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Liners, Bases and Varnishes: A Review

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***Abstract*---**One of the most controversial areas of restorative dentistry is the subject of liners, varnishes and bases. Currently, there is no single protocol, with respect to the use of liners, varnishes and bases, for clinicians to follow. This article is an in-depth literature review that discusses the use of liners, varnishes and bases and the types of materials that are available to the restorative dentist. The new emerging concept of minimally invasive dentistry will require new restorative techniques. These changes will require the clinician to revaluate their use of liners, varnishes and bases. Other clinical considerations and findings from recent research are discussed.

***Keywords*---**affected dentine, bases, infected dentine, liners, review, technique, varnishes.

Introduction

Liner is a material that is applied in a thin layer on the floor and the walls of a cavity. The function of a cavity liner is to maintain adhesion at the tooth restoration interface and sealing the dentine from an influx of microorganism and irritants resulting from restorative procedures.[1] Varnish is a natural gum dissolved in an organic solvents such as acetone, chloroform or ether the purpose of placing a varnish is to seal the dentin attributes which will reduce the effect of microleakage. [1] Bases serve as a replacement or substitute for dentine that has been destroyed by caries or removed during cavity preparation. Bases can be shaped and contoured to a specific form.[2]

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Review of Literature

Vaikunt (2000)[3] conducted a study to evaluate the efficacy of fluoride varnishes as caries preventive agents. The author concluded that fluoride varnishes are a safe and efficacious way of delivering and retaining fluoride on tooth structure. In addition, they are effective in controlling caries progression by enhancing remineralization at the tooth surface and inhibiting demineralization.

Davidson C L (2009)[4] performed a study to describe the properties, advances and shortcomings of Glass ionomer cement as a restorative material. The author concluded that in contrast to resin bonding the adhesion of glass ionomer to tooth structure is not technique sensitive and its quality increases with time.

Gupta M, Pandit IK, Srivastava N et al (2010)[5] performed a study which was designed to compare 2% sodium fluorides iontophoresis with other cavity liners. The author found that 2% sodium NaF iontophoresis was more effective in reducing the postoperative sensitivity compared with that of varnish and scotch bond multipurpose

Paul j (2015)[6] conducted a study to review on proper selection of dental cements. The authors concluded that the clinician should give special consideration to the advantages and disadvantages of any dental cement and select them scientifically and of utmost importance adhere strictly to manufacturer's instructions

Varnishes

Varnish is a thin layer placed on the floor and walls of the preparations to seal the tubules and minimise microleakage. [1] Typical cavity varnish are principally natural gum such as copals or rosin or synthetic resin dissolved in an organic solvents such as acetone chloroform or ether they form a coating on the tooth by evaporation.

Types of fluoride varnishes

Several fluoride varnishes are available commercially

- Duraphat® [Woelm and Pharma, Eschwege, Germany] is a 5% sodium fluoride formulation in a viscous colophonium base. One millilitre of the varnish contains 50 mg of NaF (22.6 mg fluoride/ml). [2]
- Fluor Protector [Ivoclar/Vivadent, Schaan, Lichtenstein] contains 1% difluoro silane in a polyurethane base. Each millilitre of varnish contains 1 mg of fluoride ion (1,000 ppm). Fluor Protector has a lower pH than Duraphat and is supplied in a box containing 20 vials. Each vial contains 0.4 ml (0.4 mg F) of the varnish solution. Fluor Protector is less viscous than Duraphat or Duraflor. [2]
- Duraflor® [Medicom, Montreal, Canada] is similar to Duraphat in formulation and contains 5% sodium fluoride varnish in an alcoholic suspension of natural resins. The one additional ingredient in Duraflor (22.6 mg fl/ml) is the artificial sweetening agent xylitol which, as per

manufacturer, improves taste and patient acceptability. The varnish is less viscous in nature than Duraphat and is supplied in a 10 ml tube. [2]

- CavityShield™ (Omnii Products, West Palm Beach, FL) is the most recent entrant into the fluoride varnish market. It is a 5% sodium fluoride varnish in a resinous base. Each millilitre contains 50mg NaF. The difference between CavityShield and the other varnishes is that it is a unit-dosed fluoride varnish. Each individual package contains either 0.25 ml (12.5 mg NaF) or 0.40 ml (20 mg NaF) depending on the number of teeth to be treated. This offers several advantages: a) It avoids waste and therefore improves cost effectiveness; b) Each patient gets a controlled amount of fluoride and this prevents over-application; c) It reduces the chance of over-ingestion and prevents fluoride toxicity. Additionally, there is a tendency for the sodium fluoride in the varnishes to settle down due to the particulate nature of NaF. This may be significant because in the tubes (Duraflor, Duraphat) there is no way to assess the amount of fluoride each child is getting. The CavityShield varnish are supplied in individual pouches that are light resistant to avoid congealing of the varnish. [2]

Varnish application and technique

The frequency of varnish application is best determined based on individual caries risk. Several studies have evaluated the optimum frequency of application as it relates to disease control. The most often used regimen seems to be a semi-annual application.[7] In his review, Clark discussed the various application protocols along with percentage caries reduction seen with each application.[8] Three trends in application frequencies seem to appear:

- One application every six months. [7]
- One application four times a year.[9]
- Three application over a one-week period.[10]

It is important to stress that for fluoride varnishes to be effective, reapplication is necessary. How often this is done depends on the child's caries risk. A semi-annual application frequency, however, is the optimum frequency if any benefit is to be expected. [7]

Technique for application

One of the primary advantages of fluoride varnishes is their ease of application. There is considerable confusion as to whether a thorough prophylaxis is essential prior to varnish application. Seppa's study shows that plaque removal is not critical prior to varnish application. The author suggests that a time-consuming professional prophylaxis is not necessary and can be replaced with a toothbrush prophylaxis performed by the patients themselves.[11] This may be advantageous from a behavioural standpoint in young patients who are afraid of the handpiece. Most manufacturers, however, recommend a prophylaxis prior to varnish application, despite evidence to the contrary. The following sequence of steps can be followed to ensure proper varnish application: [11]

- Prophylaxis (toothbrush or professional).

- Isolate quadrant that is ready to receive the varnish using cotton rolls. Most commercially available varnishes set in the presence of moisture, so meticulous drying of the teeth is not critical.
- Dispense fluoride varnish as per manufacturer's instruction. Usually 0.5-1 ml is more than adequate for the entire dentition.
- Apply varnish on tooth surfaces using a disposable brush or cotton applicator . The entire surface of the tooth must be treated. Avoid getting varnish on the soft tissue. The varnish sets in a few seconds leaving a fluoride rich layer adjacent to the tooth surface.
- e) The entire process takes 3-4 minutes. Duraflor and Duraphat set to a yellowish-brown layer causing a temporary change in tooth color. Parents and patients should be instructed that this discoloration is temporary and will vanish once toothbrushing is commenced. Patients should avoid brushing their teeth for the rest of the day and to avoid eating for the next two hours. It is advisable to put the patients on a soft diet for the rest of the day.

Fluor Protector and CavityShield are meant for single one time use only. [11]

Ingestion and toxicity concerns

Fluoride varnishes are highly concentrated in their fluoride content. Three of the four commercially available fluoride varnishes have a fluoride content of 22.6 mg/ml (22,600 ppm of fluoride ion). So the potential for ingestion and toxicity does exist. In addition, overapplication is a common occurrence and one must be careful to apply just the required amount on the tooth surface. Varnish application must be carefully monitored until further data proves otherwise. In the state of Texas, its application is still limited to use by dental professionals only. [12]

However, in some states, paediatricians and nurse practitioners are prescribing it and advocating its use. Since patients are instructed not to brush their teeth for 24 hours, most of the varnish applied to the tooth surface is ingested and not expectorated. The probable toxic dose for a child weighing 20 kg is approximately 100 mg (potential toxic dose for fluoride – 5 mg/kg). If 0.5 ml is used in one fluoride application, the amount of fluoride ingested could amount to 11.30 mg, well below the toxic dose. Ekstrand et al., evaluated the plasma fluoride concentration and urinary fluoride excretion following application of Duraphat varnish. Their studies revealed that urinary fluoride concentration 12 hours after application was between 500- 1,100 µg F ion. These levels are well below the toxic dose.[12] Roberts and Longhurst evaluated 128 patients treated by 39 operators and found that the amount of varnish used was consistent between the providers and that none of the patients received a toxic fluoride dose.[13]

Bases and liners

Definition of base

Marzouk et al[14] defined cavity bases as insulating materials that can be used directly on certain areas of the dentinal parts of the preparation. Additionally,

they may also be used indirectly as supporting, retaining modes for sub-bases (liners). [14]

Definition of liners

The term liner is relatively a thin layer of material which is used to protect the pulp and dentin. It provides a barrier against remaining reactants diffused from restoration and / or oral fluids and may enter leaky tooth restoration interfaces. According to Marzouk et al[14] cavity liners is defined as film forming materials that carry therapeutic agents, which generate their larger film thickness (up to 25 μm) and frequently applied to dentine only. [14]

Requirements for liners and bases [25,26]

- They should be non-harmful, and it does not irritate to the pulp and other tissues. [25]
- It is not soluble in saliva and fluids taken into the mouth.
- It provides good mechanical properties which fulfil the requirements filling material to be packed on liner.
- Protect the pulp from pulpal reactions caused by different restorative material.
- Under a large metallic restoration cement is used to provide thermal insulation to the pulp e.g. amalgam [26]
- Liners and bases also provides chemical protection to prevent infiltration of hazardous chemicals from the dental material to the pulp.
- It provides electrical insulation under the metallic restoration to reduce the galvanism.
- Optical properties for cementation of a translucent restoration (for example, a porcelain crown) the optical properties of the cement should be parallel to those of tooth substance. [25]
- A cement should ideally be adhesive to enamel and dentin, and to gold alloys, porcelain and acrylics, but not to dental instruments.
- It should be bacteriostatic while inserted in a cavity with residual caries.
- Cements should have a minimum adverse effect on the pulp.
- For luting purposes, cements should have a low film thickness. [26]

Bases Under Amalgam

The use of bases under amalgam is a topic of considerable controversy. Previously, cavity bases were recommended under amalgam restorations placed in moderate (middle third of dentine) and deep cavities (close to the pulp).[15,16,17] However, their use is currently limited to deep cavities where a calcium hydroxide liner is placed.[18,19,20]

There is a common misconception that it is necessary to place a base beneath any metallic restoration to protect the pulp from thermal shock and pain. Little et al,[20] assessed the heat transfer through four lining materials (Kalzino, Vitrebond, Scotchbond 1, Dycal) and dentine and related their findings to the temperature exposures that may be experienced in the oral environment. They concluded that

only extreme temperatures applied for long times would be harmful to the pulp. As these are unlikely to occur in vivo, the insulating property of a cavity lining material is not of great significance and therefore, other criteria for selecting a base or a liner should be applied. [19,20]

Bases under composites

The practice of placing a base under resin composite restorations seems to be extrapolated from the principals of cavity preparation and pulp protection under amalgam restorations. There is scarce evidence available on the advantages of a base under resin-based composites, except in deep cavities. Chailert et al[21] compared the internal adaptation of composite restorations without lining using a two-step etch and rinse and a two-step self-etch adhesives to restorations with a RESIN MODIFIED GLASS IONOMER base. The study reported that composite restorations with no lining had the best internal adaptation, which did not depend on the type of adhesive. Peliz et al[22] reported that using adhesive agents alone provides superior internal adaptation at the dentin-restoration interface than does calcium hydroxide or resin modified glass ionomer. Dionysopoulos and Koliniotou-Koumpia[23] evaluated the interfacial microgaps between different materials (Dycal, Clearfil Tri-S Bond, Vitrebond) and dentin after polymerization of the composite restorations, using SEM. The results of their study showed that the microgaps between the bonding agent and dentine was significantly smaller than that observed between the Vitrebond-dentine and the Dycal-dentine. Azevedo et al[23]reported that the use of RESIN MODIFIED GLASS IONOMER lining does not affect the bond strength and gap formation at the lateral walls of a Class I type cavity. [22,23]

Types

Calcium hydroxide

Indication for use[25]

- Protects the pulp from chemical irritation by its sealing ability.
- Stimulates the production of reparative or secondary dentin.
- Compatible with all types of restorative materials.

Zinc oxide eugenol

The powder is composed of zinc oxide (70% by weight) with rosin added to reduce the brittleness of the set material. The eugenol is in the liquid portion, derived from oil of cloves (one of the 'essential oils'). The eugenol is bactericidal on its own, but is more potent when combined with zinc oxide.[25] The requirements for ZOE as a base are given in ISO 3107-2004 (Dentistry – Zinc oxide / eugenol and zinc oxide / non eugenol cements), under the category of Type 3. [25]

Zinc phosphate

Of all the materials discussed in this paper, zinc phosphate (also known as zinc oxyphosphate, ZOP) has been in use the longest. As with zinc oxide eugenol, it

has two components, a powder and a liquid. The powder contains zinc oxide (90%) and magnesium oxide (10%), and some products may have other chemicals added such as tannin fluoride (Shofu Corp, Osaka, Japan). The liquid is composed of phosphoric acid, aluminium phosphate (which acts as a buffering agent) and water. The water influences the rate of the acid base reaction and increasing the amount of water results in a reduction in both the compressive and tensile strengths and a longer setting time. [26]

Glass-ionomer

Composed of acid soluble calcium or strontium fluoroaluminosilcate glass and an aqueous solution of polyacrylic acid, conventional glass-ionomers (GI), which are governed by ISO 9917.1-2007 (Dentistry – Water based cements – Part 1: Powder/ liquid acid-base cements) have been available for about 40 years. To make these products radiopaque, some contain zinc oxide or barium glass.[26] After mixing powder and liquid, the acid etches the glass which results in a release of calcium, aluminium, sodium and fluoride ions into solution. This is an acid-base reaction where the water serves as the medium for the reaction. Set GI has a compressive strength similar to that of ZINC OXYPHOSPHATE, a tensile strength higher than ZINC OXYPHOSPHATE and a modulus of elasticity of about half of ZINC OXYPHOSPHATE.[26]

Resin-based materials

The final materials that can be used as either a liner or a base are those that are resin-based. These can be categorized in two different ways: either by filler content (unfilled or filled), or by how they are cured (either self-, light- or dual-cured) [26].

When resin-based products are used, manufacturers either include the bonding system in the package or recommend a separate purchase of one of their own. The bonding systems are usually composed of a primer (wetting agent) and / or a bonding agent (unfilled resin). From the perspective of a liner, the material that is first placed in the cavity preparation is most important to the clinician, as it is this material that will act as the liner. [26]

Conclusion

Cavity *Varnish*, *Base*, *liner* or Sealer are an integral part of Operative Dentistry which has the main goal of Preserving the health of Dental Pulp. Fluoride varnishes are a safe and efficacious way of delivering and retaining fluoride on tooth structure. In addition, they are effective in controlling caries progression by enhancing remineralization at the tooth surface and inhibiting demineralization. In this regard it is important to note that fluoride varnishes are most effective when used on early white spot lesions which have an intact surface layer. As can be seen from the above review, the materials science of liners and bases is not a finite area of study. It is an evolving situation that requires the clinician to stay alert of the constantly changing research.

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