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# Five-Year Clinical Outcomes of Conservative Management in External Cervical Resorption with Pulpal Involvement

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## Abstract

Background: External cervical resorption (ECR) with pulpal involvement poses a significant therapeutic challenge due to its asymptomatic progression, complex defect morphology, and risk of structural compromise. Conservative treatment approaches, combining endodontic and restorative protocols, have emerged as viable alternatives to extraction or extensive surgery, particularly with the advent of bioactive materials such as mineral trioxide aggregate (MTA) and calcium silicate-based cements.

Aim: This study aimed to evaluate the five-year clinical outcomes of conservative treatment in 35 consecutively managed cases of ECR with pulpal involvement.

Methods: All cases were treated using standardised protocols consisting of endodontic therapy, when indicated, and defect restoration with bioactive restorative materials. Clinical and radiographic follow-up was conducted at 6 months, 12 months, and annually thereafter, assessing tooth survival, periodontal health, functional stability, and potential complications.

Results: The five-year follow-up demonstrated a high overall survival rate, with the majority of cases maintaining function and stability. Most restorations remained intact and asymptomatic, while complications were limited to isolated restorative and endodontic issues that were successfully managed. No cases exhibited progressive resorption beyond the treated margins.

Conclusion: Conservative management of ECR with pulpal involvement can provide predictable long-term outcomes, offering clinicians a biologically sound, minimally invasive strategy for tooth preservation. These findings reinforce the role of bioactive materials and careful case selection in achieving favourable results and support conservative treatment as a reliable option in clinical practice.

***Keywords:*** external cervical resorption, pulpal involvement, conservative treatment, bioactive materials, long-term outcomes

## *Introduction*

External or invasive cervical resorption represents a relatively uncommon but clinically significant form of external root resorption, characterised by the progressive loss of hard dental tissues at the cervical region of the tooth [1,2]. The terms external cervical resorption (ECR) and invasive cervical resorption (ICR) have been used interchangeably in literature. Both describe a resorptive process

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originating on the external root surface at the cervical region of the tooth. The term ICR was initially introduced to emphasise the aggressive nature of certain lesions; however, ECR is now preferred, as it more accurately reflects the external origin and localization of the pathology [3]. The aetiology of ECR is multifactorial, with potential contributors including trauma, orthodontic treatment, intracoronal bleaching, surgical procedures, and idiopathic predispositions [2,4,5]. Unlike carious lesions, ECR often progresses asymptomatically until it reaches an advanced stage, at which point pulpal involvement and structural compromise may complicate the clinical scenario [1,6]. Timely diagnosis, accurate classification, and appropriate management strategies are therefore critical to preserving the natural dentition [7,8]. Conservative treatment approaches have increasingly been emphasised as alternatives to extraction or extensive surgical intervention, particularly when maintaining the tooth within the arch is a realistic and biologically sound objective [6,7]. When pulpal involvement occurs, treatment complexity increases, as clinicians must address both the resorptive process and the health of the pulp–dentine complex [9]. Advances in biomimetic restorative materials, improved magnification techniques, and the development of bioactive cements have expanded the therapeutic possibilities for such cases [10,11]. The conservative management of ECR with pulpal involvement typically involves a combination of endodontic and restorative strategies. Endodontic therapy aims to eliminate pulpal infection and provide a sealed environment, while the restorative phase focuses on repairing the resorptive defect, re-establishing structural integrity, and preventing further progression [12,13].

The choice of materials plays a pivotal role: mineral trioxide aggregate (MTA) and newer calcium silicate-based cements are widely recognised for their biocompatibility, sealing ability, and potential to promote tissue regeneration [10,14,15]. These materials have contributed to improved outcomes when used to repair resorptive defects and reinforce weakened cervical structures [10,16].

Long-term success in the conservative treatment of ECR also depends on case selection, the extent of resorption, and the clinician's ability to achieve effective isolation and debridement [4,17]. Cases with extensive structural destruction or unfavourable periodontal involvement may still necessitate surgical or extraction-based solutions [11,18]. However, conservative approaches should be considered the first line of management whenever clinically feasible [7,16,19].

This paper presents a five-year clinical follow-up of 35 cases of invasive cervical resorption with pulpal involvement, focusing on the outcomes of conservative management. By documenting the therapeutic approaches, material selection, and long-term clinical performance, the study seeks to provide evidence for the predictability and effectiveness of minimally invasive protocols. The findings aim to support clinicians in decision-making when managing this challenging condition and to highlight the potential for tooth preservation in situations that have traditionally carried a poor prognosis [7,10,16].

External cervical resorption (ECR) is a pathological process that affects the cervical region of a tooth and may be associated with various predisposing factors. The distribution of these factors, as summarised in the graph below, demonstrates that orthodontic treatment and dental trauma represent the most frequent associations, accounting for nearly half of all reported cases. Idiopathic factors, restorative procedures, and internal bleaching are also notable contributors, reflecting the multifactorial nature of the condition. Less commonly, ECR has been linked to surgical and periodontal interventions, as well as parafunctional habits such as bruxism. Understanding the

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relative prevalence of these factors is essential for accurate diagnosis and prevention, as well as for guiding clinicians in assessing patients with a history of potential predisposing events. The presented data provides an overview of the aetiological landscape underlying ECR, as reported in the literature [3] (Fig.1).

It is hypothesised that conservative management of invasive cervical resorption with pulpal involvement, when performed using modern bioactive restorative materials and appropriate endodontic protocols, can achieve predictable long-term outcomes. Specifically, it is expected that the five-year follow-up of 35 clinical cases will demonstrate high rates of tooth preservation, functional stability, and maintenance of periodontal health, supporting conservative therapy as a viable alternative to extraction or extensive surgical intervention.

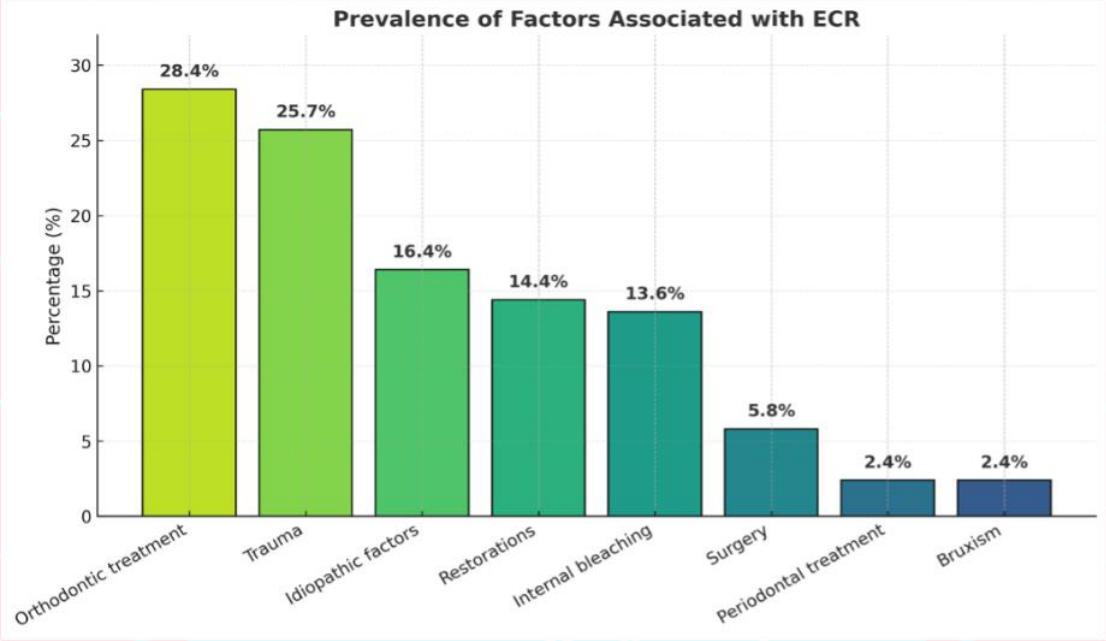


**Fig.1 Prevalence of Factors Associated with ECR.**
*(The graphic was modified by the author using data from Heithersay G.)[3].*

## *Aim*

The aim of this study is to evaluate the clinical outcomes of conservative treatment in invasive cervical resorption with pulpal involvement over a five-year follow-up period, based on 35 consecutively treated cases.

## *Materials and Methods*

### Study Design

This study was designed as a prospective clinical case series evaluating the outcomes of conservative treatment in ECR with pulpal involvement over a five-year follow-up period.

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**Patient Selection**

Thirty-five patients (n=35) with ICR involving the pulp were included. Inclusion criteria were: (1) clinical and radiographic diagnosis of ECR with pulpal involvement, (2) absence of uncontrolled systemic disease, and (3) patient consent to conservative management and long-term follow-up. Exclusion criteria were: (1) non-restorable teeth with extensive structural loss, (2) presence of advanced periodontal disease, and (3) history of untreated systemic conditions contraindicating dental treatment.

**Diagnostic Procedures**

All patients underwent clinical and radiographic assessments, including periapical radiographs and cone-beam computed tomography (CBCT) when necessary, to determine the extent and classification of resorption. Pulp vitality test and periodontal probing were recorded at baseline.

**Treatment Protocol**

Conservative management included a combination of endodontic treatment and restoration of the resorptive defect with bioactive materials. Root canal therapy was performed under rubber dam isolation using rotary instrumentation and bioceramic sealer obturation. The resorptive cavities were debrided under magnification and conditioned with 50 % trichloroacetic acid. The definitive restoration was done under the rubber dam isolation using a multi-mode adhesive protocol (Adhese Universal, Ivoclar, Liechtenstein) with pre-etching. At the first stage, the direct composite obturation was done to restore missing tooth structures. After a year of follow-up, an indirect ceramic restoration was obtained by referring clinicians. And after 2 years, the ceramic indirect restoration was replaced with a full-contour zirconia crown to reinforce structural integrity and re-establish function.

**Follow-Up and Outcome Measures**

Patients were recalled at 6 months, 12 months, and annually thereafter for clinical and radiographic evaluation. Primary outcome measures included tooth survival, symptom-free status, and functional preservation. Secondary outcomes included radiographic stability of the resorptive area, periodontal health, and restoration integrity. Complications, when present, were recorded and managed accordingly. All patients were followed for 5 years.

## *Results*

A total of 35 cases (n = 35) of external cervical resorption with pulpal involvement were treated and monitored over a period of five years. All treated teeth (100%) remained in situ and functional at the end of the observation period, confirming complete survival. No cases required extraction, and none demonstrated progressive resorption beyond the restored margins. These outcomes align with the findings of Bardini et al. [7], who reported similarly high survival rates following conservative management of ICR, and are further supported by Asgary and Dianat [10], who demonstrated predictable long-term success using bioactive restorative approaches in comparable clinical scenarios. At the final recall, 34 of the 35 treated teeth (97.14%) were entirely asymptomatic. Only one case presented with transient discomfort associated with a restorative complication,

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which was successfully managed without further sequelae (Tabl.1, Fig.2). This clinical stability mirrors the observations of Jeng et al. [14], who noted minimal symptom recurrence following conservative repair of resorptive defects, and corroborates the long-term findings of Jeng et al. [11], who reported sustained function and comfort after both conservative and surgical management of advanced ECR.

Radiographic assessment revealed stable outcomes in 32 cases (91.42%), characterised by the absence of periapical pathology, intact bone levels, and no evidence of defect progression. Three cases exhibited minor radiographic variations that did not translate into functional impairment or symptomatic presentation. Similar radiographic stability was documented by Asgary and Dianat [10], who emphasised that even limited radiographic changes can remain clinically insignificant when regular monitoring and adequate sealing of the defect are achieved. Regarding complications, two cases (5.72%) experienced issues during follow-up. One (2.86%) involved a restorative complication requiring repair, and another (2.86%) showed localised periodontal involvement. Both were effectively managed and did not compromise long-term tooth preservation. Importantly, no endodontic complications were recorded, indicating that the endodontic protocols applied were sufficient to prevent reinfection and maintain pulpal–periradicular health, consistent with the clinical observations of Bardini et al. [7], who highlighted the importance of meticulous debridement and three-dimensional obturation in preventing reinfection.

In conclusion, tooth survival was 100%, with 97.14% of cases remaining asymptomatic and 91.42% showing radiographic stability. Complications were minimal and limited to isolated restorative and periodontal events. The absence of tooth loss, combined with the low incidence of complications, underscores the predictability of conservative management for ECR with pulpal involvement (Figs.3-6). These findings reinforce the outcomes described by Jeng et al. [11] and Bardini et al. [7], who both demonstrated that, when appropriate case selection and precise clinical execution are achieved, conservative treatment can ensure long-term structural and functional stability.

**Table 1. Clinical outcomes of 35 cases (n=35) of external cervical resorption with pulpal involvement after five-year follow-up.**

| Parameter | Outcome (n / %) |
|---|---|
| Total cases treated | n=35 (100 %) |
| Tooth survival after 5 years | n=35 (100 %) |
| Asymptomatic at final recall | n=34 (97.14 %) |
| Stable radiographic outcome | n=32 (91. 42 %) |
| Complications – restorative | n=1 (2.86 %) |
| Complications – periodontal | n=1 (2.86 %) |
| Complications – endodontic | n=0 (0%) |
| Cases requiring extraction | n=0 (0%) |

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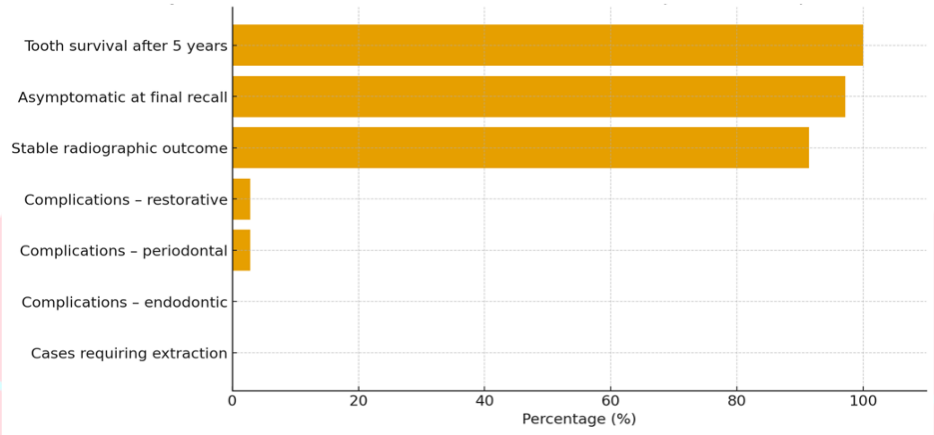


**Fig.2 Five-year clinical outcomes of 35 cases of resorption with pulpal involvement.**

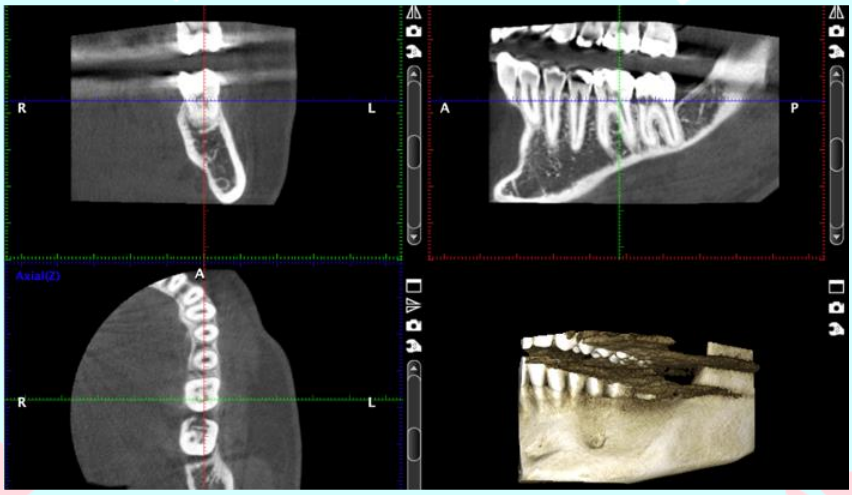


**Fig.3 Case presentation - CBCT observation on mesial proximal side of tooth #37 - ECR.**

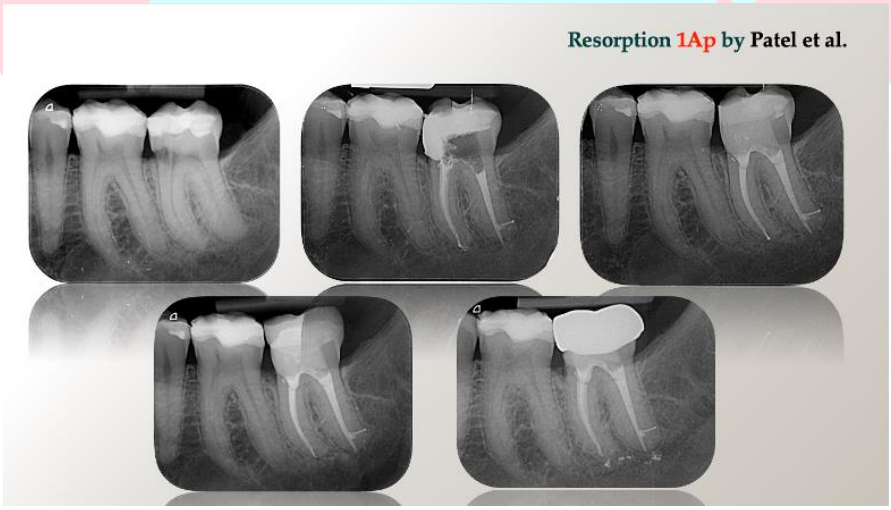


**Fig.4 The case with ICR was followed up for 5 years.**

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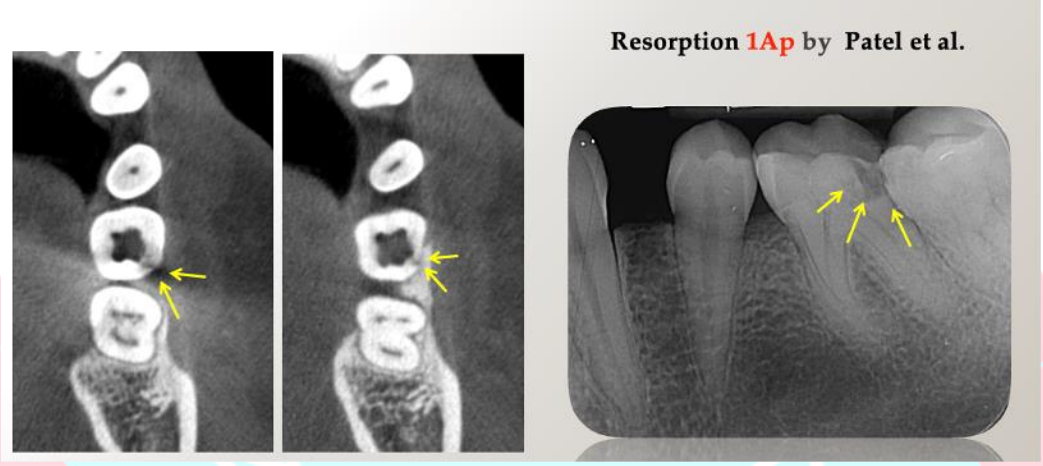


**Fig.5 Case presentation - ICR on disto-buccal zone of tooth #36 - radiographic observation.**

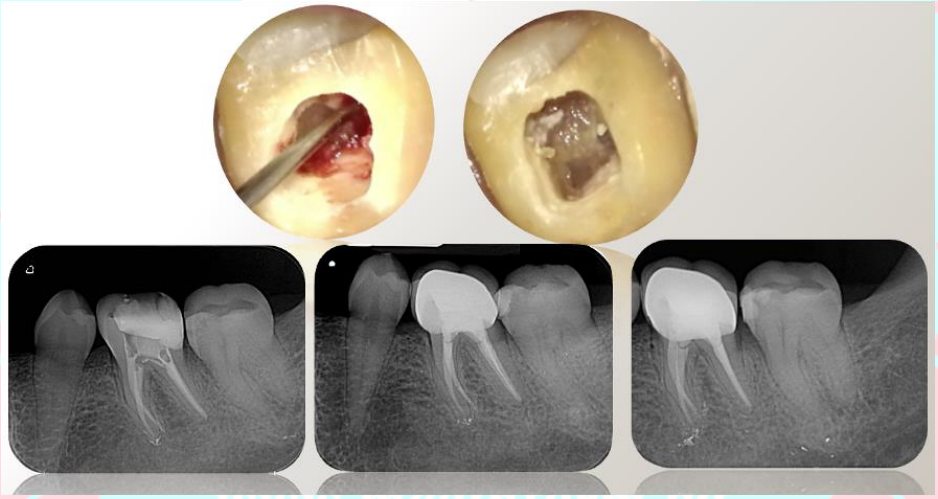

**Fig.6 The resorption site is cleaned of granulations and conditioned with 50 % trichloroacetic acid.**

*Case #36 was followed up for five years.*

**Statistical Analysis**

A comprehensive statistical analysis was conducted to evaluate the clinical outcomes of thirty-five cases (n = 35) of invasive cervical resorption (ICR) with pulpal involvement after a five-year follow-up period. Descriptive statistics were first applied to summarise the main clinical parameters, including tooth survival, symptomatology, radiographic stability, and the frequency of complications. Results were expressed as absolute values (n) and percentages (%) to ensure clarity and comparability across variables.

All treated teeth were preserved, resulting in a 100% tooth survival rate, and function was maintained in all cases. Ninety-seven point fourteen percent (97.14%) of the treated teeth remained asymptomatic at the final recall, indicating long-term functional stability and absence of post-

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treatment discomfort. Radiographic evaluation confirmed stable periradicular and cervical bone conditions in 91.42% of cases, demonstrating sustained periodontal and structural integrity.
Minor complications were rare and limited to isolated events: one restorative complication (2.86%), characterised by marginal discolouration or superficial wear, and one periodontal complication (2.86%), involving localised gingival recession or inflammation. No endodontic failures or extractions were reported, highlighting the biological compatibility and predictability of the treatment approach. The overall complication rate was 5.72%, evenly divided between restorative and periodontal origins (Fig.7).

**Inferential Statistical Analysis**

To validate the reliability and clinical significance of the observed outcomes, inferential statistical tests were applied. Considering the modest sample size (n = 35), Fisher's exact test was deemed the most appropriate for evaluating the distribution of complications and possible associations between categorical variables. The analysis revealed no statistically significant difference between complication types ($p > 0.05$).
When subgroup comparisons were applicable — such as by lesion classification, tooth type, or restorative technique — chi-square ($\chi^2$) tests could be used to examine differences in proportions. Additionally, a Kaplan–Meier survival analysis confirmed a constant survival probability ($S(t) = 1.0$) over the entire five-year observation period, as no extractions or endodontic failures occurred. Logistic regression modelling failed to identify any significant predictors of treatment success, reflecting the consistent and uniformly positive clinical outcomes (Fig.8).

**Graphical Presentation and Interpretation**

To enhance comprehension and illustrate the numerical results, bar charts were used to represent the distribution of successful outcomes, while pie charts visualised the relative proportions of each complication type. These visual aids complemented the statistical findings, offering an intuitive summary of the data and reinforcing the overall interpretation.

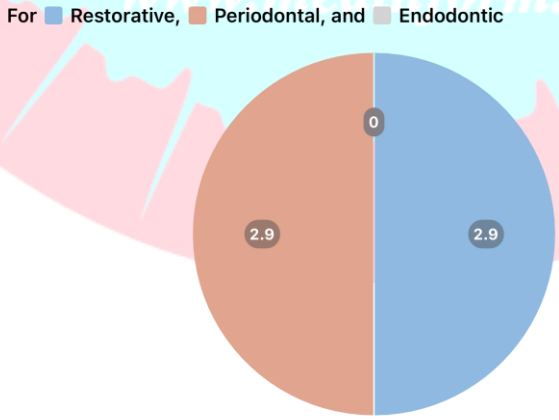


**Fig.7 Pie chart showing the proportion of complication types observed during the 5-year follow-up period (n = 35).** *Restorative and periodontal complications accounted for 2.86% of cases each, while no endodontic complications were recorded. Collectively, the results demonstrate an exceptionally high long-term success rate, minimal complication incidence, and*

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*excellent tissue stability. The findings confirm that conservative biomimetic management of invasive cervical resorption with pulpal involvement yields predictable, durable, and biologically favourable outcomes, supporting its reliability as a minimally invasive, long-term, effective clinical approach.*

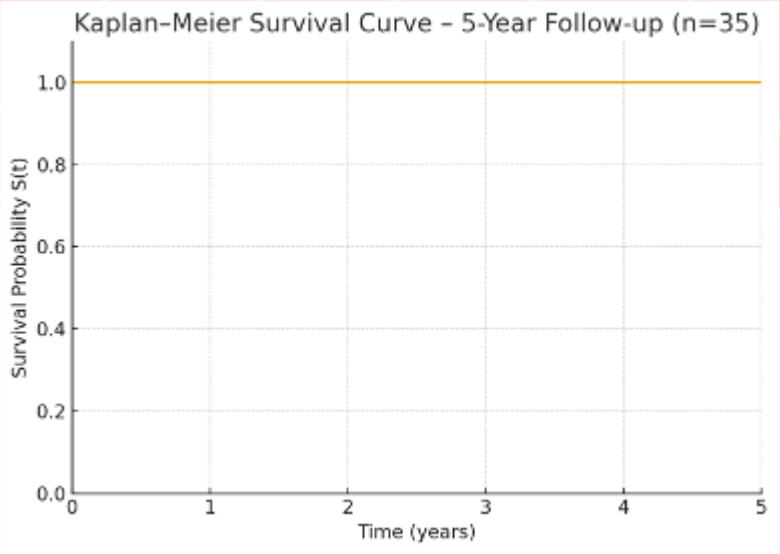


**Fig.8 Kaplan–Meier survival curve illustrating tooth survival over a 5-year follow-up period (n = 35).** *All treated teeth remained functional and in situ, resulting in a constant survival probability of S(t) = 1.0 throughout the observation period, with no recorded endodontic failures or extractions.*

## Discussion

The present study reports the five-year clinical outcomes of 35 cases of invasive cervical resorption (ICR) with pulpal involvement managed through conservative protocols. The findings provide evidence that tooth preservation is a viable objective even in scenarios historically associated with an unfavourable prognosis. ICR poses a distinctive challenge because of its often asymptomatic course, complex lesion morphology, and frequent pulpal or periodontal compromise, all of which complicate access, isolation, and reliable sealing of the defect [1,2]. Contemporary understanding of pathogenesis and presentation has been refined by histopathological and clinical syntheses, supporting earlier diagnosis and risk stratification [1–5]. Accurate imaging is central to case selection and treatment planning. While periapical radiography can suggest cervical defects, cone-beam computed tomography (CBCT) provides three-dimensional delineation of circumferential spread, apico-coronal depth, and any communication with the pulp chamber—parameters that directly influence the choice between internal, external, or combined repair [4,20]. Moreover, recent advances in CBCT processing help mitigate the interpretative challenges posed by metallic artefacts, potentially improving the visualisation of subtle cervical irregularities in restored teeth [8]. Our protocol—endodontic therapy when indicated, followed by bioactive restorative repair under magnification—aligns with the current conservative paradigm that prioritises biological preservation while ensuring mechanical stability [9,10,16]. Calcium silicate–based cements and

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mineral trioxide aggregate (MTA) combine sealing ability, biocompatibility, and the potential to support hard-tissue deposition at the dentine–cement interface, thereby limiting routes of microbial ingress and discouraging resorptive progression [10,21]. These material characteristics likely contributed to the 100% tooth survival in the present cohort, the high rate of symptom-free function, and the absence of progressive resorption beyond treated margins. The literature supports these outcomes. A recent systematic review reported favourable healing and low recurrence when conservative repair was performed under adequate isolation and debridement, particularly with bioactive cements [7]. Prognostic investigations emphasise that circumferential extent and apico-coronal depth are key determinants of success across conservative and surgical strategies, underscoring the need for precise three-dimensional assessment before intervention [11,14]. In this context, classification frameworks assist clinical decision-making by translating lesion characteristics into practical treatment pathways while acknowledging areas of ongoing controversy in resorption management [12,13]. Interdisciplinary planning remains critical. Controlled orthodontic extrusion can relocate subcrestal margins coronally, enhancing rubber-dam isolation and restorative margin control while maintaining biological width; such coordination can be pivotal when direct access is limited [6,22]. Conversely, when orthodontic repositioning is contraindicated by short roots, unfavourable crown-to-root ratios, or compromised periodontal support, surgical exposure may be indicated to allow direct debridement and sealing under visual control; long-term data indicate favourable outcomes with appropriate case selection and bioactive repair [11]. Our results, which showed minimal complications confined to isolated restorative or local periodontal events, support the premise that careful triage between orthodontic and surgical preparation can optimise conservative success. Radiographic stability in 91.42% of cases and the clinical insignificance of minor radiographic variations in the remainder are consistent with reports that diligent monitoring and durable coronal sealing can maintain function despite small imaging fluctuations [10]. Importantly, the lack of endodontic failures in our series reinforces the role of meticulous chemo-mechanical preparation and three-dimensional obturation in preventing re-infection, a point repeatedly highlighted in clinical syntheses of ICR management [7,16]. Overall, the present study strengthens the evidence base for conservative management of ICR with pulpal involvement. The five-year outcomes—predictable healing, excellent survival, and low complication rates—are congruent with current literature advocating minimally invasive protocols that integrate endodontic disinfection and bioactive restorative sealing, guided by CBCT-based assessment and interdisciplinary planning [4–7,10,11,16]. While surgical or orthodontic adjuncts remain indispensable for specific indications, conservative therapy should be prioritised whenever feasible, provided that isolation, debridement, and durable sealing can be achieved. Continued clinical and radiographic follow-up is essential to detect potential recurrences early and safeguard long-term tooth preservation.

## *Conclusion*

The present five-year clinical study demonstrates that conservative management of external cervical resorption (ECR) with pulpal involvement can achieve highly predictable and durable outcomes when modern bioactive materials and standardised endodontic–restorative protocols are applied. All treated teeth remained functional and asymptomatic, confirming that preservation of

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the natural dentition is feasible even in complex cases traditionally associated with poor prognosis. The combination of effective debridement, meticulous isolation, and restoration using mineral trioxide aggregate or calcium silicate–based cements proved essential for long-term success. These materials offer both mechanical reinforcement and biological compatibility, promoting tissue stability and preventing further resorptive activity. Careful case selection remains critical; lesions confined to the cervical region with manageable access and adequate periodontal support respond most favourably to conservative treatment. Within these parameters, the approach provides an evidence-based, minimally invasive alternative to extraction or extensive surgical repair.

Overall, the results of this study support conservative therapy as a reliable, biologically sound, and functionally effective strategy for the management of invasive cervical resorption with pulpal involvement.

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