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# Long-term survival and maintenance efforts of splinted teeth in periodontitis patients

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ABSTRACT

*Objectives:* This study assessed the survival and maintenance needs of splinted teeth in periodontitis patients.
*Methods:* Patients receiving active and supportive periodontal treatment involving teeth splinting in a university setting were retrospectively assessed. Tooth and splint survival and number of splint-repairs were recorded. Multilevel Cox and generalized-mixed linear regression analyses were performed.
*Results:* Fifty-seven patients with 227 splinted teeth (maxilla/mandible: 148/79) were followed over mean ± SD 11.0 ± 7.2 [range: 2.0–32.4]) years. Twenty-six splinted teeth were extracted during this period, the mean (95% CI) time of splint retention was 7.3 ± 5.7 (0.1–22.7). Splinted teeth did not show significantly increased risk of tooth loss compared with non-splinted teeth (HR; 95% CI: 1.30; 0.87–1.93); while age (1.07; 1.05–1.09), PPD > 6 mm (4.24; 1.26–14.31), bone loss (mean HR was 5.07–15.36 depending on severity), tooth location (posterior versus anterior teeth: HR 2.08; 1.24–3.49) and the number of occlusal contact areas (mean HR was 4.38–17.34 depending on the number of antagonistic contact areas) were associated with tooth loss. 75.3% splints required repair, with a mean of 2.6 ± 1.9 [1.0–8.0] repairs per splint during the mean observation time (0.4 ± 0.6 [0.0–3.5] repairs per splint/year).
*Conclusion:* Splinting did not significantly increase the risk of tooth loss; splinted teeth showed long-term survival. To maintain splints, frequent repairs were needed.
*Clinical significance:* Splinted teeth were not at significantly higher risk of tooth loss than non-splinted teeth. While splinting does not improve the prognosis of periodontally affected teeth, it can assist their retention by reducing their mobility.

## 1. Introduction

Periodontitis is a multifactorial disease, which, when not adequately managed, comes with progressive attachment loss and eventually tooth loss [1,2]. If managed appropriately, involving a systematic and thorough control of the periodontal inflammation, periodontally affected teeth can be retained long-term, at limited costs, even in cases where bone loss (BL) is advanced [3,4]. Given the apical shift of the rotational centre of the tooth in cases of advanced BL, these teeth are often mobile, which might impact on their masticatory and phonetic functionality and reduce patients' comfort. In these cases, splinting, i.e. connecting these teeth to their adjacent neighbours and thereby reducing their mobility, may at least partially compensate for this. Such splinting therapy may also be used to reduce the risk of traumatic dynamic occlusion [5,6]. Splints can be classified as temporary or permanent, or as fixed or removable [7]. A simple way to splint teeth in a fixed way is to adhesively connect them using resin composites [8]. Given the limited flexural strength of composite resin, metal wires or glass fibres can be used to reinforce the splint [9]. Elastic splint materials are oftentimes preferred, as they allow flexible instead of rigid splinting. On the other hand, rigid splinting eliminates the physiologic mobility of teeth and could, therefore, reduce bone remodelling stimulation in an already compromised periodontium [10].

There are limited long-term data reporting on splinted teeth in periodontitis patients [11–13]. Additionally, these data are heterogeneous with high ambiguity, showing both high survival rates (for

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example of splints in lower anterior teeth) [14] and low survival rates (in both upper and lower anterior teeth) [14]. The effect of splinting on tooth prognosis remains unclear, too [13].

Hence, the aims of our study were (1) to evaluate the survival of splinted teeth and (2) to assess the required efforts for maintaining tooth splints. We hypothesized that splinted teeth are not at significantly higher risk for tooth loss than similarly diseased non-splinted teeth, i.e. that splinting does not worsen the prognosis of teeth.

## 2. Material and methods

### 2.1. Participants

This study builds on a cohort of patients with a history of periodontitis, which was consecutively recruited in the Department of Conservative Dentistry and Periodontology at the University of Kiel, which we have reported on elsewhere in detail [4]. In the present study, only patients who had received a composite or a glass-fibre/metal reinforced-composite splint of a minimum of two teeth during or after active periodontal therapy (APT) were included. Note that in this cohort, some patients had extracted teeth adhesively re-splinted to the adjacent neighbours; these teeth were not included in the present analysis. Patients needed to be between 18 and 80 years of age at inclusion into the cohort (first visit prior to APT, T0), to have finished APT, and to have received SPT for ≥ 2 years with ≥ 1 visit/year including an annual documentation of PPD. Patients also needed to have had a radiographic documentation at the time of splint insertion (T1) or latest one year afterwards, and at the last documented visit of SPT (T2). Periodontal disease was classified based on baseline periodontal records as chronic (CP) or aggressive periodontitis (AgP) [15]. Out of 6543 documented patients available in a database (ParoDat, Department of Periodontology, Kiel, Germany), 57 fulfilled all inclusion criteria.

### 2.2. Active and supportive periodontal therapy

APT and SPT followed a conservative regimen according the treatment guidelines of the department as described previously [16,17]. APT included non-surgical mechanical root debridement (scaling and root planning, SRP) with, if indicated, additional access flap surgery and/ or adjunctive systemic antibiotic therapy. Further treatments, e.g. endodontic treatment or tunnelling procedures and molar root resections were performed in individual cases. Re-evaluation was performed after three to six months. No pocket elimination surgery or osseous resection were performed in any patients of the cohort. SPT followed individualized intervals of three to twelve months and included re-instruction/ re-motivation of patients' individual oral hygiene, professional tooth cleaning with SRP of residual pockets and polishing by a dental auxiliary. If necessary, further treatments like open flap debridement with or without subsequent systemic adjunct antibiotic therapy were performed during SPT.

### 2.3. Clinical and radiographic assessment

A full dental status was recorded once yearly. Data for third molars were excluded. The following variables were assessed on patient and individual level, respectively:

- Age and gender at T0.
- Smoking status, recorded in three categories (never/ former, i.e. quit > 5 years ago/ current smoker), as described by Lang and Tonetti [18]. Smoking status at T0 (i.e. before APT) was entered into our analysis.
- Mobility, classified in degrees 0–3 according to Lindhe and Nyman [19]. Mobility at T1 (i.e. before splinting) was entered into our analysis, ignoring possible changes during follow-up or due to splinting.
- PPD were evaluated at six sites per tooth at T0, T1 and T2. PPD at T1 was entered into our analysis.
- Radiographic bone loss (BL) was assessed at T0, T1 and T2 using peri-apical radiograph film series. These were evaluated after digitizing by one examiner (C.G.) as described previously by our group [4]. Briefly, the maximum bone loss (BL) in % of the root length for each tooth was assessed using three points; the cemento-enamel junction (CEJ), the deepest point of the root apex and the most apical extension of the alveolar crest. If the CEJ was covered by a restoration, the most apical point of the restoration was used instead. BL at T1 was entered into our analysis.
- Tooth location, categorized as upper anterior, lower anterior and posterior teeth.
- The distribution of occlusal contact areas was determined at T0 and T2 according to the classification of Eichner [20], where the four posterior contact zones (each zone stretching from the first premolar till the last molar) are assessed for antagonistic contacts. The number of occlusal contacts could indicate the masticatory force placed onto single teeth, which may be relevant for tooth and splint survival. Within the Eichner classification and for the present study, patients were divided into Class A (all four contact areas), Class B1 (three areas), B2 (two), B3 (one) and Class C (no antagonistic contacts). Note that the Eichner classification involves further classes, which were not found in our patients.
- Bruxism at T0 was entered into our analysis according to the dentists' documentation in the patients' charts.

Note that based on our data and using additionally collected data on gingival recession, clinical attachment loss (CAL) was only determined at T0. Therefore, in the current investigation PPD and BL were analysed.

### 2.4. Splinted teeth

Teeth were splinted in case of high mobility, usually combined with extensive BL, at the decision of the treating dentist in accordance with patients' preferences. Ten splinted teeth (nine patients) had received amputation of one or two roots prior to splinting. Splints were made either solely of composite, or of composite reinforced with glass-fibre or wired metal to either one adjacent tooth or to both sides. The loss of teeth and/or splints and the number of repairs per splint and year was documented. Note that splinted teeth were extracted only in our department, while for non-splinted teeth removal also occurred in private practice. For these teeth, the reason for extraction could not always be ascertained.

### 2.5. Data management and statistical analysis

As described in previous publications by our group [4,16,17,21–23], data were managed using the database ParoDat. All patients gave their informed consent for the analysis of their data documented during periodontal therapy. The Ethical Committee of the Christian-Albrechts-University of Kiel approved the protocol of the study (AZ: D442/10).

Statistical evaluation was performed using SPSS 24 (SPSS, Chicago, USA) plugged into R 3.1.0. Descriptive analyses were performed for the overall sample and stratified for tooth location (upper or lower anterior teeth, posterior teeth), bone loss and mobility. Multilevel multivariable Cox regression and generalized mixed linear modelling were performed, accounting for the clustering of teeth within patients by entering the patient as random effect. We used a number of covariates to account for patient level risk and tooth level severity of periodontal destruction both in splinted and non-splinted teeth; age, gender, smoking status, bruxism, tooth location, posterior tooth distribution, mobility, PPD, BL and splint material (material was only used for the analysis of splint repair).

**Table 1**
Characteristics of the sample.

| Characteristics of the sample | | |
|---|---|---|
| Number of patients (male/female) | 57 (19 / 38) | |
| Age at T0 (mean ± SD) in years | 48.9 ± 13.1 | |
| Observation time in years (mean ± SD. [range]) | 11.0 ± 7.2 [2.0-32.4] | |
| Number of smokers / former smokers / never smokers | 18 / 1 / 38 | |
| | **T0** | **T2** |
| Number of teeth | 1424 | 1270 |
| Number of teeth/patient (mean ± SD) | 25.1 ± 2.8 | 22.3 ± 3.9 |
| Number of teeth lost/patient (mean ± SD) | 2.9 ± 2.8 | 5.7 ± 3.9 |
| Mean PPD in mm of non-splinted teeth (mean ± SD) | 4.5 ± 1.6 | 3.0 ± 0.7 |
| Mean BL in % of non-splinted teeth (mean ± SD) | 44.0 ± 21.5 | 41.0 ± 19.2 |
| Mobility of non-splinted teeth (degree 0/1/2/3) | 766/129/69/36 | – |
| | **T1** | **T2** |
| Number of splinted teeth | 227 | 201 |
| Mean PPD in mm of splinted teeth (mean ± SD) | 5.4 ± 1.8 | 3.2 ± 1.0 |
| Mean BL in % of splinted teeth (mean ± SD) | 61.7 ± 20.5 | 59.3 ± 18.3 |
| Mobility of splinted teeth (degree 0/1/2/3) | 104/38/33/22 | – |

T0: prior to APT; T1: prior to splinting; T2: end of investigation

## 3. Results

At baseline (T0), the included 57 patients (19 male, 38 female) had a mean ± SD age of 48.9 ± 13.1 [range: 23–72] years. Forty-nine patients suffered from CP, eight patients suffered from AgP. All patients had a permanent dentition with a mean of 25.1 ± 2.8 teeth (T2: 22.3 ± 3.9). The mean number of splinted teeth per patient was 4.1 ± 2.4 [1–11] with 1.7 ± 1.0 [1–5] splints per patient, the total number of splinted teeth was 227 (Table 1).

Twenty-six splinted teeth were extracted during follow-up. Splinted teeth showed worse baseline periodontal conditions (PPD and BL) in comparison to non-splinted teeth regardless of the localisation (Table 1, Figs. 1 and 2). Prior to splinting, splinted teeth also showed higher mobility than non-splinted teeth (10.9% of the splinted lower anterior teeth had at baseline mobility degree III, while 1.5% non-splinted lower anterior teeth showed this degree; 10.7% of splinted posterior teeth showed mobility degree III, but only 3.5% of non-splinted posterior teeth).

When accounting for this difference in baseline periodontal conditions (and other covariates) using multivariable Cox regression analysis, gender, smoking, mobility but also splinting treatment as well as bruxism were not significantly associated with tooth loss any more, i.e. splinted teeth were not at significantly higher risk of tooth loss when compared to similarly diseased non-splinted teeth. Age, tooth location, classification of occlusal contact areas, PPD and BL were significantly associated with tooth loss. Posterior teeth showed significant higher risk than anterior teeth. Risk of tooth loss increased with increasing PPD/BL (Table 2).

75.3 % of the splinted teeth (171/227) required a repair during follow-up, with a mean of 2.6 ± 1.9 [1–8] repairs per splint. The annual number of repairs per splint was 0.4 ± 0.6 [0.0–3.5]. When accounting for covariates, multivariable analysis found that the annual number of repairs was significantly increased in smokers, lower anterior teeth and Eichner Class C (no antagonistic contacts); further significant associations were not detected (Table 3).

## 4. Discussion

While splinting is a widely used therapeutic option, very limited evidence on the benefits or harms of splinting teeth in periodontitis patients as well as possible factors influencing the survival rate of splints and splinted teeth is available [5,14]. We hypothesized that splinting does not negatively affect the prognosis of splinted teeth. Note that we did not expect splinting to improve the prognosis either, as the prognosis of teeth in periodontitis patients depends largely on (1) the baseline condition of the teeth and (2) the provision of a systematic long-term periodontal therapy. If, however, splinting itself reduces mobility without having any disadvantageous effects on tooth prognosis, it may be a clinically worthwhile option to reduce mobility and increase patients' comfort and masticatory function.

We used a multivariable regression analysis, accounting for a large number of covariates indicating the severity of periodontal affection in splinted and non-splinted teeth, but also patients' risk profile for tooth loss, to test our hypothesis. Using such model allowed us to – as far as possible – compare "similarly affected" splinted and non-splinted teeth. We did not find splinting to significantly impact on survival; we hence accept our hypothesis. It should be highlighted that in our cohort, only teeth which had been successfully treated using APT and SPT [1] were splinted, and none of the cases showed untreated occlusal trauma [11,24]. Based on our findings and considering that splinted teeth showed long-term survival (only 26 teeth of 227 were extracted over > 10 years follow-up), splinting seems a valid treatment option. The impact of splinting on patients' oral health-related quality of life,

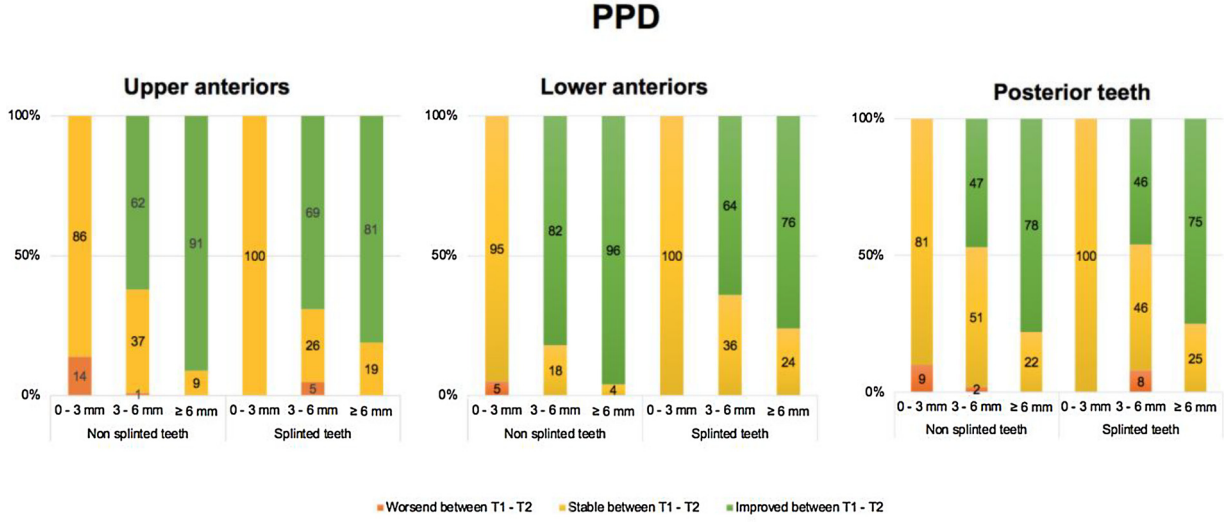


**Fig. 1.** Comparison of PPD of non-splinted and splinted teeth separated into posterior, upper and lower anterior teeth.

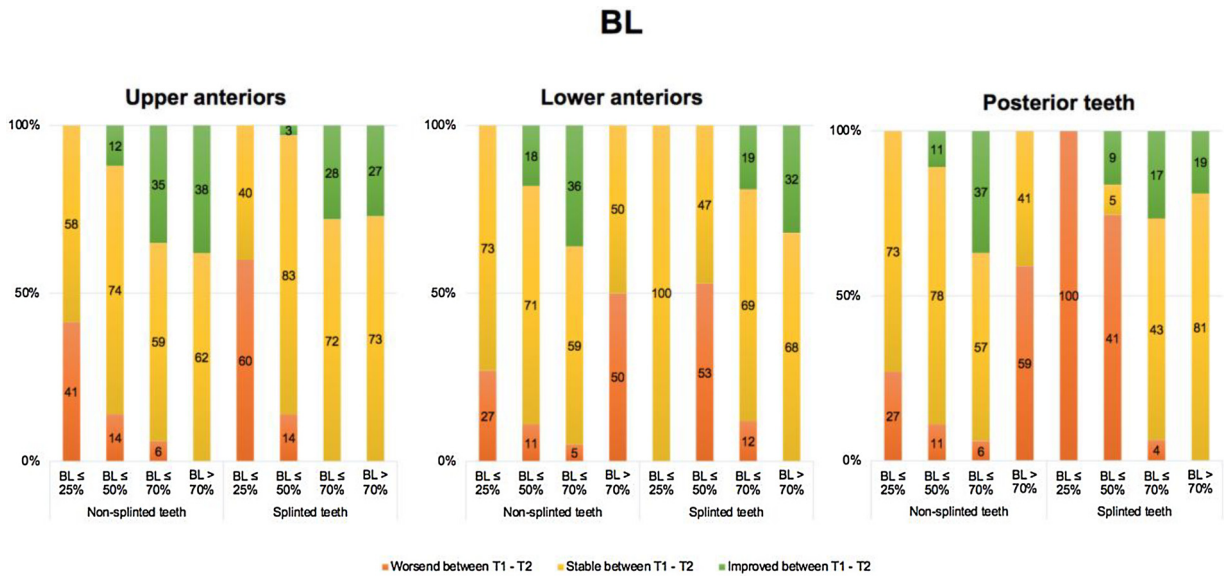


**Fig. 2.** Comparison of BL of non-splinted and splinted teeth separated into posterior, upper and lower anterior teeth.

**Table 2**
Predictors of tooth loss.

| Predictors of tooth loss | | | |
|---|---|---|---|
| Variables | HR | p-value | 95 % CI |
| Age (cont.) | **1.070** | **< 0.001** | **1.049; 1.091** |
| Gender (ref.: female) | 0.916 | 0.656 | 0.623; 1.348 |
| Never smoker (reference) | 1 | | |
| Former smoker | 1.482 | 0.065 | 0.976; 2.250 |
| Smoker | **3.470** | **0.033** | **1.105; 10.90** |
| Splinted tooth | 1.296 | 0.202 | 0.870; 1.929 |
| Bruxism | 2.385 | 0.087 | 0.882; 6.453 |
| Upper anterior tooth (reference) | 1 | | |
| Lower anterior tooth | 0.841 | 0.640 | 0.408; 1.734 |
| Posterior tooth | **2.082** | **0.005** | **1.241; 3.492** |
| Class A** | 1 | | |
| Class B1** | **4.384** | **< 0.001** | **2.542; 7.559** |
| Class B2** | 1.692 | **0.287** | **0.643; 4.457** |
| Class B3** | **14.337** | **< 0.001** | **4.696; 43.770** |
| Class C1** | **17.342** | **< 0.001** | **3.754; 80.112** |
| Mobility degree 0 (reference) | 1 | | |
| Mobility* degree I | 0.671 | 0.107 | 0.431; 1.090 |
| Mobility* degree II | 1.096 | 0.735 | 0.644; 1.867 |
| Mobility* degree III | 1.803 | 0.058 | 0.980; 3.318 |
| PPD ≤3 mm | 1 | | |
| PPD > 3-6 mm | 1.876 | 0.308 | 0.560; 6.285 |
| PPD > 6 mm | **4.242** | **0.020** | **1.257; 14.312** |
| BL ≤30 % (reference) | 1 | | |
| BL > 30-50 % | 2.188 | 0.153 | 0.747; 6.413 |
| BL > 50-70 % | **5.066** | **0.003** | **1.722; 14.90** |
| BL > 70 % | **15.359** | **< 0.001** | **5.062; 46.60** |

*mobility before splinting for splinted teeth.
**Classification of occlusal contact areas.

**Table 3**
Association of covariates with the annual number of repairs per splint.

| Association of covariates with the annual number of repairs per splint | | | | |
|---|---|---|---|---|
| Variables | Coefficients | p-value | 95 % CI | |
| Age (cont.) | −0.008 | 0.177 | −0.020 | 0.004 |
| Gender (ref.: female) | 0.109 | 0.404 | −0.148 | 0.366 |
| Never smoker (reference) | 0 | | | |
| Former smoker | −0.048 | 0.940 | −1.207 | 1.303 |
| Smoker | −0.388 | **0.003** | −0.638 | −0.138 |
| Bruxism (ref.: no bruxism) | −0.109 | 0.712 | −0.690 | 0.472 |
| Mobility degree 0 (reference) | 0 | | | |
| Mobility* degree III | −0.059 | 0.734 | −0.401 | 0.283 |
| Mobility* degree II | −0.282 | 0.070 | −0.587 | 0.023 |
| Mobility* degree I | −0.182 | 0.151 | −0.431 | 0.067 |
| Upper anterior teeth (reference) | 0 | | | |
| Posterior teeth | −0.224 | 0.077 | −0.473 | 0.025 |
| Lower anterior teeth | −0.349 | **0.024** | −0.651 | 0.046 |
| PPD ≤3 mm (reference) | 0 | | | |
| PPD > 6 mm | −0.075 | 0.757 | −0.552 | 0.402 |
| PPD > 3-6 mm | −0.101 | 0.670 | −0.567 | 0.366 |
| BL ≤30 % (reference) | 0 | | | |
| BL > 70 % (ref.: ≤ 30%) | 0.533 | 0.068 | −0.041 | 1.107 |
| BL > 50-70 % (ref.: ≤ 30%) | 0.400 | 0.158 | −0.157 | 0.957 |
| BL > 30-50 % (ref.: ≤ 30%) | 0.282 | 0.988 | −0.282 | 0.846 |
| Eichner class A (reference) | 0 | | | |
| Eichner class C | 0.775 | **0.007** | 0.212 | 1.338 |
| Eichner class B3 | −0.542 | 0.176 | −1.329 | 0.245 |
| Eichner class B2 | 0.434 | 0.076 | −0.046 | 0.914 |
| Eichner class B1 | 0.180 | 0.398 | −0.239 | 0.598 |
| Splint material solely of composite (reference) | 0 | | | |
| Splint material composite reinforced with wired metal | 0.266 | 0.060 | −0.011 | 0.543 |
| Splint material composite reinforced with glass-fibre | −0.010 | 0.932 | −0.252 | 0.231 |

* mobility before splinting for splinted teeth.

however, remains unmeasured and should be assessed in future studies.

Our findings are relevant, as it was feared that splints complicate SRP since the accessibility of (especially interproximal) subgingival root areas is hampered [25]. However, previous studies did not find splinted teeth to have a higher risk of plaque accumulation and also the subjective comfort of splinted versus non-splinted teeth was not reduced [14,26]. Moreover, the long-feared risk of severely diseased, splinted teeth compromising the survival of adjacent non- or mildly diseased teeth (due to accelerated destruction of the adjacent periodontium) could not be demonstrated. Instead, splinting may even lead to bone gain of adjacent teeth or prevent further bone loss [3]. Usually, however, splinting does not improve the periodontal situation; when teeth are de-splinted, they are often again mobile [27].

While our analysis possibly suffers from a lack of statistical power (which may come with the risk of false-negatively concluding splinting was not significantly decreasing survival, while with a larger sample, a significance may be reached), we clearly demonstrated that tooth and patient level factors were more decisive for tooth loss than splinting status. For both splinted and non-splinted teeth, factors like patients' age, BL or PPD were found to be significantly associated with tooth loss.

Notably, the classification of occlusal contact areas [20] and tooth location was highly relevant, with posterior teeth and a lower number of antagonistic contact areas coming at increased risk of tooth loss (regardless of their splinting status). Antagonistic contacts, which determine the distribution of masticatory force, have been previously found relevant for tooth retention in prosthetically rehabilitated periodontitis patients [28]. This shows the need to retain a high number of occlusal units by managing periodontal disease early one. Such early periodontal treatment in patients with more remaining teeth has been shown to be more successful and also less costly [29,30].

One additional indication for splinting may be amputated molars with severe periodontal destruction. Splinting may be useful to retain them for longer, reducing the impact of masticatory forces (by distributing them onto adjacent teeth). In a previous study [31], we demonstrated that retaining root resected molars or, generally, molars with furcation involvement is possible also for longer term [32]. However, at that time we were unable to measure the influence of splinting on molar survival. Here, we showed that splinting of such molars does necessarily come with increased risk of molar loss (but also does not increase the chance of molar retention). Given the described importance of maintaining a high number of occlusal contacts, splinting may be used to retain amputated or mobile molars, and thereby improve the chances for retaining other teeth, too [32].

While survival of splinted teeth was possible long-term, retaining these teeth came at significant efforts. A high number of repairs was needed; the majority of splints were repaired over the observational period, and nearly every second splint was repaired annually. This maintenance effort should be born in mind when planning and discussing splints with patients. Given the limited number of splinted teeth, the power of our analysis towards splint repairs was (again) limited. Nevertheless, a number of factors were or tended to be associated with splint repairs. For example, splints on lower anterior teeth and those in smokers needed fewer repairs, while repairs tended to be more likely in posterior teeth and those with severe BL (Table 3). Posterior teeth are subject to higher masticatory force than anterior teeth, and teeth with high BL may be less able to withstand chewing forces than those with low BL; the resulting stress onto the splint could lead to splint fracture. In smokers, on the other hand, it is conceivable that maintenance efforts were reduced, accepting splint failure and, later on, tooth loss as being inevitable.

Notably, different splinting materials were not associated with the number of repairs. Future analyses should aim to investigate this aspect in more detail, as different materials (glass fibre versus metal reinforced) come with different applicability, but possibly also costs and aesthetics. Note that a third option, removable thermoplastic splints, may be also clinically applied to splint teeth. However, we assumed these to constantly irritate the periodontium and additionally traumatize the teeth during repeated insertion and removal [19], and hence have not used them at all in this cohort.

The present study has a number of limitations. First, we only assessed compliant patients. Tooth (and hence splint) survival may be different in non-compliant subjects [33–35]. Generally, the findings from this specific population should not be generalized [16,17]. Smokers, for example were underrepresented [36] and possible changes during follow up were not measured. Similarly, the applied treatment regimen is not generalizable; e.g. surgical periodontal treatment has been conducted far more frequently than is the case in general dental setting in Germany [37]. Second, we assessed bruxism on patient-level only, while this does not mean that high loads are transferred onto all teeth in an identical way. Also, data on the individual oral hygiene was not always recorded and not considered in the present study. However, and as discussed, previous studies failed to find splints to impact on the ability of perform oral hygiene in the splinted area [14,27]. Third, we could not reconstruct the reason for splint repair and/or tooth loss in all cases. Also, the applied treatment regimen, where tooth removal was carefully decided, may lead to survival rates which are not comparable with those from other settings (where tooth replacement is well accepted for managing the sequels of tooth loss, and teeth are removed at earlier stages of periodontal destruction). Fourth, the unstandardized measurement of radiographic bone loss, which is common in practice, may have introduced some (non-directed) bias [4,38]. Also, BL instead of CAL had been entered into our analysis (as recession measurements had only been performed at T0, i.e. before and not after APT). Notably and to increase the reproducibility of measurements, assessment of BL had been performed twice, yielding internally reliable data. Last, and as touched above, we acknowledge the limited sample size of our study, impacting on the statistical power of our analysis. For example, our primary regression analysis did not find splinted teeth at significantly higher risk of tooth loss than non-splinted teeth. However, the Hazard Ratio was 1.3, and we think that such a 30% increase in risk could be clinically worthwhile and may be proven statistically significant in a larger sample. Prospective, larger studies (ideally conducted in practice settings), paying consideration to the discussed limitations of the present study, will be helpful to provide robust evidence on this matter.

## 5. Conclusion

Within the limitations of our study, long-term tooth survival of splinted teeth was possible in compliant periodontitis patients. When accounting for baseline periodontal conditions, splinted teeth were not at significantly higher risk of tooth loss than non-splinted ones. However, repairs of splints were frequently needed. In conclusion, periodontally affected teeth which can be retained but show high mobility can be successfully splinted to stabilize them. While re-splinting is oftentimes possible, patients and dentist need to consider the high maintenance efforts of splints in their decision-making.

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