J Clin Periodontol 2008; 35: 133–138 doi: 10.1111/j.1600-051X.2007.01178.x

Journal of Clinical Periodontology

Fibre retention osseous resective surgery: how deep is the infrabony component of the osseous-resected defects?

Gianfranco Carnevale[1], Francesco Cairo[2], Michele Nieri[2] and Maurizio S. Tonetti[3]

[1]Private practice in Periodontology, Rome, Italy; [2]Department of Periodontology, University of Florence, Florence, Italy; [3]European Research Group on Periodontology (ERGOPerio), Berne, Switzerland

Carnevale G, Cairo F, Nieri M, Tonetti MS. Fibre retention osseous resective surgery: how deep is the infrabony component of the osseous-resected defects? J Clin Periodontol 2008; 35: 133–138. doi: 10.1111/j.1600-051X.2007.01178.x.

Abstract

Background: The Aims of this retrospective study were: (i) to describe the applicability of Fibre Retention Osseous Resective Surgery (FibReORS) to infrabony defects with different radiographic depths and (ii) to identify significant anatomical elements associated with the decision of tooth extraction or application of FibReORS in the context of a treatment approach aimed at pocket elimination.

Material and Methods: Baseline radiographs with detectable infrabony defects were collected from 68 periodontal patients. Selected teeth with radiographic evidence of infrabony defects had probing depths (PD) >4 mm at revaluation following non-surgical periodontal therapy. Teeth were then surgically treated with FibReORS or extracted on the basis of the decision making of an experienced periodontist and in the context of the overall treatment plan. The total root length and the defect depth were quantified for each selected tooth using radiographic reference points.

Results: A total of 324 teeth with infrabony defects were identified. Fifty-three (16%) teeth with a mean radiographic infrabony defect of 8.5 ± 1.7 mm (range 6–12 mm) were extracted; 271 (84%) teeth with a mean infrabony defect of 3.0 ± 1.4 mm (1–8 mm) were surgically treated, achieving PD $\leqslant 3$ mm in all sites at 6-month follow-up. Surgically treated teeth showed baseline radiographic infrabony defects $\leqslant 4$ mm in 86% of the cases. Logistic multilevel modelling indicated that the probability of extraction was influenced by root length ($p = 0.0230$) and by the radiographic defect depth ($p = 0.0112$).

Conclusion: FibReORS is applicable in the treatment of shallow to moderate bony defects and deeper defects associated with longer roots.

Key words: fibre retention osseous resective surgery; infrabony defect; periodontal pocket; periodontal surgery

Accepted for publication 5 November 2007

Alveolar bone loss is one of the most common anatomical sequelae of periodontitis (Papapanou & Tonetti 2000). Periodontal osseous lesions are often associated with the persistence of deep pockets following cause-related therapy, which, in turn, may represent a site-specific risk marker for disease progression during supportive periodontal care (Claffey & Egelberg 1995, Armitage 1996).

Conflict of interest and source of funding statement

The authors declare that they have no conflict of interests.
This study has been self-funded by the authors and their institutions.

Grbic & Lamster (1992) analysed the possible role of persisting pockets in predicting future attachment loss in non-surgically treated and maintained patients. In this study, residual deep pockets 6 months after therapy showed a higher risk of future attachment. Sites with probing depth (PD) $\leqslant 3$ mm, conversely, had minimal risk of attachment loss. Moreover, several long-term studies showed that non-surgically treated patients tend to display a higher incidence of progression of periodontal disease when compared with surgically treated patients in a similar supportive periodontal condition (Kaldahl et al. 1996a, Serino et al. 2001). Therefore, surgical correction of deep pockets that responded less favourably to non-surgical treatment might be the proper approach to restore periodontal conditions that can be more easily maintained.

Different surgical procedures to treat osseous lesions have been reported. Regenerative procedures are generally indicated in the treatment of pockets associated with deep infrabony defects (> 3 mm) (Tonetti et al. 1998). An open flap for debridement or an apically positioned flap procedure is generally performed for the treatment of moderate to advanced periodontal pockets.

Flap surgery with osseous resection and elimination of bony defects is a well-known method to obtain shallow pockets (Ochsenbein 1958, 1986). This procedure classically needs the reshaping of infrabony defects to normal bone with a positive architecture by changing the most apical interdental portion of the defect to the most coronal point of the reshaped interdental bone. When carefully conducted, this procedure results in minimal PD following surgery (Kaldahl et al. 1988) and in a lower incidence of disease recurrence during maintenance as compared with root planing and/or access flap surgery (Kaldahl et al. 1996b).

Fibre Retention Osseous Resective Surgery (FibReORS) is a novel surgical approach combining the classical method of osseous resection with the gingival fibre retention technique (Carnevale 2007). Traditional approaches to osseous resective surgery firstly imply the identification of the defect bottom and then the reshaping of the bony anatomy by eliminating the buccal and lingual walls, changing the previous bottom of the defect into the most coronal part of the new interproximal bone surface (Ochsenbein 1958). The FibReORS technique shifts the bottom of the defect in a more coronal position at the level of the connective tissue fibre attachment, determining a more conservative supporting bone resection. The biological basis of this approach is founded on experimental studies demonstrating that the preservation of attached fibres prevents the apical epithelial downgrowth with no bone and attachment loss (Levine & Stahl 1972, Carnevale et al. 1983). Long-term retrospective studies suggested that, in carefully maintained patients, this procedure was associated with minimal tooth loss and recurrence of pockets (Carnevale et al. 2007a, b).

Expert opinions have suggested the use of osseous resective surgery to treat shallow to moderate infrabony defects (Ochsenbein 1986, Carnevale & Kaldahl 2000), but no data are available regarding the depth of defects that can be treated by means of osseous-resective surgery and the possible limit of this procedure when treating teeth with more advanced bony lesions.

The aims of this study were:

1. To describe the baseline radiographic depth of infrabony defects for pockets treated by means of FibReORS or extraction.
2. To assess the anatomical elements associated with the decision to apply FibReORS or to extract a tooth with an infrabony defect.

Material and Methods

The radiographs used for this retrospective study were consecutively collected from clinical records in a private periodontal office. All patients had received active periodontal treatment (APT) delivered by a single clinician (G. C.) and had a minimum set of periodontal variables recorded at the original consultation and at the first supportive periodontal care (SPC) visit following the completion of APT.

All patients had:

1. The presence, at baseline, of at least one radiologically detectable infrabony defect with a PD $\geqslant$4 mm following non-surgical periodontal therapy;
2. less than 20% FMPS, and no periodontal site with bleeding on probing or PD > 3 mm at the first SPC visit following the completion of APT (6-month follow-up);
3. no contributory medical history recorded (no medical diagnosis of diabetes mellitus, or use of immune-depressant, anti-epileptic and calcium channel blockers);
4. availability of complete clinical records including periodontal probing and diagnostic quality radiographs.

Details of clinical evaluation and treatment were presented in companion papers (Carnevale et al. 2007a, b). In brief, following the initial examination, all patients received non-surgical periodontal therapy, including oral hygiene motivation and instruction, coronal and subgingival scaling, as needed. At re-evaluation, surgical procedures were planned in order to achieve pocket elimination in each site with PD $\geqslant$4 mm. Periodontal surgery consisted only of an apically positioned flap with FibReORS (Carnevale 2007). After verification of the achievement of the surgical objectives, patients were enrolled in an SPC programme.

Radiographic evaluation

Routine diagnostic periapical radiographs were taken with the long-cone parallel technique using Rinn holders (Updegrave 1951). On the basis of the examination of full-mouth baseline radiographs, single films displaying a tooth (teeth) with a detectable intrabony defect were selected. When a single tooth displayed two bony defects, the deepest one was considered in the analysis. Then, for each radiograph, the following reference points were identified:

1. *Cemento-enamel junction* (CEJ). According to the criteria of Schei et al. (1959). Where the CEJ was not detectable because of restoration, the margin of that restoration was used as a reference point.
2. *Root apex* (RA). For upper molars, the apex of the palatal root was considered; for inferior molars, the median point of a conjunction line between the mesial and distal apex was considered; for single rooted teeth, the unique apex was considered.
3. *Bone crest* (BC). As the most coronal position of the alveolar bone crest of the infrabony defects.
4. *Defect bottom* (DB). As the most apical extension of the infrabony destruction, as described previously by Tonetti et al. (1993)

On the basis of these reference points, a single operator evaluated:

1. The total root length measuring from CEJ to RA (Radix).
2. The depth of the defect from BC to BD (Defect).

Data management and statistical analysis

Descriptive statistics included calculation of means and standard deviations. A multilevel analysis was also applied

(Goldstein 1998) using a special software (Multilevel Model Project Institute of Education, Mlwin software, version 1.00, London, U.K.) in order to explore the possible influence of different variables on the decision of tooth extraction. Two levels – the patient and the tooth – were analysed using a logistic model with an estimation procedure first-order marginal quasi-likelihood (MQL). At the patient level, age (Age), gender (Gender) and smoking habits (Smoke) were considered. At the tooth level, the length of the root (Radix), the radiographic depth of the infrabony component of the defect (Defect) and molar or non-molar teeth (Molar) were included.

The theoretic model used was:

$$\begin{aligned}\text{Logit}\,\pi_{ij} = \beta_{0ij} &+ \beta_{1j}\,\text{Age} + \beta_{2j}\,\text{Gender}\\ &+ \beta_{3j}\,\text{Smoke} + \beta_{4ij}\,\text{Molar}\\ &+ \beta_{5ij}\,\text{Radix} + \beta_{6ij}\,\text{Defect}\\ &+ \beta_{7ij}\,\text{PD}\end{aligned}$$

''Age'' was age in years, ''Gender'' was 1 if male and 0 if female, ''Smoke'' was 1 if smoking and 0 if not smoking, ''Molar'' was 1 if molar and 0 if other teeth, ''Defect'' was the radiographic defect depth in mm and ''Radix'' was the radiographic root length in millimetres. π_{ij} represented the proportion of extraction. In the theoretic model formula, the subscript ''*j*'' referred to the Patient level and the subscript ''*i*'' referred to the Tooth level. β_{0ijk} is the ''Intercept''.

The goodness of fit of the linear logistic multilevel model was assessed. Two groups were identified, group ''extraction'' and group ''not extraction'', on the basis of their predicted response probability. A threshold value of $\pi_0 = 0.5$ was considered: tooth was assigned to group ''extraction'' if $p_0 \geqslant 0.5$ and to group ''not extraction'' if $p_0 < 0.5$ (Collett 1991).

Results

A total of 68 consecutive patients displaying at least one infrabony defect with a PD $\geqslant$4 mm at the re-evaluation were enrolled in this study. Forty-two patients were females (62%). The mean age was 54.3 ± 9.2 years (32–77). Twenty-eight patients were smokers (41%). The mean number of residual teeth per patient was 25.3 ± 3.4.

Three hundred and twenty-four infrabony defects were detected in this material (mean defects for patient 4.8 ± 3.5). Osseous lesions were associated with molars in 57% of cases (186 infrabony defects), with pre-molars in 23% of cases (73 lesions), with canines in 7% of cases (23 lesions) and with incisors in 13% (42 lesions).

The mean root length (Radix) was 11.7 ± 2.2 mm (7–19) (Fig. 1). The mean PD associated with an infrabony defect was 6.6 ± 2.0 mm (4–14). The mean radiographic depth of the infrabony defect (Defect) was 3.9 ± 2.5 mm (1–12). Deeper defects (>3 mm) were frequently located in posterior teeth. Thirty-two defects = 4 mm (74.4%), 24 defects = 5 mm (100%) and 10 defects $\geqslant$6 mm (71.4%) were located at premolar–molar teeth.

On the basis of PD, radiological and clinical evaluations, 53 teeth (16%) were considered as hopeless and consequently extracted during active therapy. The mean root length of the extracted teeth (Radix) was 10.3 ± 1.4 mm (7–13). The mean PD of these teeth was 9.8 ± 1.7 mm (7–14), while the mean radiographic depth of the infrabony defect (Defect) was 8.5 ± 1.7 mm (6–12).

On the other hand, 271 teeth (84%) were surgically treated with FibReORS. The mean root length (Radix) was 11.9 ± 2.3 mm (7–19), the mean PD associated with the infrabony defect was 5.9 ± 1.2 mm (4–10) and the mean radiographic depth of the infrabony defect (Defect) was 3.0 ± 1.4 mm (1–8). In 69.7% of cases, Defect was $\leqslant$3 mm (189 defects), in 15.9% it was = 4 mm (43 defects), in 8.9% it was = 5 mm (24 defects) and in 5.5% it was $\geqslant$6 mm (15 defects) (Fig. 2). All treated sites displayed a PD $\leqslant$3 mm at the 6-month examination following the completion of APT.

A multilevel model explored the possible association of different variables at patient and tooth levels on the decision of tooth extraction. The model showed a statistically significant association between the radiographic depth of the infrabony defect (Defect) ($p = 0.0112$) and the length of the root (Radix) ($p = 0.0230$) and the probability of tooth extraction (Table 1).

No statistically significant association was found between extracted teeth and severity of pocket depth and other variables such as gender, smoking habits, age, or tooth type.

In order to simulate the risk of tooth extraction, the estimated model was applied on a female, 54 years old, non smoker, single-rooted tooth, root length 11 mm, PD 7 mm. The graphic in Fig. 3 shows that when considering a root length corresponding to 11 mm (the mean value in this study), the risk of extraction is marginal to none for infrabony defects <6 mm, it tends to increase dramatically in the range comprised between a radiographic defect depth of 6 and 8 mm, with the risk of extraction ranging from 5% to 90% (yellow-coloured area in Fig. 3), and it is very probable for defect >8 mm with the risk of extraction ranging from 90% to 100% (pink-coloured area in Fig. 3).

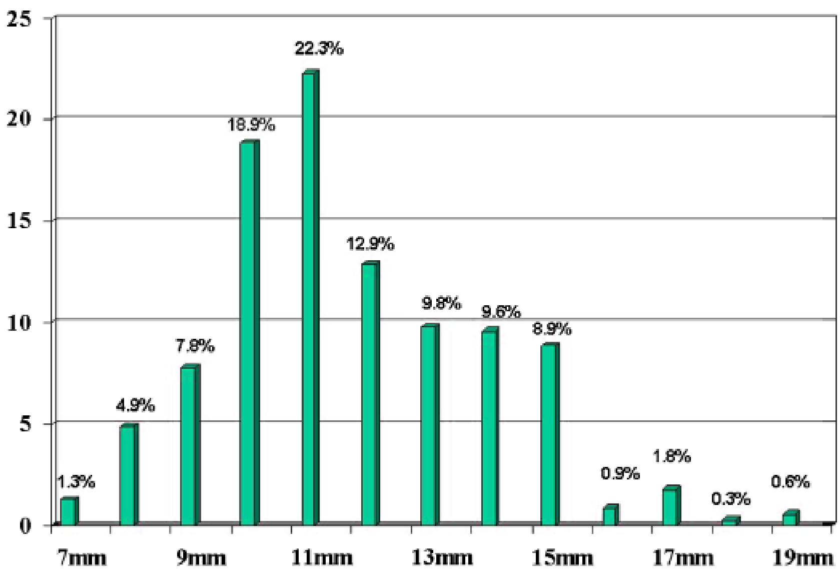

Fig 1. Root length distribution considering surgically treated and extracted teeth.

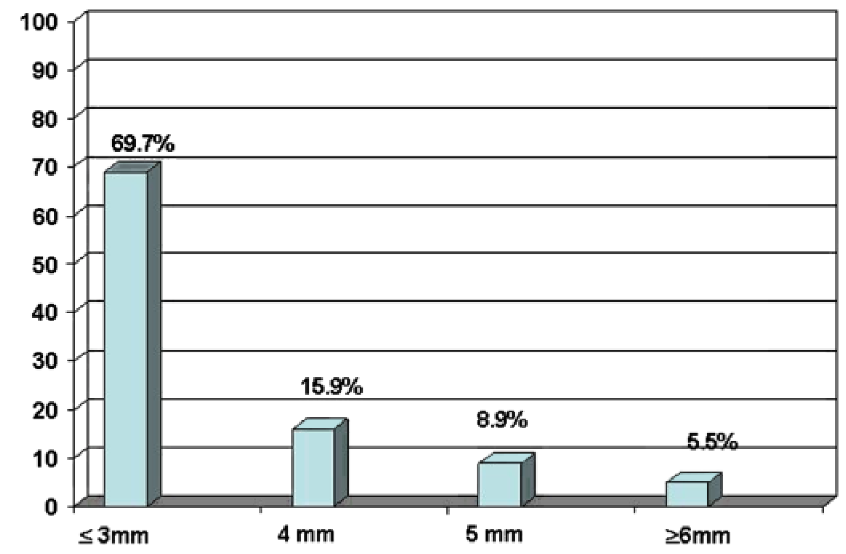

Fig 2. Distribution of osseous-resected defects for each category of defect depth.

Table 1. Multilevel Model to explore the possible influence of different variables at patient and tooth level on the clinical decision of tooth extraction

Term	Estimate	SE	*p*-value
Intercept	– 3.96	12.64	0.7537
Patient Level			
Gender	0.07	1.95	0.9714
Age	– 0.03	0.18	0.8808
Smoke	1.04	2.19	0.6359
Tooth Level			
Molar	0.31	1.59	0.8434
Radix	– 1.23	0.54	0.0230
Defect	3.45	1.36	0.0112
PD	– 0.63	1.10	0.5709
Variances			
σ^2	7.28	4.46	

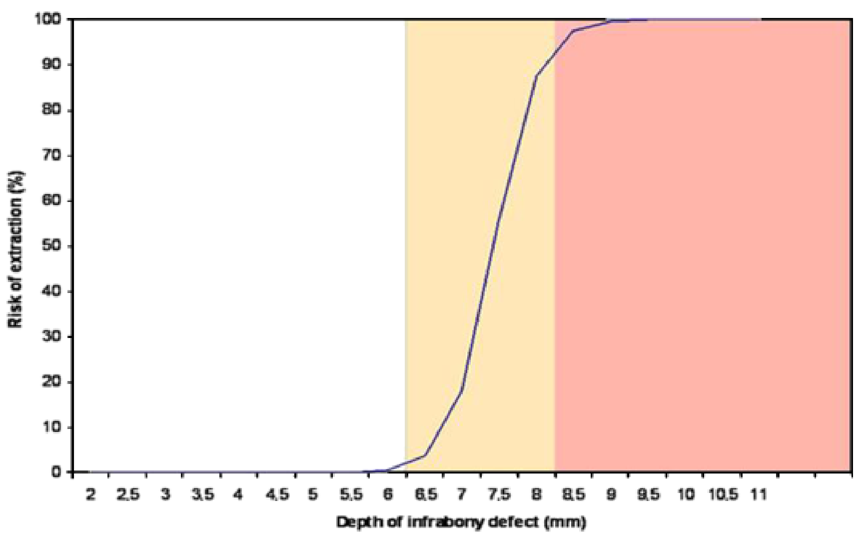

Fig 3. Logistic Model MLQ First Order for simulation of the risk of tooth extraction in a hypothetical patient (female, 54 years, no smoker, single-rooted tooth, root length 11 mm, PD 7 mm). The Yellow-coloured area includes defects with critical depths (6–8 mm), the pink-coloured area includes defects associated with tooth extraction (>8 mm) (see text for explanation).

The goodness of fit of the linear logistic multilevel model, considering $\pi_0 = 0.5$ as the threshold, showed that only six on 324 teeth were as misclassified. In fact, three teeth were considered by the model to be ''surgically treatable'' and were extracted, and three teeth were considered ''to be extracted'' and were surgically treated.

Discussion

The surgical treatment of residual periodontal pockets following cause-related therapy is a common approach to reduce PD and improve the level of clinical attachment in compliant patients (American Academy of Periodontology 1996). Over the last three decades, the selection of the most suitable surgical procedure has been an important matter of debate. Different long-term studies have demonstrated that surgical procedures based on the apical position of the gingival margin and osseous resective surgery resulted in higher pocket depth reduction and gingival recession at 6 months when compared with a conservative approach (Access flap and modified Widman flap) but these differences tended to be in significant over 5 years of supportive periodontal care (Knowles et al. 1979, Ramfjord et al. 1987, Becker et al. 2001). On the other hand, some authors reported the maintenance of a higher magnitude of pocket reduction at 5- (Townsend Olsen et al. 1985) and 7-year (Kaldahl et al. 1996a) observations, when a resective approach leading to the achievement of a positive bony architecture was produced at the time of surgery. Moreover, sites treated with this approach and maintained over time showed a lower incidence of recurrent periodontal breakdown when compared with sites treated with different, more conservative techniques (Kaldahl et al. 1996b). Therefore, osseous resective surgery still remains a predictable surgical option when the main treatment objective is pocket depth reduction. The osseous resective technique applied in conjunction with fibre retention (FibReORS) shifts the bottom of the defect in a more coronal position at the level of the connective tissue attachment, resulting in more conservative removal of supportive bone (Carnevale 2007). Until now, no information concerning the depth of treatable infrabony defects and the limits of applicability of osseous-resective techniques has been provided.

This retrospective survey was performed on periodontal patients displaying at least one infrabony defect treated by a single periodontist. The treatment philosophy consisted only of pocket elimination with FibReORS (Carnevale 2007) to facilitate self-administrated oral hygiene procedures and to obtain shallow PD 6-months post-surgery irrespective of the defect configuration or depth. For correct data interpretation, it should be kept in mind that data analysis was based on clinical and radiographic variables and no intra-surgical measurements of defects were provided. Clinical studies (Suomi et al. 1968, Tonetti et al. 1993) showed that radiographic measurements tend to underestimate the depth of the defect by approximately 1 mm compared with intra-surgical measurements.

The first aim of this study was to evaluate the radiographic depth of 271 infrabony defects in pockets treated by means of FibReORS. The resulting mean depth of infrabony defect was 3.0 ± 1.4 mm; the corresponding pre-surgical mean PD was 5.9 ± 1.2 mm. All sites displayed a PD $\leqslant 3$ mm at the end of the APT. This retrospective survey confirms that FibReORS, like traditional osseous-resective surgery, may be normally applied for the elimination of shallow-moderate bony defects (Ochsenbein 1986). Interestingly, 29.9% of the treated defects showed an infrabony component >3 mm. Different hypotheses may explain these data:

1. Multilevel analysis showed that deeper defects were associated with longer roots. This implies, from a clinical standpoint, the possibility of re-creating a positive bony architecture in deeper defects, avoiding an un favourable crown–root ratio.
2. Descriptive statistics showed that deeper defects ($\geqslant 4$ mm) were frequently associated with pr-emolar–molar teeth (81.5%). When considering only defects >5 mm, 57.5% were located at molar sites. This may be associated with the possibility to treat with a resective technique deep defects with less aesthetic concern for the patients.
3. The application of FibReORS, to restore positive bony anatomy, should result in less osseous resection allowing the treatment of more severe defects if compared with the traditional approach.
4. Treated teeth might have often been prosthetic abutments, although these data were not recorded in this analysis. This would imply the possibility to maintain mobile teeth because of the presence of rigid splints and to reduce aesthetic problems in anterior areas by means of a prosthetic restoration.

The rationale of FibReORS is based on experimental studies (Levine & Stahl 1972, Carnevale et al. 1983) demonstrating that the retention of the fibre apparatus attached to the root surface prevents, during periodontal healing, the apical migration of epithelium with no supplementary bone loss. This implies that restoration of a positive bony architecture with the retention of attachment fibre may determine a minimal pocket depth ($\leqslant 3$ mm) following surgery (Carnevale 2007a), as reported in this sample of patients. In addition, the maintenance of attached fibres into incipient furcation defects treated with ORS may prevent further loss of horizontal attachment during healing (Ochsenbein 1986). However, one should take into account that a retrospective study is prone to bias and further prospective trials to assess the healing dynamics of this procedure compared with traditional osseous resective approach are needed.

The second aim of this paper was to compare the depth of infrabony defects of surgically treated teeth *versus* extracted teeth in order to detect a possible limit of applicability of the FibReORS technique. During APT, 53 teeth (16%) with an infrabony defect were extracted. The mean radiological depth of the defects was 8.5 mm. A common criticism in applying osseous resective surgery is that teeth with moderate infrabony defects are extracted to avoid excessive bone resection at the adjacent teeth. In a prospective trial on different surgical modalities, Kaldahl et al. (1988) reported the extraction of teeth or roots with severe bone loss with a mean PD exceeding 9 mm, in quadrants treated with osseous resective surgery. In the present material, 16% of teeth displaying an infrabony defect were extracted for advanced bone loss: the mean PD for this sample of teeth (9.7 ± 1.7 mm) was very similar to that reported by Kaldahl et al. (1988) (9.8 ± 2.3 mm). Multilevel modelling showed a statistically significant association between the depth of the infrabony defect, the root length and the probability of tooth extraction as decided by a single experienced clinician. When comparing surgically treated and extracted teeth, two well distinct ranges of infrabony defects were detected: osseous-resected defects showed a depth ranging between 1 and 8 mm, while defects associated with extracted teeth displayed a depth ranging between 6 and 12 mm. This implies that defects with infrabony depth <6 mm were successfully treated with FibReORS restoring positive bony architecture and leading to shallow pockets, while in defects with infrabony depth >8 mm FibReORS was generally considered to be inappropriate and these teeth were extracted. The logistic model applied to simulate the risk of tooth extraction, considering a root length corresponding to 11 mm (mean root length in this study), showed that the risk of extraction had a sharp increase for bony defects with 6–8 mm depth (risk of extraction ranging from 5% to 90%). On the basis of descriptive statistics and the logistic model, defects with a radiographic depth of 6–8 mm are considered to be critical for the application of FibReORS. The multilevel model showed that root length is of paramount importance: the increase in root length is associated with tooth survival, while reduction in root length is associated with tooth extraction. The significance of defect depth and root length in clinical decision-making was confirmed by the goodness of fit of the linear logistic multilevel model that identifies only six of 324 teeth as ''misclassified''. In this small sample of teeth, the reason for extraction/surgical treatment is not completely explained by the anatomical elements investigated. However, it should be kept in mind that the same sites were used both to determine the classification rule and to judge their performance. This procedure may give a biased estimate of the misclassification probabilities and should be tested in a further study to confirm its goodness of fit.

When interpreting the results from this study, it should be considered that these data refer to consecutive patients treated by a single periodontist operating in a perio-restorative practice. Concerns about the validity and external applicability of these results need to be addressed. Moreover, this paper did not address the applicability of regenerative therapy as an alternative to either extraction or FibReORS in the presence of deep intrabony defects (Tonetti et al. 1998, Cortellini & Tonetti 2004). The application of predictable periodontal regenerative procedures to treat very severe defects may have led to a reduction in the incidence of tooth extraction reported in this study.

Expert opinions (Ochsenbein 1986, Carnevale & Kaldahl 2000) generally considered osseous-resective surgery as indicated in shallow–moderate bony defects. The findings of this study confirm the strength of this clinical judgement and suggest that deeper defects associated with longer roots may also be successfully treated using FibReORS when tooth survival with minimal PD is the treatment endpoint.

References

American Academy of Periodontology. (1996) Consensus report on surgical pocket therapy. *Annals of Periodontology* **1**, 618–620.

Armitage, G. (1996) Periodontal disease: diagnosis. *Annals of Periodontology* **1**, 37–215.

Becker, W., Becker, W., Caffesse, R., Kerry, G., Ochsenbein, C., Morrison, E. & Prichard, J. (2001) A longitudinal study comparing scaling, osseous surgery, and modified Widman procedures: results after 5 years. *Journal of Periodontology* **72**, 1675–1684.

Carnevale, G. (2007) Fibre retention osseous resective surgery. A novel conservative approach for pocket elimination. *Journal of Clinical Periodontology* **34**, 182–187.

Carnevale, G., Cairo, F. & Tonetti, M. S. (2007a) Long-term effects of supportive therapy in periodontal patients treated with fibre retention osseous resective surgery. I. Recurrence of pockets, bleeding on probing and tooth loss. *Journal of Clinical Periodontology* **34**, 334–341.

Carnevale, G., Cairo, F. & Tonetti, M. S. (2007b) Long-term effects of supportive therapy in periodontal patients treated with fibre retention osseous resective surgery. II. Tooth extractions during active and supportive therapy. *Journal of Clinical Periodontology* **34**, 342–348.

Carnevale, G. & Kaldahl, W. (2000) Osseous resective surgery. *Periodontology 2000* **22**, 59–87.

Carnevale, G., Sterrantino, S. & Di Febo, G. (1983) Soft and hard tissue wound healing following tooth preparation to the alveolar crest. *International Journal of Periodontics and Restorative Dentistry* **3**, 36–53.

Claffey, N. & Egelberg, J. (1995) Clinical indicators of probing attachment loss following initial periodontal treatment in advanced periodontitis patients. *Journal of Clinical Periodontology* **22**, 690–696.

Collett, D. (1991) *Modelling Binary Data*, p. 89. London: Chapman & Hall.

Cortellini, P. & Tonetti, M. (2004) Long-term tooth survival following regenerative treatment of intrabony defects. *Journal of Periodontology* **75**, 672–678.

Goldstein, H. (1998) Multilevel statistical models. In: *Kendall's Library of Statistics 3*, 2nd edition, pp. 15–68. London: Edward Arnold.

Grbic, J. & Lamster, I. (1992) Risk indicators for future clinical attachment loss in adult periodontitis. Tooth and site variables. *Journal of Periodontology* **63**, 262–269.

Kaldahl, W., Kalkwarf, K., Patil, K., Molvar, M. & Deyr, J. (1996a) Long-term evaluation of periodontal therapy. I. Response to 4 therapeutic modalities. *Journal of Periodontology* **67**, 93–102.

Kaldahl, W., Kalkwarf, K., Patil, K., Molvar, M. & Deyr, J. (1996b) Long-term evaluation of periodontal therapy. II. Incidence of sites breaking down. *Journal of Periodontology* **67**, 103–108.

Kaldahl, W., Kalkwarf, K., Patil, K., Molvar, M., Deyr, J. & Bates, R. (1988) Evaluation of four modalities of periodontal therapy: mean probing depth, probing attachment level and recession changes. *Journal of Periodontology* **59**, 783–793.

Knowles, J., Burgett, F., Nissle, R., Shick, R., Morrison, E. & Ramfjord, S. (1979) Results of periodontal treatment related to pocket depth and attachment level. Eight years. *Journal of Periodontology* **50**, 225–233.

Levine, H. L. & Stahl, S. (1972) Repair following periodontal flap surgery with the retention of gingival fibers. *Journal of Periodontology* **43**, 99–103.

Ochsenbein, C. (1958) Osseous resection in periodontal surgery. *Journal of Periodontology* **29**, 15–26.

Ochsenbein, C. (1986) A primer for osseous surgery. *International Journal of Periodontics and Restorative Dentistry* **6**, 8–47.

Papapanou, P. & Tonetti, M. (2000) Diagnosis and epidemiology of periodontal osseous lesions. *Periodontology 2000* **22**, 8–21.

Ramfjord, S., Caffesse, R., Morrison, E., Hill, R., Kerry, G., Appleberry, E., Nissle, R. & Stults, D. (1987) Four modalities of periodontal treatment compared over 5 years. *Journal of Periodontal Research* **14**, 445–452.

Schei, O., Waerhaug, J., Løvdal, A. & Arno, A. (1959) Alveolar bone loss as related to oral hygiene and age. *Journal of Periodontology* **30**, 7–16.

Serino, G., Rosling, B., Ramberg, P., Socransky, S. S. & Lindhe, J. (2001) Initial outcome and long-term effect of surgical and non-surgical treatment of advanced periodontal disease. *Journal of Clinical Periodontology* **28**, 910–916.

Suomi, J. D., Plumbo, J. & Barbano, J. P. (1968) A comparative study of radiographs and pocket measurements in periodontal disease evaluation. *Journal of Periodontology* **39**, 311–315.

Tonetti, M., Cortellini, P., Suvan, J., Adriaens, P., Baldi, C., Dubravec, D., Fonzar, A., Fourmousis, I., Magnani, C., Muller-Campanile, V., Patroni, S., Sanz, M., Vangsted, T., Zabalegui, I., Pini Prato, G. & Lang, N. (1998) Generalizability of the added benefits of the guided tissue regeneration in the treatment of the deep infrabony defects. Evaluation in multi-center randomized controlled split mouth study. *Journal of Periodontology* **69**, 1183–1192.

Tonetti, M., Pini-Prato, G. P., Williams, R. C. & Cortellini, P. (1993) Periodontal regeneration of human infrabony defects. iii. diagnostic strategies to detect bone gain. *Journal of Periodontology* **64**, 269–277.

Townsend Olsen, C., Ammons, W. & van Belle, G. (1985) A longitudinal study comparing apically repositioned flap with and without osseous surgery. *International Journal of Periodontics Restorative Dentistry* **5**, 1–33.

Updegrave, W. J. (1951) The paralleling extension cone technique in intraoral dental radiography. *Oral Surgery Oral Medicine Oral Pathology* **4**, 1250–1261.

Address:
Dr. Gianfranco Carnevale
via Ridolfino Venuti 38
Rome
Italy
E-mail: gi.carnevale@libero.it

Clinical Relevance

Scientific rationale for the study: No information concerning the depth of defects treated by means of osseous-resective techniques is available in the literature.
Principal findings: The mean depth of the infrabony defects treated by a single experienced periodontist applying FibReORS was 3 mm (ranging from 1 to 8 mm). Deeper defects were treated when associated with longer roots.
Practical implications: The primary range of applicability of FibReORS is infrabony defects with $\leqslant 4$ mm (86% of treated defects). The decision of applicability seems to depend primarily on the depth of the infrabony component in relation to the root length.