

SURVIVAL OF ENDODONTIC-PERIODONTAL LESIONS FOLLOWING CONVENTIONAL ROOT CANAL TREATMENT

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ABSTRACT

Endodontic-periodontal lesions (EPLs) are characterized by concurrent involvement of pulpal and periodontal tissues, complicating clinical management. Teeth diagnosed with endodontic-periodontal lesions (EPLs) and treated by postgraduate endodontists at Chulalongkorn University were retrospectively evaluated. Lesions were stratified according to Herrera's classification, and 4-year tooth survival was assessed. Tooth survival following treatment of endodontic-periodontal lesions is high in the short term but decreases over time. At 1-year, overall tooth survival was 98%, decreasing to 85% at 4-years depending on handling of missing data. When stratified by Herrera's classification, survival remained high across all groups at 1-year (91-100%). At 4-years low grade lesions demonstrated more favorable outcomes (82-83%), whereas advanced lesions showed reduced survival, with rates as low as 42%. Variations in survival were observed across both periodontal status and lesion severity categories. Stratification using Herrera's classification demonstrates that lesion severity and periodontal status significantly influence prognosis, supporting its value as a clinically relevant framework for outcome assessment.

Keywords: Endodontic-Periodontal Lesions; Tooth Survival; Herrera Classification

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INTRODUCTION

Broadly, the tooth can be considered as comprising two components: the tooth itself and the surrounding structures that support it. When inflammation or infection affects the tissue inside the tooth (the dental pulp), it is classified as an endodontic problem and is typically managed with root canal therapy. In contrast, when inflammation involves surrounding supporting structures, including the gums and bone, it is considered a periodontal problem and is treated with approaches such as scaling and root planing, or, in more advanced cases, procedures like guided tissue regeneration or other complex therapies. Due to anatomical connections between these regions, disease may extend from one to the other, resulting in combined involvement.

Endodontic-periodontal lesions (EPLs) represent a complex clinical entity characterized by the coexistence of pulpal and periodontal pathology within the same tooth, often resulting in diagnostic ambiguity and challenges in treatment planning. The interrelationship between the pulp and periodontal tissues has long been recognized, with pathways such as dentinal tubules, accessory canals, and the apical foramen facilitating communication between the two systems (Simon et al., 1972). This bidirectional relationship complicates the identification of the primary disease origin and contributes to variability in clinical presentation and prognosis (Chen et al., 2024; Shenoy & Shenoy, 2010).

Historically, classification systems for EPLs have primarily focused on the presumed etiologic origin of the lesion, distinguishing between primary endodontic, primary periodontal, and combined lesions (Simon et al., 1972). While this approach provides a conceptual framework, it has limitations in clinical application, as determining the true origin of disease is often difficult and may not accurately reflect the severity or extent of tissue destruction (Kristen Bingham, 2023).

To address these limitations, more recent classification systems have incorporated periodontal status and lesion severity into their framework. The classification proposed by Herrera and colleagues reflects this shift, integrating both patient-level periodontal condition and tooth-specific factors to provide a more clinically relevant and prognostically meaningful system (Herrera et al., 2018; Herrera et al., 2025). This approach aligns with contemporary periodontal classification systems, which emphasize staging and grading based on disease severity and complexity rather than solely etiology (Caton et al., 2018; Papapanou et al., 2018).

Given the relatively recent introduction of this system, outcome-based evidence remains limited, particularly in relation to clinically meaningful endpoints. From a patient perspective, tooth survival represents a critical outcome, especially in cases with periodontal involvement, where treatment is often aimed at maintaining the tooth for as long as possible rather than achieving complete resolution of disease (Schmidt et al., 2014). This is particularly relevant in clinical decision-making, where the goal may shift from cure to preservation.

Traditional approaches have frequently evaluated EPLs as a single, heterogeneous group or classified them according to presumed etiologic origin; however, such approaches may overlook important differences in disease severity and periodontal status that directly influence clinical outcomes. By accounting for variations in periodontal involvement and lesion severity, this system allows for more precise stratification of cases, potentially enabling a more accurate assessment of expected outcomes compared to evaluating EPLs. Furthermore, stratified analysis may better reflect real-world clinical scenarios, where treatment decisions are guided by the extent of periodontal compromise rather than etiology alone.

Furthermore, while previous studies have evaluated EPL outcomes, there remains limited prognostic evidence using Herrera's classification system due to its relatively recent introduction. As a result, the current literature on EPL prognosis remains sparse, and existing studies often continue to group lesions as a single heterogeneous entity or rely on etiologic classifications without subclassifying according to periodontal status and lesion severity. This limits the ability to detect clinically meaningful differences in outcomes that are assumed to

exist between categories. Therefore, there is a clear need for studies that apply Herrera's classification in an outcome-based context to determine whether this more detailed stratification translates into differences in tooth survival. Additionally, the use of a university-based clinical setting provides unique advantages, including a large patient pool, standardized documentation, and close interdisciplinary collaboration between endodontic and periodontal departments, allowing for more consistent diagnosis, treatment planning, and follow-up. This study aims to address these gaps by providing medium-term (4-year) survival data stratified according to Herrera's classification, thereby contributing clinically relevant evidence on prognosis that is currently lacking in the literature.

Therefore, the aim of the present study was to evaluate 4-year tooth survival of EPLs treated with conventional root canal therapy in a university clinical setting, stratified according to Herrera's classification system.

METHODOLOGY

Sample Size Calculation

The sample size was determined with reference to previously published retrospective studies evaluating survival outcomes of endodontic-periodontal lesions and similar endodontic conditions, which have typically included sample sizes ranging from approximately 50 to 100 teeth to estimate survival rates over time. Based on these reports, a minimum sample of 50 teeth was considered sufficient to provide a reasonably precise estimate of survival outcomes and to allow subgroup analysis across Herrera classification categories. The final sample of 80 teeth exceeded this threshold, thereby improving the reliability of the survival estimates. Ethical approval was obtained from the Human Research Ethics Committee in with study code HREC-DCU 2014-041.

Case Selection

A retrospective screening of patient records from 2013 to 2017 was conducted to identify cases of endodontic-periodontal lesions. Eligible teeth were those exhibiting probing depths ≥ 5 mm at baseline and managed with primary root canal treatment. The selection of ≥ 5 mm as an inclusion threshold in this study was based on its clinical relevance in identifying periodontal pockets associated with disease activity and aligns with criteria used in periodontal and EPL classification studies (Herrera et al., 2018; Sanz et al., 2020).

Cases that underwent root canal treatment due to trauma or were given surgical treatment, apexification, vital pulp therapy were excluded.

Lesion Classification

All classifications were performed by a single reviewer blinded to treatment outcomes and prior classifications. Classification was performed based on pretreatment clinical records and radiographic findings, including periapical radiographs and documented endodontic and periodontal parameters. For the Herrera classification, cases were categorized based on patient-level periodontal status, probing depth, and the presence or absence of root damage.

Data collection and Outcome Assessment

Follow-up data were obtained from clinical records up to 4-years post-treatment. The date of treatment completion was considered baseline. Survival status at each time point (1-4 years) was determined based on documented recall visits. Cases with unknown extraction status were analyzed using two approaches: 1) assuming unknown cases as extracted, and 2) excluding unknown cases from analysis. This allowed estimation of a range of survival outcomes and minimized bias related to loss to follow-up.

Survival was defined as retention of the treated tooth in function at follow-up. Extractions were classified as treatment failures. Where the cause of extraction was not documented, additional clinical records were reviewed, or patients were contacted to determine the reason.

Variables Assessed

Baseline variables included patient age, gender, probing depth (PD), and lesion characteristics such as furcation involvement, mobility, periapical lesion size, sinus tract presence, and crown-to-root ratio. These variables were analyzed descriptively across Herrera classification groups.

Statistical Analysis

Descriptive statistics were used to summarize baseline characteristics and survival outcomes. Survival rates were calculated at 1-, 2-, 3-, and 4-year intervals. To account for missing follow-up data, survival was analyzed using two approaches: 1) assuming teeth with unknown status were extracted, and 2) excluding cases with unknown outcomes from the analysis. Survival outcomes were further stratified according to Herrera's classification to enable subgroup comparisons.

The Kruskal-Wallis test was used to assess differences in baseline and clinical variables across diagnostic categories, as these variables were not normally distributed and the comparison involved more than two independent groups. This non-parametric approach does not assume normality and is appropriate for ordinal or non-normally distributed continuous data. All statistical analyses were performed using SPSS software (IBM Corp., Armonk, NY, USA).

RESULTS

A total of 305 cases were evaluated that underwent primary root canal treatment and had periodontal pockets in postgraduate endodontic department. Out of which, 80 teeth diagnosed with endodontic-periodontal lesions met the inclusion criteria and were further analyzed. The mean patient age was 53 years, with a gender distribution of 37 males and 43 females. The overall mean probing depth at baseline was 8.4 mm.

Overall survival remained high at 1-year and progressively declined over time (Table 1). Survival at 1-year was 98%, decreasing to 72% at 4-years when unknown cases were considered as extracted, and 85% when unknown cases were excluded. The dropout rate increased over time, reaching 15% at 4-years.

Table 1 Survival of all cases of EPL at various time intervals

	Year			
	1	2	3	4
survived (n)	78	70	62	56
extracted (N)	2	4	9	12
drop out (n)	0	6	9	12
Survival rate (%) if unknown extracted	98	90	82	72
survival rate (%) if unknown excluded	98	95	91	85
dropout rate (%)	0	5	9	15

When stratified according to Herrera's classification (Table 2), survival outcomes varied considerably across groups. At 1-year, survival was uniformly high across all categories (91-100%). However, by 4-years, marked differences were observed. Lesions in non-periodontitis patients with lower severity (Grade 1 and Grade 2) demonstrated relatively favorable survival (82% and 83%, respectively). In contrast, more advanced lesions in non-periodontitis patients (Grade 3) showed substantially reduced survival (42%).

Table 2 Distribution of EPL according to Herreras classification and survival rate at year 1,4

Herrera Classification	total (n)	Year 1			Year 4		
		Survived (n)	Ext (n)	survival rate (%)	Survived (n)	Ext (n)	survival rate (%)
Endo-Perio in Non-Perio Grade 1	17	17	0	100%	14	0	82%
Endo-Perio in Non-Perio Grade 2	6	6	0	100%	5	0	83%
Endo-Perio in Non-Perio Grade 3	12	11	1	92%	5	3	42%
Endo-Perio in Perio Grade 1	22	22	0	100%	17	3	77%
Endo-Perio in Perio Grade 2	9	9	0	100%	4	3	44%
Endo-Perio in Perio Grade 3	11	10	1	91%	8	3	73%
Endo-Perio with Damage	3	3	0	100%	3	0	100%

Among patients with periodontitis, survival outcomes were similarly influenced by severity. Grade 1 lesions showed relatively high survival (77%), whereas Grade 2 lesions exhibited lower survival (44%). Interestingly, Grade 3 lesions in periodontitis patients demonstrated a comparatively higher survival rate (73%) than Grade 2 lesions. Lesions associated with root damage showed 100% survival at 4-years, although this group included only three cases

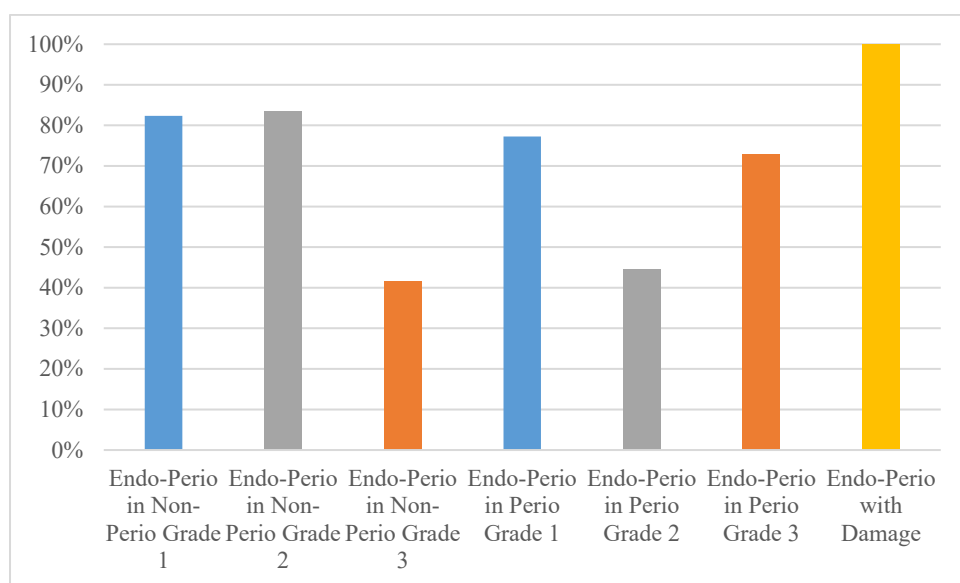
**Figure 1** Survival rate of EPL classified by Herrera at 4-year follow-up

Figure 1 illustrates the variation in 4-year survival rates across Herrera classification groups, highlighting the influence of both periodontal status and lesion severity on treatment outcomes.

Table 3 Distribution of characteristics based on Herrera classification

classification	Total cases (n)	average PD (mm)	average age (years)	proportion of cases with Furcation involvement	proportion of cases with mobility	Average PA lesion size	proportion of cases with sinus involvement	proportion of cases with CR less than 1:1
Endo-Perio in Non-Perio Grade 1	17	8.7	47.8	23.5	47.1	4.5	35.3	11.8
Endo-Perio in Non-Perio Grade 2	6	8.2	42.8	16.7	33.3	4.0	16.7	0.0
Endo-Perio in Non-Perio Grade 3	12	8.0	55.3	16.7	50.0	7.3	16.7	25.0
Endo-Perio in Perio Grade 1	22	7.0	54.5	31.8	40.9	5.0	9.1	9.1
Endo-Perio in Perio Grade 2	9	9.4	56.3	22.2	66.7	3.1	11.1	77.8

classification	Total cases (n)	average PD (mm)	average age (years)	proportion of cases with Furcation involvement	proportion of cases with mobility	Average PA lesion size	proportion of cases with sinus involvement	proportion of cases with CR less than 1:1
Endo-Perio in Perio Grade 3	11	10.4	55.5	36.4	45.5	6.7	36.4	54.5
Endo-Perio with Damage	3	9.0	65.3	0.0	0.0	2.3	33.3	33.3

Baseline characteristics differed across classification groups (Table 3). Higher grades were generally associated with increased probing depths, greater proportions of mobility, and more unfavorable crown-to-root ratios. Periapical lesion size tended to be larger in more severe categories, particularly in non-periodontitis Grade 3 and periodontitis Grade 3 groups. Furcation involvement and sinus tract presence were variably distributed but appeared more prevalent in higher severity groups.

Differences in baseline and clinical variables across diagnostic categories were assessed using the Kruskal-Wallis test. No statistically significant differences were observed between groups for age ($p = 0.244$), furcation involvement ($p = 0.881$), mobility ($p = 0.624$), probing depth ($p = 0.117$), or periapical status ($p = 0.231$). Survival outcomes also did not differ significantly across diagnostic categories ($p = 0.092$), although a non-significant trend toward variation between groups was observed.

DISCUSSION

The present study evaluated 4-year survival of teeth with endodontic-periodontal lesions following conventional root canal treatment, using Herrera's classification system to stratify cases based on periodontal status and lesion severity. The findings demonstrate that while short-term survival is consistently high, longer-term outcomes appear to be influenced by disease severity and periodontal condition. These findings are consistent with the multifactorial nature of EPLs, in which both endodontic and periodontal components contribute to treatment outcomes (Chen et al., 2024; Schmidt et al., 2014).

Among the 80 cases included in this study, the distribution of lesions according to Herrera's classification showed that Grade 1 lesions were the most prevalent, accounting for nearly half of the sample (22 periodontitis-associated and 17 non-periodontitis cases). Overall, lesions in patients with periodontitis were more common than those in non-periodontitis patients, reflecting the significant contribution of underlying periodontal disease in the presentation of EPLs. The mean probing depth across the cohort exceeded 8 mm, indicating that the study population largely consisted of advanced cases with substantial periodontal involvement.

Overall survival at 1-year was 98%, indicating that initial retention of teeth following treatment is highly predictable. This aligns with previous studies reporting high short-term survival following combined endodontic and periodontal therapy (Schmidt et al., 2014; Wong et al., 2024). However, survival declined to between 72% and 85% at 4-years, depending on how missing data were handled. This highlights the importance of longer follow-up periods when evaluating treatment outcomes for EPLs, as early success may not reflect long-term prognosis. The choice of a 4-year follow-up period is supported by endodontic outcome literature, which suggests that most periapical healing occurs within this timeframe and stabilizes thereafter (Burns et al., 2022; European Society of Endodontology, 2006; Ørstavik, 1996). However, unlike endodontic healing, periodontal outcomes remain dynamic and are influenced by long-term factors such as plaque control, systemic health, and adherence to maintenance therapy (Chapple et al., 2018; Ramseier et al., 2019).

Stratification using Herrera's classification suggested potential differences in survival outcomes. Lesions with limited periodontal involvement appeared to demonstrate more favorable prognosis, supporting the concept that periodontal status is a key determinant of long-

term outcomes (Herrera et al., 2018; Papapanou et al., 2018). In contrast, advanced lesions tended to show reduced survival, particularly in higher-grade categories, reflecting increased structural and periodontal compromise.

Interestingly, the survival pattern was not strictly linear across all categories. For example, periodontitis Grade 3 lesions demonstrated higher survival than Grade 2 lesions. This observation may reflect underlying differences in case characteristics, treatment decisions, or variability related to small subgroup sizes. As such, this finding should be interpreted cautiously and may represent a sample-specific variation rather than a true clinical pattern. It also suggests that factors beyond classification alone—such as tooth-specific characteristics and patient compliance—may influence outcomes.

A key limitation of this study relates to the small sample sizes within several Herrera subgroups. Although the overall sample size exceeded the minimum threshold required for estimating survival, certain categories—such as non-periodontitis Grade 2 ($n = 6$), periodontitis Grade 2 ($n = 9$), and lesions with root damage ($n = 3$)—included very few cases. This limits the statistical power to detect meaningful differences between groups and reduces the reliability and generalizability of subgroup-specific findings. As a result, observed differences in survival across these categories should be interpreted with caution and considered as indicative of potential trends rather than definitive conclusions. This is particularly relevant when comparing categories with uneven distributions, where small changes in case numbers may disproportionately influence survival estimates.

Baseline characteristics further support a possible relationship between disease severity and outcomes. Increased probing depth, mobility, and unfavorable crown-to-root ratios were more prevalent in higher-grade lesions and are well-established risk factors for reduced tooth survival (Sanz et al., 2020). These findings reinforce the importance of comprehensive clinical assessment and align with the understanding that structural and periodontal compromise may limit long-term maintainability. Due to the small and uneven subgroup sizes, these observations are descriptive in nature and should be interpreted as exploratory rather than indicative of definitive predictive relationships.

When stratified by Herrera classification, probing depth patterns differed between groups. In non-periodontitis patients, the mean probing depth remained relatively consistent across all grades, at approximately 8 mm, suggesting that increasing lesion grade in this group may be influenced more by factors other than probing depth alone, such as structural or localized tooth-related conditions. In contrast, a clear gradient was observed in periodontitis patients, where mean probing depth increased progressively from 7 mm in Grade 1 to 9.4 mm in Grade 2 and 11 mm in Grade 3. This pattern may indicate that, in the presence of periodontitis, lesion severity more closely reflects the extent of periodontal destruction, supporting the relevance of periodontal status in driving disease progression within this classification framework.

No consistent pattern was observed between Herrera classification and periapical lesion size or the presence of a sinus tract. These findings suggest that periapical pathology may not correlate directly with periodontal severity or classification grade, reinforcing the concept that endodontic and periodontal components may progress independently in EPLs.

In contrast, crown-to-root ratio demonstrated a possible trend across groups. Periodontitis-associated Grade 2 and Grade 3 lesions appeared to exhibit more unfavorable crown-to-root ratios, whereas non-periodontitis cases in similar grades showed relatively more favorable ratios. This difference suggests that generalized periodontal breakdown in periodontitis patients contributes to greater loss of supporting bone and structural compromise, which may adversely affect prognosis. Collectively, these findings highlight that while some parameters such as probing depth and crown-to-root ratio align with disease severity, others, including periapical lesion size and sinus tract presence, may not follow predictable patterns within EPL classifications.

An important consideration in the evaluation of EPL outcomes is the distinction between endodontic and periodontal components of healing. While endodontic treatment can predictably eliminate infection and promote periapical healing, periodontal outcomes are more variable and depend on ongoing maintenance and patient-related factors. As a result, long-term prognosis is often limited not by the success of root canal treatment, but by the ability to control periodontal disease over time. This highlights the importance of integrated treatment approaches and emphasizes the role of supportive periodontal therapy in maintaining long-term outcomes (Chapple et al., 2018; Sanz et al., 2020).

Another important methodological consideration is the handling of missing outcome data. In this study, two approaches were applied: assuming unknown cases as extracted and excluding cases with unknown outcomes. These approaches produced different 4-year survival estimates (72% vs. 85%), underscoring the sensitivity of results to how missing data are managed.

Assuming unknown cases as extracted represents a more conservative approach and is likely more appropriate in this clinical context, particularly in retrospective studies where loss to follow-up may be associated with unfavorable outcomes, such as complications or eventual extraction. As such, this method may better approximate real-world clinical scenarios and reduce the risk of overestimating treatment success. However, it may underestimate true survival if some patients with retained teeth did not return for follow-up.

In contrast, excluding cases with unknown outcomes may lead to an overestimation of survival by preferentially including patients who remained engaged in care, thereby introducing selection bias. While both approaches provide useful bounds for interpretation, the more conservative estimate may offer a more clinically cautious and realistic representation of long-term outcomes.

The findings of this study also support the clinical relevance of Herrera's classification system. By incorporating both periodontal status and lesion severity, this system provides a more comprehensive framework for assessing prognosis compared to traditional etiologic classifications. This aligns with contemporary approaches in both endodontics and periodontology, which emphasize the importance of individualized treatment planning based on multiple factors (Chen et al., 2024).

Finally, the university-based setting of this study represents an additional strength. The presence of specialized departments and close collaboration between endodontic and periodontal disciplines allows for a high level of diagnostic accuracy, coordinated treatment planning, and consistent follow-up protocols. This interdisciplinary environment enhances the reliability of clinical data and supports more standardized patient management compared to non-specialized settings.

Several limitations should be considered. The retrospective design introduces potential biases related to case selection and incomplete records. The dropout rate increased over time, which may affect the accuracy of long-term survival estimates despite attempts to account for missing data. Additionally, some subgroups had small sample sizes, limiting the ability to draw definitive conclusions for those categories.

Nevertheless, the results of this study support the use of Herrera's classification as a clinically relevant framework for prognosis assessment. By incorporating periodontal status and severity, it provides a more practical approach for predicting outcomes compared to traditional classifications based solely on presumed etiology.

CONCLUSION

Within the limitations of this retrospective study, teeth with endodontic-periodontal lesions demonstrated high short-term survival following root canal treatment, but survival decreased over time. Stratification using Herrera's classification revealed significant differences in

outcomes based on periodontal status and lesion severity. Less severe lesions showed more favorable prognosis, while advanced cases exhibited reduced long-term survival.

These findings highlight the importance of considering periodontal condition and lesion severity in treatment planning and prognostic assessment, supporting the clinical applicability of Herrera's classification system in managing endodontic-periodontal lesions.

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