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Radiographic parameters as prognostic indicators for healing of class II furcation defects

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Abstract

Objective: To evaluate radiographic measurements for use as prognostic indicators for healing of class II furcation defects following regenerative therapy.

Material and Methods: In 17 patients (eight females), 33 class II furcation defects (mandibular buccal ($n = 10$) and lingual ($n = 12$), and maxillary buccal ($n = 11$)) were treated using the barrier membrane technique. Twenty-six furcations were treated using a bioabsorbable membrane, while a nonresorbable membrane was used to treat the remaining seven furcation defects. Clinical parameters and standardized radiographs were obtained before as well as 6 and 24 months after therapy. All radiographs were digitized and evaluated by an examiner blinded to the clinical data. The following distances were measured: cemento-enamel junction line (CEJ-line) to alveolar crest (AC) at the furcation site (AC-CEJ line), CEJ-line to the furcation fornix (Fx-CEJ line), width of the furcation at the level of the AC (FW) as well as the distance from Fx to a straight line between the AC mesial and distal of the tooth (Fx-AC line).

Results: Statistically significant ($p < 0.001$) horizontal attachment gains could be observed 6 and 24 months after therapy (6 months: 1.49 ± 0.85 mm; 24 months: 1.14 ± 0.91 mm). However, a small but statistically significant ($p = 0.031$) attachment loss of 0.35 mm was observed between the 6 and 24 months examination. Multilevel regression analyses identified baseline probing depth ($p = 0.0017$) and 3 of the radiographic distances as prognostic factors: Fx-CEJ line ($p = 0.014$), FW ($p = 0.0535$), Fx-AC line ($p = 0.0827$).

Conclusion: The analysis of presurgical radiographs may yield information on the success of the regenerative therapy of buccal and lingual class II furcation defects. A long root trunk, a wide furcation entrance and an Fx coronal to the AC have negative influences on the success of therapy. Further, a deep probing depth at the furcation site at baseline increases the likelihood for more favourable horizontal attachment gain in furcations.

Key words: class II furcation defects/therapy; guided tissue regeneration; membranes, artificial; membranes, barrier; polytetrafluoroethylene/therapeutic use; radiography, dental; radiography, dental, linear measurements

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Periodontal therapy using guided tissue regeneration (GTR) in class II furcation defects demonstrated more favourable clinical results than debridement surgery alone (Pontoriero et al. 1988, Caton et al. 1994, Pontoriero & Lindhe 1995a, Avera et al. 1998). Different factors influence the outcome of GTR therapy in furcation defects (Eickholz & Hausmann 1997, 1999, Sanz & Giovannoli 2000). Patient-related general factors, including inconsistent plaque control levels, smoking and infrequent supportive treatment (Eickholz et al. 2000, 2001), lead to less favourable results. Additionally, local factors related to defect characteristics seem to influence therapeutic outcome (Eickholz et al. 2001). These include the degree and location of the furcation. Whereas class II furcations responded more favourably to GTR therapy than to conventional flap surgery, class III furcations failed to demonstrate a predictably positive outcome after GTR therapy (Pontoriero et al. 1989, Pontoriero & Lindhe 1995b, Eickholz et al. 1998). The largest clinical improvement was found in class II furcations of mandibular molars, followed by buccal class II furcations of maxillary molars and with interproximal furcation lesions exhibiting the least or no improvement (Pontoriero & Lindhe 1995a).

Radiographic linear measurements were shown to serve as prognostic factors for healing of infrabony defects. Namely, the width and particularly the depth of infrabony defects assessed radiographically were prognostic when assessing regenerative therapy (Eickholz & Hausmann 1998, Klein et al. 2001). To the best of our knowledge, no such relationship was described for furcation defects.

The aim of the present study was, therefore, to evaluate pre-operative radiographs as prognostic factors for periodontal healing following regenerative therapy in class II furcation defects.

Material and Methods

Patients

Seventeen patients (age range 21–64 years; mean age 45.8 ± 10.3 years; eight females), with severe periodontal disease, treated in the Section of Periodontology, Department of Operative Dentistry and Periodontology, Dental School, University of Heidelberg, took part in the present study. Each patient exhibited at least one buccal or lingual class II furcation defect (Hamp et al. 1975).

The GTR-technique using barrier membranes was recommended as the treatment of choice and explained to all patients. Both nonresorbable and bioabsorbable barriers were used. After recruitment of the patients, the risks, benefits and procedures were explained and informed consent was obtained.

Clinical and radiographic examinations

Following initial periodontal therapy including patient education, plaque control, scaling and root planing was accomplished in the entire dentition, standardized bitewing radiographs were obtained of teeth exhibiting class II furcation defects by modified film-holders (VIP 2 Positioning, UpRad Corp., Fort Lauderdale, FL, USA) (Duckworth et al. 1983, Eickholz et al. 1994, 1996). The design of these film-holders and the assessment of angulation differences between consecutive radiographs obtained by them have been extensively described (Duckworth et al. 1983, Eickholz et al. 1994, 1996). Therefore, only the following brief description is provided: two orthodontic wires were placed on the mandibular side of the film-holder at a specified position. The images of these wires were obtained on the radiographs and served to calculate the vertical and horizontal angulation differences between two consecutive radiographs. Additionally, a metal wire, used as a reference for linear measurements, was placed parallel to the film and measured to the nearest 0.1 mm.

Intraoral size 2 dental films (D speed, Eastman Kodak Co., Rochester, NY, USA) were exposed to an X-ray source (Heliodent 70, 70 kV, 7 mA, Siemens, Bensheim, Germany) and developed using standardized equipment (Periomat, Dürr Dental GmbH, Bietigheim-Bissingen, Germany). The gingival index (GI) and plaque index (PlI) were assessed at six sites per tooth (Löe 1967). Probing pocket depths (PD) and vertical probing attachment levels (PAL-V) were measured at six sites per tooth to the nearest 0.5 mm using a straight periodontal probe (PCP UNC 15, Hu Friedy, Chicago, IL, USA). As a reference for the PAL-V measurements, the cemento-enamel junction (CEJ) was used. If the CEJ was destroyed by a restoration, the margin of this restoration served as a reference. Further, clinical horizontal probing attachment levels (PAL-H) were assessed to the nearest 0.5 mm at each furcation location using a colour-coded, calibrated Nabers probe, marked at 3 mm intervals (PQ2N, Hu Friedy, Chicago, IL, USA) (Hamp et al. 1975). As a reference for this measurement, we used a tangent to the roots adjacent to the scored furcation. The degree of furcation involvement was calculated from the PAL-H according to Hamp et al. (1975): degree 0 = no furcation involvement; degree I = PAL-H $\leqslant$ 3 mm; degree II = PAL-H $>$ 3 mm, but the defect does not encompass the whole furcation; degree III = through and through furcation. All clinical parameters were assessed by one of two examiners (P. E., T. S. K.). Six and 24 months after surgery, clinical parameters were reassessed (GI, PlI, PD, PAL-V, PAL-H) and standardized radiographs were obtained to assess the results of therapy. Patients were asked actual and past smoking habits and pack-years were calculated. Patients who reported to smoke or who had quit smoking for less than 5 years were classified as actual smokers. Patients that had quit smoking for at least 5 years were defined as former smokers (Ramseier & Lang 1999).

Periodontal surgery

After intracrevicular incision, a mucoperiosteal flap was raised at all teeth assigned for surgical therapy. The flap was raised up to 5 mm beyond the osseous margin of the defect, inflammatory granulation tissue was removed and the root surfaces were thoroughly scaled and root planed. In seven cases, the defects were covered by expanded polytetrafluoroethylene (ePTFE) barriers (Gore Tex Periodontal Membrane, W. L. Gore and Associates, Flagstaff, AZ, USA). The remaining 26 cases were treated with bioabsorbable membranes. Nine class II furcation lesions were treated with a polyglactin 910 barrier (Vicryl Membran, Ethicon GmbH & Co. KG, Norderstedt, Germany), eight with Guidor™ (Guidor Matrix Barrier, Guidor AB, Huddinge, Sweden), three with Resolut™ (Resolut Regenerative Material, W. L. Gore and Associates, Flagstaff, AZ, USA) and six with an experimental Polydioxanon (PDS) membrane (Mempol, Ethicon GmbH & Co. KG, Norderstedt, Germany). All membranes were covered completely with the repositioned flap. Suturing was performed with ePTFE material in the ePTFE cases, and with polyglactin 910 sutures in the bioabsorbable cases. Patients were given 10^6 IU propicilline three times daily for 1 week (until 1998) or 3 g amoxicillin 30–60 min before surgery (from 1998). Analgesics were prescribed as needed. Patients were instructed to refrain from mechanical plaque control at the GTR-treated sites and to rinse with 0.2% chlorhexidine solution (Corsodyl, Fink GmbH, Herrenberg, Germany) for 5–7 weeks postsurgically. If exposure of a barrier was noted, the patient was advised to use a 1% chlorhexidine gluconate gel (Corsodyl Gel, Smith Kline Beecham, Bühl, Germany) once daily. ePTFE barriers were removed in a second surgical procedure 4–6 weeks after GTR surgery. At membrane removal no clinical measurements were performed. Patients were seen for suture removal 7–14 days postsurgery, then every 2 weeks for the first 6 weeks for plaque removal from the teeth in the surgical site and then every 3–6 months for supportive periodontal treatment.

Radiographic evaluation

Digital analysis of radiographs

All radiographs were digitized using a flat bed scanner (Friacom-Scanner: Linotype SAPHIR, Friadent AG, Mannheim, Germany) with 600×1200 dpi resolution, 10-bit grey values and then transferred to a computer (Friacom-PC, Friadent AG, Mannheim, Germany): PC: 486DX2, 66 MHz, graphics adapter: ELSA WINNER 1000 PRO; screen: 17″, EIZO T560i. Digital manipulations and measurement of linear distances were performed using a computer program (Friacom 2.0, Friadent AG, Mannheim, Germany) (Wolf et al. 2001). All radiographs were evaluated under 11-fold magnification. Images were calibrated using the actual length of the metal wire as reference, which was put into the computer program. A region of interest (ROI) was selected that contained the entire extent of the particular defect. For each of the 90 radiographs, the radiographic parameters described later have been measured.

Radiographs were randomized by one clinical examiner (P. E.) and numbered from 1 to 90 (Klein et al. 2001). Thereafter, they were analysed beginning with number 1 in the order given by the numbers by an examiner blinded to the clinical results and to the time point the particular radiographs had been taken (J. H.). All radiographic measurements were repeated after 1 week.

Anatomical landmarks

The following landmarks were identified on the radiographs (Fig. 1):

CEJ: If the CEJ was masked by the restorative treatment the margin of the restoration was used as a landmark.

Alveolar crest (AC): Most coronal point where the periodontal ligament space showed a continuous width. If no periodontal ligament space could be identified, the point where the projection of the AC crossed the root surface was taken as the landmark (Benn 1992). If an infrabony defect was found mesial or distal of the furcation-involved tooth, the most coronal wall of this defect was defined as AC.

Fx: furcation fornix.

CEJ line: A line was drawn from the mesial to the distal CEJ or restoration margin (RM).

AC line: Finally a line was drawn from the mesial to the distal AC.

The following measurements were made (Fig. 1):

Fx-CEJ line: distance from the fornix of the furcation (Fx) to the CEJ line perpendicular to the CEJ line.

AC-CEJ line: the distance from CEJ line to the AC within the furcation perpendicular to the CEJ line and through Fx.

Furcation width (FW): the distance between the mesial and distal root on the level of the AC within the furcation.

Fx-AC line: the distance from the AC line to Fx perpendicular to the AC line. If the Fx was located coronal to the AC line, the distance was entered as a negative value into analysis.

Statistical Analysis

For each defect, the measurements at the class II furcation site were entered into the analyses. Clinical horizontal attachment gain was chosen as the main outcome variable. To identify prognostic factors for the therapeutic benefits, this parameter was analysed by application of a multilevel regression model (Goldstein 1995). For this analysis, the basic level ''tooth'' was nested in the upper level ''patient'' and patient effects on the outcome were assumed to be random. In a forward stepwise algorithm, prognostic factors (baseline PD, PAL-V, PAL-H, AC-CEJ line, Fx-CEJ line, FW, Fx-AC line, baseline GI and PlI, membrane exposure, jaw, site, actual smoker, pack-years) were added to the final model according to a P-value less than 0.1. Smoking habits were defined by indicator variables. Differences in PD, PAL-V and PAL-H were estimated and tested according to the multilevel structure of the data. Statistical analysis was performed using statistic programs for general analysis (Systat™ for Windows version 10.0, Systat Inc., Evanston, IL, USA) and for multilevel analyses (SAS® version 6.12, SAS Institute, Cary, NC, USA).

The intra-examiner reproducibility of radiographic measurements was determined as the standard deviation (SD) of single measurements and the double measurements were compared by paired t-tests (Cohen & Ralls 1988).

Results

Baseline, 6 and 24 months postsurgically, 30 triplets of standardized radiographs were obtained of 33 buccal and lingual class II furcation defects in 17 patients. One patient contributed four defects, two patients three defects, nine

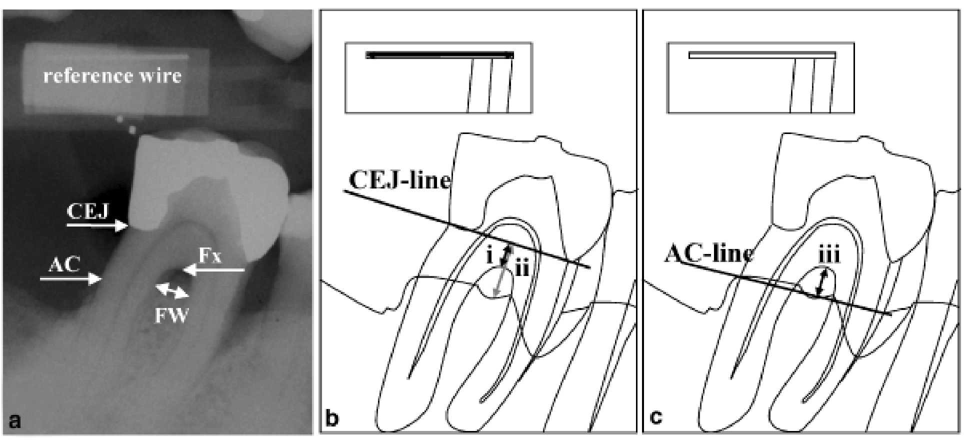

Fig. 1. (a–c) Class II furcation defect at the lingual aspect of first right mandibular molar at baseline: (a) radiograph: CEJ: cemento-enamel junction (in this case restoration margin), AC: alveolar crest, FW: furcation width, Fx: furcation fornix. The Fx is located coronal of the AC-line. (b and c) Schematic drawings of the radiograph: b) CEJ line, (i) distance Fx-CEJ line (black arrow), (ii) distance AC-CEJ line (grey arrow); (c) AC line, (iii) distance Fx-AC line.

Table 1. Distribution of class II furcation defects as related to location and jaw

	Buccal	Lingual	Total
maxilla	11		11
mandible	10	12	22
total	21	12	33

patients two defects and five patients contributed one class II defect each. The distribution of class II furcation defects with respect to the site and jaw is given in Table 1. Seven actual and three former smokers took part in the present study contributing 14 and six defects, respectively.

The healing phase passed uneventfully for all defects, except for one furcation lesion that developed an infection 2 weeks after implantation of a polydioxanon barrier. After prescription of 250 mg amoxicilline two times daily for 2 weeks the infection disappeared. Exposure of membranes occurred in five defects: two after 1 week (1 Guidor, 1 PDS), one after 2 (Guidor), one after 3 (ePTFE), one after 5 weeks (ePTFE).

The clinical parameters of these defects are given in Table 2. A statistically significant ($p<0.05$) reduction in GI and PD as well as vertical attachment gain could be observed in the class II furcation defects. PlI was statistically stable, although a slight increase was seen at 6 and 24 months after surgery (Table 2). A statistically significant horizontal attachment gain ($p<0.001$) was observed after 6 and 24 months (Table 2). However, a small statistically significant horizontal attachment loss of 0.35 mm occurred from 6 to 24 months postsurgically (Table 2). Six and 24 months after surgery, none of the furcations was completely closed. After 6 months, two-thirds of the furcations were transferred to class I and one-third remained in class II. After 24 months, 15 of the furcations were assessed as class I, while 16 showed furcation class II and two furcations had deteriorated to class III (Table 3). Table 4 shows radiographic parameters at baseline, 6 and 24 months postsurgically. The reproducibility of the radiographic parameters is given in Table 5. Paired *t*-tests failed to reveal statistically significant differences between the double measurements.

Stepwise multilevel regression analysis was performed using different influencing factors, including smoking. This revealed baseline PD ($p = 0.0017$) and an Fx apical to the interproximal bone level ($p = 0.0827$) to influence PAL-H gain positively, whereas a long root trunk (the distance between Fx and CEJ) ($p = 0.014$) and FW ($p = 0.0535$) had a negative influence (Table 6).

Discussion

In the present study, we evaluated the radiographic parameters of furcations and their relation to clinical parameters and clinical outcome. Multivariate analyses accounting for different influencing factors were used, including baseline PD, PAL-V, PAL-H, Fx-CEJ line, FW, Fx-AC line, baseline GI and PlI, membrane exposure, jaw, site, actual smoker and pack-years.

The mean horizontal attachment gains of 1.49 mm 6 months after surgery and 1.14 mm after 24 months within class II furcation defects with mean baseline PAL-H = 4.71 mm were observed. This is consistent with the results reported elsewhere 12 months after GTR surgery in class II furcation defects: Hugoson et al. 1995: 1.4 mm (ePTFE); Eickholz et al. 2000: 1.13 mm (polylactide), 0.79 (polydioxanon). However, other authors reported more favourable mean PAL-H gains in class II furcations 24 months after surgery (Eickholz et al. 1998: biodegradable: 2.22 mm; nonresorbable 1.86 mm; Eickholz & Hausmann 1999: 2.05 mm, Machtei 2001: 3.06 mm). Although beyond the scope of our study, it should be noted that GTR therapy, using membranes for the treatment of furcations, yielded a relatively small average positive change of 1–1.49 mm in horizontal clinical attachment gain. In a meta-analysis of regenerative procedures (Machtei 2001), the mean change in PAL-H was calculated to be 3.06 mm (range: 1.40–4.29), significantly higher than in our study. There are only a few studies observing regenerative therapy in class II furcation defects for periods longer than 12 months (Eickholz & Hausmann 1999, Eickholz et al. 1998, 2001). Thus, it is difficult to compare the results observed 24 months after surgery to those of other studies on the regenerative therapy of class II furcations. These results can partly be explained by the small sample size, small increase in PlI, unfavourable radiographic parameters and large number of smokers: 7 actual and 3 former smokers contributing 14 and 6 defects, respectively. It may be assumed that most studies referred to by Machtei 2001 chose key hole class II furcation defects, i.e. furcation defects that exhibit interproximal bone levels coronal of the Fx at the mesial and distal aspect of the respective furcation (Becker et al. 1996).

This type of defect morphology is described by the radiographic parameter Fx-AC line. If the Fx is located apical to the AC line, a more favourable PAL-H gain can be expected. If there is bone coronal of the furcation fornix at the mesial and distal aspect of the tooth a coronally positioning of the flap, coverage and stabilization of the membrane may be achieved. Under such conditions, the surface of the periodontal ligament to provide cells to colonize the blood clot within the defect is larger than in the case of the Fx located coronal of the AC. A wide furcation opening revealed to influence PAL-H gain negatively. The wider the opening the more difficult it is to close the furcation. Further, a long root trunk

Table 3. Distribution of furcation degrees after 6 and 24 months

Parameter	6 months	24 months
class 0 (complete closure)	0	0
class I	22	15
class II	11	16
class III	0	2

Table 2. Plaque index (PlJ), gingival index (GI), probing depth (PD), horizontal and vertical probing attachment level (PAL-H and PAL-V) at baseline, 6 and 24 months after surgery as well as changes 6 (B-6) and 24 (B-24) months after surgery: mean ± SD

	PlJ	GI	PD (mm)	PAL-H (mm)	PAL-V (mm)
baseline	0.6 ± 0.9	1.4 ± 0.9	4.4 ± 1.3	4.70 ± 0.70	5.5 ± 1.4
6 months	0.7 ± 0.8	0.8 ± 1.0	2.9 ± 0.9	3.20 ± 0.71	4.5 ± 1.1
change B-6	$0.1 \pm 1.2^{\text{n.s.}}$	$-0.6 \pm 1.2^{*}$	$-1.5 \pm 1.3^{**}$	$1.49 \pm 0.85^{***}$	$1.0 \pm 1.2^{**}$
24 months	0.7 ± 0.9	0.7 ± 1.0	3.0 ± 0.9	3.54 ± 1.15	4.9 ± 1.2
change B-24	$0.2 \pm 1.1^{\text{n.s.}}$	$-0.7 \pm 1.3^{*}$	$-1.4 \pm 1.5^{**}$	$1.14 \pm 0.91^{***}$	$0.6 \pm 1.1^{*}$

n.s., not significant.
$^{*}p<0.05$; $^{**}p<0.0001$; $^{***}p<0.01$.

Table 4. Radiographic parameters (distances: cemento-enamel junction (CEJ) line to alveolar crest (AC) at furcation: AC-CEJ-line; CEJ-line to furcation fornix: Fx-CEJ-line; line between mesio- and disto-interproximal AC and Fx: Fx-AC-line) of class II furcation defects at baseline, 6 and 24 months after surgery as well as changes 6 (B-6) and 24 (B-24) months after surgery: mean ± SD

Parameter	Baseline	6 months	Change B-6	24 months	Change B-24
AC-CEJ line/mm	5.51 ± 1.68	5.92 ± 1.64	– 0.41 ± 0.91*	5.59 ± 1.63	– 0.09 ± 1.03$^{n.s.}$
Fx-CEJ line/mm	3.64 ± 1.02	3.83 ± 1.26	– 0.18 ± 0.62$^{n.s.}$	3.69 ± 1.30	– 0.05 ± 0.39$^{n.s.}$
furcation width/mm	1.47 ± 0.67	1.72 ± 0.78	– 0.25 ± 0.66$^{n.s.}$	1.54 ± 0.71	– 0.07 ± 0.64$^{n.s.}$
Fx-AC line/mm	0.61 ± 1.21	0.34 ± 1.35	0.34 ± 0.69*	0.16 ± 1.61	0.48 ± 0.93**

n.s., not significant.
*$p<0.05$; **$p<0.01$.

Table 5. Intra-examiner reproducibility of radiographic parameters as SD of single measurements

Parameter/radiograph	AC-CEJ line/mm	Fx-CEJ line/mm	Furcation width/mm	Fx-AC line/mm
baseline	0.23	0.38	0.37	0.68
6 months	0.40	0.35	0.20	0.58
24 months	0.39	0.32	0.37	0.38

AC-CEJ line, cemento-enamel junction line (CEJ line) to the alveolar crest (AC) at the furcation site; Fx-CEJ line, CEJ-line to the furcation fornix; Fx-AC line, the distance from Fx to a straight line between the AC mesial and distal of the tooth.

Table 6. Multilevel stepwise multiple linear regression analysis

	Estimate	SE	Degrees of freedom	*t*-value	*p*
intercept	1.2788	0.4695	16	2.72	0.0150
baseline PD	0.3411	0.0770	9	4.43	0.0017
baseline Fx-CEJ line	– 0.3174	0.1044	9	– 3.04	0.0140
baseline FW	– 0.4020	0.1811	9	– 2.22	0.0535
baseline Fx-AC line	0.2265	0.1160	9	1.95	0.0827

Dependent variable: PAL-H gain/mm; $n = 17$.
PAL-H, horizontal probing attachment level; PD, probing depth; Fx-CEJ line, cemento-enamel junction line (CEJ-line) to the furcation fornix; FW, width of the furcation at the level of the alveolar crest; Fx-AC line, the distance from Fx to a straight line between the AC mesial and distal of the tooth.

(Fx-CEJ line) modulated PAL-H gain negatively. In case of a long root trunk, it needs severe bone loss to cause furcation involvement. A molar providing such conditions has experienced advanced destruction and may not respond well to regenerative procedures.

Our sample consisted of 17 patients contributing 33 defects. This sample is small and the *p*-value for inclusion into the multilevel model is high (0.1). The intention of this model definition was not to oversee radiographic parameters predictive for healing within class II furcation defects. However, to our best knowledge this was the first attempt to correlate baseline radiographic class II furcation parameters with the outcome of regenerative therapy. An analysis with more patients would be likely to have more statistical power and precision.

Thus, the less favourable PAL-H gains reported in this study are likely due to inclusion of less favourable defects. Further, smoking has a detrimental effect on regenerative therapy in class II furcations (Eickholz & Hausmann 1997, Eickholz et al. 2000), and additionally may explain the small amount of horizontal attachment gain. Surprisingly, though, in the present study, the multilevel stepwise regression analysis failed to reveal actual smoking as a prognostic factor for PAL-H gain.

Some patients contributed more than one defect to the sample investigated in this study. Thus, a multilevel regression analysis nesting the basic level ''tooth'' into the upper level ''patient'' was used to account for within-subject dependencies.

Furcation location, baseline PAL-H, individual patient (Eickholz & Hausmann 1999), baseline PD, poor oral hygiene and *Actinobacillus actinomycetemcomitans* infection were shown to influence periodontal healing in class II furcation defects (Machtei et al. 1994). Bacterial colonization of nonresorbable and biodegradable GTR membranes after exposure has been shown to result in less favourable results after GTR therapy of infrabony defects (Selvig et al. 1992, De Sanctis et al. 1996a, b). However, it was also shown that infection control may improve results in case of exposure (Nowzari et al. 1995) and Christgau et al. failed to observe any influence of membrane exposure if proper infection control was provided (Christgau et al. 1997). Intrasurgically and radiographically assessed defect characteristics of infrabony defects have been evaluated as prognostic factors for PAL-V gain (Eickholz & Hausmann 1998, Klein et al. 2001). Machtei has reported only minor effects of membrane exposure regarding clinical results after GTR therapy of furcation defects (Machtei 2001). In the present study, membrane exposure was observed in only five of 33 defects and multilevel analysis failed to reveal any influence of exposure. Presumably, infection control in case of exposure was successful in limiting the number of microorganisms in the membranes. However, apart from furcation class (Pontoriero et al. 1988, 1989, Pontoriero & Lindhe 1995a, b) and location (Pontoriero & Lindhe 1995a), radiographic defect characteristics of class II furcations have not yet been evaluated as predictors of PAL-H gain. Radiographs are easily obtainable before surgery and therefore, radiographic parameters describing class II furcation defects could serve as useful diagnostic means. The predictive value of such parameters was investigated in the present study.

Several studies have demonstrated that there are no statistically significant or clinically relevant differences after use of nonresorbable ePTFE membranes and those commercially available synthetical bioabsorbable membranes used in this study regarding the treatment of class II lesions (Christgau et al. 1995, Hugoson et al. 1995, Caffesse et al. 1997, Garrett et al. 1997, Eickholz et al. 1998). Thus, results after treatment using ePTFE and synthetical bioabsorbable barriers were combined for this study. Further, knowing that all synthetical bioabsorbable barriers used in this study perform similar to nonresorbable ePTFE membranes or do not perform statistically different from each other (Eickholz et al. 2000), no significant differences between the clinical outcomes after the use of different synthetical bioabsorbable barriers should be expected. Hence, differences between the various bioabsorbable materials were not sought after in this study.

Within the limitations of the present study, the following conclusions may be drawn: (i) Radiographic furcation parameters assessed as linear distances may be used to predict horizontal attachment gain in class II furcation defects. (ii) If class II furcation involvement has occurred a long root trunk, a wide furcation entrance and an Fx coronal to the interproximal AC have negative influences on the success of regenerative therapy. Further studies with larger samples should aim to confirm these results and to identify further influencing factors.

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