3M ™ VITREBOND ™ LINER/BASE

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Product description

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.

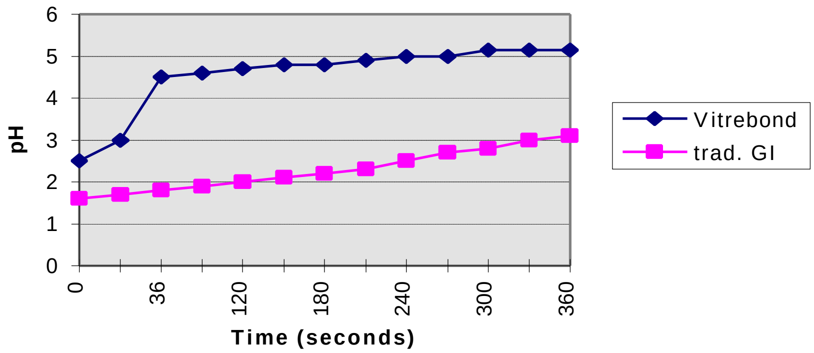
The setting process is a stepwise reaction. In step 1 the polycarboxylic acid ionizes in water in presence of the glass to form a negatively charged carboxylate polymer and protons. In step 2 the protons attack the glass causing it to release positive ions as Ca^{2+}, Al^{3+}, AlF^{2+} and AlF_2^{+}. 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.

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.

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

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 (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.

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.

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).

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