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Effects of Different Root Canal Treatment Protocols on Pain Level and Inflammatory Markers in Patients with Endodontic Diseases

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Abstract

Objective: To compare the effects of different root canal treatment protocols on pain level and inflammatory markers in patients with endodontic diseases. **Methods:** A total of 70 patients with endodontic diseases treated between May 2023 and May 2025 were enrolled. According to the root canal treatment protocol, patients were divided into the single-visit group (35 cases, single-visit root canal treatment) and the multiple-visit group (35 cases, multiple-visit root canal treatment). The pain level [assessed by Visual Analogue Scale (VAS)] and inflammatory markers [interleukin-1β (IL-1β), tumor necrosis factor-α (TNF-α), interleukin-6 (IL-6)] were compared between the two groups. **Results:** At 6 hours postoperatively, there was no significant difference in VAS score between the two groups (P>0.05); at 24 hours, 48 hours, and 72 hours postoperatively, the VAS scores of the single-visit group were significantly lower than those of the multiple-visit group (P<0.05). At time point T0 (before treatment), there were no significant differences in the levels of IL-1β, TNF-α, and IL-6 between the two groups (P>0.05); at time point T1 (7 days after root canal filling), the levels of the aforementioned inflammatory markers in the single-visit group were significantly lower than those in the multiple-visit group (P<0.05). **Conclusion:** Compared with multiple-visit root canal treatment, single-visit root canal treatment can reduce postoperative pain level and the levels of inflammatory markers in patients with endodontic diseases.

Keywords

Different root canal treatment protocols; Endodontic diseases; Pain level; Inflammatory markers

Endodontic diseases, mainly including pulpitis and periapical periodontitis, are common conditions in stomatology. The severe spontaneous pain, night pain, and pain induced by hot/cold stimuli not only reduce patients' quality of life but also threaten oral health due to the risk of inflammation spreading [1]. Root canal treatment is the core clinical approach for endodontic diseases. By thoroughly removing infected pulp, disinfecting the root canal system, and performing tight obturation, it can effectively block the infection pathway, relieve pain, and preserve the function of the affected tooth [2]. Traditional root canal treatment typically adopts a multiple-visit approach, involving steps such as pulp opening and drainage, root canal preparation, disinfection, and obturation. The treatment cycle lasts 2-4 weeks, requiring patients to visit the clinic multiple times. This repeated operation increases the risk of re-infection in the periapical tissue, and the effectiveness of postoperative pain control is affected by factors such as individual inflammation severity and operational accuracy [3]. In recent years, with the promotion of novel protocols such as single-visit root canal treatment, the precision and efficiency of root canal treatment have been significantly improved. Single-visit root canal treatment completes all procedures in one clinical visit, which shortens the treatment cycle and

reduces the risk of re-infection [4]. This study compared the effects of different root canal treatment protocols on pain level and inflammatory markers in patients with endodontic diseases. The results are reported as follows.

1. Materials and Methods

1.1 General Information

A total of 70 patients with endodontic diseases treated between May 2023 and May 2025 were enrolled. According to the root canal treatment protocol, patients were divided into the single-visit group (35 cases) and the multiple-visit group (35 cases). This study was approved by the Medical Ethics Committee. In the multiple-visit group, there were 19 cases of pulpitis and 16 cases of periapical periodontitis; the age range was 20-50 years, with an average of (37.96±4.27) years; there were 14 males and 21 females. In the single-visit group, there were 17 cases of pulpitis and 18 cases of periapical periodontitis; the age range was 21-50 years, with an average of (38.28±4.63) years; there were 16 males and 19 females. There were no significant differences in baseline information between the two groups ($P>0.05$), indicating they were comparable.

1.2 Inclusion and Exclusion Criteria

Inclusion criteria: Diagnosis of pulpitis or periapical periodontitis confirmed by clinical and imaging examinations; Fully formed tooth apex, patent root canal, and no severe calcification or obstruction; Aged ≥18 years; No previous root canal treatment history; Patients voluntarily participated in the study and signed the informed consent form.
Exclusion criteria: Complicated with severe diseases of the heart, liver, kidney, or other vital organs, or with endocrine, hematological, immunological, or psychiatric diseases; Pregnant or postpartum women; Complicated with other oral diseases such as periodontal disease, jaw cysts, or tumors.

1.3 Methods

Multiple-visit group: Received multiple-visit root canal treatment. A comprehensive assessment of the patient's dental condition was conducted, including detailed examinations and analysis of the lesion site. Necrotic tissue at the lesion site was thoroughly removed to fully expose the pulp chamber, followed by formal root canal treatment. The actual length of the root canal was measured, and camphor phenol cotton points were used for internal sealing to prevent infection and lay the foundation for subsequent root canal treatment. Patients were advised to return for re-examination every 7 days. When the oral root canal met the filling conditions, gutta-percha points and root canal sealer were used for root canal obturation.
Single-visit group: Received single-visit root canal treatment. The preparatory measures were the same as those in the multiple-visit group. Root canal files were used for localization to determine the direction of the root canal and accurately measure its actual length. Meanwhile, the lesion site was kept completely dry to avoid the impact of moisture on treatment outcomes. Appropriate materials such as gutta-percha and root canal sealer were used for tight root canal obturation.

After root canal obturation, both groups underwent X-ray dental film examination to verify the root canal length and determine whether the obturation effect met the established standards. If abnormalities were found during the examination, further trimming was performed until the standards were met, and finally, the tooth shape was adjusted.

1.4 Observation Indicators

1.4.1 Postoperative Pain Level

The Visual Analogue Scale (VAS) was used to assess the postoperative pain level of patients, with scores ranging from 0 to 10 points. Patients selected the pain score based on their subjective feelings, with higher scores indicating more severe pain. Assessments were conducted at 6 hours, 24 hours, 48 hours, and 72 hours postoperatively.

1.4.2 Inflammatory Markers

Before treatment (T0) and 7 days after root canal filling (T1), a standard filter paper strip was inserted into the gingival sulcus for 30 seconds to avoid saliva contamination. The filter paper strip absorbing gingival crevicular fluid was placed into a centrifuge tube containing 100 μL of phosphate-buffered saline, centrifuged for 10 minutes (3000 r/min), and the supernatant was collected. The levels of interleukin-1β (IL-1β), tumor necrosis factor-α (TNF-α), and interleukin-6 (IL-6) were detected by enzyme-linked immunosorbent assay.

1.5 Statistical Analysis

Statistical software SPSS 26.0 was used for data analysis. Count data were expressed as cases/percentages (n/%), and analyzed by the χ^2 test; measurement data were expressed as mean ± standard deviation ($\bar{x}\pm s$), and analyzed by the t-test. A P-value <0.05 indicated a statistically significant difference.

2. Results

2.1 Comparison of Postoperative Pain Level Between the Two Groups

At 6 hours postoperatively, there was no significant difference in VAS score between the two groups (P>0.05); at 24 hours, 48 hours, and 72 hours postoperatively, the VAS scores of the single-visit group were significantly lower than those of the multiple-visit group (P<0.05) (see Table 1).

Table 1. Comparison of postoperative pain level between the two groups ($\bar{x}\pm s$, points)

Group	Number of cases	6 h postoperatively	24 h postoperatively	48 h postoperatively	72 h postoperatively
Single-visit group	35	3.26±0.71	2.15±0.57	1.17±0.23	0.63±0.16
Multiple-visit group	35	3.30±0.78	2.82±0.54	1.76±0.25	0.95±0.17
t	-	0.224	5.048	10.275	8.109
P	-	0.823	0.000	0.000	0.000

2.2 Comparison of Inflammatory Markers

Between the Two Groups. At T0, there were no significant differences in the levels of IL-1β, TNF-α, and IL-6 between the two groups (P>0.05); at T1, the levels of IL-1β, TNF-α, and IL-6 in the single-visit group were significantly lower than those in the multiple-visit group (P<0.05) (see Table 2).

Table 2. Comparison of inflammatory markers between the two groups ($\bar{x}\pm s$, pg/mL)

Group	Number of cases	IL-1β		TNF-α		IL-6	
		T0	T1	T0	T1	T0	T1
Single-visit group		58.64±5.48	29.64±4.57[a]	39.85±4.32	19.75±3.27[a]	44.36±5.12	23.17±3.28[a]
Multiple-visit group	35	59.73±4.96	36.42±4.13[a]	38.75±3.98	24.65±3.18[a]	43.89±4.89	28.54±3.36[a]
t	-	0.872	6.512	1.108	6.355	0.393	6.766
P	-	0.386	0.000	0.272	0.000	0.696	0.000

Note: [a] indicates comparison with T0, P<0.05.

3. Discussion

Endodontic diseases refer to lesions of the tooth's hard tissue and pulp tissue, usually caused by dental caries, trauma, etc. They present with tooth pain and masticatory discomfort. If not treated promptly, they may lead to pulp necrosis, periapical periodontitis, and even tooth extraction in severe cases [5]. Root canal treatment is the core method for treating such diseases. By removing infected tissue in the root canal, disinfecting the root canal, and performing tight obturation, it eliminates inflammation and preserves the affected tooth [6]. Root canal treatment is divided into multiple-visit and single-visit protocols. Multiple-visit root canal treatment requires 2-4 clinical visits, with an interval of approximately 1 week between each visit, and sequentially completes root canal preparation, disinfection, and obturation. It is suitable for cases with severe infection and obvious periapical inflammation, as it can control infection more adequately. Single-visit root canal treatment completes all procedures in one clinical visit, reducing the number of patient visits, and is suitable for cases with mild pulp infection and no obvious periapical inflammation.

This study found that at 6 hours postoperatively, there was no significant difference in VAS score between the two groups (P>0.05); at 24 hours, 48 hours, and 72 hours postoperatively, the VAS scores of the single-visit group were significantly lower than those of the multiple-visit group (P<0.05). At T0, there were no significant differences in the

levels of IL-1β, TNF-α, and IL-6 between the two groups (P>0.05); at T1, the levels of the aforementioned inflammatory markers in the single-visit group were significantly lower than those in the multiple-visit group (P<0.05). The underlying reasons are as follows: First, completing the entire process of root canal cleaning, disinfection, and obturation in one visit avoids the risk of temporary filling material loss and re-invasion of oral bacteria into the root canal during multiple visits, thereby reducing the inflammatory response caused by secondary infection and minimizing the release of inflammatory factors from the source [7]. Second, multiple-visit treatment requires repeated pulp chamber opening and root canal manipulation, which easily causes multiple mechanical stimuli to the periapical tissue, aggravating postoperative edema and pain; in contrast, single-visit treatment only involves one root canal preparation and obturation, resulting in milder mechanical stimuli and lighter postoperative tissue repair burden [8]. In addition, in single-visit treatment, after the action of root canal disinfection drugs, tight obturation can be performed immediately, avoiding long-term stimulation of the periapical tissue by drugs. At the same time, the root canal is quickly sealed to prevent harmful substances from penetrating into the periapical region, thereby alleviating pain perception and reducing the levels of inflammatory markers [9]. The research results of Yin Lifang [10] showed that in the treatment of endodontic diseases, single-visit root canal treatment can effectively alleviate inflammatory reactions and pain symptoms compared with multiple-visit root canal treatment, which is consistent with the results of this study.

In conclusion, compared with multiple-visit root canal treatment, single-visit root canal treatment can reduce postoperative pain levels and the levels of inflammatory markers in patients with endodontic diseases.

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