MEDICINE

CEMENT SELECTION IN DENTAL PRACTICE

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ABSTRACT

The cementation procedure is considered to be the most important stage of fixed prosthodontics, while the correct selection of cement is the guarantee of successful restoration which is conditioned by the its durability. Over the recent years, numerous cementing substances have been introduced to the dental practice that differ greatly from conventional cements with their properties and application methods and that is why even experienced dentists often have certain difficulties in the variety of cements to choose the one that is right for each clinical case. The selection of cement depends on a number of factors, such as the type of resorption substance, the shape of prepared tooth, the possibility to isolate the area, subject to cementation in the oral cavity as well as the patient's aesthetic requirements. Thus, the objective of the article is to analyze currently used dental cements in order to help the dentists make the right selection of cement for different clinical cases.

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Introduction. Currently, indirect restoration is frequently applied to reconstruct affected teeth. These are attatched to the teeth with the help of cement which is poured into the gap between the restoration and prepared tooth in order to prevent the restoration displacement [1]. Thus, successful outcome is conditioned by the right choice of dental cement to ensure sufficient retention and durability. Moreover, some cement types might have yet unexplored properties, disclosure of which may have positive impact on clinical success [2]. It should be mentioned, that the new category of cement (hybrid bioactive cement) contains a large amount of calcium, has base pH and cause surface apatite thence having an immediate influence on the vital tissue, promoting regeneration and convalescence [3-9].

There are two groups of cement: temporary and permanent. Permanents are zinc phosphate cement, zinc polycarboxylate cement, conventional glass-ionomer cement, resin-modified glass-ionomer cement and resin cement. Taking into consideration the fact that every cement has its peculiarities and none of them is perfect, the doctor should be able to choose specific type of cement for each particular case, this being the objective of the review.

Required cement properties. At present, the search for perfect cement which will maintain and protect the tooth tissues, have high resistance to tension and pressure, provide lasting bond between the tooth tissues and substances of fixed constructions as well as will prevent tooth decay on the cement contact surface still persists. The matter should be biologically compatible with pulp, endowed with antimicrobial activity, ensure edge impermeability and provide a layer of minimal thickness; it should be easy to use, poorly soluble, transparent and radiopaque, have optimal working and curing duration. Besides, this type of cement should manifest high resistance to breakage, optimal wettability (low angle of wetting), sufficient viscosity for complete distribution and esthetic properties when applied together with restoration substance. Removal of excess cement should be as effortless as possible [10-12].

Temporary cements. Temporary cement can be calcium hydroxide or zinc oxide based. Zinc oxide eugenol cement slows down polymerization of resin cement, as well as makes a thick layer due to which its application is currently restricted [13, 14]. Some researches reveal the bond strength decrease in resin cement while using eugenol containing temporal cement [15-17]. Thus, eugenol-free temporary cement is preferable before the application of resin cement [18]. According to the recent researches, bond strength of some self-adhesive cements doesn't change when temporary cement is previously applied [19, 20].

Permanent cements.

Zinc Phosphate cement.

Liquid of zinc phosphate cement contains phosphoric acid, water and buffers, while powder consists of zinc and magnesium oxides [21]. Exothermic reaction occurs as a result of kneading powder with liquid, so glass slab is used to neutralize shut off temperature. Zinc phosphate cement is highly resistant to pressure and has sufficient working time. Shortcomings of this water-based substance is its high solubility in oral liquid (0.36%), low rigidity, low resistance to tension, high risk of hypersensitivity due to low initial pH, as well as absence of anti-cariogenic effect. During the cementation its pH constitutes 2.0 (pH of fully cured cement is 4.5 -5.0) which can lead to pulp irritation due to phosphoric acid impact. Despite low initial pH, the irritation of the pulp wasn't confirmed by some researches. The irritating effect of zinc phosphate cement might be conditioned by the presence of bacteria on the surface of prepared tooth. Nevertheless, hypersensitivity might occur in case of small residual dentin thickness both in the process of cementation and afterwards.

Zinc Polycarboxylate Cement

The liquid of zinc polycarboxylate cement contains 40% of polyacrylic acid, while powder consists of zinc and magnesium oxides as well as stannous fluoride. Due to polyacrylic acid interaction with the calcium of enamel and dentine, chemical bond is created with hard tissues of tooth [17]. The strength of chemical bond is higher in enamel that in dentine owing to higher content of calcium in enamel [22]. Zinc polycarboxylate cement is more soluble that zinc phosphate one and its excess is difficult to remove. After curing, zinc polycarboxylate cement can be subjected to considerable plastic deformation under dynamic loading [23]. Accordingly, it is used to fix crowns and small fixed partial dentures. The major advantage of this cement is its high biocompatibility, attributed to the big size of polyacrylic acid molecule, which doesn't allow it to penetrate dentine canals [24]. Due to this property, it's used as a temporary cement to prevent hypersensitivity after cementation in case of small residual dentine thickness.

Conventional glass-ionomer cement.

The powder of this cement contains aluminosilicates and a large amount of fluoride, while the liquid contains polyacrylic and tartaric acids. In the process of cement kneading polyacrylic acid interacts with the outer layer of particles releasing calcium, aluminum and fluoride ions. Hardening time is 24 hours. The cement is endowed with moderate compressive strength and low tensile strength. The physical properties of conventional glass-ionomer cement are extremally mutable and are conditioned by power-liquid ratio [25]. The benefits of this type of cement are long-term excretion of fluorine, that promotes tooth decay prevention. The bond between conventional glass-ionomer cement and dentine decreases significantly in case the latter gets overdried which also results in hypersensitivity after cementation [26]. Thus, before the cementation, wet dentine surface can be dried up with cotton wool. The hypersensitivity to humidity is the drawback of this cement. Early exposure to saliva or water increases considerably the solubility of cement and decreases the ultimate rigidity [27], thus while working with this cement the margins should be protected with a coating agent or petroleum jelly [28]. This substance is widely used to fix cast crowns and fixed partial dentures, metal-ceramic crowns and fixed partial dentures, zirconium dioxide-based restorations, metal posts, metal inlays as well as implant-supported crowns and fixed partial dentures.

Resin-modified glass-ionomer cement

This cement combines some properties of glass-ionomer cement (fluoride release and chemical adhesion) with high rigidity and low solubility of resin cement [29,30]. These cements own higher adhesion to the tooth hard tissues, higher compressive/tensile strength, low solubility, than conventional glass-ionomer types of cements. They are stable to marginal leakage [31]. The process of cement curing occurs in dual mechanism i.e. acid-base reaction and polymerization. On kneading powder and liquid acid-base reaction takes place, while polymerization is stimulated by the light or enough free radicals [32, 33]. Resin-modified glass-ionomer cements are used to fix cast crowns and fixed partial dentures, metal-ceramic crowns and bridges, zirconium dioxide-based restorations, metal posts, metal inlays as well as implant-supported crowns and bridges. Light-curing type in applied to immobilize orthodontic brackets.

Resin cement

The basis of these types of cement is bisphenol-a-glycidyl methacrylate (Bis-GMA) resin and other methacrylates, and hardening takes place through polymerization. High compressive/tensile strength, low solubility and esthetics are the advantages of resin cement [34]. Yet, it also has shortcomings, such as technic sensitivity, difficulty in removing cement excess, discoloration in the process of hardening and darkens in course of time [35].

According to one of the researches, the retention of adhesive composite cement for 24^0 taper prepared teeth was by 20% more than in conventional cements (zinc-phosphate, glass-ionomer) for 6^0 taper prepared teeth [36]. Besides, glass-ceramic restoration can be stronger when fixed by resin cement, rather than by resin-modified glass-ionomer cement [37-40]. The bond strength of some resin cements with non-retentive preparation may exceed the rigidity of ceramic substance, however it cannot be consistently achieved [41]. Moreover, in case of inlay, onlay, short and over-tapered preparation resin cements provide higher bond strength, than resin-modified glass-ionomer cement [42]. Although, in good isolation resin cement bonds to dentine tighter than resin-modified glass-ionomer cement, still in case of dentine contamination with saliva or blood this bond strength is lower than that of resin-modified glass-ionomer cement, thus impossibility of adequate isolation is a contraindication to resin cement application [43]. Ferric sulfate or aluminum chloride-containing astringent is used to stop gum bleeding, though it leaves iron-containing precipitates, which hinder bonding and thereby phosphoric acid or ethylendiaminetetraacetic acid followed by water rinsing is applied to remove them [44].

Currently used resin cement layer thickness corresponds to the standards proposed by ISO [45]. Some resin cements contain ytterbium trifluoride or barium aluminum fluorosilicate filler, due to which fluorine is released after the hardening, thus these cements have cariostatic effects [46].

There are light-cured, self-cured and dual-cured types of resin cement [47]. The latter two are used in all kinds of cementation procedures, meanwhile light-cured cements are applied for ceramic venires and glass-ceramic restorations, the thickness of which doesn't exceed 1.5mm thus allowing the curing light to penetrate through ceramics. Compared to self-cured and dual-cured types of composite cement, light-cured resin is considered to be more color resistant and wearproof [48-53]. Without light-curing, dual-cured composite cement displays low bond strength and micro-hardening [54-56], so it's important to perform light-curing at the area of adjacent margin.

By the bonding mechanism resin cements are divided into total-etch, self-etch and self-adhesive subtypes [47]. The total-etch (etch-and-rise) systems have three main steps: 1. acid etching, rinse, gently dried; 2. bonding agents applied, cured; 3. resin cement applied, cured. For the self-etch systems, the acid etching and bonding steps are replaced with the self-etching bonding agent application, which combined the conditioner, primer, and adhesive [12]. Self-adhesive resin cements were suggested to make the work easier and are currently widely used [57]. These cements don't require preliminary preparation of the tooth and restoration surface and application of bonding substances before cementation [58-61], so they are less technically sensitive than conventional composite cements. According to some researches, conventional resin cements provide tighter bonding strength with dentine than self-adhesive ones [62,63], though other studies affirm the similar bonding strength [64,65]. New generation of self-adhesive resin cements binds directly to zirconium, not requiring application of any additional primers [66-72].

Adhesive cements require preliminary processing of restoration, subject to cementation [73]. Glass-based restorations (feldspathic porcelain, leucite-reinforced porcelain and lithium disilicate porcelains) are processed with hydrofluoric acid, rinsed with water and afterwards covered with pure silane and bonding substance [74]. Etching time is different, depending on restoration substance. It's 60 seconds for feldspathic porcelain, and 20 seconds for lithium disilicate porcelain. Metal, composite and oxide ceramic restorations are subjected to sandblasting, performed with 50μm 110μm grain-sized aluminum trioxide powder by 0.2MPa pressure, at the distance of 10-20mm for 13-20 seconds [75]. After the fitting, restorations should be rinsed with water, cleaned with phosphoric acid, acetone or alcohol, or universal cleaning pastes, available on sale, while cleaning strategy is a little different for zirconium base constructions [76, 77]. Conventional silanes are not applicable to zirconium, though there are zirconia primers, which provide tight bond with zirconium. Resin cements have more toothlike translucency and larger color choice similar to the tooth shades. Resin cements are used to fix all-metal restorations, all-ceramic restorations (onlay, inlay, crowns, bridges), zirconia-based restorations (new group of composite cements), indirect composite restorations, conventional metal-ceramic restorations, metal and fiber posts, implant-supported crowns and bridges.

Conclusions. The evolution of restorative dentistry has led to the introduction of various types of cement substances and the implementation of the newest cementation protocols. Wide manufacturing of adhesive restorations has resulted in greater application of adhesive cements, while some conventional cements do not have much use at present. Obviously, the choice of cement depends on the type of restoration, the material it is made of, and the shape of prepared tooth. Currently, awareness of the properties of widely used composite cements and possession of certain skills allow to achieve successful results in almost any clinical case.

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