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Review Article

Dental Cements Used in Everyday Fixed Prosthodontics - Part I

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Abstract

Dental cements are used in fixed prosthodontics primarily to fix or fasten the crowns, inlays, onlays, veneers or bridges to the abutment tooth and to protect the tooth structure from chemical, thermal and mechanical impacts. They can be divided according to the method of application to temporary and permanent cements and according to the degree of adhesion to dental tissues: non-adhesive (mechanical and classical cements), micromechanical and molecular adhesive cements. The paper discusses indication and manipulations with type of described cements used in everyday clinical practice.

Keywords: *Dental Cements; Fixed Prosthetics; Permanent Cements; Temporary Cements*

Introduction

Cements are used in fixed prosthetics primarily to fix the crowns, inlays, onlays, veneers or bridges to the abutment tooth and to protect the tooth structure from chemical, thermal and mechanical impacts. They can be divided according to the method of application to temporary and permanent cements and according to the degree of adhesion to dental tissues: non-adhesive (mechanical and classical cements), micromechanical and molecular adhesive cements.

Classical, conventional cements that are mechanically bonded to hard dental tissues, passively fill the gap between the fixed prosthetic appliance and the tooth, thus preventing fluid passage and bacterial infiltration from oral environment to the tooth surface. There is no chemical or physical interaction between the tooth and cement. The basis for adherence to the tooth surface is the design of the tooth preparation, which must ensure retention and resistance of the fixed prosthetic appliance [1].

Micromechanical bonding is based on the activation of the different contact surfaces (enamel and dentin with orthophosphoric acid, metals - with sandblasting, chemical and electrochemical corrosion, ceramics - with sandblasting or chemical corrosion with hydrofluoric acid). The goal is to increase the total contact area and to create microstructures that achieve mechanical retention between the tooth and fixed prosthetic appliance. Molecular adhesion is established between molecules of different materials.

Regarding the chemical composition, cements can be divided into: zinc phosphate, silicophosphate, zinc oxide eugenol, epoxybenzoic, polycarboxylate, glass ionomer and resin modified glass ionomer cements. The cements must meet biological, physical, mechanical and aesthetic requirements.

Ideal cement should preserve biological tissues and have a stable, impermeable bond with the tooth and the appliance material. It should not be toxic or cause allergic reactions and be biocompatible with the pulp tissue and provide protection against thermal, electrical, chemical and infectious influences. Preferably for cement is to possess antimicrobial, karyostatic and bacteriostatic properties. It must have high compressive and tensile strength, hardness, shear and wear resistance, be insoluble and resistant to micro cracks. The thermal expansion coefficient should be as similar as possible to the tooth structure. It should not contract during curing. It should have a low viscosity and be fluid. Once achieve bonded thickness of the cement layer should be between 10 - 40 μm. Equally important are the ease of manipulation and application. Working time and bonding should be long enough to allow the material to be placed in the appliance in the optimum consistency. Curing should not be too long and removal easy and simple. Aesthetic properties should be connected with the choice of proper color and acceptable optical characteristics of the cement material. From all the above, it can be concluded that there is no ideal cement for all clinical situations nowadays [2].

Zinc phosphate cement

Zinc phosphate cement was introduced into clinical practice from 1879 year. The connection of this cement between the tooth and the prosthetic appliance is mechanical. The basic element of retention and stabilization is the shape of the tooth abutment. They are commercially available as powder and liquid. The powder consists of 80 - 90% zinc oxide, 10% magnesium oxide which increases the compressive strength, and 10% silica, aluminum trioxide and calcium fluoride, which improve the quality of bonded cement and regulate color. The fluid consists of 52 - 56% phosphoric acid, 36% water that controls the degree of acid dissociation, and 2% of aluminum that fixes the cement. If there is more water in the liquid or the ambient temperature is higher, the bonding will be accelerated. Changing the powder to liquid ratio can change the bonding time, less mixed cement and slower mixing prolong the bonding time. The mixed material is simply placed in the appliance, the excess easily leaks out because it is pseudo plastic and under pressure changes the viscosity which allows the appliance to properly attached to the tooth. Once hardened it is easily removed. The compressive strength of the cured material is 70 MPa after 24 hours, the film thickness is 25 μm. It is not dimensionally stable as it expands in the humid environment and shrinks in the dry conditions, leading to the formation of a marginal crack. The cement is porous and soluble. It dissolves 0.1 - 0.3% in distilled water over 7 days and up to 30 times more in acidic medium. Increased incorporation of the powder during mixing reduces the solubility. Because of their sensitivity on moisture, it is necessary to prevent contamination during their mixing and insertion in the mouth while curing. Biologically they are potentially harmful for the pulp because their binding reaction is acetous. Acidity gradually decreases and after 24 hours the pH is 3.5 and after 7 days 6.9. Free phosphoric acid is pressed into the dentin tubules and can cause tooth sensitization. However, successful use over many years suggests that its action is clinically acceptable as long as precautionary measures are followed in its preparation and when the thickness of the remaining dentin layer is sufficient. The ability of any cement bonding is questionable if the tooth or appliance surfaces are contaminated with water, blood or saliva, therefore all surfaces must be thoroughly cleaned and dry before cementing procedure [3,4].

The appliance is cleaned with alcohol or acetone, and the tooth surface with a float and a rotating brush. It is flushed with water and disinfected with chlorhexidine. It can be coated with a protective varnish to reduce pulp irritation. The material is mixed on a glass plate with a metal spatula. At the manufacturer's recommendation, an optimal ratio of 1.5g of powder to 1g of fluid is required. To slow the binding and to insert the powder further into the liquid, it is necessary to cool the mixing tile. This process increases compression resistance, reduces solubility and the amount of residual acid. The powder is divided into 4 portions which are gradually added to the liquid. The first dose is stirred for 20 - 25 seconds and stretched over a wide surface of mixing tile. Each subsequent dose is stirred for 15 - 20 seconds. When mixing is complete, the consistency is checked by lifting the cement off the tile using a spatula. The cement has optimum consistency if it is stretched into a 20 mm thread. The mixed material is placed in a pure appliance, resting a cement spatula against the wall to allow the material to slip in and expel air. The tooth is air-dried, taking care not to over dry it, as this could jeopardize tooth vitality [5].

The appliance is placed on the tray and held with moderate pressure by the fingers so that the excess material expires smoothly. The edge of the fixed prosthetic appliance is checked for proper restraint, after which the patient bites. After complete curing, the excess cement is removed with a probe and interdental thread. It takes 24 hours for the cement to achieve complete bonding [5].

This type of cement is used for fixing metal and aesthetics metal base fixed prosthetic appliances. It can also be used for fully ceramic solid base appliances (aluminum and zirconia).

Zinc oxide eugenol cement

This cement is available as powder and liquid or two pastes. The powder consists of 70% zinc oxide, 1 - 5% magnesium oxide accelerator, zinc stearate, zinc propionate and succinate and 25 - 30% resins responsible for dimensional stability and sturdiness. The fluid consists of 85% eugenol and 15% oil, which affects the viscosity. The bonding is accomplished by a chemical reaction of the formation of zinc hydroxide which reacts with eugenol to form zinc eugenolate. Binding time is 2 - 10 minutes, the strength is only 1.4 - 21 MPa, the film thickness is greater than that of other cements, and the solubility is 1.5 - 2.5% in 24 hours. Due to unsatisfactory mechanical properties it is used as temporary cement. The acid-related biological properties are good since the pH varies from 6.6 - 8.0, but eugenol acts on the peritubular dentin and may cause irritation of the pulp. Cement residues, i.e. eugenol, act on synthetic materials and may interfere with the binding of definitive cements. Newer generations of temporary cements do not contain eugenol [6].

Zincoxide eugenol cement comes in two paste form in clinical use too. Depending on the size of the appliance, the appropriate amount of base and the same catalyst are mixed on a paper plate with a plastic spatula. Unbound cement is cleaned with solvent. Temporary cementation is most commonly used to determine satisfaction with the appearance of the appliance to the patient and the therapist and to check the functionality of the fixed prosthetic appliances over short time. In order to avoid the difficulties and complications that may occur due to difficult removal of the appliance, it is possible to apply petroleum jelly, only on the edges of the crown or bridge. The patient should be warned that this is temporary cementation and that regular controls are required. This type of cement is used for temporary fastening.

Ethoxybenzoic cement

This cement is commercially available in form of powder and liquid. The powder consists of 60 - 74% zinc oxide, 34% silica and aluminum trioxide and 6% resins. The liquid contains 50 - 60% ethoxybenzoic acid which contributes to higher compressive strength and 25 - 30% eugenol. The reaction product is zinc ethoxybenzoate. Binding time is 7 - 13 minutes, the strength of the cement bound 55-85 MPa, the thickness of the cement film is 40 - 70 μm. It is poorly soluble in water and significantly in organic acids and saliva. This type of cement is used for temporary fastening [7].

Polycarboxylate cement

Consists of powder and liquid. The powder contains 50 - 90% zinc oxide, 0 - 10% magnesium oxide, 10 - 40% aluminum trioxide and 0 - 2% zinc fluoride. The liquid consists of 40 - 50% polyacrylic or itaconic acid and 50 - 60% water. The chemical reaction products zinc polycarboxylate [8].

Working or manipulating time is short. Although very viscous when mixed, it forms a cement film of only 10 - 15 μm. Binding time is 5 - 8 minutes, solubility is 0.12% in 24 hours. It is subject to a contraction that is 4 times greater than zinc phosphate. It has also high compressive and tensile strength. It's ability to adhere via chemical bond to the tissues of the tooth is important. Polyacrylic acid, through carboxyl groups, produces hydrogen and ionic bonds with calcium apatite ions forming chelates. Ionic and hydrogen bonds of cement are forming with the organic component of dentin, i.e. collagen. The strength of the enamel bond is 4.4 - 8.5 Mpa, with comparison to dentin is significantly lower due to the lower calcium content. For application of this cement it is necessary to ensure a dry working field and to clean the tooth surface with 10% polyacrylic acid for 10 - 15 seconds, followed by rinsing and drying. Powder and liquid are dosed at a ratio of 1: 3 (1 dose of powder and 3 drops of liquid), stirred for 30 seconds. Working time is 3 minutes. The cement is placed into the appliance until the surface is glossy. The excess is removed after complete curing. Indications for use of this cement is to attach single crowns and smaller bridges with metal base [9].

Conclusion

Dental cements are the part of everyday procedure in surgeries nowadays all around the world. They are used mostly as the base for filling in restorative dentistry or as adhesive agents for different fixed prosthodontic appliances. Zinc phosphate cement although introduced into clinical practice from 1879. Year is still in use in fixed prosthodontics. Different clinical procedures demands different type of cement. Therefore, it is very important for the practitioner to follow the instructions for preparing and manipulating with them.

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