Clinical and Patient-Centered Outcomes After Minimally Invasive Non-Surgical or Surgical Approaches for the Treatment of Intrabony Defects: A Randomized Clinical Trial

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Background: The present study aims to compare the performance of minimally invasive non-surgical and surgical approaches for the therapy of intrabony defects.

Methods: Twenty-nine patients who presented with intrabony defects were randomly assigned to: 1) a minimally invasive non-surgical technique (MINST) group, or 2) minimally invasive surgical technique (MIST) group. The chair time of each therapeutic procedure was calculated. The probing depth (PD), position of the gingival margin (PGM) and relative clinical attachment level (RCAL) were evaluated at 3 and 6 months after treatments. The patient perception of discomfort/pain experienced during and after therapy and patient satisfaction regarding treatments were also evaluated.

Results: Significant PD reductions, RCAL gains, and no changes in the PGM were obtained at 3 and 6 months in MINST and MIST groups ($P<0.05$). No differences were observed between groups at any time points ($P>0.05$). Patient-oriented outcomes did not demonstrate differences between therapeutic approaches ($P>0.05$). Significant higher chair times were required in the MIST group than in the MINST group ($P<0.05$).

Conclusions: Minimally invasive non-surgical and surgical approaches were successfully used for the treatment of intrabony defects and achieved periodontal health in association with negligible morbidity and suitable patient satisfaction. However, non-surgical therapeutic modality presented an advantage in terms of a reduction of treatment chair time. *J Periodontol 2011;82:1256-1266.*

KEY WORDS

Microsurgery; periodontitis; root planing; surgical procedures, minimally invasive.

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Intrabony defects, which are associated with periodontal pockets, are site-specific risk factors for periodontal disease progression and tooth loss.[1] A variety of therapies were suggested for the treatment of these defects.[2-6] Both non-surgical and surgical approaches may be used during the treatment of intrabony defects to accomplish the resolution of the periodontal disease in these sites as evidenced by probing depth (PD) reduction and clinical attachment level (CAL) gain.[2,3,7]

Recently, less invasive procedures were incorporated into the periodontal clinical practice that benefited different therapeutic approaches[6,8-15] according to the principles of the medical community that has routinely used a minimally invasive approach to achieve better results with reduced morbidity and a more comfortable postoperative period. According to Hunter and Sackier,[16] this therapeutic approach was described as "the ability to miniaturize our eyes and extend our hands to perform microscopic and macroscopic operations in places that could previously only be reached only by large incisions." Although a minimally invasive procedure can be performed using a magnification such as

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with a surgical microscope, surgical telescope, or endoscopic visualization, the type of magnification does not define the surgical procedure as minimally invasive.[16,17] Rather, the retention of the preoperative gingival architecture, creating a minimal wound and gentle handling of the soft and hard tissues, is essential to minimally invasive approaches.[15-17]

In this context, a minimally invasive non-surgical periodontal treatment during scaling and root planing favored therapeutic outcomes.[8,11,12] Although comparisons of minimally invasive non-surgical approach with traditional masked scaling and root planing have not yet been published to our knowledge, clinical and histologic evidences reported optimistic outcomes after non-surgical minimally invasive therapy.[11,12] Based on the foundation of the minimally invasive surgery[15] and considering the use of the papilla preservation techniques,[18-20] the minimally invasive surgical technique (MIST) was also designed for the surgical treatment of intrabony defects,[6] and its application has achieved positive outcomes.[6,9,10,13,17,21]

However, to our knowledge, no previous study compared the performance of the surgical treatment with non-surgical therapy using the principles of minimally invasive therapeutic approaches during the treatment of intrabony defects. Additionally, the success of periodontal therapy was usually demonstrated with clinical parameters such as PD reduction and CAL gain. However, there was considerable discussion regarding the use of these traditional outcome indicators because these parameters are surrogate markers and do not reflect the real patient-centered outcomes, such as the consequences of periodontal treatment on the daily routines of patients. Furthermore, in addition to the psychologic well-being of patients during and after the procedure, esthetics is an important aspect for consideration. Thus, this controlled study aims to evaluate the clinical and patient-centered outcomes after minimally invasive surgical and non-surgical procedures for the therapy of intrabony lesions.

MATERIALS AND METHODS

Study Design

This study is a masked, randomized controlled trial with a parallel design that compares a MIST or minimally invasive non-surgical technique (MINST) for the treatment of intrabony defects. The study was approved by the ethics committee of the University of Campinas, Piracicaba, SP, Brazil. All patients and participants received a detailed description of the proposed treatment and provided informed written consent to participate in the study. The participant recruitment started in June 2008 and was completed in February 2009. The first procedure was carried out in October 2009. All 6-month follow-up visits were completed in June 2010. Data entry of all information and statistical analyses were performed in July 2010.

Population Screening

All patients were selected from individuals referred to the Graduate Clinic of the Piracicaba Dental School. Patients received periodontal examinations and radiographs after anamnesis.

The study inclusion criteria were: 1) a diagnosis of chronic periodontitis,[22] 2) ≥1 single-rooted tooth with PD ≥5 mm with bleeding on probing (BOP), 3) CAL >5 mm, 4) radiographic evidence of an isolated intrabony defect (depth: ≥4 mm, width: ≥2 mm)[6,9,10,13,14] determined by periapical radiographs taken with the long-cone paralleling technique, 5) a full-mouth plaque score (FMPS)[23] and full-mouth bleeding score (FMBS)[24] <20%, and 6) the absence of a medical condition that could affect the progression of periodontal disease. Patients who were: 1) pregnant or lactating, 2) required antibiotic premedication, 3) received antibiotic treatment in the previous 3 months, 4) received a course of periodontal treatment within the past 6 months, 5) were smokers, or 6) whose tooth presented with signs of mobility and/or traumatic occlusion were excluded from the study.

All patients submitted to an initial therapy including scaling and root planing and motivation sessions, and were maintained in periodontal supportive therapy. These procedures were performed by the same operator (MZC). After 6 months, patients that fulfilled the inclusion criteria were incorporated into the study.

Sample-Size and Power Calculations

A sample-size calculation was assessed and included an α error of 5%, 80% power, and a standard deviation of 1.0 mm, and a difference of 1.0 mm between groups was considered clinically significant. It was indicated that a sample of 12 patients per group would be needed. Considering that some patients may be lost during follow-up, 14 and 15 patients were included in MIST and MINST groups, respectively.

The study power value was calculated with a statistical program† using the sample size of the per protocol population and considering the standard deviation of each group of the present clinical trial. The power value was evaluated for all clinical parameters in each period of evaluation. The minimum power value found was 83% (for the position of the gingival margin [PGM] at 6 months). All other parameters presented a power value >86%.

Randomization and Allocation Concealment

The study used a masked examiner (FVR) with a randomized and parallel design. All patients included in the study were recruited before the beginning of the randomization to therapeutic approaches. Treatment-group

† SAS Release 9.1, 2003, SAS Institute, Cary, NC.

assignment was carried out immediately before the beginning of the procedure (MIST or MINST) by a coin toss that was performed by a different operator (MAGP). The randomization code was not broken until all data had been collected.

Treatment of Intrabony Defects

By using an operating microscope[‡] and microsurgical instruments, all procedures were performed by the same operator (MZC). One hour before therapy, patients received a dose of 4 mg dexamethasone.[§] At this time, the treatment was randomized, and the procedures for the different groups were chosen.

MINST group. Experimental sites designated to receive non-surgical treatment were submitted to careful scaling and root planing with minicurets[‖] and using an ultrasonic device[¶] with specific thin and delicate tips.[#] These instruments were carefully inserted through the periodontal pocket of the defect-associated tooth to reach the root surface for debridement. Caution was taken to preserve the stability of soft tissues (Fig. 1).

MIST group. Experimental sites were accessed by the MIST,[6] and incisions were performed with preservation techniques.[18-20] Only the defect-associated papilla was accessed, vertical-releasing incisions were not made, and the full-thickness flap was minimally elevated. The granulation soft tissue was dissected with a microblade and carefully removed with minicurets.[**] The visible calculus was carefully removed with minicurets[††] and an ultrasonic device[‡‡] with specific tips.[§§] The flaps were repositioned, and passive internal mattress sutures[‖‖] were used to obtain primary closure of tissues (Fig. 2).

Post-Therapy Care

At the end of all procedures, patients received analgesic medication (paracetamol)[¶¶] and were instructed to take the medication every 6 hours, for 2 days, only if they experienced pain. Patients were instructed to mark the number of tablets taken. For biofilm control, all patients were instructed to rinse with 0.12% chlorhexidine (twice a day for 15 days). In the MIST group, sutures were removed at 10 days post-surgery. During the postoperative period, patients were requested to avoid toothbrushing and flossing in the treated area for a period of 10 days. After that, the hygiene was reinstituted.

Procedure Chair Time

The chair time of each therapeutic procedure was calculated starting from injection of the local anesthesia and ending at the completion of sutures in the MIST group or at completion of the scaling and root planing in the MINST group.

Clinical Parameters

Clinical measurements were evaluated at baseline and at the 3 and 6 month follow-up visits. An individually manufactured acrylic stent was made to standardize the location of periodontal probes.

The following clinical parameters were measured using a periodontal probe[##] at 6 sites per tooth. The PGM was measured from the stent to the gingival margin, and relative CAL (RCAL) was measured from the stent to the bottom of the periodontal pocket. The PD was calculated by deducting the PGM from RCAL. The FMPS and FMBS were calculated after dichotomously assessing the presence of plaque or BOP from the bottom of the pocket when probing with a manual probe and calculating the percentage of sites that revealed the presence of plaque or bleeding.

The same examiner (FVR), who was masked to the therapies, carried out all measurements of clinical evaluation. To perform the intraexaminer calibration, 12 non-study participants presenting intrabony defects were selected. The designated examiner measured the RCAL, which was the primary outcome variable, of all patients twice within 24 hours. The examiner was judged to be reproducible after fulfilling the predetermined success criteria (the percentage of agreement within ±1 mm between repeated measurements had to be ≥90%). The intraclass correlation was calculated as resulting in 96% reproducibility.

Patient Satisfaction and Perception Regarding Therapy

To evaluate patient perceptions about the performed procedure and post-therapy period, patients received a questionnaire on day 7 after the procedure. The extent of discomfort and/or pain experienced during the intratherapy period was evaluated using a 100-mm horizontal visual analog scale (VAS). The anchors for each end of the scales were designated as none and extreme.[25] Patients were also instructed to quantify the analgesic medication taken. In addition, the extent of discomfort, root hypersensitivity, edema, hematoma, high fever, and interference in daily activities during the first post-therapy week were evaluated in the same way. After 6 months, another questionnaire was given to each patient to determine the patient perception of the outcomes of therapy and the level of satisfaction with treatment. The questionnaire used a simplified scale to record the satisfaction of treatment in terms of the esthetic appearance of the treated teeth by selecting

‡ DF Vasconcelos, São Paulo, SP, Brazil.
§ Roche Brasil, São Paulo, SP, Brazil.
‖ Gracey, Hu-Friedy, Chicago, IL.
¶ Cavitron, DENTSPLY, Tulsa, OK.
# UI25KSF10S, Hu-Friedy.
** Gracey, Hu-Friedy.
†† Gracey, Hu-Friedy.
‡‡ Cavitron, Dentsply,
§§ UI25KSF10S, Hu-Friedy.
‖‖ 6.0 polygalactin-A, Vicryl, Johnson & Johnson, São Paulo, SP, Brazil.
¶¶ Tylenol, 750mg, Janssen-Cilag Farmacêutica, São Paulo, SP, Brazil.
PCP-15,Hu-Friedy do Brasil, Rio de Janeiro, RJ, Brazil.

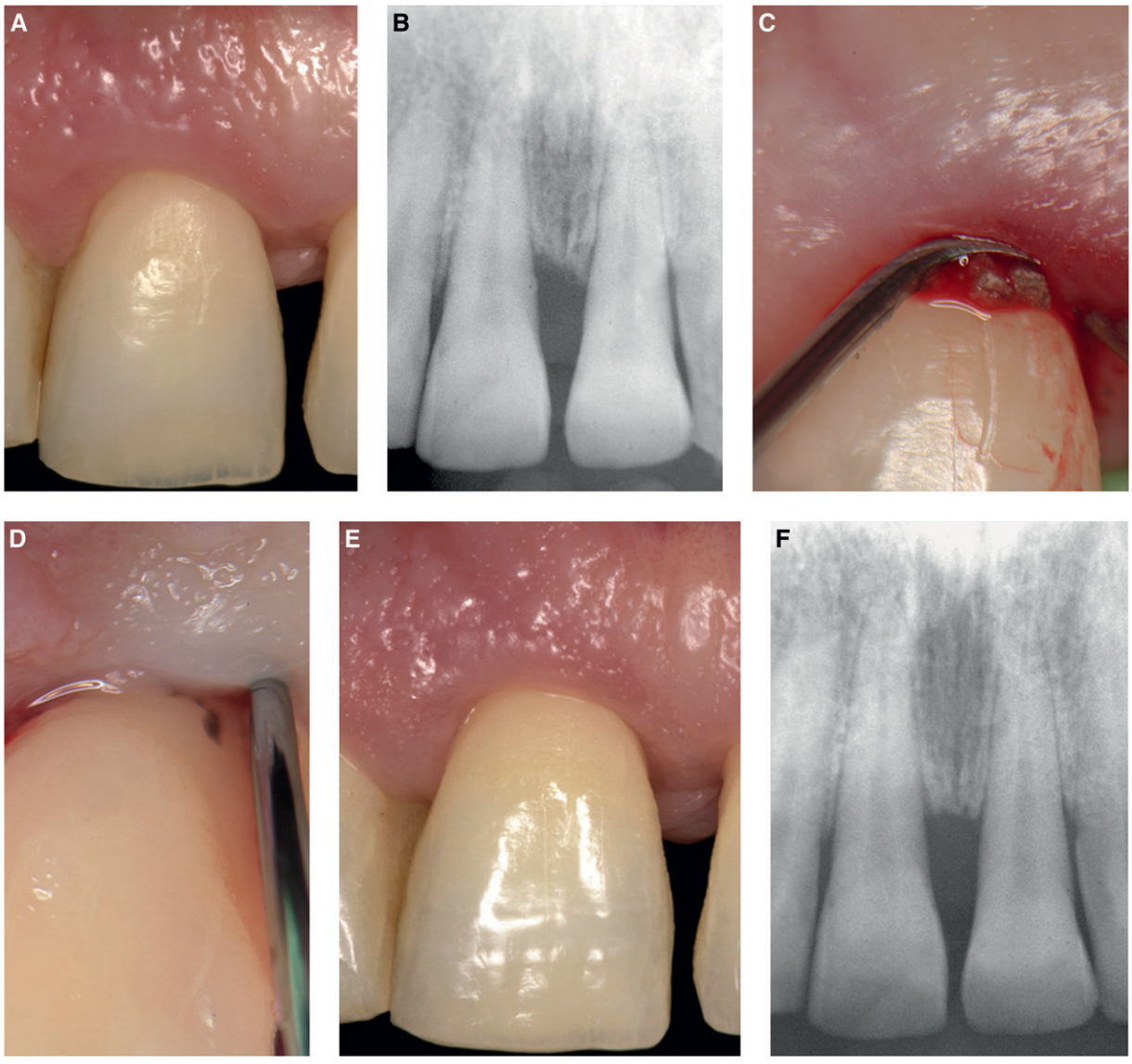

Figure 1.
MINST. Preoperative clinical ***(A)*** *and radiographic* ***(B)*** *views of an intrabony defect on the mesial aspect of the central incisor.* ***C and D)*** *Scaling and root planing . Clinical* ***(E)*** *and radiographic* ***(F)*** *aspects at 6 months post-therapy.*

one of the following choices: very satisfied, satisfied, neutral, moderately satisfied, or unsatisfied.[26] In addition, patients were asked to describe their perception of the outcome of the therapy at the treated tooth in terms of the improvement in gingival bleeding, redness, and gingival edema and hygiene ability. These parameters were also measured using the VAS with zero denoting no improvement and 100 denoting maximum improvement.

Reassessment Evaluations

Reassessment visits occurred every 15 days during the first month and monthly until the sixth month. At the end of the appointment, a supragingival prophylaxis was performed.

Primary and Secondary Outcome Measures

The primary outcome measurement of the study was RCAL. Secondary outcome measurements included the 1) PD, 2) PGM, 3) FMPS and FMBS, 4) patient-centered outcomes, and 5) chair time.

Data Management and Statistical Analyses

A statistical program*** was used. The homogeneity of groups at baseline (PD, RCAL, FMBS, and FMPS) was tested using the analysis of variance (ANOVA). Repeated-measures ANOVA and the Tukey test were used to detect intra- and intergroup differences in clinical parameters (PGM, PD, and RCAL). The

*** SAS Release 9.1, 2003, SAS Institute.

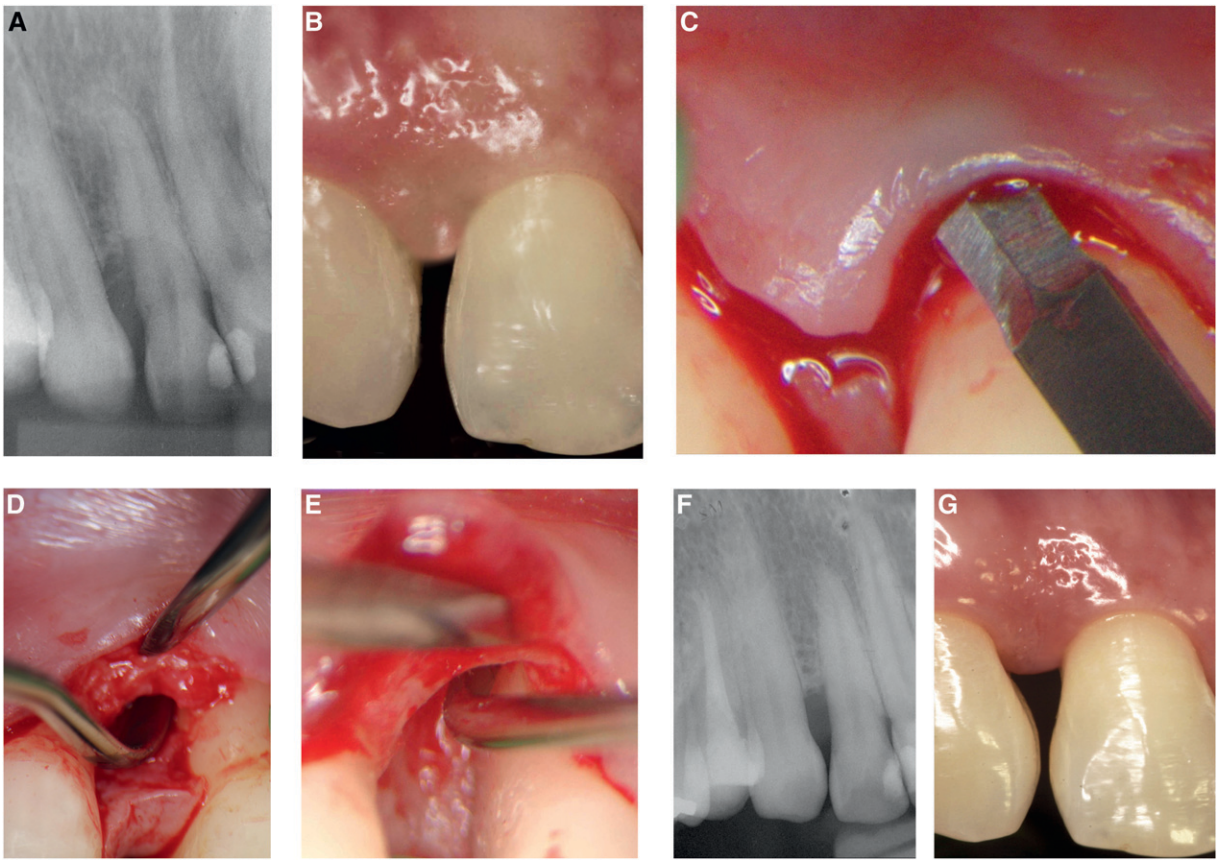

Figure 2.
MIST. Preoperative radiographic ***(A)*** *and clinical* ***(B)*** *views. Note the intrabony defect on the distal aspect of lateral incisor. Incisions* ***(C)*** *and tissue flap* ***(D)*** *using a minimally invasive surgical approach.* ***E)*** *A view of the intrabony defect during debridement. Radiographic* ***(F)*** *and clinical* ***(G)*** *aspects at the 6-month follow-up.*

Friedman test was used to detect intragroup differences, and the Mann-Whitney *U* test was used to detect intergroup differences in the FMPS and FMBS. The student *t* test was used to detect intergroup differences in chair times of each therapeutic procedure. The Mann-Whitney *U* test was used to evaluate VAS questionnaires regarding patient perceptions and satisfaction. To evaluate the questionnaire, a simplified scale was used to record the satisfaction of treatment in terms of esthetic appearance, and a χ^2 test was applied. An experimental level of significance was determined at 5% for all statistical analyses.

RESULTS

Subject Accountability

Briefly, 987 individuals were assessed for eligibility. A total of 938 were excluded because of not meeting inclusion criteria. Forty-nine patients were submitted to the initial therapy and maintained in periodontal supportive therapy. After 6 months, 29 patients were recruited at the beginning of the study. Participants were randomly assigned to participate in the study and received the allocated procedure. Two patients who presented one intrabony defect each one were lost during follow-up because of the administration of an antibiotic medication for medical reasons or because of an address change. All other 27 participants (14 [MIST] and 13 [MINST]) were included in the statistical analyses.

Patient Characteristics at Baseline

Patient characteristics at baseline were not significantly different between groups. A prevalence of whites (85.71% and 76.92%) and females (57.14% and 69.23%) was detected in the MIST group (6 males and 8 females, aged 35 to 57 years; mean ± SD: 45.43 ± 6.79 years) and MINST group (4 males and 9 females, aged 35 to 57 years; mean ± SD: 45.31 ± 7.57), respectively. The distributions of intrabony defects according to teeth were: 28.58% incisive, 28.57% canine, and 42.85% premolar for the MIST group and 15.39% incisive, 38.46% canine, and 46.15% premolar, for the MINST group. Acceptable oral hygiene was achieved before the study in both groups (Table 1). The means of PD and RCAL at intrabony defect sites were not statistically

Table 1.

Percentages (mean ± SD) of FMPS and FMBS at the Different Assessment Times

Parameter	Group	Baseline	3 Months	6 Months
FMPS	MIST	16.20 ± 6.50 Aa	11.44 ± 4.55 Ba	10.97 ± 4.77 Ba
	MINST	13.64 ± 5.57 Aa	10.35 ± 4.76 ABa	8.69 ± 4.18 Ba
FMBS	MIST	9.62 ± 5.46 Aa	7.15 ± 3.36 Ba	6.36 ± 3.67 Ba
	MINST	9.37 ± 3.59 Aa	5.27 ± 2.24 Ba	5.54 ± 3.31 Ba

Means followed by different capital letters in a line represent significant intragroup differences (Friedman test; $P<0.05$). Means followed by different non-capital letters in the column represent significant intergroup differences (Mann-Whitney *U* test; $P<0.05$).

Table 2.

PGM, PD, and RCAL (mm; mean ± SD) at Baseline, 3 and 6 Months

Parameter	Group	Baseline	3 Months	6 Months	0- to 6-Month Difference
PGM	MIST	3.74 ± 1.09 Aa	4.24 ± 1.08 Aa	4.22 ± 1.06 Aa	0.48 ± 0.51
	MINST	4.96 ± 1.66 Aa	5.36 ± 1.37 Aa	5.41 ± 1.46 Aa	0.45 ± 0.46
PD	MIST	7.07 ± 1.13 Aa	3.87 ± 0.86 Ba	3.56 ± 0.84 Ba	3.51 ± 0.90
	MINST	6.35 ± 0.92 Aa	3.88 ± 0.97 Ba	3.21 ± 0.85 Ba	3.13 ± 0.67
RCAL	MIST	10.73 ± 1.56 Aa	8.20 ± 1. Ba	7.88 ± 1.46 Ba	2.85 ± 1.19
	MINST	11.25 ± 2.11 Aa	9.35 ± 1.83 Ba	8.70 ± 1.87 Ba	2.56 ± 1.12

Means followed by different capital letters in a line represent significant intragroup differences (ANOVA and Tukey test; $P<0.05$). Means followed by different non-capital letters in the column represent significant intergroup differences (ANOVA; $P<0.05$).

different between groups at baseline ($P>0.05$) (Table 2).

To compare the intrabony defects characteristic between groups at baseline, the radiographic defect angle was evaluated on scanned radiographs with the assistance of image-analysis software††† and defined by the two lines that represented the root surface and bone-defect surface. The mean of the defect angle at baseline was 45.81° ± 8.44° and 44.54° ± 7.90° for MIST and MINST groups, respectively, with no differences between groups ($P>0.05$).

Clinical Parameters

Both FMPS and FMBS were maintained at <20% throughout the study, and no statistically significant differences were observed between groups ($P>0.05$) (Table 1).

No significant differences in the PGM were observed after 3 and 6 months in both experimental groups compared to baseline measurements ($P>0.05$). In additional, the intergroup analysis did not show statistically significant differences in the PGM between MIST and MINST groups ($P>0.05$). Statistically significant PD reductions and RCAL gains were achieved after 3- and 6-months evaluation from baseline ($P<0.05$) in both groups. No significant differences between MIST and MINST groups were observed at any assessment time in theses parameters ($P>0.05$).

Patient-Centered Outcomes

Perception about therapy. Data from patient perception evaluation about therapy are shown in Table 3. Based on a horizontal VAS, it was observed that the extent of discomfort/pain experienced during therapy was statistically similar between groups ($P>0.05$). In addition, the extent of discomfort, root hypersensitivity, and edema during the first post-therapy week was very discreet, and no differences were observed between groups ($P>0.05$). No patients in this study developed hematoma, high fever, or an interference with daily activities during the first post-therapy week. The quantity of analgesic medication taken by patients was minimal (lower than one analgesic medication in both groups), and it was statistically similar between groups ($P>0.05$) (Table 3).

Patient satisfaction. After 6 months, a questionnaire recorded the patient satisfaction regarding the treatment in terms of the esthetic appearance of the treated teeth by selecting one of the following choices: very satisfied, satisfied, neutral, moderately satisfied, or unsatisfied. Most patients in both experimental groups selected the choice very satisfied (92.85% and 92.30% of patients for MIST and MINST groups, respectively). The choice satisfied was revealed by 7.15% and 7.7% of patients for MIST and MINST

††† Image-Pro, Media Cybernetics, Silver Spring, MD.

Table 3.

Evaluated Parameters (mean ± SD) Related to Patient Perception About Therapy and Number of Analgesic Tablets Taken

Parameters	MIST	MINST
Pain/discomfort during procedure	0.54 ± 0.81	0.48 ± 0.66
Pain/discomfort after procedure	0.48 ± 0.89	0.38 ± 0.63
Root hypersensitivity	0.44 ± 0.81	0.59 ± 0.82
Edema	0.34 ± 0.62	0.23 ± 0.75
Hematoma	0.00 ± 0.00	0.00 ± 0.00
High fever	0.00 ± 0.00	0.00 ± 0.00
Interference in daily activities	0.00 ± 0.00	0.0 ± 0.00
Number of analgesic tablets	0.40 ± 0.74	0.31 ± 0.63

No statistical differences were observed among groups (Mann-Whitney *U* test; $P > 0.05$).

Table 4.

Patient Perceptions (mean ± SD) at 6 Months After Therapy Regarding Outcomes at the Treated Tooth

Parameters	MIST	MINST
Gingival bleeding	94.16 ± 8.54	90.48 ± 0.66
Redness and gingival edema	96.50 ± 5.61	80.24 ± 22.25
Hygiene ability	93.06 ± 10.24	75.43 ± 24.78

No statistical differences were observed between groups (Mann-Whitney *U* test; $P > 0.05$).

groups, respectively. No patients in either group chose the options neutral, moderately satisfied, or unsatisfied. Statistical analyses did not demonstrate differences between groups with regard to satisfaction levels in terms of the esthetic appearance of treated teeth ($P > 0.05$).

In addition, patients described their perception of the outcome of the therapy at the treated tooth in terms of improvements in gingival bleeding, redness, and gingival edema and hygiene ability by using a VAS questionnaire. The improvements for all aspects evaluated were very satisfactory, and no differences in the perception of outcomes of therapies at the treated tooth were observed between groups ($P > 0.05$) (Table 4). Also, a statistically higher chair time was observed in the MIST group (60.71 ± 9.41 minutes) than in the MINST group (29.15 ± 4.30 minutes) ($P < 0.05$).

DISCUSSION

Although previous studies demonstrated positive outcomes after non-surgical periodontal treatment[8,11,12] and after MIST for the treatment of intrabony defects,[6,9,10,13,17,21] to our knowledge, no investigation compared the performance of non-surgical treatment with surgical therapy, both using the principles of minimally invasive therapeutic approaches, during the treatment of intrabony lesions. Thus, this randomized controlled trial with a parallel design was conducted to compare MIST or MINST for the treatment of intrabony defects. It was demonstrated that, independent of the therapeutic procedure, successful clinical outcomes were achieved in combination with negligible morbidity and suitable patient satisfaction in the therapy of intrabony defects.

In general, systematic review studies[27,28] revealed that both conventional non-surgical and surgical therapies were effective methods to achieve improvements in terms of CAL gain and reduction in PD. However, the authors[27,28] emphasized that, in initially deep pockets (PD >6 mm), there was a greater attachment level gain and PD reduction after periodontal surgical therapy. In this study, in which baseline PD measurements were 7.07 ± 1.13 mm and 6.35 ± 0.92 mm for MIST and MINST groups, respectively, clinical evaluations demonstrated that similar and significant PD reductions and CAL gains from baseline were obtained in the intrabony treated defects in both groups at the 3- and 6-month evaluations.

The current investigation showed that the MINST group obtained a RCAL gain of 2.56 ± 1.12 mm and a PD reduction of 3.13 ± 0.67 mm. These means were higher than those obtained by studies[29,30] in which control intrabony defects were treated by non-surgical therapy, in which means of about 1.8 and 2.2 mm were presented for CAL gain and PD reduction, respectively. Data of the present study demonstrated an appropriate periodontal response obtained by the MINST group, which supported evidence that non-surgical subgingival instrumentation, in conjunction with frequent supragingival plaque removal, may reduce PDs and increase CALs.[7,31] The absence of differences between experimental groups in the present study may have been associated with the favorable response obtained after the non-surgical therapy, which yielded similar and successful results in both evaluated groups. Although the use of a microscope may improve the visual acuity and magnification during periodontal procedures, additional studies are required to determine the impact of its use during the non-surgical therapy.

Another important aspect to be considered when evaluating these clinical findings is that the positive results, in terms of PD reduction and CAL gain, achieved in the present investigation might have been attributed to the rigorous periodontal maintenance carried out at 1-month intervals and confirmed by the satisfactory FMPS and FMBS obtained during the experiment. In support of this hypothesis, studies[2,32,33] demonstrated that, in conjunction with professional maintenance and acceptable plaque control, conservative approaches, including surgical or non-surgical periodontal therapies, were effective for efficiently increasing CALs and reducing PDs, even in the presence of bony defects.

Although previous studies[27,28,34-36] investigated clinical outcomes after scaling and root planing and open-flap debridement for the treatment of chronic periodontitis, there was insufficient evidence to compare treatment effects after conventional non-surgical or surgical therapies when specifically treating intrabony defects. In addition, to our knowledge, no investigation compared minimally invasive non-surgical and surgical approaches to treat intrabony lesions. The clinical rationale for the assessment of minimally invasive approaches included the reduction of operative trauma, the increase in wound stability, the maintenance of the preoperative gingival architecture, the possibility of a gentle handling of the periodontal tissues, the reduction of the operative chair time, and the minimization of intraoperative and postoperative patient discomfort and morbidity.[15-17] Considering the lack of trials available that evaluated minimally invasive non-surgical and surgical therapeutic approaches, it was difficult to establish a comparison of the current investigation with other studies.

Moreover, greater baseline PDs, narrow defects, and 2- or 3-wall defects may promote a more favorable potential for improvements in PD reductions and CAL gains in angular defects.[37] In the present study, the mean radiographic defect angle in both groups was ≈45°, and no difference in this defect anatomic characteristic was observed between groups as was also verified in relation to baseline PDs. However, in this trial, the defect configuration regarding the number of walls could not be compared between groups since the clinical visualization of defects was limited to one experimental group that performed surgical access flap to treat the defect — MIST group. This was a limitation of the current investigation because differences in the number of walls may affect the outcomes.

Traditional periodontal therapies involving surgical procedures were frequently associated with the recession of the gingival margin, which is a negative consequence that may impair the patient satisfaction in terms of esthetics.[4,38-41] When using a minimally invasive surgical approach, one of the aims is to limit the recession of the gingival margin. Regarding the PGM measurements, the findings of this study demonstrated that, at 6 months, no significant differences in gingival recession, compared to baseline measurements, were observed in both groups. Moreover, no differences were noted between groups for the PGM increase (0.48 and 0.45 mm of gingival recession for MIST and MINST groups, respectively), which was a favorable result from an esthetic point of view. Previous investigations that performed surgical approaches to treat intrabony defects frequently demonstrated gingival recessions of ≈2 mm,[4,38-41] in contrast with the findings of the present study. Considering these outcomes, it may be hypothesized that this optimal result of this study is a consequence of the use of less invasive therapeutic approaches, which contributed to the maintenance of the integrity of the soft tissues and the stability of the gingival margin, particularly in areas with high esthetic demands.

In the present investigation, a relevant aspect concerns the importance of the flap design to the revascularization of the tissues. The flap design of minimally invasive surgical approaches allows for access to the root-surface instrumentation in combination with negligible flap elevation and the improved preservation of the blood supply in the operated area.[42] The flap design is of paramount importance in surgical procedures in which the stability of the marginal tissue and a better revascularization of the tissues during early wound healing are critical for the success of the therapy.[42,43] The flap design may exert a positive role in increasing the stability of the blood clot, which contributes to a better preservation of presurgical esthetics when using surgical procedures,[44] as supported by the PGM outcomes of the MIST group in the present study.

The negligible changes in the soft tissue position of the treated teeth in the present study may be related to the high satisfaction in esthetic appearance reported by most patients in both experimental groups. Moreover, patients revealed similar improvements in gingival bleeding, redness, gingival edema, and hygiene in treated teeth in MIST and MINST groups.

When using conventional techniques to perform surgical periodontal therapy, compared to the traditional non-surgical procedure, a higher patient discomfort/pain during the postoperative period is expected.[45,46] In the current study, when evaluating the patient perception about the procedures during the intra- and post-therapy period, a minimal extent of discomfort/pain is described during the treatment and a negligible extent of discomfort, root hypersensitivity, and edema was reported during the post-therapy period after both therapeutic approaches. Additionally, no patients developed hematoma, a high fever, or an interference

of daily activities during the first post-therapy week, and the quantities of analgesic medication taken by patients was minimal in both groups, which confirmed the advantages of using less-invasive approaches for the treatment of intrabony defects. Taken together, these patient-centered evaluations indicated that both MIST and MINST approaches promoted similar results in terms of morbidity and patient satisfaction. The importance of patient-centered outcomes in assessing periodontal treatment efficacy was recognized,[46,47] and these aspects were designated a research priority area in periodontology.[24] However, there were limited data evaluating the impact of the treatment of intrabony periodontal defects on the satisfaction, life quality, and well-being of the patient,[6,9,25] and further studies on these aspects should be encouraged.

Although case series[6,9,10,13,17,21] revealed that the application of enamel matrix derivative (EMD) proteins as an adjunctive to the MIST may achieve positive outcomes in the treatment of angular defects, it was recently shown that the use of EMD during the MIST may not promote relevant advantages in the therapy of intrabony lesions compared to the use of minimally invasive surgical alone.[14] Although studies[15,48] showed the positive clinical performance of EMD during the therapy of angular defects, meta-analyses[5,49] indicated that the actual benefits of EMD were not clinically defined because of the high degree of heterogeneity observed in the trials. Considering this aspect, the present investigation evaluated the performance of the minimally invasive surgical approach alone without the use of EMD. Although investigations indicated contradictory outcomes of the clinical efficacy of EMD, these outcomes had no relation to the histologic role of EMD because histologic findings indicated its ability in the periodontal regeneration.[5,14,15,48-50]

Although the clinical findings obtained in the present investigation suggested that both evaluated therapies were effective to treat intrabony defects, long-term results with regard to the maintenance of attachment levels and prevention of loss of teeth are required. Previous studies that revealed long-term treatment outcomes over a 5- to 7-year period reported that breakdown sites that required retreatment were more frequently found in deep sites treated by traditional scaling and root planing than those treated by surgical procedures.[3,7] In contrast, a study[51] that compared the repeated non-surgical therapy and periodontal surgery in residual pockets 5 months after the initial subgingival scaling demonstrated that the second non-surgical scaling reduced the need for periodontal surgery. Additionally, according to a systematic review[28] of studies of ≥12 months of duration, it was observed that, in deep pockets, surgical therapy resulted in 0.6 mm more PD reduction and 0.2 mm more CAL gain than non-surgical therapy. Although outcomes achieved at 6 months of follow-up in the present trial were relevant, this evaluation period may have been a limitation of the present study because different results could be detected in long-term studies.[28] Future research with longer reevaluation periods are required to confirm the clinical data observed in the present study. Moreover, because long-term evaluations are required to adequately determine radiographic bone remodeling after periodontal therapies, future investigations with longer follow-ups using assessments of radiographs are required to support the data obtained in the present trial.

A pivotal aspect of the present investigation concerned the prescription of dexamethasone preoperatively. The rationale for the administration of dexamethasone as a preemptive medication was based in studies[52,53] that suggested that the preoperative administration of different anti-inflammatory medications may reduce postoperative pain intensity and prevent patient discomfort. In the present study, to adequately evaluate the patient perception about each different therapeutic approach (during the intra-therapy procedure and post-therapy period), the same protocol of medication was administrated in MIST and MINST experimental groups.

Most of the minimally invasive procedures proposed in the literature[6,9,13,14] were designed for the treatment of isolated infrabony defects, as evaluated in the present trial. However, the common association of intrabony defects with other types of periodontal bony lesions and the frequent occurrence of multiple intrabony defects in adjacent sites/teeth suggested the adoption of procedures designed to successfully treat these defects simultaneously in the same session. In a case-cohort study, Cortellini et al.[10] showed that a single minimally invasive surgical procedure was an effective and low-morbidity surgical approach for the treatment of multiple adjacent intrabony defects. Additionally, Harrel et al.[17] showed successful clinical outcomes after the application of a minimally invasive surgical procedure in patients who presenting multiple sites with deep pockets associated with different defect morphologies, including furcation involvements. Although the data of the current investigation were limited to isolated intrabony defects, minimally invasive procedures may be adequately indicated to treat multiple periodontal defects.[10,17]

Decision making about the therapeutic approach to treat intrabony defects should consider the patient profile and preference, the professional's experience, and the ease in performing one technique over another. In addition, the patients' perceptions of costs and benefits may also interfere in the decision making to choose a surgical versus non-surgical therapy. In

this context, therapeutic approaches involving surgical procedures may be frequently related to superior financial costs, and they require a considerably higher chair time compared to the application of non-surgical therapies, as observed in this investigation. Additional trials are needed to establish how all these factors might influence the decision making regarding the treatment of intrabony defects.

CONCLUSIONS

Both therapeutic modalities used for the treatment of intrabony defects achieve successful outcomes in terms of periodontal health because satisfactory supportive periodontal therapy was maintained. In addition, minimally invasive non-surgical and surgical approaches promoted similar negligible morbidity and suitable patient satisfaction, whereas the non-surgical therapy presented an important advantage in terms of a reduction of treatment chair-time.

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REFERENCES

1. Armitage GC. Periodontal diseases: Diagnosis. *Ann Periodontol* 1996;1:37-215.
2. Isidor F, Attström R, Karring T. Regeneration of alveolar bone following surgical and non-surgical periodontal treatment. *J Clin Periodontol* 1985;12:687-696.
3. Kaldahl WB, Kalkwarf KL, Patil KD, Molvar MP, Dyer JK. Long-term evaluation of periodontal therapy: I. Response to 4 therapeutic modalities. *J Periodontol* 1996;67:93-102.
4. Froum SJ, Weinberg MA, Rosenberg E, Tarnow D. A comparative study utilizing open flap debridement with and without enamel matrix derivative in the treatment of periodontal intrabony defects: A 12-month re-entry study. *J Periodontol* 2001;72:25-34.
5. Esposito M, Grusovin MG, Coulthard P, Worthington HV. Enamel matrix derivative (Emdogain) for periodontal tissue regeneration in intrabony defects. *Cochrane Database Syst Rev* 2005;(4):CD003875.
6. Cortellini P, Tonetti MS. A minimally invasive surgical technique with an enamel matrix derivative in the regenerative treatment of intra-bony defects: A novel approach to limit morbidity. *J Clin Periodontol* 2007;34:87-93.
7. Ramfjord SP, Caffesse RG, Morrison EC, et al. 4 modalities of periodontal treatment compared over 5 years. *J Clin Periodontol* 1987;14:445-452.
8. Rethman MP, Harrel SK. Minimally invasive periodontal therapy: Will periodontal therapy remain a technologic laggard? *J Periodontol* 2010;81:1390-1395.
9. Cortellini P, Tonetti MS. Minimally invasive surgical technique and enamel matrix derivative in intra-bony defects. I: Clinical outcomes and morbidity. *J Clin Periodontol* 2007;34:1082-1088.
10. Cortellini P, Nieri M, Prato GP, Tonetti MS. Single minimally invasive surgical technique with an enamel matrix derivative to treat multiple adjacent intra-bony defects: Clinical outcomes and patient morbidity. *J Clin Periodontol* 2008;35:605-613.
11. Wilson TG Jr., Carnio J, Schenk R, Myers G. Absence of histologic signs of chronic inflammation following closed subgingival scaling and root planing using the dental endoscope: Human biopsies – a pilot study. *J Periodontol* 2008;79:2036-2041.
12. Wilson TG, Harrel SK, Nunn ME, Francis B, Webb K. The relationship between the presence of toothborne subgingival deposits and inflammation found with a dental endoscope. *J Periodontol* 2008;79:2029-2035.
13. Ribeiro FV, Nociti Júnior FH, Sallum EA, Sallum AW, Casati MZ. Use of enamel matrix protein derivative with minimally invasive surgical approach in intrabony periodontal defects: Clinical and patient-centered outcomes. *Braz Dent J* 2010;21:60-67.
14. Ribeiro FV, Casarin RC, Júnior FH, Sallum EA, Casati MZ. The role of enamel matrix derivative protein in minimally invasive surgery in treating intrabony defects in single-rooted teeth: A randomized clinical trial. *J Periodontol* 2011;82:522-532.
15. Harrel SK, Rees TD. Granulation tissue removal in routine and minimally invasive procedures. *Compend Contin Educ Dent* 1995;16:960-964, 962, 964 passim.
16. Hunter JG, Sackier JM. Minimally invasive high tech surgery: Into the 21st century. In: Hunter JG, Sackier JM, eds. *Minimally Invasive Surgery*. New York: McGraw-Hill;1993:3-6.
17. Harrel SK, Wilson TG, Nunn ME. Prospective assessment of the use of enamel matrix proteins with minimally invasive surgery. *J Periodontol* 2005;76:380-384.
18. Takei H, Yamada H, Hau T. Maxillary anterior esthetics. Preservation of the interdental papilla. *Dent Clin North Am* 1989;33:263-273.
19. Cortellini P, Prato GP, Tonetti MS. The modified papilla preservation technique. A new surgical approach for interproximal regenerative procedures. *J Periodontol* 1995;66:261-266.
20. Cortellini P, Prato GP, Tonetti MS. The simplified papilla preservation flap. A novel surgical approach for the management of soft tissues in regenerative procedures. *Int J Periodontics Restorative Dent* 1999;19:589-599.
21. Harrel SK, Wilson TG Jr., Nunn ME. Prospective assessment of the use of enamel matrix derivative with minimally invasive surgery: 6-year results. *J Periodontol* 2010;81:435-441.
22. Armitage GC. Development of a classification system for periodontal diseases and conditions. *Ann Periodontol* 1999;4:1-6.
23. Ainamo J, Bay I. Problems and proposals for recording gingivitis and plaque. *Int Dent J* 1975;25:229-235.
24. Mühlemann HR, Son S. Gingival sulcus bleeding – a leading symptom in initial gingivitis. *Helv Odontol Acta* 1971;15:107-113.
25. Tonetti MS, Fourmousis I, Suvan J, et al. Healing, postoperative morbidity and patient perception of outcomes following regenerative therapy of deep intrabony defects. *J Clin Periodontol* 2004;31:1092-1098.

26. Wismeyer D, van Waas MA, Vermeeren JI. Overdentures supported by ITI implants: A 6.5-year evaluation of patient satisfaction and prosthetic aftercare. *Int J Oral Maxillofac Implants* 1995;10:744-749.
27. Heitz-Mayfield LJ, Trombelli L, Heitz F, Needleman I, Moles D. A systematic review of the effect of surgical debridement vs non-surgical debridement for the treatment of chronic periodontitis. *J Clin Periodontol* 2002;29(Suppl. 3):92-102, discussion 160-162.
28. Heitz-Mayfield LJ. How effective is surgical therapy compared with nonsurgical debridement? *Periodontol 2000* 2005;37:72-87.
29. Gutierrez MA, Mellonig JT, Cochran DL. Evaluation of enamel matrix derivative as an adjunct to non-surgical periodontal therapy. *J Clin Periodontol* 2003;30:739-745.
30. Sculean A, Windisch P, Keglevich T, Gera I. Histologic evaluation of human intrabony defects following non-surgical periodontal therapy with and without application of an enamel matrix protein derivative. *J Periodontol* 2003;74:153-160.
31. Cobb CM. Clinical significance of non-surgical periodontal therapy: An evidence-based perspective of scaling and root planing. *J Clin Periodontol* 2002; 29(Suppl. 2):6-16.
32. Lindhe J, Nyman S. Long-term maintenance of patients treated for advanced periodontal disease. *J Clin Periodontol* 1984;11:504-514.
33. Casarin RC, Del Peloso Ribeiro E, Nociti FH Jr., et al. A double-blind randomized clinical evaluation of enamel matrix derivative proteins for the treatment of proximal class-II furcation involvements. *J Clin Periodontol* 2008;35:429-437.
34. Isidor F, Karring T. Long-term effect of surgical and non-surgical periodontal treatment. A 5-year clinical study. *J Periodontal Res* 1986;21:462-472.
35. Antczak-Bouckoms A, Joshipura K, Burdick E, Tulloch JF. Meta-analysis of surgical versus non-surgical methods of treatment for periodontal disease. *J Clin Periodontol* 1993;20:259-268.
36. Hung HC, Douglass CW. Meta-analysis of the effect of scaling and root planing, surgical treatment and antibiotic therapies on periodontal probing depth and attachment loss. *J Clin Periodontol* 2002;29:975-986.
37. Tonetti MS, Pini-Prato G, Cortellini P. Periodontal regeneration of human intrabony defects. IV. Determinants of healing response. *J Periodontol* 1993;64:934-940.
38. Becker W, Becker BE, Ochsenbein C, et al. A longitudinal study comparing scaling, osseous surgery and modified Widman procedures. Results after one year. *J Periodontol* 1988;59:351-365.
39. Pontoriero R, Wennström J, Lindhe J. The use of barrier membranes and enamel matrix proteins in the treatment of angular bone defects. A prospective controlled clinical study. *J Clin Periodontol* 1999; 26:833-840.
40. Sipos PM, Loos BG, Abbas F, Timmerman MF, Van der Velden U. The combined use of enamel matrix proteins and a tetracycline-coated expanded polytetrafluoroethylene barrier membrane in the treatment of intra-osseous defects. *J Clin Periodontol* 2005;32: 765-772.
41. Sculean A, Schwarz F, Chiantella GC, et al. Five-year results of a prospective, randomized, controlled study evaluating treatment of intra-bony defects with a natural bone mineral and GTR. *J Clin Periodontol* 2007;34:72-77.
42. Nobuto T, Imai H, Suwa F, et al. Microvascular response in the periodontal ligament following mucoperiosteal flap surgery. *J Periodontol* 2003;74:521-528.
43. Zucchelli G, De Sanctis M. A novel approach to minimizing gingival recession in the treatment of vertical bony defects. *J Clin Periodontol* 2008;79: 567-574.
44. Trombelli L, Farina R, Franceschetti G, Calura G. Single-flap approach with buccal access in periodontal reconstructive procedures. *J Periodontol* 2009;80: 353-360.
45. Kloostra PW, Eber RM, Wang HL, Inglehart MR. Surgical versus non-surgical periodontal treatment: Psychosocial factors and treatment outcomes. *J Periodontol* 2006;77:1253-1260.
46. Ozcelik O, Haytac MC, Seydaoglu G. Immediate postoperative effects of different periodontal treatment modalities on oral health-related quality of life: A randomized clinical trial. *J Clin Periodontol* 2007;34: 788-796.
47. Hujoel PP. Endpoints in periodontal trials: The need for an evidence-based research approach. *Periodontol 2000* 2004;36:196-204.
48. Tonetti MS, Lang NP, Cortellini P, et al. Enamel matrix proteins in the regenerative therapy of deep intrabony defects. *J Clin Periodontol* 2002;29:317-325.
49. Esposito M, Grusovin MG, Papanikolaou N, Coulthard P, Worthington HV. Enamel matrix derivative (Emdogain(R)) for periodontal tissue regeneration in intrabony defects. *Cochrane Database Syst Rev* 2009;7: CD003875.
50. Yukna RA, Mellonig JT. Histologic evaluation of periodontal healing in humans following regenerative therapy with enamel matrix derivative. A 10-case series. *J Periodontol* 2000;71:752-759.
51. König J, Schwahn C, Fanghänel J, Plötz J, Hoffmann T, Kocher T. Repeated scaling versus surgery in young adults with generalized advanced periodontitis. *J Periodontol* 2008;79:1006-1013.
52. Pilatti GL, André dos Santos F, Bianchi A, Cavassim R, Tozetto CW. The use of celecoxib and dexamethasone for the prevention and control of postoperative pain after periodontal surgery. *J Periodontol* 2006;77: 1809-1814.
53. Rashwan WA. The efficacy of acetaminophen-caffeine compared to Ibuprofen in the control of postoperative pain after periodontal surgery: A crossover pilot study. *J Periodontol* 2009;80:945-952.

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