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Four-year follow-up of a randomized clinical trial**

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Soft tissue regrowth after osseous resective surgery with and without fibre retention technique. Four-year follow-up of a randomized clinical trial.

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Abstract

Aim: The aim of this study was to compare the clinical outcomes and soft-tissue rebound following Fibre Retention Osseous Resective Surgery (FibReORS) and Osseous Resective Surgery (ORS) over a 48-month period.

Materials and Methods: Thirteen chronic periodontitis patients, displaying two contralateral posterior sextants with residual intrabony defects ≤ 3 mm in single-rooted or multi-rooted teeth with no or grade I furcation involvement, were treated in a split-mouth study model. ORS procedure was randomly applied on one side, while FibReORS on the contralateral side. Clinical measurements were recorded at 12 and 48 months after surgery.

Results: All 13 patients were available for the 48-month recall. At this time point probing depth (PD) and keratinized tissue changes did not significantly differ between treatments. FibReORS-treated sites exhibited less gingival recession than ORS-treated sextants (2.1 ± 0.3 mm *versus* 2.5 ± 0.4 mm, $p = 0.001$), but comparable coronal soft-tissue rebound. The mean difference of 0.4 ± 0.3 mm was consistent with higher amount of bone resection in the ORS group (0.92 ± 0.11 *versus* 0.38 ± 0.09 mm, $p < 0.001$).

Conclusion: FibReORS resulted in similar PD changes and soft-tissue rebound compared to ORS in posterior teeth with no or limited furcation involvement.

Clinical relevance

Scientific rationale for study: Limited information is available on the clinical outcomes and the changes in soft tissue position after Fibre Retention Osseous Resective Surgery (FibReORS) compared with traditional Osseous Resective Surgery (ORS) in chronic periodontitis patients.

Principal findings: FibReORS-treated defects experienced more coronal gingival tissue regrowth in the first 12 months after surgery, while ORS-treated sites in the interval between 12 and 48 months.

Practical implications: Due to the faster soft tissue rebound, FibReORs represents an attractive alternative to ORS in the treatment of shallow-moderate intrabony defects at posterior natural teeth.

1. Introduction

The osseous resective surgery is a well-documented treatment approach to eliminate residual periodontal pockets associated with shallow intrabony defects at posterior teeth (Ochsenbein 1958, Kaldhal et al. 1996a). This treatment modality combines the use of both osteoplasty and ostectomy to restore positive bone architecture at a more apical position and to obtain a gingival contour facilitating home oral hygiene and periodontal maintenance (Carnevale & Kaldhal 2000). This requires proper soft tissue management to ensure a close adaptation of soft tissue to the reshaped bone profile.

Recently, two randomized clinical trials compared Apically Positioned Flap (APF) and classical osseous resective surgery (ORS) to APF and ORS with gingival fibre retention (Fibre Retention Osseous Resective Surgery, FibReORS) (Cairo et al. 2013, Aimetti et al. 2015). This more conservative approach considers the level of supracrestal periodontal fibres inserted in the root cementum as the bottom of the defect, leading to a more conservative removal of supporting bone (Carnevale 2007, Carnevale et al. 2008). FibReORS was associated with similar probing depth reduction, but less clinical attachment loss, radiographic bone remodelling and patient morbidity after surgery than conventional ORS (Aimetti et al. 2015, Cairo et al. 2013). This might be attributable to the protective effect of preserved connective tissue over the interproximal sites and to the milder inflammatory host response (Romano et al. 2017).

Limited information is available on the amount of time necessary to obtain complete healing and stability of the soft tissue levels. Data on soft tissue postsurgical modifications were previously reported following crown lengthening around teeth with health periodontal tissue with conflicting results. Bragger et al. (1992) found minimal changes in the gingival levels over a 6-month healing period, while Pontoriero & Carnevale (2001) and van der Velden (1982)

observed a considerable amount of coronal regrowth of the interdental gingival tissue 1 year and 3 years after surgery.

Only one study exists describing the 12-month pattern of soft tissue regrowth after traditional ORS and FibReORS (Cairo et al. 2015), with the conclusion that, although both procedures were followed by a coronal displacement of the gingival margin, it was slightly more pronounced in the ORS-treated sites. A substantial stability of the gingival margin was obtained in the first 6 months after surgery for both resective techniques with a mean reduction of 90% of the post-surgical recession.

Therefore, the aim of this study was to analyse the clinical outcomes as well as the changes in soft tissue position for a period of 48 months after osseous resective treatment in relation to the type of surgical technique (FibReORS *versus* ORS).

2. Material and Methods

2.1 Study population and design

The paper was written accordingly to the CONSORT guidelines. The present study reports on the 48-month follow-up of a study population participating in a split-mouth prospective randomized controlled clinical study designed to compare the efficacy of APF plus FibReORS *versus* APF plus ORS for the surgical treatment of residual moderate-shallow intrabony defects at posterior natural teeth (Aimetti et al. 2015). Each patient provided a written informed consent to participate to the study. The study was in accordance with the Helsinki Declaration of 1975, as revised in 2000 and the study protocol was approved by the Institutional Ethics Committee (Protocol n° 0068553).

Patient selection

Patients treated with osseous resective surgery between January and October 2012 at the Section of Periodontology, C.I.R. Dental School, University of Turin (Italy) were recalled for 4-year periodontal examination. The patient inclusion criteria were reported in detail previously (Aimetti et al. 2015). In brief, each patient was older than 18 years, systemically

healthy, non-smoker and was diagnosed as having generalized chronic periodontitis (Armitage 1999). Three months after the completion of non-surgical periodontal therapy, all patients with a full-mouth plaque score (FMPS) and a full-mouth bleeding score (FMBS) <15% and two contralateral posterior sextants with at least one intrabony defect with residual probing depth (PD) \geq 5 mm, persisting bleeding on probing (BoP), and radiographic evidence of an intrabony component \leq 3 mm were consecutively selected. Teeth with prosthetic restorations or natural teeth with undetectable cemento-enamel junction, severe furcation involvement (degree II or III, Hamp et al. 1975) or severe mobility (degree II or III, Miller et al. 1950) were excluded from the study.

2.2 Randomization/blinding

Patients were randomized after enrolment, with the test or control treatment assigned to the right or left sides. The treatment side as well as the treatment sequence (first treatment FibReORS or ORS) were randomly assigned using computer-generated randomization tables with patients numbered according to the order in which they were consecutively enrolled. Allocation concealment was ensured with two sealed opaque envelopes. The first one was opened just after the patient entered the surgical room and determined which side of the mouth should be first surgically addressed. The second envelope was opened after defects were degranulated and determined whether that side would be the test (APF + FibReORS) or the control side (APF + ORS). The examiner and the patients were blinded to the type of surgical procedure that was used in each sextant.

2.3 Surgical procedure and post-operative care

The surgical procedures were described in detail in the previous paper (Aimetti et al. 2015). In each patient APF + FibReORS (Carnevale 2007) and APF + ORS (Ochsenbein 1958) were performed on the same surgical session. A single experienced clinician, not involved with the clinical measurements, carried out all the surgeries using loops 5X under coaxial light.

At the buccal side internally bevelled paramarginal or intrasulcular incisions were made based on PD values and on the width of keratinized tissue (KT) available. A split-thickness flap just beyond the mucogingival junction was then raised. Vertical releasing incisions were used for better access when necessary. At the palatal side the thinned palatal flap technique was performed.

Bone remodelling was carefully made by using manual and rotary instruments in order to reshape positive attached fibres/bony architecture. In the FibReORS sextant great attention was made in the differential diagnosis between inflammatory tissue and connective fibres inserted into the root cementum by using a periodontal probe with a magnification system (Carnevale 2007). The soft tissue not attached to the root surface was gently removed by means of a microsurgical blade. Flaps were positioned apically at the level of the bone crest and closed with external vertical mattress sutures.

Patients received post-operative systemic antibiotics for 5 days and analgesics for 2 days. They were advised to abstain from brushing and flossing in the surgical areas and to use 0.12% chlorhexidine gluconate rinses twice a day for the first 2 weeks. Sutures were removed after 10 days. After 2 weeks patients resumed oral hygiene procedures with a soft toothbrush. During the first 4 weeks after surgery patients were recalled once a week for supra-gingival professional tooth cleaning. After that, they resumed normal oral hygiene practices with medium toothbrush and interdental devices according to the morphology of the interdental spaces and were enrolled in a maintenance program with 4-month interval sessions. The recall appointments consisted of reinforcement of oral hygiene measures, supragingival scaling and polishing, subgingival debridement for pockets with $PD \geq 5$ mm and persisting BoP, and occlusal adjustment when needed.

2.4 Clinical parameters

The 4-year follow-up data were compared to clinical data recorded at baseline, and at 12-month follow-up. Consistent with the original study, at the 4-year recall the following

measurements were recorded in the ORS- and FibReORS-treated sextants: 1) PD at six sites/tooth; 2) gingival recession (Rec) at six sites/tooth; 3) clinical attachment level (CAL) at six sites/tooth; 4) KT at the mid-buccal aspect; 5) periodontal biotype (thin = 0; thick =1), categorized as thin or thick, by assessing the transparency of periodontal probe through the gingival margin at the mid-buccal aspect of each treated tooth (De Rouck et al. 2009). In addition, whole mouth evaluation of plaque (0/1) and BoP (0/1) was performed at six points per tooth, and FMPS and FMBS were obtained. The independent, blinded, calibrated examiner from the original study performed all measurements using a 1-mm graduated periodontal probe (PCP 15, Hu-Friedy). A calibration exercise was performed to obtain acceptable intra-examiner reproducibility for PD and Rec. The sites measured were comparable to the sites to be measured in the study. Repeated measurements were performed twice in 24 hours. The agreement was between 92% and 96%.

2.5 Statistical analysis

Description of the sample size calculation was reported in a previous paper (Aimetti et al. 2015). Data collected were organized into a spreadsheet using a computer program (Excel, Microsoft). After proofing for entry errors, the database was locked and loaded in statistical software. The statistician was masked to the given treatments. All statistical tests were performed using a commercially available statistical software package (SAS 9.2).

Data were analysed using sextant and site as the unit of statistical assessment. Descriptive statistics are reported as means \pm standard deviation (SD) or as numbers and percentages. The significance of the differences in clinical parameters between the time points within each group was analysed using repeated-measurement analysis of variance (PD, CAL) or the Friedman's test (FMPS, FMBS, Rec). Multiple comparisons were conducted with post-hoc tests (Newman-Keuls test and Dunn test). Subsequently, pairwise comparisons between the groups were performed using Student's *t*-test for paired samples or Wilcoxon test with Bonferroni correction. The experimental level of significance (alpha) was set at 0.05.

3. Results

The flow chart of the experimental design is reported in Fig. 1. All the original 13 subjects (3 males, 10 females, mean age 48.4 ± 4.7 years) were available for 4-year follow-up. Thirteen sextants (6 maxillary and 7 mandibular) were treated with FibReORS, while 13 with ORS (7 maxillary and 6 maxillary). No data points were missing for analysis through the entire experimental period. All 4-year follow-up visits were completed in November 2016. The mean FMPS and FMBS remained $<15\%$ throughout the entire study period.

The sextant-based data at baseline, 12 and 48 months after surgery in both treatment groups are presented in Table 1. At the baseline examination, no significant differences could be detected between FibReORS- and ORS-treated sextants in any of the investigated parameters ($p > 0.05$). Significant higher osteotomy was performed in the ORS-treated sextants (0.92 ± 0.11 versus 0.38 ± 0.09 mm, $p < 0.001$) leading to a slightly higher distance between CEJ and gingival margin immediately after surgery in the ORS group (5.0 ± 1.2 mm versus 4.5 ± 1.0 mm).

Both surgical techniques were associated with statistically significant reductions of mean PD and increases in mean CAL and Rec values at 12 months after treatment ($p < 0.001$). Mean CAL loss and mean Rec increases at 12 months were significantly higher in the ORS group, when compared with the FibReORS group ($p < 0.001$). The overall CAL loss and REC increase amounted to 1.0 ± 0.6 mm and to 2.5 ± 1.0 mm, respectively, in the FibReORS group, and to 2.4 ± 1.0 mm and 3.5 ± 1.1 mm, respectively, in the ORS group. In both groups, changes in KT values at the 1-year time point were minimal, without showing any difference between the two procedures ($p > 0.05$).

When comparing the changes from 12 to 48 months, mean PD values increased from 2.1 ± 0.4 mm to 2.8 ± 0.3 mm in the FibReORS-treated sextants and from 2.3 ± 0.5 mm to 3.0 ± 0.5 mm in the ORS-treated sextants, without any significant difference between them ($p > 0.05$).

Similar results were obtained when data were restricted to pockets initially ≥ 5 mm and BoP positive as summarized in Table 2. The FibReORS procedure resulted in mean PD reduction of

2.8 ± 0.9 mm and mean Rec increase of 2.1 ± 0.5 mm at 48-month evaluation. These values amounted to 2.5 ± 0.8 mm and to 2.8 ± 0.4 mm in the ORS group.

The frequency distribution on the PD reduction outcome at 4-year follow-up is reported in Tables 3 and 4 at the sextant and site level, respectively. In the FibReORS-treated sextants the proportion of closed pockets (PD ≤ 3 mm) was 91.7% and only 2% of sites had residual PD of 5 mm (Table 3). No pockets with PD of 6 mm were observed in this treatment group. Pocket closure and residual PDs of 5-6 mm were observed at a frequency of 88.7% and 3.1%, respectively, in the ORS-treated sextants. At the site level (Table 4), the percentage of initial pockets with PD ≥ 5 mm and BoP that exhibited pocket closure was 84% and 80.5% in the FibReORS and ORS group, respectively.

Significant changes in Rec values (0.6 ± 0.6 mm, $p = 0.003$) were observed in the FibReORS sextants, and in Rec (1.3 ± 1.0 mm, $p = 0.001$) and CAL values (0.6 ± 0.7 mm, $p = 0.01$) in the ORS sextants between the 12- and 48-month examinations (Table 1). Data were consistent with those recorded at the site level (Table 2). At the pair-wise comparisons both parameters showed statistically significant difference between the treatment groups ($p \leq 0.001$). No patient reported residual root sensitivity.

Soft-tissue rebound following resective surgery was assessed by measuring variations in the gingival margin position during the 48-month examination period with respect to the level at the time of flap suture. Gingival tissues experienced a coronal displacement of about 2.5 ± 1.1 mm for ORS and of 2.4 ± 0.9 mm for FibReORS during 48 months after surgery. In the time interval between post-surgery and 12 months, FibReORS-treated sextants displayed more soft tissue rebound compared with ORS sextants (1.8 ± 0.7 mm *versus* 1.2 ± 0.8 mm), while in the interval between 12 and 48 months the sextants treated with the traditional technique experienced more coronal regrowth (1.3 ± 1.0 mm *versus* 0.6 ± 0.6 mm). As reported in Figure 2, this trend of soft tissue regrowth was more evident at the inter-proximal sites, where at the end of the experimental period the mean difference in Rec between FibReORS and ORS

procedure was 0.5 ± 0.4 mm favouring the FibReORS group ($p = 0.002$). The change in PD was more pronounced at the interdental sites but was not statistically different between the two procedures (Fig. 3).

When considering the gingival biotype, 12 sextants had a thin biotype and 14 a thick biotype. Irrespective of the surgical technique, sextants with thick gingival tissue experienced greater soft tissue regrowth than those with thin gingival tissue at both interdental (3.7 ± 0.7 mm *versus* 3.3 ± 0.2 mm for ORS and 3.4 ± 0.7 mm *versus* 2.9 ± 0.4 mm for FibReORS) and buccal/lingual sites (1.7 ± 0.5 mm *versus* 1.2 ± 0.9 mm for ORS and 1.8 ± 0.2 mm *versus* 1.4 ± 0.9 mm for FibReORS).

Finally, both techniques were associated with a significant mean KT gain from baseline to the 4-year follow-up (2.1 ± 1.2 mm for FibReORS and 1.8 ± 0.9 mm for ORS, $p < 0.001$) (Table 1), but without any significant difference between the two procedures.

4. Discussion

This follow-up observation of a prospective, randomized and controlled clinical study aimed at comparing the clinical outcomes and the changes in soft tissue position for a period of 48 months after resective surgery of shallow-moderate intrabony defects at posterior natural teeth using either ORS or FibReORS.

The present results demonstrated that, irrespective of the surgical procedure, physiologic PD and clinical attachment level stability were achieved and maintained over a 48-month period. During the maintenance therapy a stringent plaque control was performed and at 4-year follow-up prevalence of FMPS and FMBS $< 15\%$ was detected. At this time point the majority of sites in the FibReORS group showed complete pocket closure (91.7%) and the prevalence of 5 mm pockets was 2.0%. In the ORS group these percentages were 88.7% and 2.5%, respectively. Only two pockets of 6 mm were observed in the ORS group. Probing depths ≤ 3 mm without bleeding were depicted in 95.3% and 94.7% in the FibReORS and ORS-treated sites,

respectively. According to Matuliene et al. (2008), a very low percentage of sites in these conditions have the probability to develop disease progression.

The current findings are in agreement with previous data in the literature. Pocket sites treated with APF and bone recontouring experienced the best clinical results in terms of PD reduction in the short (Smith et al. 1980, Kaldhal et al. 1988) and long period (Becker et al. 2001, Townsend Olsen et al. 1985, Kaldhal et al. 1996a). In the study by Kaldhal et al. (1996b) sites treated with osseous resection showed a lower incidence of recurrent periodontal breakdown when compared with sites treated with conservative techniques during a 7-year maintenance program.

Of interest is the observation that the incidence of deep pockets over a 4-year follow-up was not significantly different between ORS and FibReORS treatment. In a retrospective study Carnevale et al. (2007) reported a prevalence of 98.5% of shallow pockets 3-17 years after the completion of FibReORS in a well-maintained and complaint population in a private specialty practice. In a prospective 1-year clinical study (Cairo et al. 2013) comparable magnitude of PD reduction was achieved with ORS and FibReORS, but no frequency distribution of residual PDs was provided.

Concerning soft tissue behaviour, postsurgical gingival recession was greater in the ORS group compared to the FibReORS group, but differences did not reach statistical significance. A different pattern of soft tissue regrowth between the two surgical procedures was observed over the 48-month healing period. A higher coronal displacement of the gingival margin was depicted in the FibReORS-treated sextants during the first 12 months after surgery when the gingival margin reached about 75% of its final position. In the ORS-treated group the soft tissue rebound occurred mostly in the interval between 12 and 48 months. At the end of the experimental period, the gingival margin was 2.5 mm and 2.4 mm coronally from where it was located immediately after FibReORS and ORS procedures, respectively. This post-surgical gingival displacement was greater in the interproximal sites.

These findings are in line with those of clinical studies on surgical crown lengthening procedures reporting the reformation of a new supracrestal gingival unit at a mean distance of 3.0 to 4.6 mm coronal to the surgical bone level during 6 to 12 months of healing (van der Velden 1982, Pontoriero & Carnevale 2001, Lanning et al. 2003). The gingival margin position remained unchanged during 5 to 7 years of maintenance, demonstrating a predictable stability in properly maintained patients. Histologically, the re-establishment of the biological width with reformation of attached connective fibres and small soft-tissue inflammatory infiltrate was previously demonstrated after osseous resective procedures (Oakley et al. 1999, Zitzman et al. 2005a, 2005b).

The results of the present study differ, however, from those obtained by Cairo et al. (2013), where the postsurgical recession was reported more severe at ORS-treated sites compared to FibReORS sites. We can speculate that these differences may be attributable to the hard tissue management resulting in highly scalloped bony architecture. This may impact on soft tissue morphology and rebound.

In a companion paper, Cairo et al. (2015) also observed a greater tendency of the marginal periodontal tissue to grow in a coronal direction after traditional osseous resective surgery than after FibReORS. According to the Authors, the reason for these patterns of marginal tissue alterations may be due to the differences in the amount of bone remodelling. ORS-treated sites experienced higher amount of bone resection enhancing the re-establishment of a new connective tissue attachment and the potential coronal tissue regrowth (Oakley et al. 1999). Conversely, the less extent of bone removal in the FibReORS technique (Carnevale et al. 1983) could have limited the rebound effect of soft tissue. The present data showed a 48-month difference in Rec between the 2 procedures consistent with that observed in the amount of the ostectomy.

The factors influencing the amount of coronal displacement of the marginal periodontal tissues seemed to be related to the different tissue biotypes and to the various positions of the flap at

the time of suture. Biotype assessment based on visibility of periodontal probe through the gingival margin has been shown to be a simple, reliable, and reproducible method for gingival thickness assessment in routine practice (De Rouck et al. 2009) and was therefore used in the present study. In agreement with previous studies on surgical crown lengthening (Pontoriero & Carnevale 2001, Arora et al. 2013) patients with thick tissue biotype demonstrated significantly more coronal soft tissue regrowth than patients with thin biotype due to the natural biological differences in inter-individual patterns of healing responses. Conversely, Cairo et al. (2015) did not observe any influence of tissue biotype on the amount of coronal displacement of the gingival margin after osseous resective surgery with or without fibre retention.

Considering the postsurgical flap position, the placement of the gingival margin at the osseous crest for both procedures could have contributed to the rebound observed (Lanning et al. 2003, Deas et al. 2004, Arora et al. 2013) and to the increase in KT width. Irrespective of the surgical procedure, a mean gain in KT of about 2 mm was depicted 48 months after surgery.

The limitation of the present trial was the small sample size, but a split-mouth design was applied with the advantage of removing a lot of inter-subject variability from the estimated treatment effect.

An aspect to be addressed is that all surgical interventions were carried out by an experienced clinician on non-smoking patients demonstrating high compliance to the recall system and strict home plaque control. This may limit the external generalizability of the present findings.

In conclusion, the data presented in this study suggest that there is a significant marginal soft tissue rebound following osseous resective surgery that has been fully stabilized by 12 months in the FibReORS-treated sextants. The amount of soft tissue rebound appears to be related the tissue biotype. During 48 months of healing, PD values increased when compared to 12-month values but remained in a physiological range, so both techniques demonstrated to be effective in maintaining periodontal health conditions in the medium-term period in single-rooted teeth

and multi-rooted teeth with no or limited furcation involvement. The amount of KT progressively increased along time as a sign of periodontal stability and soft tissue health.

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Table 1. Mean values of clinical parameters at baseline, 12 and 48 months postsurgery: sextant-level analysis.

	FibReORS (n = 13)	ORS (n = 13)	Differences between FibReORS and ORS
PD (mm)			
baseline	3.6 ± 0.6*	3.4 ± 0.6*	NS [‡]
12 months	2.1 ± 0.4***	2.3 ± 0.5***	NS [§]
48 months	2.8 ± 0.3**	3.0 ± 0.5**	NS [§]
Rec (mm)			
baseline	0.2 ± 0.5*	0.3 ± 0.5*	NS [‡]
Post-surgery	4.5 ± 1.0***	5.0 ± 1.2***	NS [§]
12 months	2.7 ± 0.7***	3.8 ± 1.0***	<0.001 [§]
48 months	2.1 ± 0.3***	2.5 ± 0.4***	0.001 [§]
CAL (mm)			
baseline	3.8 ± 1.0*	3.7 ± 0.8*	NS [‡]
12 months	4.8 ± 0.8***	6.1 ± 1.0***	<0.001 [§]
48 months	4.9 ± 0.5***	5.5 ± 0.4***	0.001 [§]
KT (mm)			
baseline	3.3 ± 0.5*	3.4 ± 0.6*	NS [‡]
12 months	3.3 ± 0.5 [†]	3.5 ± 0.5 [†]	NS [§]
48 months	5.4 ± 0.4***	5.2 ± 0.8***	NS [§]

FibReORS, Fibre Retention Osseous Resective Surgery; ORS, Osseous Resective Surgery; PD, probing depth; Rec, gingival recession; CAL, clinical attachment level; KT, keratinized tissue.

NS, difference between groups is not statistically significant ($p > 0.05$).

* $p < 0.001$, p value represents changes among the three time points (ANOVA or Friedman test).

** $p < 0.005$, p value represents longitudinal changes from baseline (Newman-Keuls test or Dunn test).

*** $p < 0.001$, p -value represents longitudinal changes from baseline (Newman-Keuls test).

[†] $p > 0.05$, p -values represent longitudinal changes from baseline (Newman-Keuls test).

[‡]paired t -test or Wilcoxon test.

[§]Bonferroni-corrected paired t -test or Bonferroni-corrected Wilcoxon test.

Data are reported as mean ± SD.

Table 2. Mean values of clinical parameters at baseline, 12 and 48 months postsurgery: site-level analysis.

	FibReORS (n = 75)	ORS (n = 72)	Differences between FibReORS and ORS
PD (mm)			
baseline	5.5 ± 0.4*	5.3 ± 0.3*	NS [‡]
12 months	2.5 ± 0.5***	2.7 ± 0.4***	NS [§]
48 months	2.7 ± 0.6***	2.8 ± 0.9***	NS [§]
Rec (mm)			
baseline	0.4 ± 0.4*	0.3 ± 0.5*	NS [‡]
12 months	3.5 ± 0.4***	4.7 ± 0.3***	<0.001 [§]
48 months	2.5 ± 0.3***	3.1 ± 0.2***	0.001 [§]
CAL (mm)			
baseline	5.9 ± 0.7*	5.6 ± 0.5*	NS [‡]
12 months	5.9 ± 0.8 [†]	7.4 ± 0.4***	<0.001 [§]
48 months	5.2 ± 0.5**	5.9 ± 0.9	0.01 [§]

Site-level analysis, pockets sites with initial PD ≥ 5 mm, BoP and intrabony component ≤ 3 mm; FibReORS, Fibre Retention Osseous Resective Surgery; ORS, Osseous Resective Surgery; PD, probing depth; Rec, gingival recession; CAL, clinical attachment level.

NS, difference between groups is not statistically significant ($p > 0.05$).

* $p < 0.001$, p value represents changes among the three time points (ANOVA or Friedman test).

** $p < 0.05$, p value represents longitudinal changes from baseline (Dunn test).

*** $p < 0.001$, p value represents longitudinal changes from baseline (Newman-Keuls test or Dunn test).

[†] $p > 0.05$, p value represents longitudinal changes from baseline (Newman-Keuls test).

[‡] paired t -test or Wilcoxon test.

[§] Bonferroni-corrected paired t -test or Bonferroni-corrected Wilcoxon test.

Data are reported as mean ± SD.

Table 3. Frequency distribution (%) of residual probing depths (PDs) and persisting bleeding (BoP) at 48 months: sextant-based data.

RESIDUAL PD (mm)	FibReORS (<i>n</i> = 300)			ORS (<i>n</i> = 318)		
	BoP-	BoP+	Total	BoP-	BoP+	Total
	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)
≤ 3 mm	95.3% (262)	4.7% (13)	91.7% (275)	94.7% (267)	5.3% (15)	88.7% (282)
4 mm	73.7 % (14)	26.3% (5)	6.3% (19)	69.2% (18)	30.8% (8)	8.2% (26)
5 mm	33.3% (2)	66.7% (4)	2% (6)	25% (2)	75% (6)	2.5% (8)
6 mm	0% (0)	0% (0)	0% (0)	0% (0)	100% (2)	0.6% (2)

FibReORS, Fibre Retention Osseous Resective Surgery; ORS, Osseous Resective Surgery.

Table 4. Frequency distribution (%) of residual probing depths (PDs) and persisting bleeding (BoP) at 48 months: site-based data.

RESIDUAL PD (mm)	FibReORS (<i>n</i> = 75)			ORS (<i>n</i> = 72)		
	BoP-	BoP+	Total	BoP-	BoP+	Total
	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)
≤ 3 mm	92.1% (58)	7.9% (5)	84% (63)	93.1% (54)	6.9% (4)	80.5% (58)
4 mm	75 % (6)	25% (2)	10.7% (8)	70% (7)	30% (3)	13.9% (10)
5 mm	25% (1)	75% (3)	5.3% (4)	25% (1)	75% (2)	4.2% (3)
6 mm	0% (0)	0% (0)	0% (0)	0% (0)	100% (1)	1.4% (1)

Site-based data, pockets sites with initial PD ≥ 5 mm, BoP and intrabony component ≤ 3 mm; FibReORS, Fibre Retention Osseous Resective Surgery; ORS, Osseous Resective Surgery.

Figure legends

Fig 1. Consort diagram showing the study design.

Fig 2. Variations in Rec at buccal/lingual and interproximal sites (y axis, in millimeter) during the 48-month observation period after Fibre Retention Osseous Resective Surgery (FibReORS) and Osseous Resective Surgery (ORS).

Fig 3. Variations in PD and CAL at buccal/lingual and interproximal sites (y axis, in millimeter) during the 48-month observation period after Fibre Retention Osseous Resective Surgery (FibReORS) and Osseous Resective Surgery (ORS).

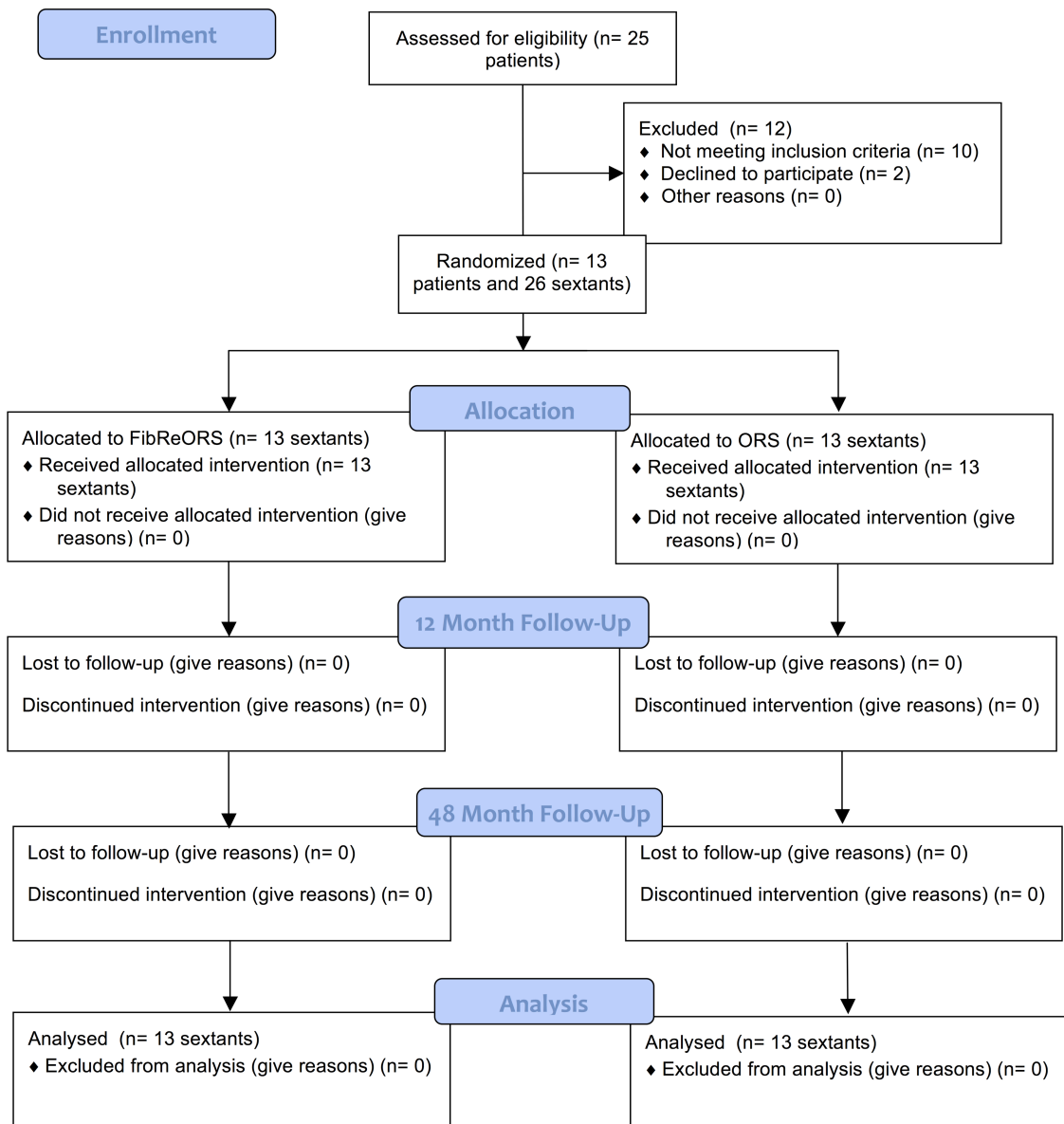


Figure 1.

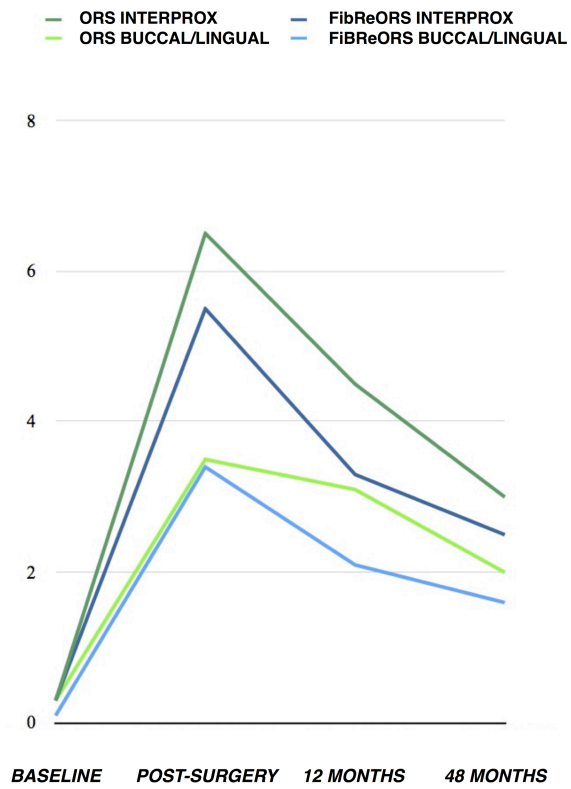


Figure 2.

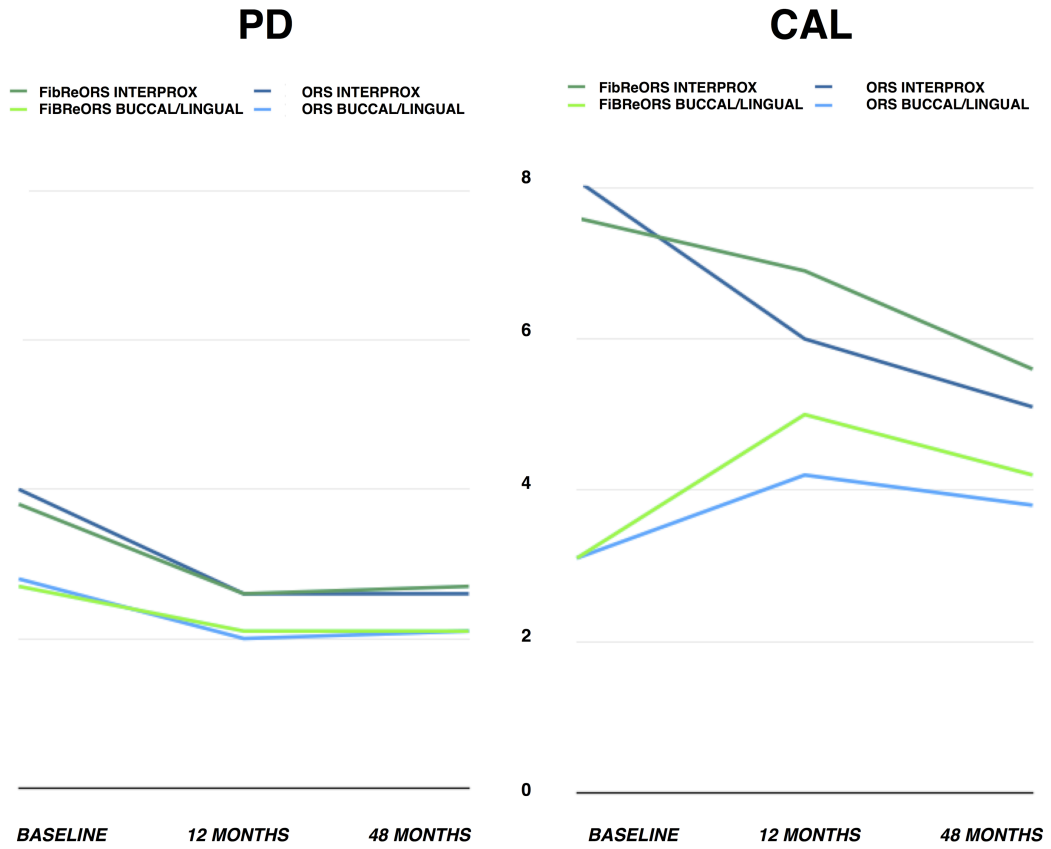


Figure 3.