



Multilink® Automix

NEW

Easy
Clean-Up

Scientific Documentation

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1. Introduction und Product Description

1.1 Luting agents and cements

Luting agents are used in dentistry as an adhesive substance to attach fixed prosthetic restorations to the tooth structure. The entire group is often erroneously called "cements".

Same as in the construction industry, "cements" are exposed to various environmental influences in the oral cavity. However, the cements used in construction would not be suitable to meet the very special conditions in the oral cavity alone for reasons of hygiene and toxicity. The substrates that have to be luted in dentistry cover a wide range. Dental cements and composites have to establish a durable bond between the tooth structure and restorations made of various metals and metal alloys, resins, and different ceramics. Since the advent of the first magnesium cements, these materials have been continuously further developed to produce phosphate cements, glass-ionomer cements, resin-reinforced glass-ionomer cements up to adhesive composite materials. The adhesion and aesthetic appearance have reached a very high level in the meantime. With the help of adhesive luting composites, it is now also possible to cement restorations with small retentive surfaces. This is also a further step toward minimally invasive tooth preparation with dentists trying to preserve as much of the healthy tooth structure as possible.

To date, the following luting agents are available:

- Phosphate cements
- Polycarboxylate cements
- Glass-ionomer cements
- Resin-reinforced glass ionomer cements
- Compomers
- Luting composites

Despite their obvious drawbacks regarding solubility and adhesion, phosphate cements were, and still are, very popular. They consist of an aqueous phosphoric acid solution and metal oxides, mainly zinc oxide. The setting reaction is based on an acid-base reaction between the phosphoric acid and the basic oxides. They represent a category of very brittle materials. Up until today, the clinical experiences with phosphate cements stretch over more than 100 years.

Polycarboxylate cements consist of metal oxides and polyacrylic acid. The dry mixture is mostly used as a powder, which is mixed with water for processing. The complicated setting reaction takes place by the reaction of metal oxides with the polyacrylic acid. The comparatively high solubility of the cement is a substantial disadvantage.

Glass-ionomer cements also enjoy great popularity. They demonstrate the advantage of being able to release fluoride ions. Setting also takes place with the help of an acid-base reaction. In this case, the polyacrylic acid reacts with a calcium fluoraluminium silicate glass. Clinical experiences with glass-ionomer cements have been gathered for more than 20 years.

In addition to the cement setting reaction, resin-reinforced glass-ionomer cements also demonstrate light-curing components. Consequently, polymer networks are formed by light-curing to supplement the purely inorganic network. This group of luting agents includes a number of hybrid cements, the physical and clinical properties of which strongly vary depending on the composition of the individual components. Their adhesion to the tooth structure is often weak.

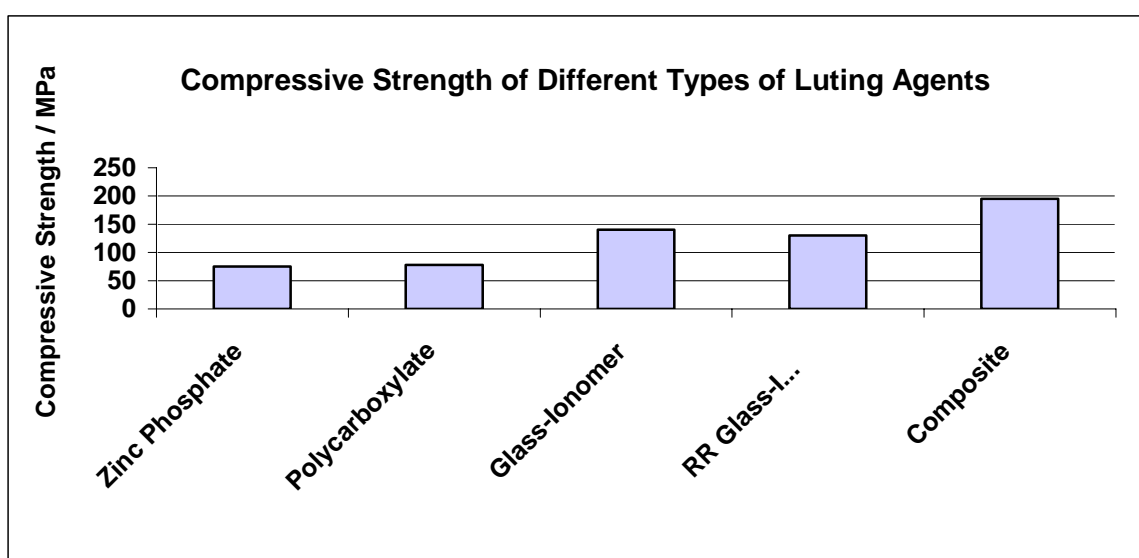
The bulk of compomers are already mainly composites. They contain components, such as monomers containing carboxylic acid, which react with the glass ionomer fillers. They can be used in the "Total Etch" technique and thus exhibit better adhesion to the tooth structure.

Given the strongly hydrophilic monomers, they are very sensitive to moisture and tend to swell.

Luting composites are entirely based on dental restorative composites. They consist of monomers and inorganic filler particles. Their setting is based on a cross-linking of the polymer chains, which is initiated chemically and / or by light. Luting composites are more wear resistant, demonstrate resistance to the oral environment, and offer outstanding aesthetics provided by the choice of several shades.

Phosphate cements, polycarboxylate cements, and glass-ionomer cements belong to the group of "dental water-based cements", the properties of which are specified by ISO 9917. Composite "cements" are covered by ISO 4049, which also applies to the entire range of composite restorative materials.

Using the example of compressive strength, the properties of the different types of luting agents are compared with each other.



Average values from different sources in the literature (RR Glass-Ionomer = resin-reinforced glass-ionomer cement).

1.2 Luting composites

Conventional luting composites are used in combination with a dental adhesive system. This means that this type of cementation establishes an adhesive bond with the tooth structure. Adhesive cementation also permits a bond, where no large retentive surfaces were or could be prepared. An adhesive bond increases the fracture resistance and thus the survival rate of restorations fabricated of non-high-strength ceramics. Minimally invasive restorative techniques, such as adhesive bridges, would be unthinkable without adhesive luting composites.

Etching removes the smear layer and demineralizes the outer dentin layer. After curing, the bonding agent forms an interpenetrating network with the free collagen fibres, which is known as the hybrid layer. In order for the collagen fibres to be available for this network, the tooth must not be overdried.

Self-curing luting composites were introduced on the market some years ago. The application of a dentin adhesive is no longer necessary if they are used. As this conditioning step is omitted, the treatment is shortened by approx. 30 s and is less prone to errors. The bond strength values, however, are considerably lower than those of adhesive luting systems (cf. chapter 3.4).

Self-adhesive, or, more accurately, semi-adhesive composites use a different bonding mechanism than self-conditioning adhesives. In this case, the smear layer is not removed, but instead it is penetrated by a reactive composite and bonded to the dentin. If good wetting is ensured, it is even possible that the dentinal tubules are penetrated, which are visible as resin tags on SEM pictures. Without a hybrid layer, bonding values that meet the requirements of adhesive cementation materials cannot be achieved. Therefore, the term semi-adhesive luting composite will come into use for this type of materials.

	Semi-adhesive	Adhesive
Examples	RelyX Unicem, Maxcem	Multilink Automix, Variolink II, Panavia F
Preparation	retentive	non-retentive preparation is possible
Bonding mechanism	Curing of the smear layer	Formation of a hybrid layer
Primer	-	yes
Shear bond strength on dentin	self-curing 1 – 6 MPa dual-curing 3 – 14 MPa	up to 30 MPa (cohesive fracture)

Comparison of various characteristic parameters of adhesive and semi-adhesive luting composites

1.3 Self-curing adhesive luting composites

Most adhesive luting cements are light- and / or dual-curing. In other words, in order to achieve quick and thorough polymerization, the curing light must (light-curing) or should (dual-curing) reach the composite unimpeded. However, restorations made of metals, metal alloys, and opaque ceramics, e.g. zirconium oxide, are impervious to light. To date, such restorations were usually incorporated using conventional phosphate cements and glass-ionomer cements. These cements, however, require well-prepared retention to establish a durable bond, which, very often, entails a substantial loss of tooth structure.

1.4 Multilink Automix

The luting system Multilink Automix consists of a composite and Multilink Primer A and B. The corresponding initiator system permits a chemically initiated polymerization (self-curing), which is accelerated by the contact of the composite with the primer. Furthermore, the presence of a photo initiator also enables final polymerization with light.

The indications for Multilink Automix are as follows:

- | | |
|----------------|--|
| Cementation of | <ul style="list-style-type: none">- Crowns- Bridges- Inlays- Onlays- Root canal posts |
| made of | <ul style="list-style-type: none">- Metal (gold, titanium, ...)- Metal-ceramics- All-ceramics (silicate, zirconium oxide, aluminium oxide, ...)- Resins, composites (also fibre-reinforced) |

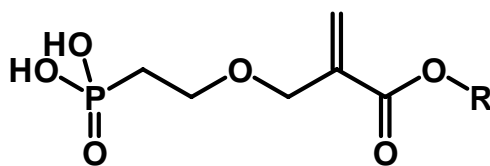
Multilink Automix is a composite and is used in conjunction with Multilink Primer. Multilink Primer is a self-etching adhesive system, which is offered in two bottles. One contains the acidic monomers and the other the initiator solution. These two components are mixed in a 1:1 ratio and applied on dentin for 15 seconds and on enamel for 30 seconds. The restoration can be seated using Multilink Automix immediately afterwards. The high adhesive values are reached after only a few minutes. They are also responsible for a very good marginal seal and the prevention of postoperative sensitivity.

A number of selected product properties at a glance:

- Multilink Automix is a self-curing, self-etching luting composite system, which can be used for nearly all the typical clinical cementation applications (⇒ "multi"-use). Moreover, it also offers the possibility of final light-curing.
- As a paste-paste system, Multilink Automix demonstrates a nice creamy and stable consistency and is supplied in the convenient double-push syringe with mixing tip.
- In the Multilink / Multilink Primer System, the material sets quickly and reliably and cement excess is easily removed.
- Together with the Multilink Primer, very high bonding values are achieved after only a short time. In investigations on the marginal quality, Multilink Automix also showed outstanding results.
- In clinical investigations, Multilink Automix showed none or minimum postoperative sensitivity.
- Multilink Automix demonstrates high mechanical strength values.
- Multilink Automix is based on the hybrid filler technology and is comparable to the tried-and-tested Variolink II as far as the paste composition is concerned.

1.5 Materials and compositions

The new components of the self-etching primer are a further development of the hydrolytically stable phosphonic acid methyl acrylate, which has already been used in the Excite and AdheSE adhesives.



The rest R is either an ethyl rest or a large bulky rest, which, in the presence of water, is no longer split off, even in a very acidic medium. This compound class has been protected with a patent by Ivoclar Vivadent. The toxicological properties of these derivatives have been thoroughly investigated.

The composition of Multilink Automix has been adjusted to this primer. It is necessary to bring in line the surface properties of the monomer paste with the hydrophilic primer formulation in order to achieve an optimum bond between the composite and the primer. Phase separation caused by incompatibility would reduce the strength of the bonding system and the resulting porosities could lead to postoperative sensitivity. The slightly increased hydrophilicity of the composite, which is achieved by the selection of the monomers used in the formulation, also permits optimum wetting of most restorative materials.

1.6 Caution: Interactions

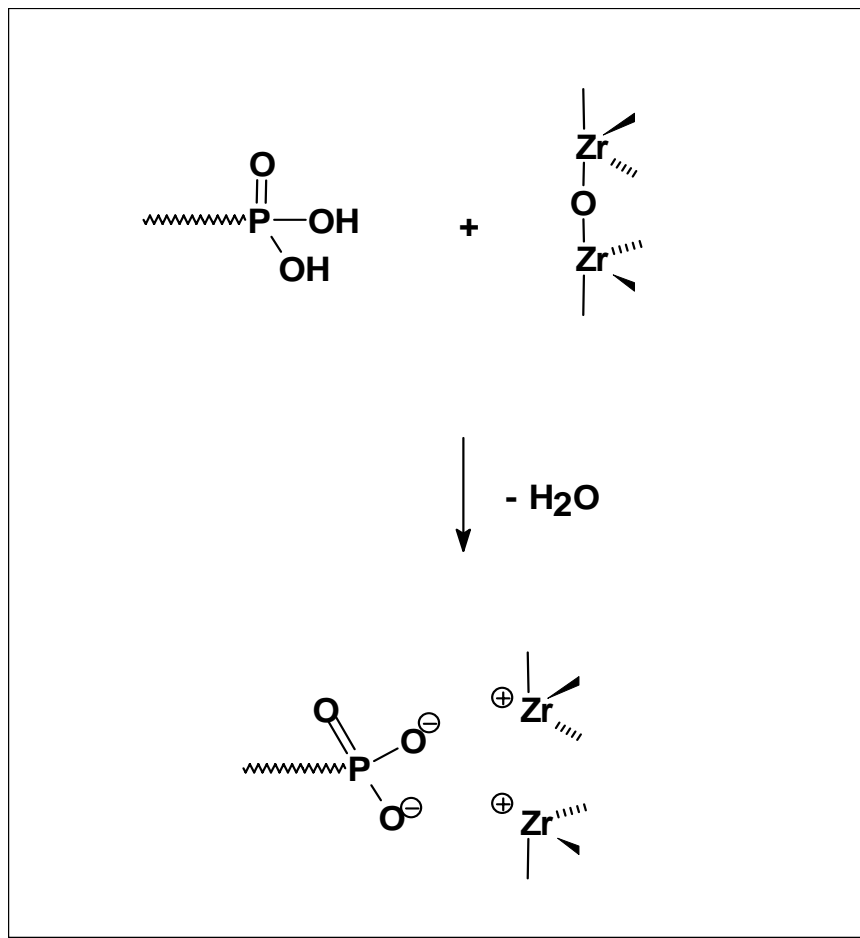
Potential interactions with other products used in the treatment should also be excluded, in order to ensure that the selected restoration can be placed safely and durably.

The active component in the adhesive (Primer B) is a phosphonic acid group. Its acidic effect demineralizes the tooth surface and irreversibly bonds to calcium ions. Alkaline components can neutralize the phosphonic acid and thus eliminate its activity. This is the case when the cavity is treated with an *Airflow* before the adhesive cementation. The solid component of such an *Airflow* is sodium hydrogen carbonate, which has a strong basic effect. In addition, it is known that the oxidizing components, which can be used to disinfect the cavity, influence the initiator systems for self-curing. A classic example is the use of *hydrogen peroxide*. If it has not been thoroughly rinsed from the tooth, adequate bonding cannot be achieved with self-curing composites. If *alcohol* is used for disinfection, it has to be considered that alcohol is hygroscopic and may lead to over-drying and therefore to a collapse of the collagen layer. In this case, no hybrid layer can be obtained.

1.7 Conditioning of metals and oxide ceramics – Metal/Zirconia Primer

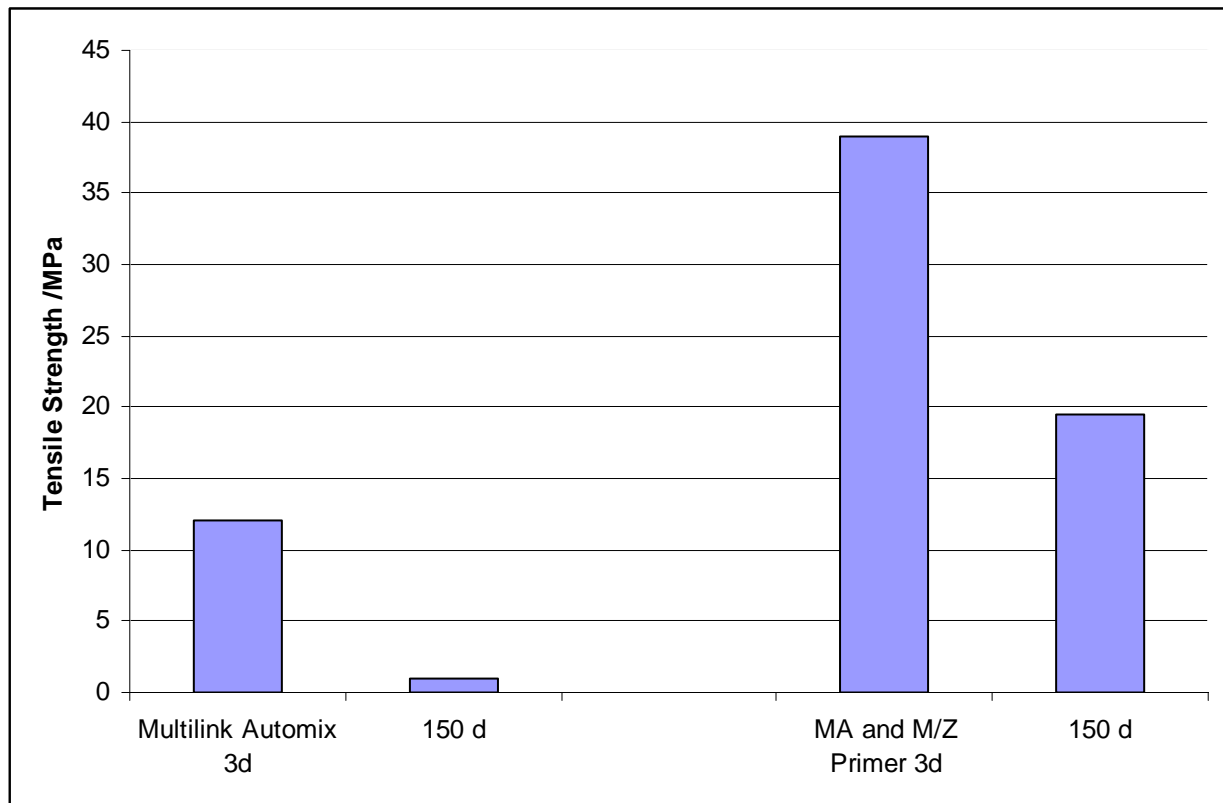
For the adhesive cementation of glass-ceramic restorations, a combination of etching and silanizing has proved most efficient. Hydrofluoric acid gels, such as the Ceramic Etching Gel, can create a micro-retention pattern on the ceramic surface by dissolving silicate components. The silanization, on the one hand, forms a chemical link to the glass-ceramic surface, and on the other, changes the hydrophilic properties, so that a better wetting with the luting composite is possible.

Zirconium oxide as well as most metals cannot be etched with the hydrofluoric acid gel. The retention can be increased for instance by sandblasting with aluminium oxide (< 1 bar). In this case it is recommended to use a phosphoric / phosphonic acid reagent. Zirconium and many metals form low-soluble, stable phosphates / phosphonates with phosphoric acid / phosphonic acid.



Presumed surface reaction of phosphoric / phosphonic acid with zirconium oxide

The Metal/Zirconia Primer utilizes the high affinity between these two components. The active reagent of the primer is a methacrylate monomer which has one phosphonic acid group. Similarly to silane on silicate ceramic, chemical bonding is made possible and the zirconium oxide / metal surface can be wetted with the luting composite. This conditioning is stable enough to withstand the stress of thermocycling.



Determination of tensile bond strength values after 3 days and after 150 days plus thermocycling of Multilink Automix and zirconia with and without Metal/Zirconia Primer (University of Kiel 2006)

Important:

Zirconium oxide must not be cleaned with phosphoric acid (e.g. Total Etch) before cementation. Like phosphonic acid methacrylate, phosphoric acid reacts irreversibly with the zirconium oxide surface. A layer of zirconium phosphate is created which inhibits the adhesion of the Metal/Zirconia Primer and thus renders it ineffective.

2. Technical Data

Standard composition: (in wt%)

<u>Multilink Automix</u>	<u>Base</u>	<u>Catalyst</u>	<u>Multilink Primer A</u>	
Dimethacrylate and HEMA	30.5	30.2	Water	85.7
Barium glass filler and Silica filler	45.5	45.5	Initiators	14.3
Ytterbiumtrifluoride	23.0	23.0		
Catalysts and Stabilizers	1.0	1.3	<u>Multilink Primer B</u>	
Pigments	< 0.01	-	Phosphonic acid acrylate	48.1
			Hydroxyethyl methacrylate	48.1
			Methacrylate mod. polyacrylic acid	3.8
			Stabilizers	< 0.02

Metal/Zirconia Primer

Solvent	87.9
Phosphonic acid acrylate	5.0
Ethoxylated Bis-EMA	5.0
Initiators and Stabilizers	2.0

Physical properties:

In compliance with ISO 4049:2000 – Polymer-based filling, restorative and luting materials Mixing ratio of base and catalyst (1:1)

	Self-curing	Dual-curing	
Working time (37 °C)	3 - 4	---	Min.
Setting time	6 - 7	---	Min.
Film thickness	< 50	< 50	µm
Water absorption (7 days)	< 40	< 40	µg/mm ³
Solubility in water (7 days)	< 7.5	< 7.5	µg/mm ³
Radiopacity	350	350	% Al

Additional values:

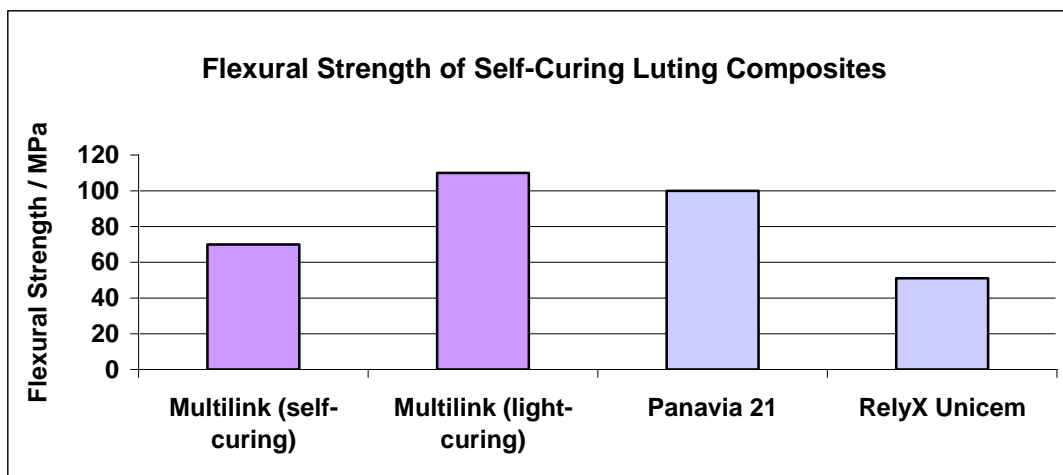
	Self-curing	Dual-curing	
Flexural strength	70 ± 20	110 ± 10	MPa
Modulus of elasticity	3250 ± 400	6000 ± 400	MPa
Compressive strength	240 ± 20	280 ± 20	MPa
Transparency	Base transp. and cat.	12 ± 1.5	%
	yellow and cat.	10 ± 1.5	%
	opaque and cat.	2 ± 0.5	%
Vickers hardness (HV 0.5/30)	---	440 ± 30	MPa
Shear bond strength	Dentin / 24h	17 ± 5	MPa
	Enamel / 24h	18 ± 3	MPa

3. Materials Science and Physical Investigations

The most important physical properties were determined before the clinical use of Multilink Automix.

3.1 Flexural strength

The flexural strength is the resistance of a test sample against flexural stress at the point of breaking. In addition to the compressive strength and tensile strength, it is a significant parameter describing the mechanical strength of a material. The flexural strength of composites is essentially influenced by the chemical composition.

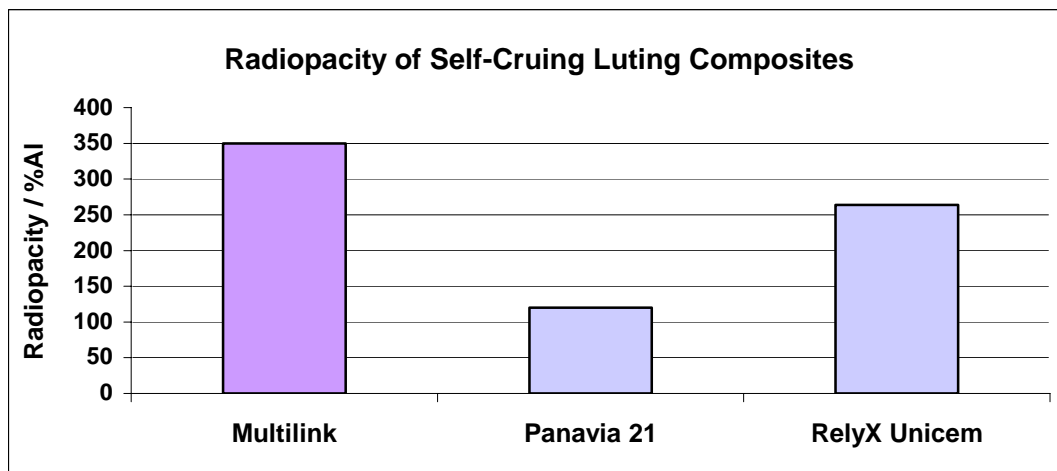


Ivoclar Vivadent, R&D

The cements were cured for 1 h at 37 °C and stored in water for 24 h at 37 °C.

3.2 Radiopacity

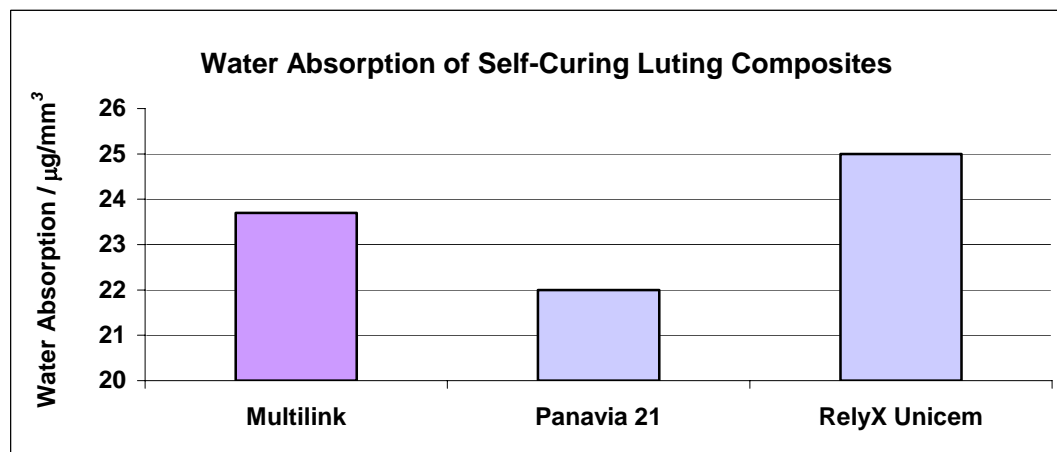
The radiopacity of dental materials permits the differentiation of tooth-coloured restorative materials from the natural tooth or caries in X-rays. The radiopacity is determined in comparison to aluminium.



Ivoclar Vivadent, R&D

3.3 Water absorption and water solubility

The absorption of water may result in an increase in volume (expansion) and thus damage to the restoration. The higher the hydrophilicity of the composite, the higher its tendency to absorb water and to swell. On the other hand, the luting composite must have a surface that is compatible with the hydrophilic dental material to ensure sufficient wetting.



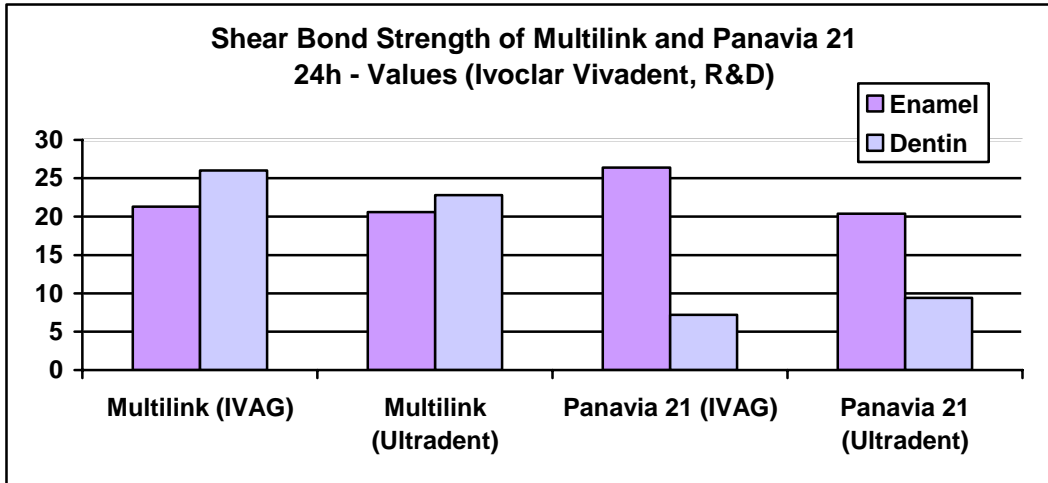
Ivoclar Vivadent, R&D

Water absorption was determined after 7 days of water storage according to ISO 4049.

3.4 Bonding to dentin and enamel

3.4.1 Shear bond strength

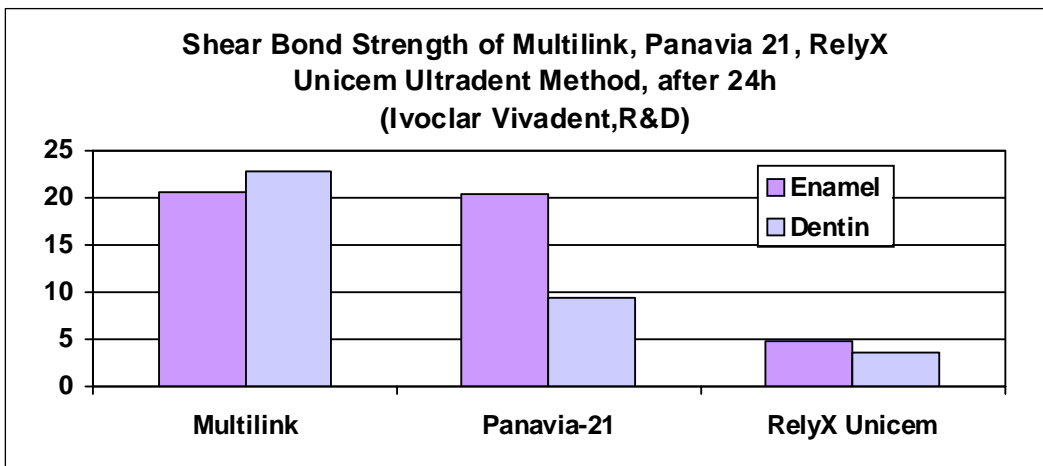
MPa



Ivoclar Vivadent, R&D

The shear bond values were obtained using two different methods: IVAG means that the shear bond strength was determined according to ISO TS 11405 on bovine teeth. For what is known as the Ultradent method, dentin and enamel of human teeth were used.

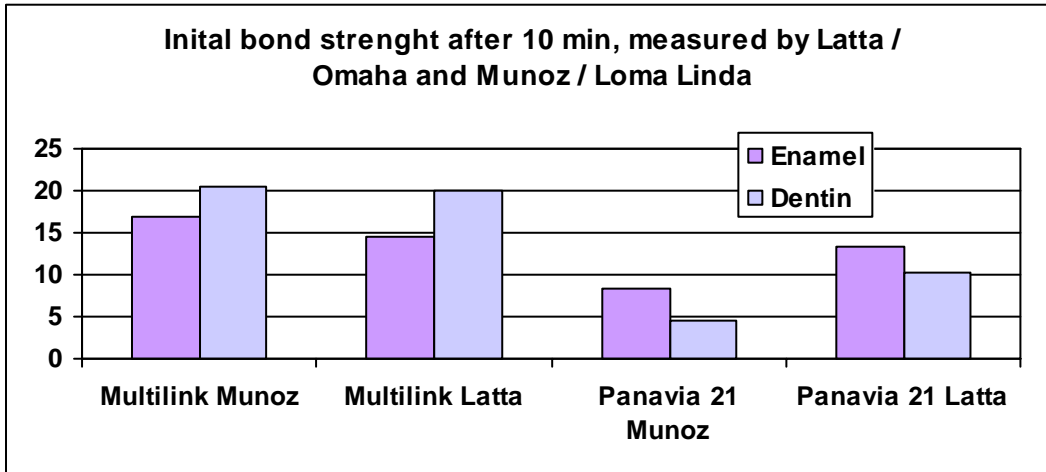
MPa



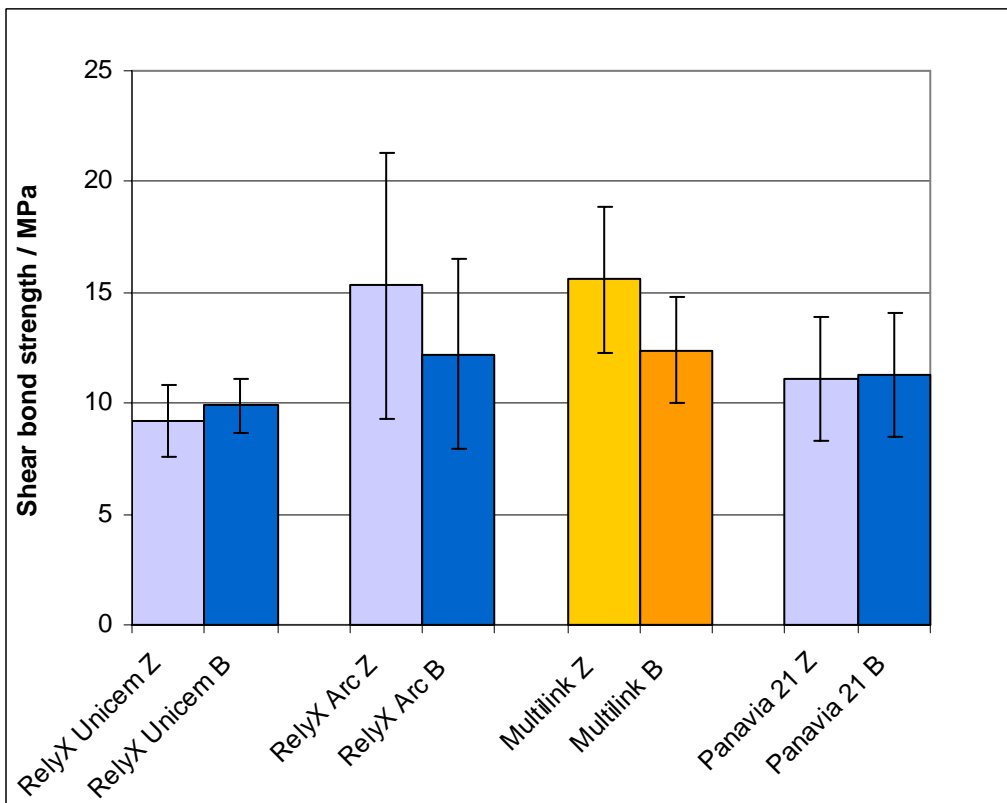
Ivoclar Vivadent, R&D

Shear bond strength of Multilink on human dentin and enamel compared to that of Panavia 21 and the self-curing RelyX Unicem. In this test, Multilink also showed very high bonding values both on enamel and dentin.

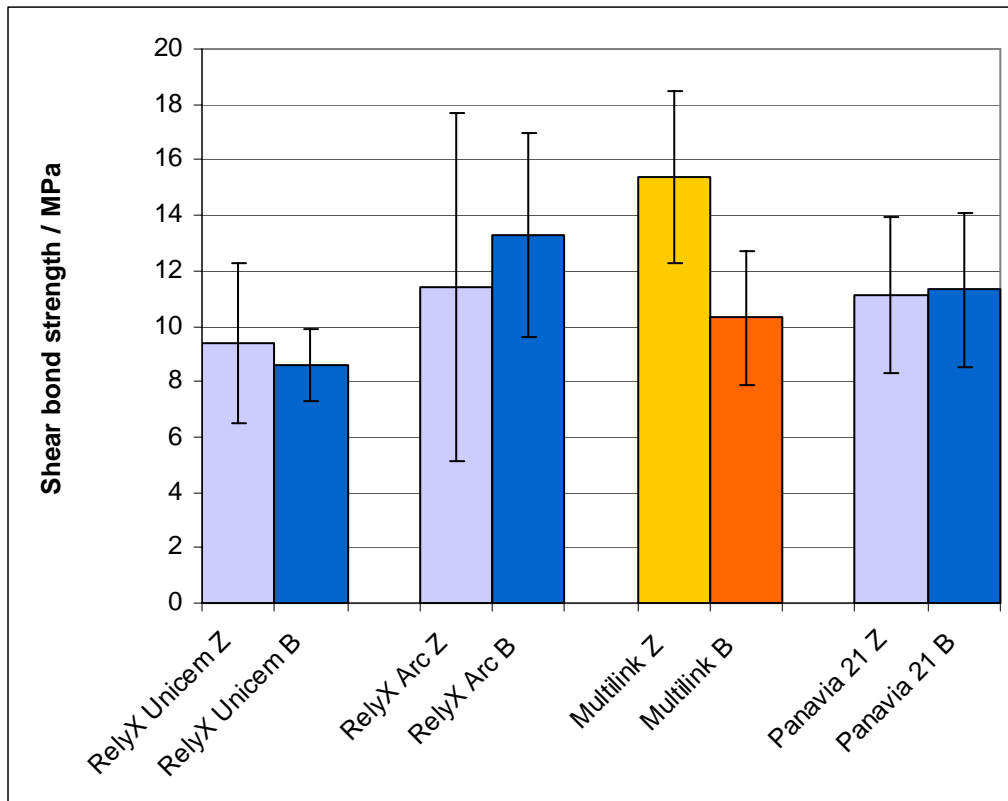
MPa



The shear bond strength tests are usually carried out according to the standard ISO TR 11405: 2003. The measured values, however, strongly vary due to individual differences. In an independent study conducted at the University of Zurich (Z) and Berne (B) [C. Holderegger et al.; Dent. Mater. 24, 944 (2008)], the correlation between the shear bond strengths and the study centre as well as the age situation was established. Apart from RelyX Arc, all luting composites were cured purely chemically.



Shear bond strength after 24 h of water storage



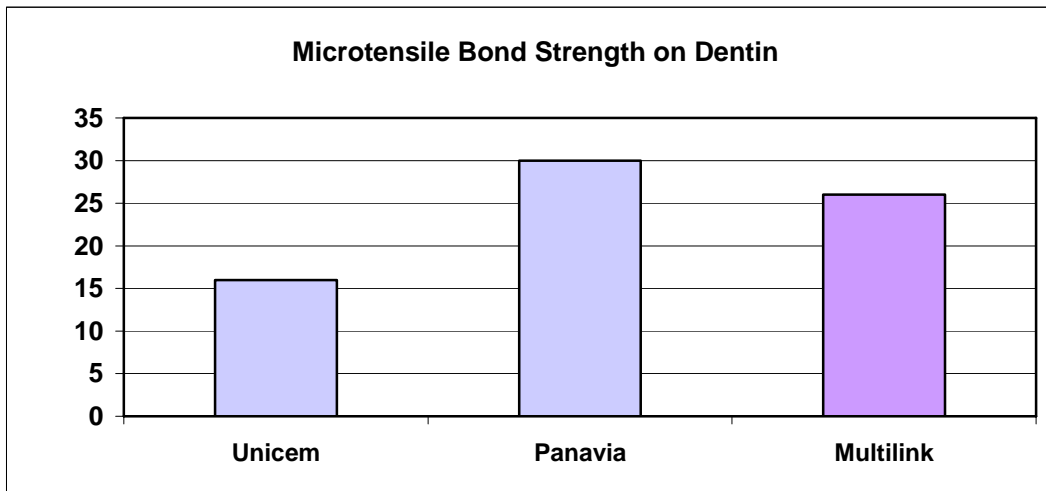
Shear bond strength after 1,500 thermocycles between 5°C and 55°C

In spite of the influence of the investigator and the ageing process, Multilink performed very well in the examined series.

3.4.2 *Microtensile bond strength*

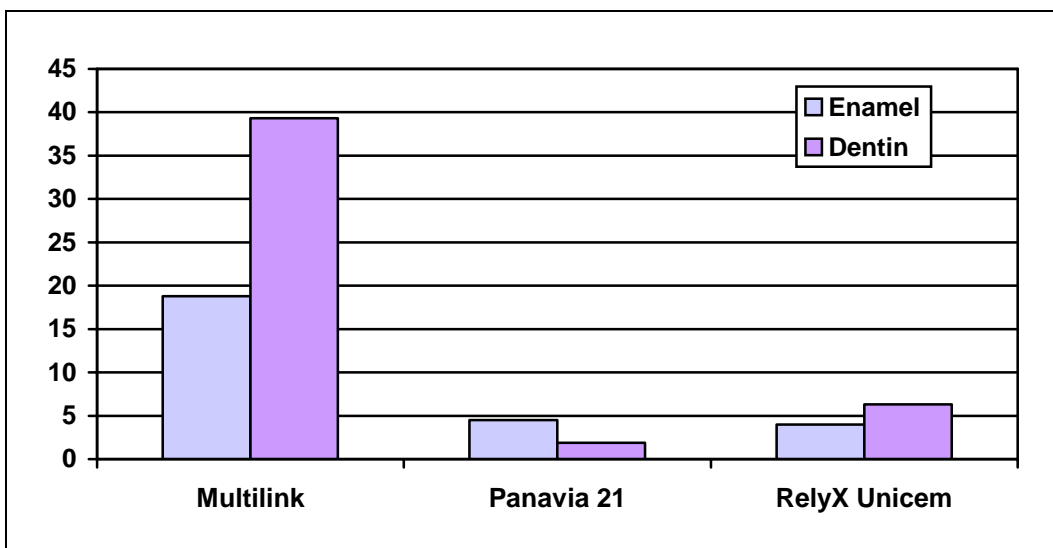
Measurements of the shear bond strength present the problem that their results show considerable scattering. The methods of microtensile strength measurement have been developed in an attempt to reduce this scattering. For this purpose, the adhesive is applied on prepared, even, retention-free dentin or enamel blocks according to the instructions. Subsequently, another block of a previously defined size is adhesively bonded to the block. The tooth structure and composite blocks are then cut into rectangular blocks perpendicular to the adhesive surface using a diamond saw. The tensile stress is then determined using a corresponding universal testing machine.

MPa



Ferrari, Siena

MPa



Perdigao, Minneapolis

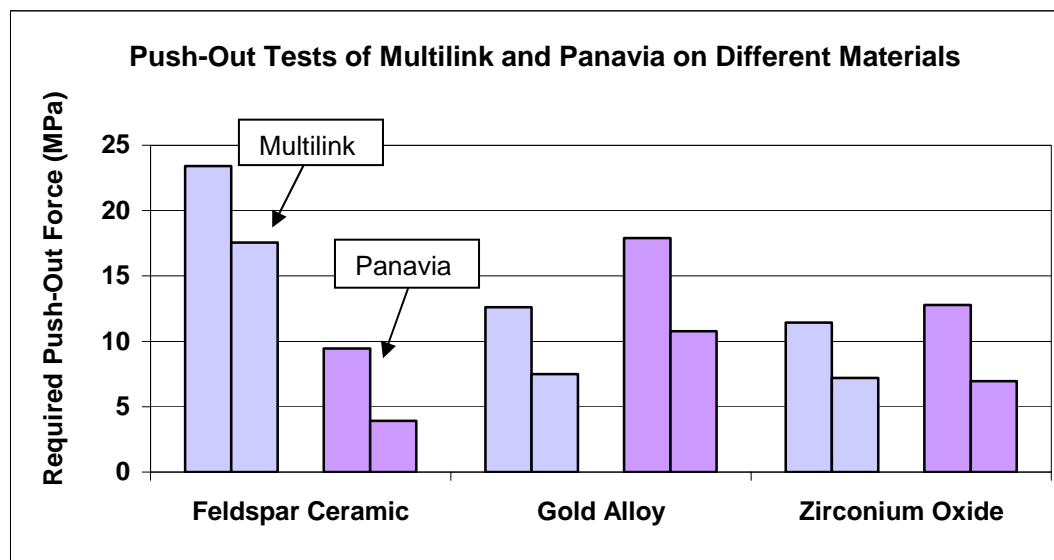
(Abstract# 3179; IADR 2004, Honolulu)

The tensile stress tests were conducted on human dentin and roughened enamel. The luting systems were applied according to the instructions for use of the corresponding manufacturers. Sandblasted cylindrical composite blocks (8 mm in diameter and 5 mm high) made of Tetric Ceram HB were adhesively cemented.

In sum, Multilink demonstrates a very good bond on dentin and enamel.

3.5 Push-out tests on various substrates

While the Multilink Primer ensures the adhesion on the tooth structure, the composite must provide a bond with the substrate of the restorations to be seated. The hydrophilic components in Multilink are responsible for achieving optimum wetting. The present study was also meant to provide an initial idea as to whether or not the substrate requires special conditioning to ensure an optimum bond.



The first bar of each group represents the bonding values after storage at room temperature and one week storage in tap water.

The second bars represent the values after 5000 thermocycles (5 ° / 55 °C) in tap water.

Dagustin, University of Chicago

The conditions stipulated in the instructions for use were selected for Panavia 21. For the tests involving Multilink, the following conditioning steps were conducted:

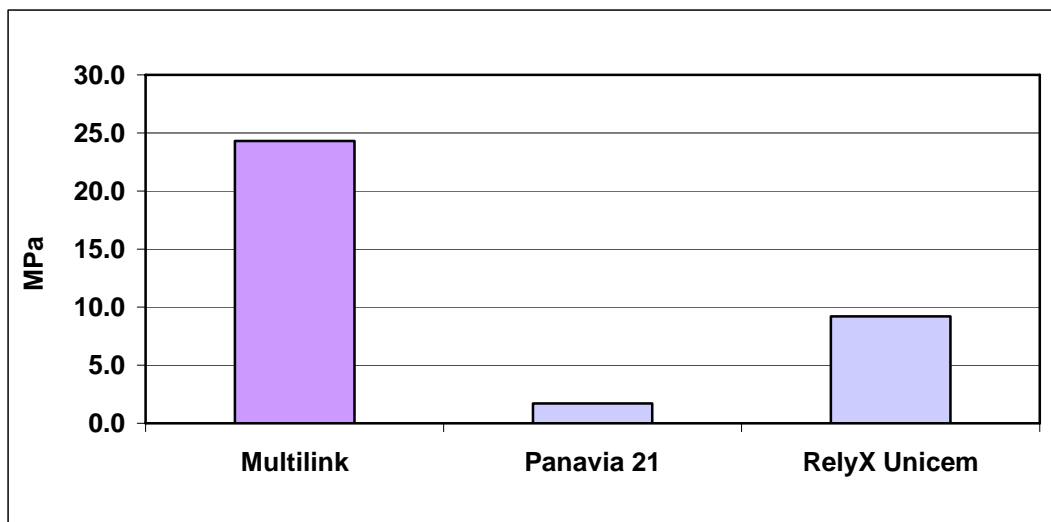
- Feldspar ceramic: a) Etching with etching gel, b) Silanating with Monobond-S
- Gold alloy: Sandblasting
- Zirconium oxide: Sandblasting

Given these results, an effective primer was developed for the improved bonding to metal and oxide ceramic.

3.6 Bonding strength of Multilink on different substrates

As a multi-purpose luting composite, Multilink has to adhere to various materials. In addition to the adhesion on various ceramic materials, such as glass-ceramic and oxide ceramic, the adhesion to metals was also investigated.

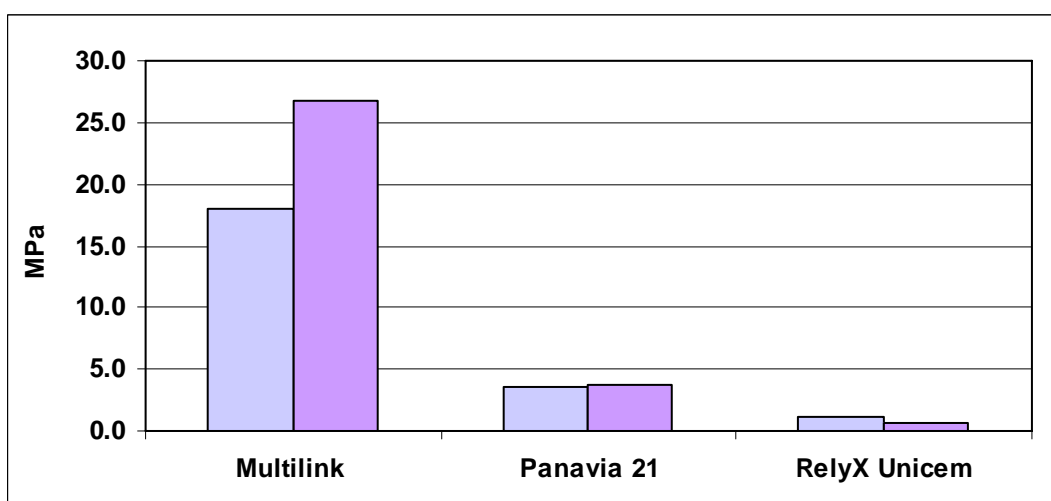
3.6.1 Shear bond strength values after 10 min. on IPS Empress 2 dental ceramic



Munoz, Loma Linda University

Test samples made of the lithium disilicate ceramic (diameter: 2.4 mm; thickness 2 - 4 mm) were sandblasted according to the instructions for use, etched with hydrofluoric acid for 20 s, rinsed, and conditioned with Monobond-S for 60 s. Subsequently, the samples were bonded to a human dentin surface according to the corresponding instructions for use. After 10 min. in an incubator at 37 °C, the shear bond strength values were determined with the help of an Instron machine.

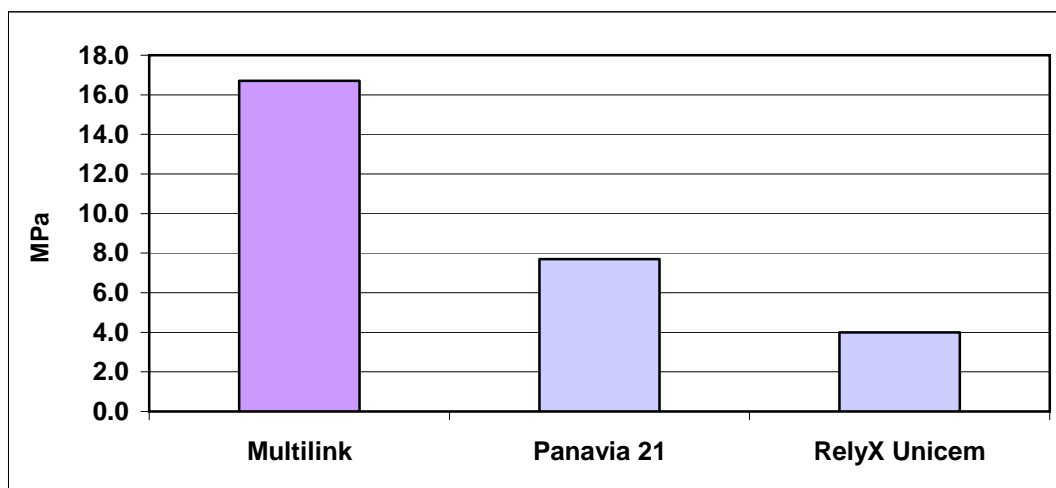
3.6.2 Shear bond strength values after 10 min. on zirconium oxide



Munoz, Loma Linda University

Test specimens made of zirconium oxide (diameter: 2.4 mm; thickness: 2 - 4 mm) were sandblasted using 50 µm aluminium oxide, and cleaned with steam. The lighter bar (left) indicates the bonding values without conditioning, while the darker bar (right) represents the results for the ZrO₂ samples, the surface of which had been silanated with Monobond-S for 60 seconds. Subsequently, the samples were adhesively bonded to a human dentin surface according to the corresponding instructions for use. After 10 min. in an incubator at 37 °C, the shear bond strength values were determined with the help of an Instron machine.

3.6.3 Shear bond strength values after 10 min. on the Pisces Plus alloy

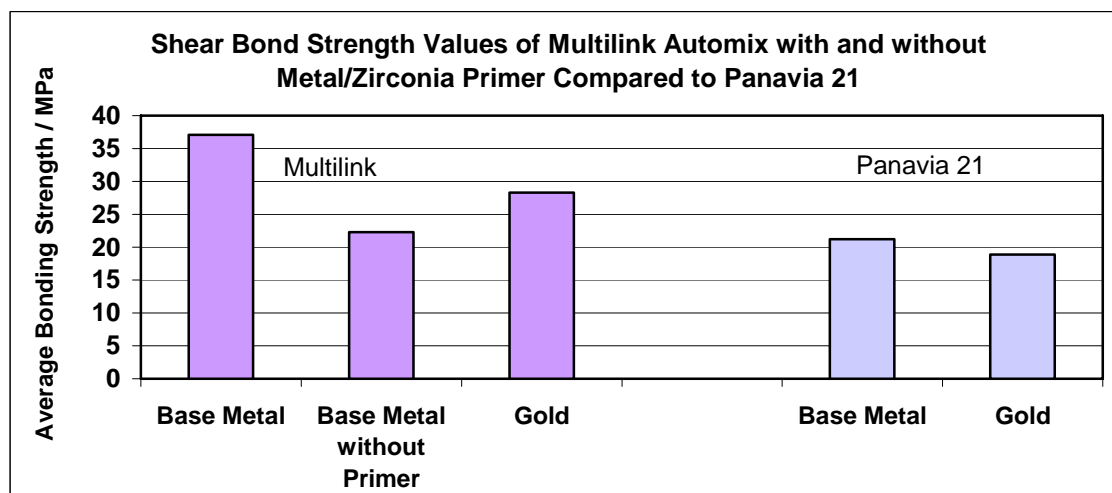


Munoz, Loma Linda University

Test specimens made of the Pisces Plus base metal alloy (diameter: 2.4 mm; thickness: 2 - 4 mm) were sandblasted using 50 µm aluminium oxide, and cleaned with steam. Subsequently, the samples were adhesively bonded to a human dentin surface according to the corresponding instructions for use. After 10 min. in an incubator at 37 °C, the shear bond strength values were determined with the help of an Instron machine.

These results prove that Multilink, in a comparison with Panavia 21 and RelyX Unicem, shows high bond strength values on various substrates after only a short period of time.

3.6.4 Shear bond strength values of Multilink on various metals

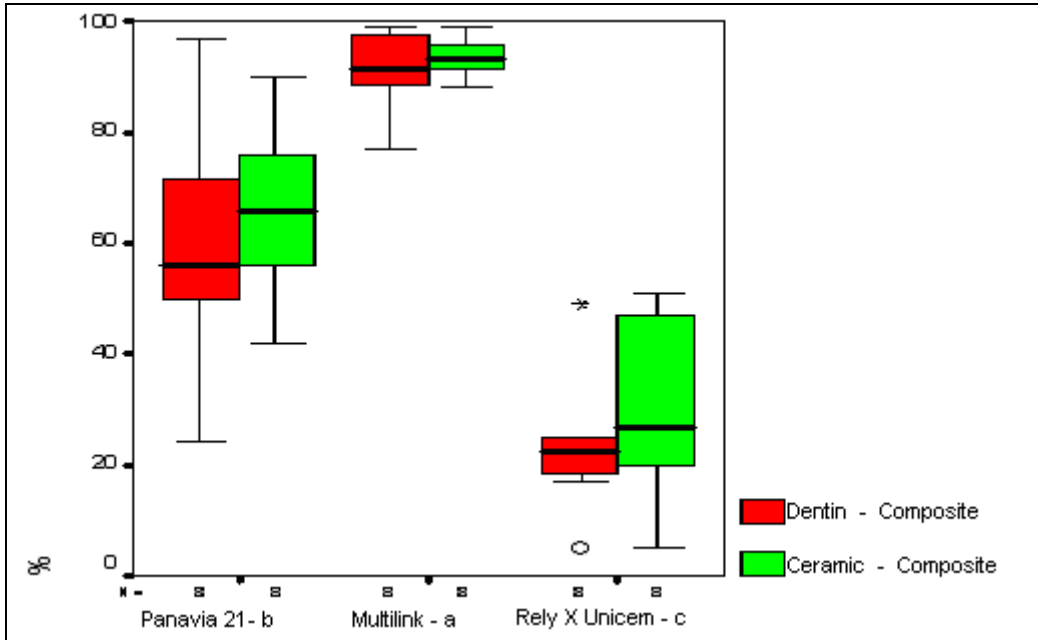


Latta, University of Nebraska

The shear bond strength values of Multilink were determined with Primer and without Primer. Panavia 21 was used according to the instructions for use with an "airblock". The results show that the shear bond strength values of Multilink can be increased by using the Metal/Zirconia Primer.

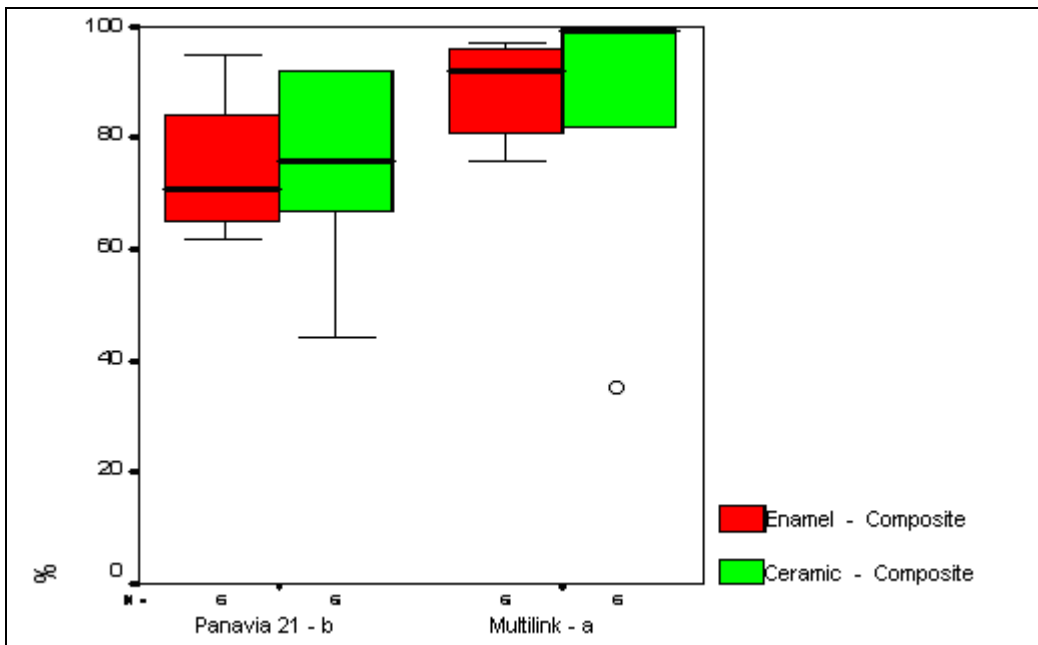
3.7 Marginal quality

The marginal quality was determined with the help of ceramic inserts in standardized drill-holes in bovine dentin (diameter = 4 mm). The diagram below shows the percentage of continuous margin after 2000 thermocycles.



Ivoclar Vivadent, R&D

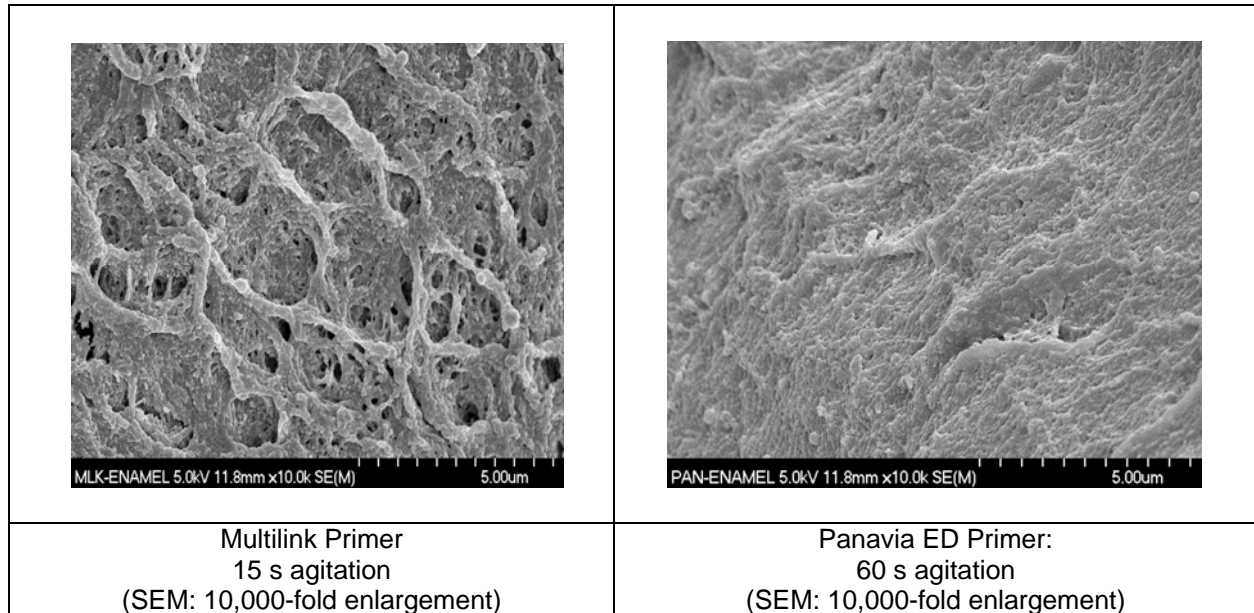
In accordance with the tests to evaluate the dentin margins, ceramic inserts were placed in standardized drill-holes in bovine enamel and subjected to 2000 thermocycles.



Ivoclar Vivadent, R&D

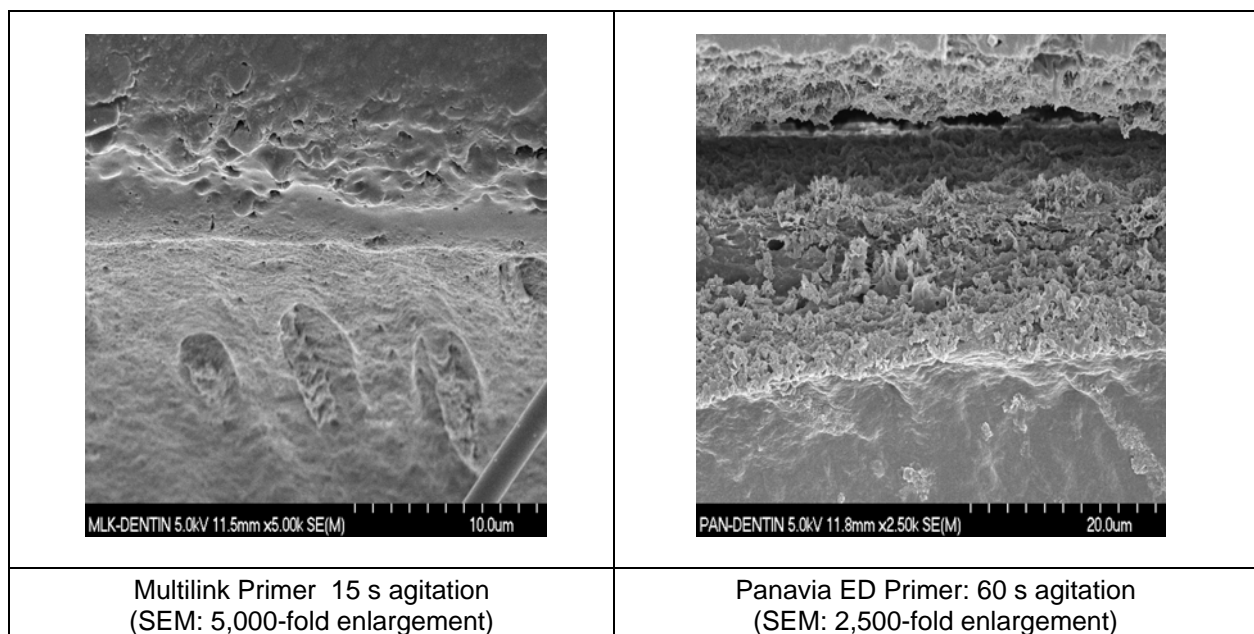
3.8 SEM images of the tooth-adhesive interface

Enamel etching patterns after the application of Multilink Primer and Panavia ED Primer according to the instructions for use (according to G. Perdigao, University of Minnesota)



After the agitation of Multilink Primer, the enamel demonstrates a typical etching pattern with clearly increased retention.

Hybrid layer after different reaction times of Multilink Primer and Panavia ED Primer on dentin (according to G. Perdigao, University of Minnesota)



After the application of both adhesives according to the instructions for use, the dentin-composite interface shows a hybrid layer.

3.9 Further studies on Multilink

Durability of the adhesive bond of the Multilink luting composite and a new phosphate primer on various restorative materials in comparison to established luting agents containing phosphate monomers.

Prof. Kern, University Clinic Kiel, Germany

In vitro stability tests on inlay-retained bridges made of lithium disilicate ceramic

Prof. Ludwig, University Clinic Kiel, Germany

Adhesion de postes de fibra de vidrio a distintos niveles del canal radicular

Prof. Gonzalez, Universidad de Granada, Spain

Sealing ability of Empress II porcelain inlays luted with Excite self-curing and Multilink self-curing resin cement

Prof. Ferrari, Cagidiaco Emilio Studio Associato, Livorno, Italy

4. Clinical Studies

Up until today, Multilink has been used and documented in several clinical studies on the cementation of restorations.

Clinical trial of fibre posts luted with self-curing ExciTE in combination with an experimental resin cement.

Head of study: M. Ferrari, Research Center for Dental Health, Livorno, Italy

Objective: Establish the performance of Multilink in the incorporation of 40 fibre-reinforced composite root canal posts.

Experimental: Incorporation of 40 fibre-reinforced composite root canal posts using Multilink as the luting agent

Results: Thirty-five patients were examined in a recall after 36 months. No loss of retention occurred.

Clinical trial of Empress 2 porcelain inlays luted to vital abutments with self-curing ExciTE and Multilink resin cement

Head of study: M. Ferrari, Research Center for Dental Health, Livorno, Italy

Objective: Determine the adhesive properties of Multilink for ceramic inlays under clinical conditions.

Experimental: 40 inlays made of Empress 2 (lithium disilicate press ceramic).

Results: Thirty-three patients were examined in a recall after 36 months. No loss of retention occurred. Slight discolouration was noted for 2 margins.

For these two studies, ExciTE DSC was used as the adhesive. Multilink Primer, developed in house, was used as the self-curing and self-etching adhesive in the studies below.

***In-vivo* marginal seal of Multilink: Empress 2 all-ceramic crowns vs. conventional porcelain veneered crowns**

Head of study: Prof. Dr. Gerwin Arnetzl; University of Graz, Austria

Objective: Clinical long-term investigation over a period of 48 months on metal-ceramic restorations vs. Empress 2 all-ceramic restorations adhesively cemented using Multilink.

Experimental: 54 crowns (27 made of Empress 2 and 27 made of d.SIGN on Porta Geo Ti), as well as 6 inlays, 5 onlays, 6 adhesive bridges, 3 root canal post build-ups

Results: For only 2 (2.7 %) of 74 restorations, postoperative sensitivities were noted (inlay with the cavity area near the pulp, onlay with postoperative sensitivity to pressure). Both sensitivity episodes did not last longer than 36 hours.

Unlike with other self-etching primers, no desquamation of the epithelial tissue was noted.

No tissue reaction of the gingiva in the form of reddening, bleeding, oedema, or whitish surface burns occurred.

No loss of retention was noted after 48 months.

Pilot Clinical Trial on Modified Lithium Disilicate Ceramic Crowns

Head of study: Dr. John A. Sorenson; Pacific Dental Institute, Lake Oswego, OR, USA

Objective: Incorporation of 16 all-ceramic crowns made of IPS e.max Press.

Experimental: Sixteen molar and premolar crowns.

Results: No loss of retention after 36 months. No postoperative sensitivities were reported (9 vital teeth).

Clinical evaluation of Multilink used for inlay and onlay restorations

Head of study: Dr. Arnd Peschke; Ivoclar Vivadent, Schaan, FL

Objective: Investigation of the handling properties and clinical performance level of Multilink used for the incorporation of inlays and onlays

Experimental: 21 vital teeth

Results: All the restorations showed a large contact surface between dentin and the luting agent. Nevertheless, no postoperative sensitivities were reported.

Clinical Evaluation of an Experimental Dental Ceramic Material for Anterior and Posterior Crowns

Head of study: Dr. Nathanson, Boston University, Boston, MA, USA

Objective: Incorporation of 40 IPS e.max CAD crowns using Multilink.

Experimental: Forty crowns in the anterior and posterior region

Results: During the incorporation period, not postoperative sensitivities were described. No decementation reported after 48 months.

Summary

Experiences with Multilink from clinical studies stretch over more than 3 years. Multilink and later Multilink Automix have proved its outstanding clinical properties for the cementation of crowns, bridges, and inlays made of ceramic and metal alloys. The cementation of root canal posts was also successfully tested. The rare occurrence of postoperative sensitivities is especially noteworthy. The quick curing in the presence of Multilink Primer has been particularly praised by our study partners.

Multilink has been on the market now for more than 4 years and has held its ground well. In 2005, Multilink Automix, a self-curing luting material which offered the option to be light-cured through the addition of champhor quinone, was introduced into the market. In order to optimize the bonding to restorations based on metal-alloys and oxide ceramics, the conditioner Metal/Zirconia Primer was additionally developed.

5. Toxicological Data

The cytotoxicity, genotoxicity, and carcinogenicity of Multilink and Multilink Primer were tested according to ISO 10993.

5.1 Multilink

- 1.) XTT Test (Cytotoxicity Assay *in vitro*: Evaluation of materials for Medical Devices) RCC-CCR Report 670501; 05. 09. 2000
- 2.) Ames Test (Salmonella Typhimurium Reverse Mutation Assay) RCC CCR Report 670502; 04.07.2000

Both the cytotoxicity test and the mutagenicity test did not show any toxicological risk. Given the composition of the composite, which contains components comparable to those used for most of the established dental composites, nothing else has to be expected.

5.2 Multilink Primer

- 1.) XTT Test (Cytotoxicity Assay *in vitro*: Evaluation of Materials for Medical Devices) RCC-CCR Report 758703; 13. 11. 2002

The Primer shows a XTT value of 1693 mg/l. This means that it demonstrates a cytotoxicity that is clearly lower than that of many monomers used in the dental industry.

- 2.) Ames Test (Cytotoxicity Assay *in vitro*: Evaluation of materials for Medical Devices) RCC-CCR Report 758702; 28. 01. 2003
- 3.) Comet Assay (*In Vitro* Single Cell Gel Electrophoresis in Chinese Hamster V79 Cells) RCC-CCR Report 760 700; 18. 10. 2002
- 4.) *In vivo* mutagenicity test (Micronucleus Assay in Bone Marrow Cells of the Mouse) RCC-CCR Report 776201; 19. 05. 2003

The results of these evaluations and investigations have shown that the adhesive composition of Multilink Primer does not demonstrate any mutagenic risks.

6. Literature

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