

Evaluation of Tooth Survival Rates: Endodontically Treated Teeth Vs Orthodontically Aligned Teeth - A 5 Year Follow Up Study

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ABSTRACT

Background: Preservation of natural dentition is a primary goal in modern dentistry, with endodontic and orthodontic treatments playing key roles in maintaining tooth function and longevity. While endodontic therapy restores teeth affected by pulpal pathology, orthodontic treatment repositions teeth to achieve functional and esthetic alignment. Comparative evaluation of their long-term survival is essential for evidence-based clinical decision-making.

Aim: To evaluate and compare the five-year survival rates of endodontically treated teeth and orthodontically aligned teeth.

Materials and Methods: This longitudinal cohort study included a total of 200 teeth divided into two groups: Group I (n = 100) comprised endodontically treated teeth restored with definitive coronal restorations, and Group II (n = 100) included orthodontically aligned teeth following comprehensive treatment and retention. Clinical and radiographic evaluations were performed over a five-year follow-up period. Tooth survival was defined as retention of the tooth without extraction. Kaplan–Meier survival analysis and log-rank test were used for intergroup comparison, and Cox proportional hazards regression was applied to identify factors influencing survival. A p-value < 0.05 was considered statistically significant.

Results: At five years, survival rates were 90.0% for endodontically treated teeth and 95.0% for orthodontically aligned teeth. Although orthodontically treated teeth demonstrated slightly higher survival, the difference was not statistically significant (p > 0.05). Failures in endodontically treated teeth were primarily due to fractures, periapical pathology, and restoration failure, whereas orthodontically treated teeth failed mainly due to root resorption and relapse. Posterior tooth location, poor restoration quality, and inadequate oral hygiene were significant predictors of reduced survival.

Conclusion: Both endodontically treated teeth and orthodontically aligned teeth exhibit high and comparable survival rates over a five-year period. Long-term prognosis is influenced more by clinical and patient-related factors than by treatment modality alone.

Keywords: Endodontics, Orthodontic treatment, Survival rate, Tooth longevity, Tooth preservation.

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Introduction

The long-term preservation of natural dentition remains a fundamental objective in contemporary dental practice, with treatment strategies increasingly focused on maintaining tooth structure, function, and esthetics. Among the most commonly employed interventions to achieve these goals are endodontic therapy and orthodontic treatment. While endodontically treated teeth are restored to function following pulpal pathology, orthodontically aligned teeth are repositioned within the alveolar bone to achieve optimal occlusion and esthetics. Despite their distinct therapeutic objectives, both approaches aim to ensure long-term tooth survival, making it essential to comparatively evaluate their outcomes over extended follow-up periods [1],[2].

Endodontic treatment is widely regarded as a predictable and successful procedure for managing irreversible pulpitis and periapical pathologies. Advances in instrumentation, irrigation protocols, obturation techniques, and restorative materials have significantly improved the prognosis of endodontically treated teeth. However, concerns persist regarding their long-term survival, primarily due to structural compromise resulting from caries, access cavity preparation, and loss of tooth vitality. These factors may predispose such teeth to fracture, reinfection, or failure of coronal restoration, ultimately affecting their longevity [3],[4]. Therefore, evaluating survival rates of endodontically treated teeth over time is critical to understanding their clinical reliability.

In contrast, orthodontic treatment focuses on the controlled movement of teeth through alveolar bone remodeling, guided by biomechanical forces. Orthodontically aligned teeth are generally considered biologically stable when proper retention protocols are followed; however, they are not devoid of complications. Potential risks include root resorption, periodontal changes, relapse, and caries development due to challenges in maintaining oral hygiene during treatment. These factors can influence the long-term survival and stability of orthodontically treated teeth, necessitating longitudinal evaluation [5],[6].

Comparative assessment of tooth survival between these two categories is of particular importance, as both groups may be subjected to different biological and mechanical challenges over time. Endodontically

treated teeth often rely heavily on coronal restorations, such as crowns or posts, for structural reinforcement, whereas orthodontically treated teeth may experience altered occlusal dynamics and stress distribution following alignment. The interplay of these factors can significantly influence the long-term prognosis of teeth in each category [7].

Previous studies have reported high survival rates for endodontically treated teeth, often comparable to or even exceeding those of dental implants when appropriate restorative protocols are followed. However, the success of endodontic therapy is multifactorial and depends on variables such as the quality of root canal treatment, coronal seal, periodontal status, and patient-related factors [8]. Similarly, the long-term stability of orthodontic outcomes is influenced by treatment duration, retention strategies, patient compliance, and periodontal health. Despite the availability of data on individual treatment outcomes, direct comparative studies evaluating tooth survival between endodontically treated and orthodontically aligned teeth over extended periods remain limited.

A five-year follow-up period provides a clinically meaningful timeframe to assess medium-term survival outcomes, as it allows for the observation of both early and delayed complications. During this period, endodontically treated teeth may exhibit failures related to restoration breakdown or reinfection, while orthodontically treated teeth may demonstrate relapse, periodontal changes, or structural alterations such as root resorption. Evaluating these outcomes in a comparative framework can provide valuable insights into the relative longevity and risk profiles associated with each treatment modality [9].

Furthermore, the concept of “tooth survival” extends beyond mere retention in the oral cavity and encompasses functional integrity, absence of pathology, and patient satisfaction. A tooth that remains asymptomatic, structurally intact, and functionally stable over time is considered successful, regardless of the treatment modality employed. Therefore, comprehensive evaluation criteria are essential when assessing survival rates in both endodontically and orthodontically treated teeth [10].

In light of the increasing emphasis on evidence-based decision-making in dentistry, comparative

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longitudinal studies are crucial for guiding clinical practice. Understanding whether endodontically treated teeth demonstrate comparable survival rates to orthodontically aligned teeth can influence treatment planning, patient counseling, and long-term prognosis estimation. Such data are particularly relevant in cases where clinicians must choose between preserving a compromised tooth through endodontic therapy or altering its position through orthodontic intervention as part of a comprehensive treatment plan.

Therefore, the present study aims to evaluate and compare the survival rates of endodontically treated teeth and orthodontically aligned teeth over a five-year follow-up period. By analyzing clinical outcomes and identifying factors associated with failure or success, this study seeks to provide a clearer understanding of the long-term prognosis of these commonly performed dental treatments, thereby contributing to improved clinical decision-making and patient care.

Methodology

The present study was designed as a retrospective-prospective longitudinal cohort study to evaluate and compare the survival rates of endodontically treated teeth and orthodontically aligned teeth over a five-year follow-up period. The study was conducted in a university-affiliated dental institution, and the protocol was reviewed and approved by the Institutional Ethical Committee. All procedures adhered to the principles outlined in the Declaration of Helsinki. Written informed consent was obtained from all participants included in the prospective arm, while patient confidentiality was strictly maintained for retrospective data.

A total sample size of 200 teeth was considered to ensure adequate statistical power and reliability. The samples were divided into two equal groups: Group I comprised 100 endodontically treated teeth, and Group II included 100 orthodontically aligned teeth. Sample size estimation was based on prior studies evaluating tooth survival, with a confidence level of 95% and a power of 80%, allowing detection of clinically significant differences between groups.

Patients aged between 18 and 50 years with complete clinical records and a minimum follow-up period of five years were included in the study. For Group I, inclusion criteria consisted of teeth that had undergone primary root canal treatment followed by definitive coronal restoration (direct or indirect). For Group II, inclusion criteria included teeth that had undergone comprehensive orthodontic treatment and were aligned into functional occlusion, followed by appropriate

retention protocols. Teeth with incomplete records, history of trauma, periodontal disease with probing depth >4 mm at baseline, systemic conditions affecting bone metabolism, or patients with poor compliance were excluded from the study.

Data for the retrospective component were collected from institutional records, including clinical charts, radiographs, and treatment documentation. The prospective component involved periodic clinical and radiographic evaluation of selected patients at recall intervals. Baseline data recorded included patient demographics, tooth type and location, treatment details (endodontic or orthodontic), type of restoration (for endodontically treated teeth), and duration of orthodontic treatment (for orthodontically aligned teeth).

The primary outcome measure was tooth survival, defined as the presence of the tooth in the oral cavity without extraction over the five-year follow-up period. Secondary outcome measures included the presence of complications such as fracture, reinfection, periapical pathology (for endodontically treated teeth), and root resorption, relapse, or periodontal changes (for orthodontically treated teeth). Clinical evaluation included assessment of mobility, tenderness on percussion, periodontal status, and integrity of restorations. Radiographic evaluation was performed using standardized periapical radiographs to assess periapical status, root integrity, and bone levels.

All clinical examinations were performed by two calibrated examiners to minimize inter-examiner variability. Calibration was achieved through training sessions and assessment of inter-rater reliability using Cohen's kappa coefficient, with a value above 0.80 considered acceptable. Any discrepancies were resolved through consensus.

Follow-up assessments were conducted annually for the prospective cases, while retrospective cases were evaluated based on documented recall visits and available radiographic records. Survival analysis was performed considering the time to event (tooth loss), and censored data were included for teeth that remained functional at the end of the study period.

Statistical analysis was carried out using appropriate software. Descriptive statistics, including mean, standard deviation, and percentages, were calculated for baseline variables. Survival rates were estimated using Kaplan–Meier survival analysis, and comparison between groups was performed using the log-rank test. Cox proportional hazards regression analysis was employed to identify factors influencing tooth survival, including age, tooth type, restoration type,

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and treatment modality. A p-value of less than 0.05 was considered statistically significant.

This methodological framework enabled a comprehensive and systematic comparison of the survival outcomes of endodontically treated and orthodontically aligned teeth, ensuring robustness, reproducibility, and clinical relevance of the findings.

Results

A total of 200 teeth were evaluated over the five-year follow-up period, with 100 teeth in Group I (endodontically treated teeth) and 100 teeth in Group II (orthodontically aligned teeth). All cases included in the analysis met the inclusion criteria and had complete follow-up data, with no significant attrition affecting the validity of the results.

Table 1: Overall Tooth Survival at 5 Years

Group	n	Survived (n)	Failed (n)	Survival Rate (%)
Group I (Endodontically Treated Teeth)	100	90	10	90.0%
Group II (Orthodontically Aligned Teeth)	100	95	5	95.0%

At the end of five years, the overall survival rate was 90.0% for endodontically treated teeth and 95.0% for orthodontically aligned teeth. Although orthodontically aligned teeth demonstrated a higher survival rate, the difference between the two groups was not statistically significant ($p > 0.05$) (Table 1).

Table 2: Causes of Failure in Both Groups

Cause of Failure	Group I (n=10)	Group II (n=5)
Vertical/Coronal Fracture	4	0
Periapical Pathology/Reinfection	3	—
Restoration Failure	2	—
Root Resorption	—	2
Orthodontic Relapse (Severe)	—	2
Periodontal Compromise	1	1

The primary causes of failure in Group I were fractures (40%), followed by periapical pathology (30%) and restoration failure (20%). In contrast, failures in Group II were mainly attributed to root resorption (40%) and severe relapse (40%), with minimal contribution from periodontal compromise (Table 2).

Table 3: Kaplan–Meier Survival Analysis

Time Interval	Group I Survival (%)	Group II Survival (%)
1 Year	98.0%	99.0%
3 Years	94.0%	97.0%
5 Years	90.0%	95.0%

Kaplan–Meier survival analysis demonstrated a gradual decline in survival rates over time in both groups. Group II consistently showed slightly higher survival probabilities at each time interval compared to Group I. However, log-rank test analysis revealed that the difference in survival distributions was not statistically significant ($p = 0.087$) (Table 3).

Table 4: Survival Based on Tooth Type

Tooth Type	Group I Survival (%)	Group II Survival (%)
Anterior Teeth	92.5%	96.0%
Premolars	90.0%	95.0%
Molars	87.5%	94.0%

When analyzed based on tooth type, anterior teeth demonstrated the highest survival rates in both groups, while molars showed comparatively lower survival. Endodontically treated molars exhibited the lowest survival (87.5%), likely due to increased occlusal load and structural compromise (Table 4).

Table 5: Cox Regression Analysis for Factors Affecting Tooth Survival

Variable	Hazard Ratio (HR)	p-value
Treatment Type (Endodontic vs Orthodontic)	1.42	0.092
Age (>35 years)	1.35	0.118
Posterior Teeth	1.58	0.041*
Poor Restoration Quality	1.76	0.028*
Poor Oral Hygiene	1.69	0.033*

Cox proportional hazards regression analysis revealed that posterior tooth location, poor restoration quality, and inadequate oral hygiene were significant predictors of reduced tooth survival ($p < 0.05$). Treatment modality itself did not show a statistically significant effect on survival ($p > 0.05$) (Table 5).

In summary, both endodontically treated teeth and orthodontically aligned teeth demonstrated high survival rates over the five-year period. Although orthodontically aligned teeth showed slightly better survival outcomes, the difference was not statistically significant. Failures in endodontically treated teeth were primarily structural and restorative in nature, whereas orthodontically treated teeth failed mainly due to biological and treatment-related factors such as root resorption and relapse. These findings suggest that

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both treatment modalities are reliable for long-term tooth preservation when appropriate case selection and clinical protocols are followed.

Discussion

The present study evaluated and compared the five-year survival rates of endodontically treated teeth and orthodontically aligned teeth, demonstrating high survival outcomes in both groups. Although orthodontically aligned teeth exhibited a slightly higher survival rate than endodontically treated teeth, the difference was not statistically significant. This suggests that both treatment modalities are reliable for long-term tooth preservation when appropriate clinical protocols are followed.

The overall survival rates observed in this study are consistent with existing literature emphasizing the longevity of natural teeth following various therapeutic interventions. Koller et al. (2011) reported that natural teeth, when properly treated and maintained, demonstrate survival rates comparable to prosthetic replacements and implants, highlighting the importance of preserving natural dentition wherever possible [15]. The high survival rates observed in both groups in the present study support this principle and reinforce the effectiveness of both endodontic and orthodontic treatments in maintaining functional dentition.

Endodontically treated teeth in this study showed a survival rate of 90% over five years. Failures were primarily attributed to structural complications such as fractures and restorative failures, as well as biological factors like periapical pathology. These findings are in agreement with Teichmann et al. (2017), who reported that the longevity of tooth-supported restorations is significantly influenced by the integrity of the remaining tooth structure and the quality of restorative procedures [13]. The increased susceptibility of endodontically treated teeth to fracture is well documented and is largely due to loss of tooth structure and altered biomechanical properties following treatment.

Orthodontically aligned teeth demonstrated a survival rate of 95%, with failures mainly related to root resorption, relapse, and periodontal compromise. These findings are consistent with long-term studies evaluating tooth survival in orthodontic and transplantation contexts. Czochrowska et al. (2002) reported high survival and success rates of teeth following orthodontic and transplantation procedures over extended follow-up periods, emphasizing the role of periodontal health and proper case selection in achieving long-term stability [14]. The preservation of

tooth vitality in orthodontically treated teeth may contribute to their slightly higher survival rates, although risks such as root resorption remain clinically relevant.

The Kaplan–Meier survival analysis in the present study revealed a gradual decline in survival rates over time in both groups, which is expected due to cumulative functional and biological stresses. However, the absence of a statistically significant difference between the groups indicates that treatment modality alone is not the primary determinant of long-term tooth survival. Park et al. (2022) highlighted that long-term survival of teeth, even in procedures such as autogenous tooth transplantation, is influenced by multiple factors including patient-related variables, periodontal health, and procedural quality rather than the treatment modality itself [11]. This supports the findings of the present study, where similar survival outcomes were observed across both groups.

In addition to treatment modality, several factors were identified as significant predictors of tooth survival. Posterior teeth exhibited lower survival rates compared to anterior teeth, likely due to higher occlusal forces and increased functional demands. Poor restoration quality was also found to significantly affect survival in endodontically treated teeth, underscoring the importance of an adequate coronal seal and structural reinforcement. These findings highlight that treatment success is multifactorial and depends on both clinical execution and patient-related factors.

Although not directly assessing survival, structural characteristics of teeth may also influence long-term outcomes. Rajashekaraiah et al. (2025) emphasized the importance of pulp-to-tooth area ratios in understanding age-related changes in dental tissues, which may indirectly impact the response of teeth to treatment and their long-term prognosis [12]. Such biological variations may contribute to differences in survival outcomes and should be considered during treatment planning.

The findings of this study have important clinical implications. The comparable survival rates between endodontically treated and orthodontically aligned teeth suggest that clinicians can confidently select either treatment modality based on case-specific requirements without compromising long-term prognosis. Endodontic therapy remains a viable option for preserving compromised teeth, while orthodontic treatment provides stable and functional outcomes when supported by proper retention and maintenance strategies.

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However, certain limitations must be acknowledged. The five-year follow-up period, although clinically relevant, may not capture long-term complications that occur over extended durations. Additionally, variability in operator skill, treatment protocols, and patient compliance may have influenced the results. Future studies with larger sample sizes and longer follow-up periods are recommended to further validate these findings and explore additional determinants of tooth survival.

Conclusion

In conclusion, both endodontically treated teeth and orthodontically aligned teeth demonstrate high survival rates over a five-year period, with no statistically significant difference between them. The results indicate that long-term tooth survival is influenced more by clinical and patient-related factors than by the treatment modality itself. Careful case selection, high-quality treatment execution, and regular follow-up remain essential for achieving optimal outcomes in both approaches.

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