3M ESPE

RelyX™ Unicem

Self-Adhesive Universal Resin Cement

Technical Product Profile

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Introduction

3M™ ESPE™ RelyX™ Unicem Self-Adhesive Universal Resin Cement is a dual-cure, self-adhesive universal resin cement in a capsule, designed for adhesive luting of all-ceramic, metal or composite indirect restorations, including fiber posts. RelyX Unicem self-adhesive universal resin cement has been developed for universal luting of both ceramic and metal-based restorations.

Bonding and conditioning of the tooth structure are unnecessary when using RelyX Unicem self-adhesive universal resin cement, as, without pre-treatment, it produces a bond between the restoration and tooth structure comparable to that achieved by multi-step adhesive technologies. Mechanical properties of RelyX Unicem self-adhesive universal resin cement are superior to those of zinc phosphate and glass ionomer-based cements, with little risk of marginal gap formation.

RelyX Unicem self-adhesive universal resin cement is also distinguished by its unique moisture tolerance. Its use is associated with little risk of postoperative sensitivity. In addition, the high dimensional stability of RelyX Unicem self-adhesive universal resin cement permits minimal swelling or expansion due to water absorption. The cement also releases fluoride ions and is available in several shades. Together, these characteristics of RelyX Unicem self-adhesive universal resin cement justify its wide application in dental ceramics.

History

Aspects of present-day dental ceramics can be traced back to 1856, when Sorel described formulations for a magnesium chloride-based cement. The search for better materials has since inspired many developments to meet ever-changing requirements of the dentist.

Cements are classified by their chemical composition. A description of standard cements in current use is presented below.

Cement Types

- Zinc phosphate cements
- Carboxylate cements
- Glass ionomer cements
- Hybrid cements (resin-modified glass ionomer cements and compomers)
- Composite cements

Hybrid cements are increasingly being used to lute crowns and bridges, as well as inlay and onlay restorations. These new cements are relatively easy to handle and are especially suitable for routine application with metal-based crown and bridge work. Their use, however, is limited in the adhesive application of ceramic works with low retentive surfaces. Efficiency of adhesion to the tooth substance and indirect restoration depends upon materials involved, but can be poor with these agents, as excess water absorption and swelling may cause tooth and ceramic fracture.

A wide range of materials with differing properties is available for final luting of crowns, bridges, inlays, onlays, posts and pins restorations. Table 1 compares the commonly available dental luting cements.

Table 1.
Current material classes of luting cements

Strengths	Area of Application	Weaknesses
Zinc Phosphate Cement		
Over 100 years of clinical experience	Good for routine application in metal supported - crowns and bridges	Occasional postoperative sensitivity
		Low hardness
		High solubility
Polycarboxylate Cement		
25 years of clinical experience	Acceptable for retention of metal-supported crowns and bridges, but becomes soluble over time	Comparatively high solubility
Low fluoride ion release		Low hardness
Molecular bonding to the tooth substance	Long-term provisional cement	
No postoperative sensitivities		
Glass Ionomer Cements		
20 years of clinical experience	Routine application for metal-supported crowns and bridges	Occasional postoperative sensitivity
Fluoride ion release		
Molecular bonding to the tooth substance	Limited application with high-strength ceramics during curing	Sensitive to water and mechanical loading
Minimal dimensional change		
Simplicity of use		
Medium material strength		
Good routine cement		
Resin-Modified Glass Ionomer Cements		
Good routine cement	Routine application for metal-supported crowns and bridges	Moisture-sensitive powders
Fluoride ion release		Swelling
Medium strength	Limited application with lab-manufactured composite works	Not indicated for most ceramics
Molecular bonding to the tooth structure	Limited application with high-strength ceramics	
Low solubility		
Less technique-sensitive than composite cements		
Little postoperative sensitivity		
Compomer Cements		
Easy processing	Metal-supported works	Little long-term experience
Good adhesive qualities (with pre-treatment; etching, priming, bonding)	Most all-ceramic systems	Moisture-sensitive
	Lab-manufactured composite restorations	Low release of fluoride ions
Low solubility	Lining material	
Good mechanical properties	Emergency provisional restoration	
Resin Cements (Composite)		
Over 10 years of successful application	All metal-based, ceramic and lab-manufactured composite works	Difficult to handle
		Requires use of separate primers or adhesives
High adhesion qualities (with pre-treatment)		
High hardness		Too strong for certain applications
Low solubility		Difficult to remove excess
High mechanical properties		No release of fluoride ions
Good esthetics		Occasional postoperative sensitivities

Zinc phosphate cements, and to a lesser extent carboxylate and glass ionomer-based cements, have been successfully used in clinical application for many years. It should be noted, however, that material properties of these agents are inadequate in some cases.

The search for biocompatible restorations, and increasing esthetic demands of patients, have recently prompted the development of several all-ceramic systems. Resin cements, in particular, are well suited to adhesive luting of indirect all-ceramic works. Clinical success, however, can be compromised by the technical challenges associated with their use.

Motivation

3M™ ESPE™ RelyX™ Unicem Self-Adhesive Universal Resin Cement was developed with the aim of combining the improved handling and self-adhesion of conventional cements with the superior mechanical properties, adhesion and esthetic qualities of resin cements (Table 2). These properties were to be combined in a universal cement suitable for luting metal or ceramic materials without compromising long-term or dimensional stability. Additionally, it was desired to achieve this without priming or other pretreatments designed to ensure bond strengths to the tooth. Finally, RelyX Unicem self-adhesive universal resin cement was to be dual-curing.

Table 2. Advantages of conventional and adhesive luting materials

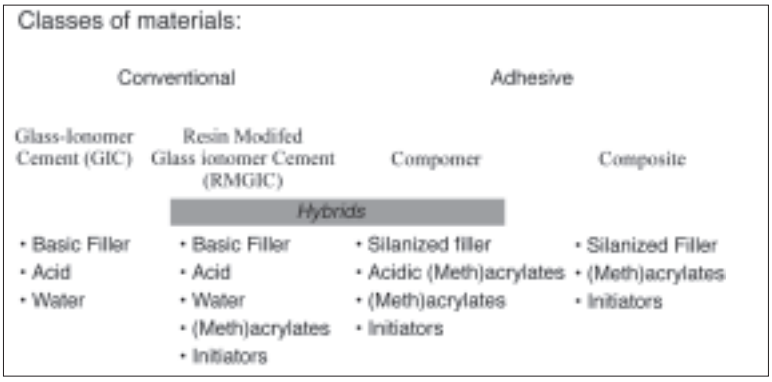
Advantages of Conventional Cements	Advantages of Adhesive Luting Materials
Easy handling	Excellent mechanical properties
Moisture tolerance	High bonding strength with appropriate pre-treatment
No pre-treatment steps for adhesion to the tooth	High esthetics / translucency
Routine cement for metal-supported works	Also suitable for ceramic and composite restorations

Overview of Materials

Conventional cementation is based on mechanically retentive forces. Dentists promote good retention by optimal site preparation, with long axial walls, angles of approximately 6°, and a precise fit ranging from 30 to 100 µm. Conventional cements fill this gap and seal the tooth.

Adhesive cementation is quite different. In this case a restoration, typically ceramic, is stabilized by adhesive bonding. Glass ionomer and composite materials typify the essential differences between conventional and adhesive cementation, as shown in the glass ionomer composite continuum (Figure 1).

Figure 1.
Glass ionomer-composite continuum; composition of material classes

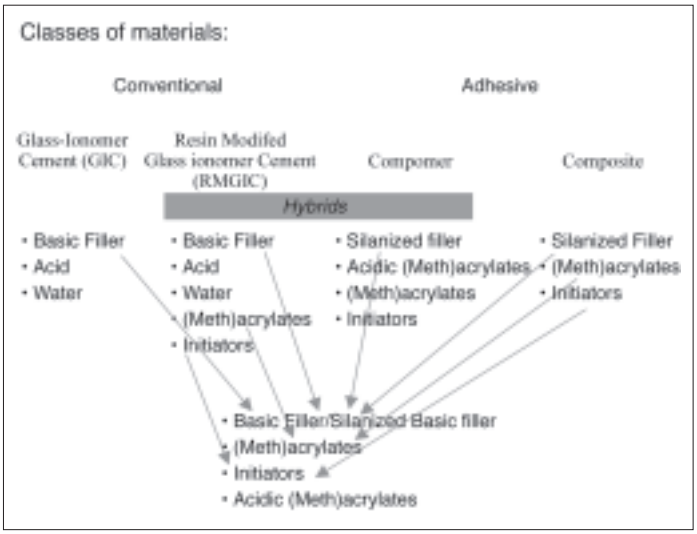


Water and reactive alkaline filling materials are essential components of conventional cements, which include both zinc phosphate and conventional and resin-modified glass ionomers. By contrast, compomer and resin materials designed for adhesive use are anhydrous and have silanized, unreactive fillers.

Chemistry

The benefits of conventional and adhesive luting techniques were combined by the successful integration of different components from all material classes, as shown in Figure 2.

Figure 2.
Combination of chemical advantages of both conventional and adhesive luting cements



It is clear from a close examination of the product profile of 3M™ ESPE™ RelyX™ Unicem Self-Adhesive Universal Resin Cement that simple recombination of known ingredients could not develop this self-adhesive universal resin cement. Therefore, a completely new monomer, filler and initiator technology was created.

New Monomers

In principle, phosphorulated (meth)acrylates can generate self-adhesion. The acidic nature of the phosphorulated methacrylates allow for demineralization of the tooth surface and penetration of the cement into the tooth surface. Once polymerized, micromechanical retention is achieved between the cement and the tooth. Important requirements like high mechanical strength, esthetic quality, and minimal swelling can, however, be guaranteed only through use of multifunctional monomers and optimization of the monomer system (Figure 3). These properties are basic prerequisites for applications involving indirect dental ceramics and composites.

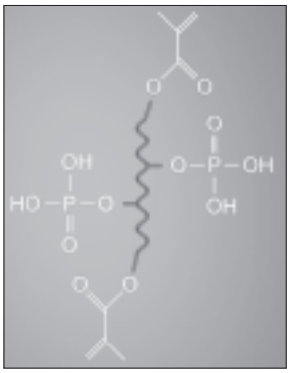


Figure 3. Schematic representation of the multifunctional monomers in RelyX Unicem Self-Adhesive Universal Resin Cement

Typical 3M™ ESPE™ RelyX™ Unicem Self-Adhesive Universal Resin Cement monomers contain at least two phosphoric acid groups and a minimum of two double bonded carbon units (C=C) per molecule. This provides high reactivity and, ultimately, a high degree of matrix cross-linking which in turn generates excellent mechanical properties, allows for adhesive bonding without pre-treatment, and increases the system's long-term stability.

Filler Technology

Maintenance of the long-term stability of an initially acidic system requires neutralization during the setting process to avoid excessive hydrolysis. This goal is achieved using a concept from glass ionomer technology. Acidic functionalities are neutralized with alkaline filler molecules rather than soluble fluoride salts leading to a pH increase and fluoride ion release, as shown in Figure 4.

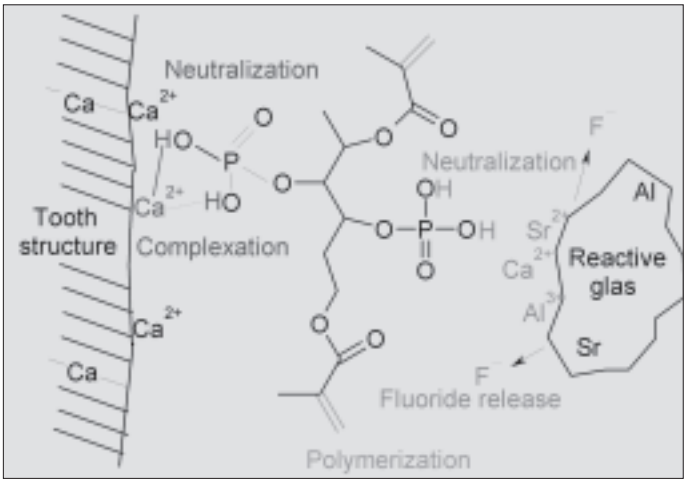


Figure 4. Schematic representation of the adhesion mechanism and neutralization reaction in RelyX Unicem Self-Adhesive Universal Resin Cement

Initiator System

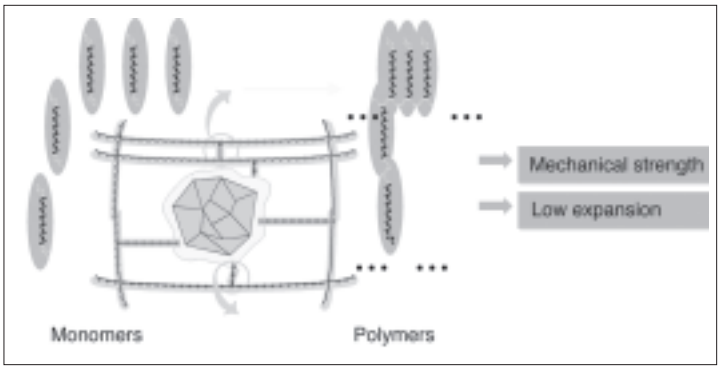
As most initiator systems used for chemical curing in dental technology employ basic amines, incompatibilities may arise in an acidic environment. This problem occurs commonly with self-etching systems. To develop a self-adhesive dual-cure cement, it was therefore necessary to create a completely new initiator system. Expectations for this system require that it be both light-curing and self-curing. Tolerance to

moisture is another critical characteristic equally as important as dependable curing over a wide pH range. A high degree of cross-linking of the monomer matrix is also essential to enable long-term stability and lasting adhesion. These aims comprise a complex problem that has been successfully solved with the development of 3M™ ESPE™ RelyX™ Unicem Self-Adhesive Universal Resin Cement.

Setting Reactions and Adhesion to Tooth Structure

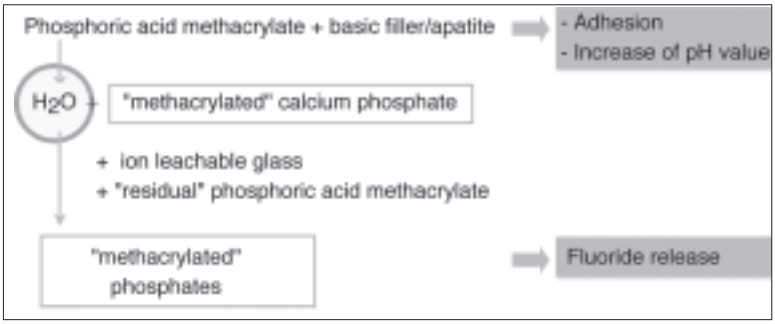
The most commonly used setting reaction involves radical polymerization. This cures the material, creating excellent mechanical strength and dimensional stability. The reaction can be begun by exposure to light or using an oxidation-reduction self-cure mechanism, and proceeds in the same way as those for composite materials. Extensive cross-linking of RelyX Unicem self-adhesive universal resin cement monomers (shown in Figure 5) creates high molecular weight polymers with low solubility, minimal absorptivity, and high biocompatibility.

Figure 5. Polymerization reaction of RelyX Unicem Self-Adhesive Universal Resin Cement and incorporation of the silanized filling bodies into the resin matrix.



In addition to the reactions discussed so far, a few additional ones should be considered for a full understanding of RelyX Unicem self-adhesive universal resin cement. These include the cascade of cement reactions shown in simplified form in the following chart.

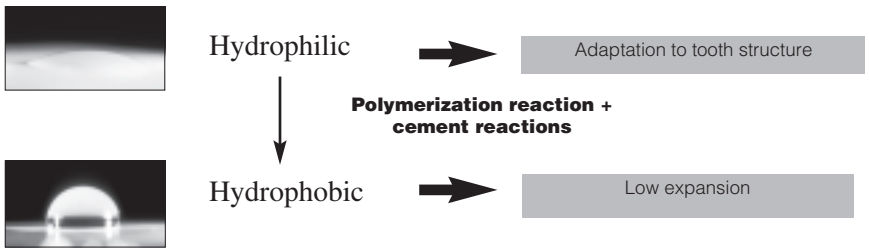
Figure 6. Cement reactions of RelyX Unicem Self-Adhesive Universal Resin Cement



RelyX Unicem self-adhesive universal resin cement monomers also react with basic salts and tooth apatite through functional groups modified by phosphoric acid. Water is formed in this neutralization. This step increases hydrophilicity, improving adaptation of the cement to the tooth structure and moisture tolerance, which should benefit subgingival application during routine use.

The water is reused by reaction with acidic functional groups and during the cement reaction with ion-releasing basic filling bodies. This allows two distinct advantages of RelyX Unicem self-adhesive universal resin cement: an intelligent switch to a hydrophobic matrix (shown in Figure 7), and the verifiable release of fluoride ions.

Figure 7.
Switch during setting reaction from to hydrophobic properties



What Are the Differences Compared to Hybrid Systems?

Resin-modified glass ionomer systems remain very hydrophilic even after setting because of the use of hydrophilic monomers and the presence of water. This can lead to disadvantages such as swelling. In addition, monomers are used that yield comparatively less cross-linking and thus smaller polymeric products.

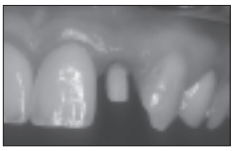
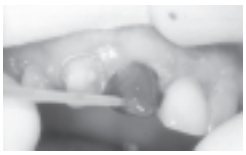
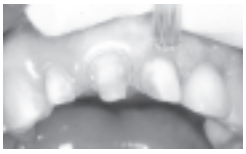
While compomers achieve a high degree of cross-linking, the reaction of polyacid with glass fillers is inhibited, limiting complete neutralization, with enhanced susceptibility to hydrolytic processes as the long-term result.

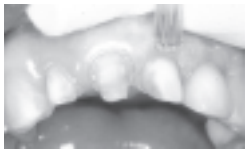
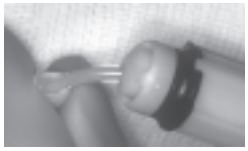
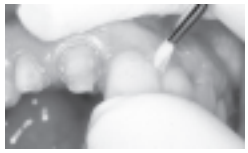
These drawbacks were specifically eliminated by the novel chemical strategies used to create 3M™ ESPE™ RelyX™ Unicem Self-Adhesive Universal Resin Cement.

Clinical Application of 3M™ ESPE™ RelyX™ Unicem Self-Adhesive Universal Resin Cement

As discussed earlier, the need for adhesive cementation of ceramic or composite restorations poses a recurring technical challenge for dentists and dental assistants. Clinical situations calling for this demanding technique are listed below in Table 3. In it, the adhesive cementation of a ceramic crown with RelyX Unicem self-adhesive universal resin cement is compared with adhesive cementation using a conventional total-etch system.

Table 3.
Step-by-step illustration of the adhesive cementation of a ceramic crown, comparing a conventional total-etch luting system and RelyX Unicem Self-Adhesive Universal Resin Cement.

Working Steps	Adhesive Cementation with Composite	Adhesive Cementation with RelyX Unicem
Initial situation: Pretreat bonding surface of restorative. Etch and silane treat ceramic and composite restorations. Roughen surfaces of metal restorations.		
Tooth stump freed from the provisional restoration and cleaned		
Etch with a phosphoric acid etching gel		N/A
Thoroughly rinse with water		N/A
Lightly dry with oil-free and anhydrous air or blot dry excess water. Do not overdry.		N/A
Apply primer with a disposable applicator and rub in thoroughly		N/A
Dry primer in a light air stream. Avoid direct blowing, as excess may coagulate.		N/A
Apply bonding agent with a disposable applicator and rub in thoroughly		N/A

Lightly thin or air dry the bonding agent evenly with an air stream. Avoid pooling of the bonding agent. Cure adhesive if indicated.		N/A
Mix cement and apply in the restoration and/or cavity No dispensing or hand mixing required with the Aplicap capsule system; direct application possible		
Place the restoration		
Remove excess		
Light-cure or allow to self-cure		Optional
Final situation: Adhesively cemented ceramic crown after trimming and polishing		

Indications

3M™ ESPE™ RelyX™ Unicem Self-Adhesive Universal Resin Cement is a self-adhesive universal resin cement for adhesive luting of:

- Inlays
- Onlays
- Bridges
- Crowns
- Posts and screws (including fiber posts) made of metal, composite and ceramic.

RelyX Unicem self-adhesive universal resin cement is dual-curing.

Shades

RelyX Unicem self-adhesive universal resin cement is offered in the following shades:

- A1
- A2 Universal
- A3 Opaque
- White Opaque and
- Translucent

All shades are radiopaque.

Composition

RelyX Unicem self-adhesive universal resin cement is a powder/liquid system that is offered in Aplicap™ and Maxicap™ (available January, 2003) capsules.

- The organic matrix of RelyX Unicem self-adhesive universal resin cement is made of novel multifunctional phosphoric acid (meth)acrylates. This leads to a high degree of polymerization and cross-linking creating excellent mechanical strength and dimensional stability. In addition, phosphorulated units condition the tooth structure and allow for self-adhesion.
- The percentage of inorganic filling bodies is approximately 72% (by weight), while the particle size (d[90] = 90% of filling bodies) is <9.5µm. Moreover, the fillers make all available shades of this cement radiopaque. The filler particles are basic by nature, leading to a cementing reaction with monomeric acidic functional groups. This controls adhesion to the tooth structure, raises the pH to neutral during the setting reaction, and regulates release of fluoride ions.

The qualitative composition of 3M™ ESPE™ RelyX™ Unicem Self-Adhesive Universal Resin Cement is listed in Table 4.

Table 4. Composition of RelyX Unicem Self-Adhesive Universal Resin Cement

Powder	Liquid
Glass powder	Methacrylated phosphoric ester
Initiator	Dimethacrylate
Silica	Acetate
Substituted pyrimidine	Stabiliser
Calcium hydroxide	Initiator
Peroxy compound	
Pigment	

Test Results

Properties

In addition to a simplified dental technique and improved properties of the luting cement, performance of the luting cement is an important element in the clinical success of an indirect restoration. The following qualities are especially important in a universal cement used to seat metal, composite and ceramic restorations.

- High adhesion to the tooth structure and restoration
- High marginal quality
- Outstanding mechanical properties
- Low frequency of postoperative sensitivity

Results of selected clinical studies are discussed below. Initial results from clinical applications of RelyX Unicem self-adhesive universal resin cement are described in the chapter, “3M ESPE Field Evaluation Application Test.” Several publications concerning RelyX Unicem self-adhesive universal resin cement and literature concerning cementation in general are included in the bibliography to guide interested readers to relevant primary literature.

Tests of Adhesion to Tooth Structure

Adhesion to enamel, dentin and ceramics is an absolute requirement for clinical success of luting ceramics. The tooth-cement-restoration bond guarantees stabilization of the residual tooth structure and the restoration. The best current technology involves composite luting materials and time-consuming, technique-sensitive “total-etch” procedures. Studies described in the following section show that RelyX Unicem self-adhesive universal resin cement achieves results comparable to those of other resin cement systems, but without pretreatment of the tooth structure.

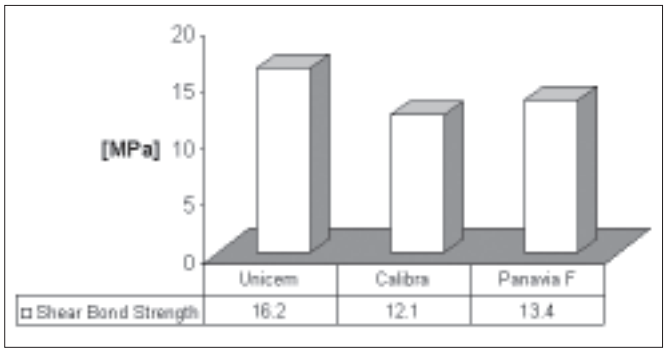
Shear Bond Strength to Human Dentin

M. Irie et al., Okayama University, J. Dent. Res. 81 (Spec Iss A) 2002, A-415.

The shear bond strength of 3M™ ESPE™ RelyX™ Unicem Self-Adhesive Universal Resin Cement was tested in a trial at Okayama University in Japan. Composite test specimens were cemented to human dentin and sheared off after being immersed in water for one day. Panavia™ F and Calibra™, market-established resin cements, served as controls and were used in combination with their respective adhesives or primers. All materials were used in the light-cured mode.

Results of this investigation show that RelyX Unicem self-adhesive universal resin cement provides shear bond strength in the absence of pretreatment that is comparable to results achieved using composite cements and their respective bonding systems (Figure 8). Handling is also simplified with RelyX Unicem self-adhesive universal resin cement, and time spent on cementation is reduced without sacrificing the high adhesion of composite systems.

Figure 8.
Shear bond strength to human dentin. M. Irie et al.



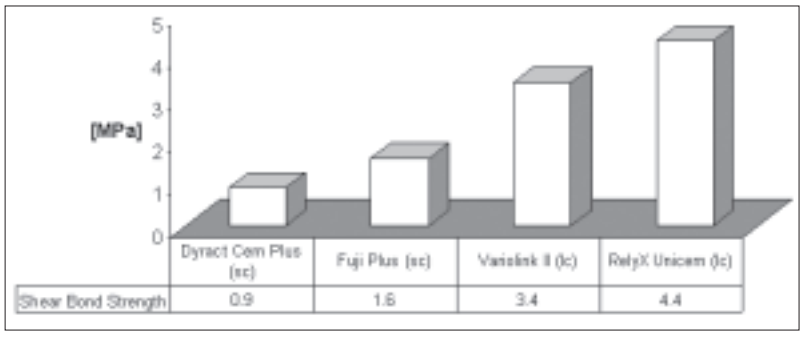
Shear Bond Strength to Bovine Dentin

R. Hecht et al., J. Dent. Res. 81 (Spec Iss A) 2002, A-75.

It is currently accepted that a conditioner or adhesive system is necessary for resin cements to achieve optimal bonding to tooth structure. In this study, RelyX Unicem self-adhesive universal resin cement (without tooth conditioning) was compared to standard commercial cements from the resin-modified glass ionomer, compomer and composite material classes. Shear bond strength was examined on bovine dentin suitable for routine testing.

Without prior tooth structure treatment, RelyX Unicem self-adhesive universal resin cement provided bovine dentin adhesion values comparable to or exceeding those of commercially available products (Figure 9). As the first self-adhesive universal resin cement, RelyX Unicem self-adhesive universal resin cement therefore offers a user-friendly, time-efficient alternative to current adhesive options.

Figure 9.
Shear bond strength to bovine dentin. R. Hecht et al.



Micro-tensile Bond Strength Testing at Human Dentin and Enamel

B. Van Meerbeek, J. De Munck, P. Lambrechts, Leuven BIOMAT Research Cluster, Catholic University of Leuven, Belgium, Industry Report 2002.

With the latest generation of dental adhesives, adhesion values are often generated in pull and shear testing and are so high that fracturing no longer occurs at the interface (adhesive failure), but directly in dentin. Moreover, pull and shear testing often has the disadvantage of yielding very high scatter distributions. The different variations of the microtensile experiment aim to avoid these two drawbacks (see schematic representation in Figure 10). For this, several test specimens were obtained simultaneously from a prepared tooth treated with a direct or indirect restoration (retention-free, flat preparation). After the interface has been reduced again, the final test specimen is obtained, which is then fractured in the tensile test.

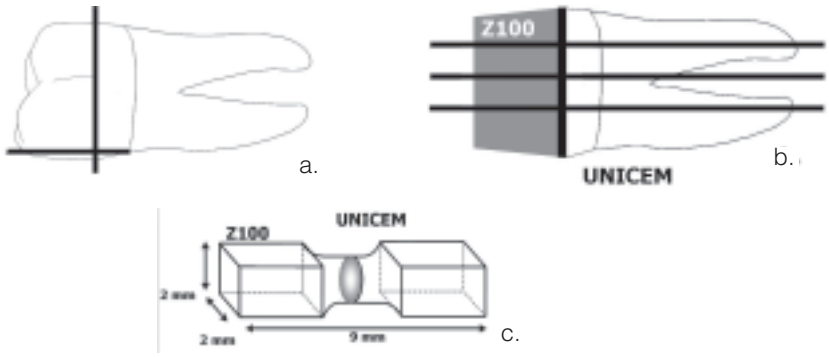


Figure 10.
Specimen preparation for µTBS testing. a. For the dentin samples, the occlusal third of the crown was removed using a slow-speed diamond saw, after which an additional thin layer of dentin was removed using a diamond bur; for the bur-cut enamel samples, enamel was flattened using the same diamond bur. b. A Z100™ block was then luted on either enamel or dentin using RelyX Unicem Self-Adhesive Universal Resin Cement. c. Using a diamond saw, rectangular beams were cut. At the interface, a round constriction was milled in a custom-made lathe (Iowa MicroSpecimen Former).

The results of the tests by B. Van Meerbeek et al. are shown in the following charts (Figure 11). The specimens for this experiment were generated by cementing Z100™ Composite blocks. 3M™ ESPE™ RelyX™ Unicem Self-Adhesive Universal Resin Cement once again provides adhesion values on human dentin that are equivalent to Panavia™ F. The comparatively low adhesion values of Variolink™ II must probably be attributed to an incomplete polymerization of the material under the simulated indirect restoration. This could be caused by limited light transmission through the restoration.

On enamel, RelyX Unicem self-adhesive universal resin cement yields lower values than the control group specimens etched with phosphoric acid (Variolink II) or the ED primer (Panavia F). This is not surprising for a self-conditioning luting material. Nevertheless, adhesion values of about 20 MPa are significant on the prepared enamel. There was only one “pre-treatment failure” (out of fourteen).

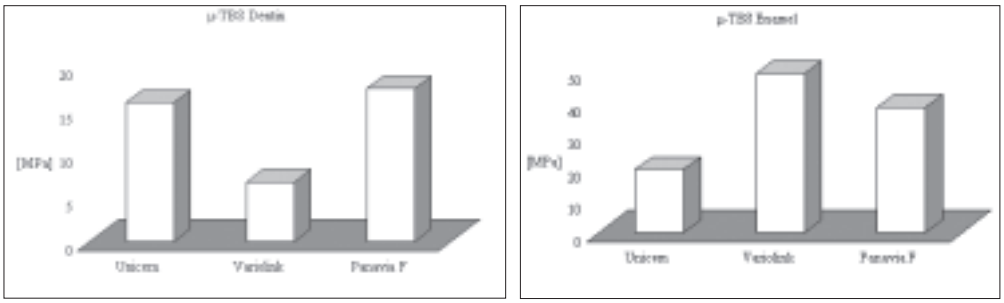


Figure 11.
Micro-tensile adhesion tests on human dentin and enamel by B. Van Meerbeek et al., 2002.

Adhesion Trials on Restoration Materials

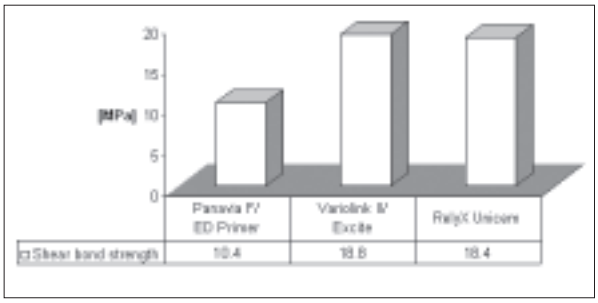
To achieve optimal bonding strength between the tooth structure, cement, and restoration, the cement must provide high adhesion to the enamel, the dentin, and the indirect restoration. Adhesive cementation using etchable ceramics clearly achieves this goal. An increasing role is also evident for adhesive bonding to high-strength aluminum oxide or zirconium oxide ceramics and metal alloys. There is, additionally, a clear current trend toward minimally invasive preparations in both direct and indirect restorative dentistry. Finally, extensive loss of tooth structure has become less acceptable during the preparation of retentive surfaces. Requirements for cements are therefore changing. 3M™ ESPE™ RelyX™ Unicem Self-Adhesive Universal Resin Cement, distinguished by its simple use without pre-treatment, may make a major contribution in these areas. The studies summarized below explore the bonding strength of luting systems on indirect restoration materials.

Shear Bond Strength to Glass Ceramic (IPS Empress® 2)

A. Piwowarczyk, J. Sorensen et al., Universities of Frankfurt, Germany and Portland, Oregon, USA, J. Dent. Res. 81 (Spec Iss A) 2002, A-401.

Highly esthetic all-ceramic restorations are made primarily from glass ceramic with a wide range of indications. These are typically attached by adhesive cementation to stabilize the ceramic restoration and the residual tooth structure. The most advanced technique for doing this employs resin cements using the total-etch method. In a shear bond strength trial at the Universities of Frankfurt and Portland, RelyX Unicem self-adhesive universal resin cement was compared to these standard commercial methods. The results are summarized in Figure 12.

Figure 12.
Shear bond strength to IPS Empress 2 glass ceramic after 14 days with a thermocyclic alternating load; cements light-cured



RelyX Unicem self-adhesive universal resin cement achieved bond strength values on the commercial standard glass ceramic IPS Empress 2 similar to those found for the Variolink™ II and Panavia™ F systems, two global market leaders.

In combination with the adhesion values on tooth structure discussed previously, this result supports the application of RelyX Unicem self-adhesive universal resin cement cement, which is used without etching, priming and/or bonding.

Shear Bond Strength to Zirconium Oxide Ceramic (3M™ ESPE™ Lava™ All Ceramic System)

A. Piwowarczyk, J. Sorensen et al., Universities of Frankfurt, Germany and Portland, Oregon, USA, J. Dent. Res. 81 (Spec Iss A) 2002, A-413.

Cementation of high-strength zirconium oxide ceramic represents a new and appealing alternative in tooth-colored ceramic restorations. Etchable ceramics often reach the limits of their capability, especially when multi-unit works are required in the molar region or as part of subgingival preparations. Zirconium and aluminum oxide ceramics focus attention on the question of which cement is suitable in routine clinical practice. Conventional cements such as zinc phosphate, glass ionomer, and

resin-modified glass ionomer cement are considered appropriate, though adhesive cementation is also appealing, considering the advantageous material properties of composite. Adhesive cementation is a challenging technique and zirconium oxide ceramic is difficult to condition, as etching with hydrofluoric acid is not possible. Adhesive cementation should be considered as an equivalent strategy for generating chemical adhesion during use of these new materials. Bonding material must also resist hydrolysis in order to create a lasting marginal seal. Until recently, only 4-META-based systems like Panavia™ could really comply with this performance requirement. However, its complicated handling led practitioners to select conventional cementation methods instead. As the following results of the shear bond strength trial on Lava™ All Ceramic System indicate, 3M™ ESPE™ RelyX™ Unicem Self-Adhesive Universal Resin Cement is opening up new horizons in this restorative area.

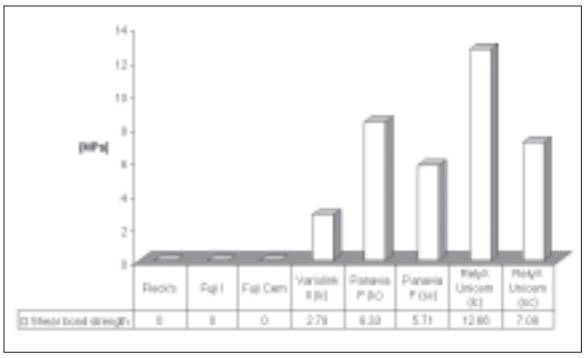


Figure 13.
Shear bond strength to Lava All Ceramic System (zirconium oxide) after 14 days of a thermocyclic alternating load; lc = light-cured, sc = dark (self)-cured

As shown in Figure 13, RelyX Unicem self-adhesive universal resin cement demonstrates maximum adhesion values on the zirconium oxide ceramic, Lava all ceramic system, after an alternating thermal load and water storage. High adhesion values are obtained with both light and dark curing.

In contrast to the above results, conventional cements do not generate any bonding strength, as their effect is based solely on retentive forces that must be controlled by preparation and tight seating. Even resin systems that require the use of adhesives show weaknesses in long-term bonding.

Shear Bond Strength to High Gold Alloy (Targis Gold)

A. Piwowarczyk, J. Sorensen et al., Universities of Frankfurt and Portland, CED Meeting, Cardiff, September 2002, industrial report 2001.

The bonding strength of high gold alloys to dental cements is typically low because its surface is relatively reduced and difficult to bond to. To assess this, a comparison of shear bond strength was conducted with selected luting cements as a worst-case scenario for metal-supported restorations. Standard conventional cements were used based on zinc phosphates and glass ionomers. RelyX Unicem self-adhesive universal resin cement was also tested against other resin cements. The results of the work are shown in Figure 14, below.

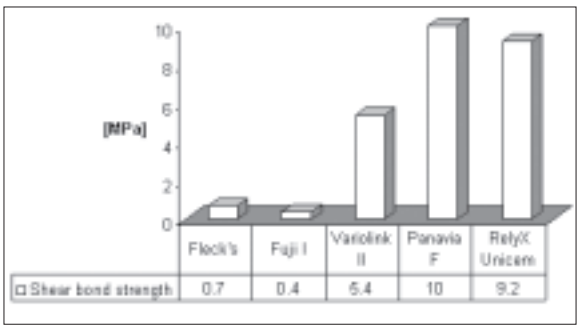


Figure 14.
Shear bond strength to sandblasted high gold alloy after 14 days of a thermocyclic alternating load; all cements were self-cured.

After a 14-day thermocyclic alternating load, RelyX Unicem self-adhesive universal resin cement and Panavia F provided the best adhesion values. This result supports the adhesive application of RelyX Unicem self-adhesive universal resin cement for metal-supported works.

In summary, 3M™ ESPE™ RelyX™ Unicem Self-Adhesive Universal Resin Cement represents a new standard for bonding to a wide variety of dental materials, including etchable and high-strength ceramic, metal and composites.

Marginal Quality After Mastication Simulation

The final objective test for new dental materials is controlled clinical trials. Model experimental systems also play an important role. Interest in an "artificial mouth" with simulated masticatory forces and jaw movements began in the 1980s. Variation in temperatures and microbiological processes are under consideration. A reproducible test design validated by clinical outcomes will be an important aid in assessing new materials. New developments can then be compared quickly and easily to established and possibly even failed products to allow fact-based assessment.

Mastication simulation in an artificial oral environment is an established evaluative method. In this system, mechanical and thermal influences are simulated in a stress test. These evaluations can provide information on the strength of a material and marginal quality after fatigue loading. Key trials of variously cemented ceramic inlays and crowns are presented and discussed below.

Marginal Quality of Ceramic Inlays after Mastication Simulation

M. Rosentritt et al., Regensberg University, Germany, J. Dent. Res. 81 (Spec Iss A) 2002, A-36.

This study evaluated marginal quality and density of ceramic inlays (IPS Empress® I) on human teeth, which were seated with various cement systems and subject to a stress test simulating a 5-year wearing period. Class 2 MOD inlays were prepared with cervical margins lying primarily in the dentin and secondarily in the enamel. Margins in the surface were evaluated with scanning electron microscopy (SEM), and a dye penetration test was used to evaluate marginal density.

As the following charts and diagrams show, the self-adhesive universal cement, RelyX Unicem self-adhesive universal resin cement, along with the other resin cments, show comparatively good marginal adaptation after mastication simulation in both the marginal closing analysis and the dye penetration test. The resin-modified glass ionomer and compomer material show higher dye penetration and fewer proportions with perfect marginal closing. Poor results for Dyract® Cem Plus were apparent.

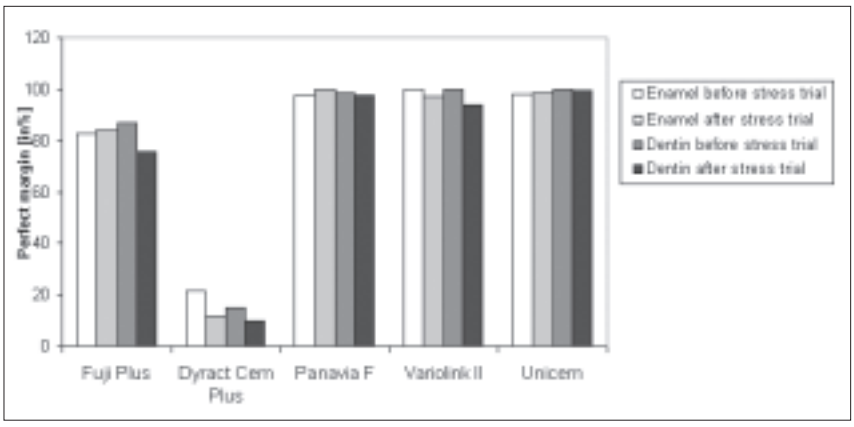


Figure 15.
Surface evaluation of marginal quality with SEM; Fuji™ Plus/Conditioner, Dyract® Cem Plus/Prime & Bond™ NT/NRC, Panavia™ F/ED Primer, Variolink™ II/Syntac Classic, RelyX Unicem Self-Adhesive Universal Resin Cement; all materials were light-cured

Figure 16.
Characteristic SEM photo after alternating thermal and mechanical load for a competitor's resin-based material.

Figure 17.
Characteristic SEM photo after alternating thermal and mechanical load for RelyX Unicem Self-Adhesive Universal Resin Cement.

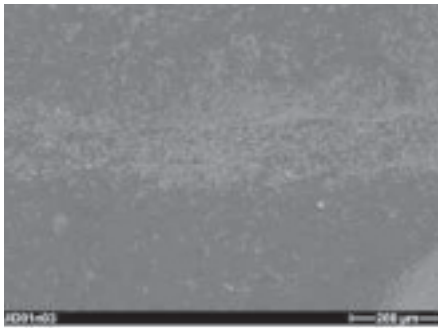
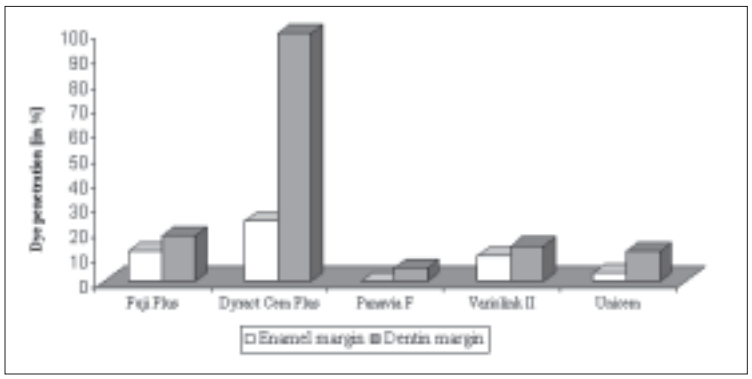
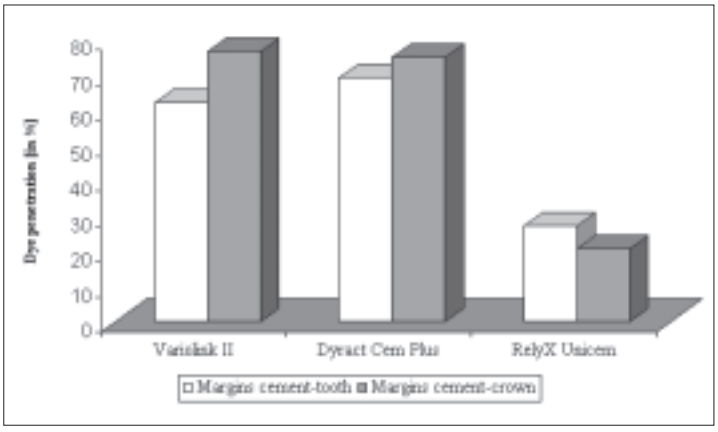


Figure 18.
Dye penetration evaluation; all materials were light-cured



Marginal Quality of Ceramic Crowns and Bridges after Mastication Simulation
M. Behr et al., Regensberg University, Germany, J. Dent. Res. 81 (Spec Iss A) 2002, A-421.
Single crowns make up the largest portion of ceramic restorations. Consequently, the testing method described earlier was repeated with IPS Empress® 2 crown restorations.

Figure 19.
Dye penetration evaluation: Variolink II/Syntac Classic. Dyract Cem Plus/Prime & Bond NT/NRC; all materials were light-cured



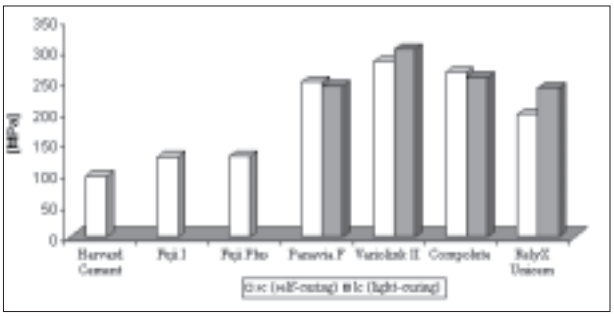
With these restorations, 3M™ ESPE™ RelyX™ Unicem Self-Adhesive Universal Resin Cement achieved results comparable to current conventional and resin cements but without time-intensive technique steps (Figure 20).

In conclusion, an analogous study evaluating CAD-CAM milled zirconium oxide bridges (Lava™ All Ceramic System) led to similar results (M. Rosentritt et al., Regensberg University, Germany, CED Meeting, Cardiff, September 2002, approved for publication). After the stress test in the mastication simulator, the cements Panavia™ F/ED Primer, Compolute™/EBS Multi and RelyX Unicem self-adhesive universal resin cement (without pre-treatment) showed comparatively good results in marginal quality and density. Only Variolink™ II/Syntac Classic yielded significantly lower values.

Mechanical Properties

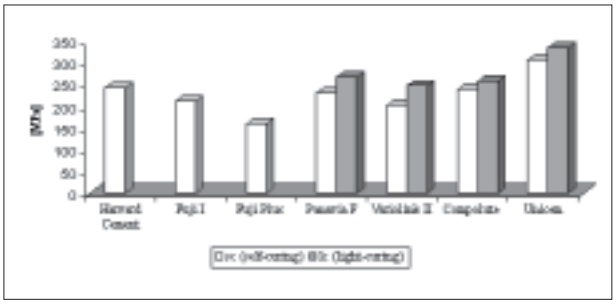
Though stabilization of the restored tooth is strongly influenced by the metal restoration itself during cementation of metal-supported works, the scenario is different for ceramic works, in which the luting cement must make a larger contribution and provide greater inherent stability to withstand the forces of the oral environment. For this reason, the material properties of 3M™ ESPE™ RelyX™ Unicem Self-Adhesive Universal Resin Cement were compared with those of conventional and resin-based systems. The trials were performed in accordance with the international standards ISO 9917 and ISO 4049.

Figure 20.
Compressive strength; A. Piwowarczyk et al., Frankfurt University, Germany, J. Dent. Res. 81 (Spec Iss A) 2002, A-413.



In the compressive strength parameter, RelyX Unicem self-adhesive universal resin cement and the composite materials were superior to conventional luting materials of the zinc phosphate or conventional and resin-modified glass ionomer cement classes (Figure 20).

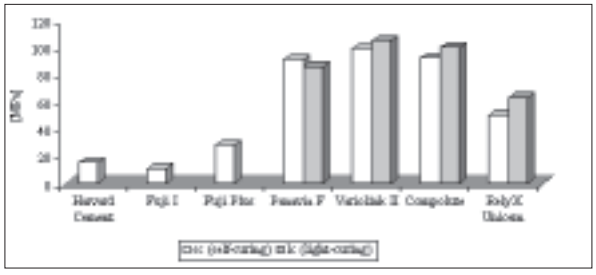
Figure 21.
Surface hardness; A. Piwowarczyk et al., Frankfurt University, Germany, J. Dent. Res. 81 (Spec Iss A) 2002, A-413.



With over 300 MPa, RelyX Unicem self-adhesive universal resin cement yields outstanding results compared with conventional and resin cements (Figure 21). Results obtained with chemical curing are in the same range as those obtained with light curing.

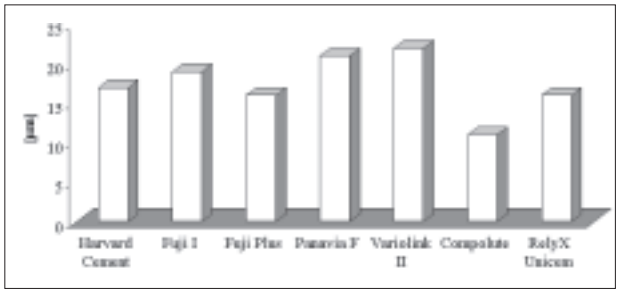
With flexural strength, the differences between the material classes become most obvious. RelyX Unicem self-adhesive universal resin cement shows much higher values than Harvard cement (zinc phosphate), Fuji™ I (glass ionomer) and Fuji™ Plus (resin-modified glass ionomer) (Figure 22). Composite materials achieved the highest values. The differences between light-cured and self-cured remained low for dual-cure materials.

Figure 22.
Flexural strength; A. Piwowarczyk et al., Frankfurt University, Germany, J. Dent. Res. 81 (Spec Iss A) 2002, A-413.



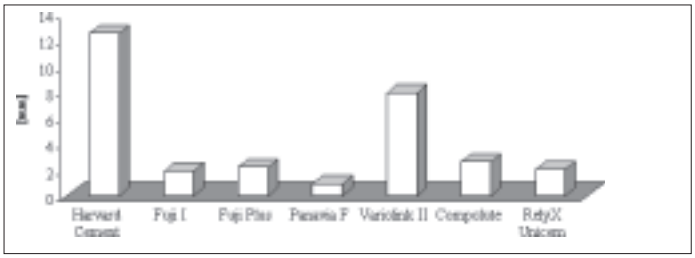
Another advantage of RelyX Unicem self-adhesive universal resin cement is apparent with film thickness (Figure 23). At 16 µm, the film thickness is in a low range. It should also be noted that RelyX Unicem self-adhesive universal resin cement does not require any primer or bonding layer. A frequent fault of the adhesive technique is that film thickness could be increased by the addition of the adhesive layer.

Figure 23.
Film thickness; A. Piwowarczyk et al., Frankfurt University, J. Dent. Res. 81 (Spec Iss A) 2002, A-413.



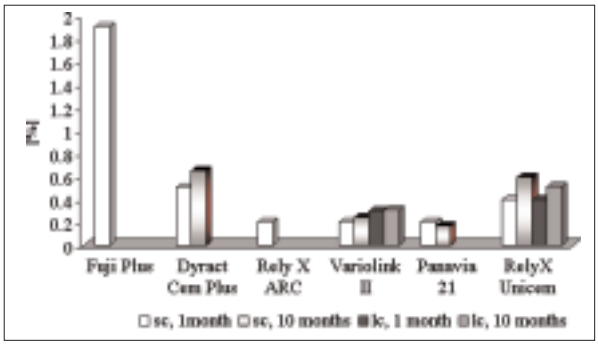
Radiopacity of the cement is desirable, especially for checking ceramic restorations after removal of excess material. Except for Panavia™ F, all the cements tested comply with the standard limit of 100% or 1mm. 3M™ ESPE™ RelyX™ Unicem Self-Adhesive Universal Resin Cement achieves a value of 2mm (or 200%) (Figure 24), which is clinically preferred.

Figure 24.
Radiopacity; A. Piwowarczyk et al., Frankfurt University, J. Dent. Res. 81 (Spec Iss A) 2002, A-413.



Dimensional stability is an important consideration in the failure of hybrid cements in cementing glass ceramics. The worst-case scenario for risk assessment involves measurement of expansion during water immersion over several months. Maximum expansion is obtained without allowing counteracting shrinkage to exert a positive influence during polymerization. Dyract® Cem Plus is suitable for all ceramic indications, while Fuji™ Plus is only acceptable for ceramic inlays. Expansion values of these materials can therefore be used as a reference aid. Moreover, according to the literature, a linear swelling of 0.8 - 1% can be viewed as the upper limit for use with conventional all-ceramic restorations.

Figure 25.
Linear expansion: 3M ESPE in-house data, 2002.



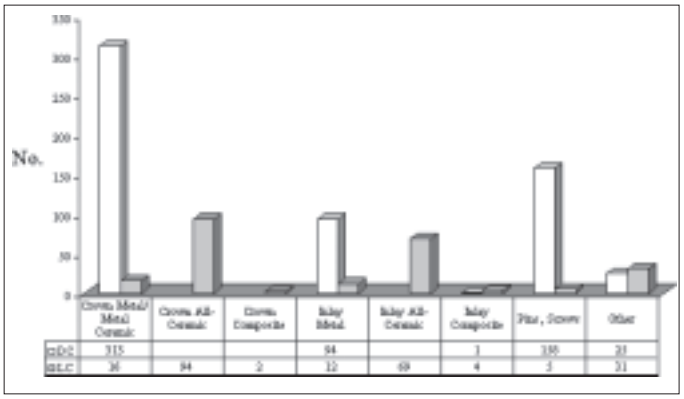
The data summarized in Figure 25 show that RelyX Unicem self-adhesive universal resin cement and the tested composite materials RelyX™ ARC Adhesive Resin Cement, Variolink™ II, Panavia™ 21 and Compolute™ Luting Cement, meet this criterion.

Results of the RelyX Unicem self-adhesive universal resin cement studies can be summarized as follows. Bonding strength achieved between restoration and tooth structure attains values that previously could only be produced in modern adhesive technology using an etching, priming and bonding procedure. RelyX Unicem self-adhesive universal resin cement displays outstanding mechanical properties far superior to those of zinc phosphate and glass ionomer cements. The high observed marginal quality and dimensional stability is comparable with that of other proven resin cements. RelyX Unicem self-adhesive universal resin cement can therefore be expected to provide high long-term stability and excellent marginal behavior.

3M ESPE Field Evaluation Application Test

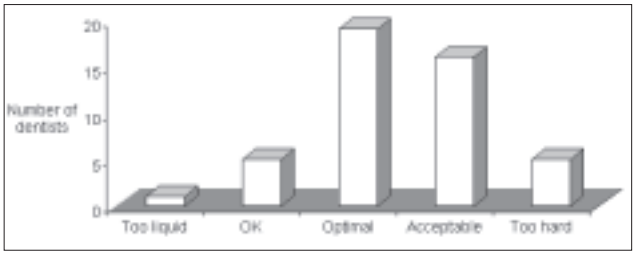
In an application test (field evaluation), 47 dentists cemented a total of 857 restorations with 3M™ ESPE™ RelyX™ Unicem Self-Adhesive Universal Resin Cement. The observation period was 8 weeks. The dentists completed a questionnaire regarding their experiences in use and application of the product. RelyX Unicem self-adhesive universal resin cement was supplied in the translucent and A3 opaque shades.

Figure 26.
Cases cemented with RelyX Unicem Self-Adhesive Universal Resin Cement



857 ceramic, metal and composite restorations, including 163 pins and screws, were cemented with RelyX Unicem self-adhesive universal resin cement (Figure 26). Chemical curing was used in 72% of cases, while 28% were light-cured. The later group included metal restorations, which were light-cured in the margin region.

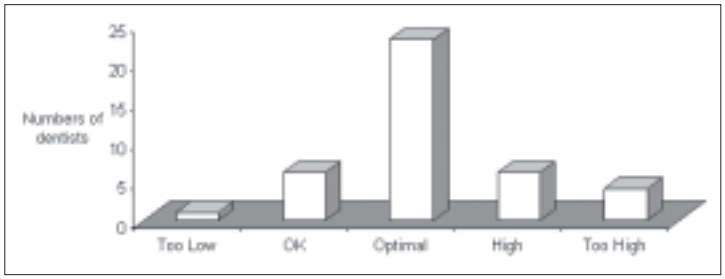
Figure 27.
Rating of flowability

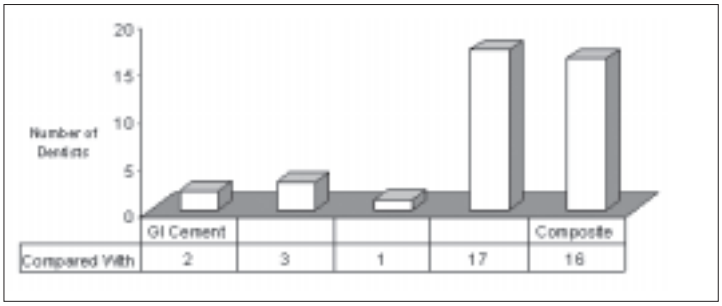


RelyX Unicem self-adhesive universal resin cement is a thixotropic material. This feature results in good stability, preventing material leakage and allowing good flowability under pressure when seating the restoration. Forty-two percent of the dentists rated the flowability as optimal, while 47% judged the flowability as good to acceptable (Figure 27).

Figure 28.
Rating of translucency

Figure 29.
Rating of esthetics





Assessment of translucency is an important esthetic criterion. The translucency was rated as optimal by 58% of the dentists, while another 30% considered it almost optimal (Figure 28). This finding is consistent with the overall assessment of the esthetics of RelyX Unicem self-adhesive universal resin cement. Most of the dentists judged the esthetics of this new cement to be comparable with those of composite materials (Figure 29).

When compared to zinc phosphate and other resin cements, the handling of 3M™ ESPE™ RelyX™ Unicem Self-Adhesive Universal Resin Cement was considered excellent (Figures 30 and 31). Mixing, application, working times, excess removal, and the overall impression of the material were all considered in this assessment category.

Figure 30.
Rating of the handling compared to zinc phosphate cements

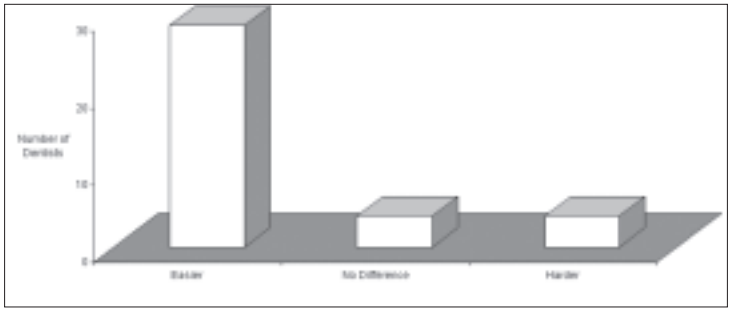
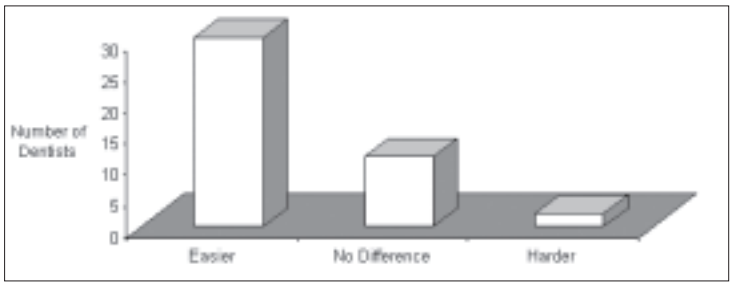


Figure 31.
Rating of the handling compared to resin cements



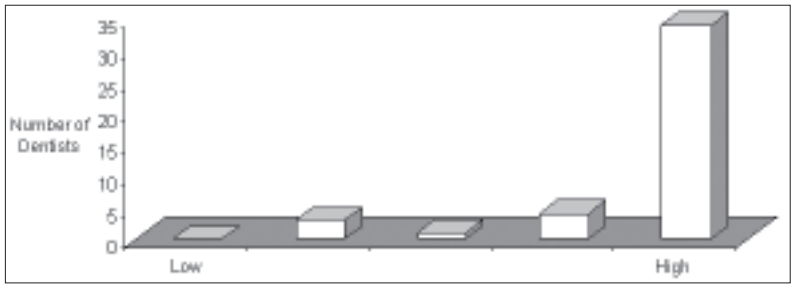
Incidences of postoperative sensitivity were reported for only three cementations, though an exact incidence rate could not be determined because cementation was done on vital and non-vital teeth. Nonetheless, the expectation of an extremely low postoperative sensitivity rate was confirmed.

The reasons for this expected low postoperative sensitivity are as follows:

- No etching of the tooth structure with phosphoric acid
- The demineralization zone and monomer penetration depth are the same, so there is no nanoleakage.
- No removal of smear layer
- No opening of the dental tubules
- No low-molecular-weight acids that could penetrate the tubules.
- Only one step was necessary for a quick and easy procedure

The profile of RelyX Unicem self-adhesive universal resin cement was judged to be very innovative, not only in theory but in practical application (Figure 32). Eighty-one percent of the dentists involved in the study intended to buy and use the material.

Figure 32.
Rating of the degree of innovation



Instructions for Use

3M™ ESPE™ RelyX™ Unicem Self-Adhesive Universal Resin Cement

Product Description

RelyX Unicem self-adhesive universal resin cement is a dual-curing, self-adhesive composite cement in capsules for adhesive cementation of indirect ceramic, composite, or metal restorations. Bonding and conditioning of the prepared tooth structure are not necessary with RelyX Unicem self-adhesive universal resin cement. The cement releases fluoride ions, and is available in various shades.

RelyX Unicem self-adhesive universal resin cement contains bifunctional (meth)acrylate. The proportion of inorganic fillers is approximately 72% by weight; grain size (D 90%) is 9.5 µm. The dispensable quantity of a capsule is at least 0.1 ml.

For details on all products mentioned in the following sections, please refer to "Instructions for Use", which should be retained during product use.

Fields of Application

Permanent cementation of ceramic, composite or metal inlays, onlays, crowns, bridges, posts and screws.

Precautionary Measures

Before the final cementation of restorations with RelyX Unicem self-adhesive universal resin cement, temporary restorations should be seated with a eugenol-free product (e.g. RelyX™ Temp NE, manufactured by 3M ESPE). The use of eugenol-containing temporary luting materials can inhibit the polymerization process of RelyX Unicem self-adhesive universal resin cement during final cementation.

Preparation

RelyX Unicem self-adhesive universal resin cement Aplicap™ is a self-adhesive cement that requires no pre-treatment. Etching and use of a primer and/or bonding are not necessary. Steps for preparation of the procedural area are as follows.

- Select and prepare the desired shade of RelyX Unicem self-adhesive universal resin cement.
- Remove the temporary restoration and thoroughly clean the preparation of any temporary cement residue.
- Clean the prepared tooth or cavity with a water spray, and dry with air, cotton, or a paper tip. Do not overdry! **Hydrogen peroxide should not be used. The use of substances such as desensitizers, disinfectants, astringents, and dentin sealants, etc., after final cleaning with pumice paste and water is not recommended. Their residues may have a detrimental effect on the bonding strength and setting reaction of the cement.**
- Try in the definitive final restoration and check the fit and contact points. For glass ceramics, check occlusion only after cementation to avoid breakage.

Pulp Protection

Cover areas in close proximity to the pulp by applying small amounts of hard-setting calcium hydroxide material (e.g. Alkaliner™ Liner/Base, manufactured by 3M ESPE) or resin-modified glass ionomer liner (e.g. Vitrebond™ Liner/Base, manufactured by 3M ESPE) prior to taking an impression for the final restoration.

- Clean the restoration thoroughly and pretreat according to manufacturer's instructions.

Activation of the Capsule

- Insert the capsule in the Aplicap™ Activator, manufactured by 3M ESPE.
- Push the activator lever down and hold it down for 2 seconds.

Mixing

- Mix the 3M™ ESPE™ RelyX™ Unicem Self-Adhesive Universal Resin Cement capsule in a high-frequency mixing unit (e.g. Capmix™) for 15 sec or in the Rotomix™ capsule mixing unit for 10 sec (see also the section on "Times"). Both mixing units are manufactured by 3M ESPE.
- Longer mixing causes minimal acceleration of setting. Shorter mixing should be avoided.

Application

RelyX Unicem self-adhesive universal resin cement distinguishes itself from other cements with its high stability, combined with good flow under pressure.

- Insert the capsule in the Aplicap Applier after mixing and open the nozzle as far as possible.
- Protect the working area from water and saliva during application.
- Evenly cover the entire cavity walls, cavity floors, and, if necessary, the underside of the inlay/onlay with the mixed RelyX Unicem self-adhesive universal resin cement. Fill crowns with the cement. For a root canal post, only apply cement onto the post and insert directly into the dry root canal. To avoid entrapped air, it is recommended that posts be allowed to vibrate slightly when being inserted into a root canal. Do not use Lentulo-Spirals to insert the cement into a root canal as this will accelerate setting excessively.
- For ceramic and composite work, light curing of the cement through the restoration is recommended. Exposure time should be determined based on size (see also the section on "Times").

Times

Processing and setting times depend on ambient and mouth temperatures. The times listed are based on normal office conditions. Safe processing and curing of the materials can be achieved within these times.

	min:sec
Mixing:	
In a high-frequency mixer (e.g. Capmix™)	00:15
or in the Rotomix™ rotary mixer	00:10
Working time from the start of mixing	02:00
Light-curing:	
Single surface, from occlusal	00:20
Any other surface, additional	00:20
Self-curing:	
Intraoral cleanup time after start of mixing	02:00
Set time after start of mixing	05:00

Trimming

- Excess cement is best removed after brief light exposure (with a conventional polymerization device) or during self-hardening (starting 2 min after beginning of mixing in the "gel phase") with an appropriate instrument such as a scaler. Excess material of larger volume is readily removed.
- Remove any remaining uneven areas and polish the marginal area with diamond polishing devices, aluminum oxide coated discs (e.g. Sof-Lex™ Finishing and Polishing Discs, manufactured by 3M ESPE), and diamond polishing paste.
- Finally, check occlusion.

Notes

3M™ ESPE™ RelyX™ Unicem Self-Adhesive Universal Resin Cement also polymerizes in daylight or artificial lighting therefore, the capsule should only be activated immediately before mixing. The paste should be applied immediately after mixing. Processing times are shortened significantly when the product is applied under operating lights.

Incompatibilities

Sensitization to the product cannot be excluded in susceptible individuals. If allergic reactions are observed, use of the product should be discontinued and the product completely removed. Pulp complications may occur in rare cases particularly if the "Instructions for Use" are disregarded.

Storage and Shelf Life

Store RelyX Unicem self-adhesive universal resin cement in the blister packing. After the blister packing has been opened, the capsule can be used for a maximum of one month.

Do not store at temperatures over 25°C/77°F.

Do not use after expiration date.

Activator and Applier for Capsules

Product Description

The Aplicap™ and Maxicap™ System manufactured for 3M ESPE, each contain an activator for capsule activation and an applier for application of the ready-mixed capsule contents to the cavity.

The Aplicap activator and applier are used to process Aplicap capsules. The activator is equipped with an orange plastic base, and the applier contains an orange marking at the top of the handpiece.

The Maxicap activator and applier are used to process Maxicap capsules. The activator is equipped with a blue plastic base, and the applier contains a blue marking at the top of the handpiece.

Areas of Application:

- Activation and application of Aplicap capsules.
- Activation and application of Maxicap capsules.

Application

- Place the activator on a level and sturdy surface.
- Insert the capsule into the activator with the application tip pointing downward, such that the tip rests in the recess.
- Slowly depress the activating lever down to the stop and hold for 2 to 4 seconds. It is essential to adhere strictly to this procedure to prevent premature curing of the material inside the capsule.
- Slowly depressing the lever ensures that the capsule does not get stuck inside the activator and that the clip above the liquid reservoir engages in the proper position. Keeping the lever depressed for the indicated time ensures that all of the liquid is squeezed from the reservoir into the mixing chamber containing the powder.
- Insert the capsule into a mixing unit and mix the capsule contents as recommended in the relevant section of the “Instructions for Use”.
- Directly after mixing, insert the capsule into the applier so that the capsule holder engages the groove at the plunger end of the capsule and the capsule is pressed into the capsule holder as far as it will go. The capsule can be rotated inside the holder to achieve an optimal position for application. Activate the dosing lever two or three times. This pushes the plunger into the capsule and moves the ready-mixed paste toward the application tip.
- Push the application tip up as far as it goes to open its orifice. The paste is not transported if the orifice is only half-open.
- To apply the paste, slowly activate the dosing lever.
- To remove the empty capsule from the applier, push the release button while the dosing lever is not activated. This retracts the plunger and releases the capsule.

Technique Guide

3M ESPE **CEMENTATION TECHNIQUE**

RelyX™ Unicem Self-Adhesive Universal Resin Cement Aplicap™

Indicated for Final Cementation of:

- Metal and porcelain-fused-to-metal crowns, bridges, inlays and onlays
- All-ceramic/composite crowns, bridges, inlays and onlays.
- Strengthened core ceramic crowns and bridges.
- Pre-fabricated and cast posts and pins.

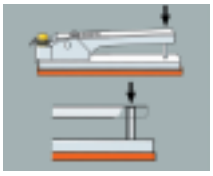

1

Preparation:

- Remove provisional restoration and all temporary cement residue.
- Trial fit the restoration and clean thoroughly.
- Pretreat restoration according to manufacturer's instructions (e.g. roughen metal and composite surfaces and apply ceramic primer if indicated).

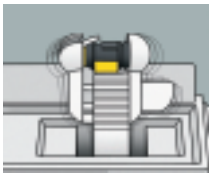

2

- Clean tooth, rinse and lightly dry leaving tooth slightly moist. **Do Not Overdry**.


3

Activation:

- Insert capsule into Activator.
- Press down handle **completely and hold for 2-4 seconds**.


4

Mixing:

- Insert activated capsule into mixing device (triturator/amalgamator).
- Mix 10 seconds for 3M™ ESPE™ RotoMix™ Capsule Mixing Unit.
- Mix 15 seconds at highest speed for other mixing devices.


5

Dispensing:

- Remove capsule from mixing device and insert into Applier.
- Open nozzle and dispense cement directly onto bonding surface of restoration or directly onto tooth surface for inlays and onlays. For posts and pins, **do not use a Lentulo-Spiral**.
- Working time is 2 minutes from start of mix.


6

Placement:

- Seat restoration and hold in place with light pressure.
- Excess cement is best removed in the cement's gel state with scaler or explorer. Tack cure excess with light for 2–3 minutes from start of mix to reach the gel state.


7

Final Cure:

- For translucent ceramic restorations, light-cure each surface for 20 seconds.
- For all others, allow cement to self-cure for 5 minutes from start of mix.


8

Finish and Polish:

- Insure all excess cement is removed.
- Adjust occlusion.
- Finish exposed surfaces using appropriate instrument and polishing paste.
- Finish proximal surfaces using 3M™ ESPE™ Sof-Lex™ Finishing and Polishing Discs and Strips.

3M ESPE Customer Hotline for U.S. 1-800-634-2249
Please refer to instructions for more detailed information as well as precautionary and warranty information.

44-0007-3493-7

Questions and Answers

Why can all kinds of all-ceramic crowns be used with 3M™ ESPE™ RelyX™ Unicem Self-Adhesive Universal Resin Cement?

A distinction is made between the following types of dental ceramics:

- Glass ceramic
- Zirconium oxide or aluminum oxide ceramic

Glass ceramics require stabilization of the restoration and tooth by an adhesive bond because of their low inherent strength. This can be achieved with RelyX Unicem self-adhesive universal resin cement. It is a good idea to coat the inside of the ceramic crown with the Rocatec™ method and subsequently silane treat it with 3M ESPE Sil or 3M™ ESPE™ RelyX™ Ceramic Primer. Etching with hydrofluoric acid and silane treated the all-ceramic is an alternative. This creates an optimal bonding strength between the resin cement and the indirect restoration.

The higher-strength ceramics, aluminum oxide and zirconium oxide, have an intrinsic strength that allows conventional cementation. RelyX Unicem self-adhesive universal resin cement is the most suitable cement for these materials and unlike conventional cements, such as zinc phosphate, RelyX Unicem self-adhesive universal resin cement provides additional bonding strength between the tooth structure, cement and indirect restoration.

RelyX Unicem self-adhesive universal resin cement meets the standards for adhesive technology and can be handled as readily as conventional luting cements.

What are the contents of RelyX Unicem self-adhesive universal resin cement capsules?

Product	Net Weight	Dispensable Quantity
RelyX Unicem Self-Adhesive Universal Resin Cement Aplicap™	295 mg	0.01 ml
RelyX Unicem Self-Adhesive Universal Resin Cement Maxicap™	936 mg	0.36 ml

An Aplicap is proportioned for the requirements of a typical single cementation. Maxicaps are especially suited for efficient cementation of multiple unit situations.

What is the difference between the accessories of the Aplicap and Maxicap products?

The Aplicap working accessories (Aplicap Activator and Applier) are color-coded orange. To allow better distinction, Maxicap working accessories (Maxicap Activator and Applier) are color-coded blue.

What are the advantages of 3M™ ESPE™ RelyX™ Unicem Self-Adhesive Universal Resin Cement over conventional luting materials?

RelyX Unicem self-adhesive universal resin cement has the following benefits over conventional luting cements:

- Excellent mechanical properties
- High bond strength without pre-treatment steps
- Excellent esthetics (translucency)
- Also suitable for composite and ceramic restorations and fiber posts

What are the advantages of RelyX Unicem self-adhesive universal resin cement over adhesive technology with total-etch?

Unlike compomer and resin materials, RelyX Unicem self-adhesive universal resin cement is characterized by the following:

- Easy handling (pre-treatment steps to condition the tooth structure are not necessary)
- High bond strength at tooth structure and indirect restoration material
- Moisture tolerance
- Reliable dual curing
- Easy removal of excess material

Is the use of rubber dam necessary as it is for the adhesive technique with composite materials?

No, use of a rubber dam may not be essential. This is because RelyX Unicem self-adhesive universal resin cement has a higher moisture tolerance compared to conventional composite systems. Also, the use of RelyX Unicem self-adhesive universal resin cement requires only one step, allowing rapid application and avoiding the need for technique-intensive steps like etching, priming and bonding. Consequently, insulating the treatment site with cotton pellets is almost always sufficient.

Why is postoperative sensitivity not expected for RelyX Unicem self-adhesive universal resin cement?

Dentin is not etched when RelyX Unicem self-adhesive universal resin cement is used. Consequently, the smear layer is not removed and the dentin tubules remain closed. This minimizes the risk of acid or bacterial penetration. Because standard adhesive technical procedures are not used, etching, priming and bonding are not employed. The risk of overdrying, overly moist dentin, and generation of nanoleakage by inadequate penetration of the primer/bonding system are therefore avoided.

When is the best time to remove excess?

Cement excess is best removed after short light exposure ("tack cure" for 2-4 seconds with a standard polymerization device) or during self-curing (from 2 minutes after start of mixing in the "gel phase") with a suitable instrument such as a scaler. Larger-volume excess material is readily removed.

How is 3M™ ESPE™ RelyX™ Unicem Self-Adhesive Universal Resin Cement different from resin-modified glass ionomers and compomers?

After curing, RelyX Unicem self-adhesive universal resin cement is a hydrophobic system that is protected against water absorption, expansion and solubility. Resin-modified glass ionomer systems remain very hydrophilic due to the use of hydrophilic monomers and the presence of water in the system after setting. In addition, monofunctional monomers used with this class of material cause comparatively less cross-linking. With RelyX Unicem self-adhesive universal resin cement, only multifunctional monomers are used which polymerize into a heavily cross-linked and stable matrix.

While compomers achieve more cross-linking than do resin-modified glass ionomers, this cross-linking limits the reaction of polyacid with glass fillers. This in turn prevents complete neutralization and causes continued susceptibility to hydrolysis. In contrast, the initially acidic RelyX Unicem self-adhesive universal resin cement is neutralized by cement reactions during the setting phase that contribute to its final hydrophobic state.

The shortcomings of compomers and resin-modified glass ionomers mentioned previously have been specifically eliminated by the novel chemistry employed by RelyX Unicem self-adhesive universal resin cement.

Summary

Cementation is an important and crucial procedure in the management of teeth with indirect restorations. The variety of indirect dental materials, from metal and composite to different ceramics, continues to justify the use of luting cements from various material classes. In dental surgery, selection of one luting material or another depends on the indication for the cement. Zinc phosphate, carboxylate and glass ionomer-based cements are used for routine application because they are easy to process. However, due to poor esthetics and high opacity, low strength and limited adhesion, these materials are limited in their use for ceramic restorations. Compomer and resin materials, which should be universally used in principle, are also limited in clinical practice because of their time-consuming, technique-intensive application. Moreover, the increased potential for postoperative sensitivity associated with these materials may justify their use only for special indications.

3M™ ESPE™ RelyX™ Unicem Self-Adhesive Universal Resin Cement is a novel luting cement that addresses the complex needs of a variety of prosthodontic restoration materials.

RelyX Unicem self-adhesive universal resin cement is the first self-adhesive universal resin cement designed for universal application in cementation of ceramic, composite and metal-based restorations.

The bond strength achieved between restoration and tooth structure attains qualities previously achieved only by using an etching, priming, and bonding procedure. RelyX Unicem self-adhesive universal resin cement requires no pre-treatment, and the use of a rubber dam may not be essential due to its rapid application and increased moisture tolerance.

RelyX Unicem self-adhesive universal resin cement displays excellent mechanical properties superior to those of zinc phosphate and glass ionomer-based cements. Its high margin quality and dimensional stability is comparable with those of established resin cements. The prognosis for use of RelyX Unicem self-adhesive universal resin cement is long-term stability and outstanding marginal behavior.

Initial clinical results confirm that its use is associated with a very low risk of postoperative sensitivity. Application of RelyX Unicem self-adhesive universal resin cement is simple and fast, avoiding etching and removal of the smear layer, exposure of the dentin tubules and possible acid penetration.

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Technical Data

	RelyX™ Unicem	Panavia™ F	Variolink™ II	Dyract® Cem	Fuji™ Cem	Fuji™ I	Harvard	Fleck's
	Self-Adhesive	*Resin*		*Compomer*	*Resin-modified Glass Ionomer*	*Glass Ionomer Cement*	*Zinc Phosphate*	
Property								
Curing Depth [mm][1,2]	2.5	0.7	3.1	—	—	—	—	—
Water Absorption (Light Curing) [µg/mm³][1,2]	25	26	20	78	261	—	—	—
Solubility (Light Curing) [µg/mm³][1,2]	-4	2	-3	21	23	—	—	—
Radiopacity [mm][1,2]	2.0	0.9	7.9	1.8	1.1	1.9	12.5	9.7
Flexural Strength (Light Curing) [MPa][1]	63 ± 7	86 ± 17	105 ± 18	68 ± 7	14 ± 3	11 ± 4	15 ± 2	10 ± 3
Compressive Strength (Light Curing) [MPa][1]	241 ±9	244 ± 26	303 ± 32	171 ± 44	96 ± 11	129 ± 12	98 ± 27	57 ± 14
Linear Expansion after 1 month [%][2]	0.4	n.m.	0.3	—	—	—	—	—
Shear Bond Strength to Human Dentin								
Dark-Curing[3] [MPa]	16.2 ± 1.9	13.4 ± 3.0	n.m.					
Light Curing[4] [MPa]	19.5 ± 5.1	n.m.	19.4 ± 5.2					
Shear Bond Strength to Indirect Materials								
Empress 2/HF etched (light curing) after 14 days of thermocycling and mechanical load	18.42 ± 2.17	10.35 ± 1.86	18.82 ± 5.86					
Lava™/sandblasted (light curing) after 14 days of thermocycling and mechanical load	12.66 ± 2.29	8.33 ± 2.42	2.78 ± 0.94					
Marginal Analysis of Ceramic Inlays (Mastication Simulation Trial)								
Perfect margin [%] enamel before and after thermo-cycling and mechanical load	98.1/98.5	97.3/100.0	100.0/97.0					
Perfect margin [%] dentin before and after thermo-cycling and mechanical load	100.0/99.5	98. /97.3	100.0/93.5					

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