Annotation to the lesson № 17

**Topic:** Permanent fixation of dental prostheses

At the present stage of development of prosthetic dentistry, in the era of new technologies and the development of structural materials, orthopedic treatment with application of fixed constructions of dentures is a popular and promising direction. Functional efficiency of fixed dentures is largely determined by their proper fixation, so modern technologies of this direction are progressing in parallel with the development and improvement of fixation materials. **Materials for permanent fixation** of fixed dentures should meet a number of basic requirements:

- should not have adverse effects on the teeth pulp and oral soft tissues;
- should adhere to the teeth tissues and to the fixed prosthesis material (metals, ceramics, polymers);
- should not dissolve in oral fluid;
- should not shrink upon hardening;
- its thermal expansion coefficient should be close to thermal coefficient of dental hard tissues and of artificial crown materials;
- should stimulate dentin genesis.

Application of **modern dental prostheses** determines additional requirements for fixation materials: thixotropy, high compressive strength, ability to form a thin film of cement, should have adjustable adhesion, transparency, wide range of colors, ergonomics, prolonged working time.

Currently, there are **5 types** of materials for permanent fixation of prosthetic constructions which can be used by clinicians in everyday practice. These materials differ in chemical composition, physical and mechanical as well as clinical properties, have their advantages and disadvantages. Therefore, one of the practical approaches for the permanent fixation of fixed prostheses should be based on the peculiarities of physicochemical properties of cement upon its application in each particular case, taking into account clinical situations, types of dental prostheses and materials used for manufacturing of fixed prostheses.

The **first** type includes **zinc phosphate cements** which are represented by the powder/liquid system. Zinc phosphate cements' powder consists of zinc oxide and magnesium oxide, and liquid is represented by an aqueous solution of orthophosphate acid containing zinc, aluminum and magnesium phosphate. The main advantages of zinc phosphate cements are: mechanical adhesion, good flowability, ease of application. Disadvantages: can cause hypersensitivity of the pulp, lack of marginal stability, high solubility in oral fluid, dependency on mixing technique. Representatives: "Visfat" (Russia), "Unifas" (Russia), "Adhesor" (Czech Republic), "Kron-Fix" (Germany). Indications for use: fixation of fixed stamped-brazed dentures.
The **second** type includes **polycarboxylate cements**, which are also represented by the powder/liquid system. The main component of the powder fraction contains specially treated zinc oxide, which reacts with polyacrylic acid without residues.

The advantages of polycarboxylate cements are: chemical adhesion to dental tissues and metals, high tensile strength, good biocompatibility, low solubility, minimal cement film thickness. Disadvantages: low compressive strength, plastic deformation. Representatives: "Belokor" (Germany), "Adhesor Carbofine" (Czech Republic), "Cellfast" (France), "Carboco" (Germany).

Indications for use: fixation of single metal crowns and prosthetic bridges of small extent.

The **third** type is represented by traditional **glass ionomer cements**, which are attributed to genuine acid-base materials in which the base is represented by fluoro-aluminosilicate glass with high content of fluorine, which reacts with polyacrylic acid. The new generation of traditional glass ionomer cements - water-curable materials. In these cements, polyacrylic acid dried under certain conditions is a part of the powder interacting with distilled water.

Glass ionomer cements have the following advantages: biocompatibility, absence of irritating effect on the __ pulp, chemical adhesion to dentin and metals, thin fixing film, high anticaries activity due to the sustained release of fluoride. Disadvantages: slow hardening, susceptibility to moisture in the early stages of hardening. Representatives: "Ketac cem" (Germany), "Meron" (Germany), "Fuji I" (Japan); "Akvion" (Russia), "Aqua Meron" (Germany).

Indications: fixation of inlay cores, anchor pins, cast, metal-ceramic crowns and bridges.

The **fourth** type includes **polymer modified cements** (glass ionomer cements reinforced with polymers), as well as **compomer cements**. Polyacrylic acid, which is a part of polymer-modified cement, contains acrylate functional groups. By acid-base reaction these groups interact with glass powder with formation of polyacrylic salt. The material contains initiators, which start free radical polymerization leading to formation of polyacrylic salt covalent cross-links, which greatly strengthen the cement. **Compomers** are also glass ionomers supplemented with resins, but polyacrylic acid groups are formed in these cements through polymerization of crosslinks of acid-functional dimethacrylate monomer.

The advantages of polymer-modified glass ionomer cements and compomers in comparison with traditional cements are: lower susceptibility to moisture, lower solubility, higher mechanical strength, controllable hardening. Representatives of polymer-modified glass ionomer cements: "Relyx Luting" (Germany), "Calibra" (USA), "Fuji Plus" (Japan), "Fuji Cem" (Japan). Compomer cements that deserve attention are: "Dyract Cem" (Germany), "StarterKit" (USA), "Relief powder"
Indication for use: fixation of metal, metal-ceramic, metal composite crowns and bridges, as well as inlays, veneers made of composites, ceramics and other dental alloys.

The fifth type is represented by composite cements. The main components (phases) of composite materials are organic monomer and inorganic fillers. In addition, they include silanes, polymerization initiators, stabilizers, and colorants. Composites with chemical polymerization usually consist of two pastes, paste and liquid or liquid and powder. Within the polymerization process two components of the composite materials (catalytic paste (containing benzoyl peroxide) and accelerating main paste (containing tertiary amines)) react with each other leading to formation of free radicals that start the polymerization process. Composites with light polymerization have are represented by pastes with a uniform consistency, and their polymerization moment can be controlled. Substances used as polymerization initiators are photoactive substance camphorquinone and amine activator. Intensive camphorquinone breakage occurs under influence of light with a wavelength of 400-500 nm. The advantages of the composite fixing cements are: high levels of adhesion, strength characteristics, which can withstand significant occlusal loads, practically zero solubility in oral fluid, good aesthetic properties. Disadvantages: polymerization shrinkage, they do not release fluorine, risk of post-operative sensitivity. Representatives: RelyX U100 (Germany), Bifix (Germany), RelyX ARC (Germany).

Indication for use: fixation of dental bridges of a large extent, crowns with locking attachments for clasp dentures; crowns and bridges on implants; cementation of inlays, crowns and bridges made from ceramic, metals, composite materials; as well as for cementation of endodontic anchoring pins and fiberglass pins. Thus, the composite cements are a new and promising generation of fixation materials. It should be noted that these materials have a number of specific characteristics that distinguish them from other types of fixation materials and determine broad opportunities for their application in modern prosthetic dentistry. However, the experience of their use in the clinic of orthopedic dentistry is a little over 10 years, which leads to the need for further research in this area, as well as for new developments in this area in view of complete absence of domestic analogues.

Glass ionomer cements

Composition: the main components of glass ionomer cements are glass, polyacid, water and tartaric acid. Glass for glass ionomer cements contain three major components: silicon oxide (SiO₂), aluminum oxide (Al₂O₃), which are mixed with the flux of calcium fluoride (CaF₂).

The two main properties of glass ionomer cements, which ensured the possibility of their extensive use in clinical practice, are: their ability to form an adhesive bond with enamel and dentin (by hydrogen bonding with collagen and ionic
bonding with enamel and dentin apatite), as well as with metal casted constructions and all-ceramic dentures. Another equally important property of glass ionomer cements is the ability to release fluoride from the glass, which is a part of the cement.

Disadvantages of glass ionomer cements can be summarized in the following way: short working time; low strength and low toughness.

Field of application: for fixation of metal, metal-polymer, metal-ceramic and all-ceramic (with no fluorescent properties) fixed dentures.

**Glass ionomer cements modified with polymers**

Composition: components of glass ionomer cements with addition of hydroxyethyl methacrylate (HEMA). Addition of polymers to glass ionomer cements greatly improves many of their properties. Therefore, such well-known advantages of glass ionomer cements as the ability to form a bond with dentin and enamel, as well as fluoride release, are successfully combined with the extended working time, strength and insolubility of polymers. Introduction of this group of photoinitiators reduces hardening time after exposure to visible light to 30-40 sec.

Field of application: for fixation of metal, metal-polymer, metal-ceramic and all-ceramic (with no fluorescent properties) fixed dentures.

**Polymer (hybrid) cements**

Composition: polymer cements for fixation of fixed constructions of dentures are very similar to the composites for filling or restoration of teeth containing Bis-GMA, UDMA and glass filler. The only difference between them is that fixation materials are always represented by the "paste-paste" system of chemical or dual curing.

Mechanism of bonding of polymer cements with supporting teeth tissues and structural materials is based on micromechanical and/or chemical adhesion. Chemical bonding of polymer cements with hard tissues of supporting teeth is achieved by: enamel and dentin etching with hydrofluoric acid, treating of the tooth stump surface with enamel or dentine adhesives.

Chemical adhesion of polymer cements to all-ceramic constructions is provided by: etching of the inner surface of the ceramic construction with hydrofluoric acid; silanization of the etched surface followed by application of an adhesive.

To implement the chemical adhesion when fixing metal, metal-polymer and metal-ceramic prostheses, the inner surface of the crown should be pretreated with metal primer. The material of choice in this case is a chemically cured polymer cement based on modified monomers (does not contain Bis-GMA or UDMA).
Polymer fixation materials have all the advantages of glass ionomer cements modified with polymers in combination with the possibility of formation of a chemical adhesive bond with metal and ceramic frames.

Field of application: for fixation of metal, metal-polymer, metal-ceramic fixed dentures. When fixing all-ceramic constructions with fluorescent properties, polymer cements are the material of choice. Chemical affinity of polymer cements to metal and all-ceramic materials, as well as to hard dental tissues allows their use for the fixation of fixed constructions in complex clinical situations (low height of crown part of the supporting teeth).

**Temporary fixation of dentures**

Cements for temporary fixation are divided by chemical composition into eugenol-containing and eugenol-free cements, and by polymerization method - into materials of chemical and dual curing. Eugenol is a surface active oily substance, therefore, it is not recommended for use in combination with the permanent fixation on polymer cements.

Eugenol-free dual-cure cements have a number of positive qualities (compared to eugenol-containing and eugenol-free cements of chemical curing): good retention (possibility of long-term fixation); can be easily removed (economy of time); low solubility coupled with the release of fluorine and/or calcium (provide antibacterial action).

If after 2-4 weeks of wearing the denture the patient does not have any complaints, and if there are no violations of the denture construction and visible complications of prosthetic treatment, the denture can be fixed on abutment teeth using materials for permanent fixation.

When choosing permanent fixation material, it is necessary to taken into account that the existing gap between the denture frame and the tooth stump, which in case of optimally suitable restoration does not exceed 30-50 mm, should not be increased after the denture cementation. Studies of bond strength, film thickness and distribution of the powder particles in the cement performed after the cementation have shown that glass ionomer cements show better properties in comparison with zinc phosphate cements.

Quality of the fixation of a denture improves when mixing of glass ionomer cements that are pre-dosed in capsules is performed using special mixing devices, for example Silamat S5 (Vivadent).

**The success of the prosthetic treatment depends** not only on the proper obtaining of impressions, but also on the application of cements, providing a solid, long-term and secure fixation. Fabricated restoration should remain unnoticed to an eye from a distance normal for having a conversation. At the same time, absence of
an edge gap is an indispensable condition. This is achieved by compliance with the technology of manufacturing of this type of constructions. The right choice of color, compliance with the preparation technique, careful implementation of all technical phases of the manufacture of the restoration, presence of an optimal cement and compliance with the fixation rules - all of these items affect the quality and longevity of the prosthesis. Fixation materials are used according to the material of the restoration. The cement should have biocompatibility, mechanical strength and be convenient in application. At the present time, cements used in prosthetic dentistry have different chemical composition and nature (zinc sulfate, zinc oxide-eugenol, zinc phosphate, polycarboxylate, glass ionomer, composite). It is rational to use the adhesive technique for the fixation of all-ceramic restorations. In this case a solid and stable connection, which is formed between the hard tissues of the tooth stump and the restoration material, enhances the resistance of the prosthesis to fracture. Metal-free constructions have sufficient transparency. It is important that the cement used for their fixation does not change the selected color. The aesthetics is ensured by transparency of the fixation composite and by invisible margins of the restoration. It is more comfortable to work with "paste-paste" version of the packaging. The selected material should be capable of both light and chemical-light (dual) curing after mixing of the basic paste and a catalyst. Enamel-dentine adhesive should be used in this case.

The fixation should be performed in a certain sequence. Non-eugenol temporary cement is eliminated from the surface of the tooth. Then the hard tissues are washed and dried. The restoration is fitted in the oral cavity. The use of water-soluble test tones from the set of fixation material of different colors allows to control the preservation of the selected color of the restoration after its fixation. Absolute dryness is a necessary condition for successful adhesive cementation technique, so it is strongly recommended to use rubber dam. Let’s have a closer look at one of the options of fixation of metal-free restorations on light-curing material. Hydrofluoric acid is applied on the inner surface of the restoration for 60 seconds, and then is rinsed out. Restoration surface is dried. The next step is silanization - the restoration is treated with silane within 60 seconds and purged. After that bonding agent is applied but not polymerized. It is recommended to cover the workpiece with orange glass. Tooth enamel is etched for 30–60 seconds, rinsed out, and dried. Dentine is treated with primer within 15 seconds, after that the primer is purged but not rinsed out. Then the adhesive is applied for 10 seconds, purged and not wash off. Bond is applied on the enamel and dentin and purged. Cement is mixed up according to the instruction. Fixation material is distributed over the tooth surface and on the restoration with a brush or a tool. Then the construction is placed in the oral cavity, the excess material is removed. Polymerization is carried out for 40 seconds. Then the area of junction of the construction and the tooth is grinded and polished according to the general rules.

If the ceramic restoration is made of aluminum oxide, it is possible to use conventional cementation. In order to improve the adhesion of the material to
Dentin it is recommended to use a conditioner. The tooth prepared for fixation is treated with conditioner and then washed with water. The tooth is dried with the use of a tampon without overdrying, because it deteriorates adhesion. Conditioning is carried out only on devitalized teeth.

Application of modern silicone materials and accuracy of two-phase impressions, as well as compliance with the adhesive fixation technique of metal-free constructions, ensure high quality of the restoration work.

Method of fixation of a full metal swaged crown

Powder and liquid are put on the glass slab in the ratio indicated in the instruction for the cement. Stump of the abutment tooth is isolated using cotton wool and tweezers. The stump is treated with alcohol, and dried with air. The cement is mixed up to a "sour cream" consistency. 2/3 of the crown is filled with the cement, and then it is put on the stump. The patient is asked to occlude the teeth and to maintain the position of central occlusion. Cement remains are removed in 10-15 minutes with a probe.

Method of fixation of a full cast crown with porcelain facing

The crown is decontaminated with an appropriate solution and dried with pressurized air. The tooth stump is isolated from saliva with a cotton swab, decontaminated, degreased and dried. Powder and liquid are put on the glass slab. Powder and liquid ratio is indicated in the annotation to the cement. The powder and the liquid are mixed until the obtained consistency allows cement to get out from under the crown margin without any resistance. The crown is filled with the cement by about 2/3, and its walls and the stump surface are coated with the cement. The crown is put on the stump, and the patient is asked to occlude his or her teeth tightly and maintain the position of central occlusion. The hardened cement is carefully removed in 20-30 minutes. The doctor should explain the patient that he or she should be gentle with the teeth within first 2-3 hours after the cement solidification.

Method of plastic crown fixation

The supporting stump is isolated with cotton wool and tweezers. The stump is treated with alcohol and dried with air. The cement is mixed up to a "sour cream" consistency. 2/3 of the crown is filled with the cement, and then it is put on the stump. The patient is asked to occlude the teeth and to maintain the position of central occlusion. The remains of the cement are cleaned in 10-15 minutes with an excavator or a probe. Cement color is selected separately for each color scale of plastic. Trial mixing is performed before crown fixation.

Method of fixation of cast metal crown
The crown is decontaminated, treated with alcohol and dried with pressurized air stream. The stump is isolated from saliva with a cotton swab, decontaminated, degreased and dried. Powder and liquid are put on the glass slab in the ratio indicated in the instruction for the cement, and mixed to a liquid consistency. The crown is filled with the cement by about 2/3. The crown is applied to the stump and the patient is asked to close his teeth tightly and to maintain the position of central occlusion. The hardened cement is carefully removed in 20-30 minutes.

**Fixation of bridge frameworks**

*Method of fixation of stamped soldered dental bridge*

The required amount of cement powder and liquid are put on a glass slab (the ratio of powder and liquid is indicated in the annotation to the cement). The supporting stumps are isolated with cotton wool and tweezers. Then the supporting stumps and the crowns are treated with alcohol and dried with air. The fixation cement is mixed on a glass slab to a "liquid sour cream" consistency. The crowns are filled with the cement by 2/3, introduced into the oral cavity and put on the supporting stumps. The patient is asked to occlude his or her teeth. The doctor checks the position of central occlusion. The remains of the cement are cleaned in 10-15 minutes with an excavator or a probe.

*Method of fixation of cast metal dental bridge*

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Several **errors and complications** can occur at the stage of permanent fixation of porcelain fused to metal dentures on abutment teeth with cement. They include poor degreasing and drying of the abutment teeth, improper cement mixing (too dense or too liquid), simultaneous fixation of several metal-ceramic bridge frameworks and crowns. Insufficient degreasing and drying of the abutment teeth and use of too liquid cement can lead to decementation of crowns.

Too dense cement can lead to insufficient fitting of the denture causing bite opening. Mixing of a large amount of cement and simultaneous fixation of several bridge frameworks may lead to violation of generally accepted rules of prostheses fixation (poor drying and degreasing of the abutment teeth, intrusion of saliva into the crowns, hardening of the cement and so on).