

# Retention of questionable and hopeless teeth in compliant patients treated for aggressive periodontitis

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## Abstract

**Aim:** The aim of this study was to determine the survival rates of questionable and hopeless teeth in patients with aggressive periodontitis (AgP) and chronic periodontitis (CP) during 15 years of supportive periodontal therapy (SPT).

**Materials and methods:** Thirty-four AgP and 34 CP patients (SPT  $\geq 10$  years) with bone loss of  $\geq 50\%$  at  $\geq 2$  teeth were consecutively recruited. Bone loss was measured on digitized radiographs and teeth were categorized as “questionable” ( $\geq 50$  to  $< 70\%$  bone loss) or as “hopeless” ( $\geq 70\%$ ). Progression in pocket probing depths (PPD) during SPT, tooth loss and reasons for extraction were analysed.

**Results:** In AgP patients, 262 teeth were considered as questionable and 63 as hopeless (CP: 149/51). During active periodontal therapy, 25 questionable and 26 hopeless teeth were extracted (CP: 12/16). During  $15.3 \pm 4.1$  years of SPT of AgP 28 questionable and 15 hopeless teeth were removed (CP: 28/12). The mean tooth loss per patient during SPT in total was 0.14 (AgP) and 0.16 (CP) teeth/year. There were no significant differences in tooth loss or longitudinal progression of PPD between AgP and CP patients.

**Conclusions:** In patients with AgP, 88.2% (209 of 237) of questionable and 59.5% (22 of 37) of hopeless teeth survived 15 years during regular SPT in a dental school department.

**Key words:** aggressive periodontitis; hopeless teeth; questionable teeth; supportive periodontal therapy; tooth loss

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Periodontal therapy is a successful means of arresting periodontal disease progression and maintaining patients' teeth. Its aim is the long-term retention of the natural dentition in a healthy, functional, aesthetically acceptable and painless state (Schweizerische Zahnärzte-Gesellschaft 2000, Greenwell 2001). Retention of

teeth over the complete life span is an attainable goal. Schätzle et al. (2009) and Lang et al. (2009), in this context, demonstrated the importance of an inflammation-free environment. Teeth with sites consistently presenting a gingival index of 0 (no inflammation) had a 50-year survival rate of 99.5% compared with 63.4% for sites with a gingival index of 3 (severe inflammation).

Aggressive periodontitis (AgP) is sub-classified into a localized (LAgP) and a generalized (GAgP) type. It predominantly affects younger subjects and is characterized by an early destruction

of the clinical attachment with subsequent severe alveolar bone loss (Armitage 1999). Few studies have evaluated the treatment modalities for AgP (Xajigeorgiou et al. 2006, Mestnik et al. 2010, Bäumer et al. 2011). The current notion is that a prerequisite for periodontal healing is the reduction and/or the elimination of microbial pathogens and that there may be a benefit from the use of adjunctive antibiotics (Herrera et al. 2002, Haffajee et al. 2003).

Successful treatment of periodontitis is considerably influenced by risk factors at the tooth level as well as by

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environmental and genetic risk factors at the patient level (Greenwell 2001). Smoking is among the several environmental risk factors influencing tooth loss during long-term periodontal maintenance (McGuire & Nunn 1996a, König et al. 2002a, Chambrone & Chambrone 2006, Matulienė et al. 2008, Pretzl et al. 2008) and diabetes mellitus (Faggion et al. 2007). Genetic risk factors, however, play a more important role in aggressive than in chronic periodontitis (CP) (Loos et al. 2005).

Essential prerequisites for the long-term retention of teeth being treated for periodontitis are good compliance of each patient and an individualized SPT (Knowles et al. 1979, Axelsson & Lindhe 1981a,b, Pihlström et al. 1983, Kaldahl et al. 1996, Rosling et al. 2001). Moreover, it has been demonstrated that with regular SPT, tooth loss becomes rather rare (Hirschfeld & Wasserman 1978, McFall 1982, McGuire & Nunn 1996b, König et al. 2002a, Fardal et al. 2004, Chambrone & Chambrone 2006, Faggion et al. 2007, Matulienė et al. 2008, Pretzl et al. 2008).

In clinical practice, the decision to treat or extract teeth is based not only on clinical presentation and a patient's risk factors but also on treatment philosophies, financial aspects and insurance regulations. McGuire (1991) and McGuire & Nunn (1996a,b) evaluated the accuracy of a widely accepted prognosis model based on the traditional notion that the prognosis of a tooth presenting >50% bone loss becomes *questionable* and eventually *hopeless* and found it rather ineffective. Other long-term studies further reported that retention of such teeth with a predicted *questionable* or *hopeless* prognosis over 5–10 years was feasible (McGuire & Nunn 1996a,b, Machtei & Hirsch 2007, Eickholz et al. 2008, Pretzl et al. 2008). Little is known about the treatment results and the long-term retention perspectives of periodontally compromised teeth in moderate to advanced AgP.

The aim of this study was (1) to determine the survival rate of teeth presenting with initial bone loss of  $\geq 50\%$  in patients with AgP as compared with patients with CP, (2) to evaluate the changes in pocket probing depths (PPD) during supportive therapy lasting up to 16 years and to compare the follow-up of probing depths in patients with aggressive and CP and (3) to identify the reasons for tooth extractions in such patients.

## Material and Methods

### Study population

This investigation was designed as a longitudinal retrospective study based on demographic and clinical data. The methodological quality was consistent with the standard of the Newcastle–Ottawa scale (Wells et al. 2001). Patients with AgP were identified according to the 1999 classification (Armitage 1999). In the present study, patients were classified as AgP if they were  $\leq 35$  years of age at the first proof-of-disease onset and had been characterized by radiographic bone loss of  $\geq 50\%$ . Patients older than 35 years presenting earlier radiographs with signs of severe periodontal destruction were also allocated to the AgP group. CP patients in the control group presenting bone loss of  $\geq 50\%$  had to be  $\geq 40$  years of age at the first proof-of-disease onset.

Between 1982 and 1998, a total of 2564 patients were treated for moderate to advanced CP or AgP in the Department of Periodontology, Christian-Albrechts-University of Kiel, Germany. Thirty-four patients diagnosed for AgP, receiving SPT for  $\geq 10$  years with  $\geq 1$  visit/year, presenting bone loss of  $\geq 50\%$  at  $\geq 2$  teeth and with an annual PPD documentation as well as a complete X-ray documentation at baseline ( $T_0$ ), at the end of the active periodontal

therapy ( $T_1$ ) and at the last documented visit of supportive periodontal therapy (SPT) ( $T_2$ ) qualified for participation in the study (Fig. 1). Using the same criteria, 34 out of 239 consecutive CP patients were matched.

### Active periodontal therapy (APT) and SPT

APT was non-surgical, mechanical root debridement with, when indicated, additional access flap surgery. Furcation debridement was performed using diamond-coated sonic scaler inserts (Kocher & Plagmann 1999). In some patients, guided tissue regeneration, endodontic treatment, tunnelling procedures, molar root resections and/or prosthetic rehabilitations were carried out. No pocket elimination surgery, osseous resection or augmentation of intrabony defects was undertaken. Patients presenting a persistent inflammation received adjunctive metronidazole/amoxicillin antibiotics (van Winkelhoff et al. 1996). In the case of an underlying endodontic cause, an endodontic treatment was initiated. After 6 months, a reevaluation was completed.

SPT followed an individualized interval of 3–12 months:

1. Staining of plaque, followed by re-instruction and re-motivation.

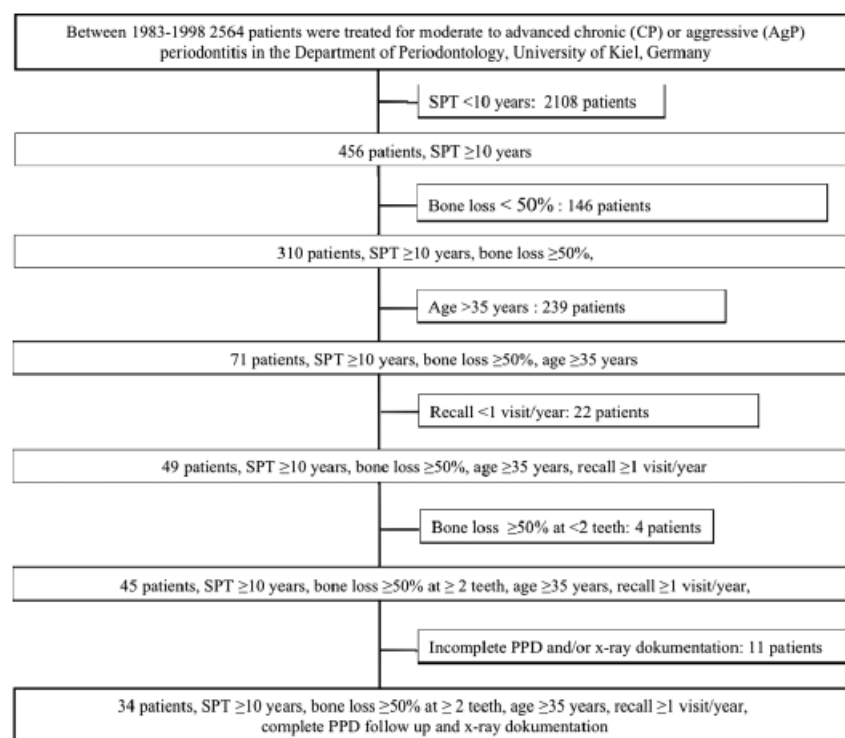


Fig. 1. Recruitment of aggressive periodontitis patients.

2. The utilization of interdental brushes was demonstrated and practiced by the patient at every appointment, with a particular focus on the selection of the right brush diameter.
3. Professional tooth cleaning and mechanical subgingival debridement of residual pockets, followed by polishing using rubber cups and polishing paste with exhaustive application of a fluoride gel was performed by the dental auxiliary.
4. Once a year, the dental status was recorded by the operator and PPD were measured at six sites per tooth.

If necessary, further treatment was defined and consisted of either non-surgical subgingival debridement alone or open flap debridement with or without subsequent systemic or local antibiotic therapy. Retaining the vitality of molars with furcation involvement was of utmost importance. Tunnelling or even molar root resection was performed only if non-cleanable furcations (grade II/III) showed persistent inflammation.

#### PPD and radiographic assessment

PPD measured once a year at six sites of each tooth were entered into a database (K. G.). Data for third molars were included. The accuracy of the data input of about 127704 PPD values (63546/64158 AP/CP) was verified by reading randomly selected samples of 20 data sets (J. F. W.) with a consistency of 99.1% (266 errors in 29698 PPD). Plots for PPD were constructed to compare the progression of PPD between AgP and CP patients.

For radiographic evaluation at  $T_0$  (baseline) and  $T_2$  (last visit of SPT), 136 radiographs of 68 patients were digitized and analysed by the first examiner (J. F. W.) using an image processing program (ImageJ, NIH, Bethesda, MD, USA). The cemento-enamel junction (CEJ), the most apical extension of the alveolar crest and the root apex at each tooth (only deepest site) were marked. If a restoration was present, its most apical point next to the CEJ was marked. All linear distances were expressed as percentages of the total root length. J. F. W. was calibrated before the beginning of the radiographic evaluation. The measurements were performed by an experienced operator (C. G.) and the inter-examiner reproducibility was verified by a second measurement (J. F. W.). We verified the reproducibility by assessment of pivotal landmarks. Multi-walled intraosseous pockets, which were

difficult to analyse on the radiographs because of overlying bony walls, were compared with clinical measurements. According, in part, to McGuire & Nunn (1996b) and Machtei & Hirsch (2007), teeth were categorized as "questionable" if they had lost from  $\geq 50$  to  $< 70\%$  of bone height at one proximal surface or "hopeless" if they had lost  $\geq 70\%$ .

#### Tooth loss during APT and SPT

Teeth lost during the initial phase of the APT ( $T_0$ – $T_1$ ) and during the SPT ( $T_1$ – $T_2$ ) were documented. The reason for tooth loss was evaluated and classified as either periodontal or other reasons (endodontic involvement, caries, restorative purposes, fracture or unknown reasons). To distinguish the reasons for extraction notations on charts, clinical and radiological findings were analysed and, if possible, the treating dentist was interviewed. The following rationale was used to determine between periodontal and other reasons for extractions: a periodontal cause was assumed if there was a continuous increase of the probing depths and progressive, radiographically apparent bone loss.

#### Data managing and statistical analysis

Data were sampled in a database (ParoDat, Department of Periodontology, Kiel, Germany), which was installed in 1982 and was set up on a database platform (FileMaker Inc., Santa Clara, CA, USA) for the continuous documentation of all patients. For the present

study, the following data were evaluated: age, gender, smoking status, periodontal diagnosis, observation time, modified full-mouth plaque scores and the follow-up of PPD during APT and SPT. Tooth loss was used as the primary outcome measure and the true endpoint.

All patients gave their informed consent for the statistical analysis of their data documented during periodontal therapy. The Ethical Committee of the Christian-Albrechts-University of Kiel approved the protocol of the study. After pseudonymization, all data were exported into a separate data set for statistical analysis. Comparisons between AgP and CP patients were performed for tooth loss, probing depths and plaque index using a paired *t*-test. Statistical significance was declared for *p*-values of  $< 0.05$ . All statistical analysis was conducted using SPSS (SPSS16, SPSS Inc., Chicago, IL, USA).

## Results

#### Patient data

The total observational period was  $16.1 \pm 4.5$  (10–24) years for AgP patients and  $16.3 \pm 4.1$  (10–24) years for CP, respectively; the mean duration of the SPT was  $15.3 \pm 4.1$  years for AgP and  $15.7 \pm 3.6$  for CP. Further demographic data are shown in Table 1. In AgP patients, 76.5% were non-smokers (CP: 88.2%). All patients received a similar periodontal treatment. Adjunctive antibiotic therapy was initiated in 10

Table 1. Demographic data, plaque score, observation period, pocket probing depth, antibiotic therapy

|   | AgP               | CP                |
|---|-------------------|-------------------|
| Number of patients                                      | 34                | 34                |
| Gender (male/female)                                    | 23/11             | 17/17             |
| Smoker/former smoker/non-smoker                         | 8/5/26            | 4/4/30            |
| Mean age $\pm$ SD (years) at baseline                   | $33.3 \pm 4.1$    | $51.6 \pm 7.4$    |
|   | Range 23–42       | Range 40–69       |
| Patients with localized/generalized periodontitis       | 2/32              | 3/31              |
| Number of teeth with bone loss ( $T_0$ )                | 598/262/63        | 674/149/51        |
| <50% / $\geq 50$ to <70% / $\geq 70\%$ of bone loss     |                   |                   |
| Mean Plaque (%) at baseline ( $T_0$ )                   | $47.00 \pm 20.29$ | $60.58 \pm 24.16$ |
| Mean Plaque (%) during SPT ( $T_1$ – $T_2$ )            | $24.32 \pm 16.37$ | $34.18 \pm 20.91$ |
| Observation period APT and SPT ( $T_0$ – $T_2$ , years) | $16.1 \pm 4.5$    | $16.3 \pm 4.1$    |
| Observation period SPT ( $T_1$ – $T_2$ , years)         | $15.3 \pm 4.1$    | $15.7 \pm 3.6$    |
| Mean pocket probing depths (mm)                         |                   |                   |
| Baseline ( $T_0$ )                                      | $6.5 \pm 2.2$     | $5.9 \pm 1.9$     |
| after APT ( $T_1$ )                                     | $3.9 \pm 1.3$     | $3.6 \pm 1.0$     |
| at end of SPT ( $T_2$ )                                 | $3.6 \pm 1.2$     | $3.5 \pm 1.2$     |
| Number of patients with antibiotic therapy in APT/SPT   | 6/4               | 0/0               |

APT, active periodontal therapy; SPT, supportive periodontal therapy; AgP, aggressive periodontitis; CP, chronic periodontitis.

(29.4%) cases of AgP (APT: 6/during SPT: 4), but in no cases of CP. In AgP, molar root resection was performed in one case (CP: 5). Five of the patients received guided tissue regeneration (AgP: 2/CP: 3).

The numbers of predicted questionable and hopeless teeth are shown in Table 1. At the beginning of APT, patients with AgP demonstrated more questionable ( $n = 262$ ) and hopeless ( $n = 63$ ) teeth compared with patients with CP (149/51) ( $p < 0.05$ ).

#### Tooth loss and reason for extraction

The numbers of teeth at baseline ( $T_0$ ) and at the end of SPT ( $T_2$ ) are shown in Tables 2 and 3. During APT ( $T_0$ – $T_1$ ), 70 teeth, respectively, 7.6% (AgP) and 40 teeth, respectively, 4.6% (CP) of all teeth present (AgP: 923, CP: 874) were extracted. During SPT ( $T_1$ – $T_2$ ) in AgP patients, 72 teeth (8.4%) of all the remaining teeth (AgP: 853) were extracted (CP: 93 of 834 teeth/11.2%).

Of the remaining teeth in AgP, 11.8% (28 of 237) questionable (CP: 20.4%/28 of 137) and 40.5% (15 of 37) hopeless teeth (CP: 34.3%/12 of 35) were extracted during SPT ( $T_1$ – $T_2$ ).

A total of 20.2% (53 of 262) questionable teeth (CP: 26.8%/40 of 149) and 65.1% (41 of 63) hopeless teeth (CP: 54.9%/28 of 51) were extracted during APT and SPT ( $T_0$ – $T_2$ ). In AgP patients, 78.9% (112 of 142 of all extracted teeth) were lost due to periodontal reasons during APT and SPT (CP: 36.1%, 48 of 133). In AgP, the number of questionable teeth extracted for periodontal reasons during APT and SPT was 81.1% (43 of 53) (CP 65.0%/26 of 40) and 41.5% (17 of 41) for the hopeless teeth (CP: 57.1%/16 of 28).

The survival rates of teeth, which were extracted during SPT, are shown in Table 3. The most commonly extracted teeth during APT and SPT were the third and first molars. During active treatment and supportive therapy ( $T_0$ – $T_2$ ), 20.6% (7 of 34) of the AgP patients lost no teeth (CP 14.7%/5 of 34) and 29.4% (10 of 34) lost more than six teeth (CP 20.6% /7 of 34) (Table 3.) None of the patients lost all of their teeth. There were no statistically significant differences in tooth loss between the AgP and the CP groups, either for *questionable* and *hopeless* teeth or for different tooth types, or reasons for extractions.

Table 2. Number of teeth before and after APT and at the end of SPT

|  | AgP                           | CP                            |
|--|-------------------------------|-------------------------------|
| No. of teeth present before APT ( $T_0$ )  | 923                           | 874                           |
| No. of teeth present after APT ( $T_1$ )   | 853                           | 834                           |
| No. of teeth present at end of SPT ( $T_2$ )   | 781                           | 741                           |
| No. of teeth/patient present before APT (mean $\pm$ SD)  | 26.8 $\pm$ 3.0<br>Range 20–32 | 24.9 $\pm$ 3.5<br>Range 17–31 |
| No. of teeth/patient present after APT (mean $\pm$ SD)   | 25.5 $\pm$ 3.3<br>Range 18–32 | 22.1 $\pm$ 5.2<br>Range 9–31  |
| No. of teeth/patient at end of SPT (mean $\pm$ SD)   | 22.6 $\pm$ 3.9<br>Range 12–31 | 19.9 $\pm$ 5.2<br>Range 9–28  |
| No. of questionable teeth/patient before APT (mean $\pm$ SD)   | 7.0 $\pm$ 4.5<br>Range 0–18   | 2.6 $\pm$ 2.2<br>Range 0–8    |
| No. of hopeless teeth/patient before APT (mean $\pm$ SD)   | 2.6 $\pm$ 2.9<br>Range 0–11   | 0.7 $\pm$ 1.4<br>Range 0–7    |
| No. (%) of questionable teeth lost during APT ( $T_0$ – $T_1$ )  | 25 (9.5)                      | 12 (8.1)                      |
| No. (%) of hopeless teeth lost during APT ( $T_0$ – $T_1$ )  | 26 (41.3)                     | 16 (31.4)                     |
| No. (%) of the remaining teeth) of teeth with predicted questionable prognosis lost during SPT ( $T_1$ – $T_2$ ) | 28 (11.8)                     | 28 (20.4)                     |
| No. (%) of the remaining teeth) of teeth with predicted hopeless prognosis lost during SPT ( $T_1$ – $T_2$ )     | 15 (40.5)                     | 12 (34.3)                     |

APT, active periodontal therapy; SPT, supportive periodontal therapy; AgP, aggressive periodontitis; CP, chronic periodontitis.

Table 3. Mean time for tooth survival and reasons for tooth loss

|   | AgP                         | CP                          |
|---|-----------------------------|-----------------------------|
| Mean time for survival of teeth with bone loss <50% until extraction during SPT                   | 7.5 $\pm$ 6.7<br>Range 1–23 | 5.7 $\pm$ 3.9<br>Range 1–17 |
| Mean time for survival of predicted questionable teeth until extraction during SPT                | 4.5 $\pm$ 6.2<br>Range 1–23 | 5.9 $\pm$ 5.0<br>Range 1–17 |
| Mean time for survival of predicted hopeless teeth until extraction during SPT                    | 3.9 $\pm$ 6.3<br>Range 1–23 | 4.0 $\pm$ 4.7<br>Range 1–15 |
| Teeth loss due to periodontal reasons during SPT (APT)  | 63 (49)                     | 48 (28)                     |
| Teeth loss due to periodontal reasons of predicted questionable/hopeless teeth during SPT and APT | 43/17                       | 26/16                       |
| Patient (%) who lost 0/1–3/4–6/>6 teeth from a total of 923 (AgP) and 874 teeth (CP)              | 21/35/15/29                 | 15/35/29/21                 |
| No. of non-molars lost during APT (SPT)   | 33 (25)                     | 15 (44)                     |
| No. of molars (M1/M2) lost during APT (SPT)   | 26 (36)                     | 19 (31)                     |
| No. of third molars lost during APT (SPT)   | 11 (11)                     | 6 (18)                      |
| Mean tooth loss per year/patient from a total of 923 (AgP) and 874 teeth (CP)                     | 0.14                        | 0.16                        |

APT, active periodontal therapy; SPT, supportive periodontal therapy; AgP, aggressive periodontitis; CP, chronic periodontitis.

#### Clinical course of PPD during SPT

At the beginning of SPT ( $T_1$ ) in AgP, the mean PPD was  $3.9 \pm 1.3$  mm (CP:  $3.6 \pm 1.0$  mm) and at the end of SPT ( $T_2$ ), it was  $3.6 \pm 1.2$  mm (CP:  $3.5 \pm 1.2$  mm) as shown in Table 1. In AgP, 67% of the teeth (CP: 64%) presented a PPD <4 mm, 31% of teeth 4–6 mm (CP: 34%) and 2% >6 mm (CP: 3%). The charts for PPD illustrate the follow-up of the mean PPD during the observation time ( $T_0$ – $T_2$ ) for questionable (Fig. 2) and hopeless teeth (Fig. 3) in AgP and CP patients. There were no significant differences. The mean values beyond 15 years of SPT were not representative due to the smaller numbers of patients.

#### Discussion

##### Patient selection

The aim of the study was to evaluate the survival of teeth presenting an initial bone loss of  $\geq 50\%$  in patients treated for AgP compared with patients with CP. Tooth loss is the primary outcome measure and a true endpoint. Therefore, we determined the rate of tooth loss during a long-term SPT of 15 years.

To avoid bias, 68 compliant patients with an SPT of  $\geq 10$  years were consecutively selected from a cohort with moderate to advanced periodontitis treated between 1982 and 1998. The patients assigned to the AgP group were  $\leq 35$  years of age at the first

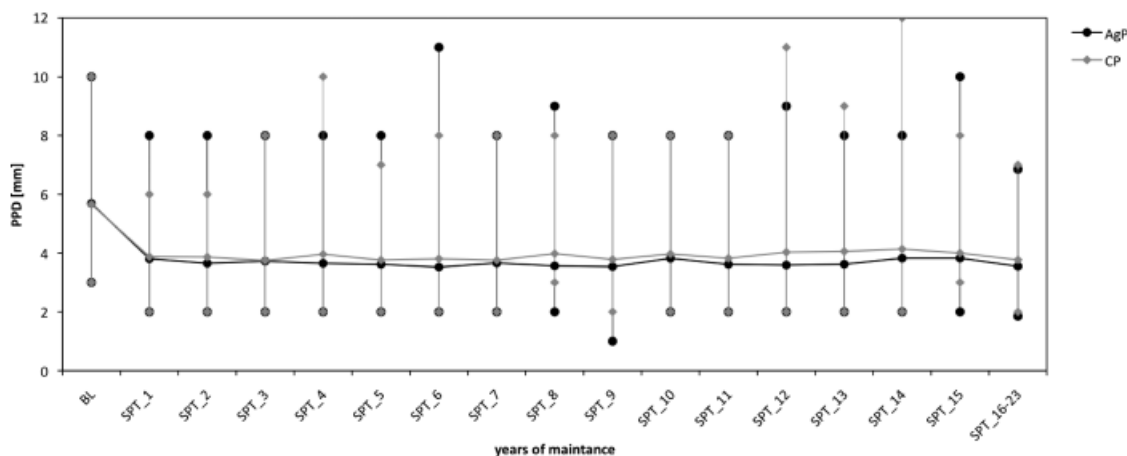


Fig. 2. Questionable teeth. Follow-up of the mean PPD during supportive periodontal therapy starting at baseline (BL) to the 15th year of SPT. No statistical difference in PPD between AgP and CP. Error bars show the maximum and minimum PPD.

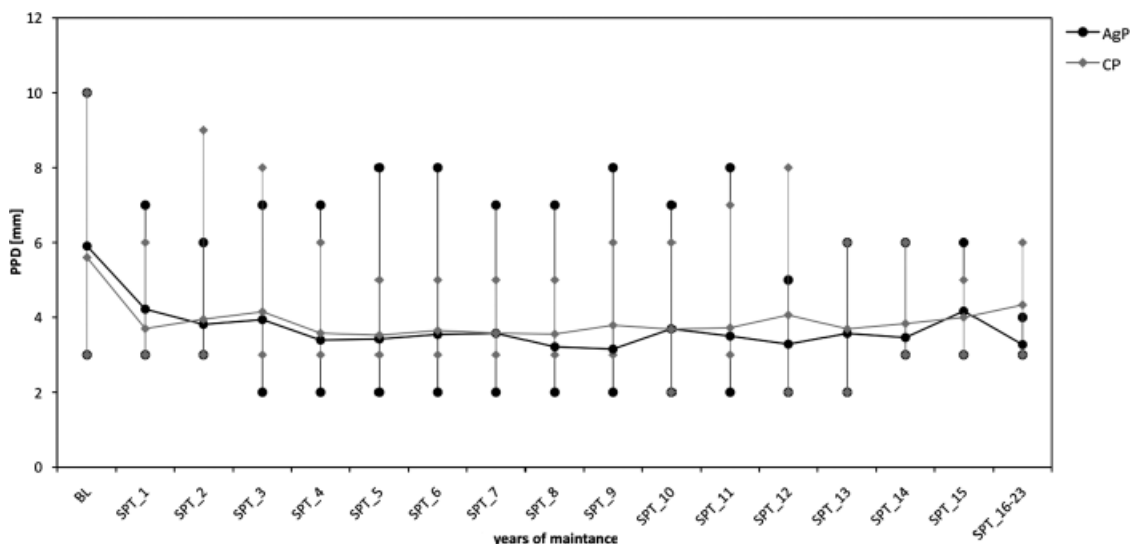


Fig. 3. Hopeless teeth. Follow-up of the mean PPD during supportive periodontal therapy starting at baseline (BL) to the 15th year of SPT. No statistical difference in PPD between AgP and CP. Error bars show the maximum and minimum PPD.

proof-of-disease onset and had been characterized by radiographic bone loss of  $\geq 50\%$ . To reduce an overlap with the AgP group, CP patients had to be  $\geq 40$  years of age. Even though age-dependent categories to distinguish between AgP and CP were eliminated in the 1999 classification, Armitage & Cullinan (2010) considered it justified to use age-related discrimination for research purposes. At the beginning of the therapy, the amount of bone loss had to be the same in patients with aggressive and CP. Subsequently, CP patients were consequently matched in pairs.

To comply with the inclusion criterion of 10 years' observation time, the number of patients was initially reduced

from 2564 to only 456 patients. This was due to patient drop out as many patients continued their treatment and maintenance in private practice. We have no results on the survival rate of questionable or hopeless teeth in patients who continued the treatment in a private practice. We assume that, according to the guidelines in the German health system, the vast majority of teeth presenting bone loss  $\geq 50\%$  were removed.

#### Treatment of periodontitis

In our study, all patients received treatment based on a protocol that has remained consistent since 1982. Patients were treated primarily by conservative

means in order to retain as many critical teeth as possible. APT was performed by subgingival scaling and root planing and/or open flap debridement, and in some patients, guided tissue regeneration, tunnelling procedures and/or molar root resections were carried out. The operators and the assistant dental professionals were well trained on root debridement by means of hand- or mechanically driven instruments using special learning programmes (König et al. 2002b, Rühling et al. 2002). In patients presenting severe AgP, only 17.6% received antibiotics during APT and 11.8% during SPT. No patients with severe CP received antibiotic therapy. As of now, there are no established

protocols for efficiently controlling AgP, but the current notion is that systemic metronidazole and amoxicillin can improve the short-term clinical outcome of non-surgical debridement in AgP (Guerrero et al. 2005, Mestnik et al. 2010). The current study shows that long-term retention of questionable and hopeless teeth in cases with severe aggressive or CP over 15 years is possible with a conservative therapy and a quite restrictive use of antibiotics.

#### Survival of questionable and hopeless teeth

Survival rates after periodontal treatment are well documented in the literature, and tooth loss in studies with at least 10 years of SPT is shown in Table 4. However, there is a lack of studies on patients younger than 35 years presenting a history of AgP.

In the study of McGuire & Nunn (1996a), 45% of questionable and 38% of hopeless teeth survived over a period of SPT lasting 10 years. In the present study, the proportions of teeth surviving were higher with 88% of questionable and 60% of hopeless teeth in patients with AgP surviving over a period of SPT lasting 15 years. The rate of tooth loss in the study of McGuire & Nunn (1996b) was 0.13 teeth per patient and year, which is similar to the current study results for the AgP group (0.14) as well for the CP (0.16) group.

Gunsolley et al. (1995) re-examined 88 of from 327 patients with localized and generalized AgP in a 15-year follow-up. The treatment of the patients consisted almost exclusively of either scaling and root planing or scaling with open flap curettage. Only a few patients received antibiotics, and the authors pointed out that hopeless teeth were not removed during initial therapy. In their cohort, the time that elapsed since the most recent visit for patients was approximately 3–4 years. They reported that patients with severe generalized AgP had lost periodontal attachment. The rate of tooth loss experienced in their study was 0.29 teeth per year in patients over a 15-year observation period, which is about two to three times higher than shown in the comparable studies in Table 4. Gunsolley et al. (1995) presumed that the cause for the comparatively high rate of tooth loss could be linked to the irregular SPT and/or termination thereof. Eickholz et al. (2008) and Pretzl et al. (2008) examined patients 10 years after the initiation of periodontal therapy. In those with irregular SPT, 21% of questionable and 39% of hopeless teeth *versus* 3% of questionable and 14% of hopeless teeth in the group of regular SPT were lost. However, differences in the definition of what constituted regular SPT make it difficult to compare these outcomes.

Studies, especially those by Hirschfeld & Wasserman (1978), McGuire & Nunn

(1996b) and Fardal et al. (2004), have shown that only a small number of patients are responsible for the majority of tooth loss. In a later paper, Fardal & Linden (2008) reported that only 2% of patients lost 4–16 teeth. In the present study, patients do not show such a distinct pattern, with tooth loss more widely distributed among the patients. This can be explained by the fact that only patients presenting at least two teeth with severe bone loss were initially included and so the risk of tooth loss was distributed throughout to the patients studied.

#### PPD follow-up and reason for extraction

The study failed to detect statistically significant differences in the follow-up of the mean PPD between predicted questionable and hopeless teeth as well as between AgP and CP. One reason for this could be that an increase in the PPD with the resulting tooth loss for periodontal reasons was found in only a limited number of teeth. Actually, in the present study, during SPT, 7.4% (CP: 5.8%) of all teeth were removed for periodontal reasons. Tooth loss due to periodontal reasons varied from 1.5% (König et al. 2002a, Fardal et al. 2004) to 9.8% (McFall 1982) and, in a review of 13 long-term studies by Chambrone et al. (2010), 6.8% of all teeth present were extracted due to periodontal reasons. It is known that teeth were extracted due to periodontal as well as other causes, ranging from endodontic complications, root fractures, caries, to prosthetic reasons, i.e., the loss of crown retention or unknown reasons, or because of treatment philosophies (Lundgren et al. 2008).

It has been suggested that teeth with a predicted questionable prognosis due to severe bone loss should not be treated periodontally, but rather extracted early instead to avoid a deterioration of the local bone volume and eventual involvement of neighbouring teeth. Machtei & Hirsch (2007) showed, in a study on 90 patients, that radiological bone fill could be achieved after the periodontal treatment of so-called questionable teeth, with no negative effects on neighbouring teeth. However, in retrospective studies, it is difficult to clearly determine the reason for extraction. We thus decided only to differentiate extractions based on periodontal reasons and other reasons. If teeth were extracted *alio loco*, we researched into and attempted to determine the cause thereof. The

Table 4. Comparison of data from the present study and other retrospective studies with an observation period of approximately 10 years of supportive therapy

| Studies                       | Number of patients | Mean Age | Mean years in SPT | Tooth loss during SPT (%) | Tooth loss per patient and year |
|-------------------------------|--------------------|----------|-------------------|---------------------------|---------------------------------|
| Hirschfeld & Wasserman (1978) | 600                | 42       | 22                | 8.3                       | 0.08                            |
| McFall (1982)                 | 100                | 43.8     | 15                | 11.3                      | 0.14                            |
| Goldman et al. (1986)         | 211                | 41.8     | 22                | 13.4                      | 0.17                            |
| Wood et al. (1989)            | 63                 | 45       | 13.6              | 7.1                       | 0.13                            |
| McGuire & Nunn (1996b)        | 100                |          | 9.97              | 5.2                       | 0.13                            |
| Checchi et al. (2002)         | 92                 | 45       | 6.7               | 2.2                       | 0.07                            |
| König et al. (2002a)          | 142                | 46       | 10.5              | 3.0                       | 0.07                            |
| Fardal et al. (2004)          | 100                | 46       | 9.8               | 1.5                       | 0.04                            |
| Leung et al. (2006)           | 97                 | 40.6     | 8.9               | 10.2                      | 0.25                            |
| Chambrone & Chambrone (2006)  | 120                | 40.6     | 17.4              | 3.8                       | 0.05                            |
| Faggion et al. (2007)         | 198                | 47.6     | 11.8              | 5.5                       | 0.11                            |
| Pretzl et al. (2008)          | 100                | 46.5     | 10                | 6.7                       | 0.15                            |
| Matulienė et al. (2008)       | 172                | 45       | 9.5               | 6.5                       | 0.17                            |
| Bäumer et al. (2011)          | 84 (AgP)           | 30.8     | 10.5              | 5.2                       | 0.13                            |
| Present study                 | 34 (AgP)           | 33.3     | 15.3              | 8.4/11.8*/40.5†           | 0.14                            |
|                               | 34 (CP)            | 51.6     | 15.7              | 11.2/20.4*/34.3†          | 0.16                            |

\*Predicted questionable teeth.

†Predicted hopeless teeth.

SPT, supportive therapy; AgP, aggressive periodontitis; CP, chronic periodontitis

mean time for the survival of questionable teeth until extraction was 4.5 (AgP) 5.9 (CP) years (hopeless: 3.9/4.0) (Table 3). It is obvious that the more teeth had been extracted during APT, the fewer teeth can be extracted during SPT. The above results show that the teeth, which were not immediately extracted during APT, did in fact have a chance of being saved until the treating physician decided to extract them.

As far as treatment planning is concerned, Lundgren et al. (2008) emphasized that the date of extraction can play a decisive role in the patients' quality of life. It makes sense that an early extraction of a putatively questionable tooth in a 40-year-old patient with a life expectancy of 80 years is perhaps the beginning of a time-consuming and expensive prosthetic treatment for the next 40 years (Pretzl et al. 2009). For this reason, treatment of strategically important teeth is – in spite of their potentially limited predicted prognosis – a meaningful goal.

## Conclusion

Our retrospective study in 68 patients demonstrated that, in patients with a history of AgP, 88.2% questionable teeth survived 15 years of SPT. The survival rate of predicted hopeless teeth was significantly lower; only 59.5% survived over this time period. In our study, we did not find any significant differences either in tooth survival between aggressive and CP or in the follow-up of PPD. Most teeth were extracted for periodontal reasons. In AgP as well as in CP, the treatment of periodontally compromised teeth with advanced bone loss is a meaningful therapeutic approach to prevent tooth loss with the consequence of prosthetic rehabilitation.

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### Clinical Relevance

**Scientific rationale for the study:** The success of long-term retention of teeth is well documented in previous studies. When regular supportive periodontal treatment was performed, tooth loss was rarely observed. In this study, the survival rate of questionable and hopeless teeth in patients with AgP *versus*

CP during long-term supportive therapy lasting more than 15 years was evaluated.

**Principle findings:** In AgP and CP, a higher proportion of questionable than hopeless teeth survived at the end of the SPT; approximately 80–88% of questionable teeth survived, compared with only 60–66% of teeth classified as hopeless.

**Practical implications:** Periodontal treatment is meaningful for patients susceptible to periodontitis irrespective of the prognosis. The aim of treatment should be to prevent the progression of periodontal disease and to prevent early extraction and inevitable prosthetic rehabilitation.