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NICOLAE TESTEMIȚANU

Valentina NICOLAICIUC

DENTAL PULPITIS AND ELEMENTS OF ENDODONTIC THERAPY

COURSE OF LECTURES
FOR THE III rd YEAR OF STUDY the VI th SEMESTER

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Introduction

The present course of lectures is prepared for the III rd year 6th semester students Dentistry Department. The course reveals the clinic, diagnosis and treatment of pulpitis. The lecture course is fully consistent with the curriculum for the Dentistry Department in Therapeutic Stomatology.

The lecture course contents reflect the classic modern national and foreign knowledge in the field of epidemiology, symptomatology, diagnosis and treatment of pulpitis. The lecture course is divided into 12 chapters, containing one lecture topic. Chapters 5, 7 and 11 include several lecture topics that are very close in contents.

The lecture course contains a large list of foreign and national bibliography on the lectures subject, useful for proper or advanced study of presented topics.

The lecture course is designed for students with English language learning and professors of the dentistry department of SMPhU "N.Testemiţianu". The lectures are based on scientific and practical data on the specialty. This lecture course has both a theoretical and a practical value. It allows students to choose alternative methods of treatments. It may also be useful for foreign students to become familiar with English terminology in the specialty. It will help students to organize and deepen the knowledge.

1. THE PULP OF A TOOTH. THE CLINICAL AND MORPHOLOGICAL ASPECTS. AGE FEATURES. DYSTROPHIC CHANGES
(Lecture 1)

A tooth has four main components - enamel, dentin, pulp and cementum. Dental pulp is the central main component of the tooth which making it a living entity due to a rich vascularity and innervations.

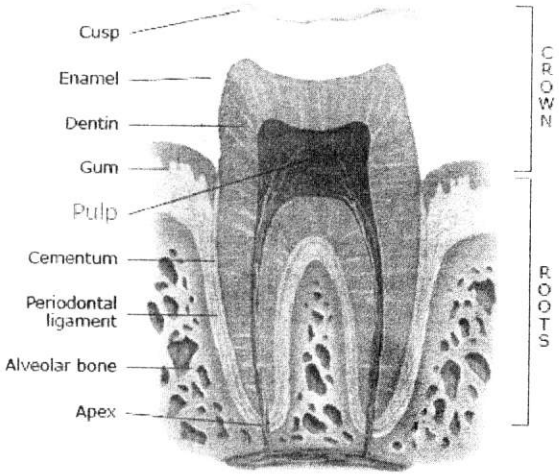


Fig. 1.1. **Structure of the pulp.**

1.1. Definitions of the dental pulp

According to Dorland's illustrative medical dictionary the dental pulp is defined as the richly vascularized and innervated connective tissue contained in the pulp cavity of a tooth, constituting the formative, nutritive and sensory organ of the dentin; called also as pulp's dentin.

According to Jablonski's illustrative dictionary of dentistry the dental pulp is a richly vascularized and innervated connective tissue of mesodermal origin, contained in the central cavity of a tooth and delimited by the dentin, and having formative, nutritive, sensory and protective functions. The portion placed in the tooth chamber proper is known as coronal pulp; that is within the root being the radicular pulp.

Fig.1.2. **Pulp topography of various teeth types on upper and lower jaw.**

1.2. Morphologic zones of the pulp

1. Odontoblast layer:

The outermost stratum of cells of the healthy pulp is the odontoblast layer. This layer is located immediately subjacent to the predentin. Since the odontoblast processes are embedded within the dentinal tubules, the odontoblast layer is composed mainly of the cells' body of the odontoblasts. Additionally, the capillaries and the nerve fibers may be found among odontoblasts.

In the coronal portion of a young pulp the odontoblasts assume a tall columnar form. The tight packing together of these tall thin cells produces the appearance of a palisade. The odontoblasts vary in height; consequently, their nuclei are not all at the same level and are aligned in a staggered array often producing the appearance of three to five cells layer in thickness. There are small intercellular spaces approximately 300 – 400 in width between odontoblasts.

The odontoblast layer in the coronal pulp contains more cells per unit area than in the radicular pulp. The odontoblasts in the coronal pulp are usually columnar whereas those in the midportion of the radicular pulp are more cubical. The odontoblasts appear as a flattened cell layer near the apical foramen. Since there are fewer dentinal tubules per unit area in the root than in the crown of the tooth, the odontoblast cell's bodies are less crowded and are able to spread out laterally. The cell

body of the most odontoblasts borders on the predentin, passes through the predentin into the dentine due to odontoblast processes.

Between adjacent odontoblasts there are three types of specialized cells in to cell junctions (Holland, 1975; Holland, 1976; Koling, 1988).

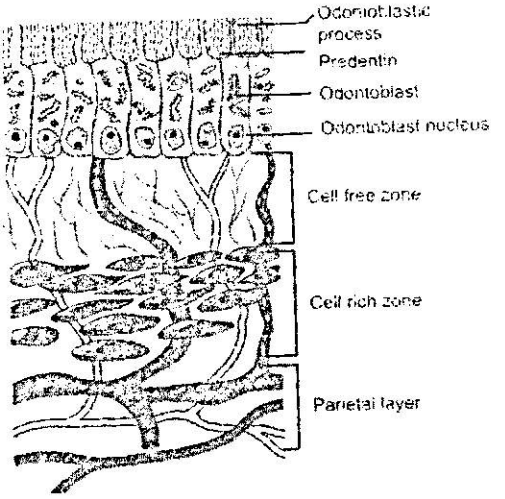


Fig.1.3. **Zones of pulp.**

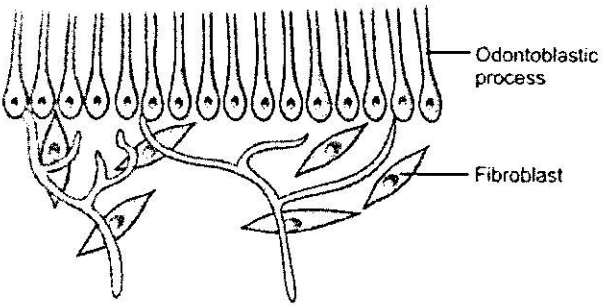


Fig.1.4. **Histology of pulp showing fibroblasts.**

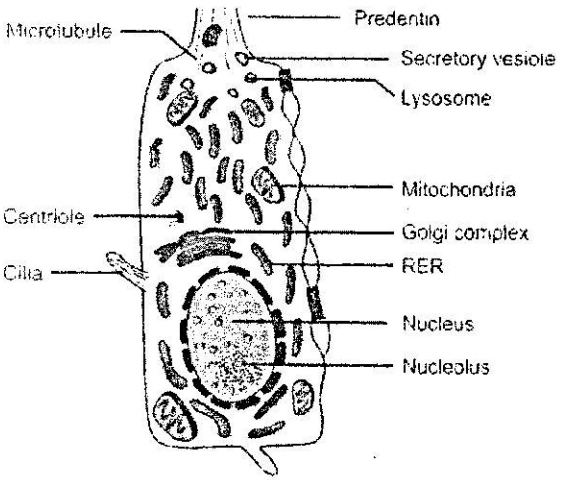


Fig.1.5. **Diagram showing odontoblasts.**

2. Poor- cell zone (Peripheral zone):

Immediately subjacent to the odontoblast layer in the coronal pulp there is often a narrow zone about 40 mm in width, which is relatively free of cells. It is broadsided by blood capillaries, unmyelinated nerve fibers and the thin cytoplasmic processes of fibroblasts. The presence or absence of the poor-cell zone depends upon the functional status of the pulp. It does not appear in young pulps which rapidly form dentin or in older pulps where the reparative dentin is produced.

3. Rich-cell zone:

Usually it is conspicuous that in the subodontoblastic area there is a stratum containing a relatively high proportion of fibroblasts compared with central region of the pulp. It is more prominent in coronal pulp than in radicular pulp. Besides fibroblasts this zone includes a number of macrophages and lymphocytes.

4. The pulp proper (Central zone):

This is the central mass of the pulp. It contains larger blood vessels and nerves. The connective tissue cells in this zone are fibroblasts or pulpal cells.

1.3. Structural elements of the pulp

Structural elements of the dental pulp can be classified into:

a. Cellular components
b. Extracellular components

a. Cellular components:

I. ***Odontoblast:*** is the most characteristic cell of the dentin pulp complex. Each of the odontoblast produces a matrix composed of collagen fibers and proteoglycans that are capable of undergoing mineralization.

II. ***Odontoblast process:*** the cytoplasmic microtubules extend from the cell body into the odontoblast process.

III. ***Fibroblasts:*** Although distributed throughout the pulp, they are particularly abundant in the rich-cell zone. Fibroblasts in the pulp appear to be specific tissue cells capable of giving rise to cells that are intended to differentiate as odontoblasts, given proper signal. These cells are also responsible for producing matrix and collagen fibers of the pulp.

IV. ***Macrophage (Histiocytes):*** These cells are present throughout the connective tissue of the pulp and are responsible for phagocytosis. In addition they also participate in the immune response and also produce interleukin 1 and other cytokines.

V. ***Dendritic cell:*** Like macrophages they are also accessory cells of immune system and are also weak phagocytes.

VI. ***Lymphocytes:*** Hahn et al. (1989) have reported the finding of T. lymphocytes and B lymphocytes in human teeth normal pulps. The presence of macrophages, dentritic cells and lymphocytes indicate that pulp is well equipped with the required cells for the initiation of immune responses.

VII. ***Mesenchymal cells (Reserve cells):*** These are present in the cell rich zone and capillaries and are pleurepotent in function.

VIII. ***Mast cells:*** These cells are widely distributed in connective tissue, where they occur in small groups in relation to blood vessels Farnoush (1984) reported the presence of mast cells in inflamed as well as uninflamed human pulps. The granules of mast cells contain heparin, an anticoagulant, as well as histamine, an inflammatory mediator.

b. Extracellular components:

I. ***Ground substance:*** It is a matrix that makes up the bulk of the pulp in which cells and fibres are embedded. Ground substance is a like substance and this property may help to limit the spread of bacteria (Trowbridge and Kim, 1997).

The principal molecular components of interstitial ground substance are proteoglycans and glycoproteins. In the pulp the principal proteoglycans include hyaluronic acid, dermatan sulfate, heparan sulfate and chondroitin sulfate.

The consistency of a connective tissue such as the pulp is largely determined by the proteoglycan components of the ground substance. The long polysaccharide chains of the proteoglycan molecules form relatively rigid coils constituting a network that holds water. Thus, forming the hyaluronic acid gel. characteristic, in particular has a strong affinity for water and is major component of ground substance. The water content of the pulp is very high (approximately 90%) and thus the ground substance forms a cushion layer capable of protecting cells and vascular components of the tooth.

The ground substance degradation can occur in certain inflammatory lesions and there is a high concentration of lysosomal enzymes proteolytic enzymes; hyaluronidases and chondroiton sulfatases of lysosomal as well as bacterial origin are examples of hydrolytic enzymes that can attack the ground substances components. The pathways of inflammation and infection are strongly influenced by the state of polymerization of the ground substance components.

II. ***Fibres of the pulp:*** Two types of structural proteins are found in the pulp collagen and elastin. Elastin fibers are confined to the walls of arterioles and unlike to collagen are not a part of the intercellular matrix.

The highest concentration of the fiber bundle is usually found in the radicular pulp near the apex. Thus Torneck (1985) stated that during pulpectomy, if the pulp is pulled out with a barbed broach in the region of the apex this generally affords the best opportunity to remove it intact.

III. ***Innervation:*** Pulp is a sensory organ capable of transmitting information from its sensory receptors to the central nervous

system. Regardless of the nature sensory stimuli (i.e. thermal change, mechanical deformation, tissues injury) the pulp afferent impulses from lead to pain sensation. The innervations of the pulp include both afferent neurons, which conduct sensory impulses and autonomic fibers, which provide neurogenic modulation of the microcirculation and perhaps regulate the dentinogenesis too.

The sensory nerves of the pulp arise from the trigeminal nerve and pass into the radicular pulp in bundles via the foramen in a close association with arterioles and venules with the completion of root development the myelinated fibers appear grouped in bundles in the central region of the pulp.

Most of the unmyelinated C fibers entering the pulp are located within these fiber bundles, the remainder are situated toward the periphery of the pulp (Reader and Foreman, 1981).

Fuss (1986) has found out that the members of A-fibers are gradually increasing five years after the eruption. The relative rate A- fibers appearance in the pulp helps to explain why the electric pulp test tends to be unreliable in deciduous teeth.

The nerve bundles pass upward through the radicular pulp together with blood vessels. Once they reach the coronal pulp, they fan out beneath the cell-rich zone, branch into smaller bundles and finally ramify into a plexus of single nerve axons known as the plexus of Raschkow.

A full development of this plexus does not occur until the final stage of root formation. It has been estimated that each fiber entering the pulp sends at least eight branches to the plexus of Raschkow.

There is prolific to the plexus, producing a tremendous overlap of receptor fields (Harris and Griffin, 1968). It is in the plexus that the A-fibers emerge from their myelin sheaths and while still within Schwann cells, branch repeatedly to form the odontoblastic plexus.

With the exception of intratubular fibers, the dentin is totally devoid of sensory nerve fibers. This offers an explanation as to why pain producing agents such as acetylcholine and potassium chloride do not elicit pain when applied to an exposed dentin. Similarly, the application of topical anesthetic solution to dentin does not decrease its sensitivity.

IV. *Vascular supply:* Blood from the dental artery enters the tooth via arterioles having diameters of 100 mm or less. These vessels pass through the apical foramina in company with nerve bundles. Smaller vessels may enter the pulp via accessory canals.

Capillary blood flow in the coronal portion of the pulp is nearly twice than that in the root portion. Also, the blood flow in the region of pulp horns is greater.

The blood circulation in an inflamed pulp involves very complex pathophysiologic reactions. A unique feature of pulp is that it is rigidly encased within dentin, thus pulp tissue has limited ability to expand, so vasodilatation and increased vascular permeability evoked during an inflammatory reaction results in intrapulpal pressure increase. So any sudden intrapulpal pressure rise would be distributed equally within the area of increased pressure including the blood vessels.

Therefore, the thin walled venules become compressed thereby increasing vascular resistance and pulpal blood flow reduction. This is why injection of vasodilators such as bradykinin into an artery leading to pulp results in reduction rather than pulpal blood flow increase (Kim et al., 1982). Torbejork and Hanin (1973) have showed that a reduction in pulpal blood flow results in depressed excitability of pulpal A-fibers. The excitability of C-fibers is less affected than that of A-fibers by blood flow reduction.

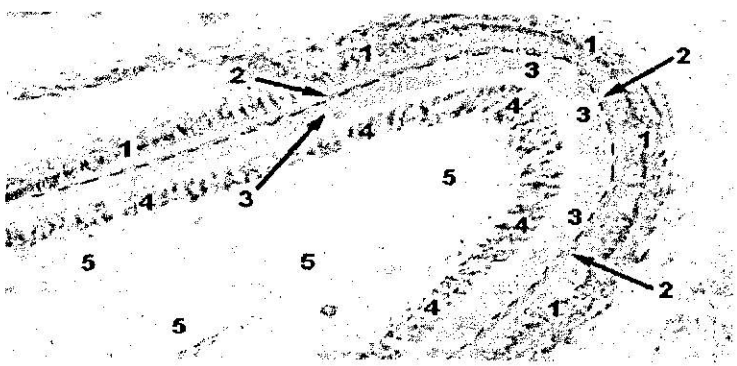


Fig.1.6. **Image of Histology and facing a test on them:**
1 - is the layer of cells that is building the enamel; 2 - is *enamel*, the very hard outer part of our teeth that we see normally; 3 - is *dentin*, the inner part- not so hard as enamel; harder than bone, but somewhat similar; 4 - is the layer that's building the dentin; 5 - is then the pulp, the bulk of tissue that is red in the diagram above.

NERVE SUPPLYING PULP OF PRIMARY TEETH:

- ✓ Maxillary central incisor;
- ✓ Maxillary lateral incisor - Anterior superior alveolar nerve;
- ✓ Maxillary canine;
- ✓ Maxillary first molar - Middle superior alveolar nerve;
- ✓ Maxillary second molar - Posterior middle superior alveolar nerve plexus.

The cells build from both inside and outside when a tooth forms.

1.4. Age changes of pulp

General age-specific structure of the pulp.

In the enamel of children's extended inter-prisms space teeth are easily detected, microcracks, micropores on the surface, high-contrast Retzius lines, in comparison with elderly people teeth, which have more typically homogenized structures (lower microporosity), occurring at different systemic levels.

The partly immatured enamel lasts longer in the cervical region and in the proximal surfaces.

In the places of the permanent teeth the enamel prisms differ quite clearly, by a cross section similar arch, rounded shape, or forming keyholes described as sledging by many authors, on longitudinal sections of appendages prisms body form wide and narrow strips. They are defined in the majority parts of the section, ending up at the surface or in a surface layer, with a narrow strip of non-prismatic peripheral enamel. They are compared with the children's teeth, which have more contrasting prisms in the deep layers, nearly to the enamel-dentin connection. Nearly to the surface they are less contrasted, because of the disappearance of the ultra micropores.

Large micropores and microcracks occur rarely and only in some areas.

Retzius lines look differently than the immature tooth enamel - as hooks" or stages at regular intervals, prisms - and much less in contrast.

The latter circumstance is due to the increase of the optical density of their borders by the age of tissue mineralization and close to the micropores, forming Retzius lines. The data areas properties are similar to the bulk of the enamel. The clearly defined Shregera bands, the

regularity of the structure due to the uniform beam prism are mineralized throughout their length.

Only in a few cases in the mature teeth preserve sections of porous structures. Thus, it refers to the enamel, is located under the dental tartar (stone). This is obvious due to the peculiarities of metabolism between the hard tissues of the teeth and dental deposits.

The last restricted contact of the tooth with saliva, as well as the movement of dental liquor. In a number of cases an increase of Retzius lines and no apparent connection with dental stone was detected.

However, this phenomenon is observed only in the cervical region. A clearer picture of prisms in this site to a significantly reduced mineralization, and hence the appearance of zones or saving specific to immature enamel, differ in the porosity and susceptibility from caries.

Besides these *age-specific transformations occur in the fissures of premolars and molars*. Their spontaneous natural sealing is often observed. Highly dense formations are found in the fissures, in such cases. Their heterogeneity is bedding or of large grain size.

In the group of older age period (45-70 years), there is a further increase in the homogeneity of the teeth enamel while preserving prismatic structure in all layers except the surface, where most of it is without prism.

Hunter- Shregera bands are in contrast, and Retzius lines, are also in contrast, being poorly allocated. Reducing the amount of the enamel organic component, the size of micro space leads to the border disappearance between prisms. The last become difficult to be seen. Reducing, correspondingly the amount of water in the solid tissues of the tooth. Seal celebrated crystal lattice - by substituting OH~ for F~. The surface layer of the enamel of mature and "old teeth", as a rule, is without prism on tens of nanometers.

Some features of the enamel structure constitute teeth abrasion. In the enamel sections the front part looks uneven due to the uneven abrasion of enamel and dentin. In the surface layer of the enamel cracks, microdefects, slightly contoured prisms are formed, their borders being partially destroyed.

Changes occurring with age as enamel homogenization of its structures have a protective - adaptive nature, providing ultimately and securing the increasing resistance of enamel.

The dentin aging has also undergone some changes: the primary sclerosis of dentinal tubules, the deposition of secondary dentin and the formation of repaired dentin.

In mature teeth about 30% of tubes have a closely mineralized material. Teksturogramma reveals calcium-containing amorphous and crystalline components. Individual tubes are mineralized so that the structure of their occlusive substrate is different from the basic substance of dentin.

Characteristic is the fact that the dentinal tubules of the primary dentin gradually calcify only if odontoblasts are kept alive.

The protoplasmic processes distal ends of the dentinal tubules forms are initially small portions inside tubular dentin, which can then completely cover their clearance.

Noticeable increases are seen in the nearby tubular dentin, which are more mineralized, while the inner tubular dentin is mineralized significantly less.

The deposition of new layers of dentin, reduces the amount of pulp occurring continuously throughout the life, and may do it in the absence of inflammation in the pulp. The process becomes more intense when the tooth is abraded as a result of the operation, exposing the dentin.

Although with a slight irritation, it is enough to stimulate the cells of the pulp to form secondary dentin that is deposited on the part of the roof" and on the pulp chamber base.

This phenomenon contributes to a "reduction" of the tooth cavity in vertical direction to a greater extent than in the horizontal direction.

When the pulp is damaged as a result of caries or surgical procedures, some odontoblasts are killed, resulting in a secondary dentin which is less regular. This is the reparative dentin. Formation of reparative dentin creates an effective mechanism to protect the pulp from the diseased processes. It is more amorphous, less channeled and less correct in form, than the primary dentin, and thus is called irregular.

When the inflammation of the pulp is chronic, especially with a sick tooth periodontium, in a lot of reparative dentin forms are seen in the root canal. In both cases, the root canal is extremely narrowed and almost obliterated, making it difficult for endodontic manipulation. The data about the aged tooth morphology are given in the practical development of drugs and therapeutic methods of hard tissues.

1.5. Functions of dental pulp

1. Formative:

The main function of pulp is the formation of dentine. From the mesodermal aggregation, known as dental papilla, a specialized cell layer of adjacent and internal odontoblasts arises on the inner layer of the ectodermal enamel organ. The ectoderm interacts with mesoderm and the odontoblasts initiate the process of dentin formation.

2. Nutritive:

It supplies nutrition to the dentin through blood vessels and odontoblastic processes and maintains tooth vitality.

3. Sensory:

The pulp and dentin innervation is linked by the fluid and by its movement between the dentinal tubules and peripheral receptors and thus by the sensory nerves of the pulp proper. The tooth sensation is felt through the nerves of the pulp.

4. Defensive:

The tooth and the pulp defense have been speculated to occur by new dentin creation in the face of irritants.

1.6. Dystrophic changes of pulp

The pulp **degenerative changes** of are not only of involutional nature but arise in injury, in the healing process, and as a result of dental procedures.

These causes can lead to creation in all areas of the pulp calcifications, often localized near the blood vessels. The dystrophic changes also include dentiklis creation.

Dentikli (pulp calcified stones) are often formed in the coronal pulp. The classified dentikli depend "on the location of the free, and the intermediate (interstitial) or biological adjacent structure – **"both true"** and **"untrue"**.

The free dentikli occur in of pulp tissue isolation, the increased dentin formation can be connected with the inner wall of dentin (parietal dentikli) or can be interstitial located.

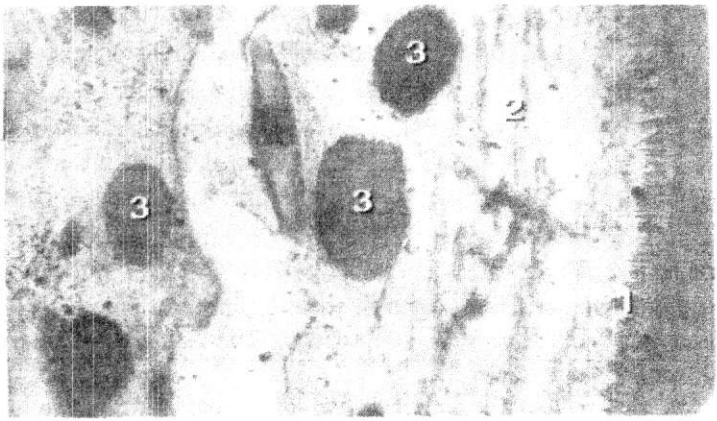


Fig.1.7. **Concrementous chronic pulpitis.**
- Thinned layer of odontoblasts. 2 - Reticular degeneration of the pulp. 3 - Petrifikated (dentiklis) different shape and size, located along the vessels

Fig.1.8. **Various dentiklis (calcified stones).**

True dentiklis are rare, mainly in the apical part of the root canal. According to the structure, they resemble the primary dentin and deployed nests are formed by epithelial cells sheath Hertwig possessing the odontogenic potential.

Untrue dentiklis are common and are located mainly in the coronal pulp. Dystrophic pulp tissue sections form a matrix for the laying of concentric layers of calcified tissue.

Clinically dentikli and other diffuse calcification are asymptomatic, with root canal narrowing or obliteration of the difficult for endodontic treatment.

2. PULPITIS ETIOLOGY, PATHOGENESIS, CLASSIFICATIONS AND DIAGNOSIS (Lecture 2)

2.1. Definition

Pulpitis - tooth pulp inflammation. Pulpitis, in most cases, occurs as a complication of tooth decay. The pulp inflammation develops as a result of microbial products combined effects of their life and dentin decay organic matter, more often in various forms of pulpitis. There is an association found between streptococci and lactobacilli bacteria, at least - negative staphylococci.

From the cavity the microorganisms penetrate into the pulp to the dentinal tubules. This is the most likely route of microorganisms' penetration into the pulp. Less common hematogenous route of penetration (through the apical hole the microbes get into the pulp with sinusitis, periodontitis, etc.).

2.2. Etiology

Pulpitis (pulpitis) is dental pulp inflammation as a result of exposure to various stimuli.

1. The most common causes of pulpitis are the **microorganisms** and their metabolic products within the pulp chamber of the cavity through the dentinal tubules.

Many authors consider the main causative agents of pulp inflammation some coccoid forms of bacteria, including **hemolytic** and **non hemolytic streptococci, diplococci, staphylococci, gram-positive rods, strepto bacilli** and **lactobacilli.**

The pulp infection can be probably pulp chamber accidental opening, during the treatment of caries, as well as the retrograde route from the deep periodontal pocket, the maxillary sinus in inflammation (sinusitis), osteomyelitis, or periodontitis in the adjacent tooth.

Perhaps the penetration of infection into the pulp is through the blood and the lymphatic system, in acute infectious diseases.

2. The second more common etiologic factor for the pulpitis development may be the acute or **chronic injury**: mechanical, physical and chemical.

Acute mechanical injury occurs when you plug a part of the tooth crown exposing the pulp horns, at the turn of the root, damaging the root apex neurovascular bundle (eg. stroke), the pulp horns opening in dental caries, or tooth crown dissection treatment.

The pulp chronic mechanical traumas are **pathological dental abrasions**, which can lead to the pulp horns exposure, over-filling the treatment of deep caries, pressure dentikles (calcification stone).

2a. **Physical injury** can lead to the pulp overheating during the preparation of cavities or tooth for a crown.

This can occur when using the blunt burs, or at work on a turbine installation for a long time without water cooling [Ivanov, BC, 1968].

The imposition of **amalgam fillings** with isolating thing base and leads to chronic physical irritation of the pulp, as the metal is a good conductor of thermal stimuli.

2b. **Chemical pulp injury** may occur as a result of the following factors:

- the use of strong antiseptic in high concentration in deep cavities (3% solution of chloramines, 96% solution of alcohol, 3% solution of hydrogen peroxide, ether);
- the application of a permanent obturation without curative line for treatment of deep caries, the use of filling materials that have toxic effects, with an isolating base (Acriloksid, Carbodent, Evicrol, etc.);
- the application of therapeutic pads with a strong alkaline medium pH 12-14 (Calmetsin, Caltsin-paste), which can lead to necrosis of the pulp;
- adding a crystal of thymol, iodoform, potassium nitrate to the base;
- the use of allergenic filling materials and drugs without adverse allergic status of the patient (acrylic, zinc-eugenol paste sulfanilamide, antibiotics, etc.), the treatment of deep caries in elderly people with a low reactivity of the organism with decompensate form of tooth decay.

Among the etiologic factors the pulpitis dentickle and petrifikaty calcification stones) are included in the cavity of the tooth.

Petrifikaty (calcification stones) dental pulp can be single or multiple, that is, there is focal or diffuse deposition of mineral salts, which can irritate the nerve endings in the pulp and squeeze the vascular formation,

disrupting the microcirculation.

The deposition of calcium salts can be traced mainly along the large vessels and nerves, which, of course, can lead to spontaneous pain in the tooth, especially when changing position of the head.

Dentikli (Bricked) - are similar to dentin formation of various sizes and shapes that are formed in the crown and in the root pulp as a result of chronic mechanical trauma of the tooth or by somatic chronic diseases.

There are:

- free,
- parietal,
- interstitial ("bricked") dentikli.

2.3. Pathogenesis

The pulp is a powerful anti infective barrier. An inflammatory reaction that may be reversible at some stages with the depletion of protective forces of the pulp and the impact of virulent microorganisms and their toxins develop.

Nonspecific and specific factors of the organism resistance are involved in the regulation of flow and the elimination of tooth pulp inflammation. The outcome (stopped) of the inflammation depends on the following factors:

- the virulence of microorganisms and toxins;
- the duration of the stimuli impact ;
- the resistance of the pulp;
- the general condition of the human body;
- the age of the patient;
- the intensity of dental caries;
- the periodontal status.

The pulp sensitization must be considered, that which develops well before clinical signs of inflammation as a result of existent carious processes.

In the early inflammatory pulp changes, a functional nature is developing, which is lately transformed into the structure.

As a response to prolonged to microorganisms and their toxins exposure the cells die and release large quantities of lysosomalenzymes (proteolytic, glycolytic, lipolytic), which initiate a cascade of reactions.

The acute pulpitis period does not exceed14 days.

Any inflammatory response consists of three components: the alteration, exudation and proliferation.

In the process of alteration the subcellular structures are damaged, particularly, mitochondrial damage causes a decrease in redox processes [A. Grigorian, 1965].

As a result of lysosomes damage and collapse, a large number of hydrolytic, glycolytic and lipolytic enzymes, are released and activated by hydrolysis, releasing organic acids of the Krebs cycle, lactic acid and amino acids.

This leads to saturation of the pulp by hydrogen ions and an increase in osmotic pressure.

After a brief constriction of arterioles there is their expansion, while expanding venules and capillaries.

There is an increased blood flow, blood clots, swelling of the vascular wall in an acidic medium, the white blood cells (leukocytes) parietal distance, increased blood clotting, thrombosis [Panikarovskiy V.V., 1989]. As a result of these processes the metabolism products removal is harmed by an increased oxygen starvation.

The depolymerized ground substance, its alkalization, increases tissue hypoxia. The protective function of the intermediate material is sharply reduced due to changes in its structure (voids interspersed with dense areas).

There are severe disturbances in the microcirculatory system, small hemorrhages. There is a disorganization of odontoblasts, vacuolization of them, cariopicnosis, is cariorexis and cariolysis. Due to alteration it is developed and exacerbated by the stage of exudation.

In the pulp tissue the swelling increases, there is a serous fluid, which in rare cases may dissolve, that is, the inflammation becomes the opposite to development, but more often in 6-8 hours from its beginning transforming into a purulent inflammation.

The pulp abscess is formed, around which there is a serous inflammation subsiding to the periphery.

In dentinal tubules cavity, partially out inflammatory transudate, the pressure drops reaching the pulp cavity of the tooth, subsiding pain for a while. If the abscess is opened in the cavities, the acute inflammation becomes chronic.

Another outcome of acute diffuse pulpitis may be the death of the pulp as a result of severe hypertension with subsequent irreversible changes.

In the transition of acute to chronic fibrous pulpitis the granulation tissue is initially formed at the periphery of the abscess. The future site of the inflamed pulp undergoes fibrous degeneration, which corresponds to the stage of proliferation.

Acute pulpitis may become chronic in the of gangrenous putrefactive microorganisms entering into the cavity of the tooth through the drain hole in the dentin.

Morphologically, the surface area necrosis, adjacent to the cavity and the proliferation of granulation tissue in the underlying layer is observed. The site of necrosis extends over time to the entire coronal part, and then to the root pulp, which ultimately leads to the development of periodontitis.

In some cases, acute pulpitis may become a chronic hypertrophy, which is more common in young age. In this case, the stage of proliferation predominates over the stages of alteration and exudation.

The site of the pulp abscess after its opening in a cavity is replaced by granulation tissue, which is a result of chronic injury (thermal, mechanical, chemical) grows in the direction of the cavity.

In case of a contact with the stratified squamous epithelium of the mouth mucous membranes pulp polyp is formed on this fabric.

The chronic hypertrophic pulpitis may lead to chronic gangrenous pulpitis and periodontitis.

The chronic forms of pulpitis may, from time to time, exacerbate, a fact observed during the mechanical closing of the drain hole from the tooth cavity, reducing the organism reactivity as a result of acute and chronic common illnesses or stress.

In the pulp, along with characteristic changes of chronic inflammation (the appearance of sclerosis, fibrosis foci, salt deposits areas), there are acute inflammation areas, microabscesses, edema and exudation phenomena.

Thus, in pulpitis various forms the effects of alteration, exudation and proliferation must exist, but it is a predominance of one process over another.

For example, in acute forms of pulpitis prevalent phenomenon of exudation in chronic gangrenous - alterations in chronic hypertrophic - proliferation.

2.4. Classification of pulpitis

WHO classification (World Health Organization) – **Russian Version:**

K.04. Diseases of the pulp;

K.04.0. pulpitis

K.04.00. hyperemia of the pulp;

K.04.01. acute

K.04.02. pus (abscess of the pulp)

K.04.03. chronic

K. 04.04. chronic ulcerative

K.04.05. chronic hiperplazic pulpitis (pulp polyp)

K.04.08. other specified pulpitis

K.04.09. unidentified pulpitis

K.04.1. Necrosis of the pulp. Gangrene of the pulp

K.04.2. The stones of the pulp. Dentrikli.

K.04.3. Abnormal formation of dental hard tissues in the pulp. Irregular secondary dentine.

WHO classification (World Health Organization) – **Original Version:**

Table 2.1.

Diseases of pulp and periapical tissues

K04.0 Pulpitis:	• NOS (National Occupational Standards) • acute • chronic (hyperplastic) (ulcerative) • irreversible • reversible
K04.1 Necrosis of pulp	Pulpal gangrene
K04.2 Pulp degeneration	Denticles Pulpal: • calcifications • stones
K04.3 Abnormal hard tissue formation in pulp	Secondary or irregular dentine
K04.4 Acute apical periodontitis of pulpal origin	Acute apical periodontitis NOS
K04.5 Chronic apical periodontitis	Apical or periapical granuloma Apical periodontitis NOS
K04.6 Periapical abscess with sinus	Dental abscess with sinus Dento-alveolar abscess with sinus

K04.7 Periapical abscess without sinus	Dental abscess NOS Dento-alveolar abscess NOS Periapical abscess NOS
K04.8 Radicular cyst	Cyst: • apical (periodontal) • periapical • residual radicular ***Excl.:*** lateral periodontal cyst (K09.0)
K04.9 Other and unspecified diseases of pulp and periapical tissues	

Classification of E.M. Gofung:

I. Acute pulpitis:
- partial,
- general,
- purulent.

II. chronic:
- simple,
- hypertrophic,
- gangrenous.

Classification of the Moscow Medical Stomatological Institute:

I. Acute pulpitis:
a. focal,
b. diffuse.

II. Chronic pulpitis:
a. fibrotic,
b. gangrenous,
c. hypertrophic.

III. Exacerbation of chronic pulpitis.

IV. State after a partial or complete removal of the pulp.

Classification of lesions of the pulp of M. Ghafar and C. Andreescu (Bucharest 1990):

1. Acute pulpitis:
a) Serous:
- with limited morphologic lesions (acute coronary partial or serous pulpitis);
- with the morphological lesions of the pulp all over (full or acute coronary root, serous pulpitis).

b) Purulent:
- with limited lesions (acute, coronary, serous or purulent, partial, pulpitis);
- covering the entire pulp (full or acute coronary root purulent pulpitis).

2. Chronic pulpitis:

a) Closed (not communicating with the external environment):
- chronic closed pulpitis proper;
- chroni internal granulomatous pulpitis (internal granuloma place).

b) Open:
- Ulcerative;
- Granulomatous (polypous).

Classification of International Diagnosis Code (IDC):

ICD-9-CM 522.0 - is a billabled medical code that can be used to specify a diagnosis on a reimbursement claim:

2012 ICD-9-CM Diagnosis Code 522.0 - Pulpitis

2.5. Diagnostics

The clinical manifestations of pulpitis are very diverse. The patients complain of severe pain, localized in a particular tooth (acute focal pulpitis). The pain provoked by thermal irritants, in the beginning of the pain process, occurs because of the cold stimuli, and in later stages – because of the hot irritants.

The pain lasts for 15-20 minutes (acute focal pulpitis).The episodes of pain at first -intermittent, over time - are becoming more frequent. The pain may occur spontaneously, especially in the evening or at night. The attacks of pain may pass spontaneously. But often for a pain relief it's necessary to use analgesics.

The pain attacks at the onset of the disease are short-time (15-20 minutes) with a long "light periods" (painless) - intervals (2-4 hours). With the progression of the disease – the pain increased during 4 hours to 2, and the "light periods" (painless) is reduced to 10-20 minutes.

The night pain prevails over the day, as during the night the para-sympathetic nervous system activity is dominated by the sympathetic. At night, the heart rate slows, and as a consequence – circulation slows, which leads to accumulation of toxic products in the pulp. This produces irritation of nerve receptors - that is pain.

The pain can be unbearable, progressive or sharp. In acute diffuse pulpitis a French author describes the pain as "crazy tooth". It may irradiate from the diseased tooth to the adjacent teeth and the region, along the branches of the trigeminal nerve.

Irradiation zone:

- The temporal region;
- Orbital (eye) area;
- Under the mandible (lower jaw);
- In the occipital region;
- The muscle Sterno-Cleino-Mastoideus.

It is important that the irradiation does not pass the medial (middle) line of the face.

2.6. Clinical examination

- The tooth has a normal color, with a deep cavity with the crushed dentin;
- After removing food debris and pulverized dentine a thin layer of pigmented dentin can be seen;
- Probing causes intense pain reaction (acute focal pulpitis - at one point and diffuse - around the bottom of the cavity).
- Percussion of the tooth (vertical) - painless (acute focal pulpitis) and slightly painful (acute diffuse pulpitis);
- The temperature probe - is an intensive long-time pain;
- EDI is an additional method of investigation. Healthy dental pulp responds to a current of 4–6 uA, with deep caries up to 12-18 uA, with acute focal pulpitis to 20 uA, with acute pulpitis generally up to 30-45 uA, chronic fibrous pulpitis to 35 uA.
- (mkA = μA = uA=0,000001A=0,001mA).
- Indicators of the current 60 uA talk about the coronal pulp death, and more than 100 uA - about death and root pulp.
- X-ray diagnosis is used as an additional method to detect hidden cavities, dentikley (calcification stones) detection and identifycation of changes in the periodontium.

Changes in the periodontium on radiographs in chronic pulpitis are detected in 28% of cases (periodontal ligament extensions, the root apex resorption).

CLINICAL MANIFESTATIONS AND DIAGNOSIS OF ACUTE PULPITIS FORMS. DIFFERENTIAL DIAGNOSIS (Lecture 3)

3.1. Clinical manifestations and diagnosis of acute focal pulpitis (Pulpitis acuta locala)

Clinical manifestations of acute focal pulpitis are very diverse.

Complaints of the patients:

- The pain of all kinds of irritant. Most of the cold.
- The pain persists after removal of the stimulus.
- The pain can be spontaneous.
- The pain increase at night.
- The duration of a painful period is 10-20 minutes.
- Painless periods 2-4 hours.
- The patient indicates exactly which tooth ache.
- The irradiation of pain is absent.

Objective examination:

- A deep cavity.
- The bottom of the cavity with soft dentine (acute process) or pigmented dentine (with chronic process).
- Probing: sharp pain at one point (in the inflamed pulp horns).
- Carious cavity does not communicate with the cavity of a tooth.
- Temperature test on cold is painful. The pain does not stop after removing the excitant.
- Vertical percussion is painless.
- EDI: 18-20 μA (in projection of the inflamed pulp horns).
- X-ray: a deep cavity, the pulp of a thin layer of dentin. Cavities do not communicate with the cavity of the tooth. No changes in the apical part of the tooth.

3.2. Differential diagnosis of acute focal pulpitis with deep caries

General:

- The pain of all types of irritants (especially from cold).
- The patient indicates exactly the tooth (no irradiation of pain).
- A deep carious cavity (The cavity of the tooth is not opened).

Differences:

- In acute focal pulpitis the pain from irritants persists after removal.
- Spontaneous pain.
- Long painless periods.
- Probing the sharp pain at one point, and in deep caries - around the bottom of the cavity.

3.3. Differential diagnosis of acute focal and acute diffuse pulpitis

General:

- The pain of all kinds of irritants.
- Spontaneous pain.
- Night pain.
- A deep cavity.
- The cavity of the tooth is not opened.

Differences:

- In acute focal pulpitis – the pain is from cold, and in acute diffuse (especially in the transition to a purulent pulpitis) – pain is from hot. The cold calm the pain.
- Acute focal pulpitis: painless periods longer than pain. In acute diffuse pulpitis - pain lasts up to several hours, and lucid intervals are short.
- Acute focal pulpitis continues 1-2 days, and acute diffuse pulpitis is up to 14 days.
- In acute focal pulpitis pain does not irradiate (the patient indicates the tooth), in acute diffuse pulpitis the pain – irradiates (the patient can't specify the aching tooth).
- Probing for acute focal pulpitis - pain at one point, and in acute diffuse pulpitis - around the bottom.
- Percussion: Acute focal pulpitis - is painless, and acute diffuse pulpitis - is painful.
- EDI: acute focal pulpitis - 20μA, and acute diffuse pulpitis - 30-45μA.

3.4. Differential diagnosis of acute focal pulpitis with chronic fibrous pulpitis

General:

- Pain from irritant factor (cold).
- Probing painful at one point.

Differences:

- In acute focal pulpitis - spontaneous pain, chronic fibrous pulpitis - the pain begins only at the time of exacerbation.
- In acute focal pulpitis - no communication with the cavity of the tooth, and the chronic fibrous pulpitis - tooth cavity is open at one point (pain and bleeding upon probing).
- EDI: In acute focal pulpitis – 20 μA, and the chronic fibrous pulpitis - 35-40 μA.
- Anamnesis: In acute focal pulpitis - in the past there was no sharp pain, in contrast to chronic fibrous pulpitis.
- Acute focal pulpitis continues 1-2 days, and chronic fibrous pulpitis - up to some years.

3.5. Clinical manifestations and diagnosis of acute diffuse pulpitis (Pulpitis acuta diffusa)

Acute focal pulpitis passes in acute diffuse pulpitis after 2 days. In this case involves the inflammation in coronal and root pulp. The serous inflammation quickly becomes sero-purulent, and then - purulent.

Complaints of the patient:

- Long-time spontaneous pain - 2-3 hours.
- Painless lucid intervals - short (30-40 minutes).
- Because of the suffering that causes acute diffuse pulpitis, a French author named it as "crazy teeth".
- The pain irradiates along the path branches of the trigeminal nerve.

Zone irradiation pains:

- When pulpitis in canines and in incisors in the upper jaw irradiation of pain in the nose, in the suborbital and supraorbital region. Irradiation may be and in the temporal area.
- From the molars of the upper jaw irradiation of pain is in the temporal region, supra orbital, zygomatic, in healthy teeth, and sometimes, in the lower jaw.

- In case of the mandible teeth pulpitis, irradiation of pain is felt in the occipital, ear, submandibular and in the teeth of the upper jaw region.
- In the incisors on the lower jaw, the pain may radiate to the opposite part.
- When pain irradiates, the patient can't specify the aching tooth, and there can be possible errors of diagnostics.
- Analgesics help a little, for a short-time, and not completely to eliminate the pain.

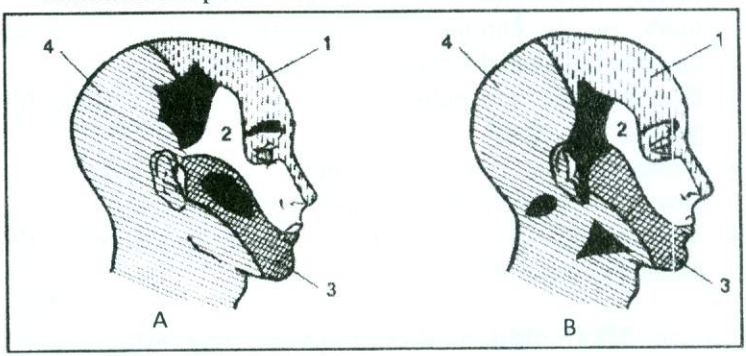


Fig.3.1. **Pulpitis zone irradiation pains with (by I.G. Lukomsky).**
A - upper teeth, *B* - lower teeth.
1 – n.infraorbitalis (from n.ophtalmicus); *2* – n.maxillaris;
3 – n.mandibularis; *4* – n.occipitalis.

Irradiations areas are painted in black.

Objective examination:

- Deep cavity with rests of food and softened or pigmented dentin.
- The painful probing over the bottom of the cavity. Make the probing it is possible to open the tooth cavity, and as a consequence, an extreme pain is felt. A probe examination should be carried out very carefully, without a pressure!
- Temperature test: the pain from cold, and at last - from hot.
- Vertical percussion is painful, because the inflamed, coronal and root pulp. The pain has a periodontal reaction.
- EDI: 30-45 μA.
- X-ray: changes in the apex of the root are not detected.

3.6. Differential diagnosis of acute diffuse and chronic aggravated forms of pulpitis

General:

- Spontaneous pain with "light" intervals, increasing from the temperature irritants.
- Irradiation of pain.
- Comparative percussion is painful.

Differences:

- In anamnesis – a spontaneous pain.
- During an examination: the carious cavity is connected with the tooth cavity. Probing - painful.
- 30% of the x-ray revealed the expansion of periodontal ligament.

All these features are absent in acute diffuse pulpitis. Acute pulpitis may be in patients with a good reactivity of the organism and a compensated form of tooth decay. In the practice of dentists chronic and acute pulpitis often occur.

3.7. Differential diagnosis of acute diffuse pulpitis, acute apical periodontitis and chronic apical periodontitis in the acute stage

General:

- Prolonged pain.

The differences:

- In acute diffuse pulpitis: pain is periodically, and in acute forms of apical periodontitis it is constant, increasing with time.
- In acute diffuse pulpitis: the tooth cavity isn't usμAlly open, but it is open in periodontitis. Probing is painless.
- In acute diffuse pulpitis: the palpation of the crease in the transition area of the sick tooth projection is painless, and in acute forms of periodontitis – it is painful.
- In acute diffuse pulpitis: the percussion can be a little painful, and in acute forms of periodontitis, the pain is felt when the tooth is touched by tongue.
- In acute diffuse pulpitis: the patient can't appreciate the painful tooth, in contrast to the acute forms of periodontitis.

- In acute diffuse pulpitis: the thermal irritants provoke pain, and in acute forms of periodontitis – there is no pain.
- X-Ray: in acute diffuse pulpitis the changes in the periodontium are not detected, and in acute forms of periodontitis (except the acute periodontitis in the stage of intoxication) the expansion of periodontal ligament and bone destruction in the apex of the tooth root are revealed.
- EDI: in acute diffuse pulpitis is always less than 100 μA, and with periodontitis it is more than 100 μA.

3.8. Differential diagnosis of acute diffuse pulpitis and trigeminal neuralgia

General:

- Paroxysmal pain with "bright" intervals.

Differences:

- In neurology: chemical and cold irritants do not provoke an attack of pain. The pain beginning from different movements of facial muscles, and when you touch the "Kurkov" areas (places of exit branches of the trigeminal nerve).
- In neurology: the pain often occurs at night, in contrast to the pulpitis.
- In examination: the teeth are not detected, this can produce paroxysmal pain.

3.9. Differential diagnosis of acute diffuse pulpitis and sinusitis

General:

- Aching pain in the jaw.

The sinus differences:

- Suffer from a common condition, headache, fatigue, fever.
- Pain gets worse when tilting the head and the sharp change of position.
- There is a discharge from the nose.
- Typical radiographic picture of the maxillary sinuses.
- Thermal irritants: don't provoke the pain in the teeth, denoting a constant, diffuse, aching, moderate pain.

3.10. Differential diagnosis of acute diffuse pulpitis and alveolitis with alveolar pain

General:

- Pain irradiating along the branches of the trigeminal nerve.

Alveolitis differences:

- There is always an alveolus tooth extraction with a broken blood clot.
- Permanent pain is not associated with the action of thermal irritants.
- The gingiva (gum) palpation in the area of the alveolus causes a sharp pain.
- The pain stopped after the alveolus curettage and anti inflammatory treatment.

3.11. Clinical manifestations and diagnosis of acute purulent pulpitis (Acute purulent pulpitis)

Complaints of the patient:

- Severe pains irradiating along the branches of the trigeminal nerve.
- A pulsed, continuous, weakened pain lasting for a few minutes and then beginning again.
- At night, the pain intense.
- Pain worsens from hot. Cold irritants reduce the pain. Patients often come with a bottle of cold water, a bag of ice (applying, rinsing the mouth the patients say that they stopped the pain at home).

Objective examination:

- Deep cavity with rest of food and softened dentin.
- Carious cavity does not connect with the cavity of the tooth (the tooth cavity is closed).
- Surface probe is painless. When the pressure, is easily used to open the cavity of the tooth by a tooth- explorer or an excavator. This releases a drop of pus with the blood.
- A deep probe - painful.

- After opening the cavity of the tooth the patient's condition improves. The pain subsides and stops.
- Hot temperature probe provokes pain. The pain subsides from cold irritants.
- Vertical percussion is painful (in the inflammatory process the entire pulp is involved).
- EDI: 50 μA or more.

3.12.Clinical manifestations and diagnosis of acute traumatic pulpitis (Acute traumatic pulpitis)

Depending on the traumatic factor there are three forms of traumatic symptoms:

1) *Randomly penetrating the pulp horn (preparing the cavity, excavated at work):*

Objective examination:

- A pin hole can be seen.
- A rayed pink pulp.
- A sharp probing is painful (it is not recommended to be done).

2) *Accidental injury of the pulp:*

Objective examination:

- The tool penetrates into the tissue of the pulp and hurt it.
- The pulp cavity is infected with microflora.
- There is a sharp pain at the time of injury.
- The bleeding pulp is visible.

3) *Exposure of the pulp in the crown fracture (acute injury):*

Objective examination:

- The clinic depends on the fracture line.
- The pulp can be stripped.
- The pulp Infection.
- The inspired air and eating provoke pain.

Table 3.1.

Differential diagnosis of acute pulpitis

Diagnostic tests	Diagnosis: Acute diffuse pulpitis	Diagnosis: Acute suppurative pulpitis	Diagnosis: Traumatic pulpitis
Anamnesis: the patient survey, the elucidation of complaints, the characteristics of disease	Acute, spontaneous, paroxysmal pain, last ing from 2 hours and more, lucid intervals – 10-30 min. Irradiation of the pain along the branches of the trigeminal nerve, worse at night, in a horizontal position. Pain arises from all kinds of irritants, a long life after their removal	Spontaneous, tearing, throbbing, constant and decreasing for a few minutes. Irradiation in the course of the branches of the trigeminal nerve. The pain is worse at night. Pain is also aggravates by the hot stimuli, calms down from the cold, and any other irritants cause a sharp pain	The pulp injury causes a short-term acutepain. At the crown's turn - a sharp pain radiates alo ng the branches of the trigeminal nerve. The pain of all irritants is felt even on air movement
The nature and depth of the cavity, the characteristic of its contents	Deep cavity with a large number of pulpal dentin is softened about	Deep carious cavity is filled with plenty of light softened dentine caries in acute and pigmented dentin - the chronic one	When injury of the dotted pulp gaping pink pulp, leaves a drop of fluid. At the turn of the crown of the tooth - the stripped pulp for a considerable distance, the red one
Probing the cavity	It is painful over the bottom of the cavity the pain persists after the termination of its sensing	Sharp pain over the bottom, easily perforates tooth arch cavity with the release of a drop of pus	Sharply painful, even in the probing surface (to touch)
The vertical percussion	painful	painful	is painful with an open pulp

The temperature probe	Painful reaction to cold or hot water is stored for a long time with irradiation along the trigeminal nerve	Painful reaction of the tooth settles down on the cold water for 3-5minutes	Sharply painful reaction to cold or hot water
Electrical excitability (from the bottom of the cavity)	20-35 μA	40-50 μA	

Table 3.2.

Differential diagnosis of acute pulpitis

Diagnostic Tests	Diagnosis: Hyperemia of the pulp	Diagnosis: Acute limited pulpitis
Anamnesis: the patient's survey, the elucidation of complaints, the characteristics of disease	Acute, spontaneous pain lastin g 1-2 minutes in the affected tooth, lucid intervals - 6-24 hours. The attacks are worse at night. Pain arises from all the irritants, lasts 1-2 minutes after removing them. There is no irradiation of pain	Acute, spontaneous pain lasting 3-10 min, lucid intervals - from 2 hours or more. Attacks are worse at night. Pain arises from all kinds of irritants, slowly settling down after their elimination. Occa-sionally radiating to the adjacent teeth.
The nature and depth of the cavity, the characteristic of its contents	The cavity within hard and soft dentin. The number of softened dentin due to the nature of the caries development and its localization	Deep cavity with a large number of softened dentin near the pulp
Probing the cavity	Painful in a limited area the bottom of the cavity, the pain persists after probing (short)	Painful at one point, the pain persists after the stopped probe
Vertical percussion of the tooth	painless	
The temperature probe	The pain from the cold water, which persists for 1-2 minutes, after removal of the irritants	Painful reaction to cold or hot water, which persists after removal of irritants
Electro excitability (from the bottom of the cavity)	8-12 μA	15-25 μA

Table 3.3.

Differential diagnosis of acute pulpitis and other diseases

Clinical signs	Diagnosis: Acute pulpitis	Diagnosis: Acute or aggravated periodontitis	Diagnosis: Acute sinusitis	Diagnosis: Neuralgia
The nature of pain	Acute, spontaneous, paroxysmal pain worsening at night and radiating along the branches of the trigeminal nerve	Constant achingpain aggravated by mechanical action of the tooth(biting)	The constant aching and throbbing pain in the upper jaw, radiating along the branches of the trigeminal nerve	The paroxysmal, debilitating pain, begins spontaneously and terminates abruptly
Factors that provok e pain	Thermal irritants when released into the cavities. After the elimination of their actions, the pain decreases disappearing gradμAlly	Touching the teeth, biting causes pain	Can cause pain when biting the teeth that are adjacent to the inflamed sinus, tilt their heads	Mechanical and thermal irritants in the trigger points
Objective clinical symptoms	The probing of the bottom cavity causes sharp pain. Acute purulent pulpitis can cause pain on percussion	Cavity, sensing the bottom safely, sharp pain on percussion, swelling and redness of the mucous membrane of the causative tooth	The feelingof nasal congestion, difficult breathing through the nose corresponding a half of the nose, mucous or purulent nasal discharge	Autonomic manife stations in the form of facial flushing, lacrimation, excessive salivation. Reflex contraction of masticatory muscles
The general condition of the patient	Possible headaches fatigue, impaired performance, especially purulent	Possible headaches, fatigue, sleep disturbance and appetite increase	Fever, weakness, headache which increase by coughing, sneezing, tiltedhead	Does not change. During the attacks the suffering patient freezes in a pose, afraid to move, holds his breath or on the contrary, has a rapid breathing, compresses or stretches the painful area

4. CLINICAL PRESENTATION, DIAGNOSIS OF CHRONIC FORMS OF PULPITIS. DIFFERENTIAL DIAGNOSIS (Lecture 4)

4.1. Clinical manifestations and diagnosis of chronic fibrous pulpitis (Pulpitis chronica fibrosa)

Chronic fibrous pulpitis - is the most common form of pulpitis, which is the outcome of acute pulpitis.

People with low reactivity of the organism have sometimes a chronic fibrous pulpitis which may occur without pre-symptomatic stage of acute inflammation.

Complaints:

The pains occur only at exacerbation of a chronic process. The pain comes as a response to thermal, chemical and mechanical irritants, and passes immediately after the removal of the cause. The pain may occur when the temperature changes abruptly.

Often, the patient has not complaints, and chronic fibrous pulpitis is detected during the inspection. Weak pains explain a good drainage (connection with tooth cavity).

With the open tooth cavity the "suction" from the tooth can provoke pain. There is a constant gravity in tooth chronic fibrous pulpitis.

Objective examination:

On examination a deep cavity with softened dentin is revealed. The tooth can change its color. The visible denuded swollen pulp has a grayish-brown, pale pink color with a bluish tint.

Description of the carious cavity:

The cavity of the tooth is opened at one point, the probing is sharply painful.

Probing:

Probing the pulp causes slight pain and unsharp bleeding, which is gradμAlly stopped.

Temperature probe:

The reaction to cold is painful. When the pain cause goes away, the pain stops in some time.

Percussion:

The percussion is painless. Sometimes the comparative percussion helps to determine the aching tooth.

Palpation:

A painless palpation

EDI:

The pulp electroexcitability decreases - 35 μA.

X-Ray:

On the x-ray the periodontium changes are identified in 30% of cases.

4.2. Clinical manifestations and diagnosis of chronic hypertrophic pulpitis (Pulpitis chronica hypertrophica)

This form of pulpitis is often found in children and young people. The anamnesis states the presence of acute pain in the past. The patients complain of pain and blood appearance from the cavity during solid food chewing, or with tooth "suction".

Chronic hypertrophic pulpitis has a number of clinical features.

- There is a granulating shape with the tooth cavity opening, from which swollen bleeding granulation tissue grows. Pain symptoms are less revealed.
- Another form (formation of the pulp "polyp") is a later stage. The surface of a rounded formation, a reddish-gray epithelium is tightly fused with the underlying tissue.

Complaints:

The patient complained of bleeding from the tooth during chewing, the pain in the tooth is in contact with hard food. Sometimes the patient's worries appearance of a tooth, from the cavity is "something protrudes".

Objective examination:

On examination, the carious cavity is determined, being partially or completely filled with the enlarged tissue.

When there is a granulation form, the color of the tissue – is bright red, due to bleeding, probing a moderate pain is detected.

Polyp pulp has a pale-pink color (the color of normal mucosa), there is no bleeding upon probing, the pain is weak, and there is a dense texture of the polyp.

Abundant dental deposits are revealed on the side of the painful tooth, patient is not chewing by teeth of this part.

Probing:

The superficial probing causes pulp tissue sprawling, a little pain and bleeding (granulation form).

Temperature response:

When cold irritants cause unsharp pain that quickly passes. The response to thermal irritants is weak.

Percussion:

Percussion is a little bit sensitive.

Palpation:

Palpation is painless.

EDI:

The pulp electroexcitability is reduced.

X-Ray:

The changes in the periapical tissues are not detected on the x-ray.

4.3. Clinical manifestations and diagnosis of chronic gangrenous pulpitis (Pulpitis chronica gangraenosa)

It develops from a fibrous or chronic purulent pulpitis, when the pulp contact with the putrefactive bacteria.

Complaints:

The patients' complaints of this pulpitis form are often lacking. The pain can be from various irritants, often from hot. The pain occurs when there is a change in temperature, a foul smell from mouth. The tooth had pain in the past. The pain passed gradμAlly. The patient complains of spontaneous aching with short light intervals during exacerbation of chronic gangrenous pulpitis. The hot irritants, at the same time provoke pain, but the cold, for a long time, calms the pain. The pain is worse when biting on a tooth.

Objective examination:

- Deep carious cavity.
- The color of the tooth has a grayish tint.
- UsμAlly the tooth cavity is widely opened.
- The surface layers of the pulp is a dirty-grayish color and do not bleed.

Probing:

The probing is painful in the deep layers of the coronal pulp and root canals. The surface probing is painless, and the profound one is painful.

Temperature response:

Hot irritants provoke pain

Percussion:

The percussion of the tooth is painless. Due to gangrenous pulpitis exacerbation there is a painful percussion.

Palpation:

The palpation is painless. In aggravation the palpation is painful.

EDI:

The pulp electroexcitability is reduced to 40-60 μA at first, then to 60-80 μA.

X-Ray:

The periodontal ligament expansion and the bone desorption with indistinct contours (with deep necrosis of the pulp).

4.4. Clinical manifestations and diagnosis of chronic concrementous pulpitis (Pulpitis chronica concrementosa)

- The reason for this form of pulpitis is denticles or petrifications, which are formed in the pulp tissue due to the active process of calcification. Denticles are a special form of various shapes and sizes that differ by location: the free ones are located in the pulp, parietal are associated with the wall of dentin, interstitial are located in the dentin.
- On the genesis and structure the denticles are divided into high organization: the first consists of dentin canalization, the second one of dentin non-canalization. In the central part of denticles - a more mineralized tissue. There are the so-called cores of amorphous mineral salts.
- Formation of connected petrifactions with metabolic violation and microcirculatory processes in the pulp tissue and should be referred to the phenomena of calcareous degeneration.
- The most salt deposits occur along the major blood vessels and nerve bundles that pass in the root pulp.
- Mineralization focus can occur in other parts of the pulp. The most frequent concrements are detected in the posterior teeth in patients over the age of 40 years.

• These structures irritate the nervous system and the pulp tissue, leading to chronic inflammation. The denticles can be both a cause and a consequence of degenerative changes in the pulp.

• The concrementous pulpitis occurs in the teeth with high solid tissues abrasion or in the teeth treated in the past from tooth decay. Sometimes concrementous pulpitis is detected in patients suffering from periodontal diseases.

• The pulp inflammation can perhaps develop in intact teeth.

• An important fact in diagnostic of concrementous pulpitis is the painful percussion of the tooth. It is needed to perform a comparative percussion of the healthy teeth. Drastic change of the head position can be a cause of paroxysmal pain.

• The final diagnosis was confirmed by X-ray examination that determines the presence of denticlis.

• Diagnosis of concrementous pulpitis is difficult.

Complaints:

Patients complain of severe pain spontaneous attacks, irraditated in trigeminal nerve branches typical for night pain.

Concrementous pulpitis is clinically similar with trigeminal neuralgia, so the differential diagnosis should be done carefully.

The pain attack appears at night.

The neuralgic pain, has a different intensity and a slow, gradμAl (over months or years), increasing frequency of attacks. There are no signs of irritation of the autonomic nervous system, characteristic for the branches of trigeminal neuralgia during the attacks.

Although the tooth denticles trigeminal neuralgia can sometimes be, by "Kurkova" a trigeminal (trigger) zone. The touch of this area causes intense pain.

Probing:

Probing the cavity of the tooth shows denticlis.

Temperature response:

Not typical.

Percussion:

Percussion is slightly painful and can provoke the appearance of paroxysmal pain.

Palpation:

Painless palpation

EDI:

Electroexcitability 40-60 μA

X-Ray:

The tooth visible denticles, obliteration of the pulp chamber and root canals in the cavity

4.5. Clinical manifestations and diagnosis of exacerbated chronic pulpitis

Each form of chronic pulpitis be can exacerbated.

More often exacerbated chronic fibrous pulpitis, flowing from the closed cavity of a tooth. Less exacerbated is the acute ganrenous pulpitis.

The sign of exacerbation is the appearance of spontaneous acute pain, worse at night and due to different irritants.

This form of pulpitis is mistaken with the diagnoses of acute pulpitis, which can lead to incorrect treatment choice.

The anamnesis has an important role in diagnosis. As a disease duration, objective research data - the state of the bottom of the cavity, a body cavity of a tooth, probing, data thermometry, EDI.

Complaints:

Paroxysmal, irradiation pain, aggravated by thermal irritants.

Probing:

Painful across the bottom of the tooth cavity, painfully on the opened horns of pulp.

EDI:

The pulp electroexcitability is reduced to 60-80μA.

X-Ray:

X-Ray: The deformation (or expansion) of periodontal ligament can be identified in apical part of root.

4.6. Differential diagnosis of chronic fibrous pulpitis and deep caries

General:

- The presence of a deep cavity;
- Complaints of pain from all types of irritants.

Differences:

- In chronic fibrous pulpitis the painful reaction to irritants does not disappear immediately after the removal of the cause, but in the deep caries - at the same time;
- The chronic fibrous pulpitis has a connection (communication) with pulp chamber. The probing is sharply painful. The bottom of deep dense carious cavity, painful probing evenly over the bottom and the dentin-enamel border;
- In anamnesis you can find, that in chronic fibrous pulpitis the tooth was ill before. In deep caries, the spontaneous or aching pain was not present.
- The performance of EDI in chronic fibrous pulpitis - up to 35-40μA, and in deep caries - up to 12-18 μA;
- X-Rays: The chronic fibrous pulpitis can identify the pulp chamber connection with carious cavities. The periodontal ligament is sometimes the extension of the root apex. That is not in the deep caries.

4.7. Differential diagnosis of chronic fibrous and chronic gangrenous pulpitis

General:

- Asymptomatic, in some cases;
- Pain irritants on the temperature probing;
- The presence of a deep carious cavity, communicating with the cavity of the tooth.

Differences in case of chronic gangrenous pulpitis:

- The crown is darker than in chronic fibrous pulpitis;
- The communication with the cavity of the tooth is wider;
- Probing of the bottom of the cavity, punching holes and the orifices of the root canal are painless or slightly painful, the pulp does not bleed;
- The temperature probe more on hot then on the cold, but in chronic fibrous pulpitis - on a cold;
- EDI in chronic gangrenous pulpitis - 60-100 μA, and the chronic fibrous pulpitis - 35 - 40 μA.

4.8. Differential diagnosis of chronic fibrous pulpitis in the exacerbation phase and acute focal pulpitis

General:

- The presence of a deep carious cavity;
- A painful probing at one point;
- Inducing a prolonged cold aching pain;
- Spontaneous pain with "light" intervals.

Differences:

- The presence of irradiating pain in chronic fibrous pulpitis in the exacerbate stage, which is not in acute focal pulpitis;
- The presence of spontaneous or prolonged aching pain from a variety of irritants in the past, but in acute focal pulpitis - there are no more than 1-2 days;
- The carious cavity communicates with tooth cavity. Probing is painful. But in acute focal pulpitis the tooth cavity is not opened (except for the traumatic pulpitis);
- Acute focal pulpitis occurs in patients with high reactivity of the organism, that is quite rare;
- In acute focal pulpitis there are no changes in the periapical tissues;
- Percussion in acute focal pulpitis is always painless.

4.9. Differential diagnosis of chronic fibrous pulpitis with exacerbation phase and acute diffuse pulpitis

General:

- Complaints on the spontaneous aching with "light" intervals, irradiating along the branches of the trigeminal nerve;
- Chemical and thermal irritants which provoke the pain;
- Deep cavity - probing is painful;
- Percussion may be painful.

Differences:

- The presence of spontaneous pain in the past, chronic fibrous pulp in the exacerbate stage. Acute diffuse pulpitis may be no more than 2-14days;
- Probing in chronic exacerbate fibrous pulpitis - painful at one point, the tooth cavity is opened. In acute diffuse pulpitis

probing is painful, over the bottom of the cavity and there is no communication with the cavity of a tooth;

- In acute diffuse pulpitis cold can stop the pain, which is not observed in chronic exacerbated fibrous pulpitis.

4.10. Differential diagnosis of chronic exacerbated fibrous pulpitis and acute or exacerbated apical periodontitis

General:

- The long-term aching pain;
- Change in the color of the tooth;
- The presence of a deep cavity (or filling tooth);
- Percussion is painful.

Differences:

- Pulpitis required the presence of "light" painless periods, and in acute forms of periodontitis pain is constant, increasing over time;
- In pulpitis - pain arises from the thermal irritants, which is not the case with periodontitis;
- The reaction to percussion during exacerbation of chronic fibrous pulpitisis is weak. But In acute forms of periodontitis - the tooth hurts even when touched;
- Palpation of transitional fold is painless, but in acute forms of periodontitis the transitional fold is edematous, hyperemic, painful;
- EDI in periodontitis is more than 100 μA, the pulp is lost;
- X-ray data also help to correct the diagnosis. In periodontitis in the periapical tissues destructive changes are revealed, with the exception of acute periodontitis in the stage of intoxication.

4.11. Differential diagnosis of chronic hypertrophic pulpitis and growth of papilla

General:

A common fact for these diseases is the appearance of the cavity, filled with the granulation tissue, probing provoke bleeding and weak pain (with the exception of the pulp polyp).

Differences:

- To grown papilla can push an instrument or a cotton ball out of the cavity and find its relation to the interdental papilla. Hypertrophic pulp grows out of the hole of tooth cavity.
- On the X-Ray we can see a carious cavity, which communicates with a tooth cavity.

4.12. Differential diagnosis of chronic hypertrophic pulpitis and overgrown granulations from the perforation of bottom of the pulp chamber (zone of bi- or trifurcation)

General:

- Carious cavity is filled with granulation tissue;
- Probing of granulations provoke bleeding.

Differences:

- Probing in zone of perforation is less painful, in contrast to chronic hypertrophic pulpitis;
- The level of perforation often lies below the neck of the tooth, but with hypertrophic pulpitis - higher (at the level of the roof of pulp chamber);
- The proliferation of granulation tissue from the zone of bifurcation (trifurkatsii) due to perforation of the bottom cavity of the tooth. This is a medical mistake in treatment of pulpitis and periodontitis.
- X-Ray: determined the communication from the tooth cavity with zone of bifurcation or trifurcation. Bone loss in this area. In the cronical hypertrophic pulpitis - the changes in the periodontium is not detected;
- EDI: In pulpitis less then 100 μA, but in periodontitis - more than 100 μA.

4.13. Differential diagnosis of chronic gangrenous pulpitis and chronic apical periodontitis

General:

- Asymptomatic begining (without exacerbation);
- Complaints about putrid smell from the cavity;
- Painless probing of the surface layers in the cavity of a tooth;
- X-Ray: changes in the periapical tissues.

Differences in chronic apical periodontitis:

- From anamnesis - an inflammation of the gums and pain when biting on a tooth during an exacerbation;
- A tooth will never respond to thermal irritants;
- When viewed from the folds of the transition a fistula, or a scar from fistula , or congestive hyperemia can be identified;
- Probing is painless in root canal. Exception: when the granulation penetrates in root canal.
- But in this case turundas are found to be of a bright red blood, which is not typical for a gangrenous pulpitis;
- The granulation at probing is less painful than the pulp is preserved in the channel with gangrenous pulpitis;
- EDI: is more then 100 μA.

4.14. Differential diagnosis of chronic gangrenous pulpitis in exacerbation stage with acute diffuse pulpitis

General:

- The presence of long-term spontaneous aching pain without "light" periods;
- Hot provokes pain, cold - is stopped;
- Percussion - painful

Differences:

- In chronic gangrenous pulpitis in the exacerbated stage of the anamnesis it was revealed that this tooth had pain before, but in acute diffuse pulpitis in the past there was not a spontaneous pain, as it exists no more than two weeks;
- In gangrenous pulpitis the carious cavity communicates with tooth cavity, but in acute pulpitis – the tooth cavity is usμAlly closed;
- X-Ray: changes in the periapical tissues in gangrenous pulpitis, which is not common in acute pulpitis.

4.15. Differential diagnosis of chronic gangrenous pulpitis in the exacerbated stage, and acute or exacerbated apical periodontitis

General:

- The presence of a long-term aching pain;
- Pain when biting, painful percussion;
- There is a communication with tooth cavity of the tooth surface probing which is painless;
- A putrid odor of the tooth;
- X-Ray: changes in the periapical tissues.

Differences:

- In pulpitis the pain is periodic, but in acute forms of apical periodontitis it is growing, without "light" periods;
- Biting on the tooth of this form of pulpitis it is not as painful as in the acute forms of periodontitis. When we touch the tooth – there is pain;
- The deep probing with gangrenous pulpitis is painful, but in periodontitis - without pain;
- In gangrenous pulpitis – pain from the hot irritant. In periodontitis – painless.
- EDI: in the pulpitis to 100 μA, but in periodontitis - more than 100 μA.

Table 4.1.

The main differential diagnosis of chronic concrementous pulpitis

Clinical signs	Diagnosis: Chronic concrementou s pulpitis	Diagnosis: Tic douloureux (neuralgia)
Pain	Slowly increasing pain irradiating to the spontaneous, prolonged episodes of pain, often at night, can be provoked by thermal stimuli	Suddenly there is a short of referred pain it is sponta-neous, sudden, often at certain times of day. The pain occurs when you touch the skin of the face, oral mucosa, the conversation (Kurkov) trigger zones.
Electroexcitability	40-60 μA	Does not change

The reaction to percussion	Slightly painful when compared with the reaction healthy teeth	None
Radiographic changes	In the cavity of the tooth visible denticlis, obliteration of the cavity of the tooth, root canal	Radiographic changes in intact missing teeth

Table 4.2.

Differential diagnosis of exacerbated chronic pulpitis

Symptoms	Diagnosis: aggravated chronic pulpitis	Diagnosis: Acute diffuse pulpitis	Diagnosis: aggravated chronic periodontitis
Pain's Type	Paroxysmal, radiation, increasing from thermal irritant	Spontaneous, paroxysmal, worsening at night from cold, irradiation	The constant, aching, the biting on the tooth
Duration of illness	The acute period of 1-2 days. In the anamnesis of an acute pulpitis 6-12 months ago	Tooth ache 2-3 days. In anamnesis - no sickness	3-5 days, anamnesis of severe pain 1-2 years ago
The cavity probing	Across the bottom of painful sharp horns of the exposed pulp	Painful over the bottom	Painless
The mucous membrane of the gums gingiva	Does not change	Does not change	Hyperemic, edematous, painful on palpation
Electroexcitability	60-80 μA	25-40 μA	100-150 μA
X-ray study	Slight expansion of periodontal ligament at the apex	No pathological changes	Deformation or destruction of periodontal ligament space, depending on the forms of periodontitis

5. METHODS OF PULPITIS TREATMENT. INDICATIONS AND CONTRAINDICATIONS FOR CONSERVATIVE METHODS OF TREATMENT (BIOLOGICAL METHODS). VITAL AMPUTATION. BIOLOGIC METHODS OF PULPITIS TREATMENT. THE MEDICAMENTOUS REMEDIES USED IN DIRECT AND INDIRECT CAPPING. MECHANISM OF THE ACTION
(Lectures 5 and 6)

5.1. Methods of pulpitis treatment

In the treatment of pulpitis it is necessary to resolve the following issues:

- Eliminate the painful symptoms;
- Eliminate the focus of inflammation in the pulp;
- Prevent periodontal tissue damage, to prevent the periodontitis development;
- Enable the root formation for the treatment of pulpitis in the child;
- Restore anatomic form and function of the tooth, as an organ.

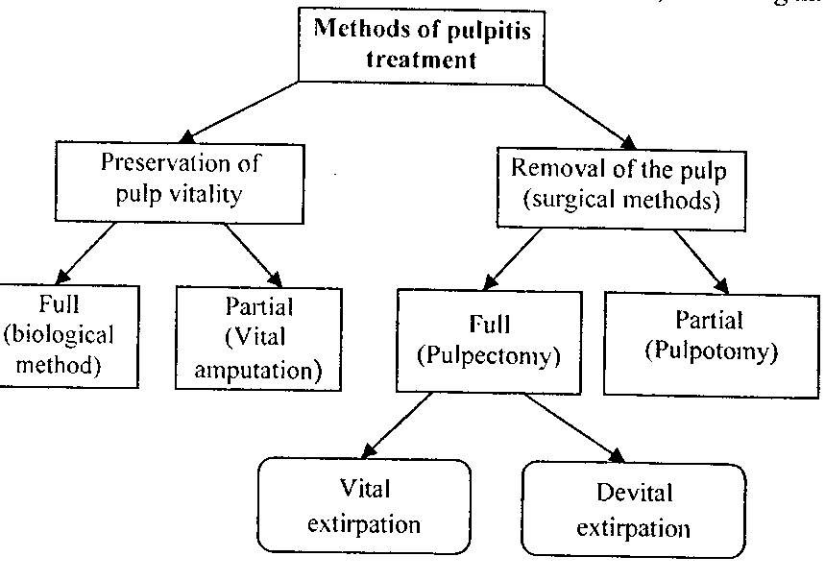


Fig.5.1. **Methods of pulpitis treatment.**

Existing methods of treatment of pulpitis can be divided into:

- Conservative;
- Surgical;
- Surgical-conservative.

Biology (conservative) methods of pulpitis treatment are aimed at the removal of inflammation in the pulp with help of drugs, without removing the pulp, or partial removal of the pulp under anesthesia, and then save the remaining part of it (the method of vital amputation).

Surgical treatment methods of pulpitis (**vital** and **non-vital extirpation**) aimed at removing the pulp under anesthesia, or after pulp devitalization.

Methods of pulpitis treatment can be classified as it follows:

1) The methods of conservative treatment with preservation of the whole pulp (vital methods):
   a) Indirect pulp capping;
   b) Direct pulp capping.
2) The methods of conservative treatment with partial preservation of the pulp:
   a) Vital amputation – Vital pulpotomy;
   b) Non-vital amputation – Devital pulpotomy.
3) Surgical procedures to remove completely the pulp of a tooth:
   a) Vital extirpation – Vital pulpectomy;
   b) Non-vital extirpation- Devital pulpectomy.

There is also the following classification of pulpitis treatment methods:

1) Preservation of the pulp (vital methods) - conservative methods:
   a) The full preservation of the pulp (biological method);
   b) On the partial preservation of the pulp (vital amputation) - Vital pulpotomy.
2) Without the preservation of the pulp - surgical methods:
   a) Vital extirpation - Vital pulpectomy;
   b) Non-vital amputation - Devital pulpotomy;
   c) Non-vital extirpation - Devital pulpectomy.

5.2. Conservative treatment of pulpitis

The theoretical basis of biological treatment of pulpitis is its high viability, reactivity and plastical function.

The essence of the conservative (biological) treatment method of pulpitis is a complex of therapeutic measures aimed at microflora suppression, and on the inflammatory process elimination with preserving maximum integrity of the tooth pulp.

Indications for conservative method:

1. Acute focal pulpitis;
2. Traumatical opening of tooth pulp at cavity preparation;
3. Young age (28 years);
4. Absence of severe concomitant chronic or acute illness before or during the treatment;
5. No changes on X-rays in the apex of the root;
6. Lack of allergic reactions to the drugs used;
7. The tooth is not subjected to prosthetics;
8. The carious cavities are not to be localized in the cervical region;
9. The path of infection - only through the crown of the tooth;
10. The pain point should be less than 24 hours;
11. Electrical pulp excitability should be 20 - 25uA;
12. Supra pulpal dentin should be similar in consistency and color to normal (unaffected), dentin;
13. The sensitivity of the pulp in probing should be high - the patient must feel the lightest touch of the probe.

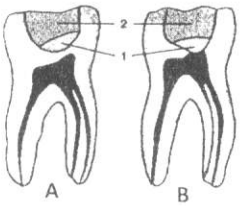


Fig.5.2. **Biological methods of pulpitis treatment:**
A - Diagram of the indirect pulp capping with curative paste;
B - Scheme of direct pulp capping with curative paste;
1-Therapeutic paste of calcium hydroxide;
2 -Filling (temporary or permanent).

Contraindications:

1. Age over 40 years;
2. The general condition - chronic diseases (diabetes, atherosclerosis, and vitamin deficiency diseases, periodontitis, periodontal disease, etc.);
3. Cavities in the cervical region;

4. Reduction of pulp electro excitability more than 25uA;
5. Radiographic changes in the periapical area of the tooth;
6. Use of the tooth as a support for the prosthesis.

The stages of biological treatment methods:

Treatment is carried out in one or two visits.

1. Anesthesia;
2. Mechanical manipulations of the cavity with the principles and stages of preparation. Carious cavity is prepared with sterile sharp spherical burs, which change as they approach the pulp of a tooth;
3. Carious cavity cleaning must be done without any, low concentration irritant antiseptic solutions. We recommend the following drugs:
   - 0,1 - 10% solution of Dimexidum;
   - 0,06 - 0,3% solution of Chlorhexidine;
   - 1% solution of Iodinol;
   - 1% solution of Betadine;
   - 0,02% solution of Furacilini (Frc);
   - 0,5% solution of Novocain;
   - Solutions of enzymes (trypsin, lysozyme, etc.).
4. Degrease and drying of the cavity - is carried out with sterile cotton rolls and a jet of warm air. Alcohol and ether are not applied because they are irritants;
5. Using curative pads (layer) and filling the cavity.

5.3. The method of conservative pulpitis treatment

At the first visit:

- Making the antisepsis of oral cavity – analgesics should be applied.
- The painful tooth is isolated by cofferdam or by sterile cotton rolls.
- The surface of the affected and of the two adjacent teeth is treated with 2% iodine solution, 1% chloral hexidine or other antiseptics.
- After that, when the suction-device is continuously working, we must to prepare thoroughly the carious cavity. This operation should be carried out in a professional manner, with a clear

representation of topographic relation – "carious cavity - the cavity of a tooth".

- Carious cavity must be disclosed maximally as to remove all the infected tissue, other - a wider field of medicinal substances contact with the inflamed pulp. Special attention during the preparing should be paid to the state supra-pulpal dentin at the bottom of the cavity this often depends on biological treatment success. The softened carious dentin was carefully removed with a sharp bur.
- Then apply curative base (layer). Curative base are applied as a thin layer (0.5 mm) at the bottom of the cavity.
- Temporary filling.

During the second visit, in the absence of patients' complaints, maintaining airtight bandage of clinical studies positive results, the second phase of treatment begins.

- Remove the temporal filling from the carious cavity;
- Irrigate with warm solution of the antibiotic or other drug;
- We impose a paste based on calcium hydroxide. It's alkaline reaction stimulates the production of secondary dentin.
  a) For a direct pulp capping it is advisable to use soft paste, a slowly hardening one (Reogan Rapid, Biopulp, etc.);
  b) To cover indirect - such as hardening paste Dycal, Life, etc.

Press pasta gently to the bottom of the cavity and close by the temporary filling for 5-7 days.

This manipulation produces cautious movements without the pressure of the back of the excavator, a slight smoothing of the drug with a sterile cotton swab (roll).

In the second visit, the patient was marked by the presence of pain. Then the re-imposition of medical dressings was done for another 1-2 days.

If the pain does not disappear after a double overlay pad with medications, it is recommended to use one of the surgical methods of treatment.

- If patient does not have pain, in 5-7 days from the temporary fillings place, the treatment will be finished in the third visit. Leave the temporary filling partially. Impose a pad of glass-ionomer cement. Place a permanent filling.

- Prior to the imposition of a permanent filling, it is necessary to check the vitality of pulp with an electro- thermometer.
- A crucial step in the treatment of pulpitis by biological methods is the influence on the inflamed pulp.
- We distinguish direct and indirect capping of the pulp.

Direct pulp capping - when carious cavity communicate with tooth cavity (accidental opening of the pulp during the treatment of deep caries).

Indirect pulp capping - supra-pulpal dentin is intact (Carious cavity doesn't connect with the tooth cavity).

The treatment includes two-steps:

The I-st visit – the imposition of glyco-cortico-antibiotic paste under the bandage (temporal filling) for 3-7 days.

The II-nd visit includes the imposition of calcium hydroxide or zinc oxide eugenol paste. When result of treatment is negative – the vital extirpation must be produced.

The evaluation of the treatment effectiveness is carried out in 2 years. It depends on:

- The patient's age,
- Limitation of pulpitis,
- Pathway of infection,
- X-Ray data,
- Electrometric data,
- Thermometric data,
- Correct treatment.

The method is technically very simple. But the difficulty of identifying the early stages of inflammation of the pulp and mistakes in diagnosis lead to a rare use of it.

5.4. The medicamentous remedies used in direct and indirect capping

As a basis for therapeutic pads sulfanilamide drugs, antibiotics, steroids, enzymes, pastes – containing eugenol, oil solution of vitamin "A", heparins and bone meal (1:10), remodent and preparations based on calcium hydroxide can be used .

Standard tools for this method were the calcium hydroxide, in numerous forms, which have a bactericidal effect, normalize the acid-

alkaline balance of the inflamed pulp have anti-inflammatory, dehydration effect stimulate remineralization of softened and secondary dentin formation.

Table.5.1.

Calcium hydroxide curing materials for direct and indirect pulp capping The materials of chemical crystallization.

Name of material	Manufacturer	Characteristics	The method of application
Calcimol	«VOCO» (Germany)	On the basis of 26% solution of $Ca(OH)_2$. System "paste-paste"	Equal parts of main paste and catalyst and mixed for 10 seconds, and used for indirect pulp capping. Crystallization time – 45Sec.
Calcimol Hydroxide	«Degussa» (Germany)	On the basis of hydro-calcium. Bases paste and catalyst	Equal parts are mixed on the paper block 10-15 Sec. Direct and indirect pulp capping. Crystallization time – 40Sec.
Alcaliner MiniTip	«ESPE», «3M» (Germany)	On the basis of calcium hydroxide in the MiniTip cartridge, Bases paste and catalyst	Equal parts are mixed 10Sec. Crystallization time – 50Sec.
Septocalcine Ultra	«Septodont» (France)	Bases paste and catalyst in tubes.	Equal parts are mixed on paper block 10Sec. Crystallization time – 40Sec.
Life	« K e r r » (USA)	Material based on calcium hydroxide in the two tubes (base and catalyst)	Equal parts are mixed on paper block -10Sec. Crystallization time – 30Sec
Dycal	«Dentosplay» (USA)	On the basis of calcium hydroxide and butylenes displitsilat In the two tubes	Equal parts are mixed on paper block -10Sec. Crystallization time – 45Sec.

The success of the **antibiotics** therapeutic effect is largely determined by the sensitivity to them. The most sensitive flora of the inflamed pulp to neomycin sulfate, chloramphenicol, polymyxin M sulfate, monomitsine, bitsilline, chlortetracycline hydrochloride. The concentration of antibiotics in the paste should not exceed 500-1000 units. in 1 ml of solution. The excess in their content inhibits the phagocytic activity of cells in the pulp and protective processes in it. Large doses of antibiotics can lead to necrosis of the pulp.

The use of **antibiotics** for conservative treatment of pulpitis does not always succeed, because it provides the only antibacterial therapy, as justified by a combination of antibiotics with drugs that stimulate the plastic and regenerative functions of the pulp: sulfanilamide drugs, corticosteroids, vitamins and enzymes.

Corticosteroids relieve pain component, have a pronounced anti-inflammatory effect, but at the same time reduce the reactive state of the pulp, preventing the formation of granulation tissue, facilitating the regeneration of the pulp. The not-lasting effect on the pulp (4-6 days) does not cause adverse changes in it. However, the use of corticosteroids in the form of dressing is advisable to limit further 3-5 days to replace them with by means of promoting the dentin-formation. The formation of dentinal bridge in pulp is accelerated by using a combination of corticosteroids with preparations containing calcium hydroxide.

Calcium hydroxide in different prescriptions affects the pulp having better funds than other.

Normalizing acid-alkaline balance of the inflamed pulp, they have anti-inflammatory dehydration effect: stimulate the processes of demineralization of softened dentin and secondary dentin formation. In this regard, there is an extensive use of dosed paste, containing calcium hydroxide, in combination with antibiotics, sulfanilamide preparations, corticosteroids, etc.

These pastes are divided into self curing (chemically cured) and light-cured and are used in direct and indirect pulp capping.

Table.5.2.

Light-cured calcium containing material to cover the dental pulp

Name of material	Manufacturer	Characteristics	The method of application
Calcesil LC	«ВладМиВа» (Russia)	On the basis of calcium hydroxide. Available in bottles of 6 g	It is used for indirect pulp capping, introduced at the bottom of the cavity. Layer -1 mm. Polymerized 20 Sec
Calcimol LC	«VOCO» (Germany)	On the basis of 5% solution of calcium hydroxide with a prolonged action. Available in tubes of 5 g	In the cavity of 1 mm thick material is introduced. Polymerized 30 Sec. Used to indirect pulp capping.
Septocal LC	«Septodont» (France)	On the basis of hydroxyl-apatite, calcium fluorine. Available in 10 g syringes	Apply at the bottom of the cavity for indirect pulp capping. Light-curing 10 Sec.
Ultra-Blend	«Ultradent» (USA)	On the basis of calcium hydroxide, hydroxyl apatite, calcium, and glass-ionomer cement. Available in 10 g syringes	Extruded directly onto the horn of the pulp or the bottom of the cavity. Polymerized 20 Sec.
Lica	«Dentamerica» (USA)	On the basis of calcium hydroxide. Available in 10 g syringes	It is used for indirect pulp capping. Layer - 2 mm. Light-curing – 30 Sec.

In biological method of pulpitis treatment using proteolytic enzymes.

The enzymes rationale use is due to their property of nonviable issue melting, dissolving micro-tombs, improving the flow of fluid, reducing the antibiotic resistance of microorganisms.

From this point of view the use of proteolytic enzymes (trypsin, chymotrypsin, lysozyme) and their inhibitors (kontrikala, ambena) is very promising in the treatment of pulp inflammation.

5.5. The method of vital amputation

The method of vital amputation is related to biological methods, as it can maintain the pulp vitality. The method requires a ruled execution of asepsis and antisepsis. It is necessary to exclude the ingress of saliva into the cavity of a tooth. It is necessary to use sterile instruments and materials, to replace often the sterile burs. This type of treatment is used in multi-rooted teeth.

The essence of this method is the surgical removal of the focal area of inflammation (coronal and orifices pulp). For the remainder part of pulp (stump) medicamentous remedies (paste) must be placed.

The method is based on the ability of the root pulp to the reparative processes. The limit of surgical intervention should be a sensitive, bleeding, pink pulp, which retain viability.

Indications: amputation should be performed in all cases, where conservative treatment for any reason can't or has not given any effect.

- Acute focal pulpitis;
- Accidental exposure of the pulp (traumatic pulpitis);
- Chronic fibrous pulp – electro excitability to 40uA;
- Age - children and young people;
- Condition - the patient is clinically healthy;
- Direct and indirect pulp capping has not given any effect;
- It is used only in multi rooted teeth, where the coronal pulp is clearly separated from the root;
- A tooth with unformed roots.

The objectives of the treatment:

- Removal of painful symptoms as a cardinal sign of pulpitis;
- Removal of the source of infection and intoxication of the necrotic tissue pulp necrectomy ;
- Disclosure of the focal inflammation source;
- Stopped inflammation's promotion by pulpotomy or pulpectomy;
- Stop bleeding of the pulp;
- Treatment of the pulp stump with antiseptics or antibiotics to relieve inflammation;
- Application of pastes, contributing to the final resolution of the inflammatory process to stimulate and restore normal function;

- Restoration of anatomical forms and physiological functions of tooth (tooth filling).

The method of vital amputation consists of a number of techniques, that are carried out consecutively:

1. **Antiseptic treatment of the surgical field.** Rinse the orifices with warm solution of permanganic acid (1:5000), or 1-2% solution of baking soda, "Stomatidina», «Tantum Verde», Furachilline solution, etc.
2. **Preparation of the operative field** is carried out by mechanical and chemical treatment of the painful tooth, and of two neighboring teeth. It is necessary to apply mild antiseptics. Painful tooth and neighboring teeth must be carefully cleared from the soft deposits.
3. **Anesthesia.** This is a crucial step that allows a painless treatment. The technique is performed under infiltration or conduction anesthesia.
4. ***Treatment of carious cavities.*** Preparation of caries cavities and disclosure of tooth cavity must be done with asepsis and antisepsis compliance. Preparation of carious cavities should be done very carefully. At first, remove the overhanging edge of the enamel. Fissured, globular, or conical burs are wide open, expanding the carious cavity, the excised nonviable tissue of dentin. With a sharp excavator removes softened infected dentin from the walls and bottom of the carious cavity. After mechanical processing of carious cavity – it is needed to do the antiseptic processing.
5. ***Opening the cavity of the tooth*** - the creation of carious communications cavity point with a pulp chamber. Communications with a tooth cavity can be detected by probing. Opening the tooth cavity (the pulp horns) is carried out applying an antiseptic. In this case sterile round bur of a medium size must be used without an undue pressure.
6. ***The opening of the tooth cavity*** - removing the roof of a tooth cavity for creating access to the pulp chamber and root canal orifices. The roof of the tooth cavity is removed with a sterile fissured bur.

   The requirements for tooth cavity opening:
   - Walls of the formed cavity should coincide with the walls of the tooth cavity;
   - Lack of a tooth cavity set and its overhanging edges;
   - Free tool access to the root canals (at the entrance of the root canal instrument do not curve).

7. ***Amputation of coronal pulp***. Amputation is removal of the coronal pulp with the root pulp preservation. Amputation is carried out with a sharp excavator or with a round bur. The orifices of the root canal pulp are cut with the least trauma. Wounds should be cut and not torn. The tooth cavity is rinsed with warm antiseptic: 0.02% solution of Furacilini (Frc), 1% solution of iodinol, 0.5% hydrogen peroxide solution, 1% solution of "Betadine".
8. ***Expansion of the root canal orifices***. Spherical, pear-shapped or hastate burs of corresponding sizes (№ 1 and 3) expand the orifices of the root canal, which prevent the possibility of complications. After expansion, the orifices must be of a funnel form.
9. ***The wound surface treatment of the pulp stump***. In the process of opening the tooth cavity and pulpotomy, the carious cavity we must be irrigated with anti inflammatory solutions. In order to prevent the infection into the root pulp, all manipulations should be carried out accurately and rapidly. We must change quickly the cotton rolls, preventing the ingress of saliva into the tooth cavity.
   The irrigation is done by introducing warm antiseptic drops with sterile syringes for 3 - 5 minutes.
10. ***Stop the bleeding***. In case of bleeding from the root channels orifices are used: 5% solution of aminocaproic acid, 0.5-1% solution of hydrogen peroxide, hemostatic sponge, a solution of adrenalin, which are used being introduced into the cavity of the tooth for 3-5 minutes on sterile cotton swabs.

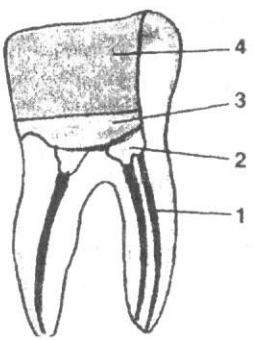


Fig.5.3. **Diagram of a tooth filling after pulpotomy:**
1 - Stump of the root pulp, 2 - Medicinal paste to the root of the pulp stump, 3 - Isolating pads, 4 - Permanent filling.

11. ***Drying of the pulp chamber.*** Drying is carried out with sterile cotton swabs or a jet of warm air (do not use ether!).
12. ***The application of treatment paste.*** The purpose of this stage -to prevent the development of the inflammatory processes in the remaining root pulp, and to stimulate pulp repair processes.

Calcium hydroxide therapeutic paste is applied, without any pressure above the orifices of the root canal. Pasta is isolated by water dentin, then placing glass-ionomer cement and permanent filling.

Sometimes the treatment is carried out in two visits. We apply the treatment pads with calcium hydroxide. After this the temporary filling on basis of zinc-eugenol paste which is set on 3-4 weeks. In the absence of the pain, the temporary filling is changed for a permanent one.

As a result of the treatment on the surface of the amputation wound, connective tissue capsule and dentin bridges are formed, that maintains a viable root pulp.

The patient is taken to the dispensary registration for a subsequent control of the root pulp state with electric pulp test methods (EDI) and X-Ray imaging.

6. SURGICAL METHODS OF PULPITIS TREATMENT. THE METHOD OF VITAL EXTIRPATION ADVANTAGES AND DISADVANTAGES
(Lecture 7)

6.1. The indications of vital pulpectomy

1. Acute and chronic pulpitis;
2. Accidental opening of the pulp horns, where vital methods are contra-indicated;
3. Complications of conservative methods (direct and indirect pulp capping, vital amputation);
4. Hyperesthesia - when other methods are not effective;
5. Pathological teeth abrasion (III, IV degree);
6. A significant loss of hard tissue (the inability of the material retention);
7. The tooth crown fracture, with the opening of the pulp chamber;
8. The arsenic paste, and does not succeed if imposed (does not remove pain);
9. In periodontal diseases with tooth mobility of the second degree;
10. Retrograde pulpitis, if the infection came through the periodontal pocket;
11. With Orthopedic goal (at anomaly position of the teeth, with risk of opening a tooth cavity);
12. Root fracture in the third middle;
13. Teeth near the pathological processes (cysts) prevent injury from neurovascular bundles;
14. Teeth in the fracture of the jaw;
15. Trigeminal neuralgia (pulpitis calculus);

6.2. Contraindications

1. For patients with common pathology, the use of anesthetics and vasoconstrictors is contraindicated (diseases of the cardiovascular system - hypertension, sensitivity to lidocaine, epilepsy, etc.);
2. Pregnancy in the first three and last two months;
3. MenstrμAl period (bleeding from the canal during the operation);
4. Inability to apply anesthesia for inflammation, trismus, jaw restrictions, etc.

6.3. Anesthesia

The pain, which is characteristic for many forms of pulpitis, is accompanied by a number of changes in the various organs and body systems.

Disturbances in these systems are not only pain but also its expectation and previous treatment experience. These patients often have an inadequAte response during the test, and the normal contact is perceived as pain and irritation, as an intense pain.

Therefore, prior to the treatment of pulpitis is necessary to eliminate or reduce the psycho-emotional stress, fear and anxiety. The attention, patience, courtesy, participation, shown by the staff, comfort-table rooms in the office (flowers, soft music) - are the psychological factors under whose influence the agitation, annoyance, emotional stress of the patients are reduced.

If it is necessary to correct the disturbed emotional state of pharmacological agents, the premedication is carried out for 30-50minutes prior to the therapeutic manipulation. As premedication (sedation) such benzodiazepine tranquilizers like Seduxenum (Relanium) at 0.005-0.01 g, Elenium - 0.01g, etc may be used . For this purpose, you can use non-narcotic analgesics (aspirin, Analgin, Paracetamol, etc.) to reduce pain associated with inflammation.

Only after the establishment of the normal contact and trust between patient and doctor the first stage of pulpitis treatment – anesthesia can pass.

During the anesthesia it is necessary to use the following principles:

1. Local anesthesia should be performed only by a special carpool syringe with a good lock on the piston;
2. Carpool with anesthetic should be securely fixed to the syringe with the plunger retainer;
3. After the puncture needle satisfied the aspiration probe, it is necessary to make sure that the needle does not hit the vessel;
4. The speed of the local anesthetic should be no more than one ml per minute;
5. Prior to anesthesia is always evalμAted the general condition of the patient, on the base of chosen anesthetic;

6. The contraindications for the use of adrenalin-containing local anesthetics for uncompensated forms of cardiovascular diseases, myocardial infarction, cardiac arrhythmia, pronounced thyrotoxicosis, severe forms of diabetes, renal diseases must be remembered ;
7. An injection of anesthetics containing vasoconstrictors, there can be such possible complications as:
   a) high blood pressure;
   b) arrhythmia
   c) tachycardia;
   d) a sense of anxiety and fear;
   e) sweating
8. The choice of anesthetic for the elderly patients with general medical conditions in a compensated form requires a special approach. It is better to use the anesthetic "Mepivacaine" - it does not contain vasoconstrictors, or "Articaine" - which contains a minimal amount of vasoconstrictor (1:200,000). It should be remembered that the anesthetic "Mepivacaine" is more toxic and has a longer period of breeding, so we recommend the "Articaine" to be used.
9. Patients with hyperthyroidism, diabetes, and taking three-cyclic antidepressants (amizin, amitriptyline, reserpine, raunatin, aminazin, thyroid hormones) have a high response to adrenergic agents. They need to use a new vaso-compressor - "Femipressin", which causes vasoconstriction of veins, rather than of arteries, and it is safe for patients with cardiovascular diseases.
10. Allowed for the introduction of anesthetics during anesthesia - from 0.8 to 4.0 ml.

Prior to the treatment of pulpitis it is necessary to remove the patient's psycho-emotional stress (fear, anxiety).

Maximum attention should be paid to the patient, with patience a calm atmosphere in the office may be quite music. If necessary, the patient is given some premedication.

The premedication is administered for 30-50 minutes before treatment, such tranquilizers as Seduxenum, renalium 0,005 - 0.01 g, Elenium - 0.01 g, etc for this purpose, you can also use analgesics: Aspirin, Analgin, Paracetamol, Ketanov).

Clinical practice shows that when in the endodontic treatment an adeqμAte pain relief is needed, a tooth removal is done only through an operation.

Good pain relief creates a psycho-physiological comfort, reduces emotional stress and contributes to a better contact between the dentist and patient, as well as improves qμAlity and shortens the time of endodontic treatment.

The medicines used for local anesthesia, can be divided into amide (lidocaine, trimecaine, mepivocaine, articaine) and ether (procaine, dicaine, anestesine). Compared with novocaine, lidocaine is 4 times stronger and 2 times its toxicity is higher. Ultracaine (Articaine) is 5 times stronger and 1.5 times more toxic than novocaine.

The preparation marcaine (bupivacaine) is 8 times stronger and 3 times more toxic than novocaine. To reduce the general reaction of the organism to the introduction of local anesthetic the anesthetic should be administered slowly (not less than 20 seconds).

For greater anesthesia injection efficiency, a vasoconstrictor is added to the anesthetic (adrenalin or noradrenalin).

In dentistry, for the teeth pain relief the following concentrations of vasoconstrictors: Adrenaline - 1:50000-1:250000, nor epinephrine - 1:50000-1:100000 are used.

Top anesthetics with high concentration of vasoconstrictors (marked as "Forte" or "SP").

The advantages of keeping a vasoconstrictor:

1. improve the efficiency of anesthesia;
2. extension of time steps;
3. reduction of the dose (longer delays);
4. provision of hemostasis;
5. reduction of toxicity (slow flow of blood).

The local anesthesia methods can be used practically for the endodontic treatment:

1. Applicative anesthesia;
2. Infiltrative anesthesia:
   a) direct;
   b) indirect.
3. Conductive anesthesia:
   a) tuberal;
   b) incisor;
   c) palatine;
   d) infraorbital;
   e) mandibular;
   f) torusal;
   g) mental.

4. Spongy anesthesia:
   a) intraosseous;
   b) intraseptal;
   c) intraligamental.
5. Intrapulpal anesthesia.

6.4. Extirpation method of treatment (Pulpectomy)

Extirpation method of treatment (or Pulpectomy) (done under anesthesia) is the surgical removal of the coronal and root pulp.

The surgical intervention is performed after the pulp's anesthesia and is considered classic, in the one-stage complete removal of the tooth s pulp from the apical part, being followed by the medication influence, for the rest of pulp tissue, in the lateral tooth root ad periodontium branches.

Indications for pulpectomy (extirpation). A complete removal of the vital pulp can be carried out in all forms of inflammation. Accordingto the established guidelines pulpectomy has direct indications:

- all kinds of inflammation, which are contained in the existing classification of pulpitis;
- traumatic pulpitis (acute trauma with fracture of the tooth crown);
- acute diffuse pulpitis;
- acute purulent pulpitis;
- calculus (concrementous) pulpitis;
- chronic hypertrophic pulpitis;
- chronic gangrenous pulpitis.

Pulpectomy (extirpation of pulp) is also indicated in cases where inflammation of the coronal pulp after amputation goes to the root pulp (residμAl pulpitis), or there is an ascending (retrograde) pulpitis as a consequence of infection by marginal or hematogenic ways.

The method is shown in the localization of the carious cavity in the cervical region or in the cement of the tooth root:

- the initial stages of inflammation of the pulp;
- in patients with various somatic diseases of the body;
- pulpitis, complicated with periodontitis, lymphadenitis;
- in the treatment of teeth that will be used as a reference for bridges;
- the planning of surgical interventions with periradicular cysts;

- If it is necessary, to remove the pulp in the treatment of generalized periodontal diseases, orthodontic and orthopedic indications.

6.5. Methods of the Vital pulpectomy (Vital extirpation)

The classic treatment is considered, when the complete removal of the pulp under anesthesia is performed in one visit.

For the success of this rather complex surgical intervention a sequence of manipulations, preparing the necessary instruments and medicines should be defined, in the future - implementation of each phase of treatment.

The technique of vital extirpation contains the next stages:

The first stage. ***Oral hygiene***

Is the antiseptic treatment of teeth at the site of the sick teeth

The second stage. ***Anesthesia***

The anesthesia methods choice depends on the overall condition of the patient, the presence of sensitization of the organism, the nature of inflammation in dental pulp, topographic anatomy of the painful tooth and around tissues.

The vital extirpation should be remembered. This procedure is long 1-1.5 hours in the treatment of single rooted tooth, and 1.5-2 hours in the treatment of pluriradicular tooth.

If the doctor chooses for pain relief one of the injection methods (or one of the combinations methods), it is advisable to use anesthetics on the basis of amides (lidocaine, articaine, mepivacaine etc.) with vasoconstrictors.

The third stage. ***Preparation of carious cavities***

The purpose of this phase is the creation of a free access to the tooth cavity (pulp chamber), a cavity extending to the border of the tooth cavity.

The access to the cavity of a tooth in the premolar and molar teeth - on the chewing surface, in front teeth - with the lingμAl (palatal) surface, for this purpose fissure burs of various sizes are used.

In this phase we can use air turbines installations and must work very careful (because it is easy to perform perforations in regions of bi- or trifurcation).

If cavities are located at the contact surface of the teeth, it is necessary to extend the chewing or lingμAl surface within the projection of the pulp chamber.

The preparation of carious cavity in the front teeth, from cosmetic reasons, is done to maintain the vestibular wall and the cutting edge. In the front teeth the access to the pulp chamber is created with the lingμAl (palatal) surface, according to the projection of the tooth cavity.

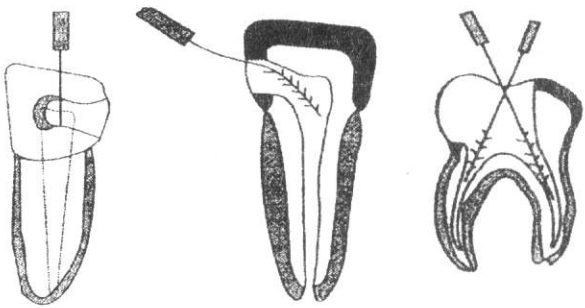


Fig.6.1. **Preparation of cavities.**

Right opening of pulp chamber (a, c); Invalid opening of pulp chamber (b).

The fourth stage. ***Disclosure of the tooth cavity***

Completing the preparation of carious cavities and the antiseptic treatment, with sterile spherical or fissure bur perforate the pulp chamber, with the small size of fissure, the bur penetrates the cavity and it expands gradμAlly it by a circular motion, excising the pulp chamber roof.

We need to work very carefully, because this manipulation may excise excess of tissue. This can lead to the pulp chamber walls thinning and it sometimes ends with perforation.

Properly disclosed a cavity of a tooth is fully merged with the carious cavity.

The fifth stage. ***Amputation of the pulp (pulpotomy)***

Amputation of the pulp is done by a large round bur (in molars) or a sharp excavator.

This step must be exercised carefully, because we can perforate the wall and the bottom of the tooth cavity. Rightly carried out the amputation creates an easy access to the orifices of the root canal. In

case of bleeding, the cavity is washed with 3% hydrogen peroxide solution and vasoconstrictors antiseptic.

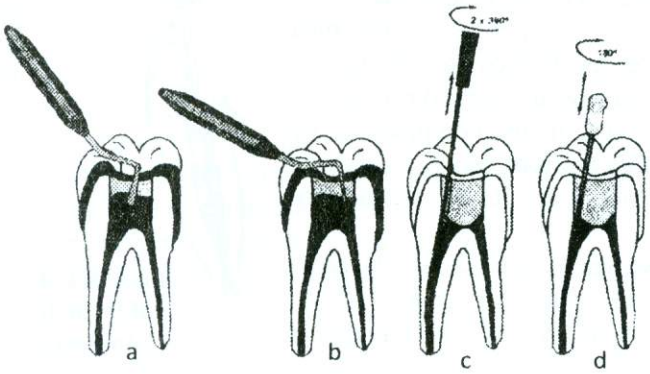


Fig.6.2. **Methodology of vital extirpation (Vital pulpectomy).**

The sixth stage. ***Expansion of the mouths' channels***

Round burs of small sizes or special tools like Gates-Glidden, Peeso, etc. are used for this purpose. It is necessary to give the orifices of the root canal a conical shape. As a result of this phase the endodontic instruments should enter the root canals freely and without bending.

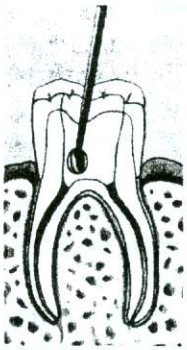


Fig.6.3. **Expansion of the mouths of channels.**

The seventh stage. Extirpation of the root pulp (pulpectomy).

Removal of the root pulp is done by the pulp-extractor in a corresponding amount. It is selected taking into account the length and diameter of the root canal.

Pulp extractor is introduced (enter) into the root canal without careful efforts to a weak stop, it is taken 1-2 mm back (up) and rotated around the axis, one or two turns, then it is extracted from the canal.

The extirpated anemic pulp (pale, bloodless) has a vermiform shape. It resembles the tip of the mouse tail.

The hysterectomy is performed using K-files or H-files to remove the pulp in the narrow and curved canals.

This step can be complicated by bleeding from the root canal. To prevent this it is necessary to do Diathermocoagulation.

In the dental practice for Diathermocoagulation such devices as "BS-2", "CS-2M", "CS-ZM", etc are commonly used.

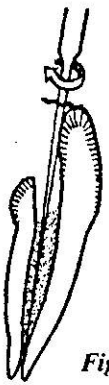


Fig.6.4. **Extirpation of the pulp's root (pulpectomy).**

The methodology of the Diathermocoagulation of vital pulp in root canals:

Diathermocoagulator is prepared for the work the power is set at 6-8 scale divisions, setting current density to 6-8 $\mu A/mm^2$, the tooth is isolated from the saliva being dried.

The acute needle root, which is an active electrode of Diathermocoagulator is introduced into the orifices of the root canal.

When we press on the button, on the active electrode (root needle) the current is supplied and at this time, push the needle inside of the root canal, to the level of the apical opening.

Without turning off the current, the needle is removed from the channel.

Circuit should be opened (to free the button of active electrode), when the tip of the needle reaches the orifices of the canal. Coagulation of the root pulp should not last more than 3-4sec.

After performing the Diathermocoagulation it's necessary to do the root pulp extirpation.

The technique of Diathermocoagulation is based on zone demarcationcreation, resulting in no bleeding from the root canal.

It is **contraindicated** to do Diathermocoagulation in patients with cardiovascular system diseases and individμAl intolerance to electric current.

The eighth stage. **Measuring the length of the canal**

It is performed by apex locator. The electrometric method is more commonly used to determine the length of root canals in modern hospitals.

*The electronic methods b*ased on Suzuki's theory of the constant electrical tissue resistance, Sunada (1962) invented an electronic root canal measurement, a device which compares the electrical resistance between the tip of a root canal tile attached to one probe lead and the reference probe which is placed on the patient's lip. Starting from these devices, they have continuously improved.

Several devices should be mentioned:

- the analogues devices (Dentometer, Endometer) which are not so accurate, because they are sensible to the canals' humidity generated by blood, connective tissue, exudates, sodium hypochloride;
- the audiometric and digital devices (Sono-Explorer. Neo-Sono, Apex finder, Odontometer, Formation IV), sensible only to the sodium hypochloride solution;
- the high frequency devices (Ultrasonic - Locater), which are more efficient.

These apex-locators use alternative current through two electrodes, one on the oral mucosa and the other inside the canal and the impedance between the apical tissue and the oral mucosa is registered; when the electrode reaches the apical foramen it emits sonorous or optical signal.

After working the length evalμAtion according to these methods a stopper will be applied on the file and a radiograph will be taken for the accuracy of the results.

One of the latest methods is the Radio-Visio-Graphy which permits the visμAlisation of the entire endodontic space, a direct control of the treatment and it also mentions the localisation of the apex. This system appears to be very promising for endodontics.

The ninth stage. **Mechanical treatment of root canal includes:**

- Expansion of the root canal;
- The necessary root canal shape formation;
- Formation of the apical stop.

Instrumental root canal treatment is carried out in conjunction with medical treatment (3% solution of sodium hypochloride, 0.2% chlor-

hexidine, 1% solution of chloramines and preparations containing EDTA). Here we can use "Step-back" and "Crown-down" methods.

The tenth stage. **Drying of the root canal**

It is done with the sterile turundas on the needle, or paper pins. Don't use air for root canal drying because it can cause air embolism.

The eleventh stage. **Root canal filling**

The results of pulpitis treatment depend on the qμAlity of root canal filling. Root canals need all over fillings. Filling material was adjusted to physiological apex. The choice of filling method and filling materials for root canal is done individμAlly. Upon completion of this step it is necessary to control the qμAlity of root canal filling - by X-Rays.

The twelfth step. **The imposition of an isolating pad (base)**

Isolating material is introduced into the tooth cavity by towel and filled by plugger.

The thirteenth stage. **The imposition of a permanent filling**

Preparation cavity is filled with permanent filling material and the anatomical shape of the tooth is restored.

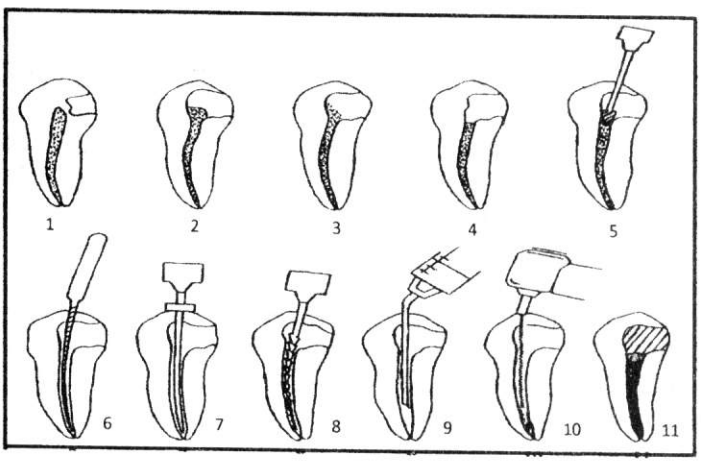


Fig.6.5. **The stages of the vital pulpectomy:**

1) before treatment (caries on approximal surfaces); 2) cavity preparation; 3) disclosure of the pulp chamber; 4) pulpotomy; 5) the expansion of the orifices of the root canal; 6) pulpectomy; 7) determination of the depth of the canal; 8) Preparation and the formation of the canal; 9) drug treatment; 10) canal filling sealer; 11) permanent filling.

Advantages and disadvantages

Advantages:

- Vital extirpation method of the most progressive method.
- Allows the painless treatment of patients.
- Allows you to complete treatment in one visit.
- Saves dentist's time.
- Saves patient's time.
- Allows you to conduct easily the medical treatment.

Disadvantages:

- Can't be used for patients with common pathologies.
- There may be bleeding from the root canal.
- There may be pain after filling.
- The possibility of allergic reactions and anaphylactic.

7. METHOD OF DENTAL PULP SENSIBILIZATION (ARSENICAL AND NON-ARSENICAL REMEDIES), MECHANISM OF ACTION. DEVITAL AMPUTATION AND DEVITAL EXTIRPATION. INDICATIONS AND CONTRAINDICATIONS STAGES. ERRORS AND COMPLICATIONS
(Lectures 8 and 9)

7.1. Method of dental pulp sensibilization. Remedies and mechanism of action

The essence of the method constitutes the coronal removal, or coronal and root pulp with devitalization before it. Devitalization a destruction of almost all the pulp tissue structures with a complete violation of its functions, including its sensitivity to pain.

Indications for use:

- The ineffectiveness of vital treatments.
- Sensitization to anesthetics.
- Patients fear of injections.
- Patients have common severe disease.

The most common drugs used for pulp devitalization are arsenic acid and paraformaldehyde.

Arsenic trioxide (As_2O_3) was proposed for devitalization of the pulp in 1836 by Spooner.

7.2. The mechanism of arsenious acid an impact on the pulp

Arsenic trioxide is a protoplasmic poison, it affects the oxidative enzymes of the pulp, it leads to local disruption of tissue respiration and hypoxia.

As a response to the initial irritation a marked dilation of blood vessels, especially of capillaries thrombosis, hemorrhage occurs depending on changes in vessel walls.

Swelling leads to compression of the pulp tissue. Nerve fibers of the pulp undergo granular disintegration of myelin sheaths, nodular swelling and disintegration of the axial cylinder. This leads to nerve fibers loss, to pulp odontoblast's cells death.

The depth of pulp destruction depends on the time duration and dose of arsenic acid. A prolonged exposure of arsenic acid provokes toxic changes in the periodontium and necrosis of surrounding tissues.

There are four forms of arsenical drugs:

- Powders;
- Pasta;
- Fibers;
- Granules.

The powder is arsenic trioxide, or arsenic anhydride (As_2O_3) - a white, poorly water-soluble powder with a slightly acidic reaction. It is easily dissolved in hydrochloric acid and caustic alkalis. It is not soluble in alcohol, ether and chloroform. It forms a salt with metal. It is a poisonous substance. A single dose of 0.01 grams is toxic. Lethal dose - 0.05-0.1 grams! Applied topically it provokes tissue necrosis. It is available in bottles with ground cover.

A positive feature is its fast action. However, it can cause a severe pain, because it increases the pulpal pressure (due to paralysis of the capillaries). Therefore, it is used in combination with an anesthetic.

For pulp devitalization it is sufficient 0,0002-0,0004 arsenic acid, the recommended duration in single rooted teeth - 24 hours, in multi rooted teeth - 48 hours.

Arsenic paste

Pasta consists *of:*

- Arsenic trioxide, rendering the pulp necrotizing action.
- Local anesthetic (Anasthesine, dicaine etc.) to relieve pain.
- A strong antiseptic (thymol, carbolic acid, camphor, eugenol) - to suppress the micro flora of the tooth cavity.
- Cementing material (tannin) - to increase the action of the paste.

Examples of arsenical paste recipe:

Rp. Ac. Arsenicosi 3,0
Thymoli
Cocaine hydrochlorice ana 0,5
Misce fiat pasta
D.S. For Dental Cabinet

Rp. Ac. Arsenicosi 2,0
Prednisolon 0,05
Lidocaine 1,5
Tricresole 0,45
Camphorae 5,0
Ut fiat pasta
M.D.S. For Dental Cabinet

Arsenic fiber

The fibers on the basis of arsenic trioxide consist of:

- Cellulose fibers;
- Cocaine hydrochloride;
- Arsenic trioxide;
- Chlorophenol;
- Metal oxides (for color).

The fibers of arsenic provoke necrosis of the pulp for 24 hours in single rooted teeth, and 48 hours of multi rooted teeth.

Arsenic granules

The composition of arsenical granules:

- Arsenic trioxide - the dose of 0.5 mg or 1 mg;
- The anesthetic (cocaine or dicaine);
- Wax (softening temperature below 36 ° C, i.e. in the mouth);
- Metal oxides (for color).

Typical, colored pink granules contain 1 mg of arsenic trioxide, and blue granules - 0.5 mg. Pink granules produce pulp necrosis in 24 hours in single rooted teeth, and within 48 hours in multi rooted teeth. Blue granules produce necrosis of the pulp in 48 hours in single rooted teeth, and within 72 hours in multi rooted teeth.

7.3. The rights (rules) of using arsenical preparations

- Do not apply arsenical drugs at the peak of pain. At first we apply anesthetic, and after 24 hours - arsenic medication.
- During the second visit we will do partial preparation of the carious cavity.
- Preparation of arsenic must be placed at the pulp horn opening. This achieves maximum effect faster and stops pain. A thin layer of dentin may be present.
- Preparations of arsenic must be applied without pressure. This prevents pain.
- The bandage should be applied tightly. This prevents necrosis of soft tissues (marginal gingiva, gingival papillae, alveolar gingiva and interdental bone septum sequestration).
- As bandage materials "Kavidur", "Plastobtur", "Dentin-paste", etc are recommended.

- Do not apply arsenical preparations in the carious cavity V class (by Blake), as it is very difficult to achieve a hermetical filling (possible necrosis of surrounding tissues).
- The bandage is applied up to 24 hours in single rooted teeth, and in 48 hours in multi rooted teeth.
- It is needed to mark in the medical chart the date of imposition and removal of arsenic medication.
- Do not apply arsenical drugs to some teeth at one time.

Exposure of the pulp is an extremely painful manipulation it can cause the patient to faint (insensibility). Before the pulp horns opening analgesia (topical or wiring) is necessary.

Techniques of arsenical paste application.

- Partial preparation of carious cavity (large round bur and the excavator).
- Topical (application) anesthesia (2% solution of lidocaine, 10% lidocaine spray).
- Opening the tooth cavity with a sharp round bur № 1 or 2, with probe. Be sure to warn (prevent) the patient about the possible pain.
- Application of arsenical paste. A portion of the arsenical paste (the size of the head of bur № 1 or poppy seed grain) the tip of the probe is placed upon the wall of the cavity over the opened pulp horn.
- Soak a cotton swab with a little anesthetic, squeeze, and promote the arsenical paste on the opened pulp horn without pressure.
- Apply bandage on dentin (24 or 48 hours).
- The patient is prevented about the possible pain in the first few hours and is recommended analgesics.

Fig. 7.1. **Application of arsenical paste.**
1 – Opening pulp horn; 2 – Arsenical paste;
3 – Cotton small tampon with sol. of anesthetic;
4 – Dentin bandage with water.

Less toxic properties has the paraformaldehyde paste. The main component – paraformaldehyde is a polymerization product of formaldehyde. It has a strong bactericidal action. High concentrations of paraformaldehyde with prolonged action are caused by tissue necrosis.

The mechanism of action is:

- In effect on the endothelium of the capillaries.
- In the expansion of blood vessels.
- In the stasis of blood.
- The progressive mummification of pulp tissue, and its turn into a dry gray cord.

Except paraformaldehyde such anesthetics as (benzocaine, trimekain), eugenol are included in the paste.

Currently, a variety of the pasta on the basis of paraformaldehyde: «Parapasta» (Chema, Polfa), «Depulpin» (VOCO), «Devipulp», «Toxovit», «Necronerve» etc are available.

Under the influence of paste containing paraformaldehyde, devitalization of the pulp occurs within 6-7 days in a single-rooted teeth and cut 10-14 days - in multi-rooted teeth.

7.4. Devital amputation (pulpotomy). Indications and contraindication

The essence of the amputation method is to remove the necrotic coronal pulp, and subsequent mummification necrotic root pulp.

Indications: the amputation should be performed in all cases, where conservative treatment for any reason can't or has not given any effect.

- Age - children and young people;
- Heavy overall conditions of the patient (for example, after myocardial infarction);
- It is used only in multi rooted teeth, where the coronal pulp is clearly separated from the root pulp;
- A tooth with unformed roots.
- Resorption of roots of deciduous teeth.

Indications are also associated with the age of the patient and the topographic-anatomical features of the roots of teeth. In some cases, amputation of the pulp is a necessary measure because of, for example,

the root canal obstruction, difficulty opening of the mouth severe general condition of the patient.

7.5. Methods of Devital pulpotomy (Amputation)

The success of the method depends on the careful implementation of the stages of treatment. The treatment is carried out in two visits.

The first visit. The treatment of Devital method of amputation (Pulpotomy) is performed the following steps:

1. Antisepsis of the mouth. Premedication.
2. Preparation of carious cavities is done carefully by references from topical anesthesia. Large round bur or a sharp excavator removes the softened dentine from the walls, and then from the bottom of the carious cavity. Conducted applicative (topical) anesthesia, with a sharp round bur №1 or a probe revealed a tooth cavity at one point. Cavities were washed (rinsed) with warm antiseptic solution.

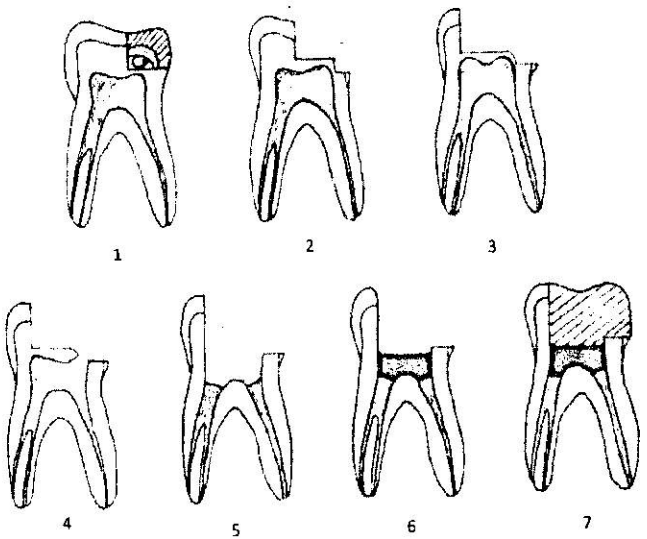


Fig. 7.2. **Steps of Devital Pulpotomy (in second visit)**
1 – Remove the bandage. 2 – Full preparation of carious cavity. 3 – To do the access to root canals. 4 – Opening the pulp camber. 5 – Disclose the pulp chamber and amputation of coronal pulp, pulp resection in the orifices of root canals. 6 – Applied curative paste for bottom of the pulp chamber and orifices of root canals. 7 – Temporal (permanent) filling.

3. Overlay devitalization paste. A portion of the arsenical paste (the size of the head of bur № 1 or poppy seed grain) at the tip of the probe is placed upon the wall of the cavity over the opened pulp horn. Wet cotton swab with a little solution of anesthetic, wring out and paste them to advance at the opening pulp horn, without pressure, the applied dentin bandage (24 or 48 hours).

Be sure to warn the patient about the need to continue the treatment of the tooth at the appointed time, as the neglection of the scheme and the time of treatment can cause various complications and lead to tooth loss.

The Second visit. If the anamnesis, clinical examination of teeth and surrounding tissues revealed no abnormalities, the following steps of treatment can be performed.

1. Removal of the bandage.
2. The final preparation of carious cavities.
3. Disclosure of the tooth cavity.
4. Amputation (pulpotomy) of the coronal pulp with a sharp excavator or big round bur.
5. Expansion of the orifices of the root canal and resection of the pulp from the orifices of root channels lance burs, spherical burs №1 or №3, or Gates-Glidden bur.
6. Antiseptic treatment of the pulp stump and the cavity of the tooth – irrigation with furatsiline (Frc) solution 1:1000, 1% solution of chlorhexidine, etc.
7. Mummification of the root pulp. The formalin-resortsin solution is injected with a pipette or forceps jaws in the tooth cavity. This saturated liquid impregnation remains in the pulp. The orifices of the root canal may be left with small cotton tampon with formalin-rezortsini solution, or liquid Foredent and temporary filling. The pulp converts into a glassy mass as a result of polymerization and the root canal filling is natural.
8. The replacement of temporary fillings is a permanent seal (above the orifices of the root canals are superimposed by resorcinol-formalin paste or Foredent.

Carrying out Devital pulp amputation method of treatment to cover the stump of it a variety of pastas is used.

They can rather be divided into three groups:

- mummified,
- metaplazied,
- odontotroped.

Mummified pastes. They cause the mummification of the pulp stump and thus prevent the further spread of the inflammatory processes in the pulp. Typically, they penetrate quickly into the pulp, causing the protein folding of tissue a sufficient deposition of antiseptics and do not irritate the periodontium. This group includes the resorcinol-formalin paste, prepared ex tempore, «Kreodent" (Russia), "Foredent" (Czech Republic), etc.

Metaplasic pastes. The main mechanism of action is to turn the inflamed tissue of the root pulp into osteoid tissue. The most common metaplased pastes are thymol, yodoformthymol, trioksimethylen paste.

Odontotropic pastes. Quite often, dentists use a paste with odontotropic action. The best known of these are zinc-eugenoly, eugenol, thymol, pasta with sulfonamides.

The effectiveness of pulpitis treatment with amputation method depends heavily on the correct choice of indications for this method, the accuracy of the methods of treatment and selection of pastas to cover the stump of the pulp.

For example, a gross mistake in amputation is the use of Devital pulp capping pastes for the so-called biological effect (with antibiotics, enzymes, etc.).

They are designed to preserve the vital pulp, while in Devital method it is much impressed by devitalization means and are unable to rebuild their livelihoods.

Currently, Devital amputating treatment is not widely used in practice, in connection with narrow indications, and in connection with frequent and serious complications.

7.6. Devital Extirpation

Indications and contraindications:

Devital extirpation (pulpectomy) is a method of complete removal of the pulp after its preliminary devitalization.

Indications:

- In all forms of pulpitis.

- Overview of the disease with contraindications to anesthetics and vasoconstrictors (cardiovascular system, hypertension, epilepsy, etc.).
- The presence of regional disease, preventing the use of anesthetics (acute inflammatory processes, tumors, etc.).
- In the case of unsuccessful conservative treatment.
- In case of refusal by the patient of conduction anesthesia (fear of injections).
- Patients with intolerance (allergy) to local anesthetic drugs.

7.7. Methods of Devital extirpation

Devitalized extirpation is performed in two visits: the first – devitalization of pulp, the second – its complete removal - extirpation.

Technique of the Devital pulp extirpation involves the following steps:

The first visit:

1. Antisepsis of the mouth. Analgesia (Topical - taking analgesics, sedative drugs audio analgesia etc).
2. Preparation of carious cavities is done carefully by references from anesthesia. Large round bur or a sharp excavator removes the softened dentine from the walls, and then from the bottom of the carious cavity. Conducted topical anesthesia, with a sharp round bur №1 or a probe revealing a cavity of a tooth at one point. Carious cavities were washed (rinsed) with warm antiseptic solution.
3. Apply (overlay) devitalization paste. A portion of the arsenical paste (the size of the head of bur №1 or poppy seed grain) is placed upon the wall of the cavity over the opened pulp horn at the tip of the probe. Moisten (soak) small cotton tampon with anesthetic, wring out and paste them to advance at the opening of the pulp horn without pressure. Applying dentin bandage (24 or 48 hours). Be sure to warn the patient about the need for further treatment of the tooth at the appointed time, as the neglect of the scheme and the time of patient treatment can have various complications and lead to tooth loss.

The second visit:

1. After the interview and physical examination - remove the bandage and carry out the final preparation of cavities.

2. Disclosure of the tooth cavity. The roof of the tooth cavity is cut with the fissure bur. The walls of the carious cavity will pass into the wall of the pulp chamber.
3. Amputation of the tooth pulp (pulpotomy). Pulp amputation is performed with a sharp excavator or round bur in the premolars and molars. Properly carried amputation provides a good overview of the surgical field: the orifices should be visible with the grayish-red pulp inside.
4. Disclosure of the orifices of root canals and removal of the pulp orifices perform lance or spherical burs, or Gates-Glidden burs.
5. Extirpation of the root pulp (pulpectomy) exercised by pulp extractors, and in narrow root canals – with H-files or K-files.
6. Determining the length of the root canal.
7. Medicamentous (drug) and instrumental treatment of root canals. After extirpation of the pulp with devitalized arsenical paste use: solutions of iodine, unitiol to inactivate residμAl arsenic. Then rinse (washed) canals with 0.5% sodium Frc, 0.1% chlorhexidine and other. Instrumental arrangements of canals carried out by conventional methods.
8. Filling the root canal and the tooth cavity.
9. Filling the carious cavity.

7.8. Combined method of pulpitis treatment

This treatment is a combination of pulpotomy and pulpectomy.

Indications for use of this method are different forms of pulpitis with a poor cross into the root canal of multi-rooted teeth.

The first visit. Partial preparation of carious cavity, opening the pulp chamber, the imposition of devitalization (or arsenious paraformaldegidy) paste, hermetic bandage.

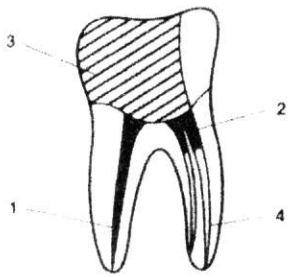


Fig. 7.3. **Combination method of pulpitis treatment.**
1 – Root filling; 2 – Mummified paste;
3 – Permanent filling; 4 – Root pulp

The second visit. The final preparation of the carious cavity, the disclosure of the tooth cavity, amputation of the coronal pulp, the expansion of the orifices of root canals, extirpation of pulp in the distal channel of lower molars and in palatal canal of upper molars, after medicamentous and instrumental treatments the filling root channels is done with hardening paste.

Devitalized pulp, is preserved in curved root channels impassable, covered with mummified paste (resorcinol-formalin, trikredent, foredent, etc.). The tooth is closed with a temporary filling. After 7-10 days in the absence of complaints from the patient and the positive results of objective studies of the tooth and surrounding tissues, the temporary filling should be replaced with a permanent filling.

7.9. Errors and complications in Devital methods of pulpitis treatment

Table 7.1.

Errors and complications in Devital Methods

Complication	The cause of	Methods of removal and prevention
The sharp increase in pain after the imposition of arsenical paste and airtight dressings	Increased swelling of the pulp at the initial stage of devitalization, and the imposition of the paste to the pulp unopened horn, applying a pressure bandage	Remove the bandage, reset paste on the cotton swab and hermetic bandage. In case of purulent pulpitis - always check opening cavity of a tooth
Papillitis, localized periodontitis	Contact arsenical paste on the papilla or in the interdental space if non-compliance the rules of its imposing	A careful examination of all sides of the tooth to identify existing cavities. For the treatment of inflammation use 5% solution unitiola, tincture of iodine, anti-inflammatory and regenerative therapy. Prevent - a hermetic closure of the cavity
Aching pain and sharp painful percussion during the second visit	An overdose of arsenical paste or exceeding the required duration time	Extirpation of pulp by using unithiol or iodine, filling with Sealer, not irritating the periodontium in channels

	Periodontal intoxication by decay products of necrotic pulp	Treatment of toxic periodontitis by Unitiol
Pain in probing the orifices of channels after amputation	A small amount of devitalization paste or little time of its action. Individμal characteristics of the organism	Extirpation under application anesthesia. Or re-imposition devitalization paste to the orifices of the canal with diathermocoagulation
Bleeding after amputations	Incomplete devitalization	Hemostatic agents: • Caprofer, • 3% hydrogen peroxide solution, • 0.25% solution adrocsona, • diathermocoagulation
Bleeding after extirpation	Incomplete devitali zation. Injury of the periapical tissue.	Diathermocoagulation. Observe the size of the channel. Do not allow for the elimination of endodontic instruments over the apical hole

8. MECHANICAL ROOT CANAL TREATMENT AFTER PULP EXTIRPATION. METHODS STAGES INSTRUMENTS (Lecture 10)

8.1. Targets and objectives of mechanical root canal treatment

The success of endodontic treatment depends on the quality of mechanical (instrumental) root canal treatment.

The tasks of mechanical root canal treatment:

- cleaning the root canal remnants of the pulp or its softened infected dentin, microbial and food residues;
- passage of obliterated areas of the root channel;
- removal of barriers inside the channel (dentikles, benches);
- expansion of the root channel, the alignment channel distortions giving a suitable form for filling;
- alignment of the root channel walls in order to improve drug contact with the surface of dentin and to ensure a snug fit for filling material.

For a successful endodontic treatment it is necessary to adhere certain rules:

- Have a full set of qualified endodontic instruments;
- To establish the right access to the orifices of the root channel: endodontic instrument should be introduced into the root channel without bending;
- Before the mechanical root canals the treatment is necessary to expand the mouth of the root channel, giving it a funnel shape;
- In mechanical root canal treatment the endodontic instruments in conjunction with lubricated preparations and chemical expansion of the root canal are used reducing the risk of sticking and instrument breaking up in the root channel, they also speed up the work;
- Before the start of the machining it is required to establish a root canal working length;
- Tools should be used in strict sequence, observing the sequence of manipulations, providing the chosen technique of root canal enlargement. Before using the tool bent in accordance with the curvature of the root channel;

- The expansion of the root channel by hand tools, don't use a large number of rotations. The main movement – reciprocating and sawing;
- In the process of mechanical root treatment (machining) the channel is washed frequently with an antiseptic solution, preferably after each use of endodontic instruments;
- During endodontic manipulations do not use excessive force as this may lead to deformation and breakage of the tool.

8.2. Requirements for root canal after machining

After machining before the canal filling the following criteria must satisfy:

- Clearance of root canal should be round or oval in shape;
- Top (coronal) third of channel should be funnel-shaped;
- The average one-third shall be conical;
- Apical third should be cone should and its diameter must exceed the diameter of the first file, which is wedged in the apex, on 3-4 sizes (but not less than number 25 for ISO);
- In the area of physiological root the tooth apex should be cone-shaped blank, but the apical hole should retain its natural anatomical narrowing. Wide opening is not recommended.

Stages of machining of the tooth root channel(s):

- Disclosure of the tooth cavity and the creation of good access to the mouth is channel(s);
- Channel(s) orifices disclosure;
- Passage of channel(s);
- Expanding the channel(s).

8.3. Principles of access to the root canal

The tooth cavity opening is considered correct if there is free access to the tooth root canal.

The process of creating access begins with the removal of the diseased tooth tissues, after the tooth cavity exposure with spherical and fissure burs.

Creation of access depends on the anatomical tooth structure features. The tooth cavity is a complex system of various configurations branches.

There are several classifications of the teeth cavities configurations.

For example, F.J. Vertucci (1984) identified eight variants (types):

1. One channel extending from the cavity of the tooth to the tip (root apex);
2. Two channels are separated in the tooth cavity and are connected at the root apex;
3. One channel out of the pulp chamber divides into two and then merges into one;
4. Two separate channels come from the cavity of the tooth to the root apex;
5. One channel out of the pulp chamber divides into two at the tooth root apex;
6. Two separate channels, out of the pulp chamber, connect and then separate again at the root apex;
7. One channel out of the tooth cavity, is divided into two, then these channels are combined in one, which is again divided at the apex of the root;
8. Three separate channels out of the cavity of the tooth crown and go to the top of the root apex.

The diameter of the root canal is reduced in the direction of the cavity root apex, and the maximum contraction is located at a distance of1.0-1.5 mm from the holes. Well disclosed tooth cavity should provide access to the mouths' channels and have no canopies (shed) over them.

Passage of the canal provides:

- Anesthesia;
- Creating access to the mouth's root channel;
- Isolation of the tooth;
- Passage of the root canal;
- Expansion of the root canal;
- Medicamentous treatment;
- Filling of the root canal.

Anesthesia. Reliable pain relief, especially in pulpitis, is the key to successful treatment it should be administered absolutely painless.

For this purpose it is necessary to use appliqué gel or solution of anesthetic, that will anesthetize mucosa at the point of injection, and the anesthetic agent should be administered slowly.

Creating access to the orifices of the channel, this is an important phase in endodontic treatment, which creates conditions for the full treatment, and root channels filling.

The cavity of the tooth is a complex system of branching, which has a variety of configurations. The diameter of the root canal is reduced in the direction of the apical foramen, and the maximum contraction is located at a distance of 1-2 mm from the holes.

The distance varying between the root tip maximum and the narrowing point, as well as between the apical foramen constrictions due to the fact that the last (hole) is in most cases not at the apex of the root.

There are apical constriction (physiologic apex), anatomic apex (hole, top) and the radiological apex.

Ideally, the apical constriction, the natural "focus" pin, is introduced into the root canal for obturation.

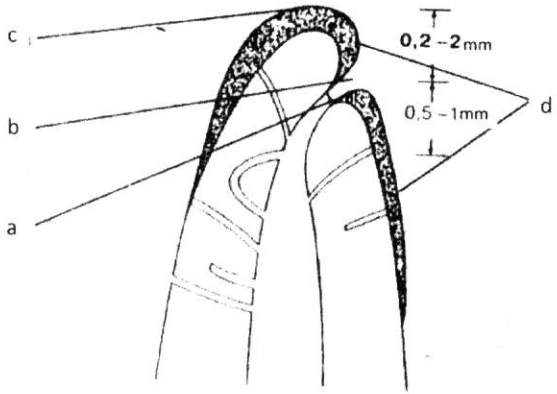


Fig.8.1. **Diagram of the root apex:**
a – apical constriction (physiological apex); b – anatomical hole (anatomical apex); c – radiographic apex of the root; d – secondary cement.

8.4. Methods of root canal treatment

Preparing the root canal it is necessary to comply with the following requirements:

- It is needed to create a funnel shape of the root canal, with a minimum diameter of the physiological apex and the maximum - in the orifices parts. Trying to preserve the shape of the root canal, to prevent its deformation and diameter enlargement.
- The relationship between wall thickness and diameter of the root canal must be balanced it does not weaken the root.
- Apical foramen must maintain consistent position.
- To create holding form for sealer and filler.
- To form the apical stop, that will protect you from removing the filling material over the apex.

It should be remembered that the instrumental processing is necessary for preventing the most common mistakes:

- The formation of the stairs.
- The accumulation of sawdust in the root canal.
- Funnel-shaped extension of the apical foramen.
- Using sharp, hard tools can lead to a "knee" formation.
- Perforation of the small curvature of the root canal (when removing a large amount of dentin).

Root canals preparation techniques:

- Reaming - It is continued work with Reamers and K-files in the root canal by their rotation, and excretion.
- Filling - a work with the K- and H-files, scraping the dentin of the walls of the root canal by up and down movements (without rotation).

Current, methods of root canal preparation are based on two techniques: StepBack («step back") – the extension of root canals from apical constriction up to orifices by the instruments increasing the diameter; StepDown («a step forward") - processing channel from the orifices of root canal up to the apical constriction by instruments which change the diameter from a larger to a less one. There may be a combination of these techniques.

Each of these methods has different variations and modifications.

Using the apical-coronal method, after determining the depth of the root canal, a consistently prepared channel, of a conical form, using endodontic instruments with increasing diameter may be obtained.

Coronal-apical method is to dissect these orifices of the root canal, to determine its working duration, to prepare a conical form in the direction of the tooth root apex. These methods of instrumental treatment of the root canals have certain advantages:

- Provide early release of the root canal orifices from bacteria, which reduces the spread of bacteria in the direction of the root apex in periapical tissue;
- The coronal early expansion part contributes to a better penetration of irrigating solution, reducing the root canal dentin particles blockage;
- The third preparation orifices of root canal shorten the length of the channel. If the working length of the channel will be determined after this phase of preparation, this will reduce the number of errors in estimating the working length of the channel.

8.5. Apical-coronal method. Standard technique

Using this technique, almost all root canals in the cross section should have a cylindrical shape.

The purpose of the method is a consistent preparation of root canal by instruments with increasing diameter up to a needed size.

Stages of work:

1. Determine the working length of the root channel;
2. Introduce the K-Reamer to the resistance, rotate clockwise to capture the dentin and insert it, clean Reamer and repeat the process until the working length of the channel arrival;
3. Repeat the process, using the Reamers with increasing diameters up to the possibility of the root apex preparation using a certain size of instrument (for example, K-file number 25);
4. Create a channel shape that is identical to the last Reamer. After that, filling the root channel.

Choosing a filling material gutta-percha or silver pin it is necessary to format a canal apical stop, which is created near the physiological apex of the tooth.

The performance of this step begins with an endodontic numbered tool, which manages to pass the top channel to the root apex (for example, №10). To K-file introduced into the root channel by rotary movements on the working length, and then sawing up and down, the handle of the channel wall.

Removing the instrument the channel is washed with an antiseptic solution. Then, the channel is treated in a similar way to the same length next to the K-file size (for example, № 15).

Thus, the diameter of the endodontic tool increases consistently, the apical portion of the root channel extends to the physiological apex 3-4numbers greater than the number of the first (original) used instrument (but not less than the number up to 25). The patency of the apical constriction is periodically monitored by K-files or the Reamer of small size - № 06 or № 08.

The method can be successfully applied only in narrow root canals with a round cross section, which are required to dissect the larger sizes.

Using Reamers of larger diameter can lead to channel straightening of the.

This method is hardly suitable for the preparation of complex shape root canals.

8.6. "STEP BACK" technique

This technique has been proposed for the treatment of curved canals.

The purpose of processing channels – tapered root canal preparation using a reciprocating motion and files larger than the usual ones in conventional methods.

This technique allows obtaining (with subsequent application of antiseptic treatment) root clean canals. But it is hard to master the technique. It has the same drawbacks as the coronal-apical method (a possible drift of waste material in the periapical tissue, blocking the root apex and the deviation from the original length, especially when working with thicker, less flexible instruments).

When you work with every type of inside-root endodontic tools, it has positive and negative aspects.

For example, H-files have a lower propensity to move the waste materials in the direction of the root apex, but a careless use may cause straightening or canal's perforation.

Only "Step Back" appliances technique allows forming the conical shape of channel.

Carrying out this technique to observe the following conditions:

1. In the curved root canals, one must first bend endodontic instruments, focusing on the X-ray data and taking into account the length of the root channel.
2. Before the introduction of the endodontic tool into the root canal, it is necessary to grease by lubricants (for example, «Gly Oxide», «Endo Gel», etc.).
3. Using endodontic instruments technique "factory of mechanical watches» (Watch Winding) - the up and down, rotating, quartered (¼), circled (2-3 movements) movements and then – retraction (removal tool), one can use easy, short, and pushed movements to a depth of 1 mm.
4. After removing the tool it should be cleaned, re-curved and lubricated.
5. During the instrumental treatment of the root canals, after each tools removal, it is necessary to carry out root canal irrigation.

Methodology:

Getting started with the definition of the working length of the canal, and then noting its limitation on the instrument. Then enter the root canal to the file size number .08 or .10 for the working length.

We perform rimming and filling up to the moment of his free passage through the channel.

Then go to the next size, reaching a free pass, hold the control flow channel dimensions of the previous instrument.

Thus, the minimum channel extent is up to instrument size .25.

We perform the following sequence of used tools sizes:

.10 - .15 -.10 - .20 - .15 - .25 - .20.

If the work is completed at the top (apical) part of the tool with a number 25, a tool size of 30 is introduced into the channel the working depth should be 1 mm less than the last apical file.

After working, spend recapitulation - the control treatment last apical file (No. .25), formed to smooth the steps and prevent the clogging of the root channel dentine filings.

After that use the size 35, the working depth is 2 mm less than the working depth of the tooth, then the size 40 at 3 mm, etc.

Using the tool of all sizes recapitulation should be carried out.

Coronal and orifices parts of the root channel one prepared by the bur «Gates Gladden».

Upon completion of work, the apical part is washed with sodium hypochlorite solution, leaving it for 5 minutes to clean the additional tubules.

In the apical zone a retention area for pin can be created, to form parallel walls with 3 mm depth from the physiological apex.

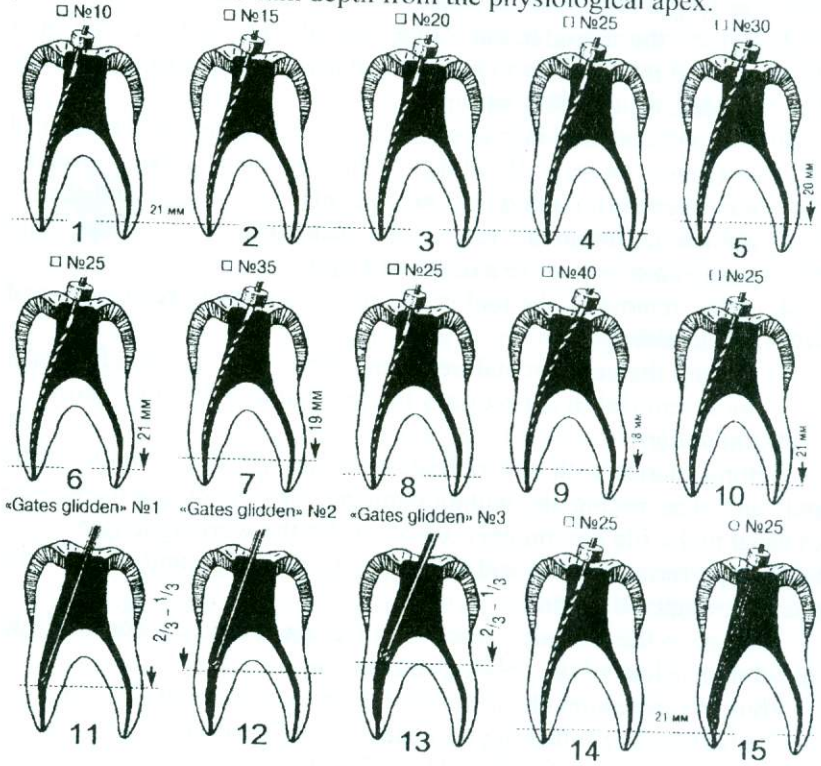


Fig.8.2. **Technique «Step Back».**

8.7. Coronal-apical method. Standard technique

Coronal-apical technique involves the processing and the expansion of the canal from the orifices to the root apex, and the use of tools from a larger size to a smaller one.

At first, dissect the orifices and average parts of the thirds of the root canal. Next, determine the working length of the root channel.

After this prepare the apical part of the root channel and create the apical stop.

Coronal-apical methods are shown in the following cases:

- infection with a significant content of the root canal when there is a risk of pushing the necrotic pulp tissue over the top;
- the use of machine penetration of root canal, for example, if the direct root channel expands by Pesso-Reamers;
- when working with titanium-nickel profiles or GT-files machines.

8.8. «CROWN DOWN» technique

This technique is provided for the phased processing of the channel from the orifices to the top with instruments changes from larger to smaller.

Machining of the channel in accordance with the technique of «Crown Down» is produced as follows.

First, determine the depth of penetration into the root canal with a file number 35.

If the depth is greater than 16 mm, the coronal portion must be prepared.

If the depth of implementation is less than16 mm, the X-ray should be done.

For the narrowing of the root canal preparation should be made up to 16 mm with a smaller size inside of root tools as an instrument with the size number 35, will not be able to reach 16 mm.

If the narrowing is caused by the curvature of the root canal, the channel must first be prepared up to the point of resistance. Then you need to determine temporary working length of root channel, before 3 mm from X-ray apex.

Next, enter the K-file number 35 to the first resistance, producing two full rotational movements without apical pressure. The same manipulation was repeated with a smaller tool to achieve a temporary working length of the root channel.

The final working length of the channel is determined by X-Ray image. After that, repeat the steps described above the file number 40 then the K-file number 50, until the desired working length and diameter.

The walls of the channel are necessary for the H-file.

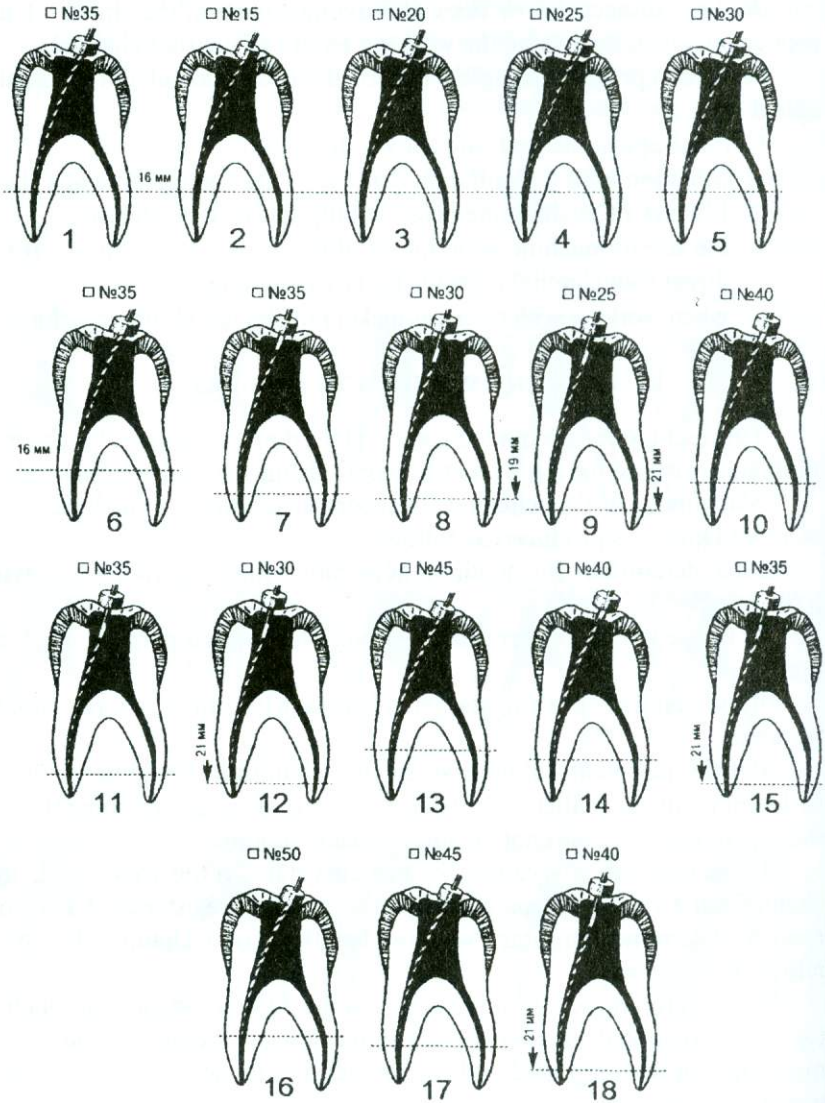


Fig.8.3. **Technique «Crown Down».**

8.9. «STEP DOWN» technique

This method is modified. The first stage of the coronal part preparation of root canal is carried out with H-files № 15, 20 and 25 to a depth of 16 to 18 mm or before the bending of the channel.

Instruments number 08 and 10 are used primarily in the narrow, difficult root canals. This allows you to control the permeability of the root channel. H-files must be re-used for cross-checking of root canal permeability.

Then burs gates Glidden form the orifices of the channel. Bur gates Glidden № 3 should be introduced 1-2 mm into the canal. After that, determine the working length of the root canal and then prepare apical part of the root canal.

Apical cavity opening can be done either manually or using an ultrasonic burs.

Technique «Crown Down» or «Step Down» helps to balance some of the disadvantages of «Step Back" technology.

Advantages of coronal-apical methods:

- provide good access to the apical part of the channel;
- reduce risk of infection near- top tissues by gradual removal of the necrotic tissue from the channel;
- facilitate the processing of medicamentous preparing of root channels;
- reduce risk of sticking the tool in the apical part of the channel;
- reduce the risk of blocking the apical part of the canal with soft tissue and dentine rasping;
- reduce the risk of "working length loss";
- retain the anatomical shape of the channel.

The disadvantage of the method consists in the fact that at the beginning of the work it can't possibly determine the permeability and working length of the channel.

8.10. Common recommendations

It should be remembered that the preparation and processing of the apical part of the channel is carried out according to the root canal technology obturation. If the doctor chooses the technique of root canal filling with gutta-percha pin, then channel dissecting is a very important moment - the creation of the apical stop.

The top of the gutta-percha pins in contact with the apical stop, should be tightly obturated the root apex hole. Rung on the wall of the root canal, you can create using the files of two and sometimes three sizes in one and the same depth. In this case formatted a pronounced shoulder, which is a good focus for the pin.

When processing in a very narrow root canal it is recommended to use chemical expansion.

For this purpose, 10-20% solution of EDTA and gels based on it are used.

When passing the instrumental treatment of root canal, the chemical means of expanding of the root canals should be used in 100% of cases.

The optimal duration of EDTA action in the root canal is 15 minutes. Expansion of the root canal, especially the top portion has minimum and maximum values. It is found that the minimum diameter of the channel is the file number 25 for ISO.

This extension of the channel provides more or less acceptable conditions for its filling. In a given clinical situation the degree of expansion of the root canal is determined individually, but there are recommendations for expanding the size of the apical part of root canals, to be followed according to the table.

Table 8.1.

Dimensions of the recommended expansion of the apical part of root canal [Kerekes K, etc, 1977]

Teeth	The recommended expansion of the apical part of the channel, mm	
	Upper jaw	Lower jaw
Central incisor	70-90	45-70
Lateral incisor	60-80	45-70
Canine	50-70	50-70
First premolar	35-70	50-70
Second premolar	60-90	50-70
First molar	anterior buccal canal – 35-60	front canals – 35-45
	distobuccal canal – 40-60	back canal – 60-80
	palatine canal – 80-100	
Second molar	anterior buccal canal – 35-60	front canals – 35-45
	distobuccal canal – 40-60	back canal – 60-80
	palatine canal – 80-100	

9. MEDICAMENTOUS ROOT CANAL TREATMENT CHEMICAL AND PHISIC-CHEMICAL METHODS REMEDIES MECHANISM OF ACTION
(Lecture 11)

9.1. Medication treatment

Tasks of medication treatment:

- Removal of the organic remnants from the pulp canals;
- Remove dentinal chips;
- Removing the smear layer from the walls of the channel to provide access to additional channels, micro-tubules and branches.

Preparations for medication treatment must meet the following requirements:

- Provide a high bactericidal effect on certain types of microorganisms and microbial associations;
- Facilitate the evacuation from the root canal of organic residues and is not inactivated in their presence;
- To be harmless to the apical tissues;
- Not to have sensitizing effect and not to cause the appearance of resistant strains of microorganisms;
- Have high diffusion properties and provide a fast (almost immediate) bactericidal activity;
- Not to lose its effectiveness in the presence of organic substances;
- If possible, to have an unpleasant odor and taste;
- Be chemically stable for a long time, and remain active.

Table 9.1.

Classification medication for the treatment of root canals

Group	Medications types	Names	Action
Nonspecific	Oxygen-containing medications	3% Solution of hydrogen peroxide, etc.	Atomic oxygen contributes to the mechanical cleaning of the channel. It has a bactericidal and haemostatic properties
	Halogenated (Chlorine) medications	-1-2% Solution of chlorine bleach; - 0.2% chlorine hexidine bigluconate; - 3-5% sodium hypochlorite solution; - Parkano 3% solution; - Proposol CHX	Dissolves necrotic tissue, has a bactericidal effect on gram-positive and gram-negative bacteria, fungi and viruses
	Halogenated (Iodinated) medications	1% solution iodinol - a complex compound of iodine with polyvinyl alcohol	It has bactericidal, fungicidal effect, accelerates the regeneration of tissues
	Medications of nitro furan series	- 0.5% solution of Frc; - Furagin, 0.1% solution	It has a broad spectrum of activity, has anti-exudative effects
	Quaternary ammonium connection	0.1% solution dekamina	Has a bactericidal effect on the spore-forming bacteria, yeast-like fungi
	20% solution of DMSO	Dimexide, dimetilsulfooksid	Has antiseptic, anti-inflammatory, analgesic, bacteriostatic, fungicidal action
	Proteolytic enzymes	Himopsin, trypsin, chymotrypsin	Hass anti-inflammatory, anti edematous effect, split the necrotic mass, diluting viscous secrets, especially immobilized proteolyses forms that retain the activity of 3 to 6 days
	The enzyme protein nature	0.1% solution of lysozyme	It is contained in the body tissues. It has anti-inflammatory, non-toxic action, stimulates nonspecific reactivity

	Orthofen	Orthofen	Has strong anti-inflammatory effect
	Antiseptics plant origin	- Novoimanin, 1% alcohol solution; - Hlorofillipta, 1% alcohol solution; - Salvini, 1% alcohol solution; - Eucalyptus leaves; - sage	Exert anti-microbial effect on the aerobic and anaerobic streptococci, staphylococci
Specific	Antibiotics and their combination with proteolytic enzymes	Trykhopol	Antibacterial
	Chelating	Solutions, gels, EDTA, citric acid and propionic acid	

9.2. Tasks of medication treatment

The main tasks of medication treatment in endodontics are:

- Eliminate the source of infection;
- Clean and shape the root canal;
- Complete the filling of the root canal space.

There are many techniques for giving the channel the necessary form.

The process is complicated by the diverse ramifications of the root canal that do not allow it to achieve a complete cleaning by mechanical processing.

In addition, during the instrumental treatment, on dentin's surface smear layer, consisting of organic and inorganic components is formed.

They are the substrate for the growth of bacteria and adverse affect the adhesive properties of restorative material to dentin of the root channel.

Smear layer must be removed, for example, using irrigation solutions.

The functions of irrigation solutions:

- Washing sawdust (chips);
- Dissolving organic matter;
- Softening the dentin and providing a better sliding of the tool in the channel.

In a classical study published in 1985, Bystrom and other, researchers have compared the effectiveness of three different sterilization methods for endodontic treatment of infected canals.

The results of studies have shown that mechanical treatment in combination with saline irrigation of canals provides sterility in 20% of cases.

Replacement of NaCl 5% sodium hypochlorite solution leads to channels sterility in 50% of cases.

Fig. 9.1. **The movement of washable solution into the root canal.**

The calcium hydroxide root canal filling – channel sterility increases to 97%.

Studies of several authors can identify seven main factors that increase the effectiveness of cleaning and irrigation of the root canal:

- Careful diagnosis of the existing pulp-periodontal disease;
- Consideration of the tissues of the tooth and the complexity of the anatomy of the root canal system;
- Removal of endodontic smear layer;
- Compliance with the testimony choosing the medicaments for irrigation;
- Optimization of the active components of the irrigation solution;
- The correct sequence of irrigation solution during root canal treatment;
- Mandatory irrigation of root canal at least 5 minutes before filling.

For a correct understanding mechanism of the irrigation effect of the root canal, let's consider briefly the question of the pulp pathology diagnosis.

Forty years ago, in 1960, when the methods of microbiological studies were not as perfect as they are now, Engstrom has shown that viable inflamed pulp in a closed cavity of a tooth is characterized by microbial insemination by more than 7% of cases.

This index is characterized by exponential growth to 80% in chronic pulpitis, acute apical periodontitis and pulp necrosis.

Typically, the infection of root canals is associated with the presence of radiographic signs of periapical pathology and clinical symptoms of acute or chronic periodontitis.

Periapical centers (foci) are divided into open and closed, regardless of the symptoms:

Open foci (pockets) often contain an opportunistic microflora of the mouth, passing directly through the pulp or through extra-pulpar entrance gate.

This group includes foci (pockets) of associated infection with not adequate (poor) endodontic treatment and violation of the edge sealing of restorations after endodontic treatment.

Closed foci (pockets) are typically for the teeth with pulp pathology, or the apical periodontal signs of direct penetration of oral microflora.

They are:

- obliteration of the canals;
- post-traumatic necrosis of the pulp;
- periapical foci after not adequately carried out endodontic treatment.

Problems in the treatment of open and closed foci (centers) are substantially different.

Open foci (hearths) associated with microbial colonization of the oral cavity.

Prognosis of these lesions is favorable, providing a complete cleaning of the root canal, obturation and hermetical filling of all the entry gates of infection.

In the study of Abou-Rass and other authors – it was detected in all cases, that more than 63.6% of closed foci had anaerobic microflora, and 36.4% - facultative anaerobic pathogens.

Among the identified microorganisms the authors point out the following strains:

Actinomyces - (22,7%),
Propionibacterius - (18,2%),
Streptococcus - (13,6%),
Staphylococcus - (4,6%),
Porphiromonas gingivalis - (4,6%)
and Gram - negative enterobacteria.

The second important factor is proper irrigation and sterilization - consideration of anatomical features of root canals and tooth structure.

System of a root canal can have very complex morphology, which is often characterized by the presence of lateral canals and anastomoses.

A complete cleaning, shaping and sterilization of root canals may not be in all cases.

The histological structure of the root canal is even more difficult.

From the center to the periphery of the channel it is represented by the following tissues:

- pulp tissue;
- the layer of odontoblasts;
- predentin, i.e. dentin zone corresponding to the mineral composition of the notion of "frontier of mineralization dentin";
- dentin with complex tubular system.

The number and orientation of the dentinal tubules can be variable by physiological characteristics and pathological changes.

According to researchers Garberoglio and Brannstrom, the concentration of dentinal tubules can be from 20,000 to 40,000 units per mm^2, and the middle diameter is within 2.4 mm.

Dentinal tubules create complex three-dimensional communication system between the mouth and the root canal system.

In teeth with viable pulp the gaps of dentinal tubules are filled processes of spikes odontoblasts and dental liquor.

They provide protection for the pulp through the formation of barriers to the penetration of bacteria and their toxins.

Dentinal tubules dehydration occurs in the case of the death of the pulp, in the lumen of the tissue which can be found only in decay processes of the odontoblasts.

Across the tubule the lumen the microorganisms, toxins and drugs that are capable of dentin penetration migrate easily, because the bacteria can lead to failure of endodontic treatment, they should be eliminated.

9.3. Removal of endodontic smear layer

During the preparation of hard tooth tissues, with hand or machine endodontic instruments, on the surface of the dentine a microscopic layer of the sawdust (chips) is formed.

The thickness and composition of this layer is changing by the properties of hard processed tissues and the characteristics of the cutting tool.

Smear layer, is formed during the endodontic treatment, it is characterized by a high content of organic components in the form of fragments of the pulp, odontoblasts and weakly mineralized predentin.

At the same time, there are inorganic components originating from the dentin.

Therefore, to remove the smear layer from the root canal walls, it is needed to use solutions that are effective for organic and mineral components.

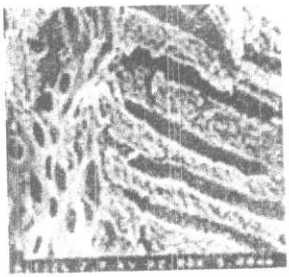


Fig.9.2. **A microscopic layer of sawdust (chips) in the root canal after mechanical treatment (machining).**

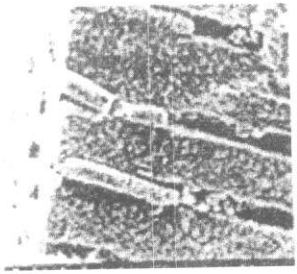


Fig.9.3. **A thick layer of sawdust (chips) and debris (thickness 50 mm).**

Smear layer of the root canal is tightly connected with the wall of the canal through a "greased cork", sinking in the dentinal tubules. The thickness of the superficial smear layer is from 1 to 6 microns, while the depth of its penetration into the dentinal tubules may be higher, reaching 50 mkm.

Smear layer of the root canal may contain micro-organisms and may be a breeding ground for them, as well as it disrupts the adhesion of filling materials to the walls of root canals.

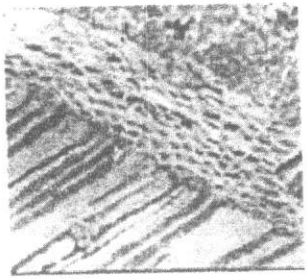


Fig.9.4. **The purified channel wall.**

In connection with the foregoing, the smear layer of root canal should be completely removed.

After removal of the smear layer, well treated dentinal tubules with gaping orifices (mouths) and moderately advanced gaps are clearly visible on root canal walls.

Peritubular dentin is highly sensitive to EDTA or acid solutions, being completely dissolved, while inter-tubular dentin may show oderate effects of demineralization.

Filling materials such as root cements or gutta-percha, with the correct method of application, penetrate and obdurate opened dentinal tubules, contributing to hermetisation of the root filling.

9.4. Irrigation solutions

9.4.1. Water

Water has a high biocompatibility and a low cost.

This makes it very suitable for mechanical jet washout of bacteria due to the reverse current of the liquid.

Unfortunately, conventional irrigation canal by water does not provide complete sterilization of the root canal system or removal of the smear layer, formed during the mechanical processing.

Washing the root channel by water is an important component of the cleaning process and shaping root canals.

It ensures removal of large tissue fragments of temporary filling materials from the channels.

To take full advantage of the jet wash, we recommend using of surgical irrigator "Stropko", preferably with a thin plastic needle to reduce the pressure of the water and air.

9.4.2. Bleach - sodium hypochlorite

Sodium hypochlorite (NaOCl) has both oxidative and hydrolyzing properties: it has a bactericidal and proteolytic effect.

A solution was proposed for the irrigation of wounds in 1915, and an irrigation solution for endodontics was adopted in 1920.

Sodium hypochlorite is traditionally prepared by passing chlorine gas through a solution of sodium hydroxide.

Ready-to-use solutions of sodium hypochlorite for endodontics have expressed an alkaline reaction, hypertensive properties and nominal concentration of 1-5% of active chlorine.

It is important to remember that many of the solutions of NaOCl, used for irrigation of root canals, are household bleach and contain

other components, such as stabilization analyzer (sodium chlorate and sodium hydroxide), cleaning additives (surfactants, fatty acids), flavorings.

In this regard, it is preferable to use solution designed specifically for endodontic applications and have an indication of the self-life and concentration on the packaging.

The popularity of NaOCl as an endodontic irrigation solution is defined by public access and low cost solution.

Many studies have demonstrated its antiseptic and solvent properties.

In particular, NaOCl provides a rapid bactericidal effect on vegetative forms, spore-forming bacteria, fungi, protozoa and viruses (including HIV, rotavirus, HSV-1 and -2, hepatitis viruses A and B).

The mechanism of antimicrobial activity of NaOCl determined the formation of hypochlorous acid and release of active chlorine, which leads to oxidation of sulfhydryl groups of essential bacterial enzymes.

However, there is no consensus on the optimal concentration of sodium hypochlorite for the use in endodontics.

Some researchers (for examples, Brangberg) believe that the 5.25% sodium hypochlorite solution should be diluted before the use of concentration of 0.5 to 5% NaOCl, while other studies have reported that the antiseptic effect is significantly reduced after dilution.

It is important, that the duration of exposure should not be less than 10 minutes, in order to allow the sodium hypochlorite to provide bactericidal activity on resistant microbial species.

Sodium hypochlorite has pronounced solvent properties with respect to the remnants of the pulp, even on the side and additional channels, as well as partially effective for the predentin collagen matrix.

Its impact on calcosferity and the inorganic matrix of the smear layer is slightly.

Solvent effect is determined by the concentration of sodium hypochlorite: the maximum intensity of the effect seen in 5% solution of NaOCl.

To increase the effectiveness of sodium hypochlorite as the solvent of tissue decay it is recommended to:

- use the heated solution at a temperature near 40°C;
- activate and warm the solution by using ultrasonic files;
- use of a temporary root canal filling with calcium hydroxide to take advantage of the synergy of these two substances;

- use in conjunction with surface-active agents to enhance penetration of sodium hypochlorite in dentinal tubules, reducing the number of intra-tubular bacteria.

9.4.3. Bleach - sodium dichloroisocyanurate

Sodium dichloroisocyanurate is one of the chlorine-producing disinfectants and is usually used for disinfection of the contaminated surfaces and solutions.

It is known that a solution of sodium dichloroisocyanurate contains 4.000 ppm (parts per million) of active chlorine, showing that the bactericidal effect is similar to a solution of NaOCl, containing 17.000 ppm of active chlorine.

In the presence of organic material and the antiseptic properties of sodium dichloroisocyanurate solvent is much higher than that of NaOCl.

Heling A recent study evaluated and compared the bactericidal effect of sodium dichloroisocyanurate and NaOCl on the following pathogens: Streptococcus sobrinus, Streptococcus salivarius, Enterococcus faecalis, Streptococcus mutans.

These data suggest that the minimum inhibitory and bactericidal concentrations of the studied bacteria were relatively similar in both the investigated solutions.

In general, the sodium dichloroisocyanurate may be an effective alternative to NaOCl.

9.4.4. Hydrogen peroxide

Hydrogen peroxide is widely used as a solution for rinsing the root canals alternating with NaOCl due to short-term, but the marked effect of foam formation when mixing these substances, which contributes to the mechanical washing of remnants tissue and microorganisms from the canal.

According to Grossman benefits of combined use of NaOCl and H_2O_2 are:

- Foam formation;
- Solvent effect of NaOCl;
- Disinfectant effect of both solutions;
- The bleaching effect of both solutions.

The interaction between NaOCl + H_2O_2 is classically described by the following reaction:

$$NaOCl + H_2O_2 \rightarrow NaCl + H_2O + 2O_2$$

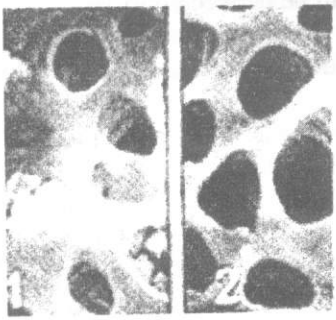


Fig. 9.5. **The surfaces of the walls of the channel before (1) and after (2) the treatment.**

Some authors (for examples, Shiozawa) insist that the reaction is much more complicated and leads to the formation of two types of active oxygen «ROS»: superoxide anion radical (O_2) and hydroxyl radical (OH).

Both «ROS» active and exhibit a more pronounced antibacterial effect for strains of Streptococcus and Staphylococcus aureus, than pure hydrogen peroxide.

However, the active radicals «ROS» can cause irritation of the periapical tissues, and in this regard, it is recommended to wash the root canal with pure distilled water before sealing.

Really alternative to the H_2O_2 is a Glyde (Dentsply-Maillefer ®).

Glyde is a clear gel containing 15% EDTA and urea peroxide on the water-soluble metil-tsellyuloza basis.

Alternating Glyde and sodium hypochlorite solution provides a pronounced and prolonged effect of foam formation, as well as bactericidal activity, while 15% EDTA provides a dissolving effect on the mineralized sawdust (chips).

In addition, Glyde has a useful lubricant and bleaching properties.

For the complete removal of these contaminants it is necessary to use a liquid form of EDTA, activated with ultrasonic files.

9.4.5. The components of EDTA

EDTA is commonly used in endodontics as a liquid or gel as achelating agent that extracts the ions from the calciumhydroxyapatite, dissolving the mineral fraction of the smear layer of the root canal.

The efficiency of EDTA solutions depends mainly on their pH. The optimum pH should be between 6 to 10.

Most ready-made forms are based on disodium EDTA with a neutral pH and provide isomolar chelate calcium binding to the full expenditure of EDTA.

This explains the importance of keeping the solution in the root canal for the use of active EDTA.

For example, O'Connell in one of the most recent research indicates that the isolated use of EDTA without sodium hypochlorite in any case did not ensure complete removal of the smear layer of root canal.

This explains the need of alternating EDTA-containing agents and hypochlorite during endodontic treatment.

Surface-active agents, such as Cetrimide, often add to the finished shape of the EDTA solution (Largal Ultra ® Septodont, or R-EDTA ®) to enhance their penetration into additional canals and dentinal tubules.

Some of the EDTA-containing gels is RC-Prep ® (by firm Premier Dental) and the production recently released Glyde (production Dentsply Maillefer).

9.4.6. Acidic components

Acids used in endodontics for canals irrigation, are phosphoric and citric at a concentration of 6% to 30%.

Acid solutions are highly effective for removal of the mineral component of the smear layer and root canal treatment of obliterated channels.

However, because of their effectiveness as antiseptic and organic solvents it is limited, we recommend combined use of sodium hypochlorite.

In a recent study, we examined the efficacy of two different irrigation solutions combinations:

1) NaOCl + EDTA;

2) NaOCl + phosphoric and citric acid - to remove the smear layer.

Our results suggest that both concentrations were effective, although the use of EDTA was characterized by a sparing effect on the peritubular dentin and inter-tubular, while ascorbic acid showed a more aggressive effect of dentin demineralization with signs on the walls of the channel.

Since acid solutions are rapidly inactivated in the presence of mineralized wood shavings, a solution must be periodically updated, especially if it starts to dry out or obscure.

After applying the acid wash it is recommended to feed with distilled water, as there is a tendency to crystallize and precipitate in the channel walls.

9.4.7. Chlorhexidine

Antibacterial effect of chlorhexidine gluconate in a concentration of 0.2 to 2% is shown in many studies.

For example, Leonardo in the study "in vivo" showed the elimination of Streptococcus mutants 100% and 78% of anaerobic bacteria by using 2% chlorhexidine solution.

Author Vahdaty confirmed the disinfectant effect of chlorhexidine about bacteria in the dentinal tubules, a Hakan-Sen showed an antifungal effect with respect to Candida albicans.

As the solvent with respect to the effectiveness of chlorhexidine organic and mineralized tissue is not expressed, it is recommended to alternate it with a solution of NaOCl.

Two of these solutions are characterized by the combined use of the total effect, perhaps due to the formation of chlorhexidine-chloride components that increase the ionizing properties of the chlorhexidine molecules.

Among the completed forms on the basis of chlorhexidine is "Cetrexidin ®" production VEBAS.

The product contains 0.2% chlorhexidine in combination with 0.2% cetrimide, which reduces the surface tension of the product, increasing its penetration capability and antiseptic properties.

Chlorhexidine can be used for short-term temporary filling of root canals.

In fact, this drug inhibits microbial activity in vivo within 48 hours after application.

9.4.8. Alcohol

The use of alcohol as an irrigation solution is not recommended.

For example, Yesilsoy found that 11.6% of alcohol was very inefficient relatively to most microorganisms.

Ayhan has received more favorable results only if the increase in concentration (21%).

On the other hand, a final washing with alcohol of the root canal for maximum dewatering of the channel walls is recommended, which contributes to a deeper penetration of cement in the root dentinal tubules and improves the tightness of filling.

9.5. Optimization of irrigation solutions

It is essential to bring a sufficient volume of irrigation solution in the apical third of root canal for treatment optimization.

Possible ways to improve the cleaning efficiency of the irrigation solutions are:

- Increasing the diameter of the apical part of root canal;
- Increasing the total amount of irrigation solution;
- Elimination of irrigation solution directly into the apical region.
- Lengthening of the exposured irrigation solution with micro-organisms and tissue disintegration and mechanical activation of the irrigation solution.

The first three interrelated ways: by expanding the lumen of the apical channel part it is possible to load the syringe needle irrigation deeply and directly taking the irrigation solution to the apical division of the channel.

The use of nickel-titanium instruments increased taper quickly and easily to provide a "deep form" that allows you to immerse endodontic needle gauge 27 or 30 directly to the apical third of curved root canals.

As for the preferred type of needles, we recommend those options with a rounded top and side sealing cavity location to prevent removal of irrigation solution in the periapical tissue.

Syringes with the irrigation solution should ideally be stored at 37°C in a special electrothermostate: "Syringe warmer" (Vista-Dental®) or the "Appli-Vac System" (Vista-Dental®), which allows up to 6 different irrigation solutions simply switching from one to another by using the buttons on the irrigation gun.

For curved root canals the use of flexible nickel-titanium needle (Vista-Dental ®) can be recommended.

Insulin needles (too short), a needle for anesthesia (too sharp) or a conventional syringe needle (too thick) is not recommended.

When the solution is in the apical third, it must activate the ultrasonic file.

You can use ultrasonic devices to ensure immediate supply of NaOCl and EDTA in the canal through the tip, or simply to fill in the channel irrigation solution, to immerse in a ultrasonic file, while holding it in working condition, until the solution is turbid, indicating the need for its refreshment (update).

The mechanism of activation solutions by ultrasound: the important components are the development of acoustic vortex flow, the process of cavitations' (the formation of micro bubbles), mechanical mixing and solution heating.

9.6. The sequence of irrigation during the preparation of root canals

1. Remove roof of pulp chamber and apply the jet lavage with water or sodium hypochlorite to remove any remaining pulp and root canal orifices to identify;
2. Start an instrumental treatment of the channel's lumen, alternating it with only sodium hypochlorite;
3. Getting to the excision of the dentin, filling the canal by material Glyde;
4. Continue instrumental processing until the Glyde does not become cloudy (change color) and sticky;
5. Flush the root canal with sodium hypochlorite feed, to the termination of foam formation;
6. Complete instrumental processing, control, that the channel always has Glyde and wash canal with sodium hypochlorite after every 3-4 instruments;
7. In infected canal lavage channels with NaOCl and chlorhexidine.

9.7. Irrigation prior to filling

Before filling we still have the last chance to remove the smear layer and disinfect the root canal system.

Usually for this purpose, we recommend the combined use of sodium hypochlorite solution with EDTA or citric acid.

The effectiveness of the final irrigation depends on chemical properties and concentration of the solution, as well as the total volume of solution and duration of exposure in the channel.

We recommend the following sequence:

- Wash the cavity of the tooth and root canal by 8-10 ml 10-15% EDTA solution, activate the solution by ultrasonic files;
- Wash with 10 ml of 5% sodium hypochlorite;
- Wash with distilled water;
- Dry the canal with sterile paper filled points.

9.8. Physical methods of treatment of obstruction root canal

9.8.1. Medicinal electrophoresis

Medicinal electrophoresis (Ionophoresis) is a method of influence on the body of a constant electric current, and the administered drug with it.

Extirpation of the pulp in the multi rooted teeth- one of the canal may be obliterated.

Pulp in the obliterated part of root canal can be a cause of the periodontium infection, and of periodontitis development.

In such cases, electrophoresis was performed with a saturated solution of potassium iodide, or 10% tincture of iodine.

The iodine tincture is used for medicinal electrophoresis, half diluted with water, which increases the dissociation (decomposition) of iodine molecules into ions.

The methodology of drug electrophoresis

- In the prepared tooth cavity the injected squeezed cotton swab soaked in a solution of iodine and active electrode.
- The tooth cavity is hermetically sealed with wax. Preparation of iodine is found with a negative pole. Current is set 2-3 mkA. Duration of treatment is 15 - 20 minutes.
- After this a tampon is removed and the cavity of the tooth leaving a tampon with an aqueous solution of iodine.
- Tooth closed by bandage from artificial dentine.
- After 3 days of medication and instrumental processing and filling of root canals.

9.8.2. Depophoresis copper-calcium hydroxide

Depophoresis - a modern and effective method of endodontic canals copper-calcium hydroxide under the influence of a weak electric field. This technique has been used in Russia since 1999.

Actually, method depophoresis copper-calcium hydroxide developped a professor at Hamburg University, Doctor of Physical and Chemical Sciences, Doctor of Medical Sciences in Dentistry Knappvostom Adolf (1998). The use of the name "depophoresis" - is copyrighted and registered in the European Union.

Copper-calcium hydroxide for use in depophoresis as patented material "KUPRAL".

The appearance of this method solved the problem of teeth treatment with root impassable canals.

The mechanism of depophoresis action:

Under the influence of a constant electric current OH - ions (OH-) and hydroxide cuprum $[Cu\ (OH)_4]_2$ - diffuse into the apical portion of the root canal and its deltoid branches.

The copper-calcium hydroxide and wall lines accumulate in the channel during the course of treatment.

Cuprum hydroxide ions in the apex of the root decay and the form of copper hydroxide (poorly), forming a "copper tube", which securely obdurate the deltoid branch of the root.

Soft tissue of root canal and apical delta are destroyed through the apical area being extracted from the root canal, and then - are resorbed.

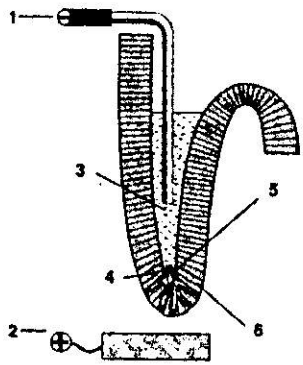


Fig.9.6. **Depophoresis copper-calcium hydroxide:**
1 - the active electrode; 2 - non-active electrode (the cheek); 3 - a suspension of copper-calcium hydroxide; 4 - movement of ions cuprum hydroxide $[Cu(OH)_4]_2$ - and hydroxyl ions (OH-) under the action of an electric current; 5 - deposition and precipitation of copper- calcium hydroxide, and in - the precipitation of copper hydroxide ($Cu(0H)_2$) and blocked deltoid tubules.

There is a root canal sterilization and deltoid branches. "CopperTube" obturates all outputs of the apical delta on the root surface.

Thus, this area is disinfected and continuously maintains sterility.

Copper-calcium hydroxidestimulates osteoblasts and provides regeneration of bone tissue in the periapical area due to alkalinization of the medium.

Indications:

- Treatment of teeth with impassable root canals;
- Pulpitis (acute and chronic suppurative and gangrenous);
- Periodontitis;
- Brake of endodontic instruments in root canals;
- In unsuccessful treatment by traditional methods;
- In teeth with wide apical foramen.

Contraindications:

- Exacerbation of chronic periodontitis;
- Festering cyst (with pus);
- The presence of silver points in root canals;
- Malignant neoplasms;
- Autoimmune diseases;
- Pregnancy;
- Allergy to copper;
- Intolerance of electric current (high sensitivity to the microcurrent).

In the case of pulpitis treatment of, the tooth must be pre devitalized, and only then - hold copper-calcium depophoresis.

The treatment consists of three visits for depophoresis. The interval between them is 8-14 days.

Methodology:

- To prepare the carious cavity;
- To reveal the cavity of a tooth;
- To get access to the rugged root canals;
- The root canals must be permeabilized and extend up to two thirds tools long № 34-50 ISO;
- To expand (funnel), the orifices of the root canal from the introduction of a suspension of copper-calcium hydroxide;

- To rinse with distilled water, the root canals and 10% suspension of copper-calcium hydroxide;
- To isolate and dry a tooth;

The patient is placed in the chair:

  - For the mandible's teeth – sitting with a slightly tilted downward (forward) head;
  - For the upper jaw teeth - lying in a chair with his head thrown back.

- The suspension is diluted with water to a creamy consistency and with a canal–filling is injected into the root canal;
- In the root canal the electrode needle is introduced to a depth of 4-8 mm - cathode (-).

Attention! The electrode must not touch the soft tissue, metal crowns, fillings, adjacent teeth! The tooth should not be exposed to blood or saliva, as all these lead to the current leakage and reduced the treatment effectiveness.

- The anode (+) is placed in the cheek on the opposite side (it should not touch the teeth). To improve the electrical contact between the electrode and the cheek is established a cotton swab moistened with saline solution. Corner of the mouth is smeared with Vaseline (petroleum jelly) to prevent irritation.

To conduct depophoresis used devices «Original – II», «Comfort» (Germany) or «Endo-Est» (Russia) are used.

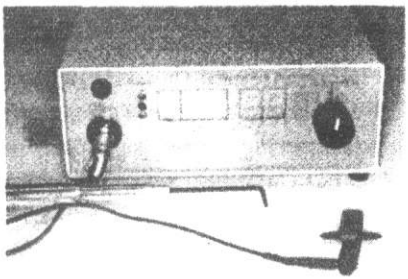


Fig.9.7. The device «Comfort» for depophoresis with copper-calcium hydroxide.

The device is switched on and configured before connection to the patient.

The handle of the current regulator (power) should be in the far left position.

The current increases slowly until a light sensation in the tooth of heat, tingling, and then it decreases and then increases to 1-2 mA (milliamps).

The procedure is calculated on one channel – 5 mA*min (i.e. multiplication of current value and time should be equal to 5).

For example: Let the current set to 1 mA. Then, the procedure must be equal to 5 minutes.

With a current of 1.2 mA – time of 4 minutes.

With a current of 2 mA – time of 2.5 minutes.

With a current of 0.5 mA – time of 10 minutes.

If the treatment is carried out for multiple channels – the procedures are carried out separately.

After the procedure, the root canals are rinsed with distilled water and 10% suspension of calcium hydroxide or diluted suspension of copper-calcium hydroxide.

A fresh portion of copper-calcium hydroxide is introduced under the bandage from artificial dentin in the root canal.

If the tooth has a periodontal inflammation, the tooth can be left open after the procedure (for a flight).

An additional exposure will not be as copper-calcium hydroxide has a high bactericidal activity.

Repeated visits should be done after 8-14 days.

During the course of treatment each root canal would have to 15 mA*min of electricity.

In the third visit the root canals are sealed with alkaline cement containing copper – "Atatsamitom" («Атацамитом»).

It is included in depophoresis set, than the permanent filling is done.

Positive aspects of depophoresis:

- High clinical efficacy – 90%;
- Successful endodontic treatment in the case of impenetrable root canals;
- Reduce the risk of complications that occur during root tool canal treatment (brake of instruments, perforation);
- There is no need to determine the length of the root canal;

- Reduce the number of radiographic studies (no patient radiation exposure);
- There is no risk of output of the filling material by the apical foramen;
- Disinfection throughout the apical delta.

The negative aspects of depophoresis:

- There is no test for quality control of obturation of the root canal, as apical portion of root canal is not filled;
- Technically it is difficult to carry out the procedures;
- Change the color of the tooth crown after depophoresis (yellowish tint);
- For a long time of treatment – 4 weeks.

Despite these drawbacks, this method opens new perspectives in endodontics.

In the future, it will need to be combined with a full depophoresis treatment and obturation of root canals all over (to the physiological apex).

Depophoresis should become an independent method of treatment and an integral part of the complex endodontic treatment.

With its help you can achieve maximum efficiency and reliability.

10. ROOT CANAL FILLING MATERIALS. CHEMICAL STRUCTURE. PHYSIC-CHEMICAL PROPERTIES (Lecture 12)

10.1. Filling materials

Root canal filling is the final stage of endodontic treatment.

Obturation of root canals has the following objectives:

- Hermetic closure of the root canals all over (in length and width) to the apical part, prevent infection of apical periodontium.
- Blocking of the microflora in dentinal tubules and creating unfavorable conditions to their development.
- Creating the conditions for the treatment of periodontal apical (apical part). Closure of the apical foramen by cement or neo-dentogenesis scarring, or scarring of the periapical osteoids. To promote the regeneration of pathologically altered periapical tissues.

10.2. Requirements for filling root canals material

In order to implement high-quality root canal, the filling materials must meet the following requirements:

1. Materials should be easily prepared (mixed) introduced into the root canal.
2. The materials should easily derive from the root canal, if necessary.
3. Materials should be hermetically sealed to the root canal.

To do this they must be:

- Liquid – to penetrate into all ramifications of the channel and diffusion in the dentinal canals;
- Do not change the amount of time;
- Do not dissolve in the saliva and other liquids;
- Must be resistant to microorganisms – have a bactericidal effect;
- Do not dissolve in the root canals.

4. Materials should be radiopaque so that you can check the quality of root canal filling.
5. Materials must have a color different from the color of dentin, which will facilitate, if necessary, the root canal unsealing.

6. The materials should not paint (color) the tooth.
7. Materials must be biocompatible, and do not irritate the periapical tissue.
8. Materials must have a bactericidal effect.
9. Materials must be easily sterilized and maintained sterile, to be chemically stable.
10. Materials should have a cure (crystallization) time, long enough to ensure normal operation of a doctor.
11. Materials should have a low price.
12. The materials should not cause an immunological response (not to sensitizing action).
13. The materials should not be mutagenic.
14. The materials should not have carcinogenic properties.

No dentistry material, currently used in the practice, does not meet all of these requirements therefore, they should be used with great care, depending on the clinical situation.

10.3. Classification of filling materials for root canal

There are several classifications of modern filling materials.

The physical state at the time of introduction into the root canal and physical condition in which the materials are stored, they are classified as follows:

1. ***Plastic paste which hardens in the channel***

- Material from the group of zinc oxide eugenol cements: EVGETSENT-B ENDOBTUR (SEPTODONT), KARIOSAN (CHEMAPOL).
- Pasta, based on zinc oxide and eugenol: Zinc eugenol paste, EVGEDENT, ENDOMETAZON (SEPTODONT).
- Zinc phosphate cements: phosphate cement, hydro-phosphate cement.
- Materials of the gutta-percha.
- Bakelite (based on resorcinol formaldehyde – Paratsin, Ftoro-dent, Rezodent, etc.).
- Paste-hermetic based on epoxy resins: AH-26, Termasil (DENTSPLAY), AH+.
- Pasta with calcium hydroxide: BIOKALEAS, ENDOKAL (SEPTODONT), APEXID, etc.

2. ***Plastic not harden pastes***

- Pasta with prolonged antiseptic effect: Iodoform paste, paste ROCLE'S, pasta GHISI.
- Pasta with biological activity (based on calcium hydroxide).

3. ***Solid materials***

- Gutta-percha pins.
- Silver pins.
- The pins made of synthetic resin.

Authors V. Ivanov, G.D. Ovrutsky, V. Gemanov give another classification of materials:

- Materials based on resorcinol-formaldehyde: Paratsin, Ftorodent, BIOPLAST, Forfenan, Rezodent, Resorcinol-formalin paste, preparing extempore.
- Materials based on epoxy resins: ENDODENT, AH-26, EPOXICAL, AH+, TERMASIL, DIAKET.
- Pastes based on zinc oxide and eugenol: zinc-eugenol, pasta GROSSMAN, Endometazon paste.
- Pasta with calcium hydroxide: BIOCALEX, ENDOFLAX.
- Zinc phosphate cements: phosphate cement adgezor, hydro-phosphate cement, phosphate cement with silver.
- Zinc oxide eugenol cements: EUGECENT-B, EUGECENT-P, ENDOOBTUR, CARIOSAN, etc.
- Materials based on methyl acrylate: HYDRON.
- Glass - ionomer cements: KETAC-ENDO.

The authors are A. Nikolaev and L. Tsepov all the materials are classified into three major groups of materials for use:

- Preparations for the temporary filling of root canals.
- Materials for permanent root canal filling.
- Preparations for the unsealing of root canals.

At the same source provide different classification:

1. Plastic fillings:
    - does not harden;
    - harden
2. Primary solid materials for fillings.

According to another classification, materials to fill the channels are divided into two types:

1. Sealers – from «to seal» (Eng) – hermetic, plugging, sealing material.
2. Fillers - «to fill» (Eng) - substances and means of filling the lumen of the root canal.

Do not harden and the paste is dissolved in the channel, do not provide long-term, reliable obturation of the apical foramen. Now for the permanent sealing of channels they are not applied. However, they are quite effective for a temporary canal filling. Plastic hardening materials are named endo-hermetic or sealer.

Modern materials for obstruction of root channels can be represented by the following indicators:

- Physico-chemical criteria.
- Fillers, sealers.

For the purpose of use:

- A temporary filling (endokal, biokaleks, endometasone, etc.);
- A permanent filling.

The form of release:

- Liquid-powder;
- Paste-paste;
- Paste ready for use;
- Capsule form.

10.4. Preparations for temporary root canals filling

In the last time a recently popular method of root canals filling with curative not hardening paste.

This method is quite effective, easy to use and allows a predictable treatment cyst-granulem, radicular cysts, destructive forms of periodontitis, and "medication periodontitis".

10.5. Pasta based on antibiotics and corticosteroids

Usually in the not hardening pastes two or three antibiotics with a wide range of antibacterial and antifungal action are included, sometimes adding one or more components i.e. a corticosteroid. As the latter is the most often used dexamethasone - which is used in a dosage that reduces inflammatory and allergic conditions, while no effect on

the protective reaction of the periodontium and organism, another component - x-ray contrast filling. Its presence makes it possible to evaluate objectively the quality of the filling of the channel. These pastes have a strong but short-living effect, are introduced into the channel for a time of 3-7 days.

An example is pasta "Septomiksin forte". This paste (firm «Septodont») is not a hardening, resorbable, antibacterial paste, with wide spectrum of action. Incorporation of three antibiotics with a wide range of antibacterial and antifungal activities enables effective to suppressed microflora of the root canal, avoiding the formation of antibiotic-resistant strains. The antibiotics belonging to the " Septomiksina Forte" practically do not cause sensitization. Dexamethasone reduces the inflammatory and allergic conditions, without affecting the protective reactions of the organism.

The paste is completely harmless to the periapical tissues, and the body is able to respond quickly and effectively to the therapeutic effect of the drug, adding to its bacterio-static and anti-inflammatory effect and restoring the damaged tissue. "Septomiksin Forte" also includes x-ray contrast filling.

"Septomiksin forte" is used in the treatment of granulating and granulomatous periodontitis, and "arsenic" periodontitis. Channel, is carefully and mechanically grafted the medication, is filled with "Septomiksin Forte" by canal-filling. When destructive forms of periodontitis are recommended for the paste removal of the top. The tooth is closed with a hermetic bandage.

In repeated visits, at intervals of two to ten days, the paste of the channels is removed and replaced with a new portion of paste "Septomiksin".

When the positive dynamics of the pathological process (disappearance of pain and inflammation, is stopped by exudation) the canal is cleaned and sealed material hardening is based on zinc-eugenol, for example, "Endometazon".

10.6. Pasta based on Metronidazole

Metronidazole suppresses effectively the anaerobic microflora of the root canals, stopping the destruction of tissue by blocking the inflammatory effects at the biochemical level.

Along with these phenomena of allergic reactions, or addiction to this drug, it is still virtually not observed.

Pasta on the basis of metronidazole is used to fill temporarily the heavily infected root canals of teeth, especially when we can expect the predominance of anaerobic microorganisms in them (with gangrenous pulpitis, acute and chronic periodontitis).

They can be used in treating of acute periodontitis with a hermetic closed cavity of the tooth.

This prevents secondary infection of the periodontal microflora of the mouth and improves the prognosis of the disease.

Pasta on the basis of metronidazole is introduced into the canal with a canal filler, at the orifices of the channel is applied a sterile cotton ball, and the tooth is sealed by a bandage.

The paste on the basis of metronidazole is used for active treatment, so that the paste in the channel is changed every day, until a complete disappearance of all symptoms.

The drug "Grinazol" company «Septodont» is a paste containing 10% metronidazole.

The technique of "Grinazolya" has some special features:

- Preparation "Grinazol", providing a strong bactericidal effect on the microflora of channels.
- It allows you to do instrumental channel treatment for the next visit, when the acute inflammation subsides.
- "Grinazol" permits to treat acute and aggravated chronic periodontitis with a hermetic closed cavity of the tooth. This prevents secondary infection of the periodontium by microflora of mouth and improves the prognosis of the disease.
- "Grinazol" is designed for an active treatment. Paste in the root channel should be changed daily until a complete disappearance of all symptoms (pain on percussion, suppuration of the canal, pain on palpation of the crease in the transition area of the projection root apex, etc.).
- "Grinazol" by changing the environment in the canal and periodontal tissues, avoiding the painful effects after filling ("reaction to the filling").

In some cases (the presence of general symptoms of inflammation, severe general condition of the patient), along with local application "Grinazolya" shows the total antibiotic treatment.

10.7. Pastes based on a mixture of long-acting antiseptics

The composition of these drugs group includes potent antiseptics: thymol, creosote, iodoform, camphor, menthol, etc. These pastes are radiopaque, do not harden, dissolves slowly in the channels.

They are used for temporary filling of channels in adults tooth for the treatment of pulpitis and periodontitis, endodontic treatment of deciduous teeth, including absorbable roots (in this case, the pastes are used as a permanent filling material).

Pasta "Tempofor" company «Septodont» consists of a mixture of antiseptics: thymol, creosote, iodoform and camphor with the addition of menthol.

It is radiopaque, does not harden dissolves slowly in the channels. "Tempofor" has a disinfecting and deodorizing effect, does not cause dysbiosis, and stimulates the protective properties of the periodontal tissue. "Tempofor" quickly stops the pain effects of the pulpitis treatment, reducing the risk of pain reaction after canal filling.

This drug is used for temporary filling of channels in adults for the treatment of pulpitis and periodontitis, in endodontic treatment of teeth, including absorbable roots.

10.8. Pastes based on calcium hydroxide

The most common paste based on calcium hydroxide used for the temporary filling of root.

Thanks to the highly alkaline (pH - about 12) calcium hydroxide the root canal filling has a bactericidal effect, destroying necrotic tissue, stimulating osteo-, dentino- and cementogenesis.

Do not harden the pastes based on calcium hydroxide being used as a temporary intra canal medicament for the treatment of destructive forms of periodontitis, radicular cysts and cystogranulem.

The carefully mechanical and medication grafted channel is filled with a canal paste filler.

When the destructive forms are recommended for the removal of the top of the paste, the tooth is hermetically closed with a bandage.

Six weeks after the first injection of paste in the channel, it is replaced by a new portion, and then - once in two months, for achieving the desired curative result.

When the positive dynamics of the pathological process (disappearance of pain and inflammation, cessation of exudation) the canal is cleaned and filled by a permanent hardening material.

The drug "Endokal" company «Septodont» is a purified powder of calcium hydroxide placed in a tightly closed glass bottle and filled with distilled water.

Keep in mind that calcium hydroxide is inactivated on contact with air with carbon dioxide, so the storage must be covered with a layer of water.

Immediately before the use the necessary amount of calcium hydroxide is removed from the vial with a spatula, it is placed on the glass and any moisture excess is removed with a piece of gauze (cotton).

The method of clinical application of "Endokal" consists of the following.

After a full instrumental and medicamentous treatment of the root, the channel is filled with canal filling "Endokal" with a small excretion of the drug amount of the tip.

Calcium hydroxide has the same radiopacity as the dentin, so that when the channel is filled, the x-ray it is not visible.

Paste in the channel must be replaced in 6 weeks after the first injection, and then - every time the control absorption of the material by X-ray is determined (survey is conducted every two months).

After achieving the desired result the channel is filled by hardening paste based on zinc oxide eugenol.

The use of "Endokal" is shown as a temporary intra canal medication in the treatment of destructive forms of periodontitis, radicular cysts and cystogranulem.

Table 10.1.

Preparations for the temporary filling of root canals

Preparates	Manufacturer	Active substances
Septomixine Forte	«Septodont»	Dexamethasone, polymyxin B sulfate, tyrothricin, neomycin sulfate
Grinazole	«Septodont»	Metronidazole
Tempophore	«Septodont»	Menthol, thymol, creosote, iodoform,
Endocal	«Septodont»	Calcium hydroxide
Gangripulpe	«Pierre Rolland»	Tricresol, resorcinol, phenol, thymol,

Biocalex	«Spad»/«Dentsply»	Calcium oxide
Pulpispad	«Spad»/«Dentsply»	Camphor, diyodtimol, parahlorfenol
Iodoform	«Produits Dentaires	Iodoform, eugenol, benzocaine,
Creidodent	«Alpha-Beta Medical Supply Inc».	Cresol
Vitapex	«J. Morita»	Iodoform and calcium hydroxide
Metapex	«Meta BiomedCo., Ltd»	Iodoform
Yodent	"VladMiVa"	Iodoform, thymol, camphor
Yodent	"Rainbow R"	Iodoform, thymol, camphor
Iodeks	"Omega"	Dexamethasone, thymol, creosote,

10.9. Materials for permanent filling of root canals

10.9.1. Zinc phosphate cements

Advantages:

- Ease of introduction into the channel, a low solubility in the interstitial fluid;
- Good adhesion to the walls of the channel;
- X-ray contrast;
- Antimicrobial activity in the first two days.

Disadvantages:

- Rapid curing (crystallization) (4-6 minutes) leads to the impossibile additional filling of the channels, as it's needed;
- A high probability of irritating to the periapical tissues, due to the increased weight in the cement's contents of free-phosphoric-acid (for root canal phosphate the cement is a more mixed liquid consistency than that of provided instruction);
- Material is not resorbed through casual breeding by the tip of the root;
- Inability to unsealing the channel if necessary.

Preparations based on zinc oxide and eugenol - zinc oxide eugenol cement (paste).

Drugs in this group are highly endo-hermetic.

There is liquid mixed with zinc oxide eugenol pasta basis.

As you know, when we mix zinc oxide with eugenol, a chemical reaction of formation of an insoluble salt – eugenoliat of zinc begin.

The paste hardens in the channel within 12-24 hours. Added to the zinc oxide the eugenol paste of various substances allows you to adjust the properties and therapeutic effects of drugs in the right direction.

The most common additives used short-term and long-acting antiseptics corticosteroid preparations, radiopaque substance.

Advantages:

- Are easily introduced into the root canal, and if it is necessary, can be easily removed from the channel;
- Radiopacity;
- The optimal time of hardening in the root canal;
- Good adhesion to the walls of the canal;
- The formation of an insoluble mass in the channel, producing no shrinkage;
- Pasta, derived for the tip, is absorbed, and this is due to the fact that eugenol diffuses rapidly into the bloodstream, and then gradually desorbs the other components;
- Antiseptic, anti-inflammatory effect, gradually waning and ceasing as hardening of the paste. Frozen pasta in the root canal is biologically neutral.

Zinc oxide eugenol cements can be used to seal the channels, both independently and in combination with gutta-percha pins, that can have a therapeutic effect, and to ensure complete and reliable obturation of root canals.

Disadvantages:

- The possibility of toxic and allergenic action components of pasta on tissue: eugenol, formaldehyde, paraformaldehyde, etc., especially in the breeding material at the tip of the root;
- The probability of resorption of paste in the root canal;
- The probability of changing color of the tooth crown;
- The probability of violation of the curing (crystallization) process of the composite during subsequent fillings (as eugenol inhibits the polymerization of composites).

"Endobtur" is zinc oxide eugenol cement with the addition of enoksolona, diyodotimola and precipitated silver.

This material has a weak antibacterial activity, high adhesion, non-irritating periodontal tissues.

Not having a pronounced therapeutic effect, "Endobtur" is a highly effective intra canal sealer.

Its use is shown primarily for filling canals with pulpitis, but it can also be used in the treatment of periodontitis.

"Endometazon" is one of the most famous and popular canal filling materials.

It can be used as a separate material for obturation of root canals, and as a sealer for sealing of gutta-percha pins or Thermafil pins.

Eugenol at the same time reacts with zinc oxide, which is a part of gutta-percha pins, forming in the channel the hydrophobic homogeneous mass.

The company «Septodont» produces three varieties of the drug: «Endomethasone», «Endomethasone ivory» and «Endomethasone N».

«Endomethasone» - material is based on zinc oxide eugenol pastes.

It consists of corticosteroids, antiseptics and radiopaque filler.

Introduction to the corticosteroid pastes (hydrocortisone and dexamethasone) can significantly reduce the risk of painful reactions from periodontal after endodontic treatment ("response to the filling"), even with breeding material for the tip.

Antiseptics (diyodotimol and paraformaldehyde) provide neutralization of organic residues in the dentinal tubules and deltoid branches, influence on the microflora of periapical focal in periodontitis.

As the hardening of the paste action of these substances decreases and then stops.

If "Endometazon" accidentally displayed for the tip, the eugenol rapidly diffuses into the bloodstream, and then gradually resorbed and the remaining components of the paste.

Thus, when filling the channel "Endometazonom" several processes occur:

- curing of the paste in the channel to form an insoluble mass, no producing shrinkage;
- anti-inflammatory action of corticoid derivatives, the waning and ceasing as hardening of the paste;
- antiseptic action of drug, gradually waning and ceasing due to hardening of the paste;
- absorption of pasta, which was derived in the periapical tissue.

The consistency of a frozen preparation is such that, on the one hand, it provides a reliable obturation of the root canal, on the other - if necessary, it is easily to unsealed.

Due to a pronounced therapeutic effect of "Endometasone" shown in the first place in the treatment of destructive forms of periodontitis, gangrenous pulpitis, dental fillings in tooth without, "not hermetic state", but it can be used in all other cases, when you need a root canal filling.

It should be borne in mind that "Endometazon" has a pinkish-orange color, so if it is not carefully removed so any excess of paste from the crown of the tooth, there is a danger of tooth crown staining after endodontic treatment.

To avoid this phenomenon, the company «Septodont» created «Endomethasone ivory», which has a yellowish color, does not produce colorants and doesn't change the color of the tooth.

Otherwise, its properties and composition is similar to those of «Endomethasone».

«Endomethasone N» does not contain dexamethasone, the active compounds are iodine and paraformaldehyde.

Because of this, it has soft and physiological effects, does not cause allergies to iodine, eliminates the risk of toxic effects of paraformaldehyde.

Therefore, "Endometazon N» must be recognized as a more acceptable means for root canals filling.

"Estesone" is also made on the basis of eugenol zinc oxide paste with the addition of drugs, but it differs in composition from the "Endometazona", so this stuff has some positive qualities.

1. The product does not contain paraformaldehyde, which is used by many authors do not recommend it because of its irritating and toxic effects on living tissue, and possible carcinogenic and mutagenic effects.
2. Due to the content of hydrocortisone it minimizes the risk of pain after the channel filling.
3. Through a combination of two antiseptics there is an intense but short-term effect the added nitrofurazone causes a long, weak bactericidal effect of ditimole two iodine.
4. Materials have radiopaque filler are easily introduced into the root canal, close the obturation being not absorbed, is not shrinkage, if necessary, can be easily removed from the channel.

At present, the group of eugenol zinc oxide cements "Estezon" is considered the most versatile and effective material for filling root canals.

10.9.2. Materials based on epoxy resins

Materials of this group are based on the epoxy-aminepolymers with the addition of radiopaque fillers.

They are a type of "powder-paste" or "paste-paste" hardened after mixing, curing occurs at body temperature for 8-36 hours.

It should also be borne in mind that the oxygen (hydrogen peroxide in the channel) inhibits the polymerization reaction and disrupts the curing process of these drugs.

Materials of this group are endo-hermetic (sealer) and should be used only in conjunction with primary hard materials - gutta-percha or termafil pins, etc.

Advantages:

- Good manipulation properties (plastic, easily introduced into the channel);
- Long-term (8-36 hours) curing time;
- Inertia with respect to the periodontal tissues;
- Stability in the channel, water resistance;
- Thermal stability, which makes it possible to use these materials when working with hot gutta-percha;
- Radiopacity.

Disadvantages:

- Polymerization shrinkage (about 2% by volume).
- The possibility of violations of fit and the hermetic seal of the root canal when drying is insufficient;
- The relatively high cost.

Currently, the interest of dentists in this group of materials has increased.

This is due to the widespread opinion that the intra canal sealer must be completely inert, biologically neutral, should not have any impact on the surrounding tooth tissue, and the elimination of the pathological process in the periapical tissues is mainly due to the local host defenses.

The most popular drugs in this group are the materials of the company «Dentsply» - «AH-26", "AH Plus» and «ThermaSeal».

"AH-26" is used in dentistry for over 40 years. It is a system of "powder-paste." This kind of glue on the basis of bisphenol α-epoxy resin, catalyst - hexamethylenetetramine.

In the process of curing a small amount of formaldehyde, but the hardened material is completely inert. "AH-26" is insensitive to moisture, cures, even in the presence of water, although a reliable sealing of the channel in this case does not occur.

These materials also have improved manipulation features, a better tissue compatibility, radiopacity, and color stability. "AH Plus» and «ThermaSeal» is thermally stable, which makes it possible to use them when working with "Termafil" and hot gutta-percha. At the same time, these materials are easier to be removed from the channel, if necessary.

The analoguous of the drug "AH-26" is "Bel AH" (VladMiVa).

10.9.3. Polymeric materials containing calcium hydroxide

Drugs in this group are polymeric compounds with the addition of calcium hydroxide. The creation of these materials is due to the widespread introduction of calcium hydroxide in endodontics.

It was assumed that the permanent sealing of the channel with such materials will stimulate the processes of reparative regeneration of tissues in the root apex.

However, according to E.V. Borovsky, the pH value in these materials is often lower than it is necessary to achieve a therapeutic effect. It is believed that the therapeutic effect of the drug is terminated after the curing of the paste. However, it should be remembered that it is gradually washing away a good guide-soluble calcium hydroxide with tissue fluid. This leads to the appearance of pores (bubble) in the material, and may cause the break of hermetic of root fillings.

This is also confirmed by laboratory tests: the solubility in water of materials of this group is higher than the solubility of epoxy sealants. Materials of this group also should only be used in conjunction with primary hard materials - gutta-percha and termafil pins, etc. In general, the polymer endo-hermetic containing calcium hydroxide, have approximately the same positive and negative properties as the materials based on epoxy resins.

The features of them are:

- ability to stimulate regeneration of periodontal tissues by therapeutic action of calcium hydroxide;

- several high solubility and, therefore, it is more likely to resorption of the material in the root canal.

The best known are drugs in this group «Sealapex» (Kerr) and «Apexit» (Vivadent).

«Sealapex» is a system of "paste-paste," the radiopaque fast setting in the root canal.

The presence of moisture is needed for curing the material. When curing - «Sealapex» increases in volume.

The material is thermal stability, which makes it possible to use when working with Termafil pins and hot gutta-percha.

Thanks to the therapeutic effect of «Sealapex» is shown in the first place in the treatment of destructive forms of periodontitis, but can also be used in all other cases, when you need a root canal filling.

10.9.4. Glass ionomer cements (GIC)

Glass ionomer cements for root canal filling from the "traditional" glass ionomers are characterized by:

- A longer curing time (1.5-3 hours);
- Higher radiopacity;
- Eenhanced biocompatibility and stability.

Unlike other materials for root canal filling, GIC have chemical adhesion to dentin, which allows for a tight, reliable and durable obturation of the canal.

High strength of glass ionomer cements makes them particularly advantageous in situations where the need to strengthen thin, weak walls of the canal reduces the risk of root fracture.

Other positive features of GIC for filling root canals are good manipulation property, minimum moisture adsorption, high bio compatibility, no shrinkage.

We can't use for fixating of anchor pins and stumps the glass-ionomer -dimensional cement, because they will cure - 1.5-3 hours.

For these purposes we must apply special quick Harding GIC.

The main drawback of the GIC for the filling of root canals is the difficulty of removal from the channel if necessary.

Unsealing of the root canal, sealed by glass ionomer cement is a very complicated and time-consuming work.

Therefore, using these materials in endodontics, they must apply at least one of gutta-percha pin.

If necessary, the channel unsealing should be remembered that the separation of the cement from the walls of the channel contributes to ultrasonic treatment in combination with chloroform.

The following drugs in this group: «Endion» (Voco), «Ketac-Endo» (ZM Espe) and «Endo-Jen» (Jendental).

The company "VladMiVa" launched the first domestic glass-ionomer cement for root canal - "Stiodent".

However, this material has a serious flaw - a short "working" time (4-5 minutes).

10.9.5. Preparations based on resorcinol-formaldehyde resin

At the core of this drugs group is resorcinol-formalin paste. It is prepared extempore by adding 2-3 drops of formalin (40% aqueous solution of formaldehyde) of crystalline resorcinol to saturation, the catalyst is then added - 2-3 chloramine crystal.

The resulting liquid is mixed with zinc oxide to the consistency of paste.

Cured paste within a few hours due to the polymerization mixture of resorcinol-formalin with the formation of phenol-formaldehyde plastic.

The same chemical reaction occurs during the impregnation of the contents of the root canal resorcinol-formalin method.

To improve the properties of tooth paste manufacturers added to the composition of various substances: glycerin - to improve the ductility, barium sulfate - for radiopacity, hormonal drugs - to prevent pain after filling.

The properties of drugs for the filling of root canals, are based on resorcinol-formaldehyde resins:

1. A strong antiseptic effect;
2. Disinfection of the dentinal tubules contents, deltoid branches, pulp unclimbed part of the channel;
3. Good manipulation properties;
4. Radiopacity;
5. Biological neutrality after curing.

At the same time:

- Highly toxic components;
- Irritant effect on periodontal tissue;
- Staining of the tooth crown in pink.

Do not use paste, prepared in the office of extempore, the mixture which is thus obtained with an approximate dosage of resorcinol, formaldehyde and zinc oxide, chemical and bacteriological purity of the ingredients are usually questionable.

Preference should be given ready-made medicines, manufacture, it is, and containing the optimum ratio of active ingredients and substances that reduce the risk of adverse side effects.

The company «Septodont» produces the drug "Forfenan" based on resorcinol-formalin paste with the addition of dexamethasone and barium sulfate. The finished paste hardens in the root canal for 24 hours, forming an insoluble radiopaque mass consisting of phenol-formaldehyde plastics and antiseptic ingredients.

The product contains two solutions, varying their ratio and can be adjusted by the length of the sequence, and antiseptic action.

Pasta, which was introduced into the canal, in the polymerization process heats up, providing that gaseous formaldehyde, which penetrates into the microtubules, disinfects them.

Experts firms «Septodont» indicate the triple effect of the drug "Forfenan":

- Fast antisepsis dentinal tubules;
- The introduction of the root canal antiseptic long-acting agents;
- Reliable obturation of root canals.

Keep in mind that "Forfenan" as well as other similar drugs may cause tooth crown color changing in pink, so it should not be used for root canal of front tooth.

"Forfenan" is widely used for devitalization of teeth before the orthopedical treatment.

It is shown in the treatment of periodontitis, and gangrenous pulpitis, when you need to neutralize the microflora in the deltoid branches, additional tubules, etc.

There is a high efficacy of this drug in pediatric dentistry for endodontic treatment of deciduous teeth.

Similar therapeutic effects have "Krezopasta» (Septodont) - ready-to-use one-component Self-Harding paste for root canals filling.

The composition of matter consists of providing long-antiseptic effect: parahlorfenol, camphor, zinc sulphate. It does not contain formaldehyde and its derivatives. When injected into the channel in the

presence of a moisture paste it hardens, increasing slightly in volume and forms chalk-shaped poorly soluble in water supply.

The curing process of "Krezopasty" is similar to the process of curing zinc sulphate cement (an artificial dentin).

Although the "Krezopasta" can be applied in well-traversed channels, included in combination with gutta-percha, the use of it first shows at root canals sealing being bad passable with incomplete extirpation of the pulp.

It is recognized that the current use of drugs in this group is reduced. Preference will be given to more neutral and biologically inert substances.

10.9.6. Materials based on calcium phosphate

Cements based on calcium phosphate for root canals filling are under development and clinical trials.

From the chemical point of view, they represent two of the phosphate compounds of calcium, one - acid, the other - alkaline.

When mixed between these substances, the chemical reaction forms a hydroxiapatite.

The properties of drugs in this group:

- Good adhesion to the walls of the channel;
- Low solubility in water, saliva and blood;
- Radiopacity equal to the radiopacity of the bone and dentin;
- Good solubility in strong acids (in case of needed unsealed channel);
- High biocompatibility.

10.9.7. Primary solid materials

Primary solid materials are fillers. They are used only in combination with plastic hardening pastes (sealers) and serve to fill the lumen of the canal and increase the reliability of sealing. This group includes a variety of pins for a root canal.

Depending on the material:

1. Hard pins:
   - Metal (silver, titanium)
   - Plastic,
   - Glass fiber,
   - The system "Thermafil" (a metal rod coated with a gutta-percha).

2. Plastic pins:
- Gutta-percha,
- Plastic,
- Fiber.

Dimensions of pins in accordance with ISO: from 010 to 140.

Color-coded pin corresponds to the marking of endodontic instruments.

They also refer to the size of alphabetic characters:

XXF very, very thin,
XF very thin,
F thin,
M medium,
L large

All pins are introduced into the required channel to paste. The paste is then called sealer, and the pin is - filler.

10.9.8. Gutta-percha pins

The most convenient and efficient is the use of the pins of the gutta-percha.

Gutta-percha is used in dentistry for over 100 years old.

It is the dried juice of gutta-percha tree, which grows in Brazil and Malaysia.

Chemically pure gutta-percha exists in two forms - α (alpha) and β (beta), which can be converted, into each other.

For the manufacture of gutta-percha pins α-gutta-percha is used. It has a good flexibility and plasticity, low adhesion and relatively high melting points - +64 ° C.

The material of the pins are manufactured endodontic, has the following formulation:

- β - gutta-percha - about 20%;
- zinc oxide - 60-75%;
- wax or resin to ensure compliance and best condensed - 1 - 4%;
- metal sulfates for radiopacity, 1,5-17,3%;
- biological colorants (dyes), antioxidants.

Gutta-percha pins are available in two types - basic and auxiliary.

Key pins are manufactured in strict accordance with ISO, the shape and size of the top of the rod they correspond exactly to the parameters of the working part of endodontic instruments.

Represented are the corresponding numbers on the ISO (15, 20, 25, 30, etc.) and color-coded (white, yellow, red, blue, etc.).

Auxiliary pins in short, have a more pronounced conical shape and a pointed tip. They are designated by letters depending on the thickness: XXF, XF, F, M and L.

The advantages of gutta-percha pins as a means for sealing of channels:

- plasticity;
- absence of toxic and irritating;
- chemical inertness;
- radiopacity;
- pin in gutta-percha root canal will not crack, does not shrink;
- ensuring long and reliable root canal obturation.

In the last years, there is an increased interest in dentistry to α-gutta-percha. It has a lower melting temperature, has high fluidity and adhesion.

There are several ways of filling with gutta-percha:

- Master pin;
- Lateral Condensation - cold, hot gutta-percha;
- Vertical condensation;
- Injection method - hot gutta-percha;
- Plasticized gutta-percha filling;
- Thermomechanical method.

10.9.9. Silver pins

Silver pins as root canals fillings are used for about 50 years.

Negative properties:

- Which prevent their wide spread use;
- Are corroded in liquid media to form toxicity to cells and silver oxides tissues;
- To change the color of the tooth after obturation;
- The inability to adapt to the shape of the channel due to the hardness of the hard rounded tip;
- Which can't replicate the anatomy of the root apex , a circular cross section;
- Are almost never encountered in natural channels;
- Used in small straight channels with circular cross section.

10.9.10. Titanium pins

Titanium pins as obturating material were proposed for root canals about 20 years ago. Are not subjected to corrosion, but have other disadvantages of silver pins.

11. FILLING ROOT CANALS WITH PASTE, GUTTA-PERCHA POINTS. "SINGLE CON" FILLING. LATERAL CONDENSATION. COLD AND WORM TECHNIQUES. CONDENSATION TECHNIQUES: WORM VERTICAL, THERMO MECHANICAL, INJECTABLE WORM GUTTA-PERCHA. OTHER TECHNIQUES OF ROOT FILLING. (Lectures 13 – 15)

11.1. Main filling tools

Root filling is the final stage of endodontic treatment. Before proceeding to the consideration of the actual methods of filling, will pay some attention to the most important instruments used at this stage.

The most important in carrying out of root filling are the four types of instruments: Root-filler (Lentulo), canal-extenders (Spreder), plugger and the condenser.

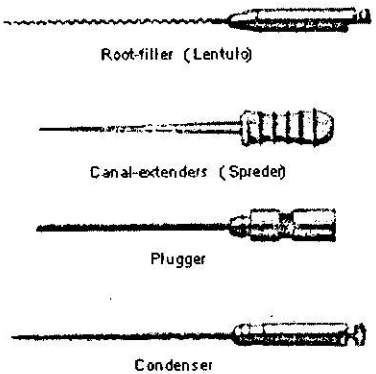


Fig.11.1. **The main instruments for root filling:**
1 - Root-filler (Lentulo), 2 - Channel extender, 3 – Plugger, 4 - Condenser

Root-filler (Lentulo) - a tool representing the helix for contra-angle handpiece. The rotation is done counter clockwise. Lentulo used to introduce a paste or cement into the root canal. They are made of various sizes according to the standard ISO (mostly 25-60) and different lengths.

To introduce the paste into the root canal at the tip of the tool the filling material is applied. Root-filler (Lentulo) is gently introduced to

the entire working length of canal, and at a maximum speed - 800 rotation/minute, rotational motion clockwise slowly removing from the channel. Lentulos are also used to introduce into canal the calcium hydroxide as a temporary seal, or to apply sealer to the walls of the root canal.

Canal-extender (Spreader) is used for lateral condensation of gutta-percha pins in the root canal. The instrument consists of a thin rod with a blunt tip, the size of which corresponds to a similar size of endodontic instrument, used for root canal treatment. Canal-extenders are made mostly 20-35 size standard ISO, they are of different lengths and have coded color.

Plugger is designed to seal the gutta-percha in the root canal and is used in various techniques of fillings. They are of a cylindrical or slightly conical form, without cuts, and have flat functionality endingss. Pluggers are made by the sizes of 30-140 by standard ISO.

For the practical application of the most convenient hand-held instruments with two functional ends. The Pluggers, are used in special techniques, marking length.

Condenser - a mechanical tool for the introduction of gutta-percha pin into the root canal and its condensation. The heat due to friction of the working part of the tool when making speed rotation of 8,000-10,000 rot/min softens the gutta-percha pin and condenses it. McSpadden condenser is similar to the inverse Hedstrema drill, and an Engine-Plugger, is used for vertical condensation of gutta-percha - with a reverse drill bur.

Filling stage begins after the mechanical, medical treatment and drying of the root canal. Drying of the root canal is performed with the root turundes on the needle or paper points (pins). Channels can't be dried with air pistols that is possible because of air-embolism (air gets into the blood vessels, tissues).

For root canal obturation the following methods are used:

- Filling method with a paste and cement;
- Filling method with a paste and only one pin;
- Filling method with a paste and some pins:
  - The method of lateral condensation by cold gutta-percha;
  - The method of vertical condensation by heated gutta-percha;
- Methods of filling with gutta-percha, which is heated outside the channel: by "Thermafil" and injection "Obtura-2" systems;

- The method of filling with gutta-percha, which is softened with solvents (chloroform, eucalyptol, halothane);
- The method of thermo mechanical condensation:
  - With the use of gutta-condenser;
  - The use of ultrasonic condensation of gutta-percha.

11.2. Method of root filling with paste or cement

The filling materials (paste or cement), which are mixed according to instructions are injected into the root canal with a needle or a Root-filler (Lentulo) by a circular motion.

Each next portion of the material at the same time imposes a lesser depth. Filling material is introduced in the root canal seal by cotton turundes. The excess of material is removed from the tooth cavity by excavator or round bur, leaving a small amount of material over the orifices of the canal. **This is the so-called manual method.**

In addition, to this there is exist a way of filling by rotating the Root-filler (Lentulo) handpiece with a low speed.

The Root-filler (Lentulo) should be free to enter into the lumen of the canal. On the Root-filler (Lentulo) a small portion of filling material is recruited, being introduced into the root canal until it stops, then it is pulled back for a couple of millimeters (not to be stuck in the apical aperture) and a drill at a speed of about 800 rot /min with a clockwise rotation is included.

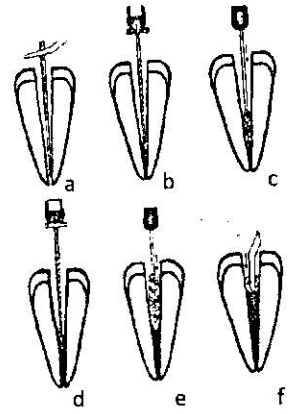


Fig.11.2. **Filling the root canal by hand:**
a – drying of the root canal; *b* – the introduction of plastic hardening paste into the root canal; *c* - seal paste in the canal with endodontic instrument with cotton turundes; *d, e* – introduction of a new portion of pasta and its seal; *f* – seal paste in the mouth of the canal with a cotton ball.

Then a rotating Root-filler (Lentulo) made 4.5 reciprocating motion (downward - upward) in the channel. Then the canal filler derived from a root canal on a running drill. The procedure is repeated 2-3 times, the Root-filler plugging (Lentulo) has a smaller depth.

Upon filling completion the channel excess of filling material is removed from the crown part of the tooth cavity. Material is compacted in the orifices of the channel with cotton swab. Carious cavity is prepared to restore anatomic form of the tooth.

Negative moments of the Root-filler (Lentulo) with paste or cement are of uncontrolled material quantity into the root canal, the possibility of voids presence in the root canal, the volumetric material shrinkage.

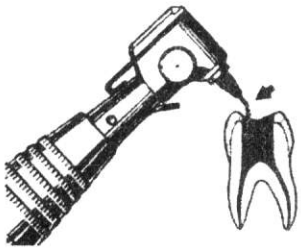


Fig. 11.3. **The introduction of filling material by the help of Root-filler (Lentulo).**

11.3. Filling method with paste and one pin cement

This method is also known as "method of the central pin" it is used in the cases where the channel is prepared in a usual way, and its form correspond to the form of the last tool used for processing.

The method consists of introducing into the channel of gutta-percha (rare metal) pin with the sealer, corresponding to the cross section channel (to achieve complete obturation of the channel).

At the orifices part of the injected canal by Lentulo first portion of liquid is mixed with paste (sealer) and is turned on an installation at the lowest speed. The material is distributed along the walls of the root canal.

Then Root-filler (Lentulo) is slowly removed from the channel.

This procedure is repeated twice.

Then, a pin (filer), with corresponding size is introduced into channel to the last endodontic instruments (or the less number), which underwent an instrumental treatment of the root canal.

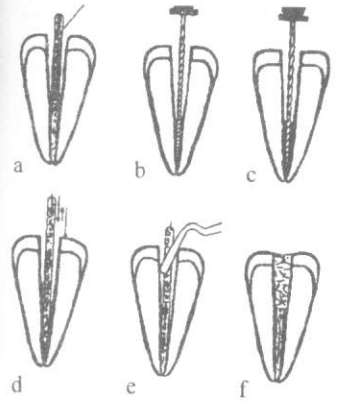
The correctness of the pin location in the channel should be checked radiographically.

The excess of the pin is removed by the heated plugger.

The disadvantages of the method:

- The formation of pores (bubble);

- Lack of strong adhesion to the walls of the channel;
- Shrinkage during hardening;
- Do not allow to fill the system of lateral canals;



There is a possibility of removing the filling material from the top (at excess of paste or with a wide apical foramen).

Fig. 11.4. **Methods of filling the channel by a single pin and paste:** *a* – the pin selection and grinding; *b, c* – the introduction of plastic hardening paste in the channel; *d* – the introduction of the pin with the paste into the channel at the working length; *e* – removal of the protruding part of the pin; *f* – temporary filling.

11.4. The method of lateral (side) condensation

Lateral condensation of gutta-percha should be taken when the instrumental permeabilization of root canal was carried out by the step-back method or a similar technique.

The purpose of lateral condensation is the achievement of high-density of root fillings with using the maximum amount of gutta-percha (Filer) and the minimum amount of sealer.

Table 11.4.

The method of lateral (side) condensation

	The sequence of actions	Means of action, methods of work
1.	Mechanical treatment of root canal	Needed: endodontic instruments of four dimensions, but not less than of the 30 the size of the appropriate length. Antiseptics, chemical preparations for the enlargement of root canals (lubricants). After the mechanical treatment of the root canal by the last tool (not less than the size 30) to pass freely to the apical foramen without encountering obstacles. The root canal should form a conical shape with a ledge in the apical part.

2.	Processing channel with antiseptics, drying	Needed: endodontic syringe root needles, cotton, paper pins. After drug treatment and drying, the channel is dry.
3.	Selection of the main gutta-percha pin (master pin)	Needed: gutta-percha pins, standardized between 15 and 140 sizes. The pin is selected by an amount corresponding to the size of the last apical file (master file). The pin is introduced into the root canal, not reaching 0.5 - 1 mm of working length, then it is necessary to make an X-ray. With the proper introduction of the master pin on the radiograph indicating its projection of 0.5 – 1 mm short of radiographic apex of the tooth.
4.	Drawing on the dried walls of the channel cooked pasta	Needed: Root-filler (Lentulo) or root needle, or a file, or paper pin, pasta.
5.	Greasing the tip of main pin with paste, its introduction into the channel	Needed: a master pin, pasta. The pin is introduced into the channel by 0.5-1 mm short of the working length of the tooth.
6.	Condensation of the pin	Needed: spreaders. Spreader size must be equal to the main pin or one size smaller. The lateral spreader, and gutta-percha pin are introduced in the canal.
7.	Introduction and condensation of additional pins	Needed: additional pins, which are available in 5 sizes: Xx-fine, x-fine, fine, medium, large; paste. The tip of the pin is lubricated by paste and injected into the channel. An additional pin is introduced into the resulting gap between the channel wall and the main pin. Additional pins are introduced as long as the spreader does not penetrate into the channel. The pins are inserted from a small amount of toothpaste. The last pin must enter into a channel not less than 3 mm, then it is necessary to control the X-ray picture.
8.	Deleting (cutting) of the pins excesses	Needed: excavator, plugger burner. The pins are cut by the heated tool to the orifices of the root canal.
9.	Preparation of cavities, restoring the lost parts of the tooth crown	Needed: tools, materials for the restoration of anatomical shape of the tooth. Materials used for indications, depending on the group membership of the tooth.

The first figure shows the stages of lateral condensation, and the second figure – radiographs illustrating the results of treatment of the described method.

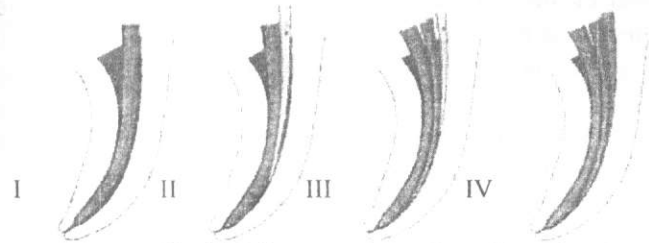


Fig.11.5. **Stages of lateral condensation:**
I – the introduction of the main gutta-percha pin; *II* – the introduction of canal-expander (Spreader); *III* – the introduction of the second lower gutta-percha pin and re-introduction of canal-expander (Spreader); *IV* – the introduction of the next, even less gutta-percha pins.

Fig.11.6. **The formation of a conical form of the canal and filling the root canal by lateral condensation method:**
a - filling the premolar root canal of the maxilla; *b* – filling the root canal (molars of the mandible); *c* – filling the root canal of the third molars of the mandible with a strongly curved mesial root.

The disadvantages of the method:

- Frequent pushing sealer over the top of the root when introducing the pin in the canal;
- Technique does not allow filling the entire system of lateral canals.

It should be noted that, the main materials used as a sealer, are calcium hydroxide, tri-calcium phosphate, hydroxyl apatite.

Examples of sealers: SealApex, Apexit, AH-26, AH Plus.

11.5. Filling the channel by lateral condensation of cold gutta-percha

The method is popular because of the right to hold it it provides the most hermetical closure of the root canal. From the chemical point of view the gutta-percha is a form of trans-polyisoprene, similar to natural rubber. Gutta-percha is of three types: α (alpha)-form, β (beta) - form, and γ (gamma) - form.

In the gutta-percha pins it is in beta form. When heated above 65°C and slow cooling is obtained by the alpha-form.

The positive properties of gutta-percha:

- Bioinert;
- Has an antibacterial effect;
- Non-toxic;
- Does not irritate periapical tissues;
- Easily introduced and removed;
- Not susceptible to moisture;
- Radiopaque;
- Does not affect the color of the tooth.

Disadvantages of gutta-percha:

- Lack of rigidity, it is relatively difficult to use if the channel does not extend to a size 30;
- Lack of adhesion to the walls of the root canal;
- The need for auxiliary material, sealer;
- Easy to shift under pressure, can be pushed out of the apical foramen;
- Does not fill the roughness of the channel walls, which create macrospace between dentin and gutta-percha pin;
- Dissolves in eugenol etc.

As sealers the primarily used materials are those, which include calcium hydroxide, tricalcium phosphate, hydroxyl apatite, and various resins. For example: Sealapex (Kerr), Apexite (Vivadent), Biocalex (Spad), Vitapex (Japan), AH-26, AH+ (Dent-splines), etc.

Table 11.2.

Filling the channel by lateral condensation of cold gutta-percha

The sequence of actions	Means, methods of work	The criterion of self-control
Conduct training of cone-shaped root canal with a ledge in the apical part	Endodontic instruments in four sizes, but not less than number 30, the appropriate length. Antiseptics, chemical preparations for the enlargement of root canals (Lubricants)	The last tool (not less than size 30) passes freely to the apical opening without encountering obstacles
Treated with antiseptics and dried	Endodontic syringe root needles, cotton, paper points	Canal is drying, does not exudate from the canal
Select the main gutta-percha pin (master-pin), enter the channel end make an X-ray	Standardized gutta-percha pins from 15 to 140 size. The selected pin by size, corresponding to the size of the last apical file (master file)	The pin is introduced into the root canal before reaching 0.5-1 mm for working length. On radiographs the pin does not reach the radiographic apex of the tooth to 0.5–1 mm
In the dry channel the mixed pasta is introduced	Root-filler (Lentulo), or root needle, or a file or paper pin, pasta	The paste is applied on the walls of the root canal
Lubricate the tip of main pin with paste, type it into the channel	Master pin, pasta	The pin comes inside of the canal of 0.5-1 mm, before reaching the working length of the tooth
Introduce in the canal spreader and push gutta-percha pin to the wall of the channel	Spreaders	Spreader must match the size of the main pin, or be a size smaller
Enter an additional pin and condense it with spreader	Additional pins are available in 5 sizes: Xx-fine, x-fine, fine, medium, large. Pasta. The tip of the pin is lubricated with a paste and is put into the channel	An additional pin is introduced into the resulting gap between the canal wall and the main pin

Enter and condenses additional pins to fill the entire channel. Make an X-ray control	Additional pins, paste. The pins are introduced with a little part of paste	Additional pins are introduced as long as the spreader no longer penetrate into the channel. The last pin must enter into a channel not less than 3 mm
Excess of the pin removes (cut) the heated tool	Excavator, plugger, the burner	Pins must be removed to the orifices of the root canal
Prepare the cavity to restore the lost portion of the tooth crown	Tools and materials for restoration of the anatomical shape of the tooth	The materials are used on the testimony based on group membership, and the defect of the tooth

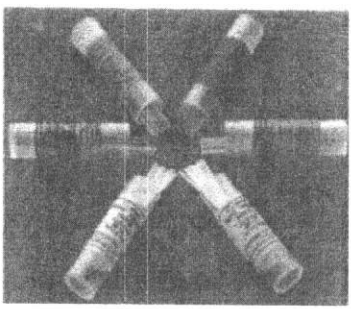


Fig.11.7. **Gutta-percha pins.**

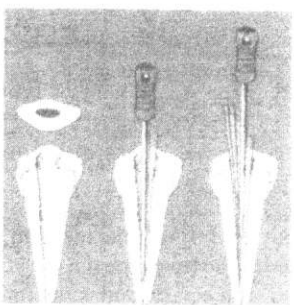


Fig.11.8. **Filling the channel by lateral condensation of cold gutta-percha.**

It should be noted that there is a similar less common method of sealing by chemically softened gutta-percha cold. The principle of the proposed method in 1914, is based on the use of chloroform as a solvent or its substitutes - eucalyptus oil, etc.

With this method the main gutta-percha pin is removed from the channel after fitting, the tip of the pin on one of the solvent is dipped the sealant's cover is placed in the channel and condensed by condenser for 1 min.

Then an additional pin, covered with a sealant's cover, which is well compacted enters. Sealing ends closing the orifices of the root channel.

11.6. The method of vertical condensation with heated gutta-percha pins

Vertical condensation method was proposed by Schilder about 30 years ago. The method consists of maximize filling of the channel gutta-percha with the minimum amount of sealer.

The main gutta-percha pin shortens to the level of the orifices of the canal, and carries out the condensation of heated pins with hot plugger in the apical direction.

The formed after condensation space is filled with small pieces of gutta-percha, which are also heated and condensed. In this case use a small amount of sealer. This method allows you to filling by gutta-percha all root canal, including the side. This requires special tools and practical skills of a doctor.

To perform this technique requires non-standard gutta-percha pins or cones, and plaggers of three sizes: large for use in the coronal third of the canal, the middle - to work in the middle third, and small - to work in the apical third.

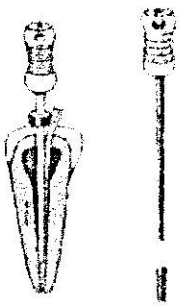


Fig.11.9. **The vertical condensation of heated gutta-percha in the root canal.**

Table 11.3.

The method of vertical condensation with heated gutta-percha pins

	Stages
1.	Drying canal with paper pin and check the apical foramen with a tool, which is smaller than the last apical file.
2.	Fit the pin to the X-ray hole (filling the entire working length) and the cutting of thick end.
3.	Remove pin and the cutting tops of 0.5-1.0 mm. Re-introduction and test retention.
4.	Preparation plaggers: the first to enter in the channel at a distance of 10 mm from the apex, the second - 15 mm, the last on - 3-4 mm. Marking the working length of each plagger.
5.	Irrigation and drying of the channel.
6.	Introduce small amount of sealer with manual Lentulo and a light coating by them the walls (cement when heated gutta-percha fillings were needed, in particular, to compensate for its reduction during cooling).
7.	Coverage of the apical third of the pin with a thin film of sealer.
8.	The introduction of the pin, the mark of its length by tightening branches of forceps.
9.	Removed excess of pin at the mouth of the channel with a hot excavator or heating plagger (the first wave of warm, leading to an increase in temperature of the gutta-percha to 5-8°C, which allows it to deform in the condensation).
10.	Beginning of condensation: the largest plagger is dipped in powdered cement, then condensed gutta-percha in the apical direction. This is accompanied by obturation of lateral canals in the middle third of the canal.
11.	Creating a second warm wave by immersion in the channel's hot part of heating plagger for 2-3 seconds.
12.	The vertical and lateral pressures by middle plagger (in this case continues the filling of lateral canals). Seal to a distance of 3-4 mm from the apex.
13.	Second heating by a plagger.
14.	Vertical condensation by the thinnest plagger.
15.	Finishing of the apical filling (gutta-percha removal of residues from the walls by plagger).
16.	Backpacking filled channel cut fragments of gutta-percha, and their condensation with cold plagger, heat, condensation and further repetition of these actions before the final filling of the canal. At this stage it is also possible the introduction of gutta-percha with a syringe.
17.	Cleaning up the cavity of the tooth before enamel-dentin border. Then temporal restoration. Sometimes in the molars the cement to the cervical part (hermetic of bifurcation) is added.

Disadvantage – to control the quality of the root canal filling it is necessary to make multiple X-Ray.

11.7. The method of thermo-mechanical condensation

The method was proposed by McSpadden (1979), to seal the gutta-percha using a special tool – McSpadden compactor, or gutta-condenser, resembling the inverse H-file seating in the corner angle headpiece.

The method is based on the softening of gutta-percha in the root canal by the heat.

When the thermoplastic gutta-percha condensation, entered into the canal the pin corresponded to the channel cross section, which softens under the influence of heat generated by friction with the pin of the working part of the condenser, the speed of which is 8000-10000 rot / min.

At the same time gutta-percha moves to the walls of the channel in the direction of the apex.

In a short time, a root canal is completely filled with gutta-percha.

The most successfully sealed are the straight and wide channels.

Curved root canal filling for posterior teeth is difficult.

Working length of gutta-condenser should be 1 mm less than the length of the processed canal, and its size should match the size of most recently used of the apical file.

Gutta-percha pin must be 1-2 sizes larger than the last file.

After the sealer and gutta-percha pin the introduction the condenser is placed in the channel to a depth of 3-4 mm and begins to rotate without any pressure.

Then, the rotating tool is introduced to the entire working length for 1second.

In this way gutta-percha is condensed by the faces of the instrument, which itself is pushed out of the root canal after compaction completion.

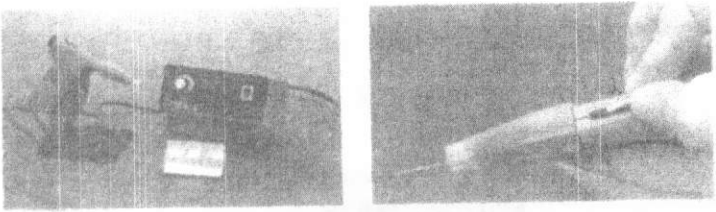


Fig.11.10. **The device for the gutta-percha heating, gutta-percha syringe for injection into the root canal.**

11.8 Ultrasonic condensation of gutta-percha method

The method consists of plasticizing the gutta-percha pins with ultrasound endodontic instrument - the file that is inserted into the channel from the pin. Gutta-percha is compacted in the channel and the final condensation plagger is carried out manually.

11.9. Method of sealing system "Thermafil"

The method was developed by BW Johnson (1978). The method is based on the gutta-percha (a-phase) canal obturation, deposited on a stainless steel, nickel, titanium or plastic rod. The method provides sufficient obturation canal, accurate apical control.

A-phase gutta-percha is heated to the operating temperature, it becomes tacky and sticky, and being firmly fixed on the central rod.

This helps to introduce the obturating material to the depth of the root canal system.

The rod acts as a central support, it condenses gutta-percha on the entire working length of the channel, providing the apical seal and reducing obturated mass shrinkage, before the channel filling is carried out to calibrate it (check the size of the processed matching for size of using obturator).

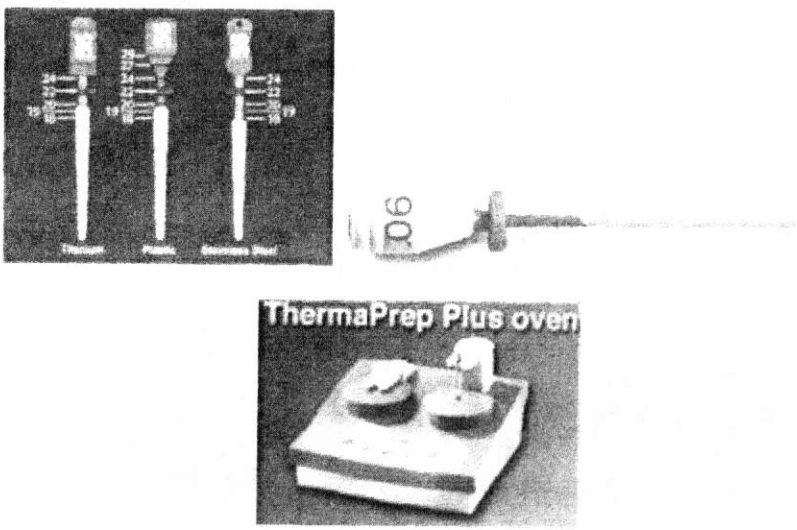


Fig.11.11. **A furnace for heating "Thermafil".**

For the calibration the verifier is applied. It is introduced into the root canal and it conducts the radiography.

Then, obturator, an appropriate-sized of verifier, is placed in an oven, "Thermo-Prep".

A small amount of sealer is injected in the root channel (or hermetic), and the warmed "Thermafil" introduced into the root canal with a little pressure on the working length.

Then the rod is cut at the mouth of the channel, the gutta-percha is condensed by plagger.

Root canal obturation using "Thermafil" involves the following steps:

1. Anesthesia, as apical pressure occurs when the penetration of "Thermafil", can be a cause of discomfort.
2. Determining the working length with the use of the verifier.
   The choice of "Thermafil" is of the same size and length as the verifier being used to determine the final working length.
   At present, a "GT" set includes "Thermafil" with taper of 10, 8, 6, 4%, which greatly facilitates and accelerates the filling of the channel. If the channel has a sharp bend, then, from size 35 and above, the pre-bent metal support. In this case there may be cracks in the gutta-percha, but it does not matter, since they disappear when heated. The size of the rods 20, 25 and 30 are flexible, so there is no need for their pre-bending. In addition, the flexibility of the process of heating the metal carrier is increased.
3. Treatment of obturator with 5% sodium hypochlorite solution for 1 min, rinsing in 70% ethanol and drying.
4. The canal drying with sterile paper points.
5. Heating of the obturator in the oven (furnace).
6. The introduction of a small amount of paste or sealer into the canal with paper points and canal filling to lubricate its walls the entire length.
7. Obturating the canal. Heated in an oven "Thermafil" is injected into the channel before a certain length. If the channel has been properly calibrated, and the gutta-percha heated to the desired state, the obturator is in place without much effort. After the introduction of the obturator into the mouth canal gutta-percha excess is accumulated. This is natural, since the rod is covered with a layer of gutta-percha, designed to fill the widest channels.

8. Removal of "Thermafil" obturator handles. Plastic pin cut round bur at the orifices of the root channel. The pin made of stainless steel is cut to 1-2 mm above the mouth of the channel with a sharp conical bur. To remove the titanium media carbide fissure bur is used. If you need an X-ray control, it is carried out to remove the handle (to extract the obturator, if it is necessary).
9. There is a gutta-percha seal around the shaft with a vertical condenser, which prevents accidental removal of gutta-percha from the orifices.
10. Excess removal of gutta-percha from the pulp chamber to provide access to other channels.

All of the above stages are repeated, if more than one channel of the tooth. After the filling all the channels remove the excess of gutta-percha from the pulp chamber and the bottom is covered with glass-ionomer cement, and then a permanent seal is imposed.

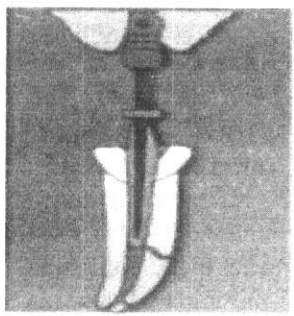


Fig.11.12. **The introduction of "Thermafil" into the root canal.**

The company Dentsply Maillefer – manufacturer of Thermafil®, – recommends the following steps of root canal obturation:

1. ***Calibration of the channel.*** To determine the size of the **Thermafil ®** obturator for filling root canal, use a template tool **Verifier**, which determines the size of the root canal. **Verifier** corresponds to the size of the last working tool that was used to working length. This **Verifier** must:

- Pass easily for the entire working length without too much effort (if **Verifier** does not pass on the entire working length, it is necessary to increase the taper of preparation or use the **Verifier** of smaller size);
- Give a slight sensation of resistance (pulling back force) the extraction (if such a sense is not present for a change larger **Verifier**).

2. ***The choice of the obturator.*** Select **Thermafil®** obturator, corresponding **Verifier** which is passively used for all the working length. Set the working length on the central plastic rod in **Thermafil ®** pattern matching the rings and / or a silicone stopper.

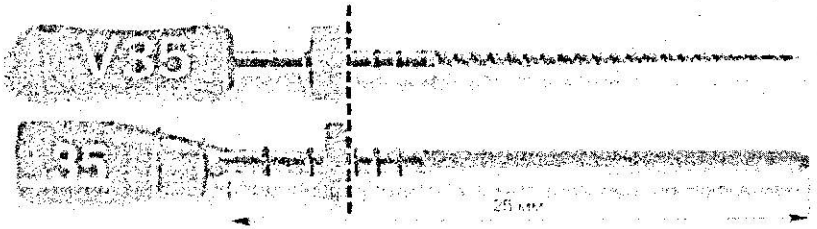


Fig.11.13. **The choice of the obturator: Verifier (top) and "Thermafil" (bottom).**

3. ***Asepsis.*** Disinfect the obturator in the solution of sodium hypochlorite for at least 1 minute and dry it by air.

4. ***Heating of the obturator.*** Heating of the obturator is done in the oven **ThermaPrep ®**:

5. ***Drying of the channel, introducing sealer.*** While the obturator is heated, mix sealer for root canal. For a complete drying of the root canal prior to the introduction of cement use sterile paper points. Apply a thin layer of sealer on the walls of the channel to the entire working length, using a sterile paper pin or a file.

6. ***Obturation of the root canal(s).*** Remove carefully the obturator from the holder and introduce it immediately into the channel, moving it slowly and deliberately towards the apex. To prevent curling, make sure that progress is on the axis of the obturator. With the introduction of gutta-percha covering the obturator rod, fill all the lateral canals and locks the root canal to the apex. In a few seconds after reaching the apex it is necessary to apply pressure. If you want to seal up a few root canals, using alternately left, then right-holders, which will save time.

7. ***Cutting shaft and handle.*** After radiographic confirmation of the entire canal obturation of the working length of the cut plastic rod of obturator by **ThermaCat** bur in the turbine hand piece (300 thousand rotations per minute - rpm) without cooling.

Fig.11.14. **Bur "ThermaCat".**

8. ***Removal excess of gutta-percha.*** With the endodontic excavator the excess of gutta-percha is removed, which can block the access to

the cavity and other channels. Use plagger for condensation of gutta-percha which is softened around the obturator. For all channels filling of multi rooted teeth, repeat the sequence of steps, always start with the channel having the most difficult access.

9. ***Preparation for pin.*** To obtain the necessary space for the pin use bur **PostSpeys** in the turbine or the high-speed hand piece with an angular speed of 200 000-300 000 rpm without water cooling with low pressure. Introduce the bur before contact with the rod **Thermafil®**. After softening the plastic rod, go with the apical pressure on the estimated depth (in 2-3 seconds maximum) remove the bur to prevent overheating.

Fig.11.15. **Bur "PostSpeys".**

10. Now you can easily drill and effortlessly create a channel for the pin. Bur **PostSpeys** removes filling material without vibration, and the space under the pin can be created immediately after the obturation of the canal. Bur should pass easily, without additional effort. If the bur does not move through the channel, check the angle of his dive.

11. Remove the obturator in retreatment. Endodontic Obturator **Thermafil®** has a groove specially designed for an easy removal. To remove the **Thermafil®** obturator pass on the full length of the rod rotating tool, such as titanium, nickel profiles .06/25, or .06/20 **GT™** file to remove the gutta-percha environment. The heat generated by the rotation of the tool softens the plastic obturator rod. The speed of instruments rotation should be 600-800 rpm. To soften the gutta-percha, you can use a solvent (chloroform) to facilitate the flow of nickel titanium instruments.

Advantages of obturation technique with "**TERMAFIL®**":

- Three-dimensional (3D) obturation of the root canal;
- The apical hermetic of the root canal (heated gutta-percha comes just before the apex), including lateral root canals;
- Ease of obstruction of long, curved and narrowed root canals;
- Reduction in working times;
- Easy to use and short learning time.

The use of "**Thermafil®**" is not recommended:

- In teeth without apical constriction: an open apex, resorption, etc.;
- The lateral teeth, which are hard to reach, at patients with limited mouth opening;
- For root canal (s) in which it is impossible to form the apical taper at least .04.

11.10. The method of filling with the injection system "Obtura-2"

The method was proposed in 1977. This method consists of gutta-percha heated to 160 degrees introduction into the root canal, by a special syringe. This temperature allows the material to be fluid and pass through the needle. When the needle is inserted into the channel, it should not reach the apical foramen to 3.5-5 mm.

Installation for heating gutta-percha and a syringe for hot injection is shown in the following figure. It is introduced to fill the space between the wall of the canal and gutta-percha sealer. Then the first portion of the material that condensed in the apical part by the manual plagger is introduced. Then a control test should be done.

Fig.11.16. **Device (Apparatus) for heating the gutta-percha.**

11.11. Assessment of the quality of root canal fillings

In qualitative sealed root Root-filler (Lentulo) the material is dense and fills it comes to top- physiological level, 1-1.5 mm from the radiographic apex (at sealing teeth with inflamed pulp - pulpits), and to the level of radiographic apex in case of filling teeth with periodontits.

The quality of the root canal filling checked the control radiograph. X-ray images can be clearly seen, the material adheres to the walls of the canal, voids and bubbles in the filling material, the level of filling in the mouth and apical parts of the the root canal(s) can be present or absent.

The clearly visible filling material removal, by the tip of the root is invalid (error, complication).

Main stages and criteria of qualified endodontic treatment:

1. Conduct radiological studies to evaluate the status of hard tissues and the apical periodontium.
2. Indicated, carried out anesthesia.
3. Isolation of the operative field (System Cofferdam, Ruberdam).
4. Opening and deleting the pulp chamber.
5. Removal of root pulp – extirpation (with pulpitis) or the necrotic tissue (with periodontitis) and antisepsis of root canal.
6. Determination of working length of the root canal(s).
7. Instrumental and medicamentous treatment of the root canal(s).
   - Permeabilization and expansion of the canal (not less than three numbers of the original width).
   - We can't work by endodontic instruments in a dry channel.
   - The apical part - at least 25 size of endodontic instrument.
   - You need to create in the top of physiological apex the stop.
   - The channel must have a tapered form, funnel-shaped and expanded in the orifices parts.
   - Making the instrumental work in the root canal one should always use chemical medications for expansion.
   - You should carefully and rinse plenty the root canal by antiseptics.
8. Drying of the root canal (cotton turundes and paper points).
9. Filling of the root canal(s).
10. Restoration of anatomic form and function of the tooth.

12. ERRORS AND COMPLICATIONS IN DIAGNOSIS AND TREATMENT OF PULPITIS
(Lecture 16)

12.1. The classification of errors and complications

In the process of endodontic treatment there are relatively frequent errors and complications, that in the future could be reflected in the treatment process.

The main causes of errors during the endodontic treatment are:

- Lack of anatomy and morphology knowledge of the teeth;
- The presence of zones topographically adjacent with possible risks;
- Use of endodontic instruments;
- The use of improper methods (techniques) of treatment.

The classification of errors and complications that can occur during the endodontic treatment:

1. Errors and complications that can occur at the level of the coronal part of tooth and marginal periodontium during the creation of access and expansion of the orifices of the root canal:
   - 1.1. Mechanical errors and complications:
     - 1.1.1. Do not open the cavity of the tooth (the error in the trepanation);
     - 1.1.2. Too broad disclosure of the tooth cavity;
     - 1.1.3. Not full disclosure of the tooth cavity;
     - 1.1.4. Perforation of the crown with damage of marginal periodontium;
     - 1.1.5. Perforation in zones of bifurcation and trifurcation;
     - 1.1.6. Broken bur.
   - 1.2. Chemical errors and complications:
     - 1.2.1. Marginal arsenic periodontitis;
     - 1.2.2. Marginal periodontitis occurring as a consequence with use of trichlore-acetic acid, sulfuric acid, hydrochloric acid, etc.
2. Errors and complications occurring at the level of tooth root:
   - 2.1. Creation of the steps;
   - 2.2. False path (root canal wall perforations);
   - 2.3. Instruments break in root canal;
   - 2.4. Partial root canal obturation.

3. Errors and complications that are possible in the apical periodontium:
   3.1. Bleeding in the root canal;
   3.2. Mechanical trauma of the apical periodontium;
   3.3. Lesions of the apical periodontal chemical origin:
      3.3.1. Arsenic;
      3.3.2. Other chemical substances.
   3.4. Push the pathological derivatives (putridnyh mass) over the apex;
   3.5. The defeat of the adjacent anatomical structures (sinuses, emphysema of soft tissue, the root canal filling with the pushed filling material over the apex).
4. Common errors:
   4.1. Aspiration of foreign bodies;
   4.2. Ingestion of needles (endodontic instruments);
   4.3. Syncope, collapse.

12.2. Perforated the walls and the bottom of the tooth cavity

Perforation of the tooth cavity bottom is the most often observed in low removal "canopies" over the tooth cavity.

Perforation at the neck of the tooth (under- or supra-gingival) is possible with a bad review, and as a result of preparation, excluding the provisions of the tooth.

It should be noted that the diagnosis of perforation is not of a much difficulty.

The appearance of abundant bleeding is combined, more or less painful, clearly indicating the presence of perforation.

In this case it is necessary to produce X-ray control.

It is desirable to introduce the alleged perforation radiopaque material.

The most suitable material is gutta-percha pin.

In most cases, the doctor did not consider it necessary to inform the patient and make the appropriate entry in the medicine card, which is also an error.

Fig.12.1. **Perforation of the crown in cervical part of mandibular molars.**

12.3. Apical perforation of the wall of root canal

Apical perforation occurs, according to some sources, up to 9% of all errors. The reasons for the apical perforation of channel wall may be a few:

1. Trying to pass through the channel with the application of significant effort when dentine chips are blocking the lumen of canal;
2. Use tools with an aggressive tip;
3. The use of machine tools in the permeabilization of curved canals;
4. Not enough opening of the tooth cavity or preparation of root canal without direct access for endodontic instrument into the canal;
5. Wrong choice of endodontic instruments. When extending the curved channels it is advisable to use the tools with blunt tip of a nickel titanium alloy (profiles) that have great flexibility.

Schematic and X-ray diagram of the apical root canal wall perforations are shown in the figures.

Fig.12.2. **Apical perforation of the root canal wall.**

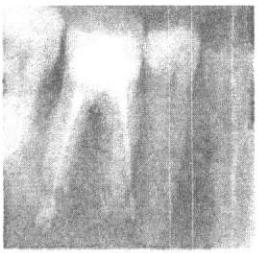


Fig.12.3. **Perforation of the medial root.**

Prevention of this complication is subjected to the following rules:

- Need to use techniques to prevent blocking of the lumen of the canal with dentine chips;
- Before the introduction into the channel, the tool should be bent, in accordance with the curvature of the channel;
- When expanding the channel with files sawing motion of the quantity should be done rotational motion should be minimal;
- Preference should be given to the tools with non-aggressive tip;
- As accurately as possible to use the working length of root canal.

12.4. The longitudinal perforation of the root canal wall

This complication is a variant of the previous complication - the excess of the longitudinal expansion of the channel in the middle third of the "lesser curvature" of the root.

The most common causes are: underestimation by doctor of channel curvature, working in a curved channel, not curved instruments, excessive expansion of the narrowed channel.

In addition, the emergency of this complication may also contribute to the anatomical features of the root.

Prevention of the longitudinal walls root canal perforation includes the same activities and techniques that prevent excessive expansion of the longitudinal channel in the middle third of the inner surface of the root:

- Preliminary assessment of the anatomic and topographic features of the root canals and tooth roots on the basis of diagnosis and (or) X-rays "measuring" ;
- Pre-bending of files;
- Use of "anti-perforation technique";
- Use of safe bur (Safety Hedstroem), - flexible files and nickel-titanium rotary instruments;
- Expansion of the channel is not more than 2-4 numbers from the original width.

Fig.12.4. **The longitudinal perforation of the wall of the root canal.**

12.5. Blockade of the canal dentine chips (dust) or soft tissues lumen

The reasons for this complication, often is the most premature use of large tools, and the rule failure - returned to fill a smaller diameter for the control of cross-channel (all over).

Go to the blockade of the channel lumen, may also result in incomplete removal of the pulp and inadequate irrigation (lavage) of the channel in the process of tooling.

Prevention. To avoid this complication, it is necessary to observe strictly the rules and the stages of instrumental root canal treatment, rinse the channel plenty after the application of each endodontic instrument.

Fig.12.5. Blockade of the canal lumen by dentine dust or soft tissue.

12.6. The formation of apical extensions or ledge - «zipping»

The reason for creating in channel ledge or apical extension is the most often used when working in a curved channel, thick, inflexible file, not a pre curved shape of the channel. The rough turning curved tool in the channel - takes the form of an hourglass.

Prevention of this complication is to prevent blocking of the canal lumen by dentine filings (chips).

There should also be pre-bent instruments, in accordance with the curvature of the channel the channel file extension should be reciprocating, rather than rotational motion.

Fig.12.6. **The formation of apical extensions or ledge - «zipping».**

It dramatically reduces the risk of creating a channel ledge or apical extension which allows you to work with non-invasive tools for the tip.

12.7. Excessive longitudinal extension of the channel in the middle third of the inner curvature of the root - «stripping»

The cause of this complication, as a rule, is an underestimation of the curvature of the channel and work in a curved channel, not curved instruments.

Prevention. To avoid excessive expansion of the channel in the "small curvature", should be pre-bending the files in accordance with the curvature of the channel used in the processing of the "antiperforation technique" when the file is pressed against the "greater curvature" of the channel.

To avoid this complication it is allowed to use safe storms (Safety Hcdstrocm), flexible files, and rotary titanium-nickel-base tools.

You should avoid excessive expansion of narrow, curved channels: they are encouraged to extend no more than 2-4 numbers from the original width.

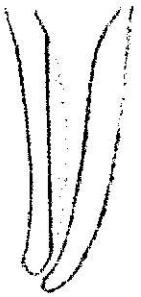


Fig. 12.7. **Excessive longitudinal extension of the channel in the middle third of the inner curvature of the root («stripping»).**

12.8. Over-extension (the "gap") of the apical foramen

When this complication occurs the destruction of the physiological apical constriction, and form the apical emphasis in this case is not possible.

The reasons for this complication may be different.

1. This will occurs in an incorrect definition of the working length. Remember that when you delete the living pulp the working length should be at least 1.5 mm radiographic root length, and when you remove the devitalized heavily infected pulp on 1 mm less than the radiographic root length.

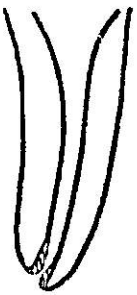


Fig. 12.8. **Over-extension (the "gap") of the apical foramen.**

2. In applying the apical-coronal methods when working the length is determined first, and then is made the expansion of the channel, "loss of working length" is possible. This is due to the straightening of a curved channel in the process of tooling (instrumental work), as a result of working length can be reduced to 0.5-2 mm. If you do not take into

account this factor, the excess will be handling the apical part of the channel with the apical foramen "break".

3. The reason for the excessive expansion of the apical foramen may be the incorrect handling techniques of the permeabilizing apical part of the channel.

4. Excessive expansion of the apical foramen can be made by doctor with medical reasons, to allow out flow of exudates, take drug substances over the tip.

5. The reason for the "gap" of the apical foramen may be resorption of the root apex in periodontitis, when the physiological apical constriction is destroyed as a result of medical manipulation, and as a result of the pathological process in the periapical area.

6. In the endodontic treatment of teeth in children and adolescents the timing of resorption and formation of the roots of their primary and permanent teeth should be taken into account.

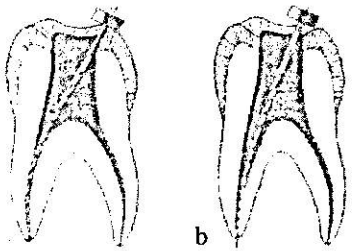


Fig.12.9. **"The loss of working length" by rectification the curved channel in the process of tooling.**

Preventing the "gap" of the apical foramen is in compliance with endodontic treatment process and a number of rules:

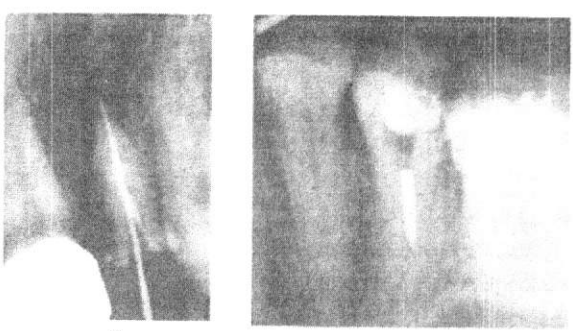
- The precise definition of the working length and its correction in the rectification of root canal;
- Strict adherence to rules and processing procedures the of the channel apical part;
- Accurate, without undue pressure working in the apical region of the root apex;
- In cases of doubt, necessary to carry out additional radiological controls;
- Use in cases of doubt, Crown Down methods of permeabilization of root canal.

12.9. Tool break in the channel

The instrument break in the canal is one of the most unpleasant complications for the doctor and patient. Leaving tool fragments in the channel dramatically worsens the prognosis of endodontic treatment, and sometimes the cause of tooth extraction.

The reasons of the instrument break most often are:

- No direct access to the root canal. Improper disclosure of the tooth cavity.
- The application of significant force on the tool during the manual or machine processing.
- Incorrect tool use. The introduction of the instrument to a considerable depth in the rotation of the tool a few times often leads to jamming, and then tool break. The tool must rotate not more than120-180 degrees.
- Attempting to expand the canal with no endodontic headpiece. When you rotate only clockwise there is a deep introduction into the root canal and as a consequence, jams and breaks.
- Violation of a sequence of endodontic instruments use;
- Work with deformed, untwisted tools. Lack or insufficient monitoring of endodontic instruments. The first sign of change in the turns structure (untwisting or twisting) the instrument must be replaced.
- Work in a dry channel.
- The haste in the work.



a b

Fig.12.10. **Lentulo breaks in the root canal:**
a) It is managed to bypass the broken tool by file;
b) Break the instrument in the second premolar.

Prevention is used in the following rules:

1. Careful work with the rules and consistency of tools application;
2. Compliance with the maximum angles rotation of tools in the channel: K-reamers - 180°, K-files - 90°, with narrow, curved canals it is recommended to reduce the angle of rotation to 20-30°. H files in the channel can't be rotated;
3. Mandatory use of gels for the expansion of root canals;
4. Prompt culling of unsuitable tools.

Criteria for rejection of endodontic instruments:

- Plastic deformation of the tool;
- Pre curved instruments;
- Deployed instruments;
- Damage to the cutting edge and top of the instrument;
- Working part of the blade is dull, as evidenced by the shiny edge;
- Pulp extractors and tools are smaller than the number 10 on ISO, being disposable after a single use to be rejected.

12.10. The use of inappropriate methods of treatments and root canal permeabilization

Until now, it is often continued to use methods that are, mildly speaking, should not be used. Here are some of them:

- Resorcinol-formaline method which components (formaldehyde + resorcinol) are irritating to the tissues, and provoke hypersementosis and cause sensitization, do not provide a guaranteed treatment.
- Filling with paste does not guarantee the reliability of the root canal obturation, but some doctors still use it.
- Filling of the root canal by phosphate cement.

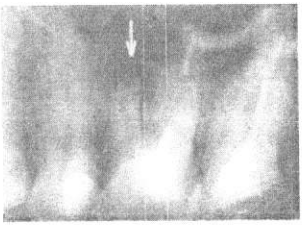


Fig.12.11. **Destructive changes in the molar periodontium after the resorcinol-formalin method**

- Medical treatment of channels, in most cases, is held without spray solution, and turundes or just turundes, but not with paper points to dry the root canals. Application of these methods provokes complication in the pre-treatment process, or in future.

12.11. Poor filling of root canals

Do not pass a root canal. Anatomical features of the root canal, curvature, low branching of channel, deposition of petrifikates, the presence of additional channels – all these factors can be cause of obstruction.

However, in most cases it is caused by:

- Lack of access to the orifices of the root canal;
- Disregard the information about the availability of additional root canals;
- Lack of a complete set of endodontic instruments;
- Not owning the method of instrumental treatment of root canals.

There is no control of the passage of the root canal – the definition of the working length of root canal is not carried out. The working length of the tooth - this is the criterion that is necessary to know preparing the tooth, its medicamentous treatment, training center pin and filling.

The method of root canal filling by one paste is used. This method does not guarantee complete obturation of the root canal up to the apical hole. This is because there is no method of verification the injected paste amount.

Long-term retention of Lentulo in the channel removes the paste up to apical hole, but the density of paste may be insufficient. When the extracted Lentulo from the canal it doesn't stop the tool rotation. That can be a cause of removing the paste from root canal.

The method of one (central) pin used. It often does not create a stop at the apical constriction, which leads to a partial filling of the root canal, or gutta-percha point go over apical hole.

Overflow the sealer over the apical hole Thermafil use may cause incorrect determination of channel length or excess sealer in the root canal.

12.12. Intracanal bleeding

Bleeding from the root canal is more often encountered in the method of vital extirpation of the pulp (from 1% to 6%). In many ways, bleeding contributes to the effect of epinephrine in the anesthetic.

Before filling the root canal, it should be cleaned the attention should be drawn to the color of turundes, which was drying the root canal. Bleeding usually occurs because of the rich vascularity of the apical region of the tooth.

When you remove the pulp with pulp extractor there will be rupture of blood vessels. The causes of bleeding are disorders of instrumental techniques of root canal treatment, incomplete removal of the pulp.

In addition, the bleeding may occur in zones of perforation of bifurcation, the root canal walls, wide apical foramen, and aggressive instrumental work, for injury periodontium with endodontic instruments and should be considered as common causes of bleeding. These include cardiovascular diseases, rheumatic diseases, atherosclerotic changes of the vascular system (the elderly), during the menstrual cycle, etc.

The method of stopping the bleeding: for bleeding inside of the root canal hemostatic agents are used (5% of the amino-caproic acid, 10% solution of calcium chloride).

Introduce turundes of 3% solution hydrogen peroxide, "Vagotil", "Kaprofer" inside of root canal. The mechanism of action of these drugs is to accelerate the clotting of blood. If the bleeding fails to stop, it is advisable to leave inside of the root canal the turundes soaked in one of these drugs under the bandage with artificial dentin.

To avoid this pulp extirpation complication (prevention) it is necessary to do diathermocoagulation. As a result a zone of demarcation and extirpation of the pulp is obtained without laceration (no blood vessels rupture), which prevents the occurrence of bleeding.

12.13. Errors of anesthesia

The causes of complications are more often technical errors in anesthesia and a violation of the rules of asepsis. It must be remembered that some of the complications do not depend on the doctor and they can not always anticipate. The consequences of these complications are

dangerous, both for the patient and the doctor. The doctor must know them, and do everything to prevent them.

Broke a needle under anesthesia. Is rare to prevent these complications it is necessary to check the reliability of fastening of the needle cannula to the syringe and the needle to follow the rules. Unquality needles and errors during anesthesia (rapid movement of the syringe to the side, a sudden stop in the bone) can cause a needle break. If you have any - you should try to remove it with tweezers or needle broke crontsanges, and in case of a failure – surgery is needed.

The formation of hematomas. Hematoma - damage to the vascular wall with injection needle. In the area of injection there can be produced swelling of a bluish color of the skin and oral mucosa. Hematomas occur as a result of vascular damage with a needle during anesthesia.

After the puncture needle into the tissue to perform aspiration test and verify that the needle does not hit the vessel. Preventing the damage to blood vessels can be slowly and continuously advancing the needle for the current anesthetic solution, the needle bevel should be directed to the bone.

If a complication arose - it is recommended to press the fingers adjacent to the hematoma by the site of cheeks or put a pressure bandage and apply cold to this place.

In addition, during anesthesia, allergic reactions to certain drug are possible and the most difficult and dangerous complication is anaphylactic shock, which results in:

- the patient's blood pressure drops;
- there comes a weak heart;
- impaired breathing;
- a feeling of fear;
- the patient loses consciousness.

In the short period of time may lead to death. An emergency care is needed.

Lack of analgesic effect - occurs when an incorrect choice of anesthetic technique and the violation of its implementation. As a consequence, there is pain in the treatment stages.

Neuritis - is caused by injury of the nerve trunk or its termination. As a result, paresthesia (occurring spontaneously with an unpleasant

sensation of numbness, tingling, burning, crawling, etc.), numbness, in severe cases - a persistent decrease in sensitivity.

Muscle contraction - is the result of violations of aseptic, injuries with needle of internal pterygoid muscle and substandard anesthesia, as a result, a pain in the muscle and the lack of mouth opening. The patient at night is recommended the imposition of four-tailed bandage, orally administered analgesics (pain relievers) and warm mouth wash with medicinal plants.

12.14. Ingestion and suction of endodontic tools

Tool entering the tool may occur in the gastrointestinal tract (ingestion) or inhalation (aspiration) during endodontic treatment. These complications are rare, but they are very dangerous.

Root needles, burs, files, drill, particles of amalgams, cements, etc can be aspirated or ingestion.

The reasons of this: wrong position of the patient in the chair, incorrect disclosure of the tooth cavity, doctor carelessness during endodontic procedures.

The endodontic instrument must be held tight to the finger tips. And the rotating tools – also must be well-kept.

It is needed to check the ficsation of bur in the handpiece before the beginning of the work. After it we must rotate test the handpiece with bur out of the mouth. And begin the work only after it!

In addition, it is recommended to use the system of endodontic manipulation "Koferdam - Rubberdam".

It should be used on the treatment of saliva ejector (suction), which prevents ingression of saliva on the doctor's hands and slide tools, which can lead to their downfall, and as a consequence, swallowing.

Ingestion and suction.

In the case of aspiration of the tool you need to call an ambulance (for bronchoscopy and extraction of foreign body) and make trahiostomi.

In case of ingestion of the instrument in the gastrointestinal tract radiography should be made in order to determine the localization of the ingested tool. Give sedatives, and appointed a diet rich in fiber. Warn the patient that he must observe the stools, as within 2-4 days, the tool should get out of the body, it is necessary to make sure. If the tool is not

eliminated - surgical intervention is needed. The best option is hospitallization and patients follow up in the surgical hospital.

12.15. Emphysema of soft tissues

Emphysema - is the presence of air in tissues. In dentistry may be postoperative emphysema. In the postoperative emphysema (surgical emphysema) air can get into the tissue, and bacteria can be formed in the soft tissues by the gas. The presence of air or gas in the affected tissues creates a characteristic crackling sensation to the touch and can be detected during X-ray examination.

Located in the tissue the air is readily absorbed as soon as the air flows to the tissue or the formation of gas within it stops. Clinically, there is an asymmetry of the face in emphysema, palpation provokes kripitatsiya (cracking). The patient should be calm and to be administered sedatives.

This complication may occur during the drying of the root canal. Keep in mind that root canals can't be dried with air under pressure from the gun of the dental unit. Root canals are dried with turundes or with paper pins.

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