A retrospective radiographic outcome assessment study of intra-bony defects treated by osseous surgery or by bone graft procedures


Abstract

Background: Intra-bony defects remain a significant therapeutic problem in periodontal therapy. Various non-surgical and surgical treatment modalities are being used. The long-term stability following treatment of intra-bony defects is poorly documented.

Objectives: To assess changes in intra-bony defects after either osseous surgery or open flap debridement in combination with grafting procedures with demineralized freeze-dried bone allografts (DFDBA).

Method: Pre- and post-surgical computer digitized images of intra-oral radiographs from 60 patients who had received periodontal surgery to manage intra-bony defects were analyzed by linear measurements.

Results: 36 patients were treated with osseous surgery and 24 had received flap procedures and grafting with DFDBA. Post-surgical radiographs were obtained on average after 4.8 years (SD=2.8) and after 9.6 years (SD=3.6). A minor mean bone fill of 0.0 mm (SD=0.8) for osseous surgery sites and 0.5 mm (SD=0.9) for DFDBA sites, was noticed, but this gain was within the margin of measurement errors. Osseous surgery and modified Widman flap procedures with DFDBA resulted in crestal resorption, on average 1.7 mm (SD=1.1) and 1.5 mm (SD=1.5) and remaining mean defect depth of 2.0 mm (SD=1.4) and 2.5 mm (SD=1.6), respectively.

Conclusions: Bone changes following bone graft procedures with DFDBA did not differ from those following osseous surgery, and neither procedure resulted in defect resolution with bone fill. It was also concluded that over the study period, stable treatment results were obtained as a result of both osseous surgery and modified Widman flap procedures with adjunct DFDBA.

Key words: osseous surgery; open flap debridement; vertical defects; radiographs; DFDBA

Accepted for publication 13 April 1999

Both non-surgical and surgical treatment modalities have been used to manage periodontal disease (for review, see Palacios (1999)). A large number of studies have demonstrated that when data are averaged, there are only minor differences in treatment outcomes (Lindhe et al. 1982, Meador et al. 1985, Ramfjord et al. 1987, Becker et al. 1988, Kaldahl et al. 1988, Kalkwarf et al. 1989). Although all periodontal therapies require good oral hygiene to succeed (Rosling et al. 1976, Axelsson & Lindhe 1981, Cortellini et al. 1994), it is generally believed that if the treatment results in shallow pockets, it would be easier to maintain the results and prevent disease recurrence or progression.

Osseous surgery (Schluger 1949, Friedman 1955) was introduced as a means to assure pocket reduction and re-establishment of a bone topography that would facilitate oral hygiene. Guided tissue regeneration procedures
and bone grafting procedures have been suggested as alternatives to osseous surgery in the management of local intra-bony defects. Several studies have been published in which de-mineralized freeze-dried bone allografts (DFDBA) have been used (Quintanilla et al. 1982, Mellior et al. 1984, Masters et al. (1996).

The long-term stability following bone graft treatment of intra-bony defects is, however, poorly documented. The principle of guided tissue regeneration (GTR) has been successfully used to manage intra-bony defects (for review, see Lauren et al. (1998)). Especially deep defects appear to be suitable for GTR treatments. Only a few studies have monitored the outcome of GTR-treated sites beyond one or a few years (Cortellini et al. 1994, 1996, Chihagari et al. 1994, Waig et al. 1995, Eckholz et al. 1998). It is therefore not well documented whether this treatment modality is effective on a longer time perspective.

The objective of the present study was to assess radiographically on a local site basis the long-term outcomes of surgical treatment of intra-bony defects treated with either osseous surgery or by open flap debridement surgical procedures using (DFDBA).

Material and Methods

All available pre- and post-surgical intra-oral radiographs and records from patients who had received surgical periodontal treatment of vertical bone defects in the Graduate Periodontics Clinic at the University of Washington after 1970 were reviewed. A total number of 60 patient records was available from 60 patients who had consistently been enrolled in a supportive care program following surgical treatment of intra-bony defects. Intra-oral radiographs depicting the treated vertical defects were available over time. The radiographs had been standardized by the use of paralleling technique with a plastic film holder (CXR, Rinn Corp. Elgin IL). In 36 patients, intra-bony defects had been treated with osseous surgery. In 24 patients, the defects were treated with bone graft procedures using de-mineralized freeze-dried bone allografts (DFDBA). Graduate students who participated in the post-doctoral training program in Periodontics at the University of Washington, Seattle had performed all the surgical procedures under close supervision by faculty members who themselves had received their graduate training at the University of Washington, Seattle. In order to undergo surgical periodontal therapy, patients must have met the clinical requirements of good oral hygiene with a pre-surgical plaque score ≤15% surfaces with visible plaque. A review of the surgical notes was made to assure that osseotomy or significant osteoplasty procedures had been performed, consistent with the principles of osseous surgery (Schuiger 1949), and that the vertical defects included a composite of 1-, 2-, and 3-wall defects. In the case of osseous surgery soft tissue surgical flaps were apically positioned and sutured with continuous or ligature sutures that were removed after 1 week. The primary objectives of the osseous surgery procedures were to eliminate any vertical defect to allow maximum pocket re-duction. The modified Widman flap surgical procedures with bone grafting using DFDBA were performed primarily at sites with combined 2- and 3-wall vertical bone lesions and with no osteoplasty procedures performed. In the case of open-flap debridement, the soft tissue surgical flaps were repositioned and also sutured with continuous or ligature sutures that were removed after 1 week.

After the immediate post-surgical follow-up period, the patients were recalled for supportive care as needed on an individual basis. The supportive care included oral hygiene instructions; supr- and sub-gingival debridement was performed by dental hygienists. The patients were re-examined by graduate students and by supervising experienced periodontists/faculty members. Full-mouth intra-oral radiographs were obtained at baseline and at approximately 5 and 10 years after surgery.

Radiographic evaluation

For the analysis of the radiographs, linear measurements were made on computer-digitized images of the radiographs using the digital X-ray processing and analysis method by Jeffcoat et al. (1984). Briefly, the digitized computer assembly consisted of a video camera (model: JE2662A, Javelin Electronics, Japan), and projection table with a stand to which the video camera was fixed. The intra-oral radiographs were placed on a illuminated view-box. The output signals from the video im-
ages were grabbed and sent to a computer (Gateway 4DX2-66E, North Si-oux City SD, USA) which was equipped with a subtraction radiography program (Perioview 3.1 by Jeffcoat, Birminham Alabama, USA). The signals were processed and made visible on a television screen (Triptron PVM 134MQ, Sony Japan). The digitizer sty-lus was positioned at the selected reference points on the television screen (i.e., CEJ and BC), and the cartesian coordinates were automatically sent to the computer and processed. The resulting distances were expressed as pixels, and in mm, based on calibration of the setup using a conversion factor of 22.4. The analysis was performed at the Regional Clinical Dental Research Imaging Laboratory at the School of Dentistry. The following linear measurements were performed: the distance from CEJ (cemento-enamel junction) or a reference point (margin of dental restor-ation) to the apex of the root (RL); the distance from CEJ to bone crest (BC); the distance from CEJ to bottom of the bone lesion (ABL); the distance from BC to bottom of defect, i.e., the radiographic depth of the defect (IBD).

Measurements were expressed in pixels, in mm, and as the % of the root length. The assessment of bone fill was calculated by subtracting ABL values obtained at the follow-up radiographs from the baseline values. Defect resolution was obtained by comparing the pre- and post-surgical IBD values. The distance between CEJ and BC was measured to assess the amount of crestal resorption.

The average of 2 measurements was used for data analysis. The same calib-
rated examiner (HF) (Falk et al. 1997) examined all the radiographs. The distortion between sets of radiographs was compensated for by calculation of the ratio of root length from baseline and follow-up radiographs. This ratio was used to correct post-treatment linear measurements of bone changes (Bonetti et al. 1993, Falk et al. 1997).

Statistical analysis

Descriptive data were presented as mean values and standard deviation. Both paired t-test and ANOVA were used to study differences over time. The p-value was declared if the p-value was ≤0.05. The SuperANOVA computer statistical package was.
Table 1. Bone-level measurements (mm) (means and standard deviations) from computer-digitized radiographic images before surgery and at the 1st follow-up measurement. (all measurements expressed in mm).

<table>
<thead>
<tr>
<th>Treatment</th>
<th>ABL</th>
<th>Bone</th>
<th>IBD</th>
<th>Defect</th>
<th>Crural</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>baseline</td>
<td>follow-up</td>
<td>baseline</td>
<td>follow-up</td>
<td>resolution</td>
</tr>
<tr>
<td>OS (n=36)</td>
<td>68.3 ± 11.3</td>
<td>NS</td>
<td>65.3 ± 1.5</td>
<td>0.05 ± 0.8</td>
<td>3.7 ± 0.5**</td>
</tr>
<tr>
<td>DFDRA</td>
<td>*</td>
<td>ns</td>
<td>*</td>
<td>0.5 ± 0.9</td>
<td>4.3 ± 1.9***</td>
</tr>
<tr>
<td>(n=24)</td>
<td>74.2 ± 23</td>
<td>NS</td>
<td>69.2 ± 2.3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ABL=CEJ to bottom of defect; IBD=Crest to bottom of defect; ns=not significant; * < 0.05; *** p < 0.001.

Table 2. Bone-level measures (mm) (means and standard deviations) at the 1st and 2nd post-treatment evaluations (mean = 4.8 and 9.6 years) for 28 sites treated either by osseous surgery (n=22) or grafting procedure (n=17).

<table>
<thead>
<tr>
<th>Treatment</th>
<th>ABL</th>
<th>ABL grafted</th>
<th>IBD Oss</th>
<th>IBD Graft</th>
<th>Crest level osseous</th>
<th>Crest level grafted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ic evaluation</td>
<td>67.2 ± 12</td>
<td>ns</td>
<td>6.5 ± 1.5</td>
<td>2.2 ± 1.5</td>
<td>2.5 ± 1.6</td>
<td>4.5 ± 1.1</td>
</tr>
<tr>
<td>2nd evaluation</td>
<td>67.2 ± 14</td>
<td>ns</td>
<td>7.0 ± 1.1</td>
<td>2.1 ± 1.5</td>
<td>2.7 ± 1.4</td>
<td>4.6 ± 1.2</td>
</tr>
</tbody>
</table>

p ns ns ns ns ns

ABL=CEJ to bottom of defect; IBD=crest to bottom of defect; ns=not significant.

Results

The average time intervals between baseline and the first follow-up was 4.8 years (SD=±2.8) and included 60 patients. A 2nd set of follow-up radiographs was available for 39 of the patients, on average, 9.7 years (SD=±3.6) after the initial procedures.

The correlation coefficient between repeated measurements as assessed by simple regression analysis was 0.953 and consistent with results published previously (Falk et al. 1997). Inter-examiner errors expressed as the SD of the difference between measurements amounted to 0.5 mm for ABL and to 0.7 mm for IBD measurements. The corresponding intra-examiner errors were 0.6 for the ABL readings and 0.5 mm for the IBD readings. The mean difference in root length between sets of measurements was 0.3 mm (SD=±1). The ratio between different sets of radiographs averaged 1.0 (SD=±0.1).

The results at the first post-operative assessment are presented in Table 1. In the osseous surgery group, a small amount of bone fill was found averaging 0.2 mm (SD=±0.9). The extent of bone gain was not statistically significant (p>0.05). In the bone graft group, a small and significant bone fill was obtained averaging 0.5 mm, (SD=±0.9, p<0.05). However, the extent of bone fill was within the range of measurement errors (SD=±0.5 mm for duplicate measurements). Thus, there were no clinically significant differences in outcome between osseous surgery and surgeries including grafting with DFDRA.

A significant defect resolution had occurred and independent of the type of surgical procedure. As there was no significant bone fill, the defect resolution was attributed to resorption of the entire of the intra-proximal bone crest. On average, this crestal resorption amounted to 1.8 mm (SD=±1.3) for the entire study population. A mean residual vertical defect depth of 2.0 mm (SD=±1.4) and 2.5 mm (SD=±1.6) was found following osseous surgery and the open flap and DFDRA graft procedure, respectively. The difference in residual defect between treatment modalities was statistically significant (p<0.05). However, the difference was within the margin of measurement errors and therefore not relevant.

The 10-year follow-up data indicated that no additional changes in ABL, IBD, or crestal resorption had occurred (Table 2). Thus, the initial results remained stable throughout the observation period and independent of procedure used.

Discussion

Intra-oral radiographs were used in the present study most likely underestimate the extent and depth of intra-bony defects (Tonetti et al. 1993, Falk et al. 1997, Eckhoff et al. 1998 a, b). Yet, many studies have employed radiographic methods to assess the outcome of periodontal surgery (Rosling et al. 1976, Polson & Heij 1978, Tonetti et al. 1993, Christgau et al. 1996, Falk et al. 1997, Eckhoff et al. 1998 a). In the present study, measurement errors may exist due to radiographs that were not standardized by the use of chief others but only standardized by using Rinn holders. Errors introduced by geometric distortion, and through observer variability must be recognized when changes in bone values over time are compared. However, any erratic effect introduced by the lack of strict standardization should not distinguish between one procedure or time-point over another procedure or time-point. The study was also limited by the retrospective approach in that the time between pre-surgical and post-surgical radiographs varied between subjects, none being shorter than 3.8 years. However, it can well be assumed that any effect accomplished by the surgical procedures in terms of additional bone loss or bone fill would have occurred within the first 2 years after treatment (Bragger et al. 1992). The follow-up time should therefore be sufficient to allow that the measurement of the surgical procedures performed had been shown to be successful in preventing further loss of bone.

The prevalence of vertical defects including all vertical defects in an adult population may be as high as 61%, and with 30% of subjects having local vertical defects ≥3.0 mm (Persson et al. 1998, Sikkonen et al. 1998). Thus, there is an obvious need for a treatment that predictably allows successful management of periodontal intra-proximal bone lesions.

Surgical treatment alternatives for site-proximal periodontal bone lesions include various types of open flap debridement, including the modified Wid-
man flap procedure in which no attempt is made to remove bone. Rather, the defects are debrided and flaps are repositioned. Osteosurgical was introduced as a means to assure pocket reduction and re-establishment of a bone topography that would enhance the method of oral hygiene (Schluger 1949, Friedman 1950). In the present study, the most apical portion of the bone defects appeared to remain stable. Thus, no further loss or gain of bone was obtained. However, approximately 2 mm of crestal bone was lost as a result of either the osteoplasty procedure, the surgical trauma per se, or an ongoing disease process. Because measurements of the crestal bone levels from radiographs are fairly reliable, the mean loss of 1.8 mm must be considered confirmed. The investigators reviewed the surgical records to assess the extent of ostectomy. The records indicated that the extent of ostectomy was defined by anatomical consideration. Thus, complete elimination of vertical defects were at times not performed in order not to compromise remaining tooth support for the tooth involved or a neighboring tooth. This may to some extent explain why residual crater defects remained after treatment.

Crestal resorption is a common effect of osteosurgical re-contouring (Moghad- addas & Stahl 1980), but may also occur after modified Widman flap procedures (Polson & Heijl 1978, Bragger et al. 1997). Froum et al. (1982) reported that following open debridement procedures, crestal resorption averaged 0.8 mm and with an average bone fill of 1.2 mm. The absence of measurable changes in the apical portion as noticed in the present study suggests successful arrest of disease. A residual defect depth of approximately 2.2 mm following the osteosurgical procedure, also implies that complete defect elimination was not achieved.

However, a remaining intra-bony defect of 2 mm indicates a potential intra-radicular probing depth of 4-5 mm (assuming a normal gingival contour), which would be manageable by normal oral hygiene measures.

An alternative treatment to achieve pocket reduction is guided tissue regeneration therapy. A recent literature review (Laurell et al. 1988) showed significant pocket reduction following GTR, mainly due to bone fill in contrast to the present study that failed to show bone fill. The amount of bone fill, however, varies between subjects in each study as well as between studies. Only a few studies have monitored the outcome of GTR treated sites beyond one or a few years (Cortellini et al. 1994, 1996, Weigt et al. 1995, Kristjain et al. 1996, Eichkoff et al. 1998 a,b). It is obvious from a very large number of studies that appropriate oral hygiene is a pre-requisite for a successful and stable outcome of periodontal therapy. In the present study, the pre-surgical requirement of a plaque score of less than 15% suggest that patients studied were compliant. The fact that they regularly attended the supportive care program over a 10-year period further suggests that these patients maintained a level of oral hygiene that could be consistent with pre-surgical requirements. However, it should be pointed out that adjunct use of chlorhexidine mouthwash was never available to the patients.

In summary, the results of the present study suggest that the use of DFDFA in conjunction with surgical treatment of intra-bony defects, did not enhance the outcome in terms of radiographically detectable bone fill as compared with osteosurgical. Both treatments resulted in some loss of crestal bone height but no further loss at the base of the vertical defect. Furthermore, long-term stable conditions with no further detectable bone loss were obtained.

Zusammenfassung

Eine retrospektive röntgenologische Ergebnisanalyse von intraossealen Knochendefekten, die mit der Methode der Kronenchirurgie oder der Kronenchirurgie mit offenem Debride-
ment in Kombination mit Transplantatmetho-
den mit dekompensationen geführten Knochen-
transplantationen (DFDBA) erfolgte. In der postope-
rativen makroskopischem Untersuchung wurden keine definitiven Befunde für die intraossealen Knochendefekte erhä-
tt. Es fanden sich jedoch feine, nicht messbare Veränderungen, welche in die Therapie eingehen müssen. Die Ergebnisse stehen im Einklang mit anderen Untersuchern (Froum et al. 1982) und zeigen, dass die Methode der Kronenchirurgie mit offenem Debride-
ment in Kombination mit Transplantatmetho-
den mit dekompensationen geführten Knochen-
transplantationen (DFDBA) effektiv ist.

Résumé

Étude radiographique rétrospective évaluant les résultats obtenus dans le traitement de défauts intra-osseux par chirurgie osseuse ou par greffe osseuse.

Le but de la présente étude était d'évaluer les changements observés à l'intérieur des défauts intra-osseux après traitement par chirurgie osseuse ou par débridement à lame, obtenu comme un adjoint de l'apport de débris. Les résultats des patients traités par chirurgie osseuse ou par débridement à lame ont été comparés à ceux des patients traités par débridement à lame et greffe avec DFDFA. Les radiographies post-opératoires montrent des résultats similaires pour les deux groupes, avec une légère différence de 0.5 mm (ET-1.5). Cela suggère que la méthode de débridement à lame et greffe est aussi efficace que la méthode de débridement à lame seule.

References