3M™ VITREBOND™ LINER/BASE

Technical Product Profile Update

3M™ VITREBOND™ LINER/BASE

3M™ VITREBOND™ LINER/BASE

Type of Product and Indication

3M™ Vitrebond ™ Liner/Base[1] is a resin modified glass ionomer (RMGI) liner/base material, its composition and curing mechanism extensively described in the literature. It is recommend for use as a liner or base under composite, amalgam, metal and ceramic restorations. Vitrebond Liner/Base is not indicated for direct pulp capping. If a pulp exposure occurs, cover the exposure with a calcium hydroxide material. Place the Vitrebond liner/base over the calcium hydroxide and surrounding dentin to seal and protect the exposure.

Composition, Primary Packaging and Handling

The powder is a radiopaque, ion-leachable fluoroaluminosilicate glass powder, which is made photosensitive by its unique chemistry. The glass is prepared by fusing together SiO_2, AlF_3, ZnO, SrO, cryolite, NH_4F, MgO and P_2O_5. To protect the powder from deactivation by ambient light, it is packaged in an amber colored bottle with a flip cap designed for easy closure after use.

The liquid component is a modified polyacrylic acid with pendant methacrylate groups, HEMA (2-hydroxyethylmethacrylate), water and photoinitiator. The liquid component is also light sensitive due to the presence of the photosensitizer. Therefore, its primary package is a light-opaque vial to protect it from ambient light exposure.

When mixed together at the recommended (standard) proportion of one scoop powder and one drop liquid, a powder-to-liquid-ratio of 1.4/1.0 by weight is obtained.

Curing Mechanism

The chemistry of the setting process of Vitrebond Liner/Base consists of two independent setting reactions. When powder and liquid are combined, the conventional glass ionomer acid-base reaction begins. In this process cations (M^{x+}) from the glass react with the carboxylate groups of the polymer resulting in chelation. When irradiated by a curing unit, a photo-initiated crosslinking of the polymer chains occurs through a free radical methacrylate polymerization. The light curing mechanism is much faster than the acid-base reaction, which results in command setting of the mixed Vitrebond Liner/Base mass upon light exposure from a curing unit. The ionic chelation reaction continues over a long period resulting in long term fluoride release.

The setting process is a stepwise reaction. In step 1 the polycarboxylic acid ionizes in water in presence of the glass to form a negatively charged carboxylate polymer and protons. In step 2 the protons attack the glass causing it to release positive ions as Ca^{2+}, Al^{3+}, AlF^{2+} and AlF_2^+. In step 3 these positive ions complex with the negatively charged polycarboxylate polymer to form an iononically crosslinked network. Some of the positive ions released as AlF^{2+} and AlF_2^+ are complexed and have fluorine present. In step 3 the polycarboxylate ions replace the fluorine of these complexed ions resulting in the very important fluoride releasing benefit of glass ionomers.

The advantage that Vitrebond has over conventional glass ionomers is that it also sets by brief exposure to visible light. This reaction is step 4 and occurs through the pendant methacryloxy groups of Vitrebond co-polymer. Literature confirms the 3M position that Vitrebond (and similar materials) need a light cure to fully develop strength.

Vitrebond glass has a relatively high reactivity contributing to its character of a 'real glass ionomer' as compared to some competitive products. Although Vitrebond is less acidic

---

[1] Upon introduction the product was named Vitrabond and its name was changed to Vitrebond

(figure 1) at the initial stage of placement, its pH rises more rapidly on light curing than other products. Chemically curing glass ionomers need more time for that.

Fig. 1 Change in pH vs time
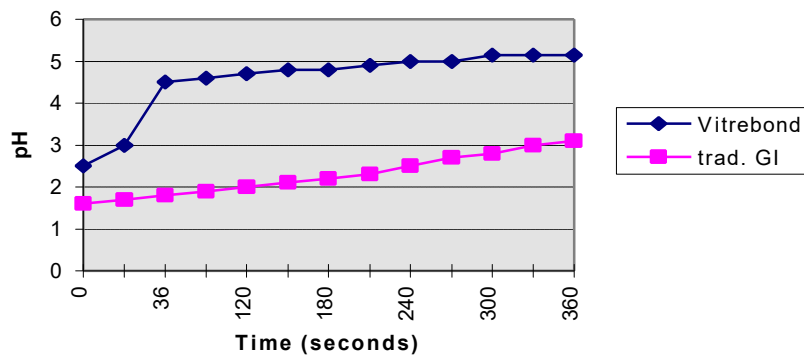
Functional properties as product assets

Function of Liner

The table below summarizes functional aspects of liners/bases and their potential results. Please note that these can overlap with the mechanisms and results of dentin adhesives. The importance of a liner/base is different for amalgam and composite resin restorations and may strongly depend on the patient. A dentist needs to find a solution based on all the individual circumstances.

Table 1

Function	Mechanism	Result
Seal dentine	Adhesion to dentine Reduce leakage	Patient comfort Less (post) operative sensitivity Cracked tooth syndrome treatment Protection against toxins Reduction of pulpal problems Less tooth discoloration
Bacterial Protection	Fluoride release Bacteriostatic	Caries reduction Less pulpal problems
Thermal protection	Heat diffusion	Patient comfort Less sensitivity to heat and cold
Mechanical protection	Resistance to packing Wash-out resistance Stabilization of calcium hydroxide liner Stress release	Pulpal protection Crack-free liner/base Adequate support restoration
Tooth strengthening	Bond restoration to tooth	Potential to reduce undercuts Improved retention and resistance Longer life-time restoration

Case Examples

An old amalgam restoration failed due to bulk fracture. No caries is present under the restoration. The patient as such is not caries active. The cavity is not too deep. The old restoration could be easily removed. Therefore, the new cavity preparation is not larger than

the old one. Due to reparative dentine formation the risk for sensitivity is small. Result: Most general practitioners will not use any liner, varnish, glass ionomer or amalgam adhesive at all.

A restoration failed due to recurrent caries. The patient is caries active. The restoration is less than one year old and the patient experienced post-operative sensitivity. There is a risk that the lingual wall is too thin. For a number of dental and socio-economic reasons a crown is not indicated. In this case, a dentist may select a glass ionomer liner or base in combination with an amalgam adhesive. As a result dentin will be sealed and bacterial and thermal and mechanical protection provided. When a calcium hydroxide liner was used the glass ionomer can help stabilize this and prevent wash-out. All this will help to improve retention and resistance and result in a longer life-time of the restoration.

Properties

Table 2

	Vitrebond	Trad. GI liner		Vitrebond	Trad. GI liner
Working Time (min: s)	2: 40	3: 30	**Diametrical Tensile Strength (MPa)**	17.4	9
Set Time (s)	30	7:00	**Flexural Strength (MPa)**	25.5	12
Dentin Bond Strength 5 min (MPa)	7	-	**Radiopacity (relative to aluminum)**	1.6	1.2
Dentin Bond Strength (MPa)	14	5	**Thermal diffusivity (mm^2/s)**	0.26	-
Compressive Strength (MPa)	96.5	75			

Biocompatibility

During its long use in the market as well as in clinical research, 3M™ Vitrebond™ Liner/Base has proven to be a safe and effective material when used within the indications specified by 3M.

3M Vitrebond Liner/Base is not indicated for direct pulp capping, and the usual precautions relative to for instance skin contact are required.

Histological studies in primates showed no adverse pulpal response when used as a liner/base without an exposed pulp . 3M also investigated the potential to use Vitrebond as a pulp-capping agent. Vitrebond provided a good seal on dentin, which is highly desirable for preventing access of microorganisms to the site of the pulp exposure. However, the preferred method of pulp capping found was the use of a hard setting $Ca(OH)_2$ material on the exposure followed by application of a layer of Vitrebond liner/base. The calcium hydroxide can help control any possible bleeding, and the Vitrebond layer effectively seals the dentin and provides a mechanically strong base upon which the restorative material is applied.

3M™ VITREBOND™ LINER/BASE

Tarim et al reported Vitrebond to have no excessive effect on pulp tissue. Microscopic findings indicate that pulpal reactions are minimal and comparable to those caused by chemically cured glass ionomer lining cement and zinc-oxide eugenol. Gruythuysen et al reported on a pulpotomy technique in primary teeth technique where calcium hydroxide powder, placed on the remaining pulp tissue, was covered and sealed with Vitrebond. The success rate of this technique at two year recall (87.7%) is comparable to that of formacresol, an indication that an alternative pulpotomy technique may be available.

Easy, Forgiving, Reliable and Enhanced Applications

Vitrebond requires application of a separate bonding agent to adhere composite to Vitrebond. The adhesion between composite and Vitrebond is found to be high with and without an separate acid etching.

The material is forgiving in the powder/liquid ratio, which can be varied within a wide range to satisfy the consistency needs of the dental team. There is no significant difference in adhesion to dentin with a scoop/drop-ratio from 0.5:1

P/L scoops/drops wt/wt Strength in MPa	0.5/1 0.7/1	1/1 1.4/1	1.5/1 2.1/1	2/1 2.8/1
Dentin Bond Strength (MPa)	12.3	12.3	13.2	9.3
Compressive Strength (MPa)	71.0	82.8	96.6	106.9
Diametrical Tensile Strength (MPa)	13.1	14.0	16.5	16.3

Table 3, Strength with different powder/liquid ratio

(0.7:1 by weight) through 1.5:1 (2.1:1 by weight). The 2:1 mix gives significantly lower dentin bond strength. Despite this decrease, the adhesion value is still higher than that of products like Cavalite, TimeLine and XR-Ionomer. The strength values are excellent for all P/L-ratios used. The depth of cure increases somewhat with increasing mix ratio. At the 2:1-ratio, depth of cure decreased 15%.

Vitrebond applied under an indirect composite restoration has a good ability to restore the tooth stiffness to an amount not significantly different from that of the sound tooth. The modulus of elasticity provides adequate support when functioning as a base under amalgam.

The product can be used in most areas where a very thin yet strong liner is required. It is ideal for use with indirect systems to block out small undercuts and to act as a protective coating over the dentin. In deep areas it can be placed over a calcium hydroxide liner.

3M™ Vitrebond™ Liner/Base is consistent with the cavity cleansing according to Brännström (Tubilicid). According to studies, removing the superficial smear layer with the cavity cleanser does not impair the bonding of Vitrebond to dentin. Although particular surface conditioners do not appear to negatively affect the dentin bond strength or even may improve other pretreatments of the dentin (Durelon or GC Conditioner) may negatively affect the adhesion to dentin.

It appears that Vitrebond has the potential for being an effective amalgam adhesive in vivo, and it adheres to a variety of substrates such as set dental amalgam. Due to its adhesion to set amalgam and its superior masking qualities, Vitrebond is useful as an adhesive masking agent on amalgam with esthetically disturbing surfaces.

Considering that the cumulative 1-yr success rate after a single treatment with Vitrebond was 79%, the use of light-cured glass-ionomers may be an effective way of treating dentin hypersensitivity.

3M™ VITREBOND™ LINER/BASE

Several reports support the use of Vitrebond for interim restoration of decayed deciduous and permanent teeth.

In a study the longevity of minimal composite sealant restorations (P-50/LC Concise WS) was compared with glass ionomer sealant restorations (Vitrebond/LC Concise WS) in permanent (pre)molars. There was no significant difference in durability, although the LC Concise WS was better retained over P-50 than over Vitrebond.

Command Setting

Vitrebond Liner/Base hardens by two setting reactions. Upon mixing a relatively slow conventional glass ionomer setting mechanism is active. Immediate hardening occurs after light exposure by the curing unit. Therefore, it has an individualized working time through command setting. The traditional glass ionomer aspect gives the dentist ample handling time, while the command curing provides an immediate set when the practitioner is ready for it without any delay. This aspect makes Vitrebond Liner/Base much more user friendly than traditional glass ionomer. Application of the material significantly reduces the chair-time compared to traditional systems. "Most busy practitioners will not wait 10 or more minutes for a restorative material to set when they're accustomed to the command set of composite resin in a few seconds" (Christensen).

Strength on Command

Vitrebond has an advantage over all chemically curing glass ionomer systems in the handling stage. Not only because it sets on command, but also because its properties develop in a shorter time frame. This is especially important for the development of strength. Stresses during amalgam packing vary considerably depending on the type of alloy, condensation instrument and the perception of the dentist, but are typically in the range 2-10 MPa.

Some old base materials e.g. zinc oxide eugenol, calcium hydroxide and zinc phosphate, are prone to fracturing during condensation of dental amalgam (compare to condensation stresses). The immediate compressive strength of Vitrebond is far higher than the 7 minute values as given for calcium hydroxide, zinc oxide eugenol and zinc phosphate cement. In case of Vitrebond, an adequate strength develops upon light curing. There is no need to wait several minutes or even longer.

In vitro studies show that amalgam condensation of calcium hydroxide does not cause significant displacement of a calcium hydroxide when carefully applied. However, the clinical situation is different. Several investigations make it clear that one frequently displaces Dycal linings during the restorative process. Long term mechanical strength is best in case of zinc phosphate. Please note that the compressive strength of 3M ™ Vitrebond™ Liner/Base is in the same order of magnitude (table . However, Vitrebond attains a high immediate strength 'on command'. Vitrebond is also superior relative to a traditional type of glass ionomer like Ketac-Bond.

Material	7 min	30 min	24 h
Zinc Oxide	2.8	3.5	5.2
Eugenol	15.9	20.7	24.1
	6.2	6.9	12.4
Calcium	7.6	6.2	8.3
Hydroxide	3.8	4.8	10.3
Zinc Phosphate	6.9	86.9	119.3

Table 4, Development of strength over time of various products by category

High Bond Strength to a Variety of Substrates

Bond strength to dentin of Vitrebond compares well or favorably relative to traditional and resin modified glass ionomer cements[2], showing higher numbers when tested on permanent teeth than on deciduous teeth. The adhesion is considered to be primarily chemically in nature. Vitrebond adheres to both carious and non-carious primary dentin both in vitro and in vivo. In vitro tests with simulated intra-pulpal pressure give consistent results for Vitrebond.

Bond strength increases with increasing light exposure time and reaches its maximum value after approximately 30 seconds, while a delay of the command curing longer than 5 minutes after mixing results in a reduced bond strength. Although dentin surface treatments as Gluma 2 and a 10% polyacrylic dentin conditioner do not appear to negatively affect the dentin bond strength, a pretreatment of the dentin (Durelon or GC Conditioner) may negatively affect the adhesion to dentin.

Studies showed that the retentive strength of amalgam restorations bonded with Vitrebond without mechanical undercuts compares to bonding amalgam with Amalgambond and Panavia Ex. Vitrebond therefore has the potential for being an effective amalgam adhesive in vivo.

Reduces Microleakage

The Council on Dental Materials, Instruments and Equipment stresses that, in animal studies, the presence of bacteria beneath a dental restoration correlates with the degree of pulpal inflammation. Vitrebond liners result in less leakage under composite and amalgam restorations in comparison to restorations with a copal varnish liner, calcium hydroxide liner or without liner. The leakage data of restorations with Vitrebond used as a liner also usually compare favorable to that of other glass ionomers and resin-modified glass ionomers. This holds true in vitro as well as in vivo.

Leakage is the result of a multitude of factors, including the technique to measure. Therefore not all studies show reduced leakage of composite with a resin-modified glass ionomer liner versus a composite control, but the majority of the studies do. Usually leakage does not occur at the dentine margin, it progresses no further than the Vitrebond lining. Immediate finishing of the composite resin restorations reportedly does not adversely affect the marginal seal. Occlusal mechanical load cycling, in addition to thermal cycling, of composite resin Class II restorations lined with 3M™ Vitrebond™ Liner/Base does not affect leakage in contrast to composite resin restorations without a Vitrebond liner. Pulpal pressure does not influence the results in deeper dentin.

In vivo results are better than in vitro experiences. No gaps between glass ionomer and dentin were found on in vivo specimens, while gaps of various sizes were present in the in vitro. Apparently, the product was able to bond to dentin when used as a liner in vital teeth but not always when used in extracted teeth. This can be attributed to the presence of a partially humid environment in vivo that favors the application and bonding process. In vitro, specimens are to a large extent dehydrated.

Reduced Stress Levels in Restoration

Stress built-up during polymerization of a composite restoration depends on several factors:
- An effective bond of the adhesive (an unbonded restoration has no internal stress)
- Polymerization shrinkage of the composite
- The modulus of elasticity
- The water absorption and the related hygroscopic expansion of the composite.

---

[2] One needs to be cautious to interpret bond strength data in comparison with other products. In case of bond strength of Vitrebond, the 'real bond strength' is not measured at all, because the material usually cohesively fractures in Vitrebond, rather than at the interface between dentin and Vitrebond.

3M™ VITREBOND™ LINER/BASE

Some composite resins are available that have reduced shrinkage. However, polymerization contraction still is a pertinent cause for internal stresses.

Reduced internal stress levels are beneficial to improve marginal integrity and reduce leakage. A less rigid composite resin or the application of an elastic intermediate layer like Vitrebond liner/base promote a higher quality of marginal integrity. As a result, low elastic modulus materials have a lower risk of leakage. Application of an elastic Vitrebond lining resulted in polymerization stress reductions of up to 50% and showed to reduce the polymerization shrinkage on average by 41%. All factors mentioned are additive in nature and contribute to stress relief and reduced leakage.

Excellent Stable Physical Properties

Properties of 3M Vitrebond liner/base don't deteriorate during aging in water, with or without thermocycling. There is no significant change in the mechanical properties of the cured cement aged in water at 37°C for prolonged periods. This indicates that long-term fluoride release does not adversely affect the physical properties of Vitrebond. There is no significant difference in the values of compressive and diametrical tensile strengths obtained immediately after curing and after extended storage in water at 37°C. Thermocycling has no effect on the bond strength of Vitrebond either. The modulus of elasticity provides adequate (and stable) support under amalgam.

Less Handling Sensitivity

Vitrebond is less sensitive than traditional glass ionomers to dehydration, it does not form cracks. Cracks in conventional glass ionomers upon dehydration progress entirely through the material. A crack through the liner or base allows for direct communication with the pulp. Etching fluid or gel can penetrate into these cracks and will be difficult if not impossible to rinse off. Therefore application of a very thin layer of Vitrebond is possible, while a normal glass ionomer based requires a thickness of 0.5 mm or more.

Enhances Patient Comfort

Hypersensitive teeth can be effectively treated. The cumulative 1-yr success rate after a single treatment with Vitrebond was 79%, making it an efficient (no pretreatment, except cleaning with a pumice slurry) and clinically effective way of treating dentin hypersensitivity. In combination with a composite such as 3M ™ Silux™ Plus Anterior Restorative it significantly reduces sensitivity to air and hot and cold water. Christensen stated that a resin-modified glass ionomer liner reduces or eliminates sensitivity of Class II composite resin restorations. Indirect composite inlays/onlays bonded to cavities lined with 3M™ Vitrebond™ Liner/Base did not show up secondary caries in the long term. The low thermal diffusivity of Vitrebond makes it an adequate thermal insulator, helping to reduce hot-cold sensitivity of especially metallic restorations.

Vitrebond is rather "foolproof", however, one of the few risks is overdrying the dentin. This may trigger of reactions of the odontoblastic processes and the bond can be negatively influenced to the extent that gaps may form between liner and dentin. This could result in increased rather than decreased postoperative sensitivity.

Vitrebond Usually Replaces Calcium Hydroxide

Under a traditional amalgam restoration, calcium hydroxide has long been used - often with overcoatings of copal varnish - as the base for the restoration. Calcium hydroxide's main advantage is its capacity for stimulating the growth of secondary or reparative dentin. Some researchers suggest this can happen when calcium hydroxide is applied to a thin layer of remaining dentin, yet others believe that secondary dentin forms only when there is pulpal exposure. A disadvantage of calcium hydroxide is that it may crack when subjected to the

crushing forces that occur under the amalgam restoration or while amalgam is being packed into the cavity preparation. Calcium hydroxide has a relatively low compressive strength. Its high solubility can lead to washout from under the amalgam restorations and result in microleakage. This may lead to recurrent caries. Though calcium hydroxide remains the standard in cases of pulpal exposure, more and more dentists are turning to a glass-ionomer liner base - both as a sealing layer over the calcium hydroxide placed over pulpal exposures or used alone- when there is at least a thin layer of remaining dentin. Several authors support such a position for direct composite restorations as well. Christensen advised that if the dentin shows pink "shine through", a thin layer of calcium hydroxide should be applied followed by a liner and/or dentin adhesive to stabilize the calcium hydroxide and to seal the dentin. Marginal integrity and inhibition to secondary caries is a critical factor in reducing inflammation to the adjacent periodontium of amalgam restorations.

Another biological aspect to take into consideration is the pulpal response. Jodaikin, Austin & Cleaton-Jones investigated the pulpal response of monkey pulps to low copper amalgam with and without smear layer removal. They reported that more inflammation is present in situations without smear layer. This study does not support removal of the smear layer when no other form of protection is provided. An exciting new application concerns the application in pulpotomy procedures in paedodontic treatment. There is concern about the possible toxicity of formacresol in pulpotomy, but attempts to find a suitable replacement for formacresol were little successful a while ago. Gruythuysen et al reported on a technique where calcium hydroxide powder, placed on the remaining pulp tissue, was covered and sealed with Vitrebond. The success rate of this technique at two year recall (87.7%) is comparable to that of formacresol, an indication that an alternative technique may be available.

The decision whether or not to do pulp capping is a complex one and uncertain, especially for large pulp exposures. However, even in case of small pulp exposures, endodontic treatment is probably the best in case teeth will be involved in conventional fixed crowns and bridges.

Optimized Radiopacity

To aid in diagnosis, a restorative material as a composite resin or a liner should be readily differentiated from dentine and enamel on radiographs. It should not be mistaken for caries and should have a radiopacity higher than that of dentine or enamel, equally, a cervical overhang should be detectable. The radiopacity of amalgam is much greater than that of tooth tissue, in fact it is too radiopaque, with the risk that caries can remain undiagnosed hidden in the "shadow" of an amalgam. Too high or too low a level of radiopacity are both undesirable from a radiographic diagnosis standpoint. In a joint investigation with independent researchers, 3M found an optimum radiopacity to detect caries. The radiopacity of 3M™ Vitrebond™ Liner/Base and 3M's restorative products are in accordance with this work.

Material	X-Ray Density Ratio[3]
Aluminum*	1.0
Amalgam	7.0
Human Dentin	0.9
Human Enamel	1.1
Vitrebond	1.6
Ketac-Bond	1.2
GC Liner	1.4

Table 5, radiopacity

Other researchers also recognize this important aspect: "To permit diagnosis of defects and caries adjacent to fillings, there has been a tendency to strive for the highest achievable radiopacity; In recent studies ..... it has, however, been shown that dentists will detect a higher

---

[3] X-ray density standardized relative to aluminium

percentage of secondary carious lesions and marginal defects adjacent to a semi-radiopaque restoration than adjacent to an amalgam filling. These investigations indicate that the best radiopacity is slightly higher than that of enamel." (Skartveit & Halse).

Some researchers and competitors still believe that "higher is better",. This idea clearly seems not to be based on the idea to maximize the detection of caries and marginal discrepancies.

Fluoride release

Vitrebond releases fluoride in similar or higher quantities than other resin modified glass ionomer products and traditional glass ionomer systems. "In contrast to the assumption of this investigation, the results demonstrated that light-activated glass ionomer cements have a potential for releasing fluoride equivalent to that of conventional acid-base glass ionomer cements" (Momoi & McCabe).

Walls suggested that fluoride from tooth paste or a fluoride rinse can give a reversed process in which fluoride would be absorbed by a glass ionomer, a process known for silicate cement. When traditional glass ionomer material was stored in a 2% NaF solution, the hydroxyl ion concentration of the solution increases. This indicates a fluoride uptake by the glass ionomer via an ion exchange mechanism. After recharging 3M™ Vitrebond™ Liner/Base with a NaF or an APF gel solution increased fluoride release was reported.

Both in vitro and in vivo experiments demonstrate that fluoride is diffusing into enamel or dentin adjacent to Vitrebond. There is evidence for the movement of ions from glass ionomer 1.5 μm into the dentin surface and the movement of calcium and phosphorus ions from dentin 1.0 μm into the ionomer.

Uptake of fluoride by tooth tissue results in a reduction of artificial root surface caries that are comparable to previous values for a traditional system. It was shown that Vitrebond lined amalgam restorations exhibit significantly less demineralization adjacent to the restoration than calcium hydroxide lined restorations. In artificial caries studies Vitrebond liners inhibited caries.

Caries inhibition or reduction is something classic liners such as calcium hydroxide cannot offer. A study reports about (pre)molars with amalgam restorations retrieved after clinical functioning. Seventy-four per cent of the samples had linings in various thickness. Unlined or lined restorations showed the same caries frequency adjacent to the restoration (53% of the teeth). In 36% of the teeth with linings, there was evidence for washout. These teeth show a significantly higher incidence of caries. Vitrebond does not have a washout effect.

Antimicrobial Activity

The high fluoride release of Vitrebond appears to positively influence in vivo and in vitro antimicrobial properties. As a result of this and/or reduced colonization properties plaque levels are reportedly lower as well. Observations were made that glass ionomers that showed the highest fluoride release, such as Vitrebond and Vitremer, also depicted more antibacterial activity against strains of mutans streptococci. A direct correlation between the amount of fluoride release and the area of bacterial inhibition was demonstrated in a study, suggesting that the use of glass ionomer cements as cavity liners/bases may reduce the consequences of microleakage due to its antibacterial properties.

These in vitro observations are consistent with in vivo results. After 6 weeks, the fluoride concentrations of unstimulated saliva were 10 times higher than the baseline values. The more restored teeth surfaces were present in the mouth, the higher was the saliva fluoride concentration found. The prevalence of S. mutans in saliva decreased after placement of Vitrebond restorations. The concentration of fluoride in saliva was 0.04 ppm before placement of the restorations. After three weeks it had increased to 0.8 ppm and the level remained as high as 0.3 ppm even after 1 year.

Clinical Performance

Indirect composite inlays/onlays bonded to Vitrebond lined cavities are successful: "None of the restorations showed fractures, recurrent caries, or a clinically visible loss of substance. All restored teeth were vital" (Krecji, Güntert & Lutz, 1994). Good clinical results were reported for direct composite resin Class III and IV restorations (Baillod, Krecji & Lutz, 1994).

"At 3 years class V restorations of glass ionomer cement or composite with a dentin bonding agent and a glass ionomer liner (3m Vitrebond) demonstrated significantly better retention than restorations of composite with a bonding agent." (Powell, Johnson & Gordon, 1992

Silux Plus with Vitrebond as a liner in Class V erosion/abrasion lesions effectively reduces sensitivity of teeth: "Composite resin with glass-ionomer liner restorations significantly reduced sensitivity to air and hot and cold water" (Powell, Gordon & Johnson, 1990).

Hypersensitive teeth treated with Vitrebond show strongly reduced sensitivity levels: "Considering that the cumulative 1-yr success rate after a single treatment with Vitrabond was 79%, the use of light-cured glass-ionomers may be an effective way of treating dentin hypersensitivity" (Hansen, 1992).

References by chapters

Composition, Primary Packaging and Handling

EAP De Mayer, RMH Verbeeck, CWJ Vercruyse. Reactivity of fluoride-containing calcium aluminosilicate glasses used in dental glass-ionomer cements. J Dent Res 77: 2005-2011.

SB Mitra. Visible light curable cements based on polycarboxylic acid/ion-leachable glass. J Dent Res 1992: 71: (Special Issue): Abstract 72.

SB Mitra, MY Li, SR Culler. Setting reaction of Vitrebond™ Light Cure Glass Ionomer Liner/Base. Proceedings of 'Setting mechanisms of dental materials', Editor DC Watts, Loch Lomond, Scotland, 1992.

Curing Mechanism

ÖH Andersson, JE Dahl. Aluminium release from glass ionomer cements during early water exposure in vitro. *Biomat 1994: 15: 882-888.*

DG Charlton, BK Moore, ML Swartz. Direct surface pH determinations of setting cements. *Operat Dent 1991: 16: 231-238.*

EAP De Mayer, RMH Verbeeck, CWJ Vercruyse. Reactivity of fluoride-containing calcium aluminosilicate glasses used in dental glass-ionomer cements. *J Dent Res 77: 2005-2011.*

AM Hegarty, GJ Pearson. Erosion and compressive strength of hybrid glass ionomer cements when light activated or chemically. *Biomat 1993: 14: 349-352*

SB Mitra. Adhesion of dentin and physical properties of a light-cured glass ionomer liner/base. *J Dent Res 1991a: 70: 72-74.*

Mitra, MY Li, SR Culler. Setting reaction of Vitrebond™ Light Cure Glass Ionomer Liner/Base. Proceedings of 'Setting mechanisms of dental materials', Editor DC Watts, Loch Lomond, Scotland, 1992.

MJ Woolford, RG Chadwick. Surface pH of resin-modified glass polyalkenoate (ionomer) cements. *J Dent 1992: 20: 359-364.*

Biocompatibility

IL Dogon, MJ Van Leeuwen, JD Heeley. A histologic evaluation of a light-cured glass ionomer liner/base. J Dent Res (Special Issue) 1989: 68: 244.

MD Gaintantzopoulou, GP Willis, AH Kafawy. Pulp reactions to light-cured glass ionomer cements. Amer J Dent 1994: 7: 39-42.

MA Gomez-Camarillo, C Mascres. La biocompatibilité des materiaux dentaires. Choix d'une méthode à tester: Faire ou ne pas faire. J Dent Que 1991: 28: 201-206.

RJ Gruythuyzen, KL Weerheijm, JW Hagen. Calcium hydroxide pulpotomy with light-cured cavity sealing after two years. Int Dent J 1995: 45: 313.

B Tarim, T Yücel, C Alatli, E Acar, V Olgaç. Histopathological investigation of the effects of various glass-ionomer cements on dental pulp. J Marmara Univ Dent Faculty 1994: 2: 429-433.

3M™ VITREBOND™ LINER/BASE

Easy, Forgiving, Reliable and Enhanced Applications

YEY Aboush, RJ Elderton. Bonding of a light-curing glass-ionomer cement to dental amalgam. Dent Mater 1991a: 7: 130-132.

YEY Aboush, RJ Elderton. Bonding dental amalgam to a light-curing glass-ionomer liner/base. Brit Dent J 1991b: 170 : 219-222.

HF Albers. Light-cured fluoride releasing liners. Adept Report 1990 : 1 : 1-8.

M Al-Moayad, YEY Aboush, RJ Elderton. Bonded amalgam restorations: a comparative study of glass-ionomer and resin adhesives. Brit Dent J 1993: 175: 363-367.

M Brännström, P Coli, M Blixt. Effect of tooth storage and cavity cleansing on cervical gap formation in Class II glass-ionomer/composite restorations. Dent Mater 1992: 8: 327-331.

RM Carvalho, RB Del'Hoyo, RS Suga, J Mondelli. Strength of base materials. Amer J Dent 1995: 8: 128-130

TP Croll. Visible light-hardened glass-ionomer cement base/liner as an interim restorative material. Quint Int 1991: 22: 137-141.

EK Hansen. Dentin hypersensitivity treated with a fluoride-containing varnish or a light-cured glass ionomer liner. Scand J Dent Res 1992: 100: 305-309.

K Hinoura, M Miyazaki, H.Onose. Dentin bond strength of light-cured glass-ionomer cements. J Dent Res 1991: 70: 1542-1544

CM Killian, TP Croll. Smooth surface glass ionomer restoration for primary teeth. J Esthet Dent 1991: 3: 37-40.

NM Kilpatrick, JJ Murray, JF McCabe. A clinical comparison of a light cured glass ionomer sealant restoration with a composite sealant restoration. J Dent 1996: 24: 399-405.

LMP Lopes, JGM Leitao, WH Douglas. Effect of a new resin inlay/onlay restorative material on cuspal reinforcement. *Quint Int 1991: 22: 641-645.*

PJJM Plasmans, EAJ Reukers. Esthetic veneering of amalgam restorations with composite resin - Combining the best of both worlds? *Operat Dent 1993: 18: 66-71.*

C Prati, G Montanari, C Biagini, F Fava, DH Pashley. Effects of dentin surface treatments on the shear bond strength of Vitrabond. *Dent Mater 1992a: 8: 21-26.*

D Staes. A case study on Vitrebond. *Fenestra 1993: 1: 8*

JL Way, AA Caputo, JR Jedrychowski. ASDC *J Dent Child 1996: 63: 261-264.*

Command setting

GJ Christensen. Tooth restoration, for mature people: Some new hope with new materials. *J Amer Dent Assoc 1992: 123: 66-67.*

SB Mitra. Adhesion of dentin and physical properties of a light-cured glass ionomer liner/base. *J Dent Res 1991a: 70: 72-74.*

RW Phillips. Glass ionomers: boosting amalgam's value. *J Amer Dent Assoc 1991: 122: 159-160.*

3M™ VITREBOND™ LINER/BASE

Strength on Command

R Grajower, S Bielak, Eidelman. Observations on a calcium hydroxide lining retrieved in deciduous teeth with proximal fillings. *J Oral Rehab 1984: 11: 561-569.*

D Novickas, VL Fiocca, R Grajower. Linings and caries in retrieved. *Operat Dent 1989: 14: 33-39.*

RW Phillips. Science of dental materials. WB Saunders, Philadelphia, 1982.

High Bond Strength to a Variety of Substrates

M Al-Moayad, YEY Aboush, RJ Elderton. Bonded amalgam restorations: a comparative study of glass-ionomer and resin adhesives. Brit Dent J 1993: 175: 363-367.

BB Bell, WW Barkmeier. Glass-ionomer restoratives and liners: Shear bond strength to dentin. J Esthet Dent 1994: 6 : 129-134.

BAM Bourke, AWG Walls, JF McCabe. Bond strength to dentine of two light-activated glass polyalkenoate (ionomer) cements. J Dent 1994: 22: 242-246

RL Cooley, WW Barkmeier. Dentinal shear bond strength, microleakage, and contraction gap of visible light-polymerized liners/bases. Quint Int 1991: 22: 467-474.

K Hinoura, M Miyazaki, H.Onose. Dentin bond strength of light-cured glass-ionomer cements. J Dent Res 1991: 70: 1542-1544.

JR Holtan, GP Nystrom, PS Olin, J Rudney, WH Douglas. Bond strength of a light-cured and two auto-cured glass ionomer liners. J Dent 1990a: 18: 271-275.

M Irie, H Nakai. Marginal sealability of resin-modified glass ionomers for base/liner: effect of hygroscopic expansion and bond strength. Dent Mater J 1996 : 15: 193-200.

RE Kerby, L Knobloch. The relative shear bond strength of visible light-curing and chemically curing glass-ionomer cement to composite resin. Quint Int 1992: 23:641-644.

A Lin, NS McIntyre, RD Davidson. Studies on the adhesion of the glass-ionomer cements to dentin. J. Dent Res 1992: 71: 1836-1841.

RA McCaghren, DH Retief, EL Bradley, FR Denys. Shear bond strength of light-cured glass ionomer to enamel and dentin. J Dent Res 1990: 69: 40-45.

G Øilo, CM Um. Bond strength of glass-ionomer cement and composite resin restorations. Quint Int 1992: 23: 633-639.

C Prati, DH Pashley, G Montanari. Hydrostatic intrapulpal pressure and bond strength of bonding systems. Dent Mater 1991: 7: 54-58.

JA Sorensen, NV Dixit. In vitro shear bond strength of dentin adhesives. Int J Prosthod 1991: 4: 117-125.

M Staninec, Y Torii, L Watanabe, M Kawakami, EM Tonn. Tensile adhesion evaluation in a new universal test. Amer J Dent 1992: 5: 187-191.

BL Stewart, JK Harcourt, MJ Tyas. Comparison of bond strengths to dentine in cavities restored before and after extraction. J Dent Res (Special Issue) 1990: 69: 945.

S Strickland, DH Retief, CM Russell. Shear bond strengths to dentin and fluoride release from fluoride-containing liners. Amer J Dent 1990: 3: 259-263.

KC Titley, DC Smith, R Chernecky. SEM observations of the reactions of the components of a light-activated glass polyalkenoate (ionomer) cement on bovine dentine. J Dent 1996: 24: 411-416.

JL Way, AA Caputo, JR Jedrychowski. ASDC J Dent Child 1996: 63: 261-264.

Reduces Microleakage

AI Abdalla, CL Davidson. Comparison of the marginal integrity of in vivo and in vitro Class II composite restorations. J.Dent 1993: 21: 158-162.

M Blixt, P Coli. The influence of lining techniques on the marginal seal of class II composite resin restorations. Quint Int 1993: 24: 203-210.

RL Cooley, WW Barkmeier. Dentinal shear bond strength, microleakage, and contraction gap of visible light-polymerized liners/bases. Quint Int 1991: 22: 467-474.

Council on Dental Materials Instruments, and Equipment. Biocompatibility and postoperative sensitivity. J Amer Dent Assoc 1998: 116: 767-768.

CL Davidson, AI Abdalla. Effects of thermal and mechanical load cycling on the marginal integrity of class II resin composite restorations. Amer J. Dent 1993: 6: 39-42.

EL Davis, X Yu, RB Joynt, G Wieczkowski, L Giordano. Shear strength and microleakage of light-cured glass ionomers. Amer J. Dent 1993: 6: 127-129.

WH Douglas, JW Fundingsland. Microleakage of three generically different fluoride-releasing liner/bases. J Dent 1992: 20: 365-369.

M Futatsuki , M Nakata. In vitro marginal leakage of Class II composite resin restorations by thermal cycling. J Clin Pediatr Dent 1994 : 18: 191-196.

ED Kingsford Smith, FE Martin. Microleakage of glass ionomer/composite resin restorations: A laboratory study. 1. The influence of the glass ionomer cement. Austral Dent J 1992: 37: 23-30.

FE Martin, M O'Rourke. Marginal seal of cervical tooth coloured restorations. Aust Dent J 1993: 38: 102-107.

GJ Mount, A Papageorgiou, OF Makinson. Microleakage in the sandwich technique. Amer J Dent 1992: 5: 195-198.

Ng BP; Hood JA; Purton DG. Effects of sealers and liners on marginal leakage of amalgam and gallium alloy restorations. Operat Dent 1998: 23: 229-235.

C Prati. Early marginal microleakage in Class II resin composite restorations. Dent Mater 1989: 5: 392-398.

C Prati, M Simpson, J Mitchem, L Tao, DH Pashley. Relationship between bond strength and microleakage measured in the same Class I restorations. Dent Mater 1992b: 8: 37-41.

C Prati, C Capuzzi, C Nucci, E Toschi, A Savino. Infiltrazione marginale - nei restauri in amalgama. Dental Cadmos 1992c: 10: 46-51.

3M™ VITREBOND™ LINER/BASE

C Prati, DH Pashley, G Montanari. Hydrostatic intrapulpal pressure and bond strength of bonding systems. Dent Mater 1991: 7: 54-58.

E Reich, H Völkl. Randqualität von Zahnhalsfüllungen aus lichthärtenden Glasionomerzementen. Dtsch Zahnärztl Z 1994: 49: 263-266.

DH Retief, RA McCaghren, CM Russel. Microleakage of Vitrebond/P-50 Class II restorations. Amer J Dent 1992: 5: 130-132

.AC Shortall. In vitro microleakage of Class V composite resin restorations with and without light-cured glass-ionomers (polyalkenoate) cement lining. Eur J Prosthod Restor Dent 1992: 1: 7-11

SK Sidhu, LJ Henderson. In vitro marginal leackage of cervical composite restorations lined with a light-cured glass ionomer. Operat Dent 1992: 17: 7-12.

K Tolidis, A Nobecourt, RC Randall. Effect of a resin modified glass ionomer liner on volumetric polymerization shrinkage of various composites. Accepted for publication, 1999.

M Tsunekawa, Y Usami, M Iwaku, JC Setcos, SJ Marshall. A new activated adhesive adhesive cavity liner: An in vitro strength and microleakage study. *Dent Mater 1992: 8: 296-298.*

G Wieczkowski, XY Yu, RB Joynt, El Davis. Microleakage evaluation in amalgam restorations used with bases. *J Esthet Dent 1992: 4: 37-40.*

Reduced Stress Levels in Restoration

T Ikemi, K Nemoto. Effects of lining materials on the composite resins shrinkage stresses. Dent Mater J 1994 : 13: 1-8.

CM Kemp-Scholte, CL Davidson. Complete marginal seal of Class V resin composite restorations effected by increased flexibility. *J Dent Res 1990: 69: 1240-1243.*

K Tolidis, A Nobecourt, RC Randall. Effect of a resin modified glass ionomer liner on volumetric polymerization shrinkage of various composites. Accepted for publication, 1999.

Excellent Stable Physical Properties

YEY Aboush. Dentine bond of light-activated glass-ionomer liner/bases. J Irish Assoc 1995: 40: 63-65.

RM Carvalho, RB Del'Hoyo, RS Suga, J Mondelli. Strength of base materials. Amer J Dent 1995: 8: 128-130..

SB Mitra. Adhesion of dentin and physical properties of a light-cured glass ionomer liner/base. J Dent Res 1991a: 70: 72-74.

SB Mitra. In vitro fluoride release from a light-cured glass-ionomer liner/base. J Dent Res 1991b: 70: 75-78.

Less Handling Sensitivity

AD Wilson, JW McLean. Glass-ionomer cement. Quintessence, Chicago, 1988.

TP Croll. Visible light-hardened glass-ionomer cement base/liner as an interim restorative material. *Quint Int 1991: 22: 137-141.*

3M™ VITREBOND™ LINER/BASE

CL Davidson. Report of a study into the shear bond strength of amalgam to freshly prepared light curing glass ionomer cement and of light cured glass ionomer cement to aged amalgam. *Report to 3M, 1988*

L Litkowski, M Durkee. Evaluation of crack formation during glass ionomer setting reactions. *J Dent Res Special Issue) 1989: 68: 273.*

KJ Reinhardt. Sind lichthärtende Zemente die bessere Wahl? *Philipp J 1992: 9: 327-332.*

Enhances Patient Comfort

WA Brantley, RE Kerby. Thermal diffusivity of glass ionomer cement systems. *J Oral Rehab 1993: 20: 61-68.*

GJ Christensen. Preventing sensitivity in Class II composite restorations. *J Amer Dent Assoc 1998b: 129: 1469-1470.*

EK Hansen. Dentin hypersensitivity treated with a fluoride-containing varnish or a light-cured glass ionomer liner. *Scand J Dent Res 1992: 100: 305-309.*

Krejci , A Güntert, F Lutz. Scanning electron microscopic and clinical examination of composite resin inlays/onlays up to 12 months in situ. *Quint Int 1994: 25: 403-409.*

PN Mason, M Ferrari. In vivo evaluation of glass ionomer cement adhesion to dentin. *Quint Int 1994 : 25: 499-504.*

LV Powell, GE Gordon, GH Johnson. Sensitivity restored of Class V abrasion/erosion lesions. *J Amer Dent Assoc 1990: 121: 694-694.*

TF Watson. A confocal microscopic study of some factors affecting the adaption of a light-cured glass ionomer to tooth tissue. *J Dent Res 1990: 69: 1531-1538.*

Vitrebond Usually Replaces Calcium Hydroxide

N Bichacho. Direct composite resin restorations of the anterior single tooth: Clinical implications and practical applications. Compendium 1996: 17: 796-802.

J Christensen. To base or not to base. J Amer Dent Assoc 1991:122:61-62.

GJ Christensen. Pulp capping 1998. J Amer Dent Assoc 1998a: 129: 1297-1299.

RJ Gruythuyzen, KL Weerheijm, JW Hagen. Calcium hydroxide pulpotomy with light-cured cavity sealing after two years. Int Dent J 1995: 45: 313.

J A Jodaikin, JC Austin, PE Cleaton-Jones. Pulpal responses to amalgam restorations in cavities with and without layer removal. J Oral Oathol 1986:15:415-418.

RW Phillips. Glass ionomers: boosting amalgam's value. J Amer Dent Assoc 1991: 122: 159-160..

J Rabchinsky, KJ Donly. A comparison of glass-ionomer cement and calcium hydroxide liners in amalgam restorations. Int J Period Restorat Dent 1993: 13: 378-383.

Optimized Radiopacity

HBM Akerboom, CM Kreulen, WE Van Amerongen, A Mol. Radiopacity of posterior composite resins, composite resin luting cements, and glass ionomer lining cement. J. Prosthet Dent 1993: 70: 351-355.

-18-

3M™ VITREBOND™ LINER/BASE

I Espelid, AB Tveit, RL Erickson, SC Keck, EA Glasspoole. Radiopacity of posterior composite restorations and radiographic detection of secundary caries. J Dent Res 1987: 66: 210.

PM Shah, SK Sidhu, BS Chong, TR Pitt Ford. Radiopacity of resin-modified glass ionomer liners and bases. J Prosthet Dent 1997:77: 239-242.

L Skartveit, A Halse. Radiopacity of glass ionomer materials. J Oral Rehab 1996: 23: 1-4.

AB Tveit, I Espelid. Radiographic diagnosis of caries and marginal defects in connection with radiopaque composite fillings. Dent Mater 1986: 2: 159-162.

Fluoride release

Bilgin Z; Ozalp N. Fluoride release from three different types of glass ionomer cements after exposure to NaF solution and APF gel. J Clin Pediatr Dent 1998: 22: 237-241.

RW Billington, JA Williams. Effect of "neutral" sodium fluoride on glass-ionomers in vitro. J Dent Res 1987: 66: 844.

JO Burgess, N Barghi, DCN Chan, T Hummert. A comparative study of three glass ionomer base materials. Amer J. Dent 1993a: 6: 137-141.

SM Chadwick, PH Gordon. An investigation to estimate the fluoride uptake adjacent to a fluoride-releasing bonding agent. Brit J Orthod 1995b: 22: 113-122.

P Dionysopoulos, N Kotsanos, Y Papadogianis. Secondary caries formation in vitro around glass-ionomer-lined amalgam and composite restorations. J Oral Rehab 1996: 23: 511-519.

KJ Donly, C Ingram. An in vitro caries inhibition of photopolymerized glass ionomer liners. ASDC J Dent Child 1997: 64: 128-130.

H Forss. Release of fluoride and other elements from light-cured glass ionomers in neutral and acidic conditions. J. Dent Res 1993: 72: 1257-1262.

L Forsten. Short-and long-term fluoride release from glass ionomer based liners. Scand J Dent Res 1991: 99: 340-342.

F Griffin, KJ Donly, R Erickson. Caries inhbition by fluoride-releasing liners. Amer J Dent 1992: 5: 293-295.

S Hatibovic-Kofman, G Koch. Fluoride release from glass ionomer cement in vivo and in vitro. Swed Dent J 1991: 15: 253-258.

S Hatibovic-Kofman, G Koch, J Ekstrand. Glass ionomer as a rechargeable fluoride-release system. Int J Paediatr Dent 1997: 7: 65-73.

P Hörsted-Bindslev, MJ Larsen. Release of fluoride from light cured lining materials. Scand J Dent Res 1991: 99: 86-88.

P Hörsted-Bindslev. Fluoride release from alternative restorative materials. J Dent 1994: 22: S17-S20.

ME Jensen, F Garcia-Godoy, JS Wefel. Artificial root caries in amalgam restorations: Effect of light-cured fluoride releasing liners. Amer J Dent 1990: 3: 295-298.

G Koch, S Hatibovic-Kofman. Glass ionomer cements as a fluoride release system in vivo. Swed Dent J 1990: 14 :267-273.

3M™ VITREBOND™ LINER/BASE

AJ Kuhn, MP Jones. A model for the dissolution of fluoride from dental cements. Biomat Med Dev Artif Organs 1982: 10: 281-286.

A Lin, NS McIntyre, RD Davidson. Studies on the adhesion of the glass-ionomer cements to dentin. J. Dent Res 1992: 71: 1836-1841.

JP Loyola-Rodriguez, F Garcia-Godoy, R Lindquist. Growth inhibition of glass ionomer cements on mutans streptococci. Pediatr Dentr 1994: 16: 346-349.

JW McCourt, RL Cooley, AM Huddleston. Fluoride release from fluoride-containing liners/bases. Quint Int 1990: 21: 41-45.

SB Mitra. In vitro fluoride release from a light-cured glass-ionomer liner/base. J Dent Res 1991b: 70: 75-78.

Y Momoi, JF McCabe. Fluoride release from light-activated glass ionomer restorative cements. Dent Mater 1993: 9: 151-154.

M Mukai, M Ikeda,T Yanagihara, K Kato, H Nakagaki, C Robinson. Fluoride uptake in human dentine from glass-ionomer cement in vivo. Arch Oral Biol 1993: 38: 1093-1098.

D Novickas, VL Fiocca, R Grajower. Linings and caries in retrieved. Operat Dent 1989: 14: 33-39

JC Pereira, AP Manfio, EB Franco, ES Lopes. Clinical evaluation of Dycal under amalgam restorations. Amer J Dent 1990: 3: 67-70.

C Prati, F Fava, D Di Giola, M Selighini, DH Pashley. Antibacterial effectiveness of dentin bonding systems. Dent Amer 1993: 9: 338-343.

J Rabchinsky, KJ Donly. A comparison of glass-ionomer cement and calcium hydroxide liners in amalgam restorations. Int J Period Restorat Dent 1993: 13: 378-383.

S Strickland, DH Retief, CM Russell. Shear bond strengths to dentin and fluoride release from fluoride-containing liners. Amer J Dent 1990: 3: 259-263.

K Takahashi, CG Emilson, D Birkhed. Fluoride release in vitro from various glass ionomer cements and resin composites after exposure to NaF solutions. Dent Mater 1994: 9: 350-354.

H Ulukapi, Y Benderli, M Soyman. Determination of fluoride release from light-cured glass-ionomers and a fluoridated composite resin from the viewpoint of curing time. J Oral Rehab 1996: 23: 197-201.

AWG Walls. Glass polyalkenaote cements: a review. J Dent 1986: 14: 231-246.

Antimicrobial avtivity

Benderli Y; Ulikapi H; Balkanli O; Kulekci G. In vitro plaque formation on some dental filling materials. J Oral Rehabil 1997: 24: 80-83.

BS Chong, ID Owadally, TR Pitt Ford, RF Wilson. Antibacterial activity of potential retrograde root filling materials. Endod Dent Traumatol 1994a: 10: 66-70.

EJ De Schepper, MR Thrasher, BA Thurmond. Antibacterial effects of light-cured liners. Amer J Dent 1989: 2: 74-76.

S Hatibovic-Kofman, G Koch. Fluoride release from glass ionomer cement in vivo and in vitro. Swed Dent J 1991: 15: 253-258.

3M™ VITREBOND™ LINER/BASE

G Koch, S Hatibovic-Kofman. Glass ionomer cements as a fluoride release system in vivo. Swed Dent J 1990: 14 :267-273.

JP Loyola-Rodriguez, F Garcia-Godoy, R Lindquist. Growth inhibition of glass ionomer cements on mutans streptococci. Pediatr Dentr 1994: 16: 346-349.

CJ Palenik, MJ Behnen, JC Setcos, CH Miller. Inhibition of microbial adherence and growth by various glass ionomers in vitro. Dent Mater 1992 :8: 16-20

C Prati, F Fava, D Di Giola, M Selighini, DH Pashley. Antibacterial effectiveness of dentin bonding systems. Dent Amer 1993: 9: 338-343.

CE Shelburne, RM Gleason, SB Mitra. Measurement of microbial growth inhibition and adherence by glass ionomers. J Dent Res 1997: vol 76; abstract 211

W Scherer, N Lippman, J , J LoPresti. Antimicrobial properties of VLC liners. J Esthet Dent 1990: 2: 31-32.

Clinical Performance

R Baillod, I Krejci, F Lutz. "Adhäsive Frontzahnrestorationen" unter Dentinadhäsivanwendung mit und ohne Unterfüllung. Schweiz Monatschr Zahnmed 1994: 104: 290-296.

EK Hansen. Dentin hypersensitivity treated with a fluoride-containing varnish or a light-cured glass ionomer liner. Scand J Dent Res 1992: 100: 305-309.

I Krejci , A Güntert, F Lutz. Scanning electron microscopic and clinical examination of composite resin inlays/onlays up to 12 months in situ. Quint Int 1994: 25: 403-409.

LV Powell, GE Gordon, GH Johnson. Sensitivity restored of Class V abrasion/erosion lesions. J Amer Dent Assoc 1990: 121: 694-694.

LV Powell, GE Gordon, GH Johnson. Clinical Evaluation of Class 5 Abrasion/Erosion Restorations. J Dent Res 1992: vol. 72: 705, abstract 1514