Combined Periodontal and Orthodontic Treatment of Severely Compromised Teeth in Stage IV Periodontitis Patients: How Far Can We Go?

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This retrospective study evaluated the effect of combined periodontal-orthodontic treatment in terms of clinical, radiographic, and patient-reported outcomes in 40 stage IV periodontitis patients with advanced attachment loss and pathologic migration of anterior teeth. Full-mouth periodontal parameters were recorded at baseline (after diagnosis; T0), at the end of active periodontal therapy (APT; T1), at completion of orthodontic tooth movement (OTM; T2), and at the last supportive periodontal care (SPC) visit (T3). Radiographic analysis was performed at T0, T2, and T3. A total of 115 teeth were lost during APT, including 5 molars at T2 (used as orthodontic anchorage) and 10 premolars at T3 (due to root fracture). All anterior migrated teeth were in function at T3 (mean duration: 9.5 years). Significant mean probing pocket depth reduction (1.5 ± 1.1 mm) and attachment level gain (0.9 ± 1.0 mm) were observed after APT, whereas OTM and SPC were associated with furthering small changes. The alveolar bone level at T3 was slightly increased from T0 values. Patient-reported outcome measurements significantly improved in terms of esthetics and masticatory function. OTM should be considered an essential part of the comprehensive treatment plan to change the prognosis of severely compromised teeth in stage IV periodontitis patients. Int J Periodontics Restorative Dent 2022;42:731–738. doi: 10.11607/prd.6247

Periodontitis is a complex chronic inflammatory disease characterized by the irreversible destruction of tooth-supporting tissues, and it is one of the most common noncommunicable diseases worldwide. In its more severe form (stage IV), the considerable damage to the periodontal support is often associated with pathologic tooth migration (PTM) and overeruption of anterior elements, posterior bite collapse, and drifting due to loss of the molar teeth.1,2 These changes in tooth position compromise the appearance and function of the dentition and negatively influence self-esteem and quality of life for the patient.3 Indeed, worsened smile esthetics is often the key motive for patients to seek treatment.4

For such cases, a comprehensive interdisciplinary treatment is recommended.1,5,6 Previous studies demonstrated that intrusive and retrusive orthodontic tooth movements (OTMs) are effective in correcting flaring, overeruption, and embrasures in the frontal area.7,9 Realignment of malpositioned teeth can help maintain the residual dentition, ameliorate periodontal parameters, and restore masticatory function, provided that non-inflamed and stable periodontal conditions have been reestablished before OTM.10 However, errors in OTM planning and

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timing may cause adverse effects that could jeopardize the prognosis of the involved teeth.\textsuperscript{11,12} Recently published systematic reviews focused on the available evidence regarding the risks and benefits of OTM in periodontitis patients and emphasized the need for additional studies.\textsuperscript{13,14}

Therefore, the present retrospective study investigated the clinical and radiographic effects of combined periodontal and orthodontic treatments on tooth-supporting tissues and the risk for tooth loss in patients with advanced periodontitis and pathologically migrated teeth who were enrolled in a strict periodontal supportive program. Moreover, patient-reported outcome measures (PROMs) were evaluated.

Materials and Methods

Study Design and Population

The study comprised patients treated for generalized severe chronic periodontitis\textsuperscript{15} or stage IV periodontitis\textsuperscript{1} and PTM of anterior teeth between January 1999 and November 2017 in a private periodontal specialist practice in Turin, Italy. Protocol approval was obtained from the Institutional Ethics Committee (no. 2028), and the investigation was conducted in agreement with the Declaration of Helsinki. Inclusion and exclusion criteria are reported in Appendix Table 1 (available in the online version of this article at quintpub.com/journals).

Combined Periodontal and Orthodontic Treatment

The treatment procedures included active periodontal therapy (APT), OTM, and supportive periodontal care (SPC).

Active periodontal therapy

After initial periodontal diagnosis based on comprehensive clinical and radiographic examinations (baseline, T0), all patients underwent APT before the start of OTM. This included risk factor control, supragingival instrumentation, and extraction of teeth considered irrational to treat.\textsuperscript{16} All sites that did not adequately respond to the second cycle of reinstrumentation were planned for surgical therapy in order to achieve pocket closure, defined as probing depth (PD) $\leq$ 4 mm without bleeding on probing (BoP). Surgeries were performed by the same expert periodontist (M.A.) involving conservative surgery/an apically positioned flap with osseous resectional surgery in small bone defects at posterior regions, or regenerative surgery with minimally invasive flap design in deep intrabony defects at both anterior and posterior teeth (enamel matrix derivative alone or combined with bone grafting, determined according to the bone morphology).

Orthodontic tooth movement

OTM began 3 to 6 months after the completion of APT (T1) for patients demonstrating full-mouth plaque score (FMPS) and full-mouth bleeding score (FMBS) $<$ 20%. A full-mouth clinical examination and periapical radiographs at surgically treated sites were performed immediately before OTM.

The orthodontic treatment goals were to change molar and canine relationships to a Class I situation, to close anterior tooth spacing, to correct overbite and overjet, and to reestablish stable occlusion, satisfactory masticatory function, lip position, and smile esthetics. All patients were treated with a full fixed orthodontic appliance and bonded brackets—either in the maxilla, mandible, or both—by the same orthodontist (D.G.) using the segmented arch technique. The active force to intrude and realign the migrated incisors and to obtain space closure was obtained by inserting one cantilever (titanium-molybdenum alloy; 0.017 $\times$ 0.025 inches) on each side. Simultaneous tooth intrusion and retraction was obtained with logarithmic shape cantilevers.\textsuperscript{17} The forces used were light, 10 to 15 g per tooth, depending on the amount of residual periodontal support. The treatment was completed with the straight wire technique using temporary bite-raising acrylic coverage of posterior teeth to avoid occlusal interferences. Anchorage, where needed, was ensured with temporary anchorage devices or prosthetic implants. Reactivation was performed every 8 to 10 weeks, and professional prophylaxis was carried out at 2-month intervals by dental hygienists during OTM. Lifelong retention was obtained with bonded lingual retainers, and an additional vacuum-pressured removable retainer was provided to prevent tooth relapse in case of accidental debonding of the retainer.
Supportive periodontal care
At the completion of OTM (T2), patients underwent full-mouth x-rays and were placed on SPC with individualized intervals. At each SPC visit, patients received reinforcement of self-performed oral hygiene measures and professional debridement. Periodontal data were collected once a year. Patients received fixed restorations on implants in the posterior area when needed.

Data Extraction
Demographic information (age at the start of APT, gender, compliance, smoking habit, self-reported systemic conditions, periodontal diagnosis) and full-mouth periodontal clinical data (excluding third molars) were recorded at T0, T1, T2, and at the time of the latest maintenance visit (T3), and the information was entered into a data set for statistical analysis. Each tooth lost during the observation period was classified according to the reason for extraction (periodontal disease, endodontic problems, caries, fracture, prosthetic reasons, or unknown reasons). According to tooth loss during SPC, patients were considered as well-maintained (0 to 3 teeth lost), downhill (4 to 9 teeth lost), or extreme downhill (≥ 10 teeth lost).18

Periodontal bone levels at treated anterior teeth were assessed twice using the Image J software (National Institutes of Health) by one calibrated examiner (C.V.) for all periapical radiographs taken at T0, T2, and T3. The intraclass correlation coefficient was 0.91, showing high reliability. Separate scorings were made at mesial and distal aspects of each anterior tooth, and the mean value was used for statistical analysis. The recorded vertical distance between the cemento-enamel junction and root apex determined the root length, and the residual bone was calculated as the percentage of coronal root length in which periodontal ligament retained its width.19

Data on PROMs were retrieved at T0, T2, and T3 from two questionnaires that measured patient concerns in terms of esthetics and masticatory function on a 5-point Likert-type scale (1 = no concern; 2 = some concern; 3 = concerned; 4 = clearly concerned; and 5 = very concerned).

Statistical Analysis
Statistical analyses were performed using SPSS (version 25.0, IBM), with a significance level set at .05. The patient was the statistical unit, and tooth loss was defined as the main outcome variable. Data from migrated treated teeth and full-mouth data were separately considered in the analysis. Parametric methods were used when appropriate, after testing for the normality of the quantitative data, using Shapiro-Wilk test and Q-Q normality plots. Longitudinal changes were analyzed with repeated-measures of analysis of variance (FMPS, FMBS, clinical attachment level [CAL], radiographic data) and Friedman test (PD, recession, PROMs), followed by post hoc tests for multiple comparisons.

Results
The files of 61 patients were reviewed, and 40 fulfilled the inclusion criteria. All participants were Caucasian and were aged between 44 and 73 years (mean: 57.5 ± 7.8 years). Of the participants, 67.5% were women, and 12.5% were light smokers (4 to 7 cigarettes/day). All patients had Class I or mild Class II malocclusion with migrated and extruded anterior teeth, leading to an increased overjet (up to 10 mm), increased overbite (up to 9 mm), spacing, extrusion, crowding of mandibular incisors, lip catching, or soft tissue impingement.

Sixteen patients underwent fixed OTM on the maxillary anterior sextant, 1 patient on the mandibular anterior sextant, and 23 on the front teeth of both arches. The treatment lasted an average of 17.3 ± 8.5 months (range: 4 to 38 months). SPC appointments were scheduled at 2- to 3-month (35%) or 4-month intervals (65%), with a mean duration of 9.5 ± 4.6 years (range: 4 to 17 years). All patients were compliant with the recommended SPC frequency.

Clinical and Radiographic Outcomes
The whole-mouth clinical changes considering six sites per tooth are summarized in Appendix Table 2. At T0, all patients presented high FMPS and FMBS values that decreased below 20% at T1 and remained low at the T2 and T3 examinations. The APT resulted in statistically significant clinical improvement. A mean
PD reduction of 1.5 ± 1.1 mm and a mean CAL gain of 0.9 ± 1.0 mm were achieved, together with a significant recession increase (0.6 ± 0.4 mm). No further significant changes were observed between T1 and T2 and between T2 and T3.

A separate analysis of migrated anterior teeth subjected to OTM was performed (Appendix Table 3). At T1, they displayed a mean PD reduction of 1.7 ± 1.2 mm and a mean recession increase of 0.5 ± 0.6 mm. Minor, nonsignificant changes were noted between T1 and T2 and during SPC. Regarding radiographic changes (Appendix Table 3), the overall alveolar bone level slightly increased at T3 from T0 values, while the average root length decreased from 16.47 ± 1.75 mm at T0 to 14.61 ± 1.82 mm at T3 (P < .01).

Tooth Loss and Reasons for Extraction

The baseline sample consisted of 901 teeth (40 patients) with a mean number of 22.5 teeth per patient (Appendix Table 1). A total of 130 teeth were lost during the study period. Six patients (15%) did not lose any teeth; 18 patients (45%) lost 1 to 3 teeth, whereas 16 patients (40%) lost 4 to 10 teeth. The distribution of extracted teeth according to the reasons for extraction is reported in Appendix Table 4. During APT, patients collectively lost 115 teeth, with 90 lost due to periodontal reasons. This represents a mean general loss of 2.8 ± 2.3 teeth per patient, with a mean of 2.2 ± 1.8 teeth lost per patient due to periodontitis. A higher frequency of extraction was noted for multirooted teeth (64.3%) compared to single-rooted teeth (35.7%). Five molar teeth that were used for orthodontic anchorage were extracted at T2 for periodontal reasons. All anterior migrated teeth were in function at the end of 9.5 years of SPC, while additional 10 premolars were lost due to root fracture. All treated patients were classified as well-maintained, and only 5 of them experienced tooth extraction during SPC. Figure 1 illustrates clinical and esthetic changes...
observed in one patient over a 13-year follow-up.

Patient-Reported Outcome Measures

The PROMs are summarized in Fig 2. At T0, patients reported high values of concern for esthetics and masticatory function. After the completion of combined periodontal and orthodontic treatment, highly significant decreases in scores were observed for both PROMs, and the improvement was maintained over time until the most recent follow-up.

Discussion

The main findings of the present study indicate that OTM may be performed safely and effectively in patients previously treated for stage IV periodontitis who experienced major functional and esthetic alterations due to PTM. Periodontal
stability was maintained throughout the entire observation period, and near-complete tooth retention was achieved during SPC. In turn, this supports the notion that highly susceptible patients may remain stable when risk factors for disease progression have been corrected and periodontal gold standards (FMPS and FMBS < 20% and no residual pockets) have been targeted.6,20 The correction of PTM could also be beneficial for periodontal stability, as it balances the transmission of occlusal forces to the supporting bone.6

A recent systematic review demonstrated that OTM in patients with healthy but reduced periodontium had little to no clinically relevant effect on CAL or PD changes.13 The present results are in accordance with the findings from a randomized clinical trial, which reported slight but consistent improvement of periodontal parameters 6 months after multidisciplinary treatment.21 However, the recent World Workshop on the treatment guidelines for stage IV periodontitis has identified the need for long-term studies evaluating tooth retention in patients undergoing ortho-peric treatment.13,14 A previous report from the present group found almost complete tooth survival of all anterior migrated teeth in 21 periodontitis patients at the end of 10 to 15 years of SPC.22 The present study aimed to increase the scientific evidence by including 40 patients with a mean follow-up of 9.5 years.

Data from the literature indicated a wide range in CAL (from 0.29 ± 0.17 mm to 5.93 ± 1.41 mm) and PD (–0.07 ± 0.75 mm to 5.5 ± 1.5 mm) changes after combined orthodontic and periodontal treatments.23 These large variations may be attributed to the differential inclusion of only pathologic sites or mean values. In the present sample, full-mouth CAL and PD values achieved after APT and OTM (1.6 ± 1.2 mm and 1.1 ± 1.3 mm, respectively) were successfully maintained over time, and no anterior tooth with PTM was lost due to periodontitis recurrence. In general, studies that included only angular defects had greater mean PD reductions than the present study, which pooled sites with different severities of periodontal damage and periodontal surgical treatment strategies.23 Radiographically, root resorption may occur during OTM (especially if intrusive forces have been applied), and it may affect tooth survival and/or stability, mainly in patients with a reduced periodontium. This should be considered when designing treatment plans, and orthodontic forces must be adjusted on the residual periodontal support.24 In the present sample, root resorption at T3 accounted for 1.86 ± 1.25 mm of root length reduction. However, the apical resorption was partially compensated by a progressive increase of alveolar bone during SPC. During APT, some remineralization of the bone surrounding the periodontally compromised teeth may have occurred, and intrusive movements on reduced but healthy periodontium may have promoted new attachment formation.25 Careful planning of the OTM, treatment timing, and posttreatment retention protocol are essential parts of the interdisciplinary management of stage IV periodontitis.26 In such patients, the advanced alveolar bone loss results
in the center of resistance of the involved teeth migrating apically, and the teeth are more prone to tipping. Thus, the mechanics and the appliance design must be adapted to each patient in order to achieve the treatment goals and avoid undesired root movements. Placement of retention appliances and patient control of oral parafunctional habits are important for stabilizing the treatment outcomes.

Regarding timing, Zasčiurinskienė et al found no differences between receiving nonsurgical periodontal treatment before or simultaneous to OTM. However, recent meta-analyses suggested that pocket closure only occurred in approximately two-thirds of the pockets and it is known that OTM may result in attachment loss when inflammation is not under control. This is particularly relevant when intrabony defects are present, as OTM prompts an accelerated periodontal destruction through untreated/inflamed vertical defects. As a consequence, Pini Prato and Chambrone suggested postponing OTM until the periodontium is completely healed, which may require up to 12 months in cases of regenerative periodontal treatment. In the present study, OTM was initiated between 3 and 6 months after completion of APT.

When assessing the effectiveness and safety of combined orthopedic treatment, it is fundamental to consider the perspective of the patient. Taking into account that improvements in esthetic appearance, tooth retention, and functional rehabilitation are the main reasons for patients to seek treatment, changes in a patient’s pretreatment concerns related to dentofacial appearance and function are indirectly reflective of the perceived quality of care. In line with previous research on OTM, the present study demonstrated high levels of patient satisfaction at both T2 and T3. This further enforces the negative impact of malocclusion on oral health–related quality of life.

The main shortcoming of the present study is its retrospective design, which makes selection, performance, and reporting biases likely to occur. However, it has the advantages to report for disease progression and tooth loss that are rarely observed due to the required long-term observation. When interpreting the present results, it should also be considered that they refer to highly compliant and well-maintained periodontitis patients who were treated by a multidisciplinary team operating in a specialist periodontal practice.

Conclusions

These data suggest that the final treatment plan must be individualized and tailored to meet the needs, objectives, and expectations of the patients. If the gold standards of periodontal treatment have been fulfilled, proper OTMs have no major effects on a healthy but reduced periodontium in patients enrolled in a strict SPC. Integrating PROMs into quality assessment of the comprehensive interdisciplinary care of stage IV periodontitis provided useful data about the overall value of complex treatment strategies and can be useful to identify their cost-effectiveness in relation to the individual’s psychosocial well-being.

Acknowledgments

No competing financial interests exist. The authors report no conflicts of interest related to this study.

References


Appendix

Appendix Table 1 Inclusion and Exclusion Criteria

<table>
<thead>
<tr>
<th>Inclusion criteria</th>
<th>Exclusion criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>• &gt; 40 years of age</td>
<td>• Any medical condition or medication that would influence treatment (diabetes mellitus, HIV/AIDS, autoimmune diseases, phenytoin, cyclosporine or calcium channel blockers)</td>
</tr>
<tr>
<td>• Good general health</td>
<td>• Heavy smokers (&gt; 10 cigarettes/day)</td>
</tr>
<tr>
<td>• At least 6 anterior teeth present</td>
<td>• Failure to comply with oral hygiene instructions provided or to keep to regular study appointments.</td>
</tr>
<tr>
<td>• Diagnosis of generalized severe chronic periodontitis or stage IV periodontitis</td>
<td>• Incomplete or deficient clinical and/or radiographic records</td>
</tr>
<tr>
<td>• At least 4 sites around at least 6 anterior teeth with CAL and PD ≥ 8 mm</td>
<td></td>
</tr>
<tr>
<td>• Pathologic tooth migration of maxillary and/or mandibular anterior teeth needing orthodontic treatment</td>
<td></td>
</tr>
<tr>
<td>• Compliance with the supportive therapy (≥ 3 visits per year, including documentation of the periodontal conditions)</td>
<td></td>
</tr>
</tbody>
</table>

CAL = clinical attachment level; PD = probing depth.

Appendix Table 2 Changes in Full-Mouth Clinical Parameters

<table>
<thead>
<tr>
<th>Parameters</th>
<th>T0</th>
<th>T1</th>
<th>ΔT0–T1</th>
<th>T2</th>
<th>ΔT0–T2</th>
<th>T3</th>
<th>ΔT0–T3</th>
</tr>
</thead>
<tbody>
<tr>
<td>FMPS, %</td>
<td>57.4 ± 18.8**</td>
<td>15.7 ± 3.5</td>
<td>41.7 ± 18.4#</td>
<td>16.4 ± 3.1</td>
<td>41.0 ± 18.5##</td>
<td>17.2 ± 4.7</td>
<td>40.2 ± 17.2##</td>
</tr>
<tr>
<td>FMBS, %</td>
<td>39.4 ± 17.8**</td>
<td>9.1 ± 3.8</td>
<td>30.3 ± 16.1##</td>
<td>8.9 ± 3.4</td>
<td>30.5 ± 15.8##</td>
<td>10.3 ± 3.9</td>
<td>29.1 ± 17.8##</td>
</tr>
<tr>
<td>PD, mm</td>
<td>4.4 ± 1.1**</td>
<td>2.9 ± 0.4</td>
<td>1.5 ± 1.1##</td>
<td>2.8 ± 0.5</td>
<td>1.6 ± 1.2##</td>
<td>2.6 ± 0.4</td>
<td>1.8 ± 1.0##</td>
</tr>
<tr>
<td>CAL, mm</td>
<td>5.1 ± 1.2*</td>
<td>4.2 ± 0.7</td>
<td>0.9 ± 1.0#</td>
<td>4.0 ± 0.7</td>
<td>1.1 ± 1.3##</td>
<td>3.8 ± 0.6</td>
<td>1.3 ± 1.1##</td>
</tr>
<tr>
<td>REC, mm</td>
<td>0.7 ± 0.6**</td>
<td>1.3 ± 0.6</td>
<td>-0.6 ± 0.4##</td>
<td>1.2 ± 0.5</td>
<td>-0.5 ± 0.5##</td>
<td>1.2 ± 0.6</td>
<td>-0.5 ± 0.6##</td>
</tr>
<tr>
<td>Teeth, n</td>
<td>22.5 ± 4.3**</td>
<td>19.7 ± 4.5</td>
<td>2.8 ± 2.3##</td>
<td>19.5 ± 4.6</td>
<td>3.0 ± 2.6##</td>
<td>19.3 ± 4.5</td>
<td>3.2 ± 2.5##</td>
</tr>
</tbody>
</table>

T0 = baseline (after diagnosis); T1 = after active periodontal treatment; T2 = after orthodontic treatment; T3 = final follow-up (mean: 9.5 years); FMPS = full-mouth plaque score; FMBS = full-mouth bleeding score; PD = probing depth; CAL = clinical attachment level; REC = gingival recession.

Values are presented as mean ± SD. An increase in recession is indicated by a negative value. Clinical parameters were evaluated at six points per tooth, and the mean was used for statistical analysis.

*P < .01 (changes among the four time points; repeated-measures ANOVA or Friedman test).

**P < .001 (changes among the four time points; repeated-measures ANOVA or Friedman test).

*P ≤ .01 (longitudinal changes from T0).

**P ≤ .001 (longitudinal changes from T0).
### Appendix Table 3 Changes in Clinical and Radiographic Parameters at Anterior Teeth with Pathologic Migration

<table>
<thead>
<tr>
<th>Parameters</th>
<th>T0</th>
<th>T1</th>
<th>ΔT0–T1</th>
<th>T2</th>
<th>ΔT0–T2</th>
<th>T3</th>
<th>ΔT0–T3</th>
</tr>
</thead>
<tbody>
<tr>
<td>PD, mm</td>
<td>4.5 ± 1.2**</td>
<td>2.8 ± 0.6</td>
<td>1.7 ± 1.2**</td>
<td>2.7 ± 0.7</td>
<td>1.8 ± 1.1**</td>
<td>2.4 ± 0.5</td>
<td>2.1 ± 1.1**</td>
</tr>
<tr>
<td>CAL, mm</td>
<td>5.4 ± 1.6**</td>
<td>4.2 ± 0.9</td>
<td>1.2 ± 1.2**</td>
<td>4.1 ± 1.0</td>
<td>1.3 ± 1.3**</td>
<td>3.9 ± 0.9</td>
<td>1.5 ± 1.4**</td>
</tr>
<tr>
<td>REC, mm</td>
<td>0.9 ± 0.8**</td>
<td>1.4 ± 0.7</td>
<td>-0.5 ± 0.6**</td>
<td>1.4 ± 0.8</td>
<td>-0.5 ± 0.7**</td>
<td>1.5 ± 0.8</td>
<td>-0.6 ± 0.8**</td>
</tr>
<tr>
<td>CEJRA, mm</td>
<td>16.47 ± 1.75*</td>
<td>–</td>
<td>–</td>
<td>15.16 ± 2.09*</td>
<td>1.31 ± 1.18</td>
<td>14.61 ± 1.82</td>
<td>1.86 ± 1.25*</td>
</tr>
<tr>
<td>Residual bone, %</td>
<td>66.59 ± 10.48*</td>
<td>–</td>
<td>–</td>
<td>66.63 ± 8.85</td>
<td>-0.04 ± 7.4</td>
<td>69.78 ± 9.94</td>
<td>-3.19 ± 6.4*</td>
</tr>
</tbody>
</table>

T0 = baseline (after diagnosis); T1 = after active periodontal treatment; T2 = after orthodontic treatment; T3 = final follow-up (mean: 9.5 years); PD = probing depth; CAL = clinical attachment level; REC = gingival recession; CEJRA = root length (vertical distance between the cementoenamel junction and the root apex).

Values are presented as mean ± SD. An increase in recession is indicated by a negative value. Clinical parameters were evaluated at six points per tooth, and the mean was used for statistical analysis.

*P < .01 (changes among the four time points; repeated-measures ANOVA or Friedman test).

**P < .001 (changes among the four time points; repeated-measures ANOVA or Friedman test).

#P ≤ .01 (longitudinal changes from T0).

##P ≤ .001 (longitudinal changes from T0).

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### Appendix Table 4 Reasons for Tooth Extraction During the Observation Period

<table>
<thead>
<tr>
<th>Reason</th>
<th>Teeth extracted between T0 and T1, n (%)</th>
<th>Teeth extracted between T1 and T2, n (%)</th>
<th>Teeth extracted between T2 and T3, n (%)</th>
<th>Total, n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Periodontal lesion</td>
<td>90 (78%)</td>
<td>5 (100%)</td>
<td>0 (0%)</td>
<td>95 (73%)</td>
</tr>
<tr>
<td>Root fracture</td>
<td>2 (2%)</td>
<td>0 (0%)</td>
<td>10 (100%)</td>
<td>12 (9%)</td>
</tr>
<tr>
<td>Endodontic failure</td>
<td>16 (14%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>16 (12%)</td>
</tr>
<tr>
<td>Carious lesion</td>
<td>7 (6%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>7 (6%)</td>
</tr>
</tbody>
</table>

T0 = baseline (after diagnosis); T1 = after active periodontal treatment; T2 = after orthodontic treatment; T3 = final follow-up (mean: 9.5 years).