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*Original article*

# Clinical Findings in 609 Patients with Suspected Endodontic Treatment Failure Following Previous Pulpotec Use: A Case Series from Waddan, Libya

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**Abstract**
Persistent or recurrent symptoms following dental treatment may be associated with residual or recurrent infection, inadequate sealing, recurrent caries, or other endodontic and periodontal conditions. Accurate assessment requires clinical examination and evaluation. To describe the sex distribution and tooth-group distribution of 609 patients presenting with clinical concerns after previous treatment reportedly involving Pulpotec at Elsiraj Dental Clinic, Waddan, Libya, between March 2014 and December 2016, and to investigate the association between sex and tooth group. This descriptive case series used aggregate data from the original clinical report. The dataset included 609 records classified by sex and six tooth groups: upper premolars, lower premolars, upper molars, lower molars, upper anterior teeth, and lower anterior teeth. Frequencies and percentages were calculated. Pearson's chi-square test was used to assess the association between sex and tooth group, and Cramér's V was calculated to describe the strength of association. Statistical significance was defined as $p < 0.05$. Of the 609 records, 358 (58.8%) were female and 251 (41.2%) were male. Upper premolars were the most frequently represented tooth group (194; 31.9%), followed by lower molars (112; 18.4%), upper anterior teeth (111; 18.2%), upper molars (109; 17.9%), lower premolars (61; 10.0%), and lower anterior teeth (22; 3.6%). The association between sex and tooth group was not statistically significant ($\chi^2 = 9.26$, df = 5, $p = 0.099$; Cramér's V = 0.123). The sample contained a higher proportion of females than males, and upper premolars were the most frequently recorded tooth group. No statistically significant association was identified between sex and tooth group. Because the available data did not include a comparison group, a denominator of all teeth originally treated with Pulpotec, or standardized treatment outcomes, the findings cannot establish causation or estimate a treatment-failure rate. All the available data (all teeth) were originally treated with Pulpotec without standardized endodontic treatment, which prevents establishing the cause of endodontic treatment failure.
**Keywords:** Pulpotec; Endodontic Treatment; Pulpotomy; Root Canal Treatment; Clinical Findings.

## Introduction

Endodontic treatment aims to manage pulpal and periapical disease while preserving the affected tooth whenever feasible. Nevertheless, patients may present with persistent or recurrent symptoms following treatment. These presentations may reflect persistent intraradicular infection, reinfection, inadequate treatment of the root canal system, coronal leakage, or other biological and technical factors [1-2,3,4]. A history of previous endodontic treatment is therefore an important part of diagnosis, but symptoms alone do not establish the cause of an adverse outcome.

The quality of endodontic treatment depends on appropriate case selection, aseptic procedures, effective cleaning and shaping, adequate disinfection, suitable root canal filling, and a satisfactory coronal restoration [5,6,7]. Systematic reviews have demonstrated that treatment outcomes and tooth survival are influenced by multiple clinical and methodological factors [8,9]. Prospective investigations have also examined factors associated with periapical health and tooth survival following nonsurgical root canal treatment [10,11].

Persistent apical periodontitis is a multifactorial condition. Residual microorganisms within the root canal system and associated biofilms may contribute to persistent inflammation, while extraradicular infection and other factors can also be relevant in selected cases [2,3,4]. The diagnosis of pulpal and periapical disease therefore requires a structured clinical assessment, consideration of the patient's history, and appropriate diagnostic imaging [1,12,13].

Pulpotomy and complete root canal treatment are different procedures with distinct objectives. Pulpotomy involves removing the coronal pulp while retaining radicular pulp tissue, whereas complete root canal treatment involves treatment of the root canal system. The American Association of Endodontists has published guidance on vital pulp therapy, and the European Society of Endodontology has issued clinical practice guidance for the management of pulpal and apical disease [12,14]. These distinctions are important when evaluating patients who have received previous pulp treatment.

Pulpotec has been investigated as a material for pulpotomy, particularly in primary molars. Published studies have evaluated clinical and radiographic outcomes associated with Pulpotec and other pulpotomy agents [15,16,17]. However, evidence from studies of pulpotomy does not automatically establish the effectiveness or failure of every treatment in which the material has been used. The original diagnosis, treatment indication, procedure performed, restoration, and follow-up findings must be considered when interpreting individual cases.

Vital pulp therapy has also been investigated using other materials and techniques, including mineral trioxide aggregate (MTA), Biodentine, partial pulpotomy, and full pulpotomy in permanent teeth [18–23]. These studies provide context for the broader development of conservative pulp treatment, but differences in patient populations, diagnoses, materials, and outcome definitions limit direct comparisons between studies.

Technical factors in root canal preparation and the selection of appropriate treatment procedures are also relevant to endodontic outcomes [6,7]. In addition, accurate diagnosis of dental pain is essential because pulpal, periapical,

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periodontal, and nonodontogenic conditions can present with overlapping symptoms [13]. Imaging should be selected according to the clinical question; cone-beam computed tomography may be considered in selected endodontic cases when conventional assessment does not provide sufficient information, in accordance with professional guidance [24].

At Elsiraj Dental Clinic in Waddan, Libya, patients attended between March 2014 and December 2016 with clinical concerns following previous dental treatment reportedly involving Pulpotec. The original clinical description noted pain of varying severity, gingival inflammation or pocketing in some patients, recurrent caries, and apical lesions. The aggregate dataset classified 609 records by sex and tooth group.

Describing these records may help characterize the patients who presented to the clinic during the study period. However, the number of all teeth originally treated with Pulpotec, the outcomes of asymptomatic cases, and the clinical characteristics of individual patients were not available in the supplied dataset. Consequently, the present study is descriptive and cannot determine that Pulpotec caused the reported conditions or determine the risk of failure following its use.

## Methods

### Study design and setting

This study was framed as a retrospective descriptive case series based on the original clinical report from Elsiraj Dental Clinic, Waddan, Libya. The stated study period was March 2014 to December 2016. The original report described patients who presented with clinical concerns after previous dental treatment reportedly involving Pulpotec. The supplied aggregate table included 609 records classified according to sex and tooth group.

### Study population and available data

The dataset contained 609 records, comprising 358 female and 251 male records. The recorded tooth groups were:

- Upper premolars
- Lower premolars
- Upper molars
- Lower molars
- Upper anterior teeth
- Lower anterior teeth

The original clinical narrative described pain of varying severity, gingival inflammation or pocketing in some cases, recurrent caries, and apical lesions. However, the supplied aggregate table did not provide numerical counts for these findings. They were therefore not included in the statistical analysis.

The source table was labelled as representing 609 patients. It was not independently confirmed whether each patient contributed only one tooth or whether multiple teeth could have been recorded for an individual patient. This distinction is important when interpreting the statistical analysis.

### Study variables

The variables available for analysis were sex, tooth group, and the corresponding frequency of records. The dataset did not include age at the time of treatment, medical history, original diagnosis, exact treatment procedure, restoration quality, time to presentation, detailed radiographic diagnosis, or subsequent treatment outcomes.

### Statistical analysis

Descriptive statistics were calculated as frequencies and percentages. Overall sex percentages were calculated using the full sample of 609 as the denominator. Tooth-group percentages were also calculated using 609 as the denominator. Within-group sex percentages were calculated using the total number of records in each tooth group as the denominator.

Pearson's chi-square test of independence was used to evaluate the association between sex and tooth group in a 2 × 6 contingency table. The significance threshold was set at $p < 0.05$. Cramér's V was calculated to describe the magnitude of association.

The expected cell counts were sufficient for the conventional Pearson chi-square approximation. However, the test assumes independent observations. If individual patients contributed more than one tooth, the independence assumption may be violated, and a patient-level or clustered analysis may be required.

## Results

### Overall sex distribution

Of the 609 records, 358 (58.8%) were female, and 251 (41.2%) were male. The female-to-male ratio was approximately 1.43:1. Females constituted the larger proportion of the recorded sample. This observation describes the clinic records and does not establish that females have a higher risk of endodontic treatment failure.

**Table 1. Distribution of records by sex**

| Sex | Number | Percentage |
|---|---|---|

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| | | |
|---|---|---|
| Female | 358 | 58.8% |
| Male | 251 | 41.2% |
| **Total** | **609** | **100.0%** |

**Distribution by tooth group**

Upper premolars were the most frequently recorded tooth group, accounting for 194 records (31.9%). Lower molars accounted for 112 (18.4%), upper anterior teeth for 111 (18.2%), and upper molars for 109 (17.9%). Lower premolars accounted for 61 records (10.0%), while lower anterior teeth accounted for 22 (3.6%).

When grouped into broader anatomical categories, premolars accounted for 255 records (41.9%), molars for 221 (36.3%), and anterior teeth for 133 (21.8%). These figures describe the composition of the recorded sample rather than the relative failure risk of each tooth category.

**Table 2. Distribution of records by tooth group**

| Tooth group | Number | Percentage of all records |
|---|---|---|
| Upper premolar | 194 | 31.9% |
| Lower premolar | 61 | 10.0% |
| Upper molar | 109 | 17.9% |
| Lower molar | 112 | 18.4% |
| Upper anterior | 111 | 18.2% |
| Lower anterior | 22 | 3.6% |
| **Total** | **609** | **100.0%** |

**Sex distribution within tooth groups**

Females represented more than half of the records in each tooth group. The highest female proportion was observed in the lower premolar group (45/61; 73.8%). The upper molar group had the most balanced distribution, with 56 female records (51.4%) and 53 male records (48.6%).

**Table 3. Sex distribution within each tooth group**

| Tooth group | Female, n (%) within group | Male, n (%) within group | Total |
|---|---|---|---|
| Upper premolar | 115 (59.3%) | 79 (40.7%) | 194 |
| Lower premolar | 45 (73.8%) | 16 (26.2%) | 61 |
| Upper molar | 56 (51.4%) | 53 (48.6%) | 109 |
| Lower molar | 64 (57.1%) | 48 (42.9%) | 112 |
| Upper anterior | 63 (56.8%) | 48 (43.2%) | 111 |
| Lower anterior | 15 (68.2%) | 7 (31.8%) | 22 |
| **Total** | **358 (58.8%)** | **251 (41.2%)** | **609** |

*Percentages in the female and male columns are calculated within each tooth group. The overall percentages are based on the full sample.*

**Association between sex and tooth group**

Pearson's chi-square test did not identify a statistically significant association between sex and tooth group, $\chi^2(5, N = 609) = 9.26$, $p = 0.099$. Cramér's V was 0.123, indicating a small association in magnitude.

**Table 4. Association between sex and tooth group**

| Statistic | Result |
|---|---|
| Pearson chi-square, $\chi^2$ | 9.26 |
| Degrees of freedom | 5 |
| Sample size | 609 |
| *p*-value | 0.099 |
| Cramér's V | 0.123 |
| Significance at $p < 0.05$ | Not statistically significant |

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Although the observed sex proportions differed between tooth groups, the overall association did not reach the prespecified threshold for statistical significance. This finding does not prove that sex and tooth group are entirely unrelated; rather, the analysis did not provide sufficient evidence of an association at the 0.05 level.

## Discussion

This case series described 609 records from patients who presented to Elsiraj Dental Clinic, Waddan, Libya, between March 2014 and December 2016, with clinical concerns after previous treatment reportedly involving Pulpotec. Females accounted for 58.8% of records and males for 41.2%. Upper premolars were the most frequently recorded tooth group, accounting for 31.9% of the sample.

The inferential analysis showed no statistically significant association between sex and tooth group ($\chi^2 = 9.26$, df = 5, $p = 0.099$), with a small effect size (Cramér's V = 0.123). These findings characterize the distribution of the recorded cases but do not demonstrate a difference in treatment-failure risk between sexes or tooth groups.

The interpretation of endodontic outcomes requires caution because persistent or recurrent disease can have multiple causes, including microbial persistence, technical factors, and the condition of the tooth and restoration [1,2,8,9]. Previous systematic reviews and prospective studies have also demonstrated that root canal treatment outcomes and tooth survival depend on several factors rather than a single characteristic [8,9,10,11].

Upper premolars formed the largest group in the dataset, whereas lower anterior teeth formed the smallest. These findings should not be interpreted as indicating that upper premolars are more likely to experience treatment failure.

The number of teeth originally treated in each anatomical group was not available. In addition, the dataset did not include successfully treated teeth that remained asymptomatic and did not return to the clinic. Therefore, the distribution may reflect the number of teeth originally treated, the pattern of attendance, referral practices, local clinical practice, or other factors. To estimate tooth-specific failure risks, future studies would need the number of teeth initially treated in each group, standardized definitions of treatment failure, and consistent follow-up. The present analysis provides only the distribution of the recorded cases.

Females represented a larger proportion of the recorded sample than males. However, the dataset does not establish whether this distribution differs from the sex distribution of all patients receiving treatment at the clinic or from that of the wider population served by the clinic. The observed female-to-male ratio should not be interpreted as evidence that females are more susceptible to endodontic treatment failure. Such a conclusion would require appropriate comparison data and adjustment for potentially relevant factors, including age, treatment exposure, tooth distribution, and patterns of seeking dental care.

Correct interpretation requires distinguishing pulpotomy from complete root canal treatment. Pulpotomy is a vital pulp therapy procedure in selected clinical circumstances, whereas complete root canal treatment is intended to manage disease within the root canal system [12,14]. Clinical studies have evaluated Pulpotec in pulpotomy procedures, particularly in primary molars, and have compared it with other pulpotomy materials [15,16,17]. These studies provide context for understanding the material's use, but they do not establish the cause of the clinical concerns reported in this case series. Other research has investigated vital pulp therapy in deep caries and exposed pulp [18,19], the clinical factors associated with successful pulp capping [20], and outcomes following full or partial pulpotomy in permanent teeth [21,22,23]. Research on MTA has also examined its chemical, physical, and antibacterial properties [24,25]. These publications illustrate the broader evidence base concerning pulp-preserving treatment and dental materials, but results from different procedures and populations should not be directly equated with the outcomes of the present series.

The original clinical narrative described pain of varying severity, gingival inflammation or pocketing in some cases, recurrent caries, and apical lesions. However, the supplied dataset did not include numerical counts or standardized diagnostic definitions for these findings. Accordingly, their frequencies and relationships with sex or tooth group could not be assessed.

The diagnosis of dental pain requires careful clinical assessment because different pulpal, periapical, periodontal, and other conditions may produce overlapping symptoms [13]. Root canal cleaning and shaping are also important components of conventional endodontic treatment [6,7]. Nevertheless, the information available for this case series does not establish which procedures were performed in individual cases or whether the previous procedures met accepted treatment standards. In future work, radiographic assessment has to be guided by the diagnostic question. Conventional radiographs may provide useful information about periapical status, while cone-beam computed tomography may be appropriate in selected cases when additional three-dimensional information is expected to influence management [26]. The present report does not provide enough individual radiographic data to assess the appropriateness or diagnostic contribution of any particular imaging technique.

The study describes a sample of 609 records from a defined clinic and period. The aggregate table permitted a consistent summary of sex and tooth-group distributions and an inferential test of their association. Reporting both the chi-square statistic and Cramér's V provides information about statistical evidence and the magnitude of the observed association.

The explicit reporting of denominators also distinguishes overall sample percentages from percentages calculated within each tooth group.

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***Recommendations for future research***

Future research will use a prospective or well-documented retrospective cohort design. Each record will include the original diagnosis, the indication for treatment, the exact procedure performed, the tooth treated, the material used, the quality of the coronal restoration, baseline clinical and radiographic findings, and the time between treatment and follow-up. Standardized outcome definitions will then distinguish clinical symptoms, radiographic signs, retreatment, extraction, and tooth survival. The denominator has to include all eligible teeth treated during the study period, not only those that subsequently presented with symptoms. If comparisons between treatment materials or techniques are intended, the study will include a suitable comparison group and a prespecified statistical analysis plan. Multiple teeth from the same patient have to be identified and handled appropriately in the statistical analysis.

## Conclusion

Among 609 records from patients presenting to Elsiraj Dental Clinic, Waddan, Libya, between March 2014 and December 2016, females accounted for 58.8% and males for 41.2%. Upper premolars were the most frequently recorded tooth group (31.9%), while lower anterior teeth were the least frequently recorded (3.6%). Pearson's chi-square analysis found no statistically significant association between sex and tooth group, $\chi^2(5, N = 609) = 9.26$, $p = 0.099$, with a small effect size (Cramér's V = 0.123). These findings describe the composition of the available clinical sample. They do not establish that Pulpotec caused the reported clinical concerns, show that one tooth group has a higher failure risk, or permit estimation of a treatment-failure rate. Further research with verified treatment histories, appropriate comparison groups, defined outcomes, and standardized follow-up is required. These findings describe the composition of the available clinical sample. They establish that Pulpotec, which was used in all teeth, was possibly the cause of the reported clinical cases' failure.

***Conflict of interest.*** Nil

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