surfaces were prepared on extracted human molars (n=56) to expose dentin or enamel (n=28 per group). Adhese 2 was applied directly (self-etch mode) via VivaPen using the black LC cannulas, agitated for 20 s, air dried and cured for 3 s using the Bluephase PowerCure light (2700–3300 mW/cm²). Composite (Tetric plus Fill) was applied, cured for 3 s and bonded specimens were formed using an Ultradent bonding fixture. Specimens (n=14 per substrate/adhesive) were stored in water at 37°C for 24 hours whereupon SBS testing was carried out. For comparison, Adhese Universal specimens were created similarly with LC cannulas, whereby the adhesive was polymerized for 10 s (1000-1300 mW/cm²).

Indirect bonding: Flat dentin surfaces (320 grit, n=56) were bonded to lithium disilicate rods (Ø 2.3 mm), etched with hydrofluoric acid (20 s) and silanized with Monobond Plus. In a light safe environment Adhese 2 was applied to dentin using the VivaPen blue DC cannula and air dried. The ceramic rods were luted with Variolink Esthetic DC and fixed under 140 g load at 37 °C, 95 % humidity for 6 minutes, then stored in water at 37 °C. Reference specimens were created with Scotchbond Universal Plus adhesive and Rely X Universal cement under dark cure conditions. For each adhesive/cement system (n=28), 14 specimens were stored 24 h in water (37 °C) and 14 were thermocycled 10,000 times between 5 °C and 55 °C before debonding/SBS. ANOVA and post-hoc tests determined group differences ($p<0.05$) for direct and indirect bonding.

Results:



Shear bond strength values with Adhese 2 under direct (left) and indirect (right) bonding conditions

Summary:

With direct bonding Adhese 2 showed comparable bond strength to Adhese Universal on dentin and significantly higher values on enamel. With indirect bonding (self cure mode), Adhese 2/Variolink Esthetics produced significantly higher bond strengths on dentin than Scotchbond Universal Plus/Rely X Universal. Thermocycling reduced bond strength for both material combinations , but the decrease was not statistically significant.

Conclusion:

Adhese 2 demonstrated superior or equivalent bond strengths with the direct and indirect bonding applications investigated.

Reference: Latta et al. (2025)

Shear bond strength of Ivoclar universal adhesives to dentin & enamel: Direct Tetric PowerFill restorations in etch & rinse vs. self-etch mode

Study location: R&D Ivoclar, Schaan, Liechtenstein
Study release: 2025
Study author(s): R&D Ivoclar

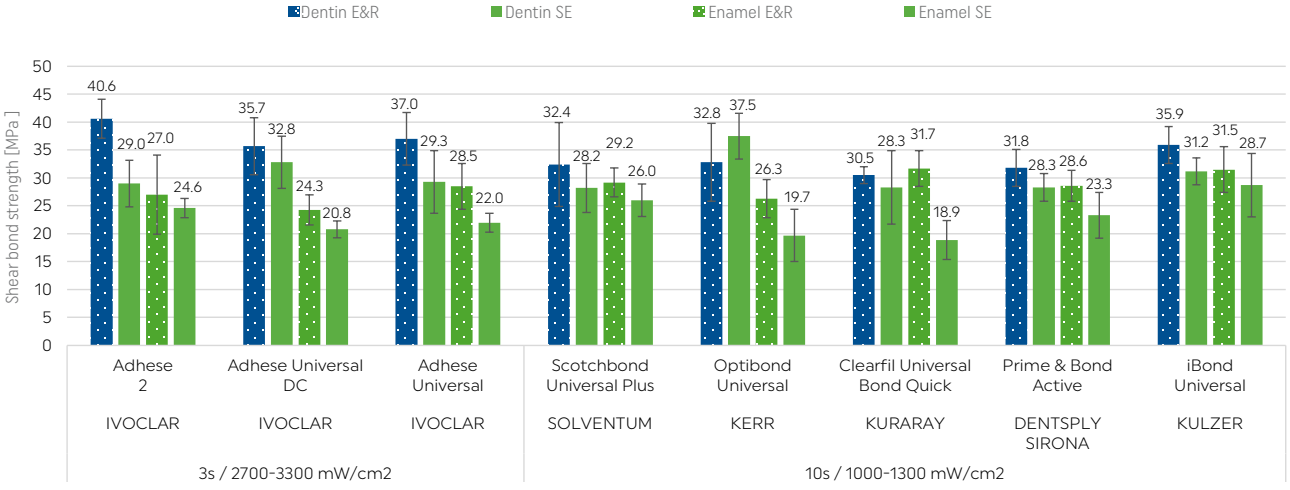
Objective:

To establish the shear bond strength (SBS) performance of Ivoclar universal adhesives and notable competitor products in bonding to dentin/enamel with different etch/bonding modes.

Method:

Bovine tooth surfaces were prepared to expose dentin/enamel. The substrates were stored in water then prior to application, enamel was dried with compressed air and dentin surfaces were blown for 0.5–1 s or blotted. Various universal adhesives were applied in etch & rinse (E&R) mode using Total Etch from Ivoclar and self-etch (SE) mode. Adhese 2 and Adhese Universal were applied with the VivaPen/black LC cannulas. Adhese Universal DC was applied via single dose and the adhesives were rubbed vigorously into the substrate for 20 s, dried and light cured for 3 s with Bluephase PowerCure (2700–3300 mW/cm²). Competitor products were applied (bottles) and light-cured (10s/1000–1300 mW/cm²) as specified by their respective instructions. Using an Ultradent application device, a 1.3-2.0mm layer of the composite Tetric PowerFill/Ivoclar was applied. The composite was then light-cured (10s/1000–1300 mW/cm²) to ensure proper polymerization and handling of the specimens. SBS testing was carried out for all substrates and bonding modes using 5 samples per group.

Results:



Mean SBS values of universal adhesives applied in both self-etch (SE) and etch & rinse (E&R) mode

Summary:

All the adhesives tested achieved good bonding values to dentin and enamel in E&R and SE modes. In general, E&R values were higher than SE values. For many adhesives, differences between SE and E&R were not significant. On dentin the E&R values were significantly higher than SE for Adhese 2. All others showed similar values in both modes. On enamel, differences were detected for Adhese Universal and Clearfil Universal Bond Quick.

Conclusion:

The SE values for the Ivoclar products correlate well with those found by Latta (2025) in the previous investigation. Ivoclar used acceptance criteria of: SBS >15 MPa for enamel and >25 MPa for dentin during the development of Adhese 2 for direct restorative testing. All the adhesives exceeded these values. Adhese 2 exhibited the highest SBS in E&R mode.

Reference: R&D Ivoclar (2025a)

Shear bond strength of Adhese 2 to dentin & enamel: Direct Tetric plus restorations in etch & rinse vs. self-etch mode

Study location: R&D Ivoclar, Schaan, Liechtenstein
Study release: 2025
Study author(s): R&D Ivoclar

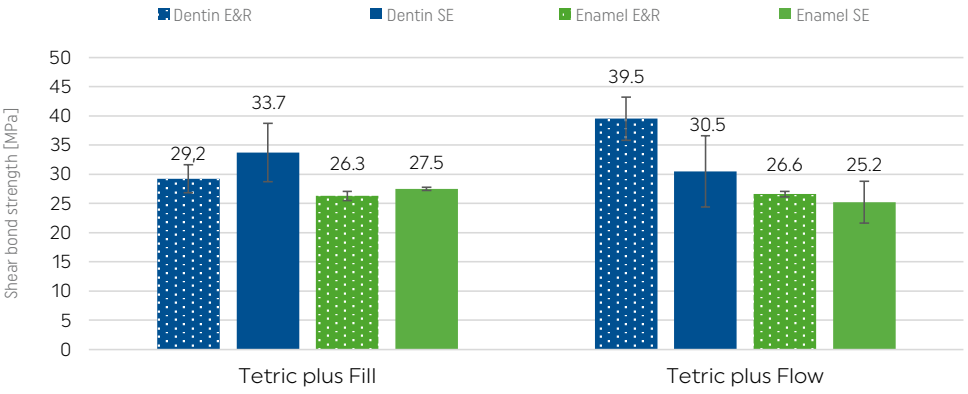
Objective:

To establish the shear bond strength (SBS) performance to dentin and enamel of the universal adhesive Adhese 2 together with the simplified universal composites Tetric plus Fill and Tetric plus Flow from Ivoclar in both etch & rinse (E&R) and self-etch (SE) mode.

Method:

Bovine tooth surfaces were prepared to expose dentin/enamel. The substrates were stored in water then prior to application, enamel was dried with compressed air and dentin surfaces were blown for 0.5–1s or blotted. Adhese 2 was applied (VivaPen/ black LC cannulas.) in etch & rinse (Total Etch/Ivoclar) and self-etch mode. The adhesive was rubbed vigorously into the substrates for 20 s, dried and light cured for 3 s with Bluephase PowerCure (2700–3300 mW/cm²). Using an Ultradent application device, a 1.3–2.0 mm layer of the composites Tetric plus Fill or Tetric plus Flow was applied. The composite was then also rapidly light-cured (3 s/2700–3300 mW/cm²). Samples were stored for 24h at 37°C in water before SBS testing was carried out for all substrates and bonding modes.

Results:



Mean (n=5 per group) shear bond strength values of Adhese 2 with Tetric plus composites in etch & rinse (E&R) & self-etch mode

Summary:

All results exceeded 25 MPa. SBS values differed between enamel and dentin, but there was no significant difference between etching modes. The only notable exception was for Tetric plus Flow on dentin, which in E&R mode achieved a very high adhesion of 39.5 ± 3.7 MPa.

Conclusion:

Adhese 2 achieved excellent bonding values to dentin and enamel in both etch & rinse and self-etch mode together with the Tetric plus composites

Reference: R&D Ivoclar (2025a)

Shear bond strength of Ivoclar universal adhesives to dentin & enamel: Direct Tetric PowerFill restorations in self-etch mode before and after aging

Study location: R&D Ivoclar, Schaan, Liechtenstein
Study release: 2025
Study author(s): R&D Ivoclar

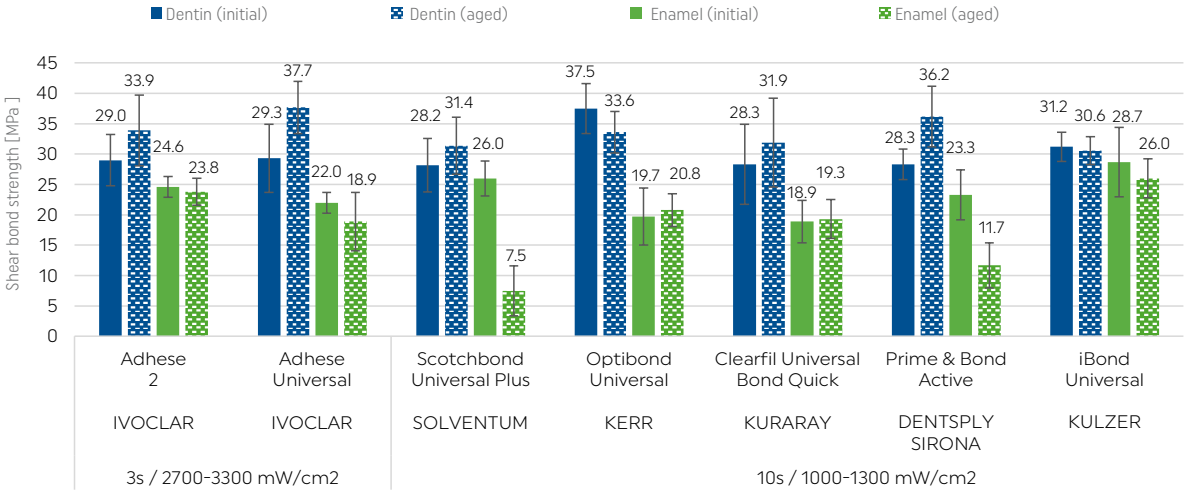
Objective:

To establish the shear bond strength (SBS) performance of rapidly-cured Adhese 2, Adhese Universal and notable competitor products in bonding to dentin and enamel in self-etch mode.

Method:

Bovine tooth surfaces were prepared to expose dentin/enamel. The substrates were stored in water then prior to application, enamel was dried with compressed air and dentin surfaces were blown for 0.5–1 s or blotted. Adhese 2 and Adhese Universal were then applied from the VivaPen with the black LC cannulas, rubbed vigorously into the substrate for 20 s, dried and light cured for 3 s with Bluephase PowerCure (2700–3300 mW/cm²). Competitor products were applied and light-cured (10 s/ 1000–1300 mW/cm²) as specified by their respective instructions. Using an Ultradent application device, a 1.3–2.0 mm layer of the composite Tetric PowerFill/Ivoclar was applied through the opening. The composite was then light-cured (10 s/ 1000–1300 mW/cm²) to ensure proper polymerization and handling of the specimens. SBS testing/debonding was carried out initially (24h at 37°C in water) and after simulated aging (10k cycles 5°C/55°C).

Results:



Mean (n=5 per group) shear bond strength values of universal adhesives applied in self-etch mode

Summary:

There were no significant differences in SBS on either enamel or dentin for the universal adhesives shown prior to aging. Differences pre versus post aging on dentin were also not significantly different with some increasing and others slightly decreasing. On enamel SBS tended to lower with significant differences for Scotchbond Universal Plus and Prime & Bond Active.

Conclusion:

Ivoclar internal acceptance criteria for direct restorative bond strength testing is set at Enamel: >15 MPa and Dentin: >25 MPa. These thresholds are met by Adhese 2 and Adhese Universal both before and after aging, suggesting good long term stability.

Reference: R&D Ivoclar (2025a)

Shear bond strength of Ivoclar universal adhesives to dentin: Direct Tetric PowerFill restorations under wet and dry conditions

Study location: R&D Ivoclar, Schaan, Liechtenstein
Study release: 2025
Study author(s): R&D Ivoclar

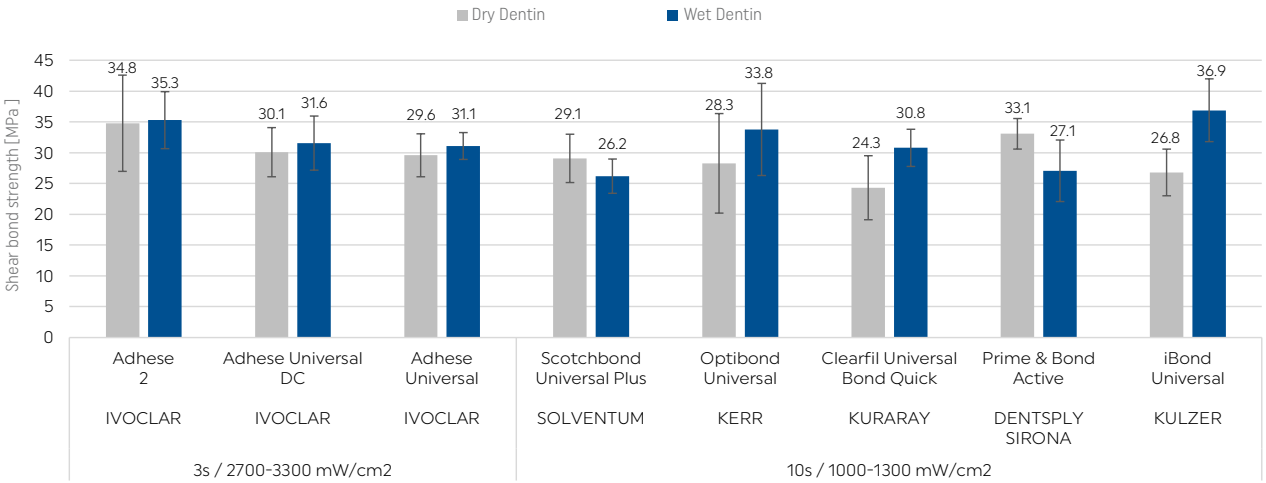
Objective:

To establish the shear bond strength (SBS) performance of Ivoclar universal adhesives and notable competitor products to wet and dry dentin.

Method:

Bovine tooth surfaces were prepared to expose dentin. The substrates were stored in water – then prior to application different drying methods were used. Dry dentin was prepared by drying with compressed air. Wet dentin was prepared by simply shaking off the water from the embedded teeth, leaving a thin layer of water on the substrate surface. Various universal adhesives were applied in self-etch mode. Adhese 2 and Adhese Universal were applied with the VivaPen/black LC cannulas. Adhese Universal DC was applied via single dose and the adhesives were rubbed vigorously into the substrate for 20 s, dried and light cured for 3 s with Bluephase PowerCure (2700–3300 mW/cm²). Competitor products were applied (bottles) and light-cured (10 s/1000–1300 mW/cm²) as specified by their respective instructions. Using an Ultradent application device, a 1.3–2.0 mm layer of the composite Tetric PowerFill/Ivoclar was applied. The composite was then light-cured (10 s/1000–1300 mW/cm²) to ensure proper polymerization and handling of the specimens. SBS testing/debonding was carried out for both wet and dry dentin.

Results:



Mean (n=5 per group) shear bond strength values of universal adhesives applied to wet and dry dentin

Summary:

All the universal adhesives tested performed well on both wet and dry dentin. The differences are not significant which is supportive of an overall reduction in technique sensitivity with universal adhesives. The Ivoclar internal threshold of Dentin: >25 MPa for direct SBS testing was easily achieved by Adhese 2, Adhese Universal and Adhese Universal DC.

Conclusion:

Current universal adhesives exhibit far less moisture (SBS) sensitivity in general compared to earlier "total-etch" or "etch& rinse" adhesive systems. The results here support this development.

Reference: R&D Ivoclar (2025a)

Bonding performance of Adhese 2 to dentin: Immediate and aged evaluation

Study location: KU Leuven, BIOMAT, Leuven, Belgium
Study release: September 2025
Study author(s): C. Yao, B. Mercelis, B. Van Meerbeek

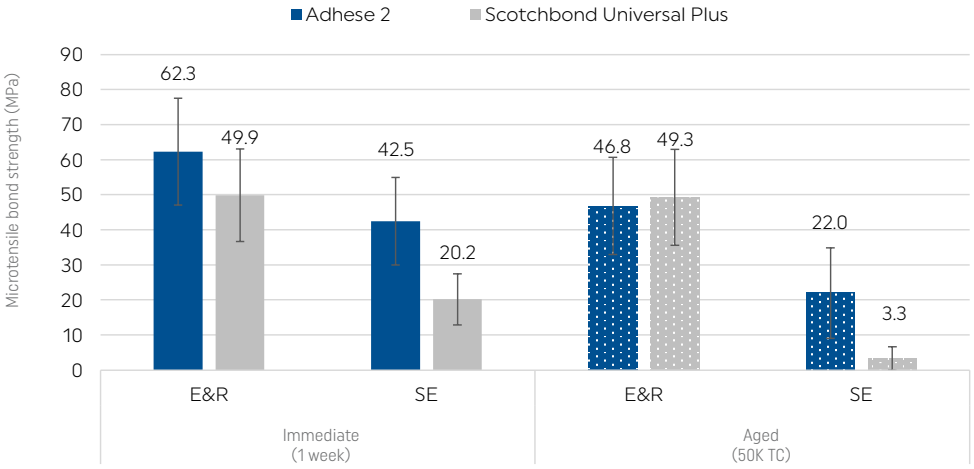
Objective:

To investigate the bonding effectiveness of Adhese 2 to dentin.

Method:

Two adhesives: Adhese 2/Ivoclar (A2) and Scotchbond Universal Plus/Solventum (SU+) were each applied to the dentin of 10 different (human) teeth per group. Each tooth surface was separated into two, in order to apply each adhesive in both etch & rinse (E&R) and self-etch (SE) mode on the same tooth. Total Etch/Ivoclar was used for both E&R-experimental groups. The adhesives were applied to flat bur-cut dentin that was prepared with the Micro-Specimen Former (Uni Iowa) with a medium-grit (107 µm) diamond. The composite Clearfil AP-X/Kuraray Noritake (A3) was applied on top. The dentin areas, split according to SE/E&R, were then halved again i.e. the teeth were visually quartered (to establish areas for immediate and aged testing) and 3 micro-specimens (composite/adhesive/dentin sticks) were cut from each quarter. As 10 teeth per adhesive were used, 30 specimens per experimental group were tested for each adhesive. Microtensile bond strength (µTBS) testing was then carried out on the differently bonded samples with half of each tested after 1 week storage in water at 37°C (= Immediate) and half after long-term 50k thermocycles at 5–55°C (= Aged). Light-microscopy fracture analysis of all specimens was carried out to establish failure mode.

Res ults:



Mean µTBS to dentin under different bonding/aging protocols. Pre-test failures were considered 0 MPa

Summary:

Immediate µTBS was higher for both adhesives and bonding modes compared to aged µTBS. Differences were significant apart from SU+ in E&R-mode. Both adhesives performed significantly better in E&R mode than SE mode, pre and post aging. A2 exhibited higher bond strengths than SU+ in all groups apart from E&R-post-aging, where it performed slightly but statistically insignificantly lower. Numerous pre-test failures (indicating debonding during thermocycling) occurred in the aged SE-group, particularly with Scotchbond Universal Plus: SU+ (n=22/30) and A2 (n=4/30). The aged failure analysis exhibited only adhesive-failures for the SE-SUP group, whereas the other 3 groups exhibited mixed, cohesive and adhesive failures.

Conclusion:

Overall, A2 outperformed SU+ in terms of microtensile bond strength to dentin applied in SE-mode, whereas both universal adhesives performed equally in E&R-mode post-aging.

Reference: Van Meerbeek (2025), Yao et al. (2025)

Shear bond strength of Adhese 2 to dentin & enamel: Indirect restorations in self-etch and self-cure/self-cure mode, before and after aging

Study location: R&D Ivoclar, Schaan, Liechtenstein
Study release: 2025
Study author(s): R&D Ivoclar

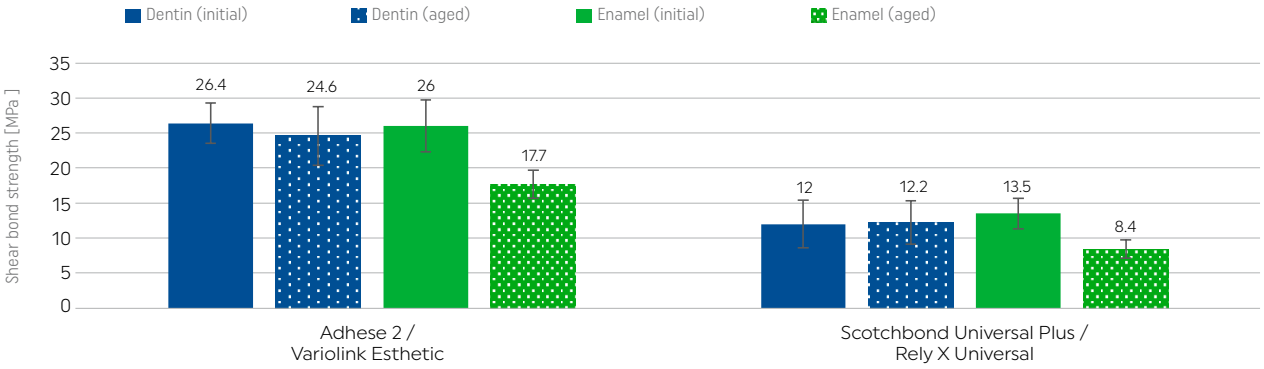
Objective:

To establish the shear bond strength (SBS) performance of Adhese 2/Variolink Esthetic DC compared to Scotchbond Universal Plus/Rely X Universal in bonding to dentin and enamel in self-etch mode – using an indirect restorative method.

Method:

Bovine tooth surfaces were prepared to expose dentin/enamel. The substrates were stored in water then prior to application, enamel was dried with compressed air until it no longer appeared moist and dentin surfaces were blown for 0.5–1 s or blotted. Adhese 2 (VivaPen and blue DC cannula) and Scotchbond Universal Plus were applied to substrates in self-etch and self-cure mode. The adhesives were rubbed vigorously into the substrate for 20 s and dried. Variolink Esthetic DC/Ivoclar and Rely X Universal were then applied with their respective adhesive according to instructions. Tetric EvoCeram composite plugs were placed onto the luting composite as a ceramic proxy. The tooth (with plug facing upward) was placed into an Ultradent application device and the upper part of this device was carefully lowered so that the fixation pin sat centrally on top of the plug. Excess composite was immediately removed using a microbrush, ensuring the plug did not move. As self-curing mode was being tested the device was covered to prevent light penetration and stored at room temperature (23 ± 2 °C) for 15 ± 1 minutes to cure. Finally, specimens were removed from their devices and stored in water at 37 ± 1 °C for 16–24 hours SBS testing/debonding was carried out initially (24h at 37°C in water) and after simulated aging (10k cycles 5°C/55°C).

Results:



Mean (n=5 per group) shear bond strength values of two universal adhesives/luting composites applied in SE, self-cure/self-cure (SC/SC) mode for indirect restorations before and after aging

Summary:

It can be seen that the SBS values for Adhese 2 are significantly higher than those for Scotchbond Universal Plus initially and also after aging/thermocycling. On dentin there was no significant change after aging for either product. On enamel there was a significant decrease with Adhese 2 but at far higher levels than Scotchbond Universal Plus.

Conclusion:

Ivoclar internal acceptance criteria for indirect restorative bond strength testing was set at Enamel: >15 MPa and Dentin: >20 MPa. These thresholds are met by Adhese 2 both before and after aging, suggesting good long term stability.

Reference: R&D Ivoclar (2025a)

Shear bond strength of Ivoclar universal adhesives to dentin & enamel: Indirect restorations in self-etch and light-cure/dual-cure mode

Study location: R&D Ivoclar, Schaan, Liechtenstein
Study release: 2025
Study author(s): R&D Ivoclar

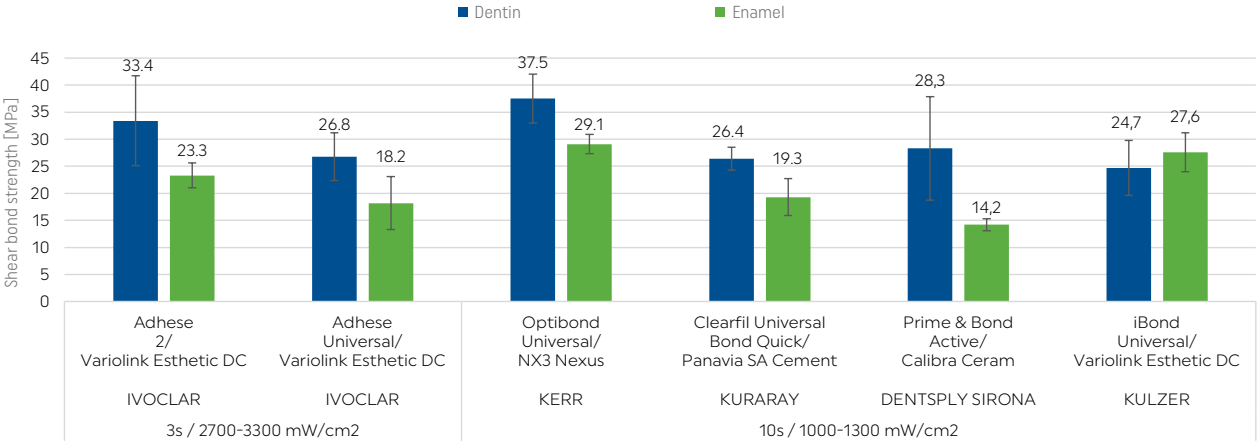
Objective:

To establish the shear bond strength (SBS) performance of Adhese 2, Adhese Universal applied with Variolink Esthetic DC compared to notable competitor adhesive/luting composite combinations, in bonding to dentin and enamel in self-etch, light-cure mode.

Method:

Bovine tooth surfaces were prepared to expose dentin/enamel. The substrates were stored in water then prior to application, enamel was dried with compressed air and dentin surfaces were blown for 0.5–1 s or blotted. Adhese 2 (black LC cannula) and Adhese Universal were applied via VivaPen to substrates in self-etch and light-cure mode. The adhesives were rubbed vigorously into the substrate for 20 s and dried and light cured for 3 s with Bluephase PowerCure (2700-3300 mW/cm²). Competitor products were applied (bottles) and light-cured (10 s/1000–1300 mW/cm²) as specified by their respective instructions. The respective company luting composites were then applied according to instructions. Tetric EvoCeram composite plugs were placed onto the luting composite as a ceramic proxy. The tooth (with plug facing upward) was placed into an Ultradent application device and the upper part of this device was carefully lowered so that the fixation pin sat centrally on top of the plug. Excess composite was immediately removed using a microbrush, ensuring the plug did not move. As dual-curing mode was being tested polymerization occurred from two opposite sides (10 s/1000–1300 mW/cm²) Finally, specimens were removed from their devices and stored in water at 37 ± 1 °C for 16–24 hours SBS testing/debonding was carried out after 24h at 37°C in water.

Results:



Mean (n=5 per group) shear bond strength values of universal adhesives/luting composites applied in SE, light-cure/dual-cure mode (LC/DC) for indirect restorations – initial values after 24h water storage.

Summary:

In LC/DC mode, SBS values were slightly higher for Adhese 2 compared to the SC/SC shown in the previous investigation. Adhese 2 exhibited the 2nd highest values on dentin and enamel within this group.

Conclusion:

Ivoclar internal acceptance criteria for indirect restorative bond strength testing with Adhese 2, was set at Enamel: >15 MPa and Dentin: > 20 MPa. These thresholds are well exceeded by Adhese 2 and met by most of the competitor products

Reference: R&D Ivoclar (2025a)

Shear bond strength of Adhese 2/Variolink Esthetic DC compared to Multilink Primer/Multilink Automix to dentin & enamel: Indirect restorations

Study location: R&D Ivoclar, Schaan, Liechtenstein
Study release: 2024
Study author(s): R&D Ivoclar

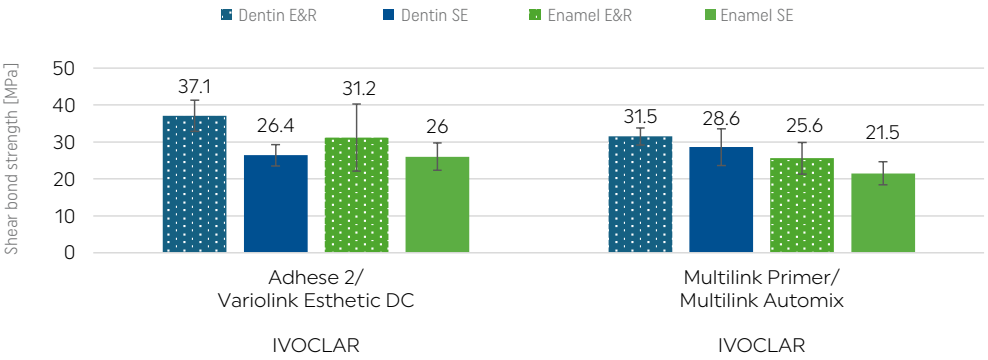
Objective:

To establish the shear bond strength (SBS) performance of the two adhesive luting systems: Adhese 2 with Variolink Esthetic DC compared to Multilink Primer with Multilink Automix in bonding to dentin and enamel in both etch & rinse and self-etch mode.

Method:

Bovine tooth surfaces were prepared to expose dentin/enamel. The substrates were stored in water then prior to application, enamel was dried with compressed air until it no longer appeared moist and dentin surfaces were blown for 0.5–1 s or blotted. Adhese 2 (VivaPen and blue DC cannula) and Multilink Primer were applied to substrates in etch & rinse or self-etch mode. The adhesives were rubbed vigorously into the substrate according to their instructions and dried. Variolink Esthetic DC/Ivoclar and Mulitlink Automix/Ivoclar were then applied to their respective adhesive. Tetric EvoCeram composite plugs were placed onto the luting composite as a ceramic proxy. The tooth (with plug facing upward) was placed into an Ultradent application device and the upper part of this device was carefully lowered so that the fixation pin sat centrally on top of the plug. Excess composite was immediately removed using a microbrush, ensuring the plug did not move. As self-curing mode was being tested the device was covered to prevent light penetration and stored at room temperature (23 ± 2 °C) for 15 ± 1 minutes to cure. Finally, specimens were removed from their devices and stored in water at 37 ± 1 °C for 24 hours, whereupon SBS testing/debonding was carried out.

Results:



Mean (n=5 per group) shear bond strength values of the adhesive luting systems: Adhese 2/Variolink Esthetic DC and Multilink Primer/Multilink Automix applied in self-cure/self-cure mode (SC/SC) with both E&R and SE techniques for indirect restorations – initial values after 24h water storage.

Summary:

The Adhese 2/Variolink Esthetic system exhibited similar SBS values to Multilink Primer/ Multilink Automix. The Adhese 2 values were mostly somewhat higher though non-significant.

Conclusion:

Ivoclar internal acceptance criteria for indirect restorative bond strength testing with Adhese 2, was set at Enamel: >15 MPa and Dentin: >20 MPa. These thresholds are well exceeded by both systems.

Reference: R&D Ivoclar (2024a)

Marginal quality of Class II Tetric PowerFill restorations bonded with either Adhese Universal or Adhese 2

Study location: Charité Universitätsmedizin Berlin, Berlin, Germany
Study release: April 2024
Study author(s): U. Blunck

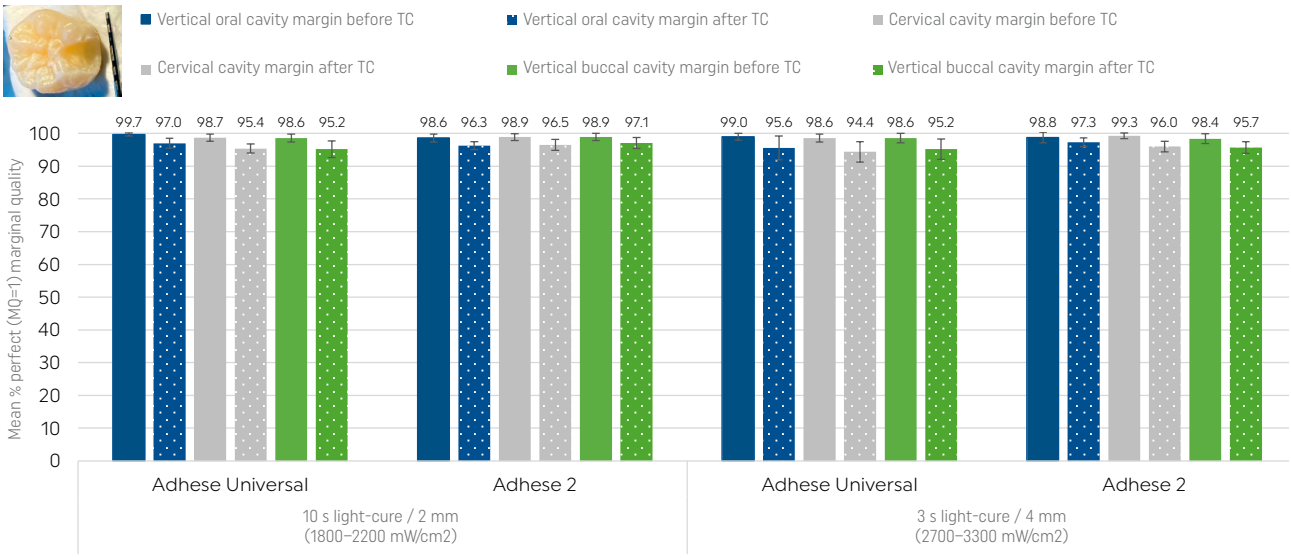
Objective:

To evaluate and compare the marginal quality of Class II composite restorations using Adhese Universal and Adhese 2. The goal was to determine whether the experimental adhesive performs as effectively as the established product when used in enamel-bordered cavities.

Method:

Extracted, caries-free human molars were prepared with standardized Class II cavities and divided into four groups. Cavities were filled with Tetric PowerFill in either 2-mm increments (10s curing) or 4-mm bulk-fill increments (3s curing) and combined with either Adhese Universal or Adhese 2. All adhesives were applied in self-etch mode (generous wetting of both enamel and dentin, agitation and subsequent drying leaving a shiny surface) and then light-cured for either 10s or 3s as described. Samples underwent (TC) thermocycling (10,000 cycles between 5 °C and 55 °C), followed by marginal quality assessment using scanning electron microscopy (SEM) at 200x magnification. Marginal quality (MQ) was rated from MQ1 (best/perfect) to MQ4 (worst/gaps), and statistical analysis was performed using the Kruskal-Wallis test. The percentage of perfect margins (pre and post TC) for 3 different aspects of the cavities are shown below.

Results:



Mean percentage of "perfect" marginal integrity (MQ1) in Tetric PowerFill (2mm and 4 mm) restorations with Adhese Universal or Adhese 2 used in self-etch mode

Summary:

The marginal Quality (MQ1) remained high across all groups and cavity margins i.e. different adhesives and increment layer depths – both before and after thermal cycling. There were minimal to no edge gaps (MQ3 + MQ4) in all groups and there were no significant differences between groups ($p > 0.05$).

Conclusion:

Adhese 2 performed equally as well as Adhese Universal in terms of marginal integrity in Class II restorations with enamel-bordered cavities.

Reference: Blunck (2024)

Marginal integrity of Class II Tetric plus Fill restorations bonded with either Adhese 2 or Scotchbond Universal Plus

Study location: Zentrum für Zahnmedizin, University of Zurich, Switzerland
Study release: July 2025
Study author(s): T. Tauböck, T. Attin

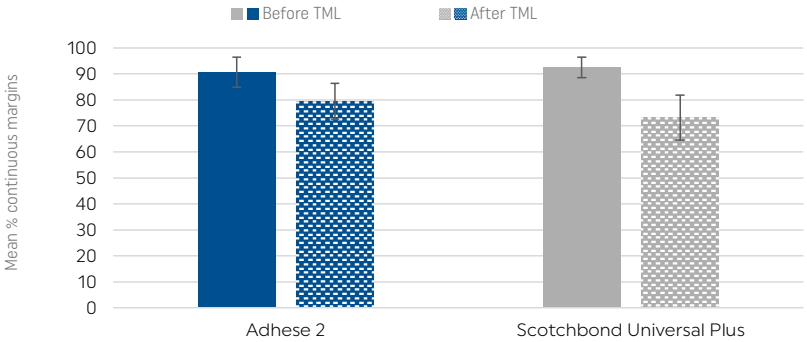
Objective:

To investigate and compare the marginal integrity of Class II composite restorations bonded with either Adhese 2 or Scotchbond Universal Plus/3M.

Method:

20 extracted, human molars were embedded in resin and prepared with standardized Class II cavities on sound proximal surfaces. Molars were randomized into two adhesive groups (n=10) with the same number of upper and lower molars. Either Adhese 2 or Scotchbond Universal Plus was applied to the enamel and dentin (in self-etch mode), scrubbed in for 20 s, air thinned and cured for 10 s at 1200 mW/cm² (Bluephase PowerCure/Ivoclar). The cavities were then restored with Tetric plus Fill using a 4-mm bulk-fill technique, followed by light-curing for 10 s at 1200 mW/cm2 (Bluephase PowerCure/Ivoclar). Restorations were finished and polished using Sof-Lex discs/Solventum with decreasing grit sizes under constant water-cooling. Occlusal surfaces were polished with the OptraGloss HP flame system/Ivoclar. Restored molars were then stored in tap water at 37 °C in dark conditions for 7 days. Silicone impressions were then taken, and replicas were made using epoxy resin, which were then sputter-coated with gold and analyzed quantitatively via scanning electron microscope (SEM 200x) for baseline marginal integrity. Afterwards all restorations underwent thermo-mechanical loading (TML: 5-50°C/1000x) to simulate mastication and replicas were re-made, analyzed and compared.

Results:



Mean percentage of continuous margins with different adhesives

Summary:

The mean percentage of continuous margins (marginal integrity) before and after thermo-mechanical loading (TML), for each adhesive group are shown in the diagram. Adhese 2 exhibited a slightly higher percentage of continuous margins, post TML than Scotchbond Universal Plus.

Conclusion:

Both adhesives achieved similar marginal integrity in Class II Tetric plus Fill restorations before and after TML, with no statistically significant differences were found between products.

Reference: Tauböck (2025)

Dentin tubuli infiltration with Adhese 2 and Adhese Universal

Study location: R&D Ivoclar, Schaan, Liechtenstein
Study release: 2025
Study author(s): R&D Ivoclar

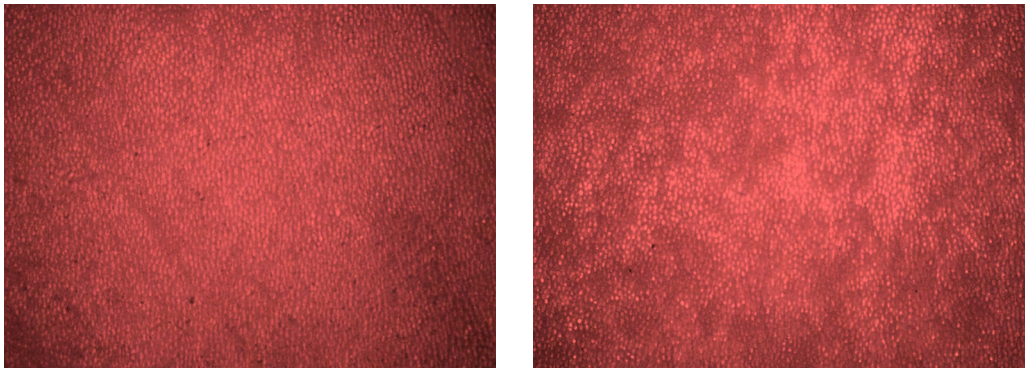
Objective:

The objective of this study was to evaluate adhesive dentin tubule penetration and sealing using fluorescence microscopy.

Method:

A fluorescent dye was added to Adhese 2 and Adhese Universal to enable visualization by fluorescence microscopy (FM). Bovine teeth were prepared per ISO 29022:2013, embedded, and ground. Dentin surfaces were etched with 37% phosphoric acid (Total Etch/Ivoclar) for 15 seconds, rinsed, and air-dried. Fluorescent adhesive was rubbed onto the etched surfaces for 20 seconds, then air-thinned. Adhese Universal was light-cured for 10 seconds; Adhese 2 was allowed to self-cure for 15 minutes at room temperature. Afterwards the adhesive layer was removed via gentle grinding. Surfaces were re-etched, rinsed, dried, and measured. FM images of resin tags were made (50x magnification) at three locations on each tooth. Grinding and re-etching steps were repeated, with microscopic inspection each time, until no more adhesive could be detected in the dentin tubuli.

Results:



Fluorescent microscopy photos (50x): Left: Adhese 2. Right: Adhese Universal

Summary:

The bright red spots in the images represent adhesive within the dentin tubuli. Both self-cured Adhese 2 and light-cured Adhese Universal infiltrate and seal the tubuli effectively and uniformly with visible adhesive-penetration up to 200 µm.

Conclusion:

Adhese 2 in self-cure mode achieved dentin tubuli sealing comparable to light-cured Adhese Universal, demonstrating that self-curing is equally effective for this application.

Reference: R&D Ivoclar (2025b)

Precipitate formation in dentin tubuli with Adhese 2 and Adhese Universal

Study location: R&D Ivoclar, Schaan, Liechtenstein
Study release: 2025
Study author(s): R&D Ivoclar

Objective:

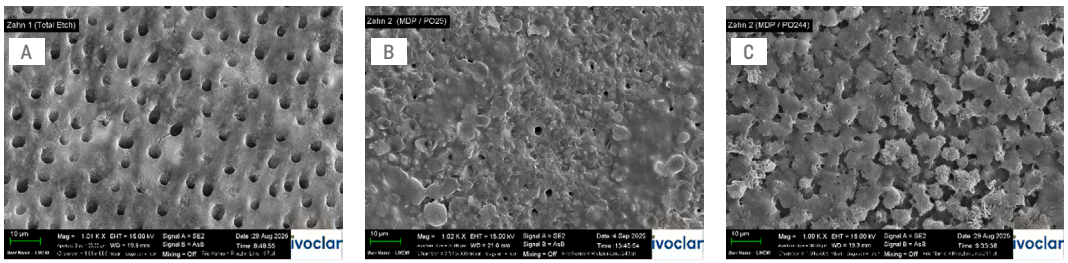
To illustrate via electron microscopy the formation of precipitates within the dentin tubuli using solutions equivalent to the acid components of Adhese 2 and Adhese Universal.

Method:

Bovine dentin surfaces were prepared according to ISO 29022:2013 and etched with 37% phosphoric acid gel (Total Etch/Ivoclar) for 15 seconds, then rinsed and dried. Solutions phosphoric acid monomer (MDP) and methacrylated carboxylic acid polymer (MCAP), at concentrations matching each adhesives were agitated onto the etched dentin for 20 seconds and the excess was rinsed off. Samples were examined by scanning electron microscopy at 1000x magnification to assess precipitate formation. The photos below show the sealing achieved by the adhesives (B and C) as compared to the open dentin tubuli of etched dentin (A).

Results:

Etched Dentin | MDP/MCAP "Adhese Universal | MDP/MCAP "Adhese 2"



SEM images (x1000) of etched dentin (A) and mechanically sealed dentin tubuli after application of MDP/MCAP solutions equivalent to Adhese Universal (B) and Adhese 2 (C)

Summary:

The SEM micrographs revealed that treating etched dentin with a solution of MDP and MCAP produced a dense, adherent precipitate that sealed the dentin tubuli. This indicates that MDP and MCAP together form an insoluble layer that mechanically blocks and seals tubules, helping the adhesive prevent hypersensitivity.

Conclusion:

The formation of an insoluble layer not only confirms consistent tubuli infiltration but also supports a durable barrier against external stimuli. The infiltration images of the previous investigation together with the photos here support the role that these adhesives play in mitigating hypersensitivity and enhancing long-term clinical performance.

Reference: R&D Ivoclar (2025b)

An ultra-morphological characterization of dentin using Adhese Universal

Study location: Dental Biomaterials Department, University of Lisbon, Portugal
Study release: 2013
Study author(s): M. Lopes

Objective:

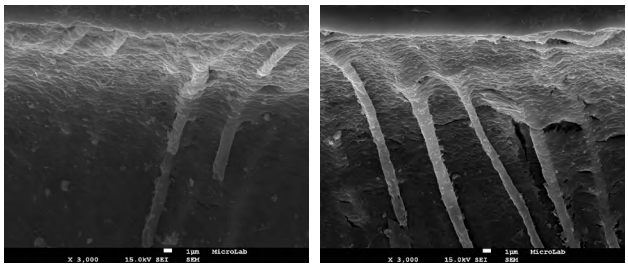
To examine the ultra-morphological characterization of wet and dry dentin using Adhese Universal with the self-etch and total-etch technique.

Method:

56 extracted human molars (refrigerated in a solution of 0.5% chloramine for up to one month post-extraction) were used in this study. Teeth were left in distilled water at 37°C for 24 hours. The occlusal enamel was then removed with an Isomet 1000 diamond saw (Buehler GmbH) and 56 dentin discs with a thickness of 800 ± 200 µm were obtained from middle dentin by slow speed sectioning. A standard smear layer was created on the occlusal surface by wet sanding with 600-grit SiC sandpaper for 60 seconds. In the total-etch group, the surfaces were etched for 15 seconds with phosphoric acid. Adhese Universal was applied to the dentin surfaces and specimens were randomly divided into 4 equal (n=14) groups. After the application of Adhese Universal, a 1 mm thick layer of Tetric EvoFlow was applied to the treated dentin and light-cured for 40 seconds. The samples then underwent ultra-morphological examination via scanning electron microscopy.

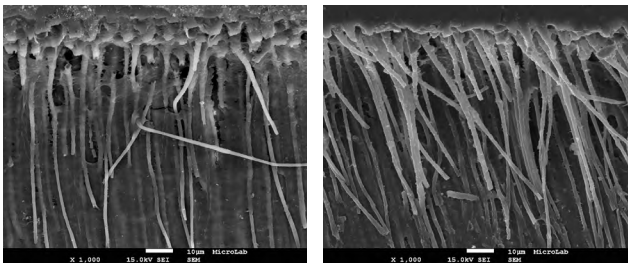
Results:

Self-etch: Wet & Dry Dentin



A: SEM (x 3000). Dentin tubules after applying Adhese Universal under wet (left) and dry (right) condtions

Etch & Rinse: Wet & Dry Dentin



B: SEM (x 1000) of dentin tubules after applying Adhese Universal under wet (left) and dry (right) condtions

Summary:

Both self-etch groups (wet and dry) exhibited a sealed acid-resistant resin-dentin inter-diffusion zone. Adhese Universal penetrated profusely into the dentin tubules up to 100 µm in all specimens analysed (Fig. A). The hybrid layer was 0.6–0.8 µm thick. In both E&R groups (wet and dry), the hybrid layer was thicker at 3.5–5.0 µm, and densely infiltrated (Fig. B). Resin tags were funnel shaped with peri-tubular triangular hybridization, which is characteristic of most E&R/total etch systems.

Conclusion:

The SEM photos show relatively uniform sealing and mechanical blockage of the dentin tubules under all conditions, supporting the ability of Adhese Universal to form a strong bond to dentin while providing protection against hypersensitivity. More sealed tubules are visible in Fig. A than Fig. B (irrespective of the magnification) due to the E&R technique having removed the smear layer. The similarity between dry and moist substrates supports the lack of technique sensitivity with Adhese Universal.

Reference: Lopes (2013)

Determination of working time with Adhese 2 and Variolink Esthetic DC

Study location: R&D Ivoclar, Schaan, Liechtenstein
Study release: 2024
Study author(s): R&D Ivoclar

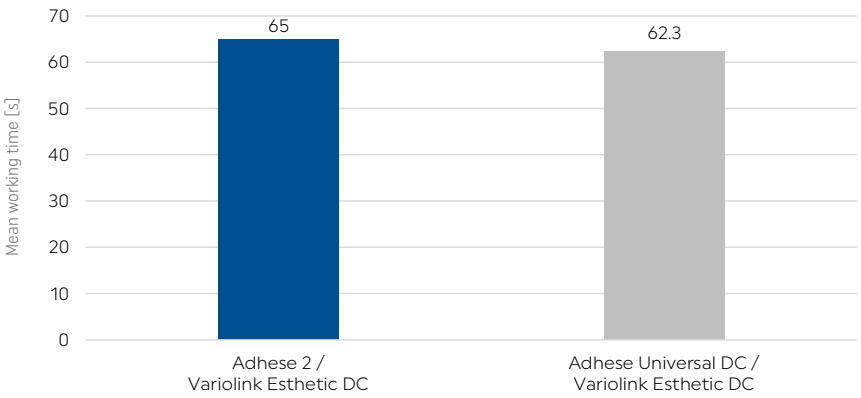
Objective:

To investigate how long the composite luting material Variolink Esthetic DC stays workable when used with Adhese 2.

Method:

Following the standard DIN-ISO 4049 (2009 conversion), time-testing was carried out with Variolink Esthetic DC both with and without contact to Adhese 2. Approximately 30mg of luting composite was pressed between glass slides with a shearing motion to produce a thin layer and visually checked for smoothness and homogeneity at different time intervals. To determine the curing time when adhesive was present, the glass plates were first coated with Adhese 2 and blown into a thin film before then receiving the luting composite between the slides. Here the curing time was tested by waiting for increasing 10-second intervals (10 s, 20 s, etc.) before the composite was applied. The longest time whereby the material remained smooth and thin in all tests was recorded as the working time. The results were compared with the predecessor product Adhese Universal DC to confirm adequate working times and clinical suitability.

Results:



Mean working times for Adhese 2 and Adhese Universal DC (Single doses) with Variolink Esthetic DC

Summary:

Adhese 2 and Variolink Esthetic provided a working time well above the clinical target of 60 seconds at 25°C with an average time of 65 seconds. This was similar to that of the established products Adhese Universal DC/Variolink Esthetic DC at 62.3 seconds. Variolink Esthetic DC without the adhesive had far higher mean curing times of 60 s + 180 s. This links to the "Touch-cure" effect described earlier. The co-initiator from the blue DC cannulas (mixed with the adhesive liquid) catalyses the polymerization reaction of the hydroperoxide from Variolink Esthetic DC – causing polymerization and shorter working times when the adhesive and luting composite are in contact.

Conclusion:

Adhese 2 indicated comparable working times to Adhese Universal DC. There were no significant differences between the adhesives.

Reference: R&D Ivoclar (2024b)

Benchmarking Study with Adhese Universal VivaPen: Use, efficiency and waste compared to conventional bottle delivery forms

Study location: Berndt & Partner Creality GmbH, Berlin Germany
Study release: April 2022
Study author(s): T. Streich

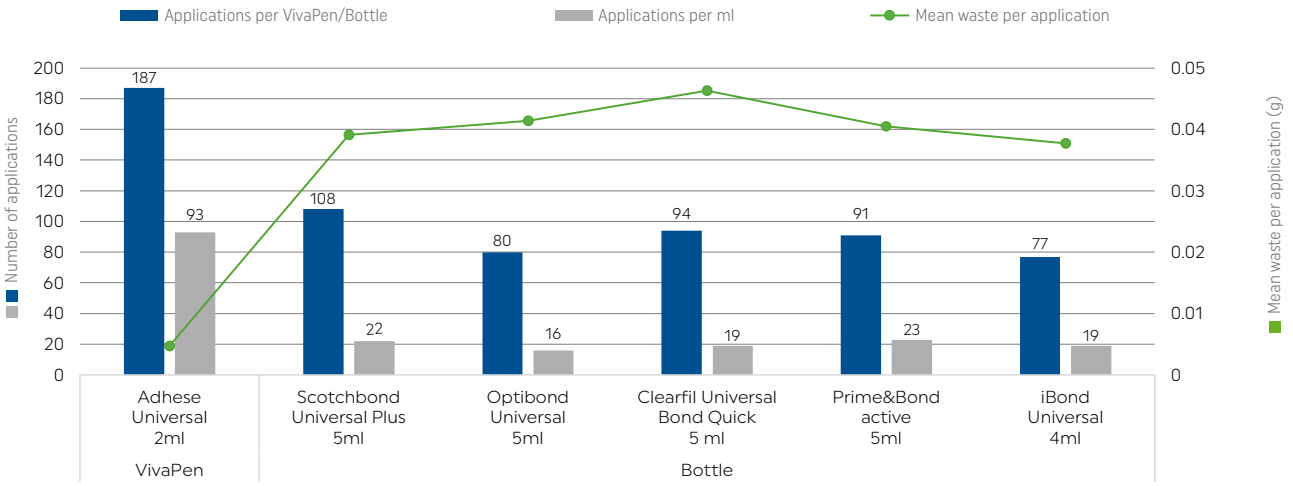
Objective:

To analyse the efficiency of and residual waste from the newest VivaPen 3.0, compared to bottled dental adhesives – using Class I plastic tooth models.

Method:

Adhese Universal (in 2ml VivaPen) was compared to the following 5 products: Scotchbond Universal plus/3M (5ml), Optibond Universal/Kerr (5ml), Clearfil Universal Bond Quick/Kuraray (5ml), Prime&Bond Active/Dentsply Sirona (4ml) and iBond Universal/Kulzer (4ml). All products were applied several times daily (to simulate standard clinical use) to tooth models. For each use the VivaPen was clicked twice to wet the cannula, and 2 drops of the other adhesives were applied to a mixing plate. The adhesives were applied and rubbed in to cavities for 20s. The number of applications per VivaPen/bottle and per ml were established for each adhesive. Weight analysis of the VivaPen/bottles, cannulas/applicators, dosing plates (only bottled adhesives) and plastic tooth-cavity models (before and after use) was also carried out to establish the extent of material loss.

Results:



Wastage and number of applications per VivaPen/Bottle and per ml for various "universal" adhesives

Summary:

The Adhese Universal VivaPen demonstrated the highest number of applications per delivery form and per ml. Per ml the Adhese Universal offered approximately 4x the number of single tooth applications compared to the adhesives supplied in bottles. The VivaPen also offered approximately twice as many applications per delivery form (VivaPen 2ml vs Bottle ml). Average material loss/waste per application was also calculated to be around 8x lower for the Adhese Universal VivaPen– largely due to the loss of product remaining in the mixing plate with the bottled adhesives and far lower levels of residual waste within the VivaPen compared to bottles.

Conclusion:

Precise efficient application with the VivaPen offered more applications both per delivery form and per ml than competitor universal adhesives in bottle form. Product wastage was also lower.

Reference: Streich (2022)

In vivo studies: Direct – Hypersensitivity

Post-operative sensitivity outcomes after 3 second curing of Adhese 2 in direct composite restorations: A case series

Study location: Dental Clinic, R&D Ivoclar, Schaan, Liechtenstein
Study release: August 2025
Study author(s): L. Enggist

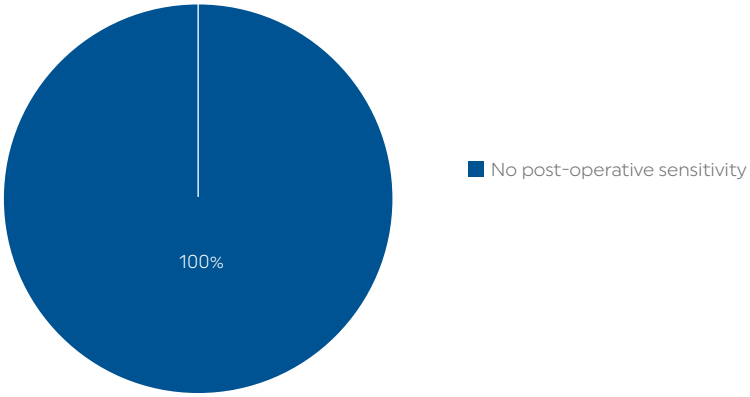
Objective:

To establish post-operative sensitivity outcomes in direct restorative treatment when Adhese 2 is cured rapidly in 3s-cure mode.

Method:

Seven patients received ten direct restorative treatment in permanent posterior teeth at the Ivoclar dental clinic. All patients were treated between August and October 2025. Adhese 2 was applied in etch & rinse mode and cured for 3 seconds with the polymerization light Bluephase PowerCure in 3sCure mode (2700–3300 mW/cm²). Of the 10 cavities overall, 7 were Class II and 3 Class 1 – involving 7 molars and 3 premolars. The cavities were restored using the simplified universal composite Tetric plus Flow alone or Tetric plus Flow topped with Tetric plus Fill. One Class II cavity was restored using Tetric EvoFlow topped with Tetric plus Fill. The composite materials were cured with Bluephase PowerCure in High mode for 10 s (1000–1300 mW/cm²). Patients were checked for post-operative sensitivity immediately following treatment and any occurrence following treatment was checked by telephone after 1–4 weeks.

Results:



Occurrence of post-operative sensitivity after direct restorative treatment with Adhese 2 – cured for 3 s

Summary:

No post-operative sensitivity was reported by any of the patients for any of the treated teeth. This was the case following treatment, after 1 week and to date (follow up of approximately 2 weeks to 2 months depending on the case). As patients work at the same location as the clinic, any subsequent post-operative sensitivity can be reported immediately.

Conclusion:

Adhese 2 cured for 3 seconds performed well in this case series involving ten cavities. No post-operative sensitivity was observed or reported over a follow-up period of up to 2 months. The results support the material's rapid curing protocol.

Reference: Enggist (2025a)

Clinical evaluation of Adhese Universal with Tetric plus Flow and Tetric EvoFlow for treating Class V non-carious lesions: Post-operative sensitivity results at baseline and after 1 month

Study location: Dental Clinic, R&D Ivoclar, Schaan, Liechtenstein
Study release: July 2024
Study author(s): C-S. Pentelescu

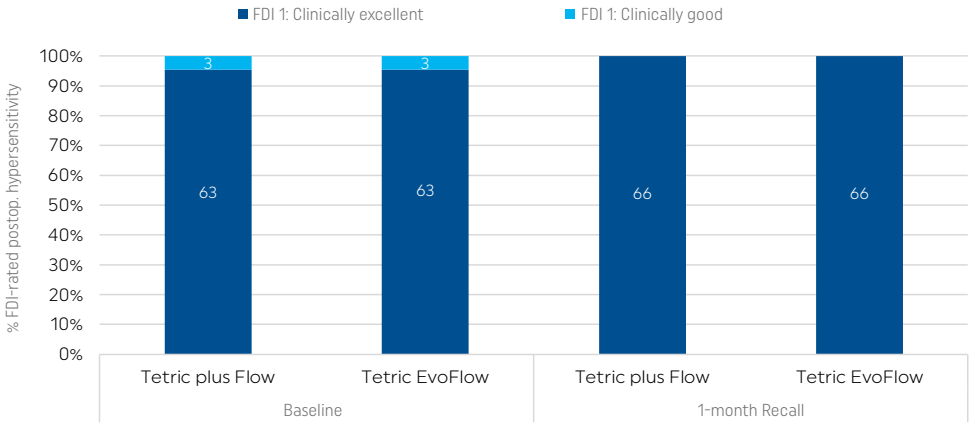
Objective:

To evaluate and compare the use of Adhese Universal with the composites Tetric plus Flow and Tetric EvoFlow for treating non-carious cervical (Class V) lesions (NCCL) and to measure the incidence of postoperative sensitivity (POS) in the short term.

Method:

66 patients aged 18–65, with regular sensitivity were treated according to split-mouth design. Two teeth per patient were treated. Test group teeth received one Tetric plus Flow restoration in layers of up to 4 mm (3.5 mm for shade A3.5 plus) and control group teeth received one Tetric EvoFlow filling in layers of up to 2 mm. Adhese Universal was used in the etch&rinse/total-etch mode mode for all restorations. All filling layers were cured for 5 s using the Bluephase PowerCure in Turbo mode (1800–2200 mW/cm²). Restorations (n=132) were assessed according to selected FDI criteria at baseline (7–10 days post placement) and after 1 month. A visual analogue scale (to measure thermal and biting sensitivity) informed the FDI values for POS.

Results:



Postoperative hypersenstivity (n=66) at baseline & after 1 month in Class V Tetric plus Flow restorations applied with Adhese Universal.

Summary:

The incidence rate for POS was the same in both groups at baseline. 63 of the 66 teeth (95.5% per group) were rated FDI 1 and the rest FDI 2 i.e. clinically excellent or good, respectively. Any sensitivity (FDI 2) subsided in both groups with all 66 (100%) rated clinically excellent (FDI 1) after 1 month. All other FDI parameters (e.g. surface lustre, vitality, fracture at margins and patient view), also demonstrated 100% FDI 1 or 2 (clinically excellent or good) scores at baseline and after 1 month.

Conclusion:

Both composite products applied with Adhese Universal performed similarly and effectively in treating non-carious cervical lesions and no treatment-associated hypersensitivity was reported after 1 month.

Reference: Pentelescu (2024a)

Clinical performance of Adhese Universal with rapidly-cured Tetric plus Flow + Tetric plus Fill restorations in Class I/II cavities. Post-operative sensitivity results at baseline and after 1-month

Study location: Dental Clinic, R&D Ivoclar, Schaan, Liechtenstein
Study release: October 2024
Study author(s): C-S. Pentelescu, L. Enggist

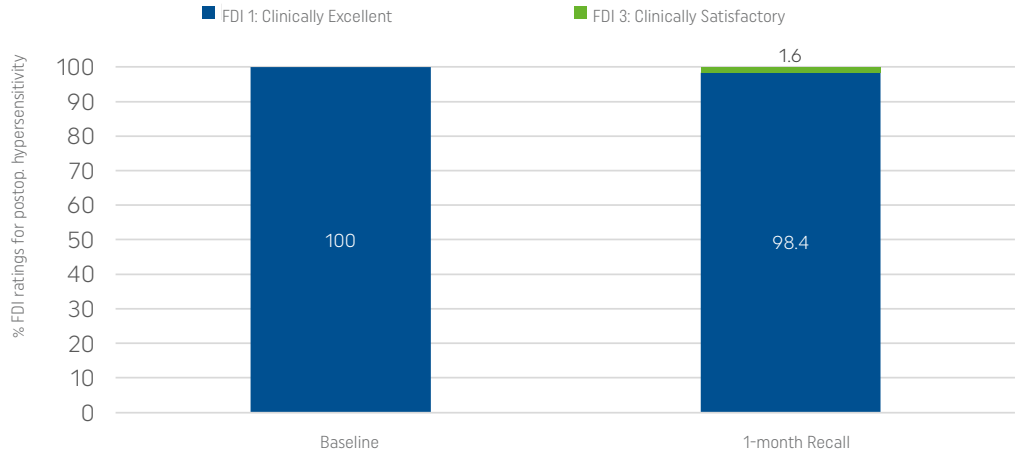
Objective:

To evaluate via a prospective single-arm study, the occurrence of postoperative hypersensitivity (POS) in Tetric plus Fill + Tetric plus Flow restorations applied with Adhese Universal in Class I and II cavities

Method:

65 restorations were placed in the vital premolars (n=16) and molars (n=49) of 65 patients aged between 18 and 65. 58% of patients were men, 42% women and the majority (76%) were treated for secondary caries. After enamel etching for 30 s and dentin for 15 s, Adhese Universal/Ivoclar was applied and light cured for 3 s (2700–3300 mW/cm²). A first layer of ≤ 4 mm Tetric plus Flow was applied and cured for 3 s, followed by a capping layer of Tetric plus Fill which was modelled and also rapidly cured for 3 s. Restorations were finished and polished with OptraGloss instruments. A visual analogue scale (VAS to measure thermal and biting sensitivity) informed the FDI values for assessing postoperative sensitivity. FDI grades 3–5 were considered indicative of POS as grade 1 indicates no problem and grade 2 subsides requiring no treatment.

Results:



Postoperative hypersensitivity ratings at baseline and after 1 month, in Tetric plus restorations

Summary:

65 patients were checked at baseline and 64 at the 1 month recall - (due to a medical issue, one patient could not be physically assessed but was interviewed by phone regarding symptoms). No POS was detected at baseline, with 100% of the restorations rated clinically excellent (FDI 1). Importantly the patient-reported VAS scores also decreased pre to post placement. After 1 month 98.1% were rated FDI 1 because one patient had begun to experience occasional light sensitivity on biting and was rated clinically satisfactory (FDI 3).

Conclusion:

A bulk flowable plus sculptable-cap restoration is considered the worst-case scenario regarding potential POS, due to the higher monomer content and therefore exotherm polymerization reaction of flowable composites. Only one patient (1.6%) reported mild POS after 1 month – whereby no intervention was desired.

Reference: Pentelescu et al. (2024b)

Clinical investigation of the 3s PowerCure system with Adhese Universal: 5 year results

Study location: Dental Clinic, R&D Ivoclar, Schaan, Liechtenstein
Study release: February 2025
Study author(s): L. Enggist

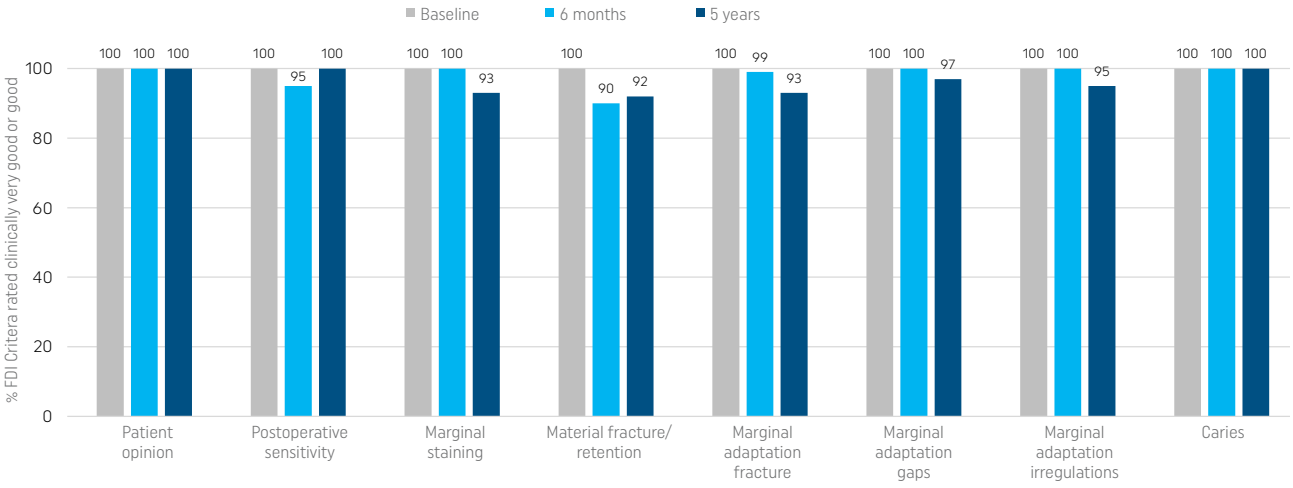
Objective:

To investigate the clinical performance of the 3s PowerCure product system, incorporating Adhese Universal, Tetric PowerFlow and Tetric PowerFill in Class I or II cavities of permanent molars or premolars.

Method:

Between January and March 2018, 75 restorations were placed in patients with a mean age of 45 (60% male and 40% female). 25 patients received two fillings (n=50) and 25 patients received one filling (n=25). 50 molars and 25 premolars were treated. 12 fillings were Class I and the rest Class II. Three operators carried out the restorations. Adhese Universal was applied according to the etch & rinse technique. Tetric PowerFlow was applied in a layer of up to 4mm followed by a covering of Tetric PowerFill in 1 or 2 layers of at least 1mm. Each increment of each material was cured for 3 seconds using the 3s Cure-Mode of the Bluephase PowerCure light (2700–3300 mW/cm²). Baseline, 6m, 1 y, 2y and 5y recalls were carried out. The graph below depicts the FDI adhesive-related criteria.

Results:



Percentage of adhesive related FDI criteria graded FDI 1 or 2 at baseline and after 6 months and 5 years

Summary:

After 5 years, 60 restorations could be evaluated, and the survival rate was 95%. The majority of restorations were rated FDI 1 or 2 for the adhesive-related FDI criteria (and other criteria). Patient opinion remained excellent throughout. Most sensitivity resolved within 4 weeks, with all remaining restorations rated FDI 1 or 2 after 5 years, however 3 restorations were replaced prior to the 5-year recall, due to persistent mild hypersensitivity. No secondary caries requiring treatment was noted over the study period. Overall no restoration failed due to marginal integrity, fracture or secondary caries.

Conclusion:

The survival rate after 5 years was 95% and the majority of restorations were rated clinically excellent or very good. The 3s Power Cure system including Adhese Universal is a promising fast treatment alternative to traditionally layered composites.

Reference: Enggist (2025b)

Clinical performance of Adhese Universal in non-carious cervical lesions: 12 month results

Study location: Indiana School of Dentistry, Indianapolis, Indiana, USA
Study release: May 2016
Study author(s): J. Platt, K. Diefenderfer, M. Rouse, N. Cook, O. Capin, B. Adams, M. Kirkup

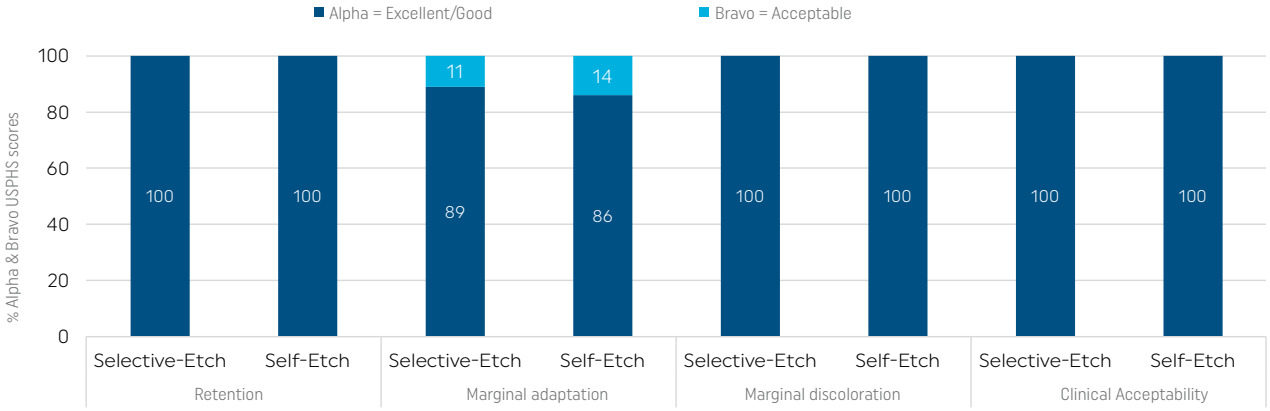
Objective:

To evaluate the clinical performance of Adhese Universal using both the self-etch (SE) and selective-etch (SLE) technique in combination with Tetric EvoCeram restorations in patients with at least 2 non-carious cervical lesions in canine or premolar teeth.

Method:

81 lesions were restored in 33 patients using Adhese Universal in both the SE and SLE technique in combination with Tetric EvoCeram. If the lesion was greater than 2 mm in any dimension, which was the case for most of the restorations, incremental placement was performed using Tetric EvoCeram with the first incremental layer placed against enamel. Pre-operative sensitivity was evaluated using a 1 s blast of air and a numeric 0-10 pain scale: (0 = no hypersensitivity, 10 = maximum hypersensitivity – whereby 0-2 was considered low sensitivity). Each restoration was also evaluated with regard to retention, marginal adaptation and discoloration. Testing was repeated after 6 and 12 months.

Results:



Percentage of Alpha and Bravo USPHS ratings after 12 months

Summary:

At the 12 month recall, 74 restorations were available for recall in 30 patients. Two patients were lost to follow-up and one moved away excluding them. All restorations were in situ and no significant differences were observed between the etching groups for retention, marginal adaptation, marginal discoloration or clinical acceptability and most criteria were rated excellent/Alpha after both 6 and 12 months. Marginal adaptation was the only criteria to elicit acceptable/Bravo ratings at the 12 month recall this value was significantly worse compared to baseline for the selective-etch group. Marginal discoloration exhibited no significant change from baseline to 12 months. Hypersensitivity values (% scores: 0-2) improved from the preoperative situation to after 12 months in both groups (SE: 86% to 97% and SLE: 81% to 97%) with one subject having sensitivty reduced from 10 to 0 over the period.

Conclusion:

All restorations were retained, were clinically acceptable and mostly rated Alpha. Adhese Universal exhibited excellent results with both etching protocols.

Reference: Platt et al (2016a), Platt (2016b)

Universal adhesives and adhesion modes in non-carious cervical restorations: 2-year randomized clinical trial

Study location: Faculty of Health Sciences, University Fernando Pessoa, Porto, Portugal
Study release: 2021
Study author(s): P. Manarte-Monteiro, J. Domingues, L. Teixeira, S. Gavinha, M. C Manso

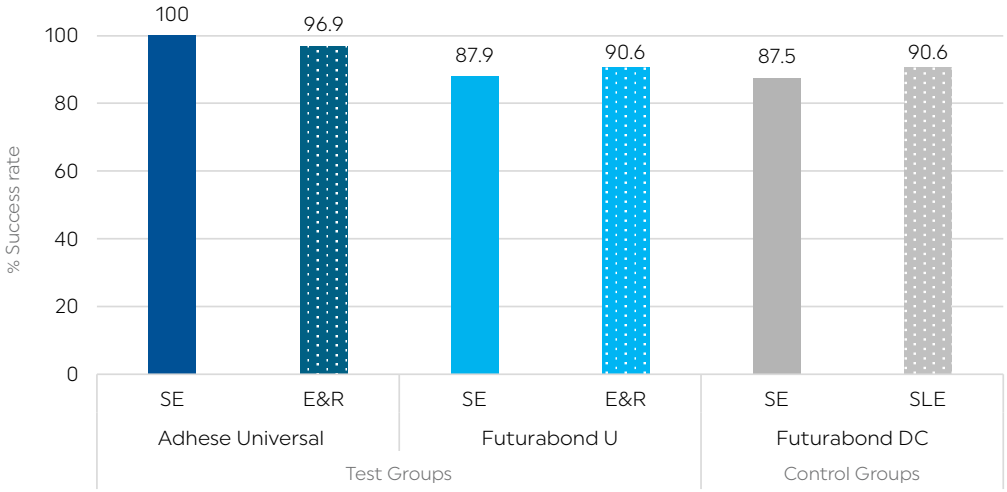
Objective:

This prospective, double-blind, six-arm parallel randomized controlled trial examined the clinical performance of two universal dental adhesives: Adhese Universal/Ivoclar (AU) and Futurabond U/Voco (FBU) for restoring non-carious cervical lesions (NCCLs) over a two-year period using FDI World Dental Federation criteria. The study also analyzed how participants' age and specific tooth lesion characteristics influenced adhesive outcomes.

Method:

Thirty-eight adults seeking routine dental care received 210 restorations, randomly assigned to six groups (35 restorations each), using either AU or FBU in self-etch or etch-and-rinse (E&R) mode and 2 control groups consisted of Furturabond DC (FBDC) in self-etch (SE) and selective-etch (SLE) modes. The ormocer composite resin Admira Fusion/Voco was used to restore all lesions. Restoration outcomes were assessed at baseline, 1 year, and 2 years based on esthetic, functional, and biological criteria. Success rates, retention, and clinical acceptability were measured.

Results:



Percentage reported success rate by adhesive and etching group

Summary:

After two years, 191 restorations in 35 patients could be evaluated. All adhesives showed acceptable clinical performance but varied by product and application mode. Adhese Universal – notably in self-etch mode (100% success rate), generally outperformed FBU and the control FBDC, with fewer failures and higher success and retention rates.

Conclusion:

Adhese Universal delivered superior clinical outcomes (retention, marginal adaptation, and overall success) compared to FBU and control adhesives, especially in self-etch mode. Patient age and NCCL-features such as dentin sclerosis and cavity shape affected restoration success.

Reference: Manarte-Monteiro et al. (2021)

Clinical evaluation of 3s PowerCure composites with Adhese Universal: 3 year results

Study location: University of Alabama, Birmingham, Alabama, USA
Study release: August 2021
Study author(s): N. Lawson, J. Burgess, C. Fu, A. Robles

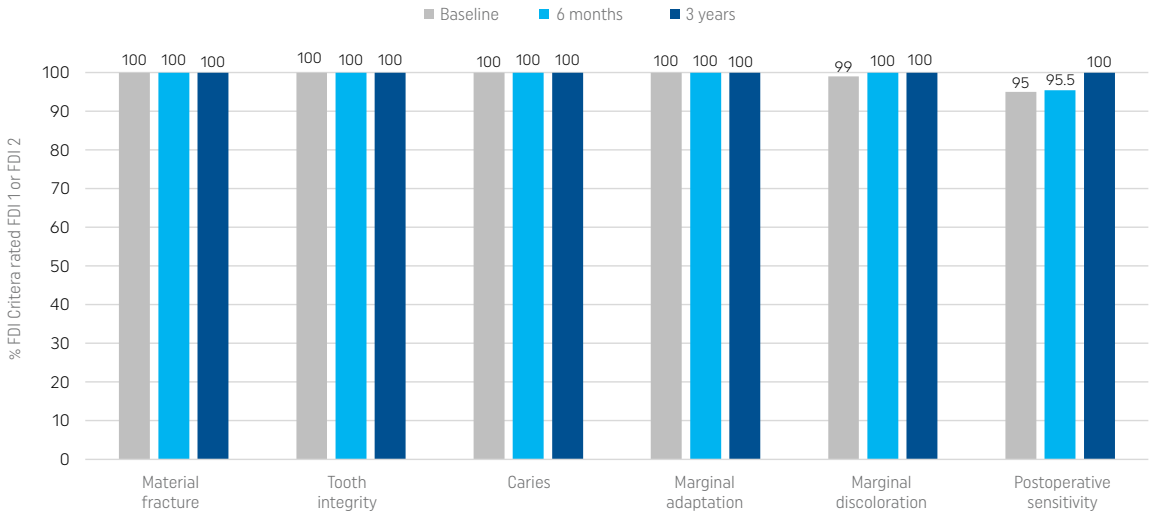
Objective:

To measure the clinical outcomes of rapidly cured direct (> 4 mm) restorations placed with Adhese Universal and Tetric PowerFill in Class I/II cavities.

Method:

Tetric PowerFill restorations were placed with Adhese Universal using the etch & rinse technique and cured in 3 s with the Bluephase PowerCure light in 3s mode (2700–3300 mW/cm²). 42 patients were enrolled and due to screening failures, 39 patients were finally included, with an average age of 43 years. Patients received 1 to 3 restorations each – resulting in 69 restorations. Prior to the study, pre-operative sensitivity and vitality were assessed according to a 0-10 visual analogue scale (VAS), ranging from no pain to worst pain imaginable. 51% of the restorations were performed on premolars and 49% on molars. 80% of the restorations were Class II, 20% Class I and most (80%) involved replacing old fillings. Restorations were placed by four clinicians but evaluated by the same clinician, according to modified FDI-criteria at baseline, after 6 months and up to 3 years. The criteria relating most to the adhesive are presented below:

Results:



Percentage of restorations rated FDI 1: (clinically very good) or FDI 2: good (very good after correction) for various clinical characteristics at baseline and after 3 years.

Summary:

39 patients were evaluated at baseline with the number decreasing to 23 patients with 40 restorations after 3 years. At baseline, most restorations were rated FDI 1 across all the criteria with no percentage lower than 80% for FDI 1. For FDI 1 and FDI 2 evaluations together (see graph) the percentages were always above 95%.. There was an overall reduction in perceived sensitivity preoperatively to baseline (due to treatment) and further after 3 years. All other adhesive related criteria were rated 100% FDI 1–2).

Conclusion:

All clinicians stated that the material polished well, had excellent handling properties and that the shortened light-curing time was an improvement in the clinical workflow. Minimal postoperative sensitivity at baseline had mostly subsided within 1–4 weeks and was no longer perceptible after 3 years.

Reference: Lawson et al. (2021)

Adhese Universal: One-year clinical performance report

Study location: Ann Arbor, Michigan USA
Study release: October 2015
Study author(s): The Dental Advisor

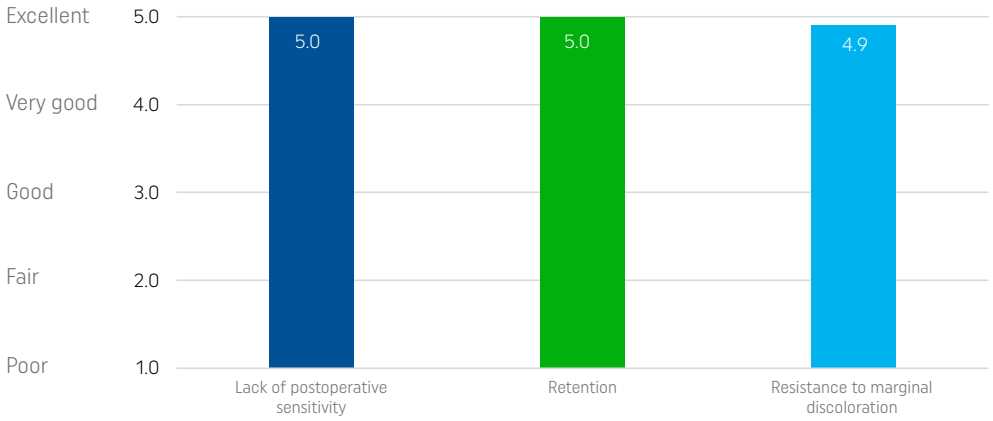
Objective:

To evaluate the clinical performance of Adhese Universal for both direct and indirect restorations – after one year.

Method:

Adhese Universal was used to place a total of 83 direct and indirect restorations. 32% were placed in molars, 27% in premolars and 41% in anterior teeth. After 1 year, 73 (88%) of these restorations (1 zirconia crown, 5 IPS e.max veneers and 67 universal composite restorations) were available for recall. The Adhese Universal-bonded restorations were evaluated in the following categories: lack of post operative sensitivity, resistance to marginal discoloration and retention. The restorations were evaluated on a 1 – 5 rating scale: 1 = poor, 2 = fair, 3 = good, 4 = very good, 5 = excellent.

Results:



Dental Advisor ratings for Adhese Universal after one year

Summary:

No hypersensitivity was reported by patients in any of the retained restorations placed with Adhese Universal. 95% of the restorations showed no signs of marginal staining. Three anterior composite restorations exhibited slight marginal staining. 99% of the restorations were retained after 1 year in service. One large anterior composite restoration debonded and was replaced.

Conclusion:

All restorations received excellent ratings regarding a lack of postoperative sensitivity, resistance to marginal discoloration and retention. Adhese Universal received a clinical performance rating of 99% at one year.

Reference: The Dental Advisor (2015)

Clinical evaluation of Adhese 2 for indirect restorative treatment: 1-month and 6-month results

Study location: Dental Clinic, R&D Ivoclar, Schaan, Liechtenstein
Study release: October 2025
Study author(s): L. Enggist

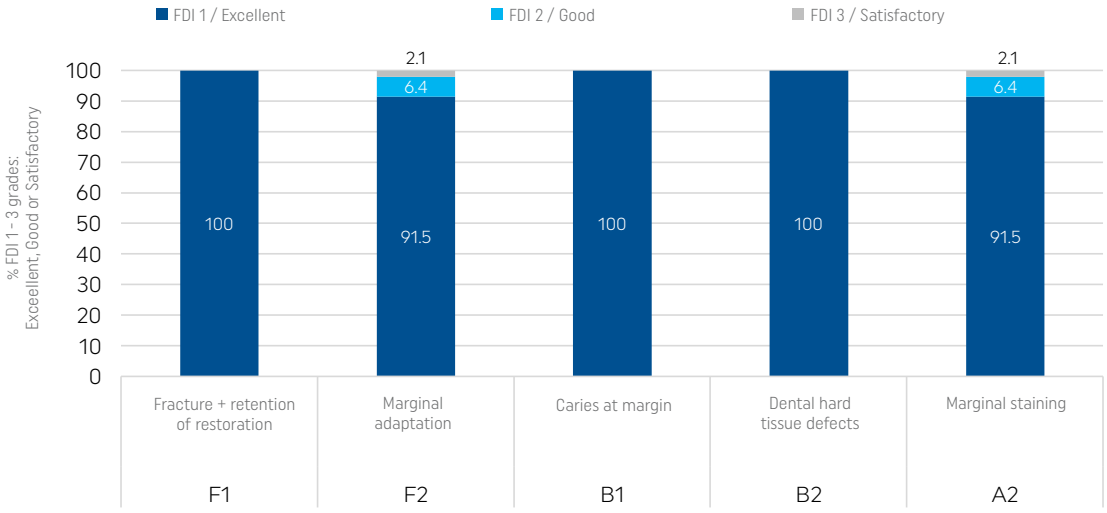
Objective:

To evaluate the clinical performance and safety of the dual-curing adhesive Adhese 2, for luting indirect ceramic restorations.

Method:

45 patients requiring 48 inlays or onlays in premolar or molar teeth, were treated with IPS e.max CAD restorations. The Class I/II restorations were placed with Adhese 2 using the etch & rinse technique without light-curing. Variolink Esthetic DC was then light-cured with Bluephase PowerCure (1000-1300mW/cm2/10s) from each aspect through the restorations. Margins were adjusted as necessary and polished. The primary endpoint was the assessment of postoperative hypersensitivity, 1 month post placement. Clinical performance was secondarily assessed for adhesive-related FDI-criteria such as marginal quality, restoration retention/fracture rates and restored-tooth vitality/fracture rates. Patients will be followed up for 5 years.

Results:



Ratings (%) for adhesive-related FDI criteria for Adhese 2/IPS e.max CAD restorations after 6 months

Summary:

At the start of the study one restoration was replaced immediately due to misplacement during cementation, and counted as a drop-out. 47 restorations could then be evaluated after 6 months. One patient reported biting/temperature-related sensitivity at baseline (VAS 2/FDI 2 compared to VAS 0 prior to treatment), but this later disappeared. No postoperative hypersensitivities were reported at the 1-month recall. The adhesive-related secondary outcomes were predominantly rated excellent after 1 and 6 months, with 100% rated FDI grade 1 for criteria F1, B1 and B2. For marginal adaptation (F2), a user-mistake during luting led to one marginal gap being rated FDI grade 3 (satisfactory) and three others were rated FDI grade 2 (good). One restoration, which was not optimally positioned during the luting procedure incurred marginal staining (A2) grade 3. Three restorations were rated FDI grade 2 due to slight discoloration.

Conclusion:

No post-operative hypersensitivity was reported after 1 month and adhesive-related FDI criteria were predominantly rated excellent after 6 months.

Reference: Enggist (2025c)

Posterior CAD/CAM adhesive ceramic restorations: 7-year clinical study status

Study location: Department of restorative dentistry, University of Washington, Seattle, Washington, USA
Study release: January 2025
Study author(s): J. A. Sorensen, Y.-W. Chen, A. Sadr

Objective:

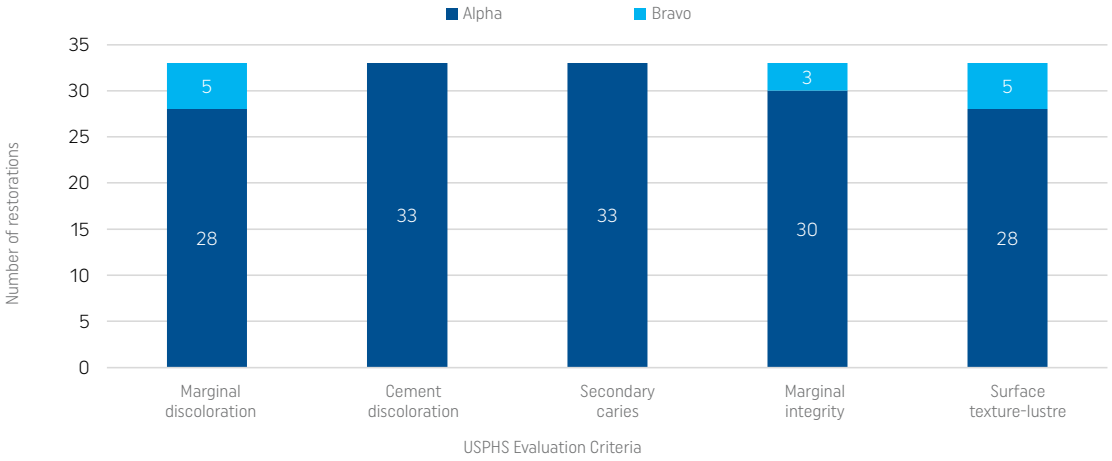
To assess the longer term clinical performance of adhesively luted IPS e.max CAD restorations.

Method:

Restorations were prepared using a tooth-conserving extra-coronal onlay design – except when replacing existing crowns. 35 onlays and 15 crowns (n=50 restorations) were prepared digitally and adhesively cemented with the Adhese Universal adhesive and the luting composite Variolink Esthetic DC/Ivoclar. Restorations were evaluated annually (gap at 5 years due to COVID) according to modified USPHS criteria, using photos, intraoral scans, OCT imaging and clinical examination. Incidence details were recorded, and Kaplan-Meier survival analysis was carried out.

Results:

94.5% survival rate



Survival and distribution of alpha/bravo USPHS scores in IPS e.max CAD restorations after 6–7 years (n=33)

Summary:

All restorations scored Alpha for all criteria at baseline, apart from 3 (6%) restorations which scored Bravo for marginal integrity. 10 of the 50 restorations could be re-evaluated after 6 years and 23 (different restorations) after 7 years (n=33) so far. After 6–7 years, all exhibited 100% Alpha scores for cement discoloration and secondary caries. For marginal discoloration, 5 (15%) restorations scored Bravo, whereby superficial discoloration was confined to small areas of shoulder margins. Surface texture-lustre also exhibited 15% Bravo scores (85% alpha). Minor changes were seen in marginal integrity. Catastrophic failure occurred in 2 cases and Kaplan-Meier analysis indicated a 94.5% survival rate over a mean service time of 61.5 ± 27 months.

Conclusion:

The adhesive-cementation system retained and supported restorations with minimal microleakage and excellent stability. The entirely digital workflow produced well-fitting restorations and stained/glazed surfaces proved durable. Despite the limitations of the current (33/50) 66% recall rate after 6–7 years, the tooth-conserving onlay designed IPS e.max CAD restorations (utilizing adhesive cementation) performed well.

Reference: Sorensen et al. (2025a), Sorensen et al. (2025b)

Prospective clinical study on the long-term clinical behaviour of IPS e.max ZirCAD Prime (monolithic 3-unit fixed dental prostheses) after 3 years

Study location: LMU Klinikum, Ludwig-Maximilians-Universität, Munich, Germany
Study release: March 2025
Study author(s): D. Edelhoff, C. Keul

Objective:

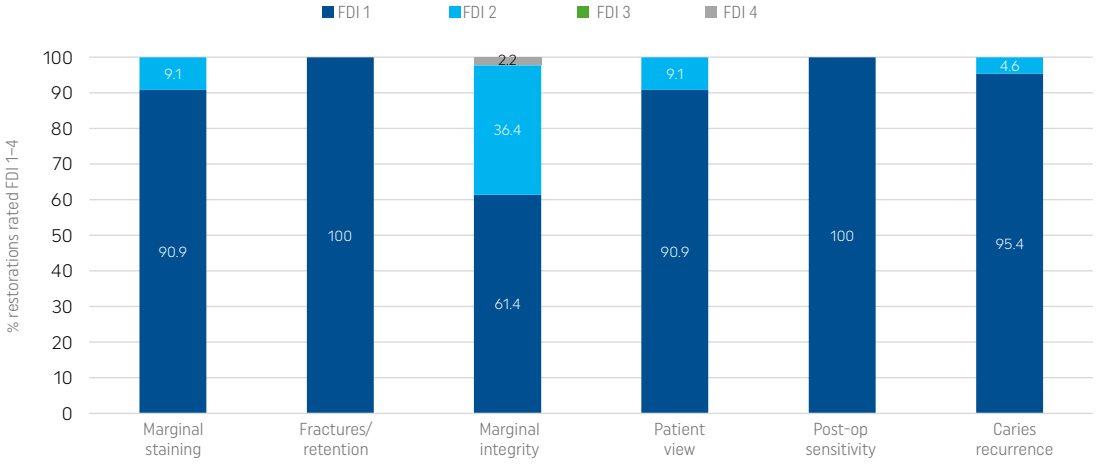
Evaluation of the clinical performance of CAD/CAM fabricated 3-unit monolithic fixed dental prostheses (FDPs) made of IPS e.max ZirCAD Prime using Adhese Universal and Tetric EvoCeram for the creation of supportive build-ups.

Method:

22 patients received one 3-unit IPS e.max ZirCAD Prime bridge for either the anterior (n=2: with vestibular veneering) or posterior region (n=20: entirely monolithic). Patients were all over 18 and exhibited good oral hygiene. 14 patients were female and 8 male, the average age was 61. The minimum material thickness was defined as 1 mm. Restorations were made according to the instructions for use and IPS Ivocolor was used for staining and glazing. Adhesive luting with Variolink Esthetic DC was carried out after sand blasting and the application of Monobond Plus to the FDPs. Various FDI parameters were evaluated according to esthetic, functional and biological properties. FDI scores 1–4 related to clinically excellent, good, satisfactory and unsatisfactory respectively. The diagram below shows the criteria most relevant regarding adhesive luting/cementation.

Results:

95.5% survival rate



Percentage of restorations rated according to FDI criteria (related to adhesive luting) after 3 years

Summary:

After 3 years, no technical (fracture, chipping, retention loss) complications were observed and esthetic criteria were mostly rated FDI 1 or 2 throughout the study period. One restoration exhibited clinically unsatisfactory marginal integrity (FDI Score 4) and due to extended secondary caries on an abutment tooth in this patient, the restoration could not be repaired and was therefore rated a failure/adverse event (requiring replacement) in this investigation. Overall survival was therefore (21/22) 95.5%.

Conclusion:

The 3-unit IPS e.max ZirCAD Prime FDPs involving build-ups (with Adhese Universal and Tetric EvoCeram) exhibited good results. At the 2-year recall the survival rate was 100%. After 3 years due to one failed FDP (due to secondary caries) it fell to 95.5%.

Reference: Edelhoff et al. (2025)

Prospective clinical observation of Adhese Universal and Variolink Esthetic LC for the placement of IPS e.max Press veneers and onlays: Interim observations

Study location: LMU Klinikum, Ludwig-Maximilians-Universität, Munich, Germany
Study release: July 2019
Study author(s): D. Edelhoff, J. F. Güth, T. Wimmer

Objective:

To investigate the performance of adhesively luting lithium disilicate IPS e.max Press veneers and onlays with Adhese Universal/ Variolink Esthetic LC with regard to postoperative sensitivity, excess removal, gingival reaction and marginal quality.

Method:

This prospective study was started in July 2015. To date 280 restorations (112 veneers and 168 onlays) have been placed in 20 patients (14 women, 6 men) and photo-documented according to study guidelines. Additionally, outside the study, 11 sintered veneers and 10 full crowns were placed in the same patients using the same adhesive protocol. The high number of restorations per patient relates to the fact that most patients required complete dental restoration of the oral cavity. The final evaluation will include 2 veneers and 2 onlays per patient. The current results are not complete but are presented to provide insight on the use of Adhese Universal and Variolink Esthetic LC for indirect procedures where light curing through the restoration is possible. The results here include follow-up examinations at 12 (n=14), 24 (n=9), and 36 (n=6) months. The interim report provides the following qualitative information:

Results:

Postoperative sensitivity	Excess removal	Gingival reaction	Marginal quality
No bite or relief pain	Excess VE LC generally easy to remove due to thixotropic flow-behaviour and notably when short 2 s polymerization used	Stable	Perfect or slightly irregular margins
No sweet/sour sensitivity		No significant abnormalities	Rare clinically non-relevant undercuts
Occasional temporary mild temperature sensitivity post treatment which subsided within days		No persistent irritation	No inherent discoloration

Qualitative assessment of adhesive luting with Adhese Universal/Variolink Esthetic DC for IPS e.max Press restorations

Summary:

Preliminary data after up to 4 years, suggest that the combination of Adhese Universal (VivaPen) and Variolink Esthetic LC provides reliable, stable, and esthetic adhesive outcomes for IPS e.max Press restorations.

Conclusion:

Continued follow-up is needed for quantitative data and to confirm long-term durability.

Reference: Edelhoff et al. (2019)

Biocompatibility

Biocompatibility can be defined as the ability of a substance or material to be in contact with a living system without producing an adverse effect. When developing new products, Ivoclar strives to use well-established raw materials that have already proven safe in vivo – in order to minimize any biocompatibility risks from the outset. This section reports on the biocompatibility of Adhese Universal, Adhese Universal DC and Adhese 2.

Medical device standards

Medical devices are subject to very strict requirements, which are designed to protect patients and operators from any potential biological risks. ISO 10993: "Biological evaluation of medical devices" defines how the biological safety of a medical device is to be evaluated. Furthermore, dental medical devices are subject to ISO 7405: "Dentistry - Evaluation of biocompatibility of medical devices used in dentistry" and standard risk management requirements as set out in ISO 14971 "Medical devices – Application of risk management to medical devices". The standard ISO 29022 „Dentistry - Adhesion - Notched-edge shear bond strength test" also sets out a standardized procedure for testing the adhesive bond strength between direct dental restorative materials and tooth structure, but does not specify minimum threshold values that should be achieved. Ivoclar carries out similar (but not identical) adhesive shear bond strength tests based on this standard, with threshold values set according to tooth substrate:

	Direct restorations	Indirect restorations
Enamel	>15 MPa	>15 MPa
Dentin	>25 MPa	>20 MPa

Ivoclar thresholds used for adhesive shear bond strength tests with Adhese 2

The Ivoclar universal adhesives were evaluated during development following the specified standards, supplemented by literature reviews and database searches.

Sensitivity

Like all resin-based dental materials the Ivoclar Universal Adhesive contain (di)methacrylates. These materials (notably in their uncured state) may cause sensitisation to methacrylates, which can lead to allergic contact dermatitis. Allergic reactions are very rare in patients but occur more frequently among dental staff who handle uncured material on a daily basis. Such reactions can be minimized or avoided by clean working conditions and avoiding skin contact with uncured material. It should be noted however that commercially available medical gloves do not provide effective protection against the sensitizing effects of methacrylates. Ivoclar universal adhesives should not be used in patients known to be allergic to any of their constituents.

Testing regime and summary

Various biocompatibility assessments were conducted with the Ivoclar Universal Adhesives including cytotoxicity (potential to damage cells), and genotoxicity (potential to damage/alter genetic material) tests. According to the data available and general world-wide use with highly comparable products, it can be concluded that the products are used in very small amounts, do not cause adverse reactions in the oral cavity and in general that the Ivoclar Universal Adhesives (Adhese Universal, Adhese Universal DC and Adhese 2):

- pose no cytotoxic concern
- are not genotoxic
- have no potential for material-mediated pyrogenicity
- present no acute nor sub-acute systemic toxicity
- do not cause oral mucosal or gingival irritation
- do not cause adverse reactions upon implantation in teeth
- do not harm the pulp or dentin
- can cause severe irritation of the eyes due to their (by necessity) low acidic pH. Proper work-flow measures avoid this risk.
- can cause irritation and sensitization in their unpolymerized state, however if used according to the instructions for use, health risks can be avoided.

Conclusion

In view of the present data covering two decades and today's level of knowledge it can be concluded that the Ivoclar range of Universal Adhesive do not pose a toxicological risk to the patient or professional user. Health risks for patients (and users) can reasonably be excluded and the benefits provided by the final products exceed any potential risks, provided they are used as intended - in a professional dental setting, according to the instructions of use.

Definition of terms

Studies

Studies are conducted to forecast or examine the behaviour of materials when used for the intended application. Aspects of functionality, reliability, safety, compatibility or user-friendliness are often of most interest.

In vitro studies

In vitro means "in glass." These examinations are conducted in a laboratory outside of their normal biological context. Many materials science or toxicological tests are carried out in vitro since they cannot be conducted on human beings for practical or ethical reasons. In vitro studies have the advantage that researchers can work under standardized conditions, and they are often quicker and less expensive than in vivo studies.

In vivo (clinical) studies

In vivo means "in the living object." Such studies are carried out within the biological context i.e. for dentistry – in human beings usually at a dental practice. The advantage is that results are more meaningful as the investigations are conducted under real conditions. They are however complex due to a wealth of possible influencing factors. They require exact planning, systematic methods, ethical permission and statistically correct evaluation. Randomized controlled studies are considered the gold standard.

Prospective study

A study planned to be conducted in the future in order to test a certain hypothesis, such as material A is as good as or superior to material B. After preparation of a test plan, the patients are recruited, and the material used. The test subjects are observed over a certain period of time and the results are subsequently compared and evaluated.

Retrospective study

Analysis of data collected in the past. For example – all cases of bridge fractures that occurred in a dental office are examined to find out if the fractures happen more frequently with one material rather than with another.

Adhesion

Adhesion or bonding is the process by which dental materials attach and hold on to tooth structures on one side and dental materials on the other – either through physical, chemical or micromechanical means.

Universal adhesive

A dental bonding system compatible with multiple etching techniques including etch & rinse (E&R), self-etch (SE) and selective-enamel-etching – allowing application-flexibility according to the clinical situation.

Smear Layer

The smear layer is a thin film (0.5–5 µm) of microcrystalline and organic debris (consisting of hydroxyapatite and denatured collagen), that forms on tooth surfaces, notably dentin, after procedures like cavity preparation or root canal instrumentation. (Swift 1995)

Hybrid Layer

The hybrid layer is a microscopically thin zone formed by the infiltration of adhesive resin into demineralized dentin, interlocking the resin with exposed collagen fibres. This layer combines elements of both the tooth and resin, serving as the essential interface that secures bonding and seals the dentin against leakage and sensitivity.

Dentin permeability

A measure of how easily fluid moves through dentin – the smear layer can reduce this property.

Demineralized collagen

Collagen on the dentin surface exposed and weakened by acid etching due to the removal of mineral content (e.g. hydroxy-apatite) – affecting adhesive penetration.

Collapsed collagen

A physical state caused by over-drying or excessive air-drying of collagen during clinical procedures, leading to the collapse of the exposed collagen network, impairing adhesive penetration and bond strength.

Hydroxyapatite
Hydroxyapatite is the main inorganic mineral found in dental enamel and dentin, primarily composed of calcium and phosphate ions providing strength and rigidity to these tissues. Hydroxyapatite is often partially removed or modified during adhesive procedures.

Collagen
The organic component of dental enamel and dentin is mainly collagen, which provides flexibility to these tissues.

Monomer
The basic building block of resin adhesives. Monomers can provide the necessary hydrophilicity and hydrophobicity, to allow both wetting and mechanical integration with restorative materials.

Degree of conversion
The degree of conversion refers to the percentage of carbon double bonds converted to single bonds i.e. the conversion of monomers to polymers via curing. With light-polymerization, the conversion rate is generally higher at the surface of a composite closest to the light guide – decreasing with increasing depth, but this less of an issue with adhesive materials due to their transparency and thin-layer application.

Amphiphilic
Describes molecules or materials that have both hydrophilic (water-attracting) and hydrophobic (water-repelling) properties allowing better compatibility and bonding between dental tissues (hydrophilic) and resin materials (hydrophobic).

Solvent
Liquid components of adhesives like water, acetone or ethanol that transport monomers and promote substrate infiltration and evaporation once the adhesive is cured.

Etching Techniques

Etching is the process of applying an acidic substance, commonly phosphoric acid to the surface of a tooth. This roughens it at a microscopic level creating tiny pores which increases the tooth's surface area – providing mechanical retention sites which enhances the potential bond strength of restorative materials to teeth. Etching is a key step in various direct and indirect dental procedures from composite fillings to veneers, sealants, and orthodontic brackets.

Enamel etching: In prepared enamel, the enamel prisms are either cut transversely or vertically. A micro retention pattern forms during acid etching with phosphoric acid, because the central and peripheral parts of enamel prisms differ in their degree of solubility – thus different etching patterns form (Silverstone 1975).

Dentin etching: Prepared dentin also undergoes changed surface morphology in that a smear layer forms. Etching with phosphoric acid removes this layer and demineralizes a few microns of the surface dentin. When the acid is rinsed away this reveals open dentin tubuli. Dentin can when clinically prudent, also be mildly etched/conditioned with acidic universal adhesives alone. The acidic nature of these adhesives is able to transform the smear layer.

Etch & Rinse / Total-Etch Technique
A bonding method that uses phosphoric acid e.g. Total Etch/Ivoclar to etch enamel and/or dentin, followed by rinsing off the acid (which removes the smear layer) before applying e.g. primer and adhesive or universal adhesive.

Self-Etch Technique
An adhesive approach where acidic monomers in the bonding agent simultaneously etch and prime the tooth surface, without a separate rinsing step; the smear layer is not rinsed off but is incorporated into the bonding interface.

Selective-Etch /Selective-Enamel-Etch Technique
A hybrid method that selectively applies phosphoric acid etchant only to the enamel before rinsing, then uses a self-etch adhesive on both the enamel and dentin. This maximizes enamel-bond while minimizing dentin sensitivity.

Traditional Adhesion Steps

Adhesive steps are all covered by one product with Universal Adhesives. Traditional multi-step adhesives like Syntac deal with these steps one by one.

Conditioning

Involves the dissolution of the smear layer, whereby apatite crystals are dissolved from superficial dentin and the collagen network is laid bare to expose a sponge-like structure to a depth of about 5 µm.

Priming

The application of a hydrophilic monomer mixture which infiltrates the sponge-like structure – preparing it for the application of a hydrophobic bonding resin.

Bonding

The application of a mainly hydrophobic mixture which penetrates and stabilizes the collagen network that was previously infiltrated with primer solution. The layer of natural collagen mixed with resin is often referred to as the hybrid layer and an adhesive layer forms on top of the hybrid layer which is then polymerized with light and/or chemically – copolymerizing with the direct composite (direct restorations) or composite luting cement (indirect restorations).

Enamel Bonding: As enamel is hydrophobic or insubstantially hydrophilic, the hydrophobic monomers of adhesives are able to penetrate the microscopic spaces created in the etched enamel and adhesive resin tags interlock with the substrate during polymerization.

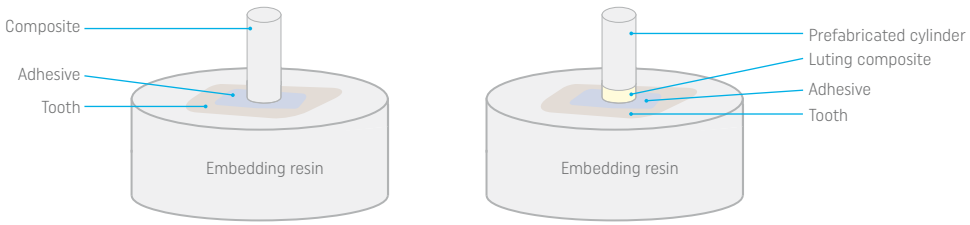
Dentin Bonding: Due to the hydrophilic, organic-rich nature of dentin, dental adhesives contain hydrophilic monomers and solvents that enable penetration into the exposed collagen matrix created by etching, forming a hybrid layer and establishing micromechanical and chemical bonds with both the organic and inorganic components of the substrate.

Bond strength testing of adhesives

In materials science, there are numerous test methods to determine the mechanical properties of materials. The object of mechanical testing in dentistry, is to make estimates about the clinical efficacy of a material. Standard test methods, however, frequently test isolated stress conditions, whereas the effects on a material are much more complex in clinical reality. Nevertheless, materials science examinations in the laboratory do at least permit the comparison of different materials when tested in exactly the same way.

Bond strength refers to how well a dental material adheres to the tooth structure. This bond is achieved by the adhesive in the case of direct restoratives and the adhesive plus luting composite in the case of indirect restoratives Bond strength can be tested in different ways.

Shear bond strength: Shear bond strength is defined as the resistance of a dental adhesive or restorative material to forces that attempt to shear it off **parallel** to the tooth surface. In typical dental testing, this is measured by bonding a material (e.g. composite resin) to tooth specimens and applying a force parallel to the interface until the material debonds or fails. The value is reported in megapascals (MPa) - calculated as the force divided by the bonded surface area.



The diagram above shows schematically how shear bond testing is carried out at Ivoclar for direct restorations (left) and indirect restorations (right)

Microtensile bond strength: Microtensile bond strength (µTBS) is a measure of a dental adhesive or material's resistance to forces that pull it **perpendicular** (tensile) to the interface, but tested on very small (micro-sized) areas, providing more detailed and discriminative evaluation. This test is popular for assessing adhesives because it allows testing multiple sites or e.g. etching protocols on the same tooth.

Megapascal (MPa)

A unit of pressure or stress equal to one million pascals (1 "MPa"=1,000,000 "Pa"). In dental research, bond strength values (like shear or tensile bond strength) are typically reported in megapascals, indicating the force per unit area needed to break a bond.

Cohesive failure

A cohesive failure occurs when the fracture happens within the body of a substrate e.g. within the dentin or the composite material itself - rather than at the interface between two different materials e.g. adhesive and composite. In these cases, the material (either dentin or composite) breaks apart internally, indicating that the bond at the interface is stronger than the internal strength of the material being tested.

Adhesive failure

Adhesive failure refers to the separation that occurs at the interface between the adhesive material and the tooth substrate i.e. enamel or dentin or between the adhesive and the restorative material – this indicates insufficient bond.

Thermocycling / Chewing simulation / Fatigue / Aging

During the development of new materials, it is important to determine how susceptible they are to fracture under the expected stress conditions in the oral cavity. In vitro chewing simulation / fatigue tests are often used, as results are available quickly and materials can be tested and compared under standardized conditions. Test specimens are usually adhesively cemented to standardized PMMA dies and subjected to cyclic, eccentric loading with a pointed steel antagonist in a water bath to represent chewing. The load is increased in steps, e.g. 100,000 cycles with approximately 80 N, then 100,000 cycles with approximately 150 N, followed by 100,000 cycles with approximately 220 N (0.8Hz). Test specimens are simultaneously subject to thermocycling of 105 s each at 5°C and 105 s at 55°C. The number of cycles before fracturing or chipping occurs is usually measured.

Cementation / Luting

Dental cements or luting agents are materials used for cementing/luting indirect restorations to the remaining tooth structure/ core. Both adhesive and non-adhesive materials are available. In this report we refer to adhesive luting composites and methods.

Conventional cementation

Zinc phosphate, carboxylate and glass ionomer cements (GICs) are all conventional materials. Most consist of a powder plus a liquid component, which are manually mixed. Some are available in mixing capsules or syringes with mixing tips. The chemical setting process starts immediately after mixing and does not involve additional initiation. No special pre-treatment of the prepared tooth is needed in conjunction with these materials. Complete isolation of the prepared tooth is not required. However, a retentive preparation design is necessary as there is no adhesive bond to tooth structure.

ZirCAD Cement (resin-modified paste-based GIC in Automix syringe) is suitable for conventional cementation workflows.

Adhesive luting composites

Adhesive composite-based luting materials are resins, composed of monomers and inorganic fillers. These materials establish a sound chemical bond with dental hard tissues and allow minimally invasive techniques. They are classified into self-curing, light-curing and dual-curing materials. By carefully selecting the pigments and colour additives, tooth-coloured luting composites should be invisible if the cement joint is exposed. Enamel and dentin are pre-treated as prescribed by the adhesive luting protocol and the glass-ceramic material to be luted is usually etched with hydrofluoric acid and treated with a silane coupling agent.

Variolink Esthetic is an adhesive luting composite and Variolink Esthetic DC is a dual curing adhesive luting composite.

Self-adhesive luting composites

These combine the advantages of conventional and adhesive luting materials. Although adhesive luting composites have many advantages, their application involves effort (isolation, additional steps and products like dentin adhesives and primers). In contrast conventional cements are simple and quick to use. Self-adhesive luting composites bond, both to the tooth structure and the restorative material, reducing the number of steps involved – thus reducing potential sources of error.

Speedcem Plus is a self-adhesive luting composite.

Clinical Evaluation Techniques for Restorations

Clinical evaluation of restorations is often carried out within the following frameworks. Whilst these are usually aimed at assessing the restorations themselves certain criteria are also relevant for adhesives such as retention, marginal integrity, discoloration and post-operative sensitivity.

Cvar and Ryge/USPHS Criteria

Cvar and Ryge (Cvar & Ryge 1971 and 2005), developed their much-used measurement scale over 40 years ago. This method of evaluation is interchangeably referred to as Cvar & Ryge criteria, Ryge criteria or USPHS criteria. The criteria were drawn up at a time when the longevity of direct restorative materials other than amalgam was limited, thus many modifications of these criteria have been made by various authors, in an attempt to make the criteria more discriminating for modern restorative materials. These are referred to as modified Ryge or modified USPHS criteria. Virtually every modification is slightly different (Hickel et al, 2007).

The criteria use the Alpha, Bravo, Charlie, Delta evaluation scale. These scores have different meanings depending on the criteria being assessed, however in general: Alpha = excellent/optimal, Bravo = acceptable, Charlie = unacceptable/insufficient and Delta = needs replacing.

FDI Criteria

Hickel et al as part of the FDI World Dental Federation Science Committee, published a paper in 2007 (Hickel et al, 2007) outlining a proposal for a more modern clinical evaluation of composite restorations. They present evaluation criteria in 5 levels from clinically excellent to poor. The levels are detailed below and how Hickel et al related these to the original Cvar and Ryge criteria. Various aspects of the FDI criteria were updated in 2010 (Hickel et al, 2010) and 2023 (Hickel et al, 2023).

Cvar & Ryge	FDI (Hickel et al)			
Alpha	Score 1	Clinically excellent / very good	Ideal	Sufficient
	Score 2	Clinically good	Not ideal	
Bravo	Score 3	Clinically satisfactory	Minor shortcomings	
Charlie	Score 4	Clinically unsatisfactory	Repairable	Partially insufficient
Delta	Score 5	Clinically poor	Need replacing	Entirely insufficient

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