منت خدای را عز وجل که طاعتش موجب قربت است و به شکر اندرش مزید نعمت، هر نفسی که فرو میرود ممد حیات است و چون بر می آ ید مفرح ذات. پس در هر نفسی دو نعمت موجود است، و بر هر نعمتی شکری واجب.

از دست و زبان که برآید
کز عهدهٔ شکرش بدر آید
بنده همان به که ز تقصیر خویش
عذر به درگاه خدا آورم

In the name of God

Shiraz University of Medical Sciences
School of Dental Medicine

Thesis For D.M.D DEGEREE

Bases and Liners in Operative Dentistry

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July : 1997

بسم الله الرحمن الرحیم

ارزیابی پایان نامه

پایان نامهٔ شمارهٔ تحت عنوان :مواد کف بندی در دندانپزشکی ترمیمی

تهیه شده توسط : مهین گندمکار در کمیتهٔ بررسی پایان نامه مطرح و

با نمرهٔ درجهٔ به تصویب رسید.

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Introduction

1-1)-Introduction:

A variety of cements have been used in dentistry through the years. In general, cements are employed for two primary purposes: to serve as a restorative filling material either alone or with other materials, and to retain restorations or appliances in a fixed position within the mouth. Certain other cements, however, are used for specialized purposes in the restorative, endodontic, orthodontic, periodontic, and surgical fields of dentistry.[6]

The zinc oxychloride cements were among the first dental cements to be used as filling materials during the middle 1850s. Other chemical combinations, described as magnesium oxychloride and zinc oxysulfate cement, also were employed in this early period, but all of these materials were found to be highly irritating to the pulp tissues and unsatisfactory as cementing media. They all exhibited a high degree of solubility in the mouth fluids and generally did not withstand the oral environment. In 1878 the zinc phosphate cement was introduced to overcome some of the objections just mentioned. This cements proved to be much more acceptable and elicited a more favorable response from members of the profession than did its predecessors.

Restoration in which the zinc phosphate and earlier cements were used displayed poor esthetic qualities because of the opacity common to the zinc oxide-containing materials. A search for a filling cement material that had a more pleasing appearance led to the introduction of the translucent cements, or silicates, at about the same time that the zinc phosphate cements were introduced. Although the translucent cements introduced by Fletcher in England in about 1871 did not become popular, the widespread use of the translucent silicates began with the improved German products about 1904. Although silicates have been classed as cements, because of their applications [8].

When the properties of the dental cements are compared with those other restorative materials such as amalgam, gold, or porcelain, the cements exhibit less favorable strength, solubility, and resistance to the conditions within the oral cavity [6]. Although, the esthetic properties of the silicates led to their widespread use as a restorative material for anterior teeth, the general use of cements for restorations exposed to the oral environment is quit limited [8].

The zinc phosphate and zinc oxide-eugenol (ZOE) types can be applied as a based in deep cavities to insulate the pulp from possible chemical and thermal trauma. A metallic, porcelain, or resin filling material then may be placed over such a cement base in sufficient bulk and in proper adaptation to the cavity walls to from the final restoration. The sedative nature of the ZOE mixtures has made them valuable for a variety of applications. The ability of the glass ionomer cements to release fluoride and to bond chemically to tooth structure has resulted in their uses as bases and for cementation of orthodontic bands [6]. The American Dental Association specifications for the various cements further classify certain of the cement as Type I and Type II on the basis of their properties, and thus their intended use.

The cement (G.I) is translucent and thus it is used for restoration of anterior teeth (Type II). Glass ionomer cement, as polycarboxylate cement, has some potential for adhesion to tooth structure and is kind to the pulp. Because of their adhesive properties, the glass ionomer cements are employed for restoration of eroded gingival areas without use of a cavity preparation for retention. There is a Type I glass ionomer cement that it used for cementation of cast metal and porcelain restorations. The cement also has been advocated as a pit and fissure sealant. Because the cement is relatively kind to the pulp it is applicable for use as a thermal insulating base beneath other types of restorations[24].

The resin cements are used for retention of orthodontic brackets and resin-bonded bridges because of their strength and bonding to acid-etched enamel [6].

zinc silicophosphate cement are available in Type I & II. They are somewhat translucent. Therefore, from an esthetic standpoint they have been particularly applicable for the cementation of the porcelain restorations, i.e., jacket crowns.

Type I zinc phosphate cement is a "fine grain" cement (small particle size intended for cementation of precision fitting castings). The Type II zinc phosphate cement is a "medium grain" cement and is recommended for all other uses, i.e., thermal insulating bases and cementation of orthodontic bands. As would be expected, certain requirements, e.g., film thickness are more stringent for the Type I cement than for the Type II.

Copper, silver and mercury salts are sometimes added to the cements to render them bacteriostatic or bactericidal. Copper oxide may also be used in place of zinc oxide for this reason. The effectiveness of such antibacterial agents in preventing dental caries, including such cements, is controversial.

Furthermore, they are more irritating to the pulp than other cements. For this reason they are rarely used today, and are generally confined to non-vital teeth or on rare occasions to the cementation of orthodontic appliances.

When the prepared cavity approaches the pulp, a cement base is employed to protect the pulp against mechanical and thermal trauma. Any of the cements can be used for this purpose except the silicate, resin, and copper cements, all of which are considered to be too irritating.

The polycarboxylate cements are a relatively recent innovation in this field. There is evidence that this type of cement develops a certain amount of adhesion to tooth structure. Such cement are used primarily as luting agents for cast restorations. Because of this adhesive characteristics, they are also employed to a certain extent for the direct bonding of orthodontic brackets, thereby eliminating the need for banding the teeth. Since their biological characteristics of comparable to zinc oxide-eugenol cement, they are also frequently used as a base material.

The silicate cements are used almost exclusively as permanent restoration materials. They possess reasonably good esthetic properties when they are first inserted in the tooth. Unfortunately, they gradually disintegrate in the oral fluids, and they may stain and craze. Thus, they should not be called permanent in comparison with the metallic filling materials, for example. Since the introduction of composite resin systems, the popularity of silicate cement has steadily declined. [24]

1-1-1)-**Classification of dental cements**

Dental cements are generally classified according to their composition, as presented in Table(1-1).

Table (1-1) Classification and use of dental cements

Cement	Principle uses	Secondary uses
Zinc phosphate	*Luting agent for restotation and orthodontic application*	*Intermediate restorations Thermal insulating base Root canal restoration*
Zinc phosphate with silver or copper salts	*Intermediate restorations*	
Copper phosphate	*Intermediate restorations*	
Zinc oxide-eugenol	*Temporary and Intermediate restorations Temporary and permanent luting agent for restorationThermal insulating base Pulp capping agent*	*Root canal restoration periodontic bandage*
Polycarboxylate	*Luting agent for restoration Thermal insulating base*	*Luting agent for orthodontic applications Intermediate restorations*
Silicate	*Anterior restorations*	
Silicophosphate	*Luting agent for restoration*	*Luting agent for orthodontic applications Intermediate restorations*
Glass ionomer	*Coating for eroded areas Luting agent for restoration*	*Pit and fissure sealant Anterior restorations Thermal insulating base*
Resin	*Luting agent for restoration*	*Temporary restorations*
Calcium hydroxide	*Thermal insulating base Pulp capping agent*	

Although, certain cements for special purposes consist of one or two pastes, dental cements are most frequently formed by mixing a powder with a liquid. The liquids of these cements fall into four general classes: modified phosphoric acid, a chelating agent, of which eugenol is the most widely used, polyacrylic and other polycarboxylic acids, and the monomers used in the resin cements. In the first instance particles are attacked by the acid liquid, dissolving the surface to form either a crystalline or a gel-like matrix that binds together the excess unreacted powders into a mass. The cements that use phosphoric acid liquids are the zinc phosphate, zinc silicate, zinc silicophosphate materials.

The resulting cement masses are acid in nature, and their pH values increase as they progress through the stages of the setting reactions. On the other hand, the zinc oxide cement powder that use eugenol as the liquid are essentially neutral in pH. The pH of polyacrylic acid in water is 1.5. When the acid is mixed with zinc oxide, the pH rises rapidly to 6.5, and a freshly mixed cement would have a pH about 4.0. The extremes in pH, for example, from the initial reading of just above 3 for a freshly mixed silicophosphate to a pH value of 7 to 8 for the ZOE cement, demand a variation in the clinical procedures necessary to protect the adjacent dentin and, in turn, the underlying pulpal tissue.

The pH of the various cements at the time they are initially introduced into the prepared cavity should decidedly influence the necessity for use of a cavity varnish or liner that will retard the penetration of acid. [6]

Many restorative dental materials that provide excellent properties for the bulk of a dental restoration may not protect the dental pulp during setting or during cyclic thermal or mechanical stressing. **pulpal protection** requires consideration of **(1)** chemical protection, **(2)** electrical protection, **(3)** thermal protection, **(4)** pulpal medication, and **(5)** mechanical protection. These concerns become more important as the cavity preparation extends closer to the pulp. **liners** and **bases** are materials placed between dentin and the restoration to provide pulpal protection. Protective needs for a restoration vary depending upon the extent and location of the preparation as well as the restorative material to be used. The characteristics of the liner or base selected are largely determined by the purposes it is excepted to serve. Because they share similar objectives, liners and bases are not fully distinguishable in all cases, but some generalizations can be made. [3]

1-1-2)-Terminology:

Liners are relatively thin layers of material used primarily to provide a barrier to protect the dentin from residual reactants diffusing out of a restoration and/or oral fluids which may penetrate leaky tooth-restoration interfaces. They also contribute initial electrical insulation, generate some thermal protection, and, in some formulations, provide pulpal treatment as well. The need for liners is greatest with metallic restorations that are not well-bonded to tooth structure and which are not insulating, such as amalgam and cast gold, or with other indirect restorations. Direct composite restorations, indirect composite or ceramic restorations, and resin-modified glass ionomer restorations routinely are bonded to tooth structure. The insulating nature of these tooth-colored materials and the sealing effects of the bonding agents preclude the need for traditional liners and bases unless the cavity preparation is extremely close to the pulp and pulpal medication becomes a concern. Thin film liners (1 to 50 μm)can be divided into **solution liners** (varnishes, 2 to 5 μm) and **suspension liners** (typically 20 to 25 μm). Thicker liners(200 to 1000 μm=0.2 to 1 mm.), selected primarily for pulpal medication and thermal protection, are sometimes identified as **cement liners**. Examples of liner materials are varnish-type materials to which calciumhydroxide or zinc oxide powder is added. [3,20]

Bases (cement bases, typically 1 to 2 mm), are used to provide thermal protection for the pulp and to supplement mechanical support for the restoration across the underlying dentin surface. This mechanical support provides resistance against disruption of thin dentin over the pulp during amalgam condensation procedures or cementation procedures of indirect restorations. Metallic restorations should seat on sound dentin peripheral to the lined and/or based regions that result from excavating infected dentin. Examples of These materials are zinc-oxide eugenol, zinc phosphate, polycarboxylate, and glass ionomer cements and some of the commercial preparation containing calcium hydroxide. various liners and bases may be combined in a single preparation, and the total cavity preparation based may be described as the combination 0f natural dentin, liner, and base.

1-1-3)-Objectives of pulpal protection:

Normal coronal dentin includes dentinal tubules that contain cellular extensions (odontoblastic processes) of the cells (odontoblasts) which originally laid down dentin during dentinogenesis. These columnar cells remain as a layer along the periphery of the dental pulp partially embedded in poorly mineralized dentin (pre-dentin), and with processes extending outward into dentinal tubules. The process are surrounded by dentinal fluid when they do not contact the walls of the tubules. In response to mild, long-term chemical or mechanical insults, the processes slowly recede toward the pulp while occluding the tubules with peritubular dentin by depositing hydroxyapatite crystals. If the insult is strong and/or near to the pulp, the processes are retracted more rapidly from that region and a thin local bridge of hydroxyapatite is created across the affected tubules. Both of these are natural defense mechanisms to insulate the pulp from chemical, thermal, mechanical, or biological challenges. If the insult produces conditions allowing fluid flow in or out of the dentinal tubules, The pressure change is sensed by mechanoreceptors within the pulp, and the patient experiences sensitivity. If leakage of chemical irritants from dental materials or bacteria occurs, then the pulp complex an become inflamed. To protect against these events, it is paramount to seal the outer ends of the tubules along the dentinal cavity preparation wall.

Cavity preparation with rotary instruments generates cutting debris, some of which is compacted unavoidably into a layer on the cut surface. That layer of material is called a **smear layer** and is typical of any cut surface, dental or otherwise.

The dentin smear layer produces some degree of dentinal tubule sealing, although it is 25% to 30% porous. Flow or microleakage in or out of tubules is proportional to the fourth power of the diameter of the opening.

Halving the diameter of the opening produces a 16 fold reduction in flow. Therefore, the smear layer is a very effective barrier. However, because it is partially porous, it can not prevent slow long-term diffusion. Therefore, for dental amalgam restorations which can leak along their enamel margins, the smear layer should be sealed with an overlying layer of a **liner**. This produces chemical protection. To produce a very thin film liner, liner ingredients are dissolved in a volatile nonaqueous solvent. The solution is applied to tooth structure and dries to generate a thin film. Any liner based on nonaqueose solvent evaporation for hardening is designated as a solution liner (or varnish). Liner based on water have many of the constituents suspended instead of dissolved and are called suspension liners. Liners that are intended to provide thermal protection as well need to be thicker in dimension. In addition to thermal protection, liners are formulated to provide pulpal medication whenever possible. Two important aspects of pulpal medication are the relief of pulpal inflammation and facilitation of dentinal bridging for physiological protection. The materials which are most commonly used to provide these two functions are not compatible and cannot be used in the some formulation. [3]

Chapter 2

Cement based on organometallic chelate compounds