Multivariate Outcome Evaluation of Furcation-Involved Molars Treated with Non-Surgical Mechanical Therapy Alone or Combined with Open Flap Debridement: A Retrospective Study

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Conflict of interest

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One sentence summary: Non-surgical and surgical debridement improves furcation involved molars retention and clinical outcomes, especially in shallow horizontal and vertical components.

Keywords: supportive periodontal therapy, molar, periodontitis, furcation defect, tooth loss

Author Contributions

J.M., L.T., S.B., HL. W, and H-L. C contributed to the conception and design of the work. J.M., L.T., and S.B. collected the data; A.S. analyzed the data; J.M. and A.S. designed the schematic illustrations and J.M., HL.W., and H-L. C led the writing.

Abstract

Aim: This retrospective study assessed the effect of non-surgical and surgical mechanical therapy for furcation-involved molars.

Materials and methods: Furcation defects treated and followed for at least one year were selected. Data relative to the clinical outcomes were recorded. The immediate (3-6 month) clinical outcomes and the long-term survival of the treated molars were assessed. The potential variables influencing the treatment outcomes through multi-level regression analysis, and Cox Proportional-Hazards Models were also analyzed.

Results: 184 molars were included with an average follow-up of 7.52 years. At the 3-6 month re-evaluation 1.39 ± 0.99 mm pocket depth reduction, 0.88 ± 1.29 mm clinical attachment gain, and a 0.51 ± 1.13 mm increase in recession was observed. The 5- and 10-year survival rates were 88.3% and 61.3%, respectively. The horizontal and vertical extent of furcation involvement, baseline probing depth, mucoperiosteal flap elevation, and the frequency of supportive periodontal therapy influenced the clinical outcomes and tooth survival.

Conclusion: Non-surgical and surgical mechanical root debridement is a viable treatment for the management of furcation involved molars with shallow horizontal and vertical components.

1. Introduction

Furcation involvement (FI) has been classified as one of the most important factors determining the complexity of periodontitis in molars[1]. If left untreated, the FI will disseminate in a horizontal pattern towards the interior part of the furcation [2], as well as in a vertical orientation directed to the apices of the roots [3], rendering this area challenging to clean during home-care [4, 5], and increasing the risk of tooth loss [6].

Several strategies have been proposed for the treatment of FI teeth, including but not limited to non-surgical and surgical mechanical debridement, root amputation, tunneling, and regeneration [7-10]. However, these treatments have their limitations, such as tooth decay after root

amputation or tunneling procedures [9, 11], or unpredictable guided tissue regeneration (GTR) treatment outcome [12-15].

Numerous studies have investigated the long-term effect of mechanical debridement for FI teeth. Nibali and colleagues conducted a systematic review on studies that performed active periodontal therapy (APT) followed by a period of supportive periodontal therapy (SPT) and found that FI doubles the risk of tooth loss for molars 10-15 years after [16]. Hirschfeld & Wasserman reported that in patients undergoing APT and followed for a period of 22 years of SPT, 7.1% of the overall included teeth were lost, whereas 31% of FI teeth were not successfully maintained and had to be extracted [17]. While some studies established that FI highly affects tooth survival [18-20], others found that the horizontal or vertical degree of periodontal tissue loss in the furcation area were a better predictor for the survival of FI teeth. When properly treated, FI teeth with less horizontal or vertical involvement had a similar risk of tooth loss when compared to teeth without FI [21-23].

Although many studies have evaluated the long-term survival of furcation involved teeth treated with non-surgical and surgical mechanical debridement (APT phase), followed by SPT [22, 24, 25], few studies have focused on the clinical outcomes of FI teeth following the APT phase. Nonetheless, evaluating the success of APT is crucial, since a successful APT is essential for long-term maintenance of dentition during SPT [25, 26]. In addition, factors that influence the change in clinical outcome following APT (e.g. the furcation defects morphology and baseline clinical parameters, etc.), as well as the overall survival of treated FI molars are essential information to obtain [17, 27].

Therefore, the aims of this study were to evaluate the clinical outcomes and survival of furcation-involved molars treated with non-surgical and surgical mechanical debridement, and to assess potential factors affecting the outcomes.

2. Materials and methods

2.1. Study design

The current investigation was designed according to the principles presented in the Helsinki Declaration of 1975, as revised in 2000 for biomedical research involving human patients. The study was approved by the Institutional Review Board for Human Studies, School of Dentistry, University of

Michigan, Ann Arbor, MI, (HUM00186895) to be conducted at the Department of Periodontology and Oral Medicine within the same institution.

This retrospective study selected all patients that had undergone APT, including non-surgical (scaling and root planing [SRP]) or surgical (open flap debridement [OFD]) mechanical debridement (excluding resective or regenerative treatment) for furcation defects followed by SPT in the time period between January 1980 and December 2018 at the University of Michigan School of Dentistry, Ann Arbor, MI. All paper files and digital charts of patients with furcation involved teeth treated with non-surgical or surgical mechanical debridement were carefully scanned and analyzed by two independent and pre-calibrated investigators as part of previous studies (JM, LT). At every stage, after examining the gathered data, in case of a disagreement, discussion was held by the two reviewers to reach a consensus. If resolution was not possible, a senior author (either HLW or H-LC) was consulted, and their decision was decisive. As no patients were treated as a direct result of this research, the study required no additional informed consent for the included patients. The current research was prepared in compliance with the STROBE guidelines (see Supplementary Table 1 in online Journal of Periodontology).

2.2 Study population

The present study included patients that had at least one tooth with a furcation defect on either a first or second molar undergoing a phase of APT, including non-surgical (SRP) or surgical (OFD) mechanical debridement followed by a SPT phase (a minimum of 1 SPT/year). To be included in the present study, all subject records must have had at least 1-year of follow-up following the APT completion and must have complete clinical and radiographic data records.

For all the included population, the baseline data was considered as the data collected prior to the APT phase. APT consisted of oral hygiene instructions followed by supra- and sub-gingival SRP. Following SRP, all patients presented for a re-evaluation appointment (4-6 weeks) during which it was determined whether further surgical therapy, i.e., OFD, was needed. OFD was then undergone when required. Mild tooth recontouring (odontoplasty) was also performed when necessary. Patients that received other surgical treatments such as regenerative therapy, tunneling procedures, root or osseous resection, or tooth extraction were excluded from the study. In addition, molars having more than one furcation defect (e.g., an upper molar having both buccal and mesio-palatal

furcation involvement) were excluded from the study, and only molars with one isolated furcation defect were included (through and through Degree 3 FI were considered as a single furcation defect). Finally, furcation involved premolars were also excluded.

2.3 Data collection and Classification

The following information were obtained for all qualified patients**: 1)** patient-related factors (age and gender) **; 2)** medical history (including documentation of smoking and diabetes); **3)** location of the treated defect (mandible/maxilla – buccal/lingual, mid-facial/mesio-palatal/disto-palatal); **4)** clinical parameters of the furcation defect: probing depth (PD), gingival recession (REC), clinical attachment level (CAL) and horizontal FI at baseline and at the 3-6 months re-evaluation appointment; 5) type of intervention during APT (SRP/ OFD); **6)** odontoplasty (yes/no); **7)** follow-up time (until tooth extraction or last maintenance appointment); **8)** SPT frequency; **9)** baseline and 1-year follow-up radiographs; **10)** endodontic or restorative treatment of the tooth.

2.4. Study outcomes: The study outcomes were as follows:

2.4.1 Survival: The primary outcome of this study was to evaluate the survival of the treated teeth. Tooth survival was assessed according to the Kaplan-Meier method. The final follow-up of any treated tooth was the last recorded appointment at the University of Michigan, School of Dentistry. A tooth was considered lost if it was extracted due to periodontal reasons (inadequate periodontal tissue support, tooth mobility, suppuration, periodontal abscess). This decision was made by the periodontal resident and approved by a faculty member when the tooth was given a hopeless prognosis [28]. If a tooth was extracted for any other reasons (decayed, fractured, endodontic, or prosthodontic reasons), this tooth was excluded from the analysis. However, teeth that were extracted as a result of combined tooth decay and periodontal disease were included. Additionally, the effect of the recorded variables on the treated teeth was assessed for their potential effect on tooth retention/survival.

2.4.2 Clinical outcomes of APT: The changes in the clinical parameters (PD, CAL, REC) were compared from baseline to the 3-6 months re-evaluation appointment. Additionally, the influence of other recorded variables was assessed on the changes in clinical parameters.

2.4.3 The effect of non-surgical and surgical mechanical debridement on the vertical and horizontal components of the furcation defects:

The vertical furcation classification was determined from peri-apical radiographs that were collected at baseline and one year (12 ± 3 months) following the surgery according to Tonetti et al. 2017 [22]. Briefly, the vertical component was calculated by one investigator (JM) and was based on the amount of bone loss in the furcation defect, Class A was designated when bone loss reached the coronal third (<33%) of the furcation region, Class B was when the bone loss reached the middle third (33%–67%) of the furcation region, and Class C was assigned when the bone loss reached the apical third >67%) of the furcation region [29]. The investigator (JM) performed the first 15 vertical furcation component measurements twice. The values obtained at baseline were then compared to the values obtained from radiographs taken at the 1-year follow-up. and based on the Cohen's weighted kappa, the reliability assessment of the two columns was 0.901 (95 CI [0.829, 0.973]). The horizontal classification of the furcation was based on assessment with the use of a Naber's probe ǂ as extracted from clinical records [2]. Briefly, this was measured based on horizontal probe penetration in the furcation region of a multirooted tooth; Degree 1 was assigned when the horizontal loss of periodontal tissue support was < 3 mm; Degree 2 was assigned when there was a horizontal loss of support that had ≥ 3 mm but not the total width of the furcation area; and Degree 3 was assigned when a horizontal through-and-through destruction of the periodontal tissue in the furcation area had been observed [2]. The values obtained at baseline were then compared to the values obtained at the 3-6 months post-surgical re-evaluation appointment.

2.5. Data management and Statistical analysis

Descriptive statistics were carried out and reported as frequencies and percentages for categorical variables and as means (±) standard deviation (SD) for continuous outcomes. The

changes in clinical parameters: CAL, PD, and REC from baseline to the 3-6 months re-evaluation appointment were assessed with dependent *t*-tests.

Mixed-effects uni- and multi-level regression analyses were achieved to identify predictive factors for CAL, PD, and REC at the 3-6 months re-evaluation appointment. Kaplan-Meier survival probabilities were calculated, and the curves for the entire follow-up period were subsequently plotted.

Multi-variate Cox Proportional Hazard models were used for assessing correlations between independent variables and tooth loss, accounting for the fact that an individual may have attributed to multiple treated furcation defects (shared frailty was accounted for by including random effects).

Step-wise regression analyses were performed using likelihood ratio tests. Hazard ratios (HR) and corresponding 95% confidence intervals (CI) were generated. All analyses were performed by a separate investigator (AS) using SPSS (IBM Corp. Released 2019, SPSS Statistics for Windows Version 26.0, Armonk, NY). The plots were generated using Origin software (OriginPro, Version 2019b. OriginLab Corporation, Northampton, MA, USA) and Rstudio (Version 1.1.383, RStudio, Inc., Boston, Massachusetts, USA), the survminer [30], survival [31], and ggplot2 [32] packages. The level of significance was set at $P < 0.05$ for all statistical testing.

Cohen's weighted kappa was performed to assess the reliability of the two set of measurements performed for the vertical furcation involvement component.

3.Results

3.1. Study population

A total of 158 patients [(78 Males and 80 Females), mean age: 49 ± 13.79 years, 55 smokers, 22 controlled type II diabetics] with 184 treated furcation defects were included in this study (Supplementary Figure 1). Out of these furcation defects, 140 were treated only with non-surgical mechanical debridement (SRP), and 44 were treated with SRP followed by surgical mechanical debridement (28 with OFD alone, and 16 with OFD and odontoplasty). The mean follow-up for the selected cases was 7.52 ± 4.05 years. During the follow-up, the average SPT visits for the included

patients was 3.07 ± 0.88 times per year. The characteristics of the subject sample at baseline are summarized in Supplementary Table 2.

3.2. Survival analysis

From baseline until the final follow-up appointment (7.52 ± 4.05 years), 64 teeth in 62 patients were lost. The 5- and 10-year FI tooth survival rates were 88.3% and 61.3%, respectively. Figure 1 demonstrates the survival curves of the treated molars, and the life table analysis which present the number of followed, censored, and extracted teeth per year of follow-up (Supplementary Table 3).

Results from the multivariate model of the multi-level cox proportional hazard models evaluating the influence of potential variables on FI tooth survival demonstrated that when compared to Degree 1 FI, Degree 2 FI (2.368 (95% CI [1.151, 4.874], p= 0.019)), and Degree 3 FI (9.094 (95% CI [2.998, 27.585], p< 0.001)), negatively affected the survival of the treated molars. In addition, when the PD, CAL and restorative treatment factors were excluded from the multivariate model, Class C FI had a higher chance of tooth loss when compared to Class A (2.907 (95% CI [1.565, 5.401], p= 0.001, (Supplementary Table 4). However, the patients that attained more SPT had less risk for tooth loss (0.456 (95% CI [0.319, 0.653], p<0.001)). Visual representation comparing the survival curves of teeth with a different horizontal and vertical extent of FI are presented in Figure 2. The odds ratios (OR) and 95% confidence intervals (CI) of tooth loss are presented in Table 1. Comparison of the survival of upper versus lower molars based on the extent of their horizontal and vertical furcation involvement is shown in Supplementary Table 5.

3.3. Clinical outcomes

At baseline, 45.16% of sites presented with BOP, a mean PD of 4.90 ± 1.16 mm, REC of 0.46 ± 0.59 mm, and CAL of 5.36 ± 1.02 mm. At the 3-6 months re-evaluation appointment, the BOP decreased to 23.11%, an average of 1.39 ± 0.99 mm PD reduction, and 0.88 ± 1.29 mm of CAL gain were observed. In addition, an increase of 0.51 ± 1.13 mm in REC was also noted. All the clinical parameter changes were statistically significant (p< 0.001). When comparing teeth receiving SRP to teeth receiving OFD, a non-statistically significant CAL gain (0.89 ± 1.19 mm for SRP and 0.84 ± 1.57

mm for OFD, p= 0.862) and PD reduction (1.27 ± 0.87 mm for SRP and 1.75 ± 1.22 mm for OFD, p= 0.019) were observed. On the other hand, a statistically significant more pronounced REC was observed in the OFD group (0.39 ± 0.72 mm for SRP and 0.91 ± 0.94 mm for OFD, p= 0.001).

3.4. Factors affecting the clinical outcomes

The results from the uni- and multi-variate analysis on CAP, PD and REC are presented in Table 2.

3.4.1 Clinical attachment level change (2A):

A multivariate analysis evaluating the predictors of CAL gain found that the degree of horizontal and vertical furcation involvement highly influenced the levels of CAL gain. In fact, Degree 2 FI (-1.022 (95% CI[(-1.327, -0.716], p< 0.001), Degree 3 FI (-1.787 (95% CI[-2.184, -1.391], p< 0.001) and Class C FI (-1.277 (95% CI[-1.654, -0.899], p< 0.001) were all associated with lower levels of CAL gain.

3.4.2 Pocket depth changes (2B):

When examining the potential factors affecting the levels of PD reduction, multivariate analysis revealed FI teeth with deeper initial PD (0.225 (95% CI [0.042, 0.408], p= 0.016) had significantly higher PD reduction. On the other hand, teeth with Class C (-0.665 (95% CI[-0.976, -0.353], p< 0.001), Degree 2 (-0.968 (95% CI[-1.210, -0.727], p< 0.001), and Degree 3 (-1.082 (95% CI[-1.389, -0.774], p< 0.001) had lower levels of PD reduction.

3.4.3 Recession depth changes (2C):

In assessing the effect of different variables on REC of the treated defects, patients that had open flap debridement had higher levels of recession (0.416 (95% CI [0.146, 0.686], p= 0.003). Teeth presenting with higher levels of PD (0.311 (95% CI [0.157, 0.465], p< 0.001), Class C (0.803 (95% CI[0.542, 1.064], p< 0.001) and Degree 3 (0.830 (95% CI [0.591, 1.069], p< 0.001) FI were also associated with more REC at the 3-6 months re-evaluation appointment.

3.4.4 The effect of furcation defect's horizontal and vertical components on the clinical outcomes

Results from the Kruskal-Wallis test showed that when dividing the treated furcation defects based on their merged extent of horizontal and vertical involvement, molars with minimal horizontal involvement (Degree 1) and lower vertical involvement (Class A and B) had the most CAL gain with minimal REC. In general, molars with Degree 2 FI did not witness major changes in CAL. It was clear, however, that FI teeth that presented with extensive periodontal tissue loss horizontally and vertically (Degree 3 and Class C, respectfully) had lower levels of CAL gain, mainly as a consequence of high levels of REC (Figure 3).

In terms of change in the horizontal and vertical extent of FI, out of 82 teeth presenting initially with a Degree 1 FI, 75 remained Degree 1, 6 became Degree 2, and one case turned out to be Degree 3 at the 3-6 months re-evaluation appointment. Most of the teeth that were diagnosed with Degree 2 (58 out of 68) remained the same; four improved to Degree 1 and six defects converted to Degree 3. Finally, all the teeth that presented with Degree 3 FI remained with the same horizontal extend of FI.

Results from the Cohen's weighted kappa showed that the reliability assessment of the two set of vertical furcation involvement component measurements was 0.901 (95 CI [0.829, 0.973]). When the change in the vertical component of FI was evaluated, we found that out of 97 teeth presenting with Class A FI, 85 teeth maintained the same status, 11 worsened to Class B, and one tooth was diagnosed with Class C one year following APT intervention. Class B FI teeth mostly remained the same (52 out of 57 teeth) and worsened to become Class C in 5 FI teeth. All teeth presenting with a Class C FI remained mostly unchanged after one year (Figure 3).

4. Discussion

The present investigation assessed patients with furcation involved molars undergoing APT (SRP or OFD) for an average of 7 years.

This study focused on the clinical parameter changes and the factors affecting the success of APT. We believe that knowing these factors are of great clinical interests. Despite that the clinical

parameters recorded before and after APT, both did not seem to influence tooth survival in our multivariate analysis, it seemed in the univariate analysis that CAL and PD obtained following APT (at the 3-6 months re-evaluation appointment) had a significant influence on tooth survival, in contrast to baseline CAL and PD that did not significantly affect tooth survival. This signifies that a successful APT leading to CAL gain and PD reduction might actually prolong the dentition lifespan, and highlights the importance of efficacious APT. Our results found that a statistically significant CAL gain of 0.88 ± 1.29 mm, PD reduction of 1.39 ± 0.99 mm, and REC increase of 0.51 ± 1.13 mm occurred at the 3-6 months re-evaluation appointment. This finding is in line with other studies evaluating the effect of surgical and non-surgical mechanical root debridement. In fact, Graziani and colleagues, in a systematic review and meta-analysis assessing randomized clinical trials that evaluated the effect of OFD on Degree 2 FI found 0.55 mm CAL gain, 1.38 mm PD reduction, and a 0.73 mm increase in REC six months following the treatment [33]. Similarly, Dannewitz and colleagues assessed the effect of non-surgical instrumentation of furcation sites with and without doxycycline and reported a CAL gain of 0.85 mm and a PD reduction of 0.9 mm 6 months following SRP in their control group [34]. In fact, FI molars have shown to respond less favorably to SRP compared to non FI molars[35, 36]. Interestingly, these changes are comparable to those obtained with GTR of FI teeth [12, 13, 37].

When analyzing the effect of mucoperiosteal flap reflection (SRP versus OFD), we found that flap refection did not significantly affect PD reduction or CAL gain but only increased the chance of gingival recession. This might be due to tissue injury resulting from the surgical separation of the sulcular/pocket epithelium and gingival connective tissue fibers from the tooth [38, 39]. Finally, molars that presented with higher levels of initial PD had more PD reduction at the re-evaluation appointment. This finding might mainly be due to a higher level of gingival recession experienced in these cases.

FI has been widely established as a risk factor for tooth loss [24, 25, 40-42]. In fact, FI is one of the most important factors determining the periodontal prognosis of molar teeth.[43]. Therefore, the primary outcome of the present study was the survival of the treated furcation-involved molars. Results from the present study observed survival rates of 88.3% and 61.3% for molars treated with non-surgical/ surgical mechanical debridement at 5, and 10 years, respectively. In a previous report we conducted on the effect of GTR on FI teeth, we observed survival rates of 86.5% and 74.3% for the GTR treated molars at 5, and 10 years, respectively [13]. In this sense, it seems that GTR does not affect the short-term survival of FI teeth but increases the long-term survival of the treated teeth

when compared to mechanical root debridement. In the current study, tooth survival was highly impacted by the average SPT appointment during study period. In fact, teeth that were extracted had received less SPT visits (2.55 ± 0.85 appointments/year for the lost teeth versus 3.33 ± 0.77 for the teeth that were maintained in the oral cavity).

Perhaps another factor that influences molar tooth survival clinical outcomes, was the furcation defect morphology. Furcation defects with a Class C vertical component or a Degree 2 and 3 horizontal components experienced less CAL gain and PD reduction at the 3-6 months re-evaluation appointment (Tables 2 and 3). In addition, furcation defects with a severe horizontal and vertical extent of periodontal destruction (Degree 3 and Class C) had significantly more REC when compared to shallower defects (Table 4). When the clinical outcomes were assessed based on the combined horizontal and vertical extent of furcation involvement, we observed that Type 1-A and 1-B FI were the defects responded the most favorably to APT (CAL gain average: 1.7 to 2 mm). Our results are in line with the literature; in fact, according to the reports by the American Academy of Periodontology Regeneration Workshop [44, 45], Degree 1 furcation defects are usually successfully treated with non-regenerative therapy. Nonetheless, we recommend diagnosing FI based on their horizontal as well as vertical extent of periodontal tissue destruction. Type 2-A and 2-B FI seem to respond less to APT. Histological proof of periodontal regeneration were most observed in teeth with Degree 2 FI, especially with GTR [45-48]. This could be attributed to the containment of the space in Degree 2 FI defects, where more than 3 mm of horizontal space is available to contain bone graft that is packed against a bony wall and could then be covered with a membrane to provide a high level of stability [15]. Our data also showed that Degree 3 FI responded poorly to the treatment; root resection and tunneling procedures have been recommended in treating these defects when patients' oral hygiene and tooth anatomy are favorable [9, 14, 49]. Finally, the treatment also failed to benefit furcation defects with a deep vertical bony component (Class C). Other treatment options such as extraction, alveolar ridge preservation, and implant placement might be considered for these defects. These findings emphasize the value of understanding the three-dimensional anatomy of the furcation defect in order to establish the correct treatment option for managing this condition.

Moreover, when the survival of the treated FI teeth was compared based on their horizontal or vertical extent of involvement, the Kaplan-Meier analysis clearly showed the positive association between tooth loss and the horizontal degree of involvement (Figure 2A). When assessing the FI

teeth based on their vertical component, we observed that teeth with Class C FI had a higher chance of tooth loss when compared to Class A and B (which had similar survival rates up to 11 years). However, Class A had significantly higher survival rates when compared to Class B in the longer-term (Figure 2B). Identifying a strong relationship between the extent of horizontal/ vertical furcation involvement and the risk of tooth loss from this study is in agreement with a recent study [23]. In this study, the authors examined 633 FI molars undergoing SPT regularly and reported that FI molars with severe horizontal and vertical components had poor long-term tooth survival rate [23]. Thus, the horizontal and vertical defect components are critical aspects when assigning a prognosis to molar teeth with FI.

Among the limitations of this study are the retrospective nature of this project, and the absence of a standardized protocol for the radiographic assessment, which would have increased the reliability and precision of our measurements. It has been shown that there is a tendency to under- or over-estimate the amount of bone loss when evaluating two-dimensional radiographs [50]. In addition, when assessing the radiographic vertical component of maxillary molar furcation defects, the presence of a third palatal root could potentially lead to a less reliable diagnosis when compared to mandibular furcation defects [23]. The unequal and relatively reduced sample size of the defects, particularly in some of the subclassifications, may limit the ability to generalize our results. Furthermore, it may be possible that due to the true clinical nature some defects, molas with a combined defect may have been under looked. Additionally, the notion that all patients had been from the same patient pool of a university setting and had received varieties of SPT regimen (some sporadic and minimal as low as 1 SPT/year), may limit the generalizability of our findings and its external validity, therefore we deem necessary future investigations to corroborate our results.

Conclusion

Our study is not free of limitations as mentioned above. However, It can be concluded that non-surgical and surgical mechanical root debridement were viable treatments for managing teeth with

shallow furcation defects, particularly for teeth with Degree 1 and Class A/B furcation defects. Factors such as supportive periodontal therapy frequency, as well as the horizontal and vertical extent of involvement significantly affected the survival of FI teeth undergoing maintenance therapy.

Footnotes

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Conflict of interest and source of funding

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Figures and Tables:

Figures

Figure 1. Kaplan-Meier survival curve for the entire follow-up period. Each event represents a tooth loss.

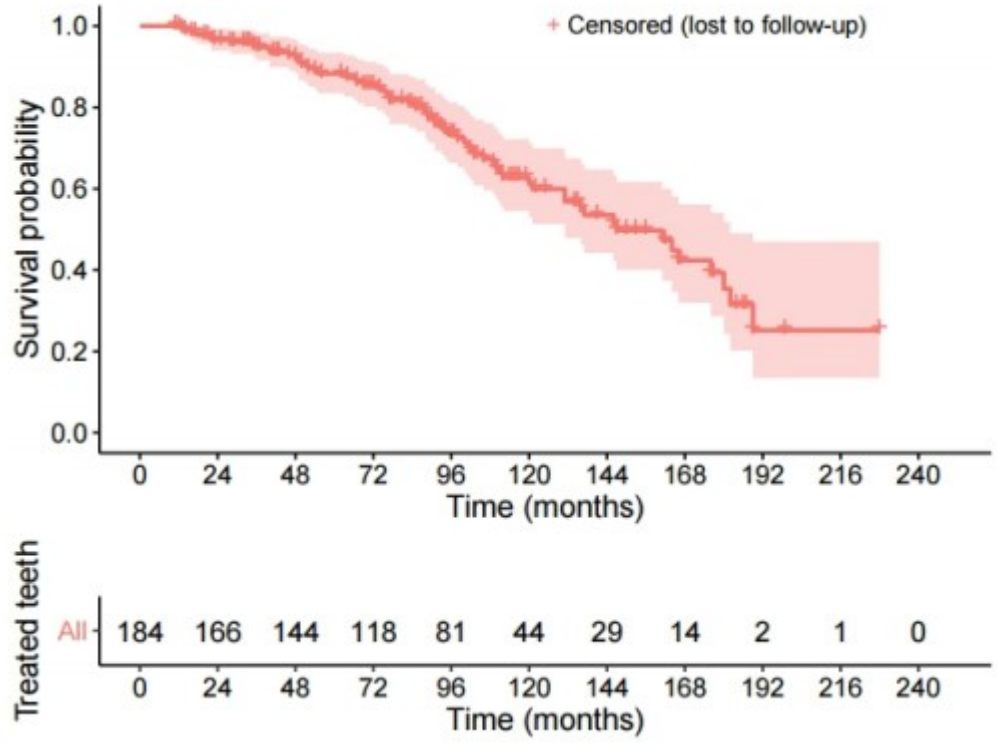


Figure 2. Kaplan-Meier survival curves displaying: **A)** the comparison between Degree 1, 2 and 3 horizontal extent of furcation involvement; **B)** the comparison between Class A, B and C vertical extend of furcation involvement. Event = Tooth loss.

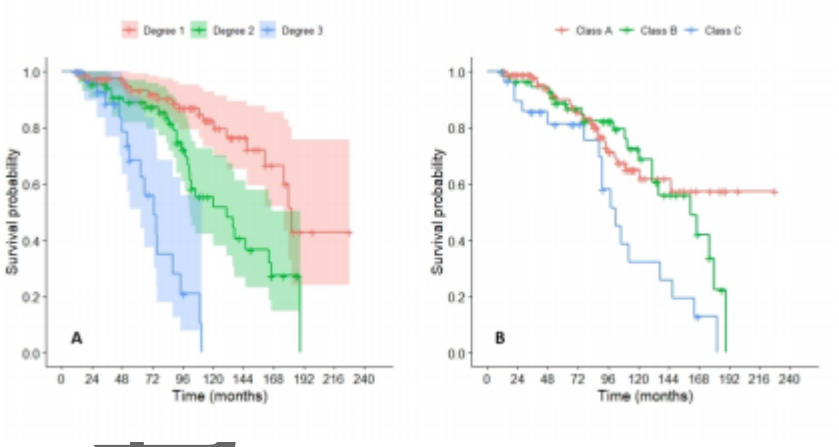
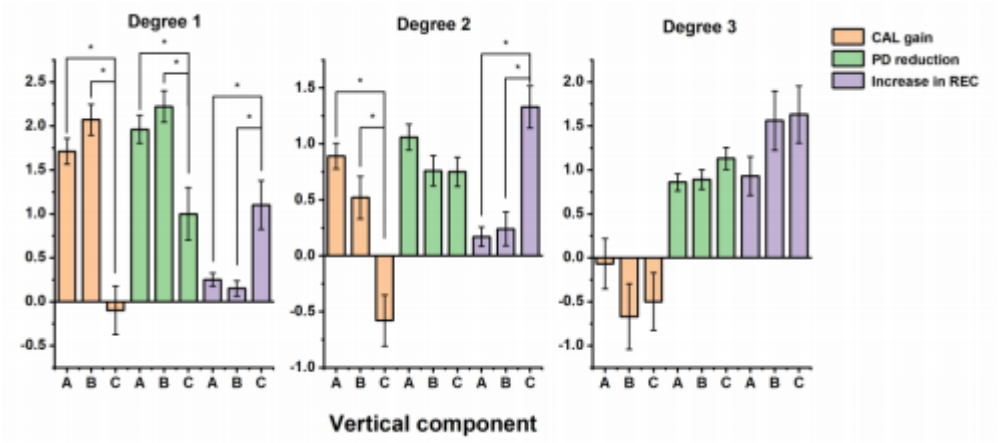


Figure 3. Horizontal (Degree 1, 2, and 3) and Vertical (Class A, B, and C) component dependent clinical measure changes at the 3-6 months re-evaluation appointment. The difference from the values obtained with vertical furcation component C are statistically significant (*).



Supplementary Figure 1. Flowchart diagram displaying the patient file screening process leading to the final inclusion of the selected patients.

Tables

Table 1. Results of the multi-level cox proportional hazard models evaluating the effect of different variables on the survival of the treated teeth.

Table 2. Results of the regression models evaluating the effect of different variables on the CALs (A), REC (B) and PD (C) of the treated defects at the 3-6 months re-evaluation appointment.

Supplementary Table 1. STROBE Statement

Supplementary Table 2. Characteristics of the included patients and defects at baseline.

Supplementary Table 3. Life table descriptively summarizing the survival probabilities according to the Kaplan-Meier analysis. Survival estimations for the 5- and 10- year timepoints have been lightly shaded in grey.

Supplementary Table 4. Results of the multi-level cox proportional hazard models evaluating the effect of different variables (excluding the clinical parameters) on the survival of the treated teeth.

Supplementary Table 5. Table comparing the survival of upper *versus* lower molars based on the extent of their horizontal and vertical furcation involvement