



Analysis of the effectiveness of a new method of treating patients with complicated forms of caries

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Abstract

AIM. The aim of the study was to compare the effectiveness of a new method of endodontic treatment a chronic fibrous pulpitis with a standard, generally accepted method at the end of 1 month and 12 months after treatment.

MATERIALS AND METHODS. were examined a total of 186 patients aged 20 to 60 years, including 94 (50.5%) men and 92 (49.5%) women, who underwent primary endodontic treatment of 302 teeth of various groups with a diagnosis of a chronic fibrous pulpitis (K04.03). A comparative assessment of the effectiveness of treating this pathology using various methods was carried out through an analysis of patient complaints, clinical examination, and radiographic monitoring of the condition of the tooth root canals and surrounding tissues. To statistically analyze the effectiveness of chronic fibrous pulpitis treatment using our method (Russian Federation Patent No. 2771916, May 13, 2022), we used the McNemar Q-test over time for the periods at the end of 1 month and 12 months after treatment.

RESULTS. In the first month after treatment, patients in Group III experienced minimal or no pain compared to patients in Groups I and II ($p < 0.05$). A comparative analysis of immediate radiographic treatment results revealed significant improvements in clinical outcomes when using our method compared to standard protocols ($p < 0.05$). After 12 months from the completion of treatment, a higher number of teeth with changes in the periodontal tissues was determined in patients of the first group and gradually decreased in the second and especially in the third group ($\chi^2 = 9.75$, $df = 1$, $p = 0.002$; $\chi^2 = 7.03$, $df = 1$, $p = 0.008$).

CONCLUSIONS. The conducted comparative analysis of the effectiveness of the new method and standard methods of treating a chronic fibrous pulpitis allows us to establish a significant advantage of our proposed method based on clinical and radiographic research methods ($\chi^2 = 9.87$, $df = 1$, $p = 0.002$).

Keywords: irreversible pulpitis, fibrous pulpitis, treatment; endodontics

Article info: received – 30.11.2025; revised – 14.01.2026; accepted – 26.01.2026

Conflict of interest: The authors report no conflict of interest.

Acknowledgements: There are no funding and individual acknowledgments to declare.

For citation: Korchagina M.S., Postnikov M.A., Rozhkova E.N. Analysis of the effectiveness of a new method of treating patients with complicated forms of caries. *Endodontics Today*. 2026;24(1):210–217. <https://doi.org/10.36377/ET-0180>

Анализ эффективности применения нового способа лечения пациентов с осложненными формами кариеса

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Резюме

ЦЕЛЬ. Провести сравнительную оценку эффективности нового способа эндодонтического лечения хронического фиброзного пульпита со стандартным общепринятым методом в конце 1 месяца и через 12 месяцев после лечения.

МАТЕРИАЛЫ И МЕТОДЫ. Обследовано 186 пациентов в возрасте от 20 до 60 лет, из них 94 (50,5 %) мужчин и 92 (49,5 %) женщины, у которых было проведено первичное эндодонтическое лечение 302 зубов различной групповой принадлежности с диагнозом хронический фиброзный пульпит (K04.03). Сравнительную оценку эффективности лечения указанной патологии различными методами осуществляли путем анализа жалоб пациента, клинического осмотра и рентгенологического контроля состояния корневых каналов зуба и окружающих тканей. Для проведения статистического анализа эффективности лечения хронического фиброзного пульпита разработанным нами методом (Патент РФ № 2771916 от 13.05.2022 г) в динамике использовался Q – тест МакНемара в периоды в конце 1 месяца и 12 месяцев после лечения.

РЕЗУЛЬТАТЫ. В первый месяц после лечения пациенты группы III испытывали минимальную болезненность или отсутствие боли по сравнению с пациентами первой и второй групп ($p < 0,05$). Сравни-

тельный анализ непосредственных рентгенологических результатов лечения показал значительные улучшения клинических исходов при применении разработанного нами метода по сравнению со стандартными протоколами ($p < 0,05$). После 12 месяцев после завершения лечения большее количество зубов с изменениями в тканях периодонта определялось у пациентов первой группы и постепенно снижалось ко второй и особенно к третьей группе ($\chi^2 = 9,75$, $df = 1$, $p = 0,002$; $\chi^2 = 7,03$, $df = 1$, $p = 0,008$). **ВЫВОДЫ.** Проведенный сравнительный анализ эффективности нового способа и стандартных методов лечения хронического фиброзного пульпита позволяет установить значительное преимущество предложенного нами метода на основании клинических и рентгенологических методов исследований ($\chi^2 = 9,87$, $df = 1$, $p = 0,002$).

Ключевые слова: необратимый пульпит, хронический фиброзный пульпит, лечение, эндодонтия

Информация о статье: поступила – 30.11.2025; исправлена – 14.01.2026; принята – 26.01.2026

Конфликт интересов: Авторы сообщают об отсутствии конфликта интересов.

Благодарности: Финансирование и индивидуальные благодарности для декларирования отсутствуют.

Для цитирования: Корчагина М.С., Постников М.А., Рожкова Е.Н. Анализ эффективности применения нового способа лечения пациентов с осложненными формами кариеса. *Эндодонтия Today*. 2026;24(1):210–217. <https://doi.org/10.36377/ET-0180>

INTRODUCTION

Currently, one of the priority objectives in contemporary dentistry is the development of methods aimed at enhancing the effectiveness of endodontic treatment for complicated forms of caries, which are a primary cause of odontogenic inflammatory processes and result in tooth extraction in 60–80% of cases [1]. It is well established that inflammatory diseases of the dental pulp predominate within this pathology, with chronic fibrous pulpitis being the most common, occurring in 64.2–69.4% of cases [2–3].

Both domestic and international authors note that the challenges associated with endodontic treatment of complicated carious lesions are linked not only to the complex anatomical structure of the tooth root system but also to specific stages of treatment: limitations in creating adequate endodontic access, insufficient mechanical and antiseptic preparation of root canals, and subsequent obturation [4–6]. For instance, Mitrošin et al. [7] identified the persistence of microorganisms causing intra-radicular or extra-radicular infection as the primary reason for endodontic treatment failure. However, many authors emphasize that complete eradication of microorganisms is a challenging task, as the need for retreatment is 2.5–3 times higher than for primary endodontic therapy, which has significant epidemiological implications [8–10].

Voloshina et al. [11] demonstrated that inadequate management of chronic fibrous pulpitis leads to a high rate of complications, which can only be resolved either through repeat endodontic treatment – a procedure that is technically more complex and financially demanding – or surgically, including premature tooth extraction. This perspective is shared by Zinkovskaya et al. [12], who emphasize that errors at any stage of endodontic treatment subsequently contribute to unfavorable outcomes.

A review of the specialized literature indicates the limited effectiveness of conventional endodontic approaches for pulpitis, as the incidence of post-treatment complications remains high, ranging from 32% to 50% over follow-up periods exceeding two years [13].

Thus, the high prevalence of chronic fibrous pulpitis, the disease's progression characteristics, the im-

pact of odontogenic infection foci on individual organs, systems, and the body as a whole, together with the complexity, labor intensity, and interdependence of the stages of therapeutic intervention, underscore the need for the development of modern, optimized methods for managing this pathology.

AIM

The aim of this study is to perform a comparative evaluation of the effectiveness of a novel endodontic treatment approach for chronic fibrous pulpitis versus the conventional standard method over both short-term and long-term follow-up periods.

MATERIALS AND METHODS

For the purpose of evaluating and analyzing the effectiveness of a novel endodontic treatment method for chronic fibrous pulpitis (RF Patent No. 2771916 dated 13.05.2022), 186 patients aged 20 to 60 years were examined, including 94 (50.5%) men and 92 (49.5%) women, who underwent primary endodontic treatment of 302 teeth of various groups diagnosed with chronic fibrous pulpitis (K04.03). The treatments were performed at the Department of Therapeutic Dentistry with an osteopathy course at the Federal State Budgetary Educational Institution of Higher Education “Samara State Medical University” of the Ministry of Health of the Russian Federation, as well as in the dental clinics Eldent LLC and Mir LLC in Samara, during the period from 2016 to 2025.

All study participants were randomly assigned to three groups: Group I – 42 patients ($n = 82$ teeth) treated using the conventional method; Group II – 60 patients ($n = 102$ teeth) treated with the addition of low-frequency ultrasound; Group III – 84 patients ($n = 118$ teeth) treated using the proposed method. No statistically significant differences were observed between the groups in terms of age, sex, or number of root canals ($p > 0.05$), indicating that the groups were representative.

Inclusion criteria for the study were: informed voluntary consent for medical intervention (Order of the Ministry of Health of the Russian Federation No. 1051n, dated 12.11.2021), age between 20 and 60 years, absence

of concomitant somatic pathology, and confirmed diagnosis of chronic fibrous pulpitis (K04.03). Exclusion criteria included: refusal to participate, mechanical tooth trauma or teeth along a jaw fracture line, other forms of endodontic pathology, depulping for prosthetic reasons, internal or external root resorption, teeth with incomplete root formation, localized or generalized moderate-to-severe periodontitis, and severe systemic pathology limiting activity or posing a life threat.

The standard treatment method for Group I patients with chronic fibrous pulpitis included: anesthesia, isolation of the operative field, preparation of the carious cavity and formation of endodontic access, initial negotiation of the root canals and creation of a “carpet track”, working length measurement using a digital apex locator, mechanical preparation of root canals using rotary ProTaper Universal files (Dentsply Sirona), irrigation of root canals with 3% sodium hypochlorite at each stage of instrumentation using an endodontic syringe, followed by final irrigation with 17% EDTA solution, drying of the canals with paper points, obturation by vertical condensation using thermoplasticized gutta-percha and epoxy resin-based sealer, radiographic control, and post-endodontic restoration.

Treatment for Group II patients was performed similarly; however, at each irrigation stage, low-frequency ultrasound (VDW Ultra, VDW Germany) was used to activate the antiseptic solution, with parameters set at 28 kHz frequency and an exposure time of 30–60 seconds.

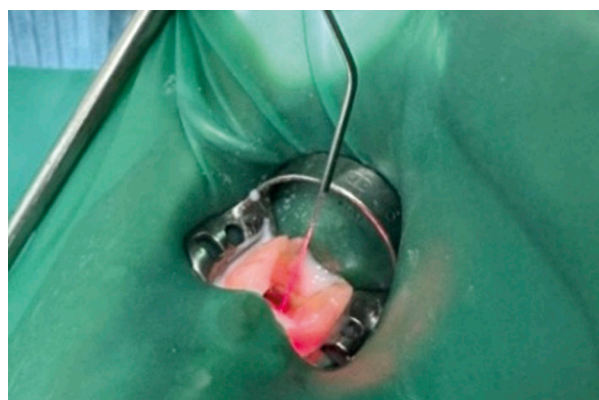
The treatment protocol for chronic fibrous pulpitis in Group III patients was as follows: anesthesia was administered, the operative field was isolated, the carious cavity was prepared, and straight-line access to the root canal orifices was established using endodontic burs. Final cavity preparation and detection of hidden canal orifices were performed with VDW Ultra ultrasonic tips in the sequence Cavi 1, Cavi 2, and Cavi 3 under a 3% sodium hypochlorite bath with an exposure time of 30–60 seconds.

Initial canal negotiation was performed using a high-strength, highly flexible C-Pilot file (#06, 08, 10) with an

EDTA-based endolubricant. Working length was verified with a digital apex locator. A “carpet track” in narrow and curved canals was created using R-Pilot files (size 12.5, taper 0.4) with reciprocal motion. Canal shaping and enlargement were completed using reciprocal nickel-titanium instruments in conjunction with a VDW Gold endomotor equipped with a built-in apex locator, allowing working length control at each stage of mechanical preparation. Straight canals were prepared with standard Reciproc files, while curved canals were treated with Reciproc Blue files. After each instrumentation stage, root canals were irrigated with 3% sodium hypochlorite solution, followed by ultrasonic cavitation using the IRRI-S VDW Ultra tip. Prior to final antiseptic irrigation, 17% EDTA solution was ultrasonically activated.

The final stage of antiseptic canal treatment involved diode laser activation using the Doctor Smile Wiser (Italy) with a wavelength of 980 nm in a nanosecond pulsed mode, at an average output of 1.2 W and pulse duration of 200 ns, with a 200 µm fiber optic tip (Fig. 1, A). The procedure was performed as follows: the canal was irrigated with 3% sodium hypochlorite, the fiber was inserted 1 mm short of the working length, with depth fixed using a stopper. Laser activation was applied with reciprocating and rotational movements of the fiber three times for 5 seconds each, with a 100 ns pause between pulses. The canal was then dried with paper points and obturated.

For sealer placement, a specially designed instrument was used (RF Patent for Utility Model “Endodontic Instrument for Sealer Placement in the Tooth Root Canal” No. 208382, dated 16.12.2021), sized according to the canal diameter and taper and customized for each patient. A stopper was set 1 mm short of the working length. Two-thirds of the plastic shaft of the instrument was immersed in the endosealer, and several rolling movements were applied to the handle to distribute the sealer evenly. The instrument was then smoothly inserted into the canal with reciprocating and rotational movements, distributing the sealer evenly along the canal walls over 10 seconds (Fig. 1, B).



A



B

Fig. 1. Root canal handling with Doctor Smile Wiser laser (A), sealer insertion into the root canal with a developed instrument (B)

Рис. 1. Лазерная обработка корневого канала Doctor Smile Wiser (A), внесение силера в корневой канал разработанным нами инструментом (B)

Canal obturation was performed using vertical condensation of thermoplasticized gutta-percha, and the treatment was completed with final tooth restoration.

The comparative evaluation of the effectiveness of chronic fibrous pulpitis treatment was carried out through analysis of patient-reported complaints, clinical examination, and radiographic assessment of the root canals and surrounding tissues at different time points: immediately (within the first month) after treatment and 12 months post-treatment.

For statistical data analysis, IBM SPSS Statistics 24 and PS IMAGO 4.0 software were used. The effectiveness of the treatment using the method developed by our team was analyzed over time using the Q-test of McNemar, which is applicable for paired data sets. The periods “end of 1 month” and “12 months after treatment” were sequentially compared. McNemar test values were interpreted by comparison with critical values and significance levels (p) using the StatTech statistical software.

RESULTS

In the comparative evaluation of treatment methods among the study groups, an important indicator of the effectiveness of chronic fibrous pulpitis management was the assessment of pain. Analysis of pain intensity using the Numeric Rating Scale (NRS) [14] allowed us to quantify the patients' subjective perception of pain immediately following treatment of chronic fibrous pulpitis with the different methods (Table 1).

Immediate clinical outcomes and radiographic assessment of root canal obturation quality are presented in Tables 2 and 3. The data in Table 2 show that both subjective patient perceptions and objective indicators of tooth and surrounding tissue condition met the “excellent” evaluation criteria in 22 patients of the first group (49 teeth, 59.8%), 38 patients of the second group (68 teeth, 66.7%), and 71 patients of the third group (101 teeth, 85.6%). Comparison of these results indicates a significant advantage of the proposed treatment method over the standard approach ($\chi^2 = 17.22$, $df = 1$, $p = 0.001$).

Table 1. Quantitative assessment of pain intensity using the NRS digital rating system

Таблица 1. Сравнительная оценка интенсивности болевого синдрома по цифровой рейтинговой шкале NRS

Points	Standard Method (Group 1)	Standard Method + Ultrasound (Group 2)	Modified Method (Group 3)	Group Comparison – Statistical Significance / Degrees of Freedom / Probability (χ^2 , $df = 1$, p)		
	Abs. (%)	Abs. (%)	Abs. (%)	Groups 1 vs 2	Groups 1 vs 3	Groups 2 vs 3
0–3 points (no pain or mild pain)	54 (65.9%)	81 (79.4%)	109 (92.4%)	$\chi^2 = 4.28$ $df = 1$ $p = 0.039$	$\chi^2 = 22.57$ $df = 1$ $p < 0.001$	$\chi^2 = 7.80$ $df = 1$ $p = 0.005$
4–6 points (moderate pain)	21 (25.6%)	17 (16.7%)	9 (7.6%)	$\chi^2 = 2.22$ $df = 1$ $p = 0.136$	$\chi^2 = 12.27$ $df = 1$ $p < 0.001$	$\chi^2 = 4.29$ $df = 1$ $p = 0.038$
7–9 points (severe pain)	7 (8.5%)	4 (3.9%)	0 (0.0%)	$\chi^2 = 1.72$ $df = 1$ $p = 0.189$	$\chi^2 = 10.44$ $df = 1$ $p = 0.001$	$\chi^2 = 4.71$ $df = 1$ $p = 0.030$
10 points (unbearable pain)	0 (0.0%)	0 (0.0%)	0 (0.0%)	–	–	–
Total (teeth)	82 (100.0%)	102 (100.0%)	118 (100.0%)			

Table 2. Comparative analysis of immediate results of treatment of chronic fibrous pulpitis

Таблица 2. Сравнительный анализ непосредственных результатов лечения хронического фиброзного пульпита

Grade	Standard Method (Group 1, $n = 82$)	Standard Method + Ultrasound (Group 2, $n = 102$)	Modified Method (Group 3, $n = 118$)	Group Comparison – Statistical Significance / Degrees of Freedom / Probability (χ^2 , $df = 1$, p)		
	Abs. (%)	Abs. (%)	Abs. (%)	Groups 1 vs 2	Groups 1 vs 3	Groups 2 vs 3
Excellent	49 (59.8%)	68 (66.7%)	101 (85.6%)	$\chi^2 = 0.94$ $df = 1$ $p = 0.333$	$\chi^2 = 17.22$ $df = 1$ $p < 0.001$	$\chi^2 = 11.01$ $df = 1$ $p = 0.001$
Good	19 (23.2%)	24 (23.5%)	14 (11.9%)	$\chi^2 = 0.00$ $df = 1$ $p = 0.954$	$\chi^2 = 4.49$ $df = 1$ $p = 0.034$	$\chi^2 = 5.21$ $df = 1$ $p = 0.022$
Satisfactory	14 (17.1%)	10 (9.8%)	3 (2.5%)	$\chi^2 = 2.12$ $df = 1$ $p = 0.146$	$\chi^2 = 13.13$ $df = 1$ $p < 0.001$	$\chi^2 = 5.19$ $df = 1$ $p = 0.023$
Unsatisfactory	0 (0.0%)	0 (0.0%)	0 (0.0%)	–	–	–
Total (teeth)	82 (100.0%)	102 (100.0%)	118 (100.0%)			

Table 3. X-ray quality control of root canal obturation**Таблица 3.** Рентгенологический контроль качества obtурации корневых каналов

Stage	Standard Method (Group 1, n = 82)	Standard Method + Ultrasound (Group 2, n = 102)	Modified Method (Group 3, n = 118)	Group Comparison – Statistical Significance / Degrees of Freedom / Probability (χ^2 , df = 1, p)		
	Abs. (%)	Abs. (%)	Abs. (%)	Groups 1 vs 2	Groups 1 vs 3	Groups 2 vs 3
High-Quality Obturation, Intact Periodontium Underfilled Root Canal	62 (75.6%)	81 (79.4%)	107 (90.7%)	$\chi^2 = 0.38$ df = 1 p = 0.538	$\chi^2 = 8.39$ df = 1 p = 0.004	$\chi^2 = 5.59$ df = 1 p = 0.018
Underfilled Root Canal	8 (9.8%)	7 (6.9%)	6 (5.1%)	$\chi^2 = 0.51$ df = 1 p = 0.476	$\chi^2 = 1.62$ df = 1 p = 0.203	$\chi^2 = 0.31$ df = 1 p = 0.577
Sealer Extrusion Beyond the Apex	12 (14.6%)	14 (13.7%)	5 (4.2%)	$\chi^2 = 0.03$ df = 1 p = 0.860	$\chi^2 = 6.72$ df = 1 p = 0.010	$\chi^2 = 6.24$ df = 1 p = 0.012
Total (teeth)	82 (100.0%)	102 (100.0%)	118 (100.0%)			

Table 4. Comparative analysis of clinical results of treatment a chronic fibrous pulpitis after 12 months**Таблица 4.** Сравнительный анализ клинических результатов лечения хронического фиброзного пульпита через 12 месяцев

Grade	Standard Method (Group 1, n = 82)	Standard Method + Ultrasound (Group 2, n = 102)	Modified Method (Group 3, n = 118)	Group Comparison – Statistical Significance / Degrees of Freedom / Probability (χ^2 , df = 1, p)		
	Abs. (%)	Abs. (%)	Abs. (%)	Groups 1 vs 2	Groups 1 vs 3	Groups 2 vs 3
Excellent	40 (60.6%)	71 (80.7%)	99 (94.3%)	$\chi^2 = 7.55$ df = 1 p = 0.006	$\chi^2 = 30.22$ df = 1 p < 0.001	$\chi^2 = 8.44$ df = 1 p = 0.004
Good	18 (27.3%)	11 (12.5%)	4 (3.8%)	$\chi^2 = 5.38$ df = 1 p = 0.020	$\chi^2 = 19.90$ df = 1 p < 0.001	$\chi^2 = 5.04$ df = 1 p = 0.025
Satisfactory	8 (12.1%)	6 (6.8%)	2 (1.9%)	$\chi^2 = 1.28$ df = 1 p = 0.257	$\chi^2 = 7.68$ df = 1 p = 0.006	$\chi^2 = 2.91$ df = 1 p = 0.088
Unsatisfactory	0 (0.0%)	0 (0.0%)	0 (0.0%)	–	–	–
Total (teeth)	66 (100.0%)	88 (100.0%)	105 (100.0%)			

Table 5. Comparative analysis of radiographic parameters of treatment a chronic fibrous pulpitis after 12 months**Таблица 5.** Сравнительный анализ рентгенологических показателей через 12 месяцев после лечения хронического фиброзного пульпита

Parameter	Standard Method (Group 1, n = 82)	Standard Method + Ultrasound (Group 2, n = 102)	Modified Method (Group 3, n = 118)	Group Comparison – Statistical Significance / Degrees of Freedom / Probability (χ^2 , df = 1, p)		
	Abs. (%)	Abs. (%)	Abs. (%)	Groups 1 vs 2	Groups 1 vs 3	Groups 2 vs 3
Intact Periodontium	44 (66.7%)	68 (77.3%)	91 (86.7%)	$\chi^2 = 2.14$ df = 1 p = 0.144	$\chi^2 = 9.75$ df = 1 p = 0.002	$\chi^2 = 2.91$ df = 1 p = 0.088
Periodontal Changes, including:	22 (33.3%)	20 (22.7%)	14 (13.3%)	$\chi^2 = 2.14$ df = 1 p = 0.144	$\chi^2 = 9.75$ df = 1 p = 0.002	$\chi^2 = 2.91$ df = 1 p = 0.088
of which: Deformation	18 (27.3%)	17 (19.3%)	12 (11.4%)	$\chi^2 = 1.36$ df = 1 p = 0.244	$\chi^2 = 7.03$ df = 1 p = 0.008	$\chi^2 = 2.33$ df = 1 p = 0.127
of which: Destruction	4 (6.1%)	3 (3.4%)	2 (1.9%)	$\chi^2 = 0.61$ df = 1 p = 0.434	$\chi^2 = 2.07$ df = 1 p = 0.150	$\chi^2 = 0.43$ df = 1 p = 0.512
Total (teeth)	66 (100.0%)	88 (100.0%)	105 (100.0%)			

A comparative analysis of the quality of endodontic treatment for chronic fibrous pulpitis at 12 months post-treatment among the study groups is presented in Tables 4 and 5.

DISCUSSION

According to the data in Table 1, in the group treated using the standard protocol (54 teeth), only 65.9% of patients reported no pain or mild pain. In Group II, where ultrasound was applied during treatment (81 teeth), this proportion increased to 79.4%. Statistical analysis confirmed the significance of this improvement ($\chi^2 = 4.28$, $df = 1$, $p = 0.039$), indicating that the use of ultrasound positively influenced the reduction of postoperative pain. An even more pronounced effect was observed in Group III, where 92.4% of patients reported no pain or only mild pain. The statistical significance of this result was very high ($\chi^2 = 22.57$, $df = 1$, $p < 0.001$), demonstrating the substantial advantage of the proposed treatment method in controlling postoperative discomfort.

High-quality root canal obturation, based on radiographic assessment (Table 3), was observed in 62 teeth (75.6%) of patients in the first group, 81 teeth (79.4%) in the second group, and 107 teeth (90.7%) in the third group ($\chi^2 = 8.39$, $df = 1$, $p = 0.004$). Sealer extrusion beyond the apex occurred more frequently in patients of the first two groups, with a statistically significant difference between the first and third groups ($\chi^2 = 6.72$, $df = 1$, $p = 0.010$). The optimal level of root canal obturation in Group III patients is likely associated with the use of the specially designed instrument for sealer placement, which allows precise control over the amount of endosealer introduced. These findings confirm the effectiveness of the new treatment method for chronic fibrous pulpitis in achieving high-quality canal obturation and minimizing complications related to sealer extrusion beyond the apex.

According to the data presented in Table 4, at this follow-up period, the condition of the teeth, periapical tissues, and post-endodontic restorations was rated as "excellent" in 40 teeth (60.6%) of patients in the first group, 71 teeth (80.7%) in the second group, and 99 teeth (94.3%) in the third group; rated as "good" in 18 teeth (27.3%) of the first group, 11 teeth (12.5%) of the second group, and 4 teeth (3.8%) of the third group; and rated as "satisfactory" in 8 teeth (12.1%) of the first group, 6 teeth (6.8%) of the second group, and 2 teeth (1.9%) of the third group.

Analysis of the radiographic status of the periodontium 12 months after treatment for chronic fibrous pulpitis (Table 5) revealed the following key points: changes in the periodontium were observed in 22 teeth (33.3%) of the first group, 20 teeth (22.7%) of the second group, and 14 teeth (13.3%) of the third group. A statistically significant difference was detected only between the first and third groups ($\chi^2 = 9.75$, $df = 1$, $p = 0.002$). Deformation of the periodontal ligament space was noted in 18 teeth (27.3%) of the first group, 17 teeth (19.3%) of the second group, and 12 teeth (11.4%) of the third group, with statistical significance observed only between the first and third groups ($\chi^2 = 7.03$, $df = 1$, $p = 0.008$). Destructive changes in the periodontium and early signs of alveolar bone resorption were identified in 4 teeth (6.0%), 3 teeth (3.4%), and 2 teeth (1.9%) respectively, with no statistically significant differences between groups. Overall, a greater number of teeth with periodontium changes was observed in the first group, gradually decreasing in the second group and particularly in the third group.

Thus, the treatment outcomes among patients in the study groups were distributed as follows: "successful" treatment was observed in 54 teeth (81.8%) in the first group, 79 teeth (89.8%) in the second group, and 101 teeth (96.2%) in the third group; "questionable" outcomes were recorded in 8 teeth (12.1%) of the first group, 6 teeth (6.8%) of the second group, and 2 teeth (1.9%) of the third group; "unsuccessful" outcomes were noted in 4 teeth (6.1%), 3 teeth (3.4%), and 2 teeth (1.9%), respectively.

CONCLUSION

Analysis of the clinical and radiographic data demonstrated that patients in the third group, treated for chronic fibrous pulpitis using the proposed method, experienced minimal postoperative pain, including a significant reduction in "moderate and severe" pain compared with patients in the first and second groups ($p < 0.05$). During root canal obturation, no sealer extrusion beyond the apex was observed in Group III, likely due to the use of the specially designed instrument for sealer placement, which allows precise control over the amount of endosealer introduced ($p < 0.001$). Accordingly, the "success rate" of treatment in the third group was statistically significant when compared with the first and second groups, highlighting the high effectiveness of the proposed method and its low rate of unsuccessful outcomes ($\chi^2 = 9.87$, $df = 1$, $p = 0.002$).

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