ORIGINAL ARTICLE

DIAGNOSTIC AND THERAPEUTIC MANAGEMENT OF PULPAL INFLAMMATION IN MAXILLARY MOLARS: A RETROSPECTIVE CASE SERIES

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Abstract: *Background*: Pulpal inflammatory diseases affecting maxillary molars represent a frequent clinical challenge in endodontic practice due to complex root canal anatomy and variable symptomatology. Accurate diagnosis and effective treatment strategies are essential for achieving predictable clinical outcomes. Objective This retrospective case series aimed to evaluate the clinical presentation, diagnostic procedures, and therapeutic outcomes of pulpal inflammatory diseases in maxillary molars treated using modern endodontic protocols. *Materials and Methods*: A retrospective analysis was conducted on 11 maxillary molars treated between August 2024 and May 2025. Diagnosis was established based on clinical examination, pulp vitality tests, and radiographic evaluation, including periapical radiographs and CBCT when indicated. Endodontic treatment was performed using NiTi rotary instrumentation, activated irrigation protocols, and bioceramic sealers. Descriptive statistical analysis was used to evaluate diagnostic distribution, anatomical findings, and treatment outcomes. *Results*: The most frequent diagnosis was total purulent pulpitis (45.4%), followed by total serous pulpitis (36.4%) and partial serous pulpitis (18.2%). The MB2 canal was identified in 18.2% of cases. Pain remission occurred rapidly, with 90.9% of patients reporting complete symptom relief within the first 24 hours following treatment. Radiographic evaluation demonstrated satisfactory obturation in all treated canals. Conclusions The anatomical complexity of maxillary molars, particularly the presence of the MB2 canal, significantly influences endodontic diagnosis and treatment. The use of modern technologies—including CBCT imaging, NiTi rotary instrumentation, activated irrigation, and bioceramic sealers—contributes to predictable clinical outcomes.

Keywords: pulpitis, maxillary molars, endodontic treatment, MB2 canal, CBCT, NiTi instrumentation

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1. Introduction

Pulpal inflammatory diseases constitute a complex and frequently encountered category of endodontic pathologies involving the dental pulp—a soft connective tissue rich in vascular and neural structures, located within the pulp chamber and root canals. These conditions often arise as a direct consequence of deep carious lesions but may also result from trauma, restorative procedures, or coronal fractures [1].

The pulpal inflammatory process represents a biological defense mechanism aimed at containing and neutralizing invading pathogens. Depending on the intensity and duration of the noxious stimulus, pulpal inflammation may be reversible—allowing for recovery—or irreversible, necessitating complete pulpectomy and endodontic therapy [2]. If untreated, irreversible inflammation may progress to pulpal necrosis and periapical pathology.

Differentiating reversible from irreversible pulpitis is fundamental for accurate treatment planning. Irreversible pulpitis is typically characterized by spontaneous, pulsating pain, thermal hypersensitivity—especially to heat—that persists after removal of the stimulus [3].

Despite advances in dental education and increased access to care, pulpal pathology remains highly prevalent. Up to 60% of endodontic treatments are performed on molars, which are particularly susceptible to carious lesions due to their posterior position and difficulty in maintaining oral hygiene [4].

Maxillary molars present significant anatomical variability, particularly involving the MB2 canal, which is often undetected during treatment. Failure to locate and instrument this canal is a major cause of endodontic failure, with reported rates exceeding 50% in some studies [5].

Endodontic diagnosis requires integrating patient history, clinical findings, pulp vitality tests, and radiographic imaging—ranging from conventional periapical radiographs to advanced CBCT scans [1,6]. Symptomatology may be atypical, and pain may radiate to adjacent structures, complicating differential diagnosis, especially in proximity to the maxillary sinus [7].

Modern endodontic therapy has greatly improved with the introduction of microscopes, NiTi rotary systems, ultrasonic/sonic irrigation activation, and enhanced three-dimensional obturation techniques. Even so, treatment success remains highly dependent on accurate diagnosis, comprehensive canal debridement, and clinician expertise.

The complex morphology of maxillary molars—three roots, variable canal configurations, severe curvatures, and frequent presence of MB2—necessitates the use of magnification and advanced technological tools to improve treatment predictability [6,8].

Study Objectives

The present study aimed to evaluate: the clinical and radiographic characteristics of pulpal inflammatory diseases in maxillary molars, the anatomical complexity associated with root canal morphology, the effectiveness of contemporary endodontic treatment protocols, the frequency of MB2 canal detection, and the post-treatment clinical evolution and symptom remission.

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2. Materials and method

2.1 *Study Design and Ethical Approval*

This study was conducted as a retrospective case series based on the clinical records and radiographic data of patients treated between August 2024 and May 2025 at the Department of Endodontics, Faculty of Dental Medicine, University of Medicine and Pharmacy of Craiova.

All procedures were performed in accordance with the ethical principles outlined in the Declaration of Helsinki. Ethical approval for the study was obtained from the institutional ethics committee (approval code No. 411/04.11.2025).

2.2 *Study Sample*

A total of 11 maxillary molars diagnosed with pulpal inflammatory diseases were included in the study. The distribution of treated teeth was as follows: 5 first maxillary molars (teeth 16 and 26), and 6 second maxillary molars (teeth 17 and 27). Patients included in the study were between 18 and 60 years of age, had no major systemic diseases, and had not previously undergone endodontic treatment on the involved tooth.

Inclusion Criteria

Patients were included if they met the following criteria:

- age between 18 and 60 years,
- diagnosis of acute irreversible pulpitis or total serous/purulent pulpitis,
- fully developed roots without mobility,
- absence of previous root canal treatment, and
- ability to attend post-treatment follow-up visits.

Exclusion Criteria

Patients were excluded if any of the following conditions were present:

- severe systemic disease (e.g., uncontrolled diabetes or immunosuppression),
- presence of apical radiolucency or extensive bone loss,
- root perforations or resorptions,
- Grade III tooth mobility, or
- incomplete clinical records or refusal of follow-up.

2.3 *Clinical assessments*

All patients underwent a comprehensive clinical examination including: intraoral inspection, vertical and horizontal percussion testing, palpation of surrounding tissues, thermal pulp testing using Endo-Ice, and electrical pulp testing (EPT). The gingival condition and surrounding periodontal tissues were also evaluated. Most patients presented with clinical signs characteristic of irreversible pulpitis, including: spontaneous pulsating pain, nocturnal exacerbation, prolonged thermal sensitivity, deep cavitated carious lesions, absence of sinus tracts or swelling. Radiographic evaluation was performed using: digital periapical radiographs, orthopantomography (OPG), and cone-beam computed tomography (CBCT) when complex anatomical conditions were suspected. Representative examples are illustrated in Figure 1.

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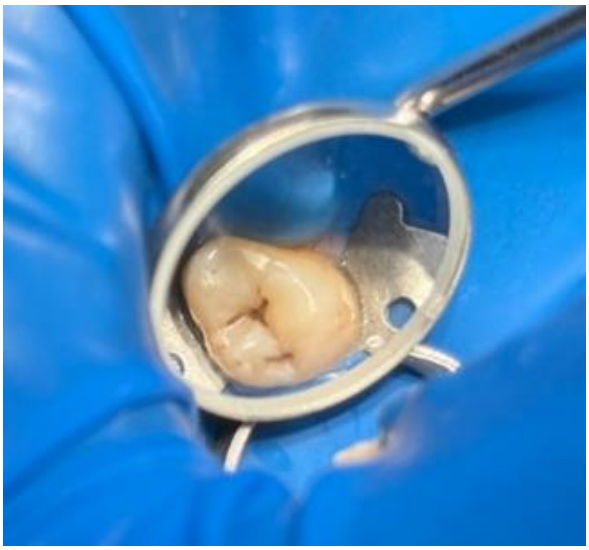

Figure 1. Initial clinical appearance of an upper molar with deep carious destruction.

Figure 2. Periapical radiograph showing deep caries and complex root morphology.

2.4 *Pulpal and Periapical Diagnosis*

Diagnosis was established according to the European Society of Endodontology (ESE) guidelines (2020). The following pulpal diagnoses were identified: Partial serous pulpitis, Total serous pulpitis, Total purulent pulpitis. Periapical status was evaluated radiographically. Most cases showed normal periapical conditions, while early inflammatory rarefaction was observed in isolated cases.

Endodontic Treatment Protocol.

All endodontic procedures were performed under magnification (3.5× loupes) and strict adherence to contemporary endodontic principles. Local anesthesia was achieved using 4% articaine with epinephrine 1:100,000 [Ubistesin Forte, 3M ESPE, Seefeld, Germany] administered through local infiltration or posterior superior alveolar nerve block. The onset of anesthesia occurred within 2–3 minutes.

Rubber Dam Isolation. All procedures were performed under rubber dam isolation [Dental Dam, Coltene/Whaledent, Altstätten, Switzerland] to ensure aseptic conditions. The isolation system included: rubber dam sheet, metal clamps, frame, punch. This ensured a contamination-free field and enhanced procedural safety.

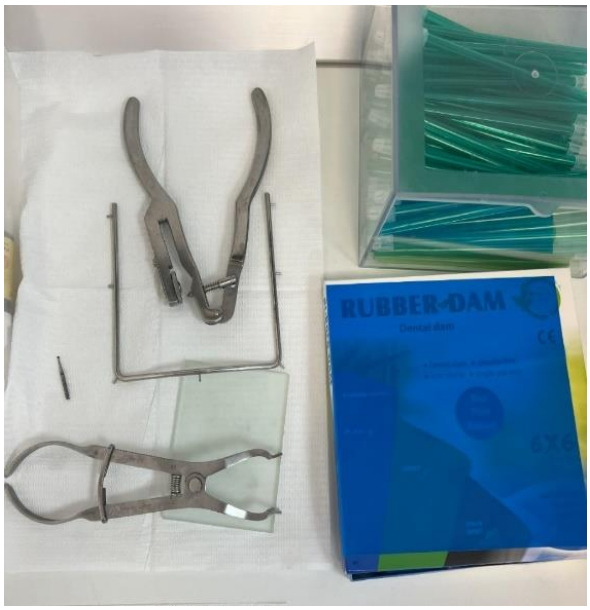

Figure 3. Components of the rubber dam isolation system.

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Figure 4. Coronal access preparation.

Access cavity preparation was performed using high-speed diamond burs [Komet Dental, Lemgo, Germany] under irrigation, and round burs for dentin removal. The objective was to obtain straight-line access to the root canal system. The following canal orifices were typically identified: MB – mesiobuccal, DB – distobuccal, P – palatal. Working length was determined using: Root ZX apex locator [J. Morita Corp., Kyoto, Japan], and radiographic confirmation. This ensured precise instrumentation while preventing over-instrumentation beyond the apical constriction. Mechanical preparation was performed using NiTi rotary systems (ProTaper Gold / ProTaper Next)[Dentsply Sirona, Ballaigues, Switzerland] . The sequence included: SX – coronal flaring, S1 / S2 – preparation of the middle third, F1, F2, F3 – canal shaping and finishing. Recapitulation with K-files (#10–15) [Dentsply Maillefer, Ballaigues, Switzerland] was performed to maintain canal patency. Recapitulation with K-files (#10–15) ensured patency.

Figure 5. Instruments used during canal preparation.

Figure 6. Root canal irrigation process.

The irrigation protocol included: 2.5% sodium hypochlorite (NaOCl) [Cerkamed, Stalowa Wola, Poland], 17% EDTA [MD-Cleanser, Meta Biomed, Cheongju, South Korea] for smear layer removal (1 minute),

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sterile saline [B. Braun, Melsungen, Germany] for final irrigation. Irrigant activation was performed using the EndoActivator system (sonic activation) [Dentsply Sirona, Ballaigues, Switzerland] . Following irrigation, the canals were dried using sterile paper points [Meta Biomed, Cheongju, South Korea] adapted to the prepared canal size.

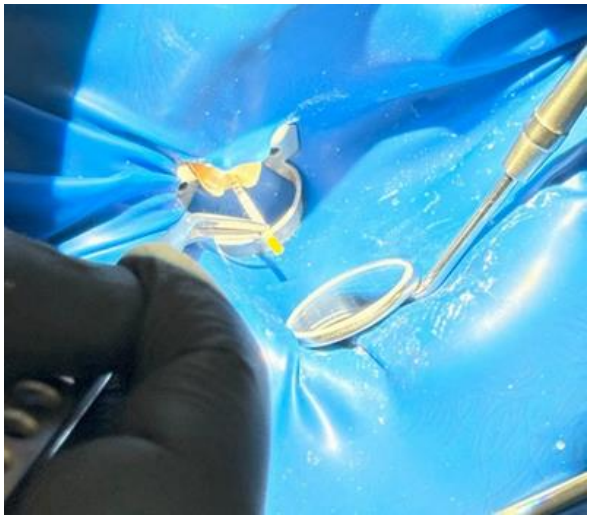

Figure 7. Canal drying with paper points.

Root canal obturation was performed using: cold lateral condensation, and warm vertical compaction in selected cases. Materials used included: gutta-percha cones (Conform Fit ProTaper) [Dentsply Sirona, Ballaigues, Switzerland] , bioceramic sealers (BioRoot™ RCS or TotalFill® BC Sealer) [Septodont, Saint-Maur-des-Fossés, France]/ [FKG Dentaire, La Chaux-de-Fonds, Switzerland] . The goal was to obtain a three-dimensional hermetic seal of the root canal system.

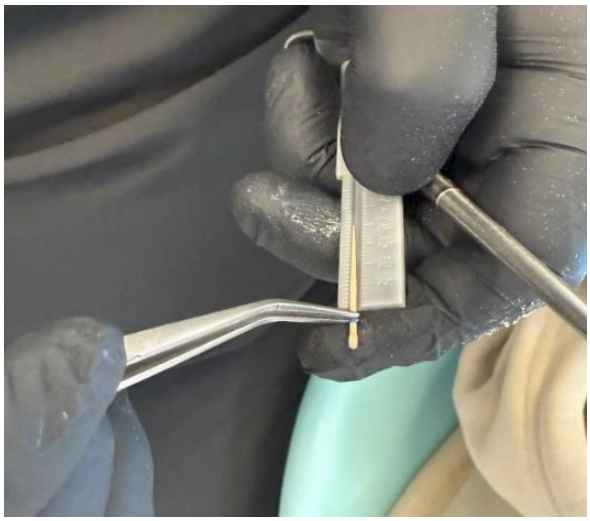

Figure 8. Gutta-percha cones prepared for obturation.

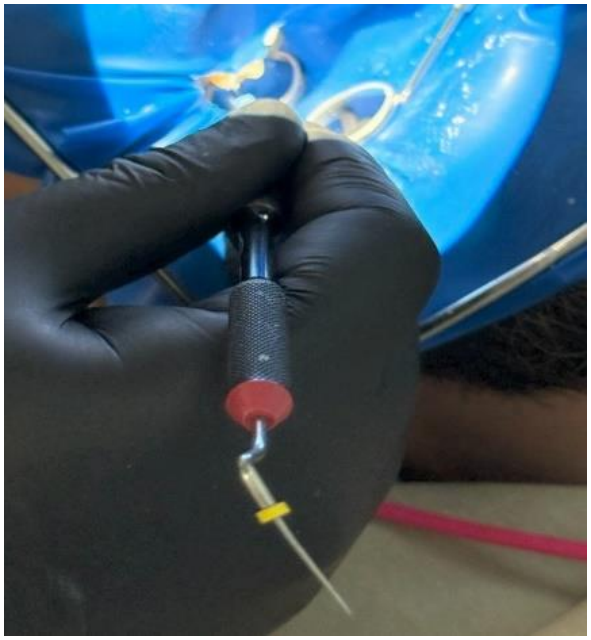

Figure 9. Lateral condensation technique.

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Figure 10. Final radiographic appearance of the obturated molar.

A postoperative digital radiograph was obtained to assess: obturation length, homogeneity of the filling material, absence of voids. After obturation, a temporary composite restoration [Cavit, 3M ESPE, Seefeld, Germany] was placed.

Patients were advised to undergo definitive restoration using: ceramic onlays, full-coverage crowns, or direct composite restorations, depending on the clinical situation. Clinical follow-up examinations were scheduled at: 7 days, 1 month, and 6 months. The evaluation included: assessment of pain intensity, percussion sensitivity, gingival and periodontal condition, radiographic monitoring. Most patients (90.9%) reported complete symptom resolution within 24 hours after treatment.

3. Results

This retrospective analysis included 11 maxillary molars diagnosed with pulpal inflammatory diseases. The results are presented according to the distribution of pulpal diagnoses, tooth type, clinical symptoms, anatomical findings, and treatment outcomes.

Distribution of Pulpal Inflammatory Diagnoses

Based on clinical and radiographic evaluation, three diagnostic categories of pulpal inflammation were identified: Total purulent pulpitis: 5 cases (45.4%), Total serous pulpitis: 4 cases (36.4%), Partial serous pulpitis: 2 cases (18.2%). Total purulent pulpitis represented the most frequent diagnosis in the study group.

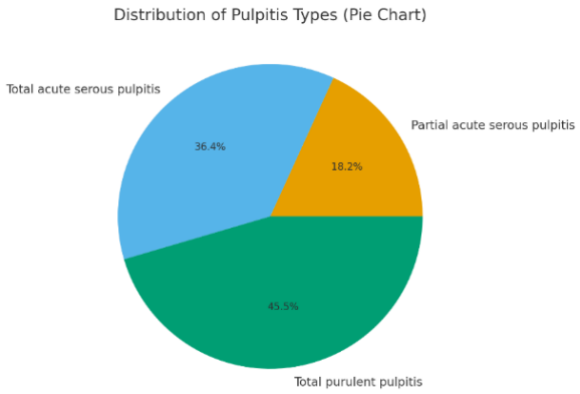

Figure 11. Distribution of clinical cases according to the type of pulpal inflammation.

Distribution According to Tooth Type

The treated molars were distributed as follows: First maxillary molars (teeth 16 and 26): 45.4%, Second maxillary molars (teeth 17 and 27): 54.6%, Second maxillary molars accounted for the slightly higher proportion of treated teeth.

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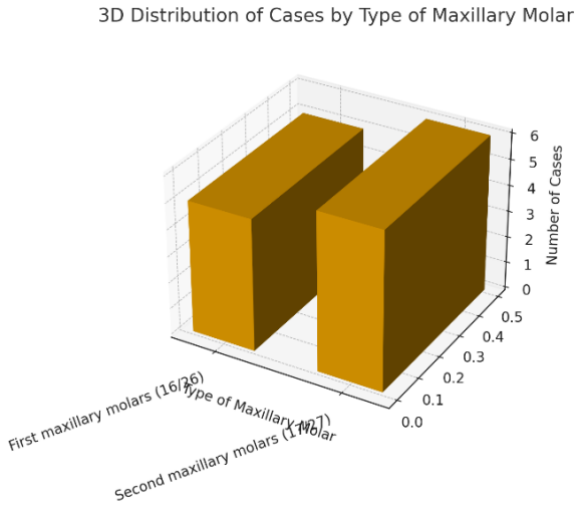

Figure 12. Distribution of cases according to the type of maxillary molar treated.

All patients presented with spontaneous pain, which was the most common clinical symptom.

The distribution of reported symptoms was: Spontaneous pain: 100%, Severe nocturnal pain: 72.7%.

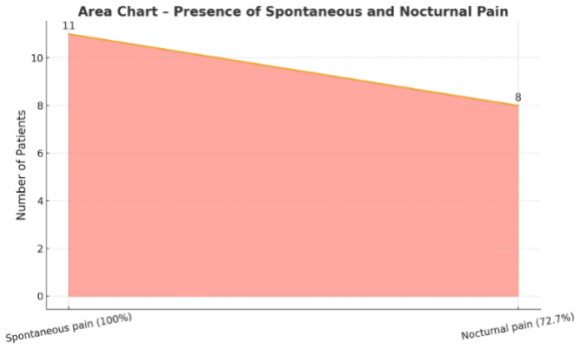

Figure 13. Frequency of spontaneous pain and nocturnal pain in the study group.

Anatomical Findings

Evaluation of root canal morphology revealed the following anatomical characteristics: Three canals identified: 81.8% of cases, MB2 canal detected: 18.2% of cases, CBCT examination required: 2 cases (18.2%). Clinical outcomes following endodontic treatment were favorable. Postoperative evaluation showed: Complete pain remission within 24 hours: 90.9% of patients, Complete symptom resolution within 48 hours: 100% of patients, No postoperative complications, including swelling, persistent pain, or flare-ups. Radiographic assessment demonstrated: appropriate obturation length, homogeneous root canal filling, and absence of voids or missed canals in all treated teeth.

The main findings of the study can be summarized as follows: Most frequent diagnosis: total purulent pulpitis (45.4%), Most affected teeth: second maxillary molars (54.6%), Primary clinical symptom: spontaneous pain (100%), MB2 canal detection rate: 18.2%, Pain remission within 24 hours: 90.9% of patients, Radiographic success: satisfactory obturation in all cases, Postoperative complications: none observed.

4. Discussion

The findings of the present retrospective study highlight a considerable prevalence of advanced pulpal inflammatory conditions in maxillary molars, with total purulent pulpitis representing the most frequent diagnosis (45.4%). This observation is consistent with previously published studies reporting that patients frequently seek dental treatment only when symptoms progress to advanced stages of pulpal inflammation [3,10,11]. The predominance of advanced pulpitis may be explained by several behavioral and clinical factors, including misinterpretation of early dental symptoms, self-medication with analgesics or antibiotics, limited access to dental care, irregular dental check-ups, and dental anxiety delaying treatment. Previous studies focusing on patient behavior, particularly among young adults aged 25–35 years, confirm that delayed dental

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intervention significantly increases the risk of irreversible pulpal inflammation [13,14].

One of the most important challenges in endodontic practice is the accurate differentiation between reversible and irreversible pulpitis, as this distinction directly influences treatment planning and long-term outcomes. Ricucci and Siqueira (2019) demonstrated a strong correlation between the histological condition of the dental pulp and the clinical symptoms reported by patients, particularly the presence of spontaneous pain and nocturnal pain [20].

In the present study, all patients reported spontaneous pain, while 72.7% experienced nocturnal pain, both considered classical clinical indicators of irreversible pulpitis. For this reason, endodontic diagnosis should rely on a comprehensive evaluation that includes patient history, thermal pulp testing, electric pulp testing (EPT), percussion and palpation tests, as well as radiographic assessment, supplemented by CBCT imaging when necessary. These diagnostic approaches are consistent with the European Society of Endodontology (ESE) clinical guidelines [4].

Maxillary molars are well known for their complex root canal morphology, which represents a significant challenge in endodontic treatment. The present study confirmed several anatomical characteristics widely reported in the literature, including three-rooted configurations, frequent root curvatures, and the presence of accessory canals such as the MB2 canal.

In this study, the MB2 canal was identified in 18.2% of cases. This detection rate is lower than those reported in studies using advanced imaging techniques such as micro–CT or CBCT, where prevalence rates of 55–90% have been described [6,15,16,23]. Several factors may explain this difference, including limited use of high-magnification devices such as operating microscopes, operator-related factors, extensive coronal destruction due to deep caries, and anatomical variability among populations.

Previous studies by Vertucci, Plotino, and Dummer have demonstrated that the detection rate of MB2 canals increases substantially—sometimes by more than three times—when magnification and enhanced illumination are used during endodontic treatment [19,20,24].

Contemporary endodontics has evolved significantly due to the introduction of advanced diagnostic and therapeutic technologies, several of which were employed in the present study.

Cone-beam computed tomography (CBCT) provides valuable three-dimensional visualization of root canal morphology, allowing clinicians to better identify complex canal configurations, root curvatures, hidden canals, and periapical changes. Patel et al. (2021) demonstrated that CBCT imaging significantly improves diagnostic accuracy and treatment planning in endodontics [28].

Nickel–titanium (NiTi) rotary instruments are widely considered the gold standard for root canal preparation, particularly in teeth with curved canals. These instruments provide superior flexibility, increased resistance to cyclic fatigue, and improved shaping efficiency compared with stainless steel hand files. Several systematic reviews have reported endodontic success rates exceeding 90% when NiTi instrumentation is combined with adequate irrigation and disinfection protocols [22,26].

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Successful endodontic treatment depends not only on mechanical preparation but also on effective irrigation and disinfection of the root canal system. In the present study, irrigation was performed using sodium hypochlorite and EDTA activated with the EndoActivator system.

Previous research has demonstrated that activated irrigation enhances smear layer removal, improves irrigant penetration into canal irregularities, and increases the effectiveness of canal disinfection, particularly in the apical third of the canal system. Keskin et al. (2021) confirmed that activated irrigation techniques are superior to passive irrigation in eliminating debris from complex root canal systems [23].

The clinical outcomes observed in this study were highly favorable. Pain assessment indicated complete symptom resolution within 24 hours in 90.9% of patients and within 48 hours in all cases, with no postoperative complications such as swelling, persistent pain, or flare-ups.

These results are slightly higher than the average success rates reported in global meta-analyses, which indicate postoperative pain resolution in approximately 70–85% of endodontic treatments [24].

Several factors may have contributed to these favorable outcomes, including: strict rubber dam isolation, standardized instrumentation protocols, activated irrigation, the use of bioceramic sealers, accurate working length determination, effective three-dimensional obturation, and appropriate coronal sealing.

The restoration of endodontically treated teeth represents a crucial factor in the long-term success of root canal therapy. Studies by Gillen et al. and Reeh et al. have demonstrated that the quality of the coronal restoration may influence treatment success even more strongly than the quality of the root canal filling itself [26,27]. Teeth that do not receive proper coronal coverage are at increased risk for microleakage, structural weakening, cusp fractures, bacterial reinfection, and eventual endodontic failure. For this reason, full-coverage restorations such as ceramic crowns or onlays are generally recommended for posterior teeth, particularly molars.

Recent technological developments have introduced new perspectives in endodontic diagnosis and treatment planning. Artificial intelligence (AI) has shown promising potential in assisting clinicians with the automatic detection of MB2 canals, identification of periapical lesions, and treatment planning based on radiographic analysis. Studies conducted by Setzer and Ahmed demonstrated that AI-based diagnostic systems may achieve accuracy levels comparable to those of experienced endodontists [29,30]. Another emerging concept in modern endodontics is minimally invasive endodontics, particularly the NSED (Narrow Shaping and Enhanced Disinfection) approach. This concept emphasizes the preservation of dentin structure, reduced canal enlargement, and enhanced chemical disinfection protocols to maintain tooth strength while ensuring adequate canal cleaning [31,32]. Pulpal inflammatory diseases affecting maxillary molars represent a significant diagnostic and therapeutic challenge due to the complex anatomy of the root canal system and the variability of clinical symptoms.

5. Conclusions

Based on the findings of the present retrospective study, several conclusions can be drawn. First, advanced forms of pulpal inflammation are common, with total purulent pulpitis representing the most frequent diagnosis (45.4%), suggesting that many patients seek dental treatment only after disease progression. Second, maxillary molars exhibit considerable anatomical complexity, particularly due to root curvatures and the frequent presence of accessory canals such as the MB2 canal, which may complicate endodontic treatment. Third, the MB2 canal detection rate of 18.2% observed in this study was lower than that reported in CBCT- and micro–CT-based studies, likely due to limited use of advanced magnification and imaging technologies. Fourth, the use of modern endodontic technologies, including NiTi rotary instrumentation, activated irrigation protocols, CBCT imaging, and bioceramic sealers, contributed to predictable and successful treatment outcomes. Fifth, clinical outcomes were highly favorable, with 90.9% of patients reporting complete pain resolution within 24 hours and all patients becoming asymptomatic within 48 hours, without postoperative complications. Finally, the quality of the coronal restoration remains essential for long-term treatment success, as inadequate coronal sealing may lead to reinfection and treatment failure. Overall, optimal management of pulpal inflammatory diseases in maxillary molars requires accurate diagnosis, the use of modern endodontic technologies, and individualized treatment strategies to achieve predictable long-term outcomes.

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Author contributions

Authors read and approved the final manuscript. All authors have equally contributed to this work.

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Conflict of interest statement

The authors declare no conflicts of interest concerning this study.

Data availability statement

Will be provided on request.

Ethics statement

This study was approved by the Ethics Committee of the University of Medicine and Pharmacy of Craiova (approval data no. 411/04.11.2025).

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