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Furcation involvement and tooth loss - A registry-based retrospective cohort study

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Abstract

Aim: This registry-based retrospective cohort study aimed to evaluate the impact of furcation status on the risk for molar loss.

Material and methods: Subjects with and without furcation involvement (FI) in 2010/2011 were identified in a nationwide registry in Sweden (age- and gender-matched sample: 381,450 subjects, 2,374,883 molars). Data on dental and periodontal status were extracted for the subsequent 10-year period. Impact of FI (at baseline or detected during follow-up) on molar loss (i.e. tooth extraction) was evaluated through multilevel logistic regression and survival analyses.

Results: FI had a significant impact on molar loss. FI degree 2 and 3 resulted in adjusted risk ratios of 1.67 (95%CI 1.63-1.71) and 3.30 (95%CI 3.18-3.43), respectively. Following first detection of deep FI (degree 2-3), estimated survival decreased by 4% at 5 years and 8% at 10 years. In addition to FI, endodontic status and probing depth were relevant risk factors for molar loss.

Conclusions: Furcation status had a clinically relevant impact on the risk for molar loss. Following first detection of deep FI, however, the decline in molar survival was minor.

Keywords: Periodontitis, Molar, Furcation Defects, Registries

1. Introduction

An individualized approach to dental and periodontal care requires a detailed understanding of factors relevant for future events. In an attempt to predict tooth survival over long-term periods, multiple prognostic tools have been developed and validated in selected populations (e.g. Martinez-Canut et al., 2018; McGuire & Nunn, 1996; Nibali, Sun, et al., 2017). Among tooth-related parameters, furcation status has been identified as a highly relevant factor. The available evidence, however, originates from studies performed on small populations followed in specialist care (e.g. Graetz et al., 2015; Nibali et al., 2018; Salvi et al., 2014). Corresponding assessments in large populations with high external validity are lacking.

Healthcare registries offer the possibility to study onset and patterns of disease on a population level. Sweden has a number of such registries, which, through their high degree of completeness, have enabled successful observational (e.g. Petrie et al., 2016) and interventional (e.g. Frobert et al., 2013) research. In the dental field, the Swedish Quality Registry for Caries and Periodontal diseases (SKaPa) contains data on the dental status of approximately 50% of the Swedish adult population (von Bültzingslöwen et al., 2019). Data from 2010 and onwards are available and the registry currently includes 7.4 million subjects (SKaPa, 2021). As prognostic assessments require long-term data preferably originating from large patient samples, a registry-based approach is justified. Using SKaPa, this study aimed to evaluate the impact of furcation status on the risk for molar loss.

2. Material and methods

The protocol of the present registry-based retrospective cohort study was approved by the Swedish Ethical Review Authority (Dnr 2020-02822). STROBE guidelines (von Elm et al., 2007) were followed in the reporting.

Study population

The Swedish Quality Registry for Caries and Periodontal diseases (SKaPa) was utilized to identify two cohorts. The search and subsequent data extraction from the registry were performed in September 2020 by a professional data analyst.

- Group A: 130,297 subjects representing all subjects (aged 25 to 85 years) with ≥1 furcation-involved molar tooth (furcation involvement class I-III; Hamp, Nyman, and Lindhe (1975)) registered in 2010/2011.
- Group B: 251,153 subjects representing a random selection (through generation of random numbers) of individuals with at least one registered periodontal examination in 2010/2011 (matched with Group A for age and gender at group level; ratio 2:1) with ≥1 remaining molar and no furcation involvement in 2010/2011. The background population consisted of 1,474,775 eligible individuals. Group B was further subcategorized according to the presence of "periodontal pocketing" (≥2 teeth with probing pocket depth ≥6 mm) into B1 (no periodontal pocketing; N=223,020) and B2 (periodontal pocketing; N= 28,133).

Eligibility criteria are summarized in Table A-1. Third molars were not considered for the present study.

Data extraction

At subject level, information on age, gender (legal rather than biological sex), number of teeth and teeth with periodontal pocketing (≥6 mm) was obtained from the registry at baseline

(2010/2011) for both groups. For each upper/lower first and second molar, parameters related to restorative, endodontic and periodontal status were extracted for the period January 2010 to December 2020 on an annual basis. The outcome "tooth loss" (i.e. tooth extraction) was registered once the tooth was recorded as either missing or replaced by implant, bridge pontic or removable prosthesis. Year of tooth loss was scored. Periodontal information included probing pocket depth (PPD; deepest site per tooth) and degree/location of furcation involvement (FI; scored as 0-3).

Sample description

Details on the study sample (381,450 subjects; 2,374,883 molars) at baseline (2010/2011) are provided in Tables 1 & 2. In short, half of the subjects were >60 years of age and the mean number of teeth was approximately 24. The proportion of subjects with ≥25 teeth was slightly larger in group B when compared to group A (65.5% versus 57.6%). "Periodontal pocketing" was more frequent in group A when compared to group B (33.5% of patients versus 11.2%). The majority of molars was restored (75.3%) and only a minority was endodontically treated (1.8%). In total, 82.7% had no FI (FI 0), 11.6% had, at worst, a FI 1, 4.7% a FI 2 and 1.0% a FI 3. Regardless of degree, FI was most frequently recorded at buccal aspects (Table A-2). PPD at baseline increased with increasing degree of FI.

Data analysis

At subject level (unit of analysis: patient), loss of any molar (up to 2018-2020) was compared between groups A, B1 and B2, using logistic regression analysis (outcome: loss of any molar between baseline 2010-2011 and endpoint 2018-2020; effect measure: odds ratio; function: *logit*). The model was adjusted for age, gender, and number of remaining teeth/molars.

At molar level (unit of analysis: tooth), three different approaches were applied. First, we used a multilevel mixed-effects logistic regression analysis (*Tooth level analysis*; lower level:

tooth; higher level: subject; outcome: tooth loss between baseline 2010-2011 and endpoint 2018-2020; effect measure: odds ratio; using the function *melogit*) to evaluate the relevance of baseline FI (2010/2011; worst site per tooth) for the risk of tooth loss up to 2018-2020. For this, only subjects with a registration in SKaPa during 2018-2020 were considered. The model was adjusted for covariates (fixed effects) at the molar level (molar position, PPD by category and restorative/endodontic status) and the patient level (age, gender, number of remaining teeth and number of teeth with PPD ≥6 mm) (random effects: patient). Potential interaction between relevant covariates was explored. We also performed subgroup analyses according to categories of age, number of teeth and number of teeth with periodontal pocketing. Second, a multilevel parametric survival model (*Baseline FI Survival model*; lower level: tooth; higher level: subject; outcome: tooth loss; effect measure: hazard ratio; using the function *mestreg*) was built to illustrate the effect of deep baseline FI (degree 2 or 3) on molar loss, adjusting for factors identified as significant in the *Tooth level analysis* (PPD by category, endodontic/restorative status, age, number of teeth and number of teeth with periodontal pocketing). Third, we evaluated the effect of newly detected deep FI (degree 2 or 3) on the risk of loss of a previously non-involved molar (*New FI Survival model*; lower level: tooth; higher level: subject; outcome: tooth loss; effect measure: hazard ratio; using the function *mestreg*). For this, only molars with FI 0-1 in 2010/2011 were selected and the detection of a deep FI was treated as a time-varying covariate. Additional covariates were PPD by category, endodontic/restorative status (at baseline and time of furcation detection) as well as age, number of teeth and number of teeth with periodontal pocketing (at baseline).

All analyses were performed in Stata (Stata SE version 17.0, StataCorp LLC, Texas, USA). Outcomes were reported as adjusted odds ratios (OR), risk ratios (RR; estimates at mean level of all other covariates using *atmeans*) and hazard ratios (HR) with 95% confidence intervals (95%CIs).

3. Results

Patient level analysis

95,956 out of 246,397 subjects lost at least one molar over the 7-10-year follow-up period: 45.4% in group A (FI), 33.9% in group B1 (no FI, no periodontal pocketing), and 48.9% in group B2 (no FI, periodontal pocketing) (Figure 1, Tables 1 and A-3). Risk for molar loss was significantly lower in group B1 when compared to A (OR 0.65; 95%CI 0.64-0.66), whereas differences between group B2 and A were minor (OR 1.07; 95%CI 1.03-1.10).

Tooth level analysis

Over the 10-year period, 9.6% of all molars were lost (Table A-4). The respective distribution of molar loss by initial FI was 8.3% for FI 0, 8.8% for FI 1, 21.9% for FI 2 and 46.4% for FI 3.

The model *(*N=1,581,608 molars in 245,634 subjects*)* revealed that furcation status, PPD, restorative/endodontic status, age, number of teeth and number of teeth with periodontal pocketing were all significantly associated with molar loss (Figure 2, Tables 3 and A-5).

The adjusted RRs for FI 1, FI 2 and FI 3 were 0.95 (95%CI 0.93-0.96), 1.67 (95%CI 1.63-1.71) and 3.30 (95%CI 3.18-3.43), respectively, when compared to FI 0. The corresponding ORs were 0.92, 1.89 and 5.28. The effect of FI was modulated by PPD, endodontic status and age. Deep FI and PPD had a synergistic effect on tooth loss (interaction: FI 1 # PPD ≥6 mm OR 1.21; FI 2 # PPD ≥6 mm OR 1.33; FI 3 # PPD ≥6 mm OR 1.13), whereas the relative effect of deep FI at endodontically treated molars was less pronounced (interaction: FI 1 # root filling OR 0.97; FI 2 # root filling OR 0.55; FI 3 # root filling OR 0.40) (Figure 3 and A-2, Table A-6).

The subgroup analysis indicated that the relevance of FI on tooth loss was greater in younger age categories (particularly in the age group 41-50 years, with an OR of 9.06 for FI 3

compared to no FI), while there were no significant differences between subgroups by number of teeth nor by number of teeth with periodontal pocketing. Across the different subgroups, FI 3 was the strongest indicator of future molar loss (range of OR 4.32-9.06) (Figure A-1, Tables A-7, A-8 and A-9).

The effect of the restorative and endodontic status was also modulated by age (Table A-7). Restored molars (fillings or crowns) were more likely to be lost in younger individuals (ORs of 2.65 and 13.63 in the youngest age category for molars with fillings and crowns, respectively, when compared to unrestored molars), whereas restorations were protective in older age groups (ORs of 0.20 and 0.25, respectively, in the oldest age category). In younger ages, endodontic treatment was a particularly strong risk factor for molar loss (OR 10.16 in the youngest age category).

Tooth level survival analysis

The estimated mean survival over the period 2010-2020 is illustrated in Figure 4 (*Baseline FI Survival model*; N=2,169,542 molars in 348,999 subjects; Table A-10). HRs were 1.77 (95%CI 1.74-1.80) for FI 2 and 3.57 (95%CI 3.47-3.68) for FI 3 relative to FI 0-1. Figure 4 also shows molar survival after first detection of deep FI (*New FI Survival model*; N=2,133,785 molars in 337,740 subjects; Table A-11). The post-detection HR for molar loss was 2.04 (95%CI 1.99-2.08) when compared to no FI. Estimated survival at 5 years was 95.7% before and 91.7% after deep FI detection; at 10 years, the corresponding estimated survival was 89.9% and 81.8%, respectively.

4. Discussion

The present study utilized data from more than 300,000 subjects who were identified in a nationwide registry. The aim was to evaluate the relevance of furcation status on the risk for molar loss over a time period of 10 years. The findings demonstrated that deep FI had a strong impact on molar loss (i.e. tooth extraction; FI 2: OR 1.9 & FI 3: OR 5.3, relative to no FI). First detection of deep FI resulted in a decrease in 10-year survival of 8%. Other independently relevant factors for risk of molar loss were probing pocket depth as well as endodontic and restorative status.

The fact that FI was shown to be strongly associated with molar loss confirms previous observations. In a systematic review by Nibali et al. (2016) the risk for tooth loss was estimated to be 2.5 times higher for molars with furcation involvement compared to those without, based on 13 clinical studies with a follow-up of at least 5 years. In the cited review, the RR for tooth loss was 1.7 for FI 2 and 3.1 for FI 3, when FI 1 was used as reference. Salvi et al. (2014) and Dannewitz et al. (2016) evaluated longitudinal data on molar survival in patients under supportive periodontal care with follow-ups ranging from 3-27 and 10-20 years, respectively. Both reports suggested that shallow FI implied no elevated risk for molar loss, while ORs for FI 2 and FI 3 were in the range of 2-3 and 5. Our risk assessments resulted in similar estimates. Nibali, Krajewski, et al. (2017) reported a stronger effect of shallow furcation in patients without regular periodontal therapy (incidence rate ratio of 1.7 over 11 years of follow-up) whilst the incidence rate of tooth loss was 3.9 times higher for molars with deep furcation (degree 2,3) compared to molars without FI. Nibali et al. (2018) found shallow FI (degree 1) to be even more relevant as a risk factor for molar loss over 5-10 years (OR 7), whereas the association with deeper FI (degree 2, 3) was not statistically significant after adjusting for confounding factors. In agreement with our findings, Graetz et al. (2015) did not observe any increased risk for tooth loss at molars with shallow FI after 9-31 years of

follow-up. However, the reported impact of deep furcation was smaller than in the present study (OR of 1.6 and 2.4 for FI 2 and FI 3, respectively). The reasons for the disparities between different studies are not fully understood, but may be related to differences in sample size, follow-up periods and treatment strategies during active and supportive therapy. Our data originate mostly from general dental practice, whereas previous studies have been performed in specialist settings. The current analysis did not consider interventional aspects, nor did it distinguish between different phases of treatment.

Previous studies did not consider the time of exposure, i.e. when the FI developed, in the evaluation of risk for molar loss. The current study presents novel data indicating that first detection of deep FI resulted only in a minor decrease in molar survival. This information is relevant for clinicians in their decision-making in daily practice. While the findings highlight the importance of registering FI, they also support the concept that FI by itself is not a reason for tooth extraction (Sanz et al., 2020).

The relevance of vertical attachment loss in combination with FI was addressed in previous studies (Dannewitz et al., 2016; Graetz et al., 2015; Nibali et al., 2018; Tonetti, Christiansen, & Cortellini, 2017). In the registry dataset utilized in the present study, direct information on attachment levels and radiographic marginal bone levels was not available. PPD, however, was demonstrated to be a strong indicator of future tooth loss (OR 2.1), possibly by serving as a proxy for vertical attachment loss. Other potentially relevant variables not considered in the present analysis included plaque and bleeding scores, gingival recession and mobility, which all suffer from a low degree of completeness in the SKaPa registry. Due to the lack of data on attachment loss and bleeding on probing, the case definition and classification for periodontitis from the 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions (Tonetti, Greenwell, & Kornman, 2018) could not be applied.

Endodontic and restorative status were critical parameters determining molar survival in the present study. Endodontic status has been identified as a risk factor for molar loss also in previous publications, albeit with varying strength of effect. For instance, Graetz et al. (2015) found the hazard ratio to be 1.7 for molars with endodontic treatment compared to those without, whereas Dannewitz et al. (2016) reported a hazard ratio of 3. Nibali et al. (2018) reported an OR for tooth loss of 8 for endodontically-treated molars when compared to non-treated molars. In this context, it should be noted that information on reasons for tooth extraction (i.e. diagnosis) was not included in the analysis. The SKaPa annual report indicated that more than half of all extractions from 50 years of age and upwards in 2020 were based on caries-, endodontic- or fracture-related diagnoses (SKaPa, 2021).

An additional confounder of the effect of FI on molar loss was age. The observation on an elevated importance of FI in younger age groups may be explained by a particularly high susceptibility to periodontitis in these individuals. When interpreting the present results, it should also be kept in mind that the outcome "molar loss" was probably only rarely a naturally occurring event but rather the result of a therapeutic decision, i.e. tooth extraction. It may therefore be argued that presently identified risk factors were relevant for clinicians in their decision-making, while the true impact on molar loss remains to be evaluated.

The registry scored FI degrees from 0-3, which were interpreted according to the classification by Hamp et al. (1975). However, amongst the multitude of clinicians responsible for the registrations, some may have scored FI according to different systems (e.g. Ramfjord & Ash, 1979; Svärdström & Wennström, 2000). In addition to this potential inconsistency, difficulties in reliable clinical assessments at furcation defects should also be considered (Eickholz & Staehle, 1994; Moriarty, Scheitler, Hutchens, & Delong, 1988; Zappa, Grosso, Simona, Graf, & Case, 1993). As a consequence of the study design, there were no intra- or inter-examiner calibrations, and no information was available on the type of

probe used. Furthermore, the risk of under-registration should be considered. A recent questionnaire-based study by Nibali et al. (2021) including 400 general dental practitioners from 7 different countries found that 34% of responders never used a Nabers probe and 44% only used it in patients with advanced periodontitis.

An additional limitation is the lack of information on possible confounders such as smoking and systemic conditions, which have been shown to be determinants of tooth loss (Al-Shammari, Al-Khabbaz, Al-Ansari, Neiva, & Wang, 2005; McGuire & Nunn, 1996; Patel, Kumar, & Moss, 2013; Salvi et al., 2014).

Although the aforementioned limitations must be acknowledged, the present study is the first to evaluate risk factors of molar loss in a large registry-based population. Registry data describe current therapeutic strategies in general dental care with high external validity, which renders the present data both novel and relevant for the dental community.

Conclusion

Furcation status had a clinically relevant impact on the risk for molar loss. Following first detection of deep FI, however, the decline in molar survival was minor.

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***Author contribution*:** ATE, TB and JD contributed to study conception and design. ATE, MP and CT contributed to data analysis. All authors contributed to data interpretation, drafting and revision of the manuscript.

***Data availability statement*:** The data that support the findings of this study are available from the corresponding author upon reasonable request.

Clinical Relevance

Scientific rationale: An individualized approach to dental and periodontal care requires a detailed understanding of risk factors for future events. This study aimed to assess the impact of furcation involvement on tooth loss at population level, using data from a national registry.

Principal findings: Furcation involvement degree 2-3 resulted in 2-3 times higher risk of tooth loss. First detection, however, resulted only in a minor decrease in the 10-year survival.

Practical relevance: Considering the high long-term survival of molars, even in the presence of furcation involvement, extraction should not be the first line of treatment.

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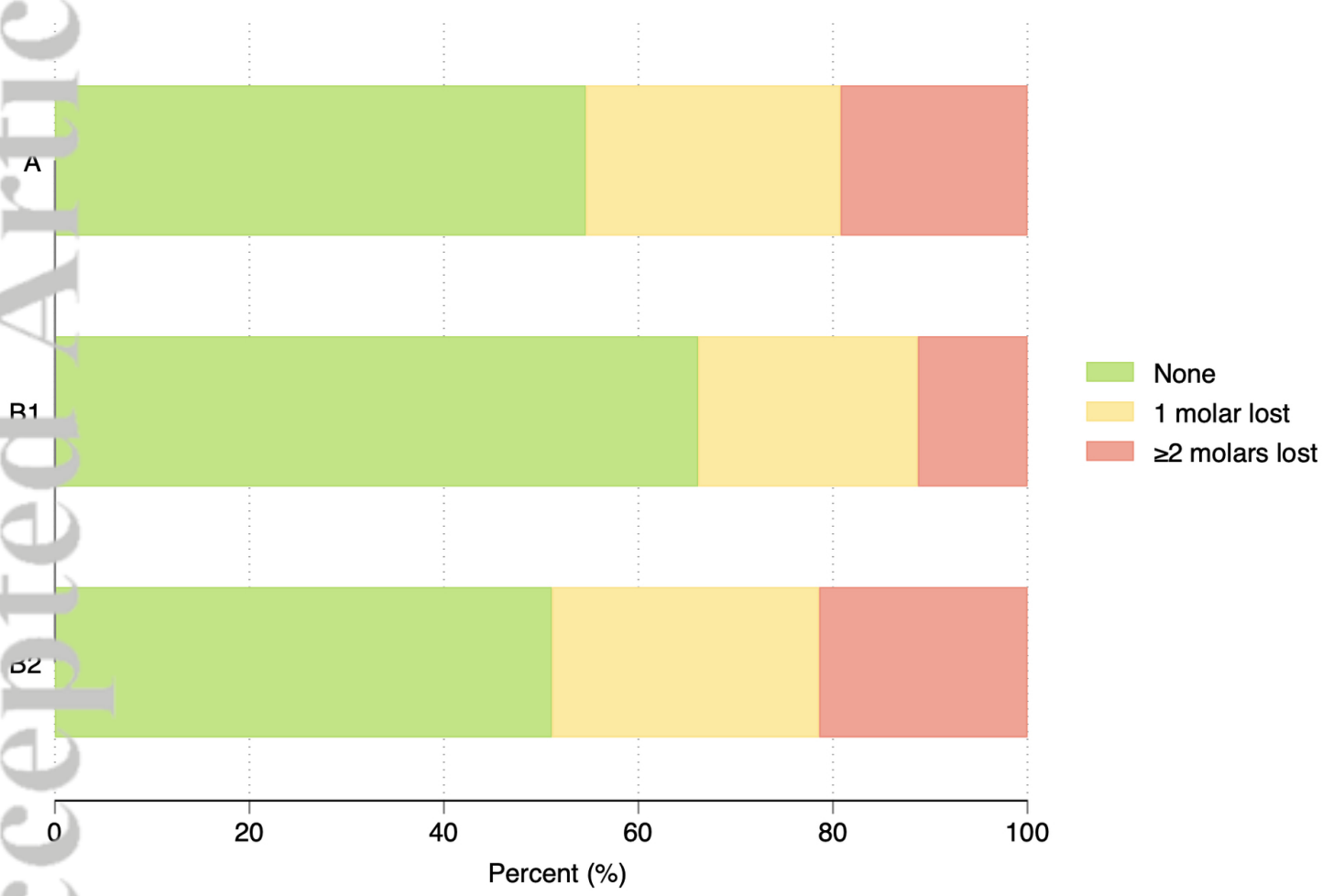
Figure 1. Molar loss over the 7-10-year follow-up period according to patient group.

Figure 2. Effect of baseline characteristics on the odds of tooth loss over the 7-10-year follow-up period, according to the multilevel regression model (OR with 95%CI). For more details, see Table 3. The relevance of number of teeth with PPD ≥6 mm is further illustrated in Figure A-2.

Figure 3. Interaction effects between FI and PPD (left) and FI and endodontic status (right) on the estimated risk for molar loss over the 7-10-year follow-up period. *This figure illustrates the estimated risk for molar loss by increasing category of baseline furcation involvement when a molar does or does not present with periodontal probing ≥6 mm (left), and whether the molar is root filled or not (right). The X-axis illustrates degree of FI. Please note that the Y-axis ranges from 10 to 40%. For more details, see Table 3.*

Figure 4. Estimated survival according to baseline FI (left; *Baseline FI Survival model*) and estimated survival before and after detection of a deep FI (right; *New FI Survival model*). *Please note that the Y-axis ranges from 50 to 100%. Additional information is provided in Tables A-9 and A-10.*
In the subpopulation included in New FI Survival model, deep FI was detected in 111,771 molars (56,225 subjects). The mean age at detection of deep FI was 67.1 ± 10.0 years. The mean follow-up was 7.6 ± 2.7 for subjects in the category FI 0-1, while the corresponding overall observation period for subjects detected with deep FI was 8.2 ± 2.0. The mean observation period post-detection was 3.5 ± 2.5 years.



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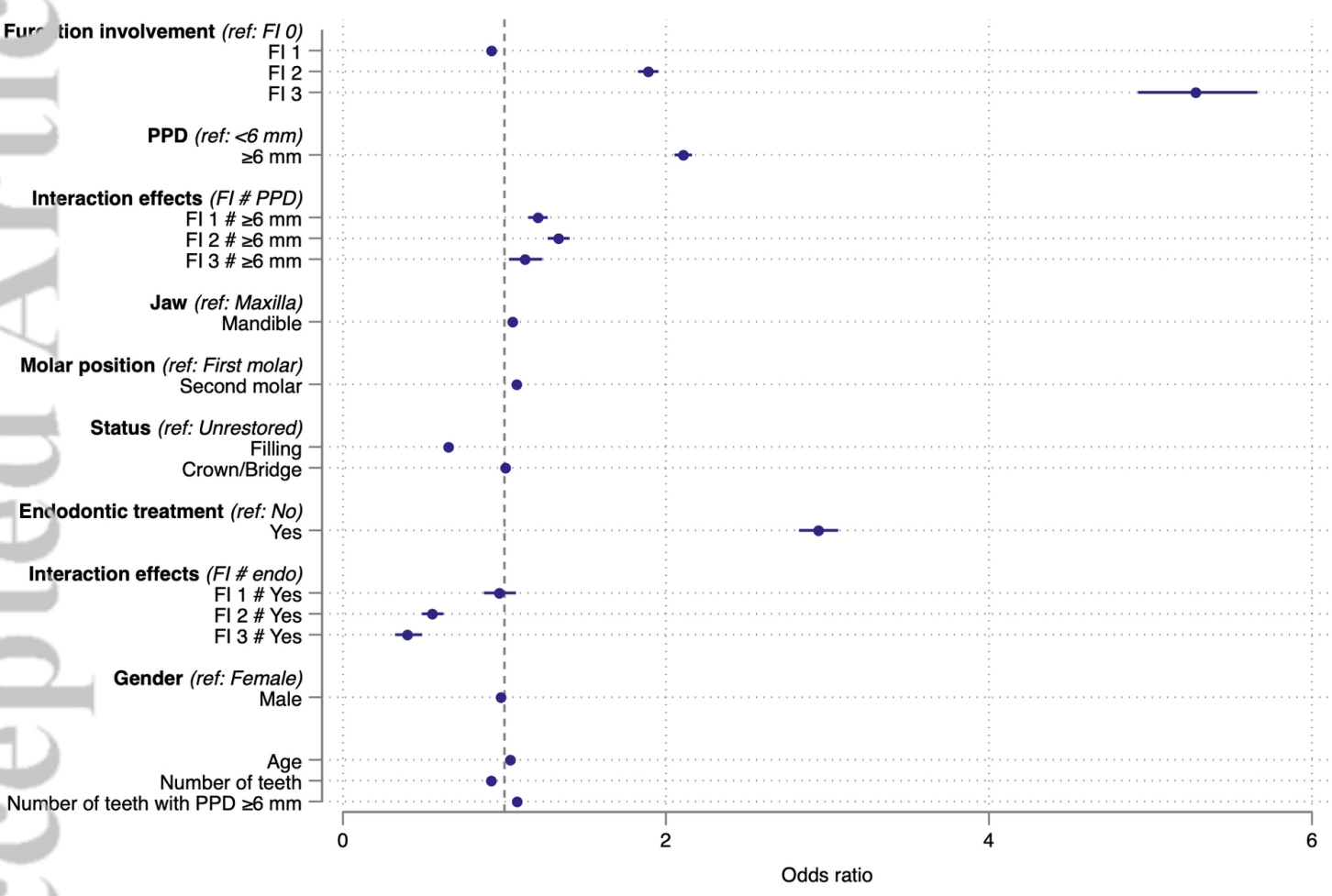

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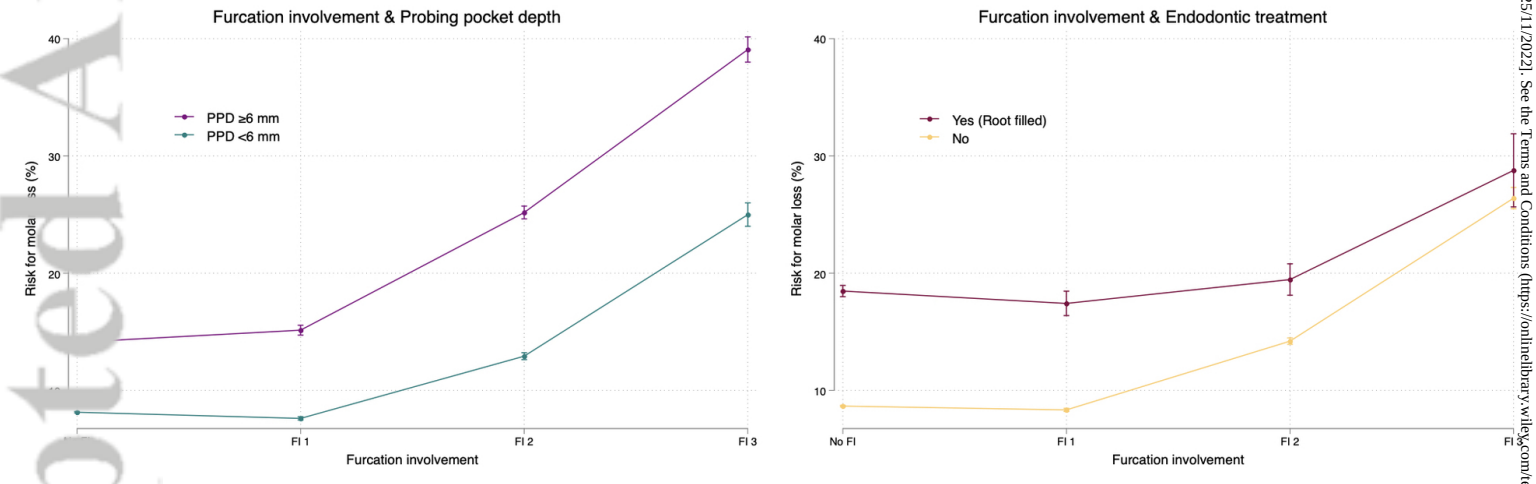
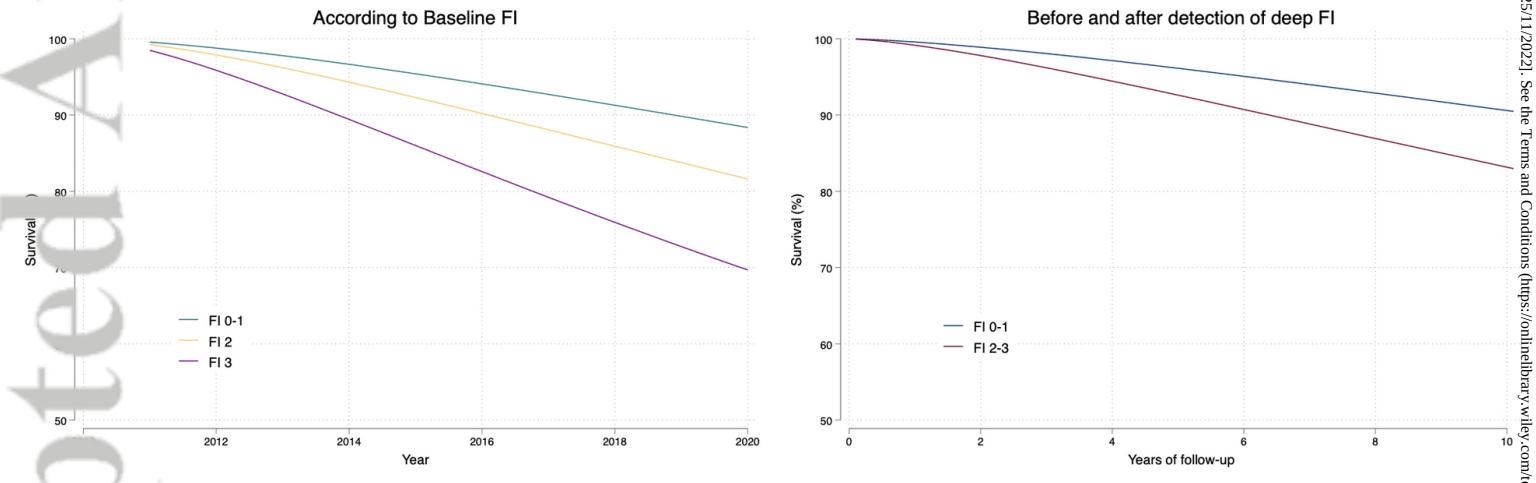


JCPE_13754_Fig3.jpg



JCPE_13754_Fig4.jpg

Table 1. Subject characteristics at baseline (2010/2011) and molar loss (2018-2020) according to patient group

	Group A FI (N=130,297)		**B1** No FI / no periodontal pocketing (N=223,020)		**B2** No FI / periodontal pocketing (N= 28,133)		**B1+B2** (N=251,153)		**Total (A+B)** (N= 381,450)	
Gender (count, %)										
Female	64,921	49.8%	112,649	50.5%	12,239	43.5%	124,888	49.7%	189,809	49.8%
Male	65,376	50.2%	110,371	49.5%	15,894	56.5%	126,265	50.3%	191,641	50.2%
Age (mean, (SD))	60.6	(12.1)	59.2	(12.7)	63.0	(10.7)	59.7	(12.6)	60.0	(12.4)
Categories (count, %)										
25-40 years	7,636	5.9%	14,743	6.6%	543	1.9%	15,286	6.1%	22,922	6.0%
41-50 years	19,694	15.1%	36,681	16.5%	2,689	9.6%	39,370	15.7%	59,064	15.5%
51-60 years	33,572	25.8%	59,790	26.8%	6,951	24.7%	66,741	26.6%	100,313	26.3%
61-70 years	42,052	32.3%	69,817	31.3%	11,423	40.6%	81,240	32.3%	123,292	32.3%
71-86 years	27,343	21.0%	41,989	18.8%	6,527	23.2%	48,516	19.3%	75,859	19.9%
Number of teeth (mean, (SD))	24.0	(4.6)	24.5	(4.9)	23.8	(4.6)	24.4	(4.9)	24.2	(4.8)
Categories (count, %)										
≤19 teeth	16,720	13.5%	25,327	12.1%	4,131	14.7%	29,458	12.4%	46,178	12.8%
20-24 teeth	35,925	28.9%	44,575	21.3%	7,814	27.8%	52,389	22.1%	88,314	24.4%
≥25 teeth	71,621	57.6%	139,353	66.6%	16,155	57.5%	155,508	65.5%	227,129	62.8%
Number of molars (mean, (SD))	5.7	(2.4)	6.0	(2.5)	5.9	(2.2)	6.0	(2.5)	5.9	(2.5)
Number of molars with FI (mean, (SD))	3.1	(2.1)	-	-	-	-	-	-	-	-
Number of teeth with PPD ≥6 mm (mean, (SD))	1.8	(3.1)	0.1	(0.3)	4.2	(3.1)	0.5	(1.7)	1.0	(2.4)
Categories (count, %)										
None	66,886	51.3%	204,277	91.6%	0		204,277	81.3%	271,163	71.1%
1-3 teeth	40,692	31.2%	18,743	8.4%	16,095	57.2%	34,838	13.9%	75,530	19.8%
≥4 teeth	22,719	17.4%	0		12,038	42.8%	12,038	4.8%	34,757	9.1%
Molar loss 2018-2020 (count, %)	(N=85,013)		(N=143,238)		(N=18,146)		(N=161,384)		(N=246,397)	
1 molar lost	22,261	26.2%	32,374	22.6%	4,986	27.5%	37,360	23.2%	59,621	24.2%
≥2 molars lost	16,323	19.2%	16,127	11.3%	3,885	21.4%	20,012	12.4%	36,335	14.8%

Table 2. Molar characteristics at baseline (2010/2011) and molar loss (2018-2020) according to baseline furcation involvement

	FI 0 (n=1,964,545)		**FI 1** (n=274,757)		**FI 2** (n=111,580)		**FI 3** (n=24,001)		**Total** (n= 2,374,883)	
Jaw (count, %)										
Maxilla	1,011,517	51.5%	135,108	49.2%	54,053	48.4%	10,866	45.3%	1,211,544	51.0%
Mandible	953,028	48.5%	139,649	50.8%	57,527	51.6%	13,135	54.7%	1,163,339	49.0%
Molar position (count, %)										
First molar	961,148	48.9%	159,100	57.9%	64,116	57.5%	15,448	64.4%	1,199,812	50.5%
Second molar	1,003,397	51.1%	115,657	42.1%	47,464	42.5%	8,553	35.6%	1,175,071	49.5%
Restorative status (count, %)										
Unrestored	196,871	10.6%	20,529	8.0%	7,409	7.1%	1,583	7.2%	226,392	10.2%
Filling	1,399,996	75.7%	192,786	75.5%	72,227	69.6%	13,800	62.4%	1,678,809	75.3%
Crown/Bridge abutment	251,874	13.6%	42,161	16.5%	24,084	23.2%	6,717	30.4%	324,836	14.6%
Endodontic treatment (count, %)										
No	1,819,010	98.4%	250,047	97.8%	100,256	96.6%	21,124	95.4%	2,190,437	98.2%
Yes	30,406	1.6%	5,592	2.2%	3,561	3.4%	1,027	4.6%	40,586	1.8%
Probing pocket depth (mm; mean, (SD))	3.6	(1.1)	4.1	(1.4)	5.0	(2.0)	6.1	(2.5)	3.7	(1.3)
Categories (count, %)										
<6 mm	1,812,309	92.3%	228,069	84.6%	69,833	63.3%	9,869	41.6%	2,120,080	89.5%
≥6 mm	152,236	7.7%	41,499	15.4%	40,466	36.7%	13,877	58.4%	248,078	10.5%
Molar loss 2018-2020 (count, %)	(n=1,313,365)		(n=184,596)		(n=70,234)		(n=13,786)		(n=1,581,981)†	
Yes	108,819	8.3%	16,308	8.8%	15,350	21.9%	6,392	46.4%	146,869	9.3%

†*Only molars with information on baseline furcation involvement*

Table 3. Multilevel logistic regression model evaluating tooth loss over 7-10 years according to baseline characteristics

Variables		Odds ratio (95%CI)
Furcation involvement (reference: FI 0)	FI 1	0.92*** (0.90 - 0.94)
	FI 2	1.89*** (1.83 - 1.95)
	FI 3	5.28*** (4.92 - 5.66)
Probing pocket depth (reference: <6 mm)	≥6 mm	2.11*** (2.05 - 2.16)
Interaction effects with FI	FI 1 # ≥6 mm	1.21*** (1.15 - 1.27)
	FI 2 # ≥6 mm	1.33*** (1.27 - 1.40)
	FI 3 # ≥6 mm	1.13* (1.03 - 1.23)
Jaw (reference: maxilla)	Mandible	1.05*** (1.04 - 1.06)
Molar position (reference: first molar)	Second molar	1.07*** (1.06 - 1.09)
Restorative status (reference: unrestored)	Filling	0.65*** (0.64 - 0.67)
	Crown/bridge abutment	1.01 (0.98 - 1.04)
Endodontic treatment (reference: no)	Yes	2.94*** (2.82 - 3.07)
Interaction effects with FI	FI 1 # yes	0.97 (0.87 - 1.07)
	FI 2 # yes	0.55*** (0.49 - 0.62)
	FI 3 # yes	0.40*** (0.32 - 0.49)
Gender (reference: female)	Male	0.98** (0.96 - 0.99)
Age		1.04*** (1.03 - 1.04)
Number of teeth		0.92*** (0.92 - 0.92)
Number of teeth with PPD ≥6 mm		1.08*** (1.07 - 1.08)
Constant		0.07*** (0.07 - 0.08)
Inter-group variance (between subjects)		1.41 (1.38 - 1.44)
Observations (molars)		1,581,608
Number of groups (subjects)		245,634

**** p<0.001, ** p<0.01*