ORIGINAL RESEARCH

Long-Term Tooth Survival Following Furcationplasty and Tunneling in Furcation-Involved Molars: A Retrospective Cohort Study

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ABSTRACT

Background: Furcation involvement presents a significant challenge in the management of periodontitis because of the complex anatomy and limited accessibility of furcation areas. Furcationplasty and tunneling are surgical approaches intended to facilitate periodontal maintenance and preserve furcation-involved molars; however, comparative evidence regarding their long-term tooth survival remains limited.

Aim: To evaluate long-term tooth survival following furcationplasty and tunneling in furcation-involved molars and compare survival between the two treatment modalities.

Methods: This retrospective cohort study included 549 furcation-involved molars from 342 patients treated at the Department of Periodontics, Saveetha Dental College and Hospitals, Chennai, between August 2019 and January 2026. Patients had Stage II–IV periodontitis and a minimum follow-up of 12 months. Clinical periodontal parameters were evaluated longitudinally. Tooth survival was assessed using Kaplan–Meier analysis, and survival distributions were compared using the log-rank test.

Results: The mean follow-up duration was 28.54 ± 10.85 months, with a median of 28 months (IQR, 19–38; range, 12–48 months). Both groups demonstrated significant reductions in PPD and improvements in CAL during follow-up ($p < 0.001$). A total of 187 extraction events occurred, comprising 103 among 301 furcationplasty-treated teeth and 84 among 248 tunneling-treated teeth. Kaplan–Meier analysis demonstrated no significant difference in survival between the groups (log-rank $\chi^2 = 0.225$, $p = 0.635$).

Conclusion: Both furcationplasty and tunneling were associated with improved periodontal clinical parameters, with no significant difference in long-term tooth survival between the treatment modalities. Both approaches may therefore be considered viable options for appropriately selected furcation-involved molars.

Keywords: Diabetes, Disease, Furcation Defects, Health, Molar, Periodontal Disease, Tooth Loss

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Introduction

Periodontitis is a complex chronic inflammatory disease of multifactorial etiology, initiated by a dysbiotic dental biofilm and modulated by host immune, genetic, systemic, and environmental factors, resulting in the progressive destruction of the tooth-supporting tissues, including the periodontal ligament, cementum, and alveolar bone [1 2]. If left untreated, it may result in clinical attachment loss, tooth mobility, and ultimately tooth loss, adversely affecting oral function, aesthetics, and quality of life [3 4]. Contemporary periodontal therapy aims not only to arrest disease progression but also to preserve the natural dentition, thereby maintaining optimal oral function, aesthetics, and quality of life [5].

Furcation involvement is one of the most challenging clinical manifestations of periodontitis in multirooted teeth and is recognised as an important determinant of long-term tooth prognosis [6]. The intricate anatomy of the furcation region, characterised by root trunk morphology, root divergence, root concavities, and limited accessibility for instrumentation, compromises effective plaque control and root surface debridement [7]. Consequently, furcation-involved molars exhibit greater periodontal destruction, increased treatment complexity, and a higher risk of disease progression and tooth loss than non-furcation-involved teeth [8].

The management of furcation defects remains clinically demanding and requires treatment strategies tailored to the severity of the defect, anatomical characteristics, and patient-related factors. Various therapeutic approaches have been advocated, including nonsurgical periodontal therapy, open flap debridement, odontoplasty, regenerative procedures using bone grafts and barrier membranes, root resection, hemisection, tunneling procedures, and furcationplasty [9]. Hamp et al. (1975) described furcation plasty as raising a mucoperiosteal flap to provide access to the furcation area and combining SRP,

osteoplasty, and odontoplasty to remove local irritants and open the furcation to allow the patient access to clean and maintain the area [7]. The result should be a firm, well-contoured papilla to cover the inter-radicular space. Recommended for Grade I and early Grade II lesions. Whereas tunnel preparation is the surgical exposure of the furcation, which is indicated for advanced Grade II and III lesions in which resection is not possible [10]. It requires roots that are long and divergent and is generally indicated for the mandibular molars. It often fails because of decay in the furcation area.

Previous studies have demonstrated that the long-term prognosis of furcation-involved molars is influenced by a combination of patient- and tooth-related factors, including the severity of furcation involvement, probing pocket depth, clinical attachment loss, tooth mobility, smoking, diabetes mellitus, and adherence to supportive periodontal therapy[10,11] . Although regenerative approaches have been extensively investigated for the management of furcation defects [12], resective procedures such as furcationplasty and tunneling remain important treatment options for selected cases. However, the long-term survival of furcation-involved molars following these procedures remains variable, and comparative evidence regarding their clinical outcomes and tooth retention is limited.

Furcationplasty aims to modify the furcation anatomy to improve access for periodontal debridement and facilitate plaque control, whereas tunneling involves surgical preparation of the furcation area to create a cleansable passage through the furcation, particularly in appropriately selected advanced furcation defects [7]. Although retrospective studies have evaluated the survival of furcation-involved molars and outcomes following individual treatment modalities [13], relatively limited evidence is available regarding the long-term tooth survival of molars treated specifically with furcationplasty and tunneling within the same study population. Furthermore, evidence from South Asian populations remains limited, despite potential differences in disease presentation, oral hygiene practices, treatment patterns, and adherence to supportive periodontal therapy.

Long-term tooth survival is an important clinical outcome because preservation of the natural dentition remains a primary objective of periodontal therapy. Evaluating the survival of furcation-involved molars following different surgical approaches may provide clinically relevant information for treatment planning and case selection, particularly when extraction or more extensive regenerative or resective procedures are being considered [14 15].

Therefore, the present retrospective cohort study aimed to evaluate the long-term tooth survival of furcation-involved molars following furcationplasty and tunneling procedures and to compare the survival distributions between the two treatment modalities. Secondary objectives were to evaluate changes in clinical periodontal parameters during follow-up.

Materials and Methods

Study Design and Setting

This retrospective cohort study was conducted in the Department of Periodontics, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences (SIMATS), Chennai, India. Clinical records of patients treated between August 2019 and January 2026 were retrospectively reviewed to evaluate the long-term clinical outcomes of furcationplasty and tunneling procedures performed for the management of furcation-involved molars.

Patient Selection

A total of 549 teeth from 342 patients were included in the study. Electronic and archived patient records were screened for eligibility. Patients aged 18 years or older diagnosed with Stage II–IV periodontitis according to the 2017 World Workshop classification who had undergone furcationplasty or tunneling procedures for the management of furcation-involved molars were considered eligible for inclusion. Patients were required to have completed active periodontal therapy and attended a minimum follow-up period of 12 months, with longer follow-up durations included whenever available. Only patients with complete baseline and follow-up periodontal records were included in the final analysis.

Patients with systemic conditions known to adversely affect periodontal wound healing (unless specifically included for analysis), pregnant or lactating women, incomplete clinical records, teeth presenting with vertical root fractures, teeth extracted for reasons unrelated to periodontal disease (including extensive caries, prosthodontic treatment planning, or trauma), and patients who failed to complete the minimum follow-up period were excluded from the study.

Patient information was extracted from the institutional electronic database and archived case records using a standardised data collection form. Demographic variables included age, sex, smoking status, diabetes mellitus, and compliance with supportive periodontal therapy. Tooth-related periodontal variables included probing pocket depth (PPD), clinical attachment level (CAL), bleeding on probing (BOP), plaque index (PI), tooth mobility, at baseline and follow-up. Treatment-related variables included the furcation procedure performed (furcationplasty or tunneling), adjunctive periodontal therapy, and maintenance recall interval. The primary outcome was long-term tooth survival following treatment, while secondary outcomes included longitudinal changes in PPD and CAL.

Statistical Analysis

Statistical analysis was performed using IBM SPSS Statistics 23 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. Baseline differences between the furcationplasty and tunneling groups were assessed using the independent-samples *t*-test for continuous variables and the chi-square test or Fisher's exact test for categorical variables, as appropriate. Changes in clinical periodontal parameters over the follow-up period were assessed using repeated-measures analysis. Tooth survival was evaluated using Kaplan–Meier survival analysis, with periodontal tooth extraction considered the event and teeth remaining present at the last available follow-up considered censored observations. Survival distributions between the furcationplasty and tunneling groups were compared using the log-rank (Mantel–Cox) test. A two-sided p value < 0.05 was considered statistically significant.

Results

A total of 342 patients contributing 549 furcation-involved molars were included in the study. The mean age of the study population was 46.1 ± 10.3 years. Of the study population, 203 patients (59.3%) were male and 139 (40.6%) were female. Smoking was reported in 52 patients (15.2%), while 41 patients (12.0%) had diabetes mellitus. Regular maintenance therapy was reported in 208 patients (60.8%).

Table 1: Baseline demographic and patient-related characteristics of the study population

Variable	Total patients (n=342)
Age (years)	46.1 ± 10.3
Male	203 (59.3%)
Female	139(40.6%)
Smokers	52 (15.2%)
Diabetes	41(12%)
Regular maintenance	208 (60.8%)

At baseline, the mean probing pocket depth (PPD) was significantly lower in the furcationplasty group (6.8 ± 0.9 mm) compared with the tunneling group (7.1 ± 1.0 mm; $p = 0.012$) (Table 2). No statistically significant differences were observed in clinical attachment level (CAL) (7.2 ± 1.3 vs. 7.4 ± 1.2 mm; $p = 0.228$), plaque index (1.82 ± 0.43 vs. 1.91 ± 0.45; $p = 0.086$), or bleeding on probing (91.2% vs. 93.4%; $p = 0.341$). However, the mean mobility score was significantly higher in the tunneling group (1.44 ± 0.68) than in the furcationplasty group (1.28 ± 0.61; $p = 0.021$).

Table 2: Baseline comparison of periodontal clinical parameters in furcation-involved molars treated with furcationplasty and tunneling

Variable	Furcationplasty	Tunneling	p-value
PPD (mm)	6.8 ± 0.9	7.1 ± 1.0	0.012
CAL (mm)	7.2 ± 1.3	7.4 ± 1.2	0.228
PI	1.82 ± 0.43	1.91 ± 0.45	0.086
BOP (%)	91.2	93.4	0.341
Mobility score	1.28 ± 0.61	1.44 ± 0.68	0.021

Both treatment groups demonstrated significant improvements in periodontal parameters during follow-up (Table 3). In the furcationplasty group, mean PPD decreased from 6.8 ± 0.9 mm at baseline to 4.5 ± 0.7 mm at 6 months, 3.9 ± 0.6 mm at 12 months, and 3.8 ± 0.6 mm at final follow-up ($p < 0.001$). In the tunneling group, PPD decreased from 7.1 ± 1.0 mm at baseline to 5.2 ± 0.8 mm at 6 months, 4.8 ± 0.7 mm at 12 months, and 4.7 ± 0.7 mm at final follow-up ($p < 0.001$).

Similarly, both groups demonstrated significant improvements in CAL over the follow-up period. In the furcationplasty group, CAL changed from 7.2 ± 1.3 mm at baseline to 5.9 ± 1.1 mm at 6 months, 5.3 ± 1.0 mm at 12 months, and 5.2 ± 1.0 mm at final follow-up ($p < 0.001$). In the tunneling group, CAL changed from 7.4 ± 1.2 mm at baseline to 6.5 ± 1.0 mm at 6 months, 6.0 ± 0.9 mm at 12 months, and 5.9 ± 0.9 mm at final follow-up ($p < 0.001$).

Table 3: Longitudinal changes in probing pocket depth and clinical attachment level following furcationplasty and tunneling (p-values represent within-group changes over time based on repeated-measures analysis)

Parameter	Baseline	6 Months	12 Months	Final Follow-up	p-value
PPD (Furcationplasty)	6.8 ± 0.9	4.5 ± 0.7	3.9 ± 0.6	3.8 ± 0.6	<0.001
PPD (Tunneling)	7.1 ± 1.0	5.2 ± 0.8	4.8 ± 0.7	4.7 ± 0.7	<0.001
CAL (Furcationplasty)	7.2 ± 1.3	5.9 ± 1.1	5.3 ± 1.0	5.2 ± 1.0	<0.001
CAL (Tunneling)	7.4 ± 1.2	6.5 ± 1.0	6.0 ± 0.9	5.9 ± 0.9	<0.001

The mean follow-up duration was 28.54 ± 10.85 months, with a median of 28 months (Inter Quartile Range, 19–38 months; range, 12–48 months). During the observation period, 187 extraction events were recorded among the 549 treated teeth (Table 4). Of these, 103 extractions occurred among 301 furcationplasty-treated teeth, while 84 occurred among 248 tunneling-treated teeth. A total of 362 teeth were censored, including 198 teeth (65.8%) in the furcationplasty group and 164 teeth (66.1%) in the tunneling group. Overall, 65.9% of observations were censored.

Kaplan–Meier survival analysis demonstrated broadly comparable survival patterns between the furcationplasty and tunneling groups throughout the follow-up period, as illustrated in Figure 1. The log-rank test showed no statistically significant difference in survival distributions between the two treatment modalities ($\chi^2 = 0.225$, df = 1, $p = 0.635$). Thus, no significant difference in long-term tooth survival was observed between teeth treated with furcationplasty and those treated with tunneling.

Table 4: Kaplan–Meier survival analysis showing extraction events and censored observations following furcationplasty and tunneling

Procedure	Total teeth	Extraction events	Censored	Censored %
Furcationplasty	301	103	198	65.8%
Tunneling	248	84	164	66.1%
Overall	549	187	362	65.9%

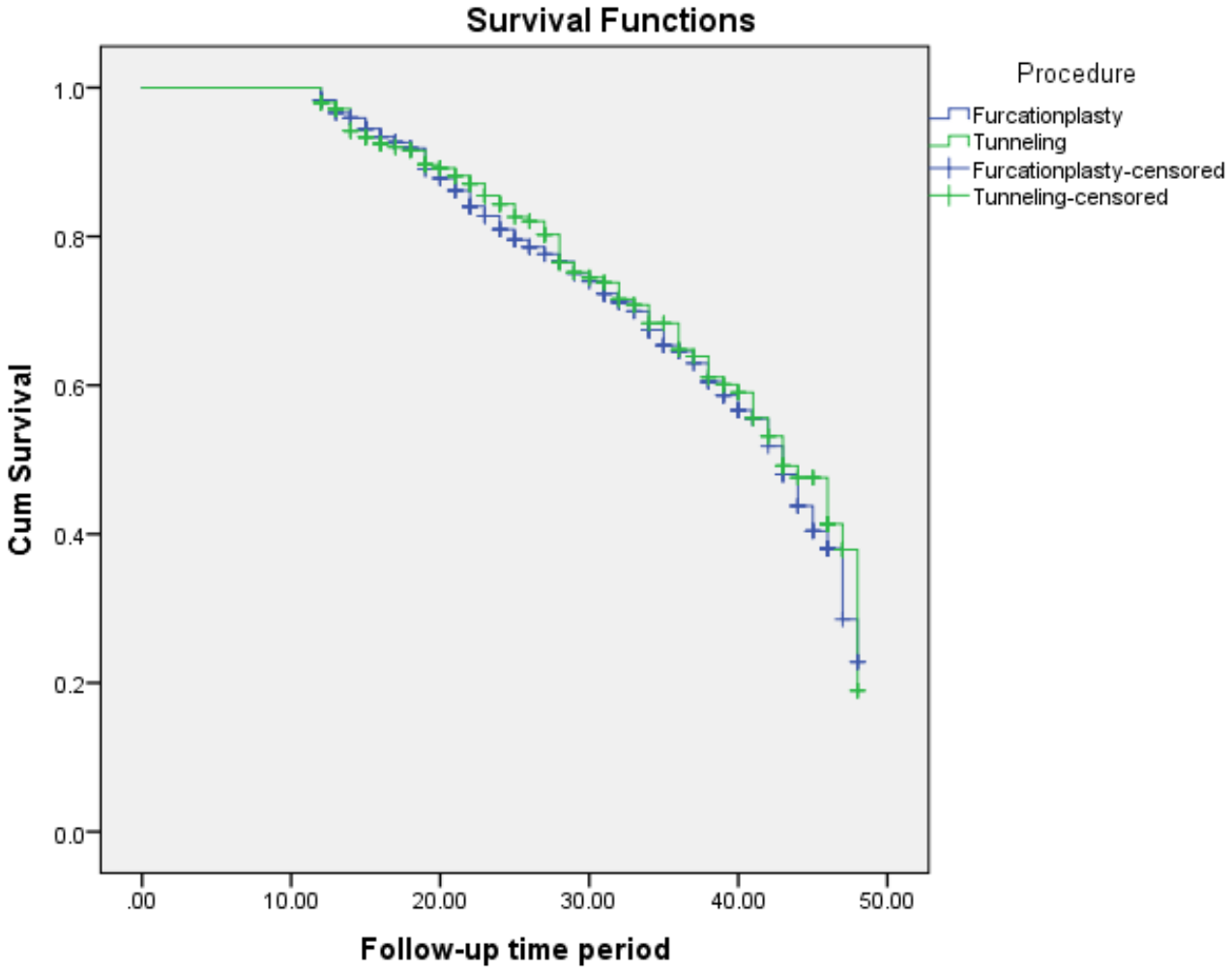

Figure 1: Kaplan–Meier survival curves for furcation-involved molars treated with furcationplasty and tunneling

Discussion

Furcation involvement represents a major therapeutic challenge in the management of periodontitis because the complex root anatomy and restricted accessibility of the furcation area may compromise effective debridement and long-term plaque control. The present retrospective cohort study evaluated the long-term survival of 549 furcation-involved molars from 342 patients treated with either furcationplasty or tunneling, with a median follow-up of 28 months. The principal finding was that no statistically significant difference in tooth survival was observed between the two treatment modalities (log-rank $\chi^2 = 0.225$, $p = 0.635$). Both groups also demonstrated significant improvements in PPD and CAL during follow-up. These findings are consistent with the broader literature suggesting that several treatment approaches can successfully maintain furcation-involved molars, while evidence for the superiority of one specific surgical approach remains limited.

The finding of comparable survival between furcationplasty and tunneling is particularly relevant because previous evidence has demonstrated considerable variability in the long-term survival of furcation-involved teeth treated by different surgical approaches. Huynh-Ba et al., in a systematic review of 22 longitudinal studies, reported survival ranges of 42.9–92.9% for tunneling procedures over 5–8 years, while survival following other surgical approaches ranged widely depending on the procedure and duration of follow-up[16].

More recently, a systematic review specifically evaluating resective surgery for class II and III furcation involvement included 2,021 teeth and reported survival ranges of 62–67% for tunneling procedures[15]. Importantly, the review concluded that there was insufficient evidence to demonstrate clinically relevant differences in tooth survival between tunneling, root separation/resection, open-flap debridement, and scaling and root planing. The absence of a significant difference between furcationplasty and tunneling in the present study therefore broadly agrees with the existing evidence that the choice of a particular surgical approach may not, by itself, determine long-term tooth survival.

Nibali et al. followed 102 surgically tunnelled molars for an average of approximately 7 years and reported tooth loss in 29.4% of the treated molars[17]. Importantly, irregular supportive periodontal therapy and increasing age were significantly associated with tooth loss, and tooth loss occurred predominantly among patients who did not participate regularly in supportive therapy. Another prospective five-year study reported that 69% of tunnelled molars remained functional after five years, with smoking, bleeding on probing, and the presence of a mucogingival problem associated with increased risk of tooth loss [18]. In the present study, 84 of 248 tunneling-treated teeth experienced extraction during a median follow-up of 28 months. Although the proportion of extraction events appears higher than that reported in some longer-term tunneling cohorts, direct numerical comparison should be made cautiously because follow-up duration, patient characteristics, furcation severity, maintenance protocols, and definitions of treatment success differed substantially among studies. The relatively shorter median follow-up in the present study may also contribute to differences in observed survival estimates.

The importance of supportive periodontal therapy is further supported by the broader literature. A systematic review and meta-analysis by Nibali et al. found that furcation involvement was associated with an increasing risk of molar tooth loss during supportive periodontal therapy, particularly with increasing severity of furcation involvement [19]. Similarly, a recent large

retrospective cohort involving 543 class II furcation-involved teeth reported that 83% of teeth were retained over approximately nine years of supportive periodontal care, while irregular supportive care and other tooth-related factors were associated with poorer prognosis [20]. These observations reinforce the importance of maintenance therapy when interpreting the long-term survival of surgically treated furcation-involved teeth.

An important finding in the present study was that both furcationplasty and tunneling were associated with significant improvements in PPD and CAL. Following furcationplasty, mean PPD decreased from 6.8 ± 0.9 mm to 3.8 ± 0.6 mm at final follow-up, while the tunneling group demonstrated a reduction from 7.1 ± 1.0 mm to 4.7 ± 0.7 mm. Similarly, CAL improved from 7.2 ± 1.3 to 5.2 ± 1.0 mm following furcationplasty and from 7.4 ± 1.2 to 5.9 ± 0.9 mm following tunneling. These findings are consistent with earlier clinical investigations showing improvement in periodontal parameters following furcation-directed surgical therapy.

The improvement observed following furcationplasty may be related to its fundamental therapeutic objective of modifying the furcation anatomy to improve accessibility and facilitate plaque control. Tunneling follows a different anatomical principle by creating a cleansable passage through the furcation. Although the techniques differ, both ultimately attempt to convert a difficult-to-maintain furcation environment into an anatomy that is more accessible to professional instrumentation and patient-performed plaque control. The comparable survival observed in the present study may therefore indicate that successful long-term maintenance of the treated furcation, rather than the surgical technique alone, may be an important determinant of tooth preservation.

Interestingly, the tunneling group had significantly greater baseline PPD and tooth mobility than the furcationplasty group. Mean PPD was 7.1 ± 1.0 mm versus 6.8 ± 0.9 mm, while mobility was 1.44 ± 0.68 versus 1.28 ± 0.61, respectively. These findings may reflect differences in the clinical characteristics of teeth selected for each procedure. Tunneling is generally reserved for advanced furcation defects in teeth with suitable root anatomy, whereas furcationplasty is more commonly performed when anatomical modification can establish a maintainable furcation environment[7]. Therefore, the absence of a significant survival difference despite somewhat greater baseline periodontal compromise in the tunneling group should be interpreted cautiously, but it may suggest that appropriate case selection can allow both approaches to achieve acceptable tooth retention.

The survival findings should also be considered in the context of previous evidence demonstrating that furcation involvement itself does not necessarily make a molar hopeless. Nibali et al. reported that the risk of tooth loss increases with the severity of furcation involvement, but also concluded that most molars with furcation involvement respond favorably to periodontal therapy [19]. Likewise, large registry-based data have demonstrated that deeper furcation involvement is associated with increased risk of molar loss, but the decline in survival following detection of deep furcation involvement was relatively modest [21]. These findings support the clinical principle that furcation-involved molars should not automatically be considered candidates for extraction and replacement when periodontal therapy can establish a maintainable tooth.

The present study therefore contributes to the existing evidence by providing a direct comparison of furcationplasty and tunneling within the same retrospective cohort. Previous systematic reviews have largely pooled heterogeneous treatment approaches and have highlighted the lack of adequately controlled comparative evidence [15]. The current study included 549 treated molars from 342 patients and used Kaplan–Meier analysis to account for variable observation periods and censored observations. Although no significant survival difference was identified, the findings provide clinically relevant evidence that both furcation-directed approaches may be considered viable options when appropriately selected.

Limitations

Several limitations should be acknowledged. First, the retrospective design introduces the possibility of selection bias because treatment allocation was determined clinically rather than randomly. Second, the treatment groups were not completely comparable at baseline, with significant differences in PPD and mobility. Third, the study was conducted at a single periodontal centre, which may limit generalisability. Fourth, the median follow-up was 28 months, although individual observations extended to 48 months; longer follow-up would be necessary to establish very long-term survival. Fifth, multiple teeth were contributed by some patients, meaning that tooth-level observations may not be statistically independent because teeth within the same patient share patient-level characteristics. Finally, the present analysis focused on tooth survival and longitudinal PPD and CAL, and did not incorporate a multivariable prognostic model; therefore, the study cannot establish independent predictors of tooth loss.

Conclusion

In the present retrospective cohort, both furcationplasty and tunneling were associated with significant improvements in periodontal clinical parameters, while no statistically significant difference in long-term tooth survival was observed between the two procedures. These findings support the use of either approach in appropriately selected furcation-involved molars, with treatment selection guided by anatomical characteristics, periodontal status, and the feasibility of long-term maintenance rather than by the surgical modality alone.

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