Summary

The choice of methods and materials for the treatment of pulpitis in molars with unformed roots, wisdom teeth and molars with inhibited endodontic access remains an important consideration in therapeutic dentistry. The capabilities of modern dental preparations permit the execution of vital pulpotomy with minimum complications and maximum clinical effect. Reviewed in this paper are long-term results of the clinical application of the dental preparations CollapAn and Pulpotec for the treatment of pulpitis by the vital pulpotomy method. Key words: Dental pulp, preparations for direct filling, preparations for vital pulpotomy.

Vital pulpotomy is a method of treating pulpitis by preserving the root section of the pulp (A.I. Rybakov, V.S. Ivanov, 1980). The vital pulpotomy method is directed towards preserving the vitality of the root pulp. The main purpose of this method, the preservation of the periodontium intact, is based upon the significant resilience of the root pulp to various effects, and is determined by the features of histological structure, in particular, any impoverishment in cellular elements, or a large number of collagenic fibres (L.I. Falin, 1963; E.I. Gavrilov, 1969).

The preservation of the vitality of the root section of the pulp ensures normal tropism of the tooth tissues and inhibits the development of periapical complications (M.M. Krashennikova, A.B. Shekhter, 1973). Studies by a number of authors have revealed that the root pulp after vital pulpotomy retains its vitality, producing secondary dentine. A dentine bridge forms on the boundary between the pathologically transformed and the vital tissues (A.S. Grigoryan, 1965; Z. Pavica, P. Junters, 2000).

Studying the means of occurrence and development of inflammation of pulp, taking into account the biological defensive properties, neuroreflex activity and resistance, indicates that pulp represents a powerful barrier against infection. Under favourable conditions tissue defence mechanisms are mobilised in it, which localise and eliminate the pathological process. Due to their phagocytotic ability, during inflammation, macrophages absorb microorganisms and degenerating leucocytes, and actively contribute to defensive reactions within the pulp. During the course of inflammation, adventitial cells are capable of mutating into macrophages. Such transformations are dependent upon the nature of the irritation sustained and the defensive capabilities of the organism.
Removing only the coronal and buccal parts of the pulp has several advantages, amongst which is free access to the sections of the pulp destined for extraction, as well as simplified procedures (J.C. Hess, E. Medioni, G. Vene, 2000; S.V. Melekhov, V.V.Tairov, 2005).

Two methods currently exist for the removal of dental pulp: devital and vital (E.V. Borovsky, 2003). The devital method allows for the removal of the coronal section of the pulp once it has been devitalised as well as the mummification of the root section of the pulp. Vital pulpotomy is understood as preserving the root section of the pulp in a state of vitality.

The history of the development of methods for the treatment of pulpitis and periodontitis is closely connected with the application of substances such as phenol and formaldehyde. In 1874, Witzel reported on the successful application of tricresol-formalin substances for treating dental pulp. In 1904, Buckley recommended using a blend of equal parts of tricresol-formalin in the treatment of devital permanent teeth. In addition, formocresol zinc oxide with eugenol was administered to the remaining pulp (E.A. Schwartz, 1980).

Historically speaking, it was recommended that the devital pulpotomy method be employed with subsequent impregnation of the remains with a resorcin-formalin mixture (E.V. Borovsky, 2003). The resorcin-formalin method was proposed by Albrecht in 1912 for the treatment and filling of infected teeth (E.V. Borovsky, 1997).

The devital pulpotomy method contradicts general biological principles for the treatment of infected wounds. High concentrations of phenol, formaldehyde and other powerful agents do, on the one hand, have a powerful antiseptic effect; however, this at the same time leads to the complete loss of the root section of the pulp and to its subsequent mummification.

The high level of complications associated with the devital method led to a search for new preparations with which to dress the exposed pulp in a tooth. The suggestion that various preparations which stimulate the production of dentine be employed permitted a transition to the more effective method of vital pulpotomy. (E.A. Magid, 1977; R. Meon, 1987).

The vital pulpotomy method is one of those biological methods that permit the retention of vitality of the root pulp (V.M. Bezrukov, 1998). However, its application has not become widespread owing to the difficulties encountered in guaranteeing aseptic conditions and sealing of the pulp, both at the time of treatment and after the insertion of a permanent filling, especially in Category II cavities (Black) – (J.C. Hess, 2002). Another reason that leads to complications after the employment of vital methods is the limited effectiveness of common courses of treatment designed to halt inflammation within the dental pulp and restore its functional activity.

With the development of an understanding of the processes taking place within the pulp various preparations came to be proposed for the preservation of coronal pulp in its vital state:
I Substances affecting components of inflammation:

1. Antibiotic and antimicrobial substances;
2. Proteolytic enzyme inhibitors;
3. Lysozyme;
4. Zinc oxide – eugenol mixtures;
5. Glucocorticoids.

II Application of substances with proven dentine stimulating properties:

1. Allogenic substances:
   1. Bone meal;
   2. Bone filings;
   3. Dentine filings.

2. Synthetic preparations:
   1. Calcium hydroxide;
   2. Mineral trioxide aggregate (MTA);
   3. Polycarboxylate cement.

There exist a number of requirements for preparations designed to be used after pulpotomy. Haemostatic, anaesthetic and antimicrobial effects should halt inflammation of the pulp during the first stage of treatment. Thereafter a process of metaplasia of the root portion of the pulp into dentine-like tissue should commence. Such an effect could be exerted by substances that contain a direct dentine-stimulating mechanism, as well as by weak doses of combinations of preparations that stimulate odontoblasts.

This work summarises the long-term results of treating pulpitis by vital pulpotomy with the aid of contemporary dental preparations: CollapAn gel (Intermedapatit, Russia – Fig. 1), and Pulpotec (PD, Switzerland – Fig. 2).

Materials and Methods

During the period from 2003 until 2008 in the Faculty of Therapeutic Dentistry of the Kuban State Medical University, research on and treatment of patients suffering from chronic simple pulpitis of permanent teeth (with both formed and unformed roots) was carried out. During the course of the research observations were made on 31 molars in 31 patients of both sexes across an age
range from 11 to 54 years. 27 molars exhibiting varying stages of pulpitis were treated by the vital pulpotomy method using Pulpotec, with 4 molars being treated with CollapAn-K gel.

Patients were diagnosed using clinical methods for investigating subjective data: collection of patient complaints, questionnaire; objective data: examination, percussion, palpation; and other data collected using additional methods of examination: electrometric method, electroodontometry (EOD), x-ray examination and targeted x-ray imaging.

Vital pulpotomy was carried out only after a meticulous necrotomy of the carious cavity with the aid of a sharp excavator. Antiseptic procedure was carried out with a 0.06% chlorohexidine bigluconate solution. After removal of the upper level of the pulp with a sharp sterile hard-alloy drill, haemostasis was, as a rule, not necessary. Where required, a haemostatic rubber was employed for haemostasis. Thereafter one of the preparations was applied to the openings of the root canals:

1. CollapAn was administered with the aid of a nozzle syringe. The material itself is a biocompatible gradually lysing matrix on the surface of which new tissue forms immediately between the membranes. CollapAn is a bioactive material insofar as sound chemical bonds form between it and the tissue. Layers of loose connective tissue never formed between the implanted material and the newly formed tissue; this distinguishes this preparation from osteoinductive preparations (Z.I. Urazgildeyev, O.M. Bushuyev, G.M. Berchenko, 1998). Claforan (Cephotaxim) is a cephalosporin-type third-generation wide-spectrum antibiotic that exercises a bactericidal function on gram-positive and gram-negative microorganisms that are generally resistant to antimicrobial substances. This is of particular relevance at the present time, given the frequently uncontrolled use of antibiotics.

2. Pulpotec was administered with the assistance of a microapplicatory system (MAP) – (PD, Switzerland – see Fig. 3.). The preparation has a moderately inductive effect. Under the effect of its components inflammation is eliminated, tissue sclerosis
develops around the pulp opening, with its partial fibrous regeneration in the distal regions of the root pulp. The components that make up Pulpotec are moderately reactive, which means that a controlled irritating effect cannot be dispensed with. Antiseptic and anti-inflammatory effects have been observed.

Then, in all cases, non-eugenol cement was overlaid (PD temporary cement in paste – PD, Switzerland – See Fig. 4.). As the patient bit down upon the temporary filling with a cotton wool roll any excess cement was removed. Given that there was no complaint of spontaneous pain or any pain when biting, some of the cement was removed and replaced with a permanent filling at the next appointment 3 days later. The periodontal state was then to be reviewed after 3 months, 6 months and one year.

![Fig.3.](image1.png) ![Fig.4.](image2.png)

Research results and analysis

Effectiveness of treatment was evaluated on the basis of clinical methods of investigation. This comprised subjective data: collection of patient complaints, questionnaire; objective data: examination, percussion, palpation; and data collected using additional methods of examination: electrometric method, electroodontometry (EOD), x-ray examination and targeted x-ray imaging.

Any changes in EOD indicators were observed during the follow-up appointments. Prior to the commencement of treatment, the EOD indicator showed an average of 35.4 mkA. After three days, this EOD index had reduced to 48.8 mkA where Pulpotec had been used, and 57.4 mkA where CollapAn had been employed. At the time of the control check-ups, six months later, EOD was measured at an average of 52.2 mkA for Pulpotec and 59.7 for CollapAn.
After one year, the mean EOD reading for those treated with Pulpotec was 56.1 mkA and for those who had received CollapAn was 61.1 mkA. During further examinations the EOD reading was recorded within the current limits throughout the whole observation period (see Fig. 5.) These data enable us to attest to the vitality of the root pulp and its capability of fulfilling its function.

In the case of the patients in the study, the development of pain during percussion immediately after the pulpotomy is carried out should be treated as a reaction of the tissue of the periodontal area to the treatment and to insignificant irritation by the preparation used to seal the remaining pulp. On the day of the treatment (the first visit) percussion of the teeth in all 31 patients (100%) in the sample caused no pain. By the third day percussion was eliciting pain in 3 patients (11.1%) of those who had been treated with Pulpotec, and in 4 (100%) of those treated with CollapAn. After six months, no periodontal reaction had been witnessed in 27 (100%) of the patients treated with Pulpotec, and in 3 (75%) of those treated with CollapAn. One year after treatment, 1 patient (3.7%) who had been treated with Pulpotec and 2 patients (50%) treated with CollapAn had complained of pain when biting down on the tooth treated one year previously.

X-rays were taken prior to treatment, and no pathological changes were noted in any of the 31 (100%) patients. The data gathered at 6 months and 1 year revealed no changes in the periapical tissues in 26 patients (96.2%). Changes were noted in one patient (3.7%) who had reported pain when biting down on the tooth that had been treated with Pulpotec. It is characteristic that this patient figured among the 11.1% who had complained of pain during percussion on the third day after treatment. Changes were observed in the upper root levels in one of the patients (25%) who had been treated six months and one year previously.
Presented here are some clinical examples:

- Patient “I”, 11 years of age: tooth no. 36 with unformed roots (see Fig. 6.). The diagnosis was chronic simple pulpitis. Figure 7 shows the same tooth six months after the application of Pulpotec.
- Patient “K”, 13 years of age: diagnosed with traumatic pulpitis of tooth no. 46 (Fig. 8.) Figure 9 shows the same tooth three months after treatment with Pulpotec, and Figure 10 ten months after the application of the preparation.
- Patient “B”, 26 years of age: tooth no. 38 in buccal position. Diagnosis of chronic simple pulpitis (Fig. 11); Fig. 12 shows the same tooth 3 months after treatment with Pulpotec; Fig. 13 shows the tooth six months after treatment with this preparation.
- Patient “S”, 47 years of age: tooth no. 48 in buccal position. Diagnosis of chronic simple pulpitis (Fig. 14); Fig. 15 shows the same tooth 3 months after treatment with CollapAn; Fig. 16 shows the tooth one year and six months after treatment with this preparation.
- Patient “A”, 49 years of age: tooth no. 38 diagnosed with chronic simple pulpitis (Fig. 17); Fig. 18 shows the same tooth 6 months after treatment with Pulpotec.

Fig.6. Patient “I” (11 years of age): Intra-oral x-ray image of the area around tooth no. 36. Diagnosis: chronic simple pulpitis of tooth no. 36

Fig.7. Patient “I” (11 years of age): Condition six months after vital pulpotomy using Pulpotec

Fig.8. Patient “K” (13 years of age): Intra-oral x-ray image of the area around tooth no. 46. Condition of tooth no. 46 at the time of the first visit to the clinic. Diagnosis: traumatic pulpitis of tooth no. 46
Fig. 9. Patient “K” (13 years of age): Condition three months after vital pulpotomy using Pulpotec

Fig. 10. Patient “K” (13 years of age): Condition 10 months after performing vital pulpotomy. The coronal area of tooth no. 46 has been restored with an OVERLAY composite filling

Fig. 11. Patient “B” (26 years of age): Intra-oral x-ray image of the area around tooth no. 38. Diagnosis: chronic simple pulpitis of tooth no. 38

Fig. 12. Patient “B” (26 years of age): Condition three months after vital pulpotomy using Pulpotec

Fig. 13. Patient “B” (26 years of age): Condition six months after vital pulpotomy using Pulpotec (two years after the commencement of treatment)

Fig. 14. Patient “S” (47 years of age): Intra-oral x-ray image of the area around tooth no. 48. Diagnosis: chronic simple pulpitis of tooth no. 48
Fig. 15. Patient “S” (47 years of age): Condition three months after performing vital pulpotomy using the osteoconductive preparation CollapAn.

Fig. 16. Patient “S” (47 years of age): Condition after performing vital pulpotomy (one and a half years after the commencement of treatment).

Fig. 17. Patient “A” (49 years of age): Intra-oral x-ray image of the area around tooth no. 38. Diagnosis: chronic simple pulpitis of tooth no. 38.

Fig. 18. Patient “A” (49 years of age): Condition six months after vital pulpotomy using Pulpotec.
Conclusion

The research undertaken demonstrates high levels of effectiveness in the modern dental preparations under examination, namely CollapAn and Pulpotec, for sealing the pulp stumps of teeth treated for pulpitis by the vital pulpotomy method. This method is simple to apply, saves time and is affordable. In the event of an unfavourable outcome, possibilities exist for endodontic treatment.

When treating pulpitis in teeth with unformed roots, a reliable isolation of pulp from external pathological irritants can be achieved, favourable conditions can be created for creating defence mechanisms in highly differentiated pulps and, to sum up, full tissue structures are formed, such as will stabilise further development of caries and associated complications.

Sources

- Borovsky E.V., Therapeutic Dentistry – Moscow, Postgraduate Research Institute, 2003 (p. 560).