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Survival and maintenance efforts of adhesively attached extracted teeth in periodontitis patients

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ABSTRACT

Objectives: For extracted teeth in periodontitis patients, adhesively attaching their crown to the adjacent teeth temporarily closes the otherwise resulting gap, allowing to postpone more comprehensive prosthetic treatment to a more appropriate time if required. This study assessed the survival and maintenance efforts of adhesively attached extracted tooth crowns ('immediate pontics'; IPs).
Methods: Patients receiving active and supportive periodontal treatment involving IPs in a university setting were retrospectively assessed. Survival and repairs of IPs were recorded. Multilevel Cox and linear regression analyses were performed to assess factors associated with survival and maintenance efforts.
Results: Twenty-seven patients (male/female: 12/15) with 34 IPs (maxilla/mandible: 13/21) were followed over mean ± SD 8.0 ± 5.0 [range: 2.0–19.3] years. At baseline 85.2% suffered from periodontitis stage II or III and 59.3% showed rapid progression (grade C). The mean (95% CI) survival time of splinting was 5.3 ± 3.8 [range: 0.1–18.0] years. Three IPs had been removed without any significant association with patient- or tooth-level factors. 35.3% of the IPs (n = 12) required a repair, with a mean of 0.5 ± 0.9 [0–3] repairs per IP (annual: 0.1 ± 0.2 [0–0.5]). The risk of repairs significantly increased with patients' age ($p = 0.018$).
Conclusion: IPs showed moderate survival. However, to maintain IPs, frequent repairs were needed.
Clinical significance: Immediately and adhesively attached crowns of extracted teeth in periodontitis patients seems like a valid, albeit temporary strategy which may allow to postpone more comprehensive prosthetic treatment if required, for example during active periodontal therapy. However, to maintain immediate pontics, frequent repairs were needed.

1. Introduction

Periodontitis accounts for a substantial proportion of tooth loss and masticatory dysfunction, generates significant dental care costs, and has a plausible negative impact on general health [1]. If managed appropriately, involving a systematic control of the dental biofilm and the associated periodontal inflammation during both active (APT) and supportive periodontal therapy (SPT), periodontally affected teeth can be retained long-term [2,3].

Before or during APT, dentists often decide to remove severely affected teeth, anticipating them to have only a poor prognosis [4], resulting in unforeseen, expensive complications in the nearer future [5] and potentially compromising the prognosis of the adjacent teeth. The removed teeth, however, usually need replacement, especially in the anterior area. Replacing teeth prior to or during APT using fixed or removable dental prothesis is associated with unfavourable results [6].

Alternative and less common is the adhesive attachment of the crown of the extracted tooth to one or both adjacent teeth. This therapy resembles the splinting of mobile, periodontally affected teeth (for reasons of masticatory function, aesthetics or treatability), which is also performed adhesively using resin composite, with or without reinforcement. Teeth splinted this way have been found to show successful long-term survival and periodontal stability [7,8].

The adhesive attachment of extracted tooth crowns hence serves as a temporary "direct bridge", also termed immediate pontic (IP), which is technically comparable to anterior resin-bonded fixed dental prostheses (RBFDPs). The latter show high long-term survival [9–11]. However, studies on such prostheses were not focussed on periodontitis patients and RBFDPs are – other than IPs – not planned as temporary, but definitive treatments (also coming with very different costs).

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It is currently unclear if IPs are a valid option for immediately (and temporarily) providing periodontitis patients with a tooth replacement; so far, only case reports have been published and data on survival or maintenance effort of IP are unavailable. The aims of our study were (1) to evaluate the survival of IPs, (2) to assess the required efforts for maintaining them, and (3) to analyse predictors for survival and maintenance needs of IPs.

2. Material and methods

2.1. Participants

This study builds on a cohort of patients with a history of periodontitis, who had been consecutively recruited in the Department of Conservative Dentistry and Periodontology at the University of Kiel. We have reported on this cohort elsewhere in detail [12]. All patients gave their informed consent for the analysis of their data documented during periodontal therapy. The ethics committee of the Christian-Albrechts-University Kiel approved the study (AZ: D442/10).

The present investigation included only patients with extracted tooth crowns adhesively attached (IPs) to their two neighbours using resin composite, with or without reinforcement. Note that while for RBFDPs, attachment to only one adjacent tooth is nowadays often recommended, this was neither the standard when most of the IPs were placed, nor is it clear if such approach is also the method of choice for placing IPs. 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, received SPT for ≥ 2 years with minimum 1 visit/year (including annual documentation of probing pocket depths (PPD)), a radiographic documentation at the time of IP insertion (T1, maximally one year before that) and at the last documented visit of SPT (T2). Periodontal disease was classified based on baseline periodontal records using the current classification of periodontal diseases [1]. Out of 6543 documented patients available in our database, 27 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 previously described [2,13]. APT included non-surgical mechanical root debridement (scaling and root planing, SRP) with, if indicated, additional access flap surgery (open flap periodontal treatment, OFP) and/or adjunctive systemic antibiotic therapy. Further treatments, e.g. endodontic treatment or tunnelling and molar root resections, were performed in individual cases. No patient received pocket elimination surgery or osseous resection. Re-evaluation after APT was performed after three to six months.

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 OFP with or without subsequent systemic antibiotic therapy were performed.

2.3. Clinical and radiographic assessment

A full dental status was recorded once yearly. Data for third molars were excluded. The following variables had been assessed:

- Age and gender at T0.
- Smoking status at T0, recorded in three categories (never; former, i.e. quit > 5 years ago; current smoker), as described by Lang and Tonetti [14].
- Mobility, classified in degrees 0–3 according to Lindhe and Nyman [15].
- PPD were evaluated at six sites per tooth at T0, T1 and T2.
- Radiographic bone loss (BL) was assessed at T0, T1 and T2 using peri-apical radiograph film series. These were evaluated after digitizing as described previously by our group [12]. 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.
- IP location, categorized as upper anterior, lower anterior and posterior area.
- The distribution of occlusal contact areas was determined at T0 and T2 according to the classification of Eichner [16], where the four posterior contact zones (extending from the first premolar to the last molar) are assessed for antagonistic contacts. The number of occlusal contacts could indicate the load placed onto single teeth during mastication, which may be relevant for IP survival. Within the Eichner classification and for the present analysis, 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.

Also note that based on our data and using additionally collected data on gingival recession, clinical attachment loss (CAL) was only determined at T0 and used for staging the periodontal disease [1]. In line with previous publications, we do not report further on CAL, but PPD and BL here.

2.4. Immediate pontics (IPs)

Overall, 34 IPs were assessed. After the extraction of the teeth, their crowns were attached to both adjacent teeth using either solely composite (n = 28), composite reinforced with glass-fibre (n = 5) or wired metal (n = 1); no IP was attached to only one adjacent tooth, as described. Details of the technical procedure are described in the supplemental material on an exemplary case (Fig. S1). The loss of IPs and the number of repairs per IP and year was documented. If removal or repair were needed, they were all performed in our department.

2.5. Statistical analysis

Statistical evaluation was performed using SPSS 24 (IBM, Chicago, USA) plugged into R 3.1.0. Descriptive analyses were performed for the overall sample of IPs. The mean survival time for IPs was estimated as the area under the survival curve for the interval T1-T2. Multilevel multivariable cox and linear regression were performed, accounting for the clustering of teeth within patients. A number of patient level and tooth level predictors for survival and repair of IPs were assessed, including age, gender, smoking status, Eichner classification, tooth location and jaw. Given that we accept this analysis to be most likely underpowered, it serves explorative rather than confirmatory purposes.

3. Results

3.1. Included patients, teeth and IPs

At baseline (T0), the included 27 patients (male/female: 12/15) had a mean ± SD age of 50.4 ± 13.0 [range: 27–72] years. Patients had a permanent dentition with a mean of 25.0 ± 3.3 teeth (T2: 21.1 ± 5.5). Twenty patients (74.1%) were non-smokers, one patient (3.7%) was a former smoker and six patients (22.2%) smokers. Four patients (14.8%) suffered from periodontitis stage II (grade A: n = 2; grade B: n = 2), 15 patients (55.6%) stage III (grade B: n = 5; grade C: n = 10) and 8 patients (29.6%) stage IV (grade B: n = 2; grade C: n = 6).

Overall, 34 IPs were placed, with a mean number of 1.3 ± 0.9

Table 1
Characteristics of the sample (IP: immediate pontic).

Number of patients (male / female)	27 (12 / 15)	
Age at T0 (mean ± SD) in years	50.4 ± 13.0	
Observation time in years (mean ± SD [range])	8.0 ± 5.0 [2.0 – 19.3]	
Number of smokers / former smokers / never smokers	6 / 1 / 20	
	T0	**T2**
Number of teeth	609	543
Number of teeth / patient (mean ± SD)	25.0 ± 3.3	21.1 ± 5.5
Number of teeth lost / patient (mean ± SD)	3.0 ± 3.3	6.9 ± 5.5
Mean PPD in mm of non-splinted teeth (mean ± SD)	4.6 ± 1.6	3.1 ± 0.9
Mean BL in % of non-splinted teeth (mean ± SD)	46.3 ± 23.4	42.3 ± 21.3
	T1	**T2**
Number of IP	34	31
Mean PPD in mm of IP before extraction (mean ± SD)	6.7 ± 1.7	–
Mean BL in % of IP before extraction (mean ± SD)	85.2 ± 19.6	–
Mobility of IP before extraction (degree 0/1/2/3)	5/5/4/20	–

T0: prior to APT; T1: prior to adhesive re-attachment of extracted tooth crown (IP); T2: end of investigation.

[1–5] per patient. Teeth which were extracted and had their crowns attached showed worse periodontal conditions at T1 than non-splinted teeth at T0 (Table 1) and were largely highly mobile.

IPs were followed over a period of 8.0 ± 5.0 [2.0–19.3] years. Three IPs were removed during this period (one IP placed using glass fibre reinforced composite and two IPs using non-reinforced composite for attaching). The estimated mean (95% CI) survival period of IPs was 5.3 ± 3.8 (0.1–18.0) years (Fig. 1), with lower anterior (n = 20; 6.3 years; 1.4–18.0) and upper anterior (n = 8; 4.9 years; 1.9–11.2) IPs showing longer survival times than posterior IPs (n = 6; 2.4 years; 0.1–4.7). A number of predictors (age, smoking, Eichner class, localisation, jaw) were entered into survival analysis; no predictor was significantly associated with removal (loss) of IP (Table 2).

Twelve (35.3%) IPs required a repair during follow-up (one IP placed using metal reinforced composite, one IP using glass fibre reinforced composite and 10 IPs using non-reinforced composite for attaching), with a mean of 0.5 ± 0.9 [0–3] repairs per IP, and 0.1 ± 0.2 [0–0.5] per IP and year. The annual number of repairs significantly increased with patients' age (by 0.24 additional repairs per patient and year of age, $p = 0.018$). No further predictors were significantly associated with annual repairs (Table 3).

4. Discussion

While splinting is a widely used therapeutic option for retaining teeth with periodontal destruction [7,8,17], very limited evidence on the survival and maintenance efforts of IPs in periodontitis patients is available. We found IPs to have relatively high survival (considering 5 years to be rather long for a temporary solution), but to frequently require repairs. These maintenance efforts need to be contrasted with the initial costs for IPs, and should be compared with those of implant or tooth supported removable or fixed dental prostheses [5,6].

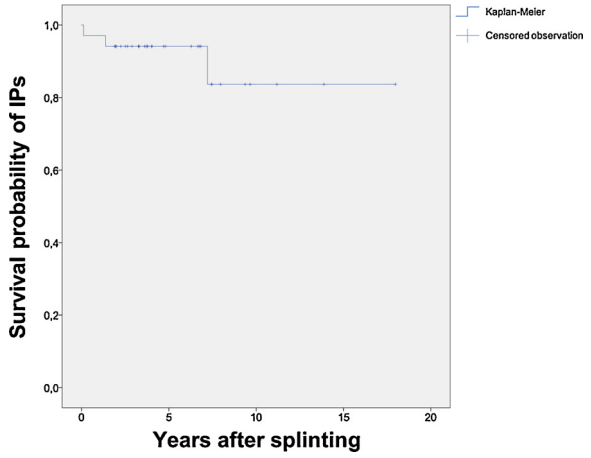

Fig. 1. Survival of immediate pontics (IPs).

Table 2
Predictors of removal of immediate pontics (IPs).

Variables	Coefficients	*p*-value	95 % CI	
Age (cont.)	−0.083	0.396	0.761	1.114check
Gender (ref.: female)	0.718	0.631	0.109	38.49
Never smoker (reference)	0	0		
Former smoker	10.536	0.976	0.000	1.136
Smoker	11.070	0.786	0.000	3.113
Eichner class A (reference)	0	0		
Eichner class B1	2.256	0.988	0.000	3.766
Eichner class B2	10.619	0.976	0.000	1.238check
Eichner class C1	−9.950	0.977	0.000	9.202check
Localisation upper-front (reference)	0	0		
Localisation lower front	−19.377	0.765	0.000	5.449check
Localisation upper/ lower premolars/ molars	−1.945	0.995	0.000	3.198check
Upper jaw (reference)	0	0		
Lower jaw	9.254	0.978	0.000	2.043check

Multilevel multivariable Cox regression was used. Regression coefficients and 95% CI are shown. No predictor was significantly associated with IP removal.

Table 3
Association of covariates with the annual number of repairs of immediate pontics (IPs).

Variables	Coefficients	*p*-value	95 % CI	
Age (cont.)	**0.240check**	**0.018**	**1.042**	**1.551**
Gender (ref.: female)	3.454	0.095	0.549	1821
Never smoker (reference)	0			
Former smoker	−0.624	0.733	0.015	19.23
Smoker	1.379	0.289	0.311	50.70
Eichner class A (reference)	0			
Eichner class B1	−15.976	0.990	0.000chec empty column	
Eichner class B2	−2.525	0.187	0.002	3.407
Localisation upper-front (reference)	0			
Localisation lower front	0.655	0.668	0.97	38.26
Localisation upper/ lower premolars/ molars	−1.601	0.403	0.005	8.617
Upper jaw (reference)	0			
Lower jaw	−2.114	0.249	0.003	4.381

Multilevel multivariable linear regression was used. Regression coefficients and 95% CI are indicating the in- or decrease of the annual number of repairs. Significant associations are highlighted in bold.

Our results on IPs are in line with findings on splinted, mobile teeth in periodontitis patients [8]. IPs seem suitable to postpone more comprehensive prosthetic treatment to more appropriate times, e.g. after APT or when a more systematic decision-making (involving several teeth with formerly unclear prognosis, for example) is possible. IPs hence also allow dentists to apply stepwise decision-making.

As mentioned, IPs can be compared with RBFDPs. Traditionally, RBFDPs were bonded to both adjacent teeth; this approach was also used for IPs (most of which had been placed in the 1990s) in the present study. More recent evidence finds bonding of RBFDPs to only one tooth to yield higher survival, as bending stress onto the adhesive layer is reduced if the RBFDP is not connected to two, but only one tooth [9,11]. In further studies it would be relevant to assess if single-tooth-bonded IPs show higher survival than conventional IPs. Another point to stress is the method of attaching the IPs to the neighbors. With only

five and one IPs attached using composite reinforced with glass-fibre and wired metal, respectively, we could not discern if the attachment material has relevance for success and survival of IPs [7]. Given that IPs are regarded as a temporary solution, the more cost-intensive use of reinforced composite may need additional justification by future studies. Generally, and similar to RBFDPs, adhesive attachment of IPs is technic sensitive; failures are often associated with the treating dentist's experience [18]. In our study, only trained specialists performed the operative procedure; it remains unclear how well such IPs perform in the hands of less experienced dentists.

A number of factors may conceivably impact on IP survival and maintenance efforts. While our analysis failed to identify any significant associations between different patient and tooth level factors and survival of IPs (which may be expected with only 3 IPs not surviving), our analysis on repairs came with a higher statistical power. Overall, around one third of the IPs were repaired over the observational period. Patients' age was significantly associated with higher number of annual repairs. We speculate that with older age, the risk of periodontal complications during SPT increases, as has been demonstrated in several retrospective studies before [19], leading to unforeseen complications either on adjacent teeth, or to masticatory dysfunctions increasing the risk of IP repair.

Unexpectedly, tooth location (anterior upper/lower, posterior) and Eichner classification were not associated with the risk of repair. One would assume that posterior teeth are subject to higher masticatory force than anterior teeth, and hence require more repairs. Notably, though, such association was also not confirmed in a 5-years-study on RBFDPs [20]. One would also assume that with more teeth missing and a reduced number of supportive zones, the risk of repairs increases. In our analysis, a trend could be detected; in patients with Eichner class C1, more repairs tended to occur. The relevance of supportive zones (and with it, likely, a better distribution of masticatory forces) has been confirmed not only for tooth splints, but also prosthetic rehabilitations in periodontitis patients [6]. Dentists should strive to maintain a high number of occlusal units by managing periodontal disease early on.

The present study has a number of limitations. First, we only assessed a small sample of compliant patients. Tooth (and hence IP) survival may be different in non-compliant subjects [21–23]. Findings from this specific population should not be generalized [2,13]; for example smokers were underrepresented [24]. Also, the applied treatment regimen is not generalizable; e.g. surgical periodontal treatment has been conducted more often than is currently common in general dental practice in Germany [25]. The limited sample size certainly impacts on our statistical power; with only 3 "events" (loss/removal of IPs) in our survival analysis, it is not unexpected to not find any significant associations with the employed predictors. The sample size was also the reason to not test for the effects of different splinting materials; we nevertheless assessed differences in failure rates. Future analyses may wish to investigate this aspect in more detail, as different materials (resin non-reinforced vs. glass fibre vs. metal reinforced) come with different biomechanical properties (mainly stiffness), but also applicability, costs and aesthetics. Second, prospective studies on RBFDPs usually assess further factors like the width of the gap, overjet and overbite, which are relevant from a biomechanical perspective [11]. All these factors had not been recorded in our present cohort, and may warrant further inspection in future studies. Last, we could not always reconstruct the reasons for IP loss/removal or repair; learning from these reasons on how to improve the prognosis of IPs is hence not fully possible.

5. Conclusion

Within the limitations of this pilot study IPs showed moderate survival. Immediately and adhesively attaching crowns of extracted teeth in periodontitis patients seems like a valid, albeit temporary strategy which may allow to postpone more comprehensive prosthetic treatment if required. However, to maintain IPs frequent repairs were needed.

Conflict of interest and source of funding

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Appendix A. Supplementary data

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