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Introduction

Treatment of pulpitis in teeth with open apex has a number of specific features. Its goal is to maintain pulp viability, which provides future formation of the tooth root. There's an increased risk of progression of infectious process and inflammation of the periapical tissue. Complete bacteria elimination from the inflamed pulp is necessary for osteoblast activation and dentin formation [1-3].

Topical antiseptic, anti-inflammatory, hypersensitizing and odontotropic medications have become widely accepted treatment for the inflamed pulp [2-9]. The medications can be used as a temporary or permanent application or introduced into the dental pulp with the help of electro- or phonophoresis.

Different biological treatments of pulpitis with antiseptics, such as ethacridine lactate, furatsilin, iodinol, enzymes, antibiotics, hormones, were

CONSERVATIVE TREATMENT OF PULPITIS

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ABSTRACT

Treatment of complicated forms of caries in permanent teeth with an open apex in children is the most relevant today. Among patients who apply for pediatric dental help the percentage of asymptomatic pulpitis is about 1/3. Inefficient treatment of teeth trauma often leads to development of acute or chronic pulpitis. Sometimes it can lead to pulp necrosis and injure the growth plate of tooth roots. After applying calcium paste the pulp canal also become infected and die.

tested by Russian scientists and accepted in dental practice in the late 20th century. (Ivanov V.S., Urbanovich L.I., Berezhnoi V.P., 1990). Indications to various dental treatment pastes containing eugenol, calcium hydroxide, collagen (Dmitrieva L.A., Nezhivenko L.N., Gerasina O.V., 1986), dimexide with crystalline lysozyme (Musharapova S.I., 1983) have been worked out. Bone meal and heparin (Chumakov A.A., Kolenova Z.D., Leontyev V.K., 1986) as well as algipor and heparin containing medications (Dmitrieva L.A., Ardabatskaya G.A., Ulyanova T.V., 1986) have shown a positive effect.

However, all these drugs have selective bacteriostatic and bactericidal activity against microorganisms that live in the carious cavity. Many drugs don't have odontotropic effect, so they don't stimulate the formation of reparative dentin and dentin remineralization. Antibiotics and sulfanilamides can selectively decrease a



microbial risk and often have a sensibilizing action. Some drugs reduce their activity with long-term keeping. Zinc oxide eugenol paste has a specific odor. Dimexide is a highly toxic drug. Calcium hydroxide formulations should be used with great care as they can cause pulp necrosis due to strong alkaline reaction (pH 11–12). Some of the drugs are tooth stainable («MTA») [10, 11].

Treatment of pulpitis (tooth filling) using polymethacrylic acid is available (Japan, application N 3-22042, publication 90.05.17. M. cl. A 61 K 6/00). However, polymethacrylic acid being in a bound form because of hardening complicates its positive effect on dental pulp through dentinal tubules. This material composition does not have dentin formation and mineralization effect, and does not change pH. This filling material is capable of forming a chemical compound with tooth enamel and dentin through carboxylate groups and does not irritate dental pulp. Due to the presence of potassium nitrate, this cavity liner has odontotropic effect and stimulates reparative function of the pulp.

Biological method of treating pulpitis is the closest to the suggested method. It involves cavity preparation followed by antiseptic treatment, placing curative cavity liner on the bottom and then isolating liner and then filling the cavity. The procedure requires sequential management of cavity with 1% solution of polymethacrylic acid with pH 8.5–9.0. Then, after mechanical pre-treatment of lesions 1–2% polymethacrylic acid solution with pH 9,0 is administered to the cavity bottom under the dressing for 3–5 days. Finally a paste consisting of a mixture of Remodent powder and 2% polymethacrylic acid

solution with pH 8,0 (see patent RU №2070032; Cl. A61K 6/08, 1996) is applied under the permanent filling.

Despite a great number of studies and suggested methods, there is no generally accepted and approved management of pulpitis in permanent teeth with open apex [2–9].

Aim: To develop a method of treatment of pulpitis in permanent teeth with open apex that would provide an effective pulp and dentin tubules sanitation removing all types of microorganisms and preventing spread of inflammation, that would finally lead to the formation of dentin bridge at the border of a healthy tooth tissue and contribute to apexogenesis.

Objectives: To develop a composition of the paste administered into the cavity before applying calcium-containing paste, that would have antimicrobial and anti-inflammatory effect and could affect microorganisms in the carious cavity and dental pulp at different levels of the lesion in permanent teeth with open apex.

Materials and methods

25 patients aged 6 to 10 years with acute and chronic inflammation of the pulp of different groups of teeth with open apex were treated. In every case the pulp chamber was opened after necrotomy. In 14 cases the vital amputation was inevitable.

2% chlorhexidine solution was used for antiseptic treatment of the tooth cavity, then paste containing «Metrogyl Denta» gel in combination with chloramphenicol powder was applied. During the second visit a calcium-containing paste



(«Trioksident», «MTA») was used to stimulate apexification and apexogenesis.

Microbiological examination was carried out in all the patients. The obtained material was prepared by ten-fold dilution. Vitelline-salt agar (VSA) was used for isolation of staphylococci, which were incubated at 37 °C for 48 hours. Biochemical plates made by SPA

«Nizhegorodsky kontur» were used for identification.

Streptococci were cultured on blood agar; enterococci – on enterococcal agar; corynebacterium – on corynebacterium agar; Klebsiella, coli bacillus – on Endo medium; anaerobic organisms – on the elective medium for cultivation using gas-producing packages GasPac made by

«HiMedia», India. Test sets Lachema made in the Czech Republic were used to identify microorganisms. Microorganism sensitivity to antibiotics was determined using disk-diffusion method and method of serial dilution.

Results and discussion

Pediatric patients with carious cavities in permanent molars and premolars and seeking dental treatment of traumas were involved in the study. Prior to the study, the children's parents were asked to complete and sign informed

consent form. Immediate treatment for pulpitis was carried out during two visits.

The preparation process showed uncovered tooth cavity. Anesthesia, preparation, drug management of the cavity, hemostasis (with sterile cotton swabs), application of dental treatment paste either to the cavity bottom or to the stump were carried out during the first visit. The paste, prepared ex tempore, consisting of a mixture of chloramphenicol powder and «Metrogyl Denta» gel was applied under a temporary bandage for 3–5 days.

During the second visit (if the patient didn't report inflammation or any other problems) the paste was removed. The cavity was treated with 2% chlorhexidine aqueous solution and calcium-containing paste («Trioksident», «MTA») was applied to the cavity bottom. Then application of an insulating lining and tooth filling were provided.

This method provides management of pulp inflammation and pain, preserving its viability and functions, further development of permanent tooth root.

Bacteriological examination revealed the prevalence of gut microflora and yeasts (table 1).

Composition of tooth microflora

| Name of Microorganisms | Number of Microorganisms |
|-----------------------------------|--------------------------|
| in the tooth cavity | |
| <i>Escherichia coli</i> | 10 ⁴ KOE/ml |
| in the infected dentin layer | |
| <i>Enterococcus faecium</i> | 10 ³ KOE/ml |
| <i>Corynebacterium granulosum</i> | 10 ³ KOE/ml |
| <i>Candida albicans</i> | 10 ³ KOE/ml |



| | |
|-------------------------------------|------------------------|
| <i>Fusobacterium spp.</i> | 10 ³ KOE/ml |
| under the dentin, in the tooth pulp | |
| <i>Candida albicans</i> | 10 ² KOE/ml |
| <i>Fusobacterium spp.</i> | 10 ² KOE/ml |
| after treatment | |
| <i>Candida albicans</i> | 10 ² KOE/ml |
| <i>Klebsiella spp.</i> | 10 ² KOE/ml |

Gram-positive and negative bacteria were found in the tooth cavity and infected dentin layer. Presence of *Escherichia coli* and *Enterococcus faecium* suggests imbalance in oral cavity microbiota. Hemolytic *E. coli* suggest contribution of intestinal flora to pulpitis pathogenesis. *Corynebacterium granulosum* affects the tissue structure. Fungi of the genus *Candida* appear to be markers of tissue immunity imbalance. Gram-negative anaerobics, which produce pathogenic factors, such as hemolysin and lecithinase, vegetate in the opened tooth cavity under the dentin. As a result of the treatment fungi and *Klebsiella* bacteria remain [1, 10].

The described method of treatment shows the following advantages caused by drugs' pharmacology and dosage forms [11-13].

Chlorhexidine gluconate is a bactericidal agent which is active against wide range of Gram-positive and Gram-negative bacteria. No evidence for resistance to Chlorhexidine has been noted. The drug works in the blood or pulp debris (cellular elements are always present in pulpitis in children), though its activity is a little reduced. The efficiency of chlorhexidine gluconate solution in

pulpitis treatment was shown in the works of Ruiz-Esparza CL et al., 2011, Rosenberg L. et al., 2013. [8, 11, 12].

Metronidazole is an antimicrobial agent, which is active against wide range of Gram-positive and Gram-negative microorganisms, as well as anaerobic forms. The use of metronidazole in combination with chlorhexidine enhances the bactericidal effect on *Fusobacterium spp* (Drugs and Medications Directory) [13].

Chloramphenicol is another antimicrobial agent, which is active against wide range of Gram-positive and Gram-negative microorganisms. It has a strong bacteriostatic action. If highly concentrated it exhibits bactericidal activity against certain strains. It is also active against *Escherichia coli*, *Enterococcus faecium* (Drugs and Medications Directory) [9].

Paste gel structure promotes good penetration of drugs through dentinal tubules. Chloramphenicol is active against microorganisms causing pulp inflammation. Thus, the composition of the paste we use provides a sufficient concentration of wide range antimicrobial drugs with prolonged effect in the pulp. This is also confirmed microbiologically: there are no pathogens, only background flora.



Elimination of infectious agents provides transition from the inflammatory to proliferative phase, which is accompanied by stimulation of connective tissue growth, increased osteoblast activity and osteoclast suppression. Use of calcium medications and alkaline environment also contribute to this positive result.

Stimulation of apexification with MTA provides faster dentinal bridge formation and fewer complications compared with calcium hydroxide apexification (Pradhan DP et al, 2006;. Kavitarani B Rudagi and BM Rudagi, 2012). «Triksident», a Russian analogue of MTA, has shown good results in treatment of pulpitis and peri-odontitis in permanent teeth with open apex [5, 6, 10].

Twelve children with complicated crown fractures were given the suggested treatment during the period of two years. After sufficient anesthesia the crown pulp was removed and chloramphenicol paste was applied to the stump under a temporary bandage for 3–5 days. During the second visit, after removal of the bandage and drug management of the cavity, «Triksident» («ProRoot MTA» or «Rootdent») [3,14] was applied.

The medical examination was repeated in 3 weeks' time, 3, 6 and 12 months' time and up to the root formation period. The patients had no complaints, clinical manifestations as well as radiologic abnormalities of the root apex were not revealed. During the whole period the process of dentin bridge formation in the pulp was observed.

All the patients showed sustained favorable long-term outcome. There were no complications such exacerbation of

chronic pulpitis or development of chronic periodontitis.

Case 1.

An eight-year-old girl with a crown fracture of the anterior teeth caused by an accident in the playground was referred to the Paediatric Dentistry Department. After the first visit to the dentist the teeth were regularly treated with fluoride. Two days later sensitivity to temperature (reaction to cold that goes away without cold stimulus) occurred in tooth 4.1.

Clinical management: The face configuration is not changed, the regional lymph nodes are not enlarged and painless on palpation. On the cutting edge of tooth 4.1 the fracture line is within vasodentin, the pulp is not exposed. One site of the cavity is slightly painful on probing, but it does not bleed.

The color of the crown is not changed. During horizontal percussion pain is experienced. Periodontal membrane is pale pink. The tooth sensitivity to cold is acute, with lingering pain after cessation of cold stimulus.

The x-ray shows that the tooth root is growing, the growth plate is contoured, indicating its viability.

The diagnosis was made by medical history and instrumental examination following ICD: chronic pulpitis in the acute stage (K04.03). The following treatment was given:

The 1-st visit:

hygienic dental treatment,
infiltration anesthesia,
cavity preparation,
cavity drug treatment,



opening of pulp cavity with a sterile bur,

crown pulp amputation,

hemostasis with sterile cotton wool tampons,

applying therapeutic paste consisting of a mixture of «Metrogyl Denta» and chloramphenicol powder for 5 days,

applying a temporary bandage. The 2nd visit:

hygienic dental treatment,

bandage removing,

cavity drug treatment with 2% chlorhexidine solution,

application of calcium-containing paste («Trioksident» made by «VladMiva») to the stump,

low modulus composite lining,

dental compomer filling.

Check-up examination after 4 months:

The patient had no complaints; no ditching was observed. The x-ray confirmed the formation of dentin bridge, the root continues growing.

Check-up examination after 7 months:

The patient had no complaints; no ditching was observed. The girl slightly bites with the tooth. The x-ray revealed dentin bridge formation, the growth plate is not contoured. Dense barrier of cement-like tissue is supposed to be forming. This method of treatment showed favourable outcome.

Case 2.

A nine-year-old girl with tooth 3.1 fracture caused by a fall was referred to the Paediatric Dentistry Department. The tooth was sensitive to cold air. First the girl was referred to a dental clinic, where the

fracture line was treated with fluoride. The patient was recommended to wait up until she was 14 years for restoration. After the first visit the teeth were regularly treated with fluoride.

Clinical management:

The face configuration is not changed, the regional lymph nodes are not enlarged and painless on palpation. On the cutting edge of tooth 3.1 the fracture line is within vasodentin, the pulp is not exposed. One site of the cavity is slightly painful on probing, but it does not bleed.

The color of the crown is not changed. During The x-ray shows that the tooth root is growing, the growth plate is contoured, indicating its viability.

The diagnosis was made by medical history and instrumental examination following ICD: chronic pulpitis in the acute stage (K04.01).

The same treatment as in case 1 was provided. After that the girl wasn't reexamined.

A visit to the dental clinic in 1,5 years

Clinical management: The facial configuration is not changed, the regional lymph nodes are not enlarged and painless on palpation. The filling in tooth 3.1 remains.

The color of the crown is not changed. Horizontal and vertical tooth percussion is painless. Periodontal membrane is pale pink. There's no reaction to cold.

The x-ray revealed dentin bridge formation, the growth plate is not contoured. Dense barrier of cement-like tissue is supposed to be forming. This



method of treatment showed favourable outcome.

Case 3.

A seven-year-old boy was referred to the Paediatric Dentistry Department. Odontolysis of tooth 4.6 began immediately after the tooth eruption.

Clinical management: The facial configuration is not changed, the regional lymph nodes are not enlarged and painless on palpation. On the chewing surface of tooth 4.6 within vasodentin there is a deep carious cavity of softened dentin and food debris. On probing One site of the cavity is slightly painful, but it does not bleed.

The tooth crown is not changed in color. Horizontal tooth percussion is painful. Periodontal membrane is pale pink. The tooth sensitivity to cold is acute, with lingering pain after cessation of cold stimulus.

The x-ray revealed that carious cavity of tooth 4.6 is linked with the tooth cavity, the roots are in the growth stage, the growth plate is contoured, indicating its viability.

The diagnosis was made by medical history and instrumental examination following ICD: chronic pulpitis (K04.03). The following treatment was provided:

The 1-st visit:

hygienic dental treatment,
infiltration anesthesia,
carious cavity preparation,
drug treatment of the carious cavity,
opening of pulp cavity with a sterile bur,
crown pulp amputation,
hemostasis with sterile cotton wood tampons,

applying therapeutic paste consisting of a mixture of «Metrogyl Denta» and chloramphenicol powder for 5 days,

applying a temporary bandage. The 2-nd visit:

hygienic dental treatment,
bandage removing,
cavity drug treatment with of 2% chlorhexidine solution,
application of calcium-containing paste (MTA made by «Dentsply») to the stump,
low modulus composite lining,
compomer filling. A visit in 2,5 years

Clinical management: The facial configuration is not changed, the regional lymph nodes are not enlarged and painless on palpation. The filling in tooth 4.6 remains, but gingival attachment is loose.

The tooth crown is not changed in color. Horizontal and vertical tooth percussion is painless. Periodontal membrane is pale pink. There's no tooth sensitivity to cold.

The x-ray revealed dentin bridge formation, near the apex growth plate is not contoured. Tooth roots are mature but there is obliteration in the root channels.

This outcome is considered to be favorable, though in many cases endodontic treatment is indicated. The boy's parents refused the suggested treatment.

Conclusions

This method of treatment of pulpitis in permanent teeth with open apex can be recommended for treatment of acute and chronic pulpitis of different etiology in different groups of permanent teeth (incisors and molars) with immature root.



It is better to perform dental procedures taking into consideration microbiological and radiological findings.

According to the clinical and microbiological data this method shows that it is possible to increase the number of cases when pulp is preserved. It is

especially important in the period of root growth. As a result of the study patent RF № 2542437, patent application № 2013147561 and invention priority October 24, 2013 (co-authors: V.A. Rumyantsev, V.Yu. Nicholsky) have been received.

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