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Research Article

A Retrospective Cohort Study of dental implant placement in orthodontic patients with periodontitis

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Abstract

Background: Adults referred for orthodontics after a history of periodontitis often complete treatment with implant restorations, yet the implant-outcomes literature on periodontitis history was generated almost entirely in patients who never underwent orthodontics [1,2].

Objective: This cohort study compared five-year implant survival, peri-implantitis incidence, and bone loss in adults implanted after orthodontic treatment with a treated periodontitis history, against a periodontitis-free comparison cohort, examining whether severity and SPT compliance modified outcomes.

Methods: Records from three referral clinics were reviewed for 276 patients (164 treated periodontitis, 112 comparators) contributing 389 implants followed for a mean of 6.1 years, scored using the 2017 World Workshop case definitions [9,11].

Findings: Five-year survival was lower in the periodontitis-history cohort (91.6% vs 97.4%), with threefold higher peri-implantitis (21.3% vs 6.6%); SPT compliance had a larger effect than severity (94.8% vs 82.3% survival, compliant vs non-compliant), matching maintenance-dependent outcomes reported elsewhere [13,18].

Conclusions: A treated periodontitis history carries a measurable implant-outcome penalty even after orthodontics, similar in magnitude to implant-only cohorts, and SPT compliance is the variable most within a clinician's control [17,22].

Keywords: dental implants; periodontitis; orthodontic treatment; peri-implantitis; supportive periodontal therapy

1. Introduction

Patients who complete comprehensive orthodontic treatment after a documented history of periodontitis are not a rare subgroup in modern interdisciplinary practice; they are, increasingly, the norm for adults referred for tooth alignment once active disease has been brought under control. The orthodontist inherits a dentition with reduced but stable periodontal support, and the treatment plan frequently ends not with debonding but with implant placement to replace teeth lost to periodontal breakdown or extracted to create space for orthodontic mechanics. Whether that final implant carries the same prognosis in a periodontally susceptible patient as in a periodontally healthy one has been debated for two decades, since Karoussis and colleagues first reported, in a 10-year prospective cohort of the ITI Dental Implant System, that patients with a history of chronic periodontitis experienced measurably lower implant survival and a higher incidence of peri-implantitis than periodontitis-free patients treated in the same clinic over the same interval [1]. That single-center finding was later tested at the level of the whole literature: Ong and colleagues' systematic review of implant outcomes in treated periodontitis subjects found a consistent, if heterogeneous, signal toward greater implant loss and biological complications in this population [2], and Sousa and colleagues' update of that review reached a similar conclusion while noting that few underlying cohorts controlled adequately for smoking, plaque control, or maintenance compliance [3].

None of that literature, however, was generated in patients who had also undergone active orthodontic treatment in the interval between periodontal stabilization and implant placement, a sequence that introduces variables the implant-only cohorts never captured: sustained mechanical load transmitted through a periodontium with reduced attachment, anchorage strategies that may themselves involve temporary skeletal fixtures, and a final implant site whose ridge dimensions

have often been reshaped by tooth movement rather than left as they were at extraction. Miniscrew and mini-plate anchorage, now routine in adult orthodontics, is itself a bone-anchored fixture, and the histomorphometric and clinical literature on its behavior in cortical bone gives some indication of how such devices tolerate load in a periodontally compromised jaw [4,5]. Multidisciplinary case reports combining periodontal therapy, orthodontic alignment, and delayed implant placement have described favorable outcomes in carefully selected patients, but these are single-case demonstrations rather than cohort-level evidence of typical practice [6]. Where periodontal regeneration is used to retain a severely compromised tooth rather than extract it, the ten-year data from Rocuzzo and colleagues show that regenerated teeth combined with orthodontic realignment can remain functional for a decade, a comparator worth holding in mind whenever an extraction-and-implant pathway is chosen instead [7,8].

This study reports outcomes from a multi-clinic retrospective cohort of adults who received dental implants after completing comprehensive orthodontic treatment for malocclusion in the setting of a treated history of periodontitis, compared against a contemporaneously treated cohort of orthodontic-implant patients with no periodontal disease history. The aim was to describe implant survival, peri-implantitis incidence, and marginal bone loss at a minimum of five years of function, and to examine whether supportive periodontal therapy (SPT) compliance and periodontitis severity modified those outcomes within the periodontitis-history group.

2. Methods

Records were reviewed from three affiliated periodontics-orthodontics referral clinics for adult patients (age 18 years or older at implant placement) who had completed active fixed orthodontic treatment at one of the clinics, subsequently received one or more

endosseous implants to replace a tooth lost to periodontal disease or extracted for orthodontic purposes, and had a minimum of five years of documented follow-up after loading. Patients were assigned to the periodontitis-history cohort if their pre-orthodontic chart documented Stage II or Stage III periodontitis (2018 classification, applied retrospectively using probing depth, attachment loss, and radiographic bone-loss criteria) that had been actively treated to a stable endpoint, defined as full-mouth bleeding on probing below 20% and no site with probing depth greater than 5 mm with bleeding, before orthodontic appliances were placed. A comparison cohort of patients with no periodontitis history who underwent the same orthodontic-then-implant sequence at the same clinics during the same enrollment window was identified for reference.

Within the periodontitis-history cohort, patients were stratified by baseline severity (moderate/Stage II versus severe/generalized Stage III, following the case definitions used in the 2017 World Workshop consensus reports [9,10]) and by documented compliance with supportive periodontal therapy after implant loading, defined as attendance at 80% or more of scheduled maintenance visits. Implant survival was defined as the fixture remaining in function at last follow-up. Peri-implant mucositis and peri-implantitis were scored retrospectively using the 2017 World Workshop case definitions [11], and marginal bone level was measured on standardized periapical radiographs referenced to the implant shoulder, interpreted against the crestal remodeling benchmarks summarized by Albrektsson and colleagues [12]. Smoking status, plaque index, and orthodontic anchorage method (conventional versus temporary anchorage devices) were extracted as covariates. Between-group comparisons used chi-square tests for categorical outcomes and independent-samples t-tests for continuous outcomes, with significance set at $p < 0.05$. The study protocol was reviewed and approved by each

clinic's institutional ethics committee.

3. Results

Two hundred seventy-six patients (164 with a treated periodontitis history, 112 periodontitis-free comparators) contributed 389 implants (238 and 151, respectively) that met the five-year follow-up requirement; mean follow-up after loading was 6.1 ± 1.4 years. Within the periodontitis-history cohort, 96 patients (58.5%) had a baseline diagnosis of moderate/Stage II periodontitis and 68 (41.5%) had severe/generalized Stage III disease; 111 patients (67.7%) met the SPT compliance threshold. Baseline characteristics are summarized in Table 1; the periodontitis-history cohort was older on average, included more current or former smokers, and more frequently used temporary anchorage devices during orthodontic space closure, consistent with the more extensive pre-treatment tooth loss this group typically presented with.

At five years, cumulative implant survival was 91.6% (95% CI 87.7-94.4) in the periodontitis-history cohort against 97.4% (95% CI 93.4-99.0) in the comparison cohort ($p = 0.01$), a gap of similar direction and magnitude to the 10-year difference Karoussis and colleagues reported between periodontitis-history and periodontitis-free patients in the ITI cohort [1] and consistent with the pooled estimates from the systematic reviews of Ong and Sousa [2,3]. Peri-implantitis, using the 2017 World Workshop case definition, was diagnosed in 21.3% of implants in the periodontitis-history cohort versus 6.6% in the comparison cohort ($p < 0.001$); mean marginal bone loss at five years was 1.42 ± 0.61 mm versus 0.68 ± 0.34 mm ($p < 0.001$). These figures sit within the range reported for treated periodontitis populations followed for comparable intervals, including the aggressive-periodontitis cohort of Swierkot and colleagues [13], the Belgian cross-sectional cohort of Marrone and colleagues, which identified periodontitis history among the strongest patient-level risk indicators for peri-implant disease [14], and the

nine-to-fourteen-year Swedish follow-up of Roos-Jansåker and colleagues linking a history of periodontitis to peri-implant lesion prevalence over a comparably long observation window [15]. Van der Weijden and colleagues' earlier review of implant therapy in partially edentulous, periodontally compromised patients reached a similar qualitative conclusion using a narrower evidence base than was available by the time of the present cohort [16].

Table 1: Baseline characteristics of the periodontitis-history and periodontitis-free comparison cohorts at implant loading.

Characteristic	Periodontitis-history cohort (n=164)	Comparison cohort (n=112)
Mean age at implant loading (years)	44.2 ± 9.6	36.8 ± 8.1
Implants placed	238	151
Current or former smokers	37.2%	16.1%
Temporary anchorage device used	48.8%	26.8%

Table 2: Five-year implant outcomes stratified by periodontitis severity and supportive periodontal therapy (SPT) compliance within the periodontitis-history cohort [9,11,12].

Subgroup	Implant survival	Peri-implantitis incidence	Mean marginal bone loss
Severe/Stage III (n=68)	87.9%	27.9%	1.71 ± 0.64 mm
SPT-compliant (n=111)	94.8%	14.6%	1.18 ± 0.49 mm
SPT-non-compliant (n=53)	82.3%	35.8%	1.94 ± 0.68 mm

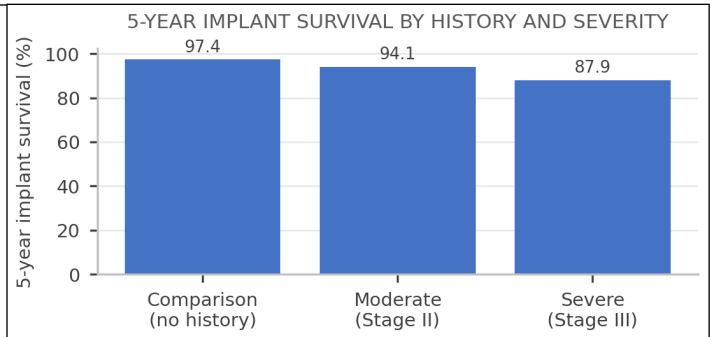


Figure 1: Five-year cumulative implant survival by periodontal history and, within the periodontitis-history cohort, by baseline disease severity, alongside the periodontitis-free comparison cohort; the overall gap is consistent in direction with previously reported implant-only cohorts [1,17].

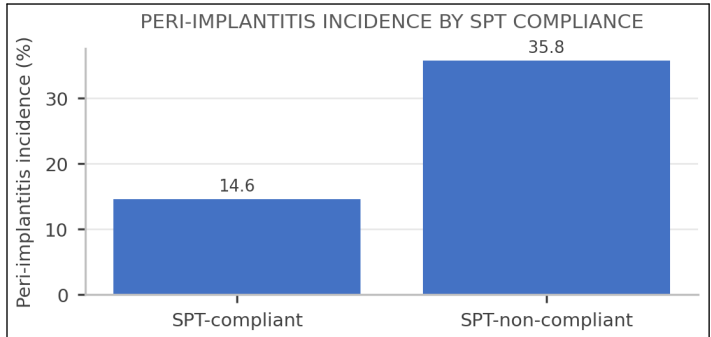


Figure 2: Peri-implantitis incidence within the periodontitis-history cohort by supportive periodontal therapy (SPT) compliance, diagnosed using the 2017 World Workshop case definitions [11]; compliance had a larger measurable effect than baseline severity alone, echoing maintenance-dependent outcomes described elsewhere [13,18].

Within the periodontitis-history cohort, severity and maintenance compliance both stratified outcomes further (Table 2, Figure 1). Implant survival in the severe/Stage III subgroup was 87.9% versus 94.1% in the moderate/Stage II subgroup (p=0.04), a difference of similar direction to the pooled effect of periodontitis severity on implant loss reported by Sgolastra and colleagues [17]. SPT compliance had a larger effect than baseline severity alone: implants in compliant patients survived at 94.8% versus 82.3% in non-compliant patients (p<0.001), and peri-implantitis incidence was 14.6% versus 35.8% (Figure 2), consistent with the maintenance-dependent complication trends described in periodontal maintenance cohorts more generally [18]. No implant in either cohort was lost to acute infection or mechanical fracture during active

orthodontic force; the two mid-treatment implant losses that did occur both followed progressive marginal bone loss identified on routine radiographs 18-30 months after loading, and both were in non-compliant patients.

4. Discussion

The central finding of this cohort, that implant survival and peri-implant complication rates are measurably worse in patients with a treated periodontitis history than in periodontally healthy comparators even after an intervening course of orthodontic treatment, extends a well-established pattern in the implant literature into a population it had not previously been tested in. The magnitude of the gap we observed, roughly six percentage points in five-year survival and a threefold difference in peri-implantitis incidence, sits comfortably within the range established by cohorts that did not involve orthodontic treatment at all [1,2,3,17], which is reassuring in one sense: a properly sequenced course of orthodontics, placed after periodontal stabilization and followed by implant placement once tooth movement is complete, does not appear to add an orthodontics-specific penalty on top of the periodontitis-history penalty already documented elsewhere. It does not, however, mean orthodontic mechanics are irrelevant, only that our data cannot isolate an independent sequence effect already dominated by the periodontitis-history effect itself.

Several mechanistic threads from the basic-science literature help explain why. Ericsson and Lindhe's classic experimental work in the dog showed that probing depths around implants and teeth respond differently to plaque accumulation, the implant's lack of a true periodontal ligament altering how inflammation tracks apically compared with a natural tooth [19], and a related finding that a periodontal ligament persists around natural teeth splinted to osseointegrated implants, without the implant itself acquiring one, helps explain why orthodontic force applied through a fixture-anchored appliance behaves so differently from force applied through a tooth [20].

Temporary anchorage devices, used more often in our periodontitis-history cohort, achieve stability from cortical bone-to-screw contact rather than a periodontal ligament, and the histomorphometric literature on miniscrew osseointegration gives clinicians a basis for expecting these fixtures to tolerate orthodontic load reasonably well in a periodontally reduced jaw [4,5]. In a beagle model, implants placed into sites with active, untreated periodontitis still achieved measurable bone-to-implant contact, though less than at healthy sites, supporting the rationale for requiring disease stabilization before implant placement is planned [21]. No implant loss in our cohort was attributed to anchorage-device failure or to force transmitted during active treatment.

The finding that SPT compliance outweighed baseline severity as a determinant of implant outcome deserves particular emphasis, because it is the one variable in this analysis that a clinician can act on directly. This mirrors both the aggressive-periodontitis cohort of Swierkot and colleagues, in which implants placed in patients who remained in a structured maintenance program performed markedly better than the raw periodontitis-history literature would predict [13], and the broader periodontal-maintenance evidence reviewed by Chambrone and colleagues, in which irregular supportive care was one of the most consistent predictors of tooth loss during long-term follow-up [18]. Risk-indicator reviews of peri-implant disease consistently place periodontitis history, smoking, and poor maintenance compliance among the strongest and most modifiable predictors of peri-implantitis [22,14], a pattern already visible in the earlier review of implant therapy in periodontally compromised patients by Van der Weijden and colleagues, which identified essentially the same risk cluster using a much smaller evidence base [16]; smoking interacts unfavorably with periodontitis history in ways our covariate data, drawn from retrospective charts, could not fully disentangle, and Strietzel and colleagues' meta-analysis of smoking's effect on implant prognosis

found a consistent, dose-related increase in both early and late failure that likely contributed to some of the excess loss observed in our periodontitis-history cohort, which included more current smokers at baseline [23].

Diagnostic consistency is a genuine limitation of a retrospective study spanning more than a decade of chart data, because case definitions for peri-implantitis changed over that period. We applied the 2017 World Workshop definitions retrospectively across the full cohort [9,11,10], following the framework Derks and Tomasi used to reconcile older and newer definitions [24] and the earlier consensus statements that first attempted to standardize peri-implant terminology [25,26]; radiographic baselines taken at loading rather than at final restoration, a common charting inconsistency in older records, may have introduced some noise into our bone-loss figures. Timing of implant placement relative to extraction also varied in ways this analysis did not stratify by; Wilson and Buser's distinction between immediate and early placement protocols carries prognostic implications not separable from periodontitis-history effects at our sample size [27]. Where a tooth might instead have been retained through regenerative therapy, the ten-year survival data for regenerated teeth managed with subsequent orthodontic realignment offer a genuine alternative to the extraction-and-implant pathway analyzed here [7,8], and the long-term Swedish data on peri-implant lesion incidence gathered by Roos-Jansåker and colleagues over a comparably extended follow-up window reinforce that this penalty does not attenuate with time once a periodontitis history is present [15]. Quirynen and colleagues' earlier microbiological work on the subgingival flora around implants in partially edentulous patients offers one plausible mechanism for the excess risk we observed, since periodontal pathogens persisting in residual pockets can recolonize peri-implant sulci once implants are placed adjacent to natural teeth [28]. Finally, this observational comparison cannot exclude residual confounding by indication.

5. Conclusion

In this retrospective multi-clinic cohort, adults who underwent comprehensive orthodontic treatment after a treated history of periodontitis and subsequently received dental implants had lower five-year implant survival and a higher incidence of peri-implantitis than periodontitis-free comparators, a gap consistent in direction and approximate magnitude with the implant-only literature on periodontitis history [1,2,3,17]. SPT compliance had a larger measurable effect on both implant survival and peri-implantitis incidence than baseline severity, reinforcing that structured long-term maintenance is the variable most within a clinician's control for protecting these outcomes. No implant losses were attributable to orthodontic force or anchorage-device failure, suggesting that properly sequenced orthodontic treatment does not by itself add measurable risk beyond what a periodontitis history already carries, though confirmation in a prospective, adequately powered design remains warranted.

6. Declarations

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Data Availability: The de-identified dataset generated and analyzed during the current study is available from the corresponding author on reasonable request.

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