

# Surgical periodontal therapy with and without initial scaling and root planing in the management of chronic periodontitis: a randomized clinical trial

Manar Aljateeli<sup>1,2</sup>, Tapan Koticha<sup>1</sup>, Jill Bashutski<sup>1</sup>, James V. Sugai<sup>1</sup>, Thomas M. Braun<sup>3</sup>, William V. Giannobile<sup>1</sup> and Hom-Lay Wang<sup>1</sup>

<sup>1</sup>Department of Periodontics and Oral Medicine, University of Michigan, Ann Arbor, MI, USA; <sup>2</sup>Department of Surgical Sciences, Faculty of Dentistry, Kuwait University, Kuwait City, Kuwait; <sup>3</sup>Biostatistics Department, School of Public Health, University of Michigan, Ann Arbor, MI, USA

Aljateeli M, Koticha T, Bashutski J, Sugai JV, Braun TM, Giannobile WV, Wang H-L. Surgical periodontal therapy with and without initial scaling and root planing in the management of chronic periodontitis: a randomized clinical trial. *J Clin Periodontol* 2014; 41: 693–700. doi: 10.1111/jcpe.12259

## Abstract

**Aim:** To compare the outcomes of surgical periodontal therapy with and without initial scaling and root planing.

**Methods:** Twenty-four patients with severe chronic periodontitis were enrolled in this pilot, randomized controlled clinical trial. Patients were equally allocated into two treatment groups: Control group was treated with scaling and root planing, re-evaluation, followed by Modified Widman Flap surgery and test group received similar surgery without scaling and root planing. Clinical attachment level, probing depth and bleeding on probing were recorded. Standardized radiographs were analysed for linear bone change from baseline to 6 months. Wound fluid inflammatory biomarkers were also assessed.

**Results:** Both groups exhibited statistically significant improvement in clinical attachment level and probing depth at 3 and 6 months compared to baseline. A statistically significant difference in probing depth reduction was found between the two groups at 3 and 6 months in favour of the control group. No statistically significant differences in biomarkers were detected between the groups.

**Conclusions:** Combined scaling and root planing and surgery yielded greater probing depth reduction as compared to periodontal surgery without initial scaling and root planing.

View the pubcast on this paper at  
<http://www.scivee.tv/journalnode/62444>

**Key words:** initial therapy; modified Widman Flap; periodontal surgery; periodontal therapy; periodontitis; scaling and root planing; wound healing

Accepted for publication 6 April 2014

The rationale for periodontal therapy is to re-establish and maintain periodontal health and function (Yusof 1987, Caffesse et al. 1995). The traditional approach to treating periodontitis includes an initial non-

surgical therapy phase followed by a surgical phase as necessary. Several longitudinal studies showed that non-surgical and surgical periodontal therapy is effective in arresting periodontitis (Knowles et al. 1979, 1980, Isidor & Karring 1986, Kaldahl et al. 1996).

In conventional periodontal therapy the “non-surgical phase” or the “initial phase” precedes the sur-

## Conflict of interest and source of funding statement

The authors do not have any financial interests, either directly or indirectly, in the products or information listed in the paper.

This study was supported by the graduate student research fund, University of Michigan, Department of Periodontics, the Rackham Graduate Funding, Bunting Scholarship & Endowment, and Delta Dental Foundation (dental master’s thesis award).

gical phase. Non-surgical therapy involves, and not limited to, scaling and root planing (SRP) combined with oral hygiene instructions (OHI) and patient motivation (Lang 1983), which aims at eliminating or reducing putative pathogens and shifting the microbial flora to a more favourable environment to achieve stable periodontal conditions (Rawlinson & Walsh 1993).

Although non-surgical therapy alone can successfully arrest periodontitis progression in shallow to moderate pockets (Badersten et al. 1981), its effectiveness in successfully treating deeper pockets is debatable and has its limitations (Waerhaug 1978, Stambaugh et al. 1981). Using scanning electron microscopy, Rateitschak-Pluss et al. (1992) demonstrated that non-surgical therapy failed to completely reach the base of the pocket on 75% of the root surfaces. In addition, molar furcation sites with initial pocket depths (PD) of  $\geq 4$  mm were shown to have a poor response following a non-surgical approach alone (Nordland et al. 1987). A more recent study showed that a successful treatment outcome of pocket closure (PD  $\leq 4$  mm) following non-surgical debridement was achieved only at 50% of the tooth sites with an initial PD  $\geq 5$  mm (Tomasi et al. 2008). The same study showed that even with retreatment, the probability of achieving pocket closure was 45% while the probability was only 12% at sites with PD  $< 6$  mm. To overcome these shortcomings, a direct surgery approach without an initial phase is proposed as an alternative to the conventional approach.

Over the years, a great number of studies compared the effectiveness of SRP alone and SRP with surgery (Hill et al. 1981, Pihlstrom et al. 1981, Lindhe et al. 1982, Ramfjord et al. 1987). Their results are in agreement with a systematic review (Heitz-Mayfield et al. 2002) and a literature review (Pihlstrom et al. 1983) that showed that although SRP alone and SRP with a surgical flap were effective treatment modalities for managing periodontitis, open flap debridement resulted in greater PD reductions and clinical attachment level (CAL) gains in deeper pockets. A meta-analysis also confirmed that in the short term, surgi-

cal treatment resulted in more PD reductions than the non-surgical treatment for all initial pocket depths. In addition, in the long term, surgical treatment showed greater PD reductions with deepest initial pockets ( $> 7$  mm) when compared to non-surgical treatment (Antczak-Bouckoms et al. 1993).

Previous investigations have not compared SRP to surgical procedures performed without initial therapy. This study was designed to compare the outcomes of surgical periodontal therapy completed with and without an initial SRP. The primary endpoint variable was the difference in CAL change over 6 months. Secondary outcome variables included: PD, bleeding on probing (BOP), linear bone gain and changes in gingival crevicular fluid (GCF) inflammatory biomarkers.

## Materials and Methods

### Study population

Human subjects approval was obtained from the University of Michigan Human Subject Institution Review Board prior to study initiation, which was conducted in accordance with the Declaration of Helsinki (version 2008). A power analysis was completed to determine an appropriate number of participants for enrolment. Assuming a 1 mm difference in CAL and using 0.8 mm as standard deviation, which seemed to be a reasonable estimate for both groups based on Serino et al. (Serino et al. 2001), power analysis revealed that 12 patients were required in each group for a *t*-test power level of 80%. Hence, 24 participants were recruited for the study. Research procedures were explained to all patients after they read and signed an informed consent document prior to any treatment. The primary investigator (MA) screened the patients according to the inclusion and exclusion criteria and selected those who fulfilled the criteria for the study. Inclusion criteria were as follows: adults  $\geq 18$  years of age; patients with no systemic diseases which could influence the outcome of the therapy; presence of two or more periodontal pockets with PD  $\geq 6$  mm and CAL  $\geq 5$  mm; patients willing and able to provide

an informed consent and to comply with all study-related procedures including good plaque control (O'Leary plaque score of  $\leq 30\%$ ) and follow-up appointments; patients with localized or generalized chronic periodontitis. Exclusion criteria were as follows: pregnant women; antibiotic therapy for more than 10 days within the last 3 months of enrolment or necessity of antibiotic prophylaxis; medications affecting bone metabolism or gingiva; history of a previous periodontal surgery within the last 2 years; history of SRP within the last year; Miller Class 2 or greater mobility on any teeth in the treatment quadrant. The selected patients were then randomly assigned to one of two treatment groups with 12 patients in each group. Each patient picked a number from an enclosed envelope during the screening appointment. Twenty-four labelled papers were placed into two envelopes which were labelled either with number 1 or number 2 evenly. If the patient picked 1 he or she was assigned to control group, while picking 2 meant assignment into test group. The first 12 screened patients that met the inclusion criteria picked from the 1st envelope, and the last 12 patients picked from the 2nd envelope to ensure that the first screened 12 patients are assigned to the two groups evenly. Control group (SRP + S) received SRP followed by surgery 6–8 weeks later, if necessary, while the test group (S only) received direct surgery with no SRP. Patients were treated at the Department of Periodontics and Oral Medicine, University of Michigan, School of Dentistry.

### Procedures

Detailed and comprehensive OHI were given to all patients, including the Bass toothbrushing (Bass 1954) technique and interproximal cleaning with dental floss and inter-dental brushes. Clinical baseline measurements were taken at screening appointment along with standardized periapical radiographs. For both treatment groups, baseline measurements were the measurements collected at this screening appointment before any treatment was initiated. Data collected included: O'Leary

Plaque index (PII) (O'Leary et al. 1972), BOP, PD (distance from the free gingival margin "FGM" to the base of the pocket in millimetres), CAL and gingival recession. Clinical measurements were registered by one masked and calibrated investigator (TK) to the nearest millimetre using a University of North Carolina (UNC) periodontal probe with 1 mm markings (Hu-Friedy, Chicago, IL, USA). Calibration was completed at two time points: pre-study and -intra-study evaluation. Each calibration was carried out by performing double measurements of a randomly selected patient not involved in the study with a 1-week gap. Measurements were taken at six sites around the teeth (mesiobuccal, midbuccal, distobuccal, distolingual, midlingual and mesiolingual). To decrease a possible bias, the experimental quadrant was selected at the screening appointment that included the experimental tooth that fulfilled the selection criteria. This tooth with the deepest PD, along with the two neighbouring teeth was included in the analysis. GCF and oral wound fluid (WF) were collected from sites within the treatment quadrant, one of which was the study tooth site, using a sterile methylcellulose sampling strip (Periopaper, Oraflow, Inc., Smithtown, NY, USA), to assess the biomarkers interleukin-1 $\beta$  (IL-1 $\beta$ ), interleukin-6 (IL-6), matrix metalloproteinases-8 and -9 (MMP-8, -9) and vascular endothelial growth factor (VEGF). Additional GCF samples were collected from sites of the contra-lateral quadrant that served as control samples (Fig. 1).

#### Control group (SRP + S)

A conventional SRP procedure was performed on the study quadrant under local anaesthesia. SRP was performed using both ultrasonic scalars and hand instruments. GCF samples were collected at 1, 2 and 4 weeks following SRP. If the patient needed SRP in other non-study-related quadrants, SRP of these remaining quadrants was also completed at 2 weeks, as necessary. Re-evaluation was completed 6–8 weeks following the SRP completion.

Patients who presented at the re-evaluation appointment with a

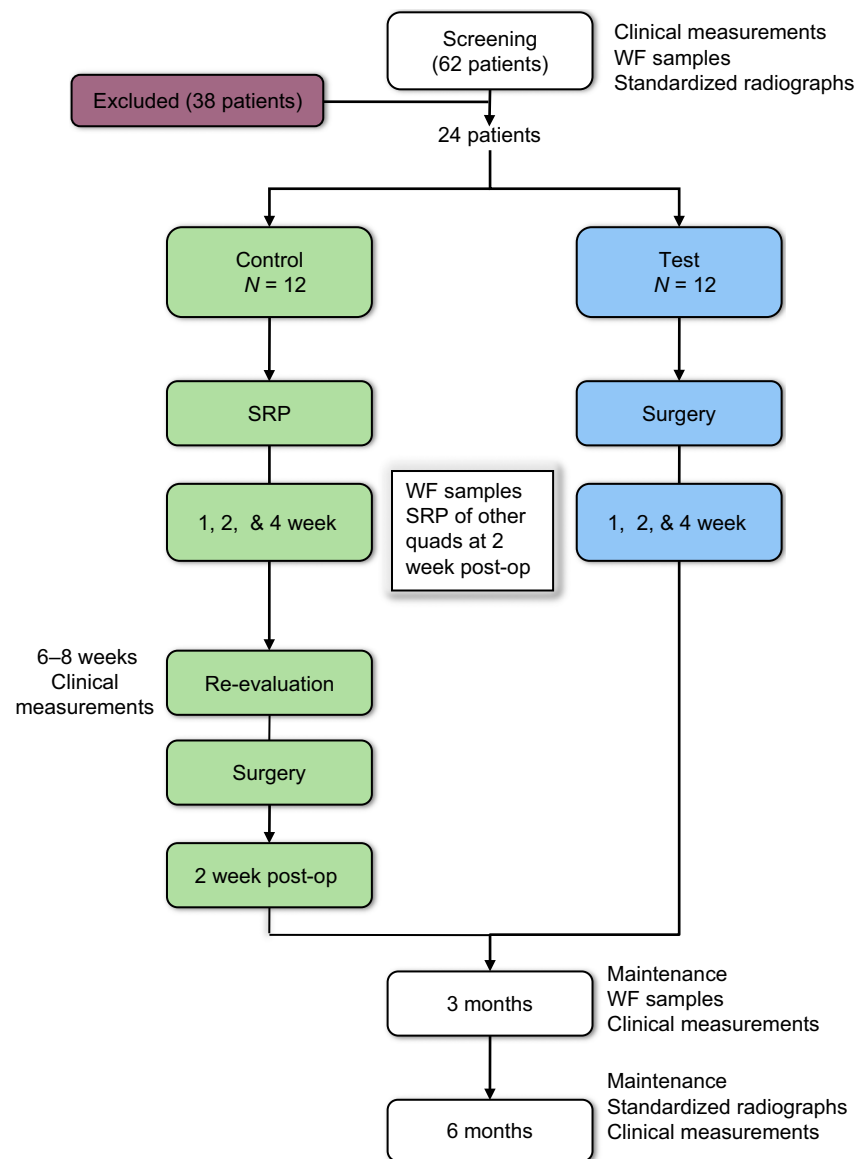


Fig. 1. Experimental flow chart for study design.

study tooth demonstrating a PD of  $\geq 5$  mm were scheduled to receive a surgery in that study quadrant, whereas patients who presented with PD  $< 5$  mm received no surgery and were placed on periodontal maintenance. Modified Widman Flap (MWF) surgery was completed under local anaesthesia by one surgeon (MA) in the study quadrant within 2 weeks after the re-evaluation. Degranulation and debridement were completed using ultrasonic and hand instruments. When found, local contributing factors (e.g. enamel pearls, cervical enamel projections (CEP), overhangs) were eliminated. Flaps were repositioned to their original

location and sutured using Vicryl sutures (Ethicon, Inc., Menlo Park, CA, USA) and a single interrupted suture technique. General postoperative instructions for periodontal surgical procedures were provided both verbally and with a standard written form. Patients were instructed to rinse with 0.12% of chlorhexidine solution (Colgate<sup>®</sup> PerioGard<sup>®</sup> Oral Rinse, Colgate Oral Pharmaceuticals, New York, NY) twice/day for 2 weeks and to refrain from oral hygiene measures in the study quadrant. Oral analgesics (Ibuprofen, 600 mg, every 8 h as necessary) were also prescribed. Patients were seen 2 weeks after surgery for follow-up

and suture removal. At this time, oral hygiene measures were re-instituted in the study quadrant.

#### *Test group (S only)*

Patients in this group received periodontal surgery without an initial SRP phase. Surgery and subsequent postoperative follow-up care were performed in the study quadrant as described above. GCF samples were collected at 1, 2 and 4 weeks following surgery. SRP of the remaining quadrants was also completed at 2 weeks after surgery, if necessary. To minimize variability and bias, both SRP and surgery were completed by a single clinician (MA).

#### **Follow-up appointments**

Periodontal maintenance of all teeth was performed at 3 and 6 months during which clinical measurements were taken. Supra- and subgingival debridement was provided using ultrasonic and hand instruments. OHI was re-enforced at all appointments. GCF samples were collected at 3 months and standardized periapical radiographs were taken at 6 months.

#### **Radiographic examination**

Standardized long cone radiographs were taken using a bite registration material (Blu-Bite HP, Henry Schein, INC., Melville, NY, USA) and a step wedge to maintain a reproducible projection. The impression material was fixed on both sides of the film-holder and stored for the duration of the study. Intra-oral films were exposed and developed under standardized conditions. These radiographs were taken at baseline and 6 months post surgery. The consecutive radiographs were paired, coded and evaluated by a masked and calibrated examiner with no knowledge of the treatment group or whether a radiograph had been taken prior to surgery or 6 months later. Calibration of the radiographic measurements was performed by double measurements of 20 radiographs of 1-week gap. Intra-examiner value of Pearson's correlation coefficient was 0.95 and inter-examiner values were 0.94 and 0.99, for the first and second measurements respectively. All the stan-

dardized radiographs were digitalized then analysed using Ema-go software (Oral Diagnostic Systems, Amsterdam, the Netherlands). Anatomical landmarks were marked and linear distance was measured from the CEJ or from any other exact margin of a restoration to the most apical part of the alveolar bone crest, where the periodontal ligament space was judged to retain its normal width. Linear subtraction radiography was used to calculate the linear bone change from baseline to 6 months.

#### **GCF/WF sampling and analysis**

Gingival crevicular fluid/Wound fluid samples were collected from both test and control teeth at baseline (GCF), 1-, 2-, 4 weeks and 3 months post treatment. Sampling was performed after assessing O'Leary plaque score and before completing any clinical parameters to avoid mechanical irritation and bleeding from periodontal probing. Before collecting the oral fluids, the area around each sample site was isolated using cotton rolls, dried with gauze and a quick blast of air from the air/water syringe making sure not to direct any air flow into the gingival sulcus. If present, any supragingival plaque was gently removed prior to sampling. Each Periopaper® strip was inserted into the gingival crevice until a slight resistance was felt and kept in position for a total of 30 s before immediate removal. Since presence of blood on the strip can affect the testing results, if bleeding occurred at the site prior to sampling, it was rinsed and cleared away prior to taking another sample with a minimum of 90 s between sampling times. Following oral fluid collection, the strips were immediately placed onto dry ice for transport to the laboratory and stored in an 80°C freezer until further analysis. Proteins within the harvested crevicular fluid were extracted from the GCF strips using an elution method involving a series of washes and centrifugations (Palys et al. 1998). Analysis of the samples using Custom Quantibody® Array was completed by following the protocol provided by the manufacturer (Ray Biotech, Inc., Norcross, GA, USA).

#### **Statistical analysis**

Data collected were uploaded to a database in which patient privacy was protected according to current regulations. A two-sample *t*-test (continuous measures) or a chi-squared test of association (categorical measures) was used to evaluate statistically significant differences between the two groups and a paired *t*-test was used to evaluate statistically significant changes from baseline within each group. A *p*-value less than 0.05 was considered statistically significant.

#### **Results**

The study cohort, who had a mean age of 49 and percentage of smokers at 37.5%, consisted of a test group with seven females and five males and a control group with four females and eight males. Patients were recruited from April 2011 to January 2012. Twenty-one participants completed the scheduled 6-month examination appointments and two patients, one from each group, did not complete the 3- and 6-month examination due to non-compliance with the study visit schedule. A third patient from the control group was not able to complete the study beyond the 4-week evaluation due to personal scheduling issues. Therefore, 21 patients were available for the final analysis. One patient from the control group presented at the re-evaluation visit with PD <5 mm at the study tooth and therefore did not qualify for periodontal surgery. There were no statistically significant differences in clinical and radiographic baseline characteristics observed among the two treatment groups (including CAL, PD, BOP and linear bone levels). In addition, no statistically significant difference was found in biomarkers baseline levels (pg/ml) between the two treatment groups. There was also no statistically significant difference in patient population in term of age, gender and smoking status (Table 1). The observed post-operative healing was similar for both groups and uneventful in all patients.

Both treatments resulted in a statistically significant difference in CAL gain at 3 and 6 months com-

Table 1. Demographic data and baseline characteristics for control (SRP + S) and test (S only) groups

	SRP + S group	S only group	p-value	Range
Age (Mean)	51.5	46.6	0.23	[31–65]
Female/male	4/8	7/5	0.41	
Smokers/non-smokers	4/8	5/7	>0.99	
CAL (Mean) (mm)	7.25	6.42	0.24	[5–9]
PD (Mean) (mm)	7.42	6.42	0.06	[6–9]
BOP (percentages of sites) (%)	55	67	0.55	
Radiographic mean linear bone level (mm)	2.95	2.31	0.10	[1.7–3.7]
Tooth type				
Bicuspid	4	1	0.31	
Molars	8	11		
Biomarker Levels (pg/ml)				
VEGF	192	119	0.27	
IL-1B	152	96.4	0.18	
IL-6	11.2	27.4	0.17	
MMP-8	3366	3327	0.87	
MMP-9	9264	8919	0.71	

pared to baseline ( $p < 0.05$ ), with no difference between the two groups. Both groups also showed statistically significant PD reduction at 3 and 6 months compared to baseline ( $p < 0.001$ ). A statistically significant difference in PD reduction was found between the two groups at 3 months (3.53 mm *versus* 2.05 mm) and at 6 months (3.42 mm *versus* 2.02 mm) respectively, in favour of the control group ( $p < 0.05$ ) (Fig. 2 and Table 2).

At 6-month examination, results revealed that pocket closure (PD  $\leq 4$  mm) was achieved at 60% of tooth sites in the control group, whereas only 40% in the test group.

The mean overall linear bone gain was 0.39 mm for the control group and 0.22 mm for the test group, compared to baseline, with a range of (–0.1 to 1.0 mm) and (–0.1 to 1.2 mm) respectively. This was determined to be statistically significant in the control group ( $p < 0.001$ ), while the bone gain in the test group had a tendency to reach a statistical significance. However, no statistical significance difference was found between the two groups.

#### Gingival crevicular fluid/Wound fluid

For both the control and test groups, the mean levels (pg/ml) of VEGF within WF increased after respective treatment when compared to baseline, then decreased by 3 months. This overall difference in

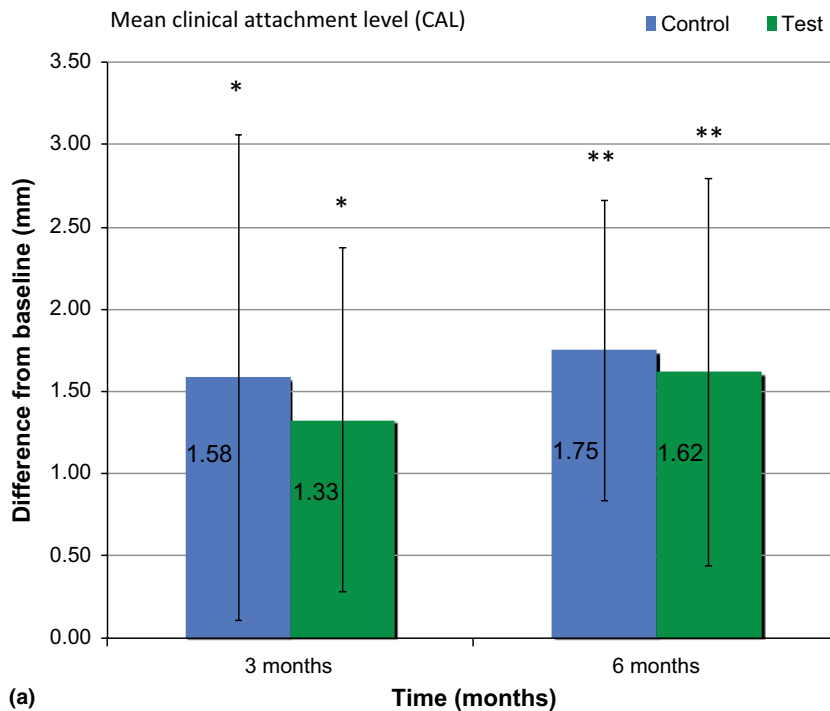
expression was not significantly different from baseline levels except in the test group, which showed higher mean levels of VEGF at weeks 1 and 2 following treatment ( $p < 0.001$  and  $p < 0.05$ ) respectively. However, when comparing the changes in mean VEGF levels from baseline in both groups, no statistically significant change was observed. The mean levels of IL-1b, IL-6, MMP-8 and MMP-9 showed no statistically significant difference, except in the test group at week 1 for IL-6, which was significantly higher when compared to baseline ( $p < 0.001$ ). However, no statistically significant difference was found between the two groups (Fig. 3).

#### Discussion

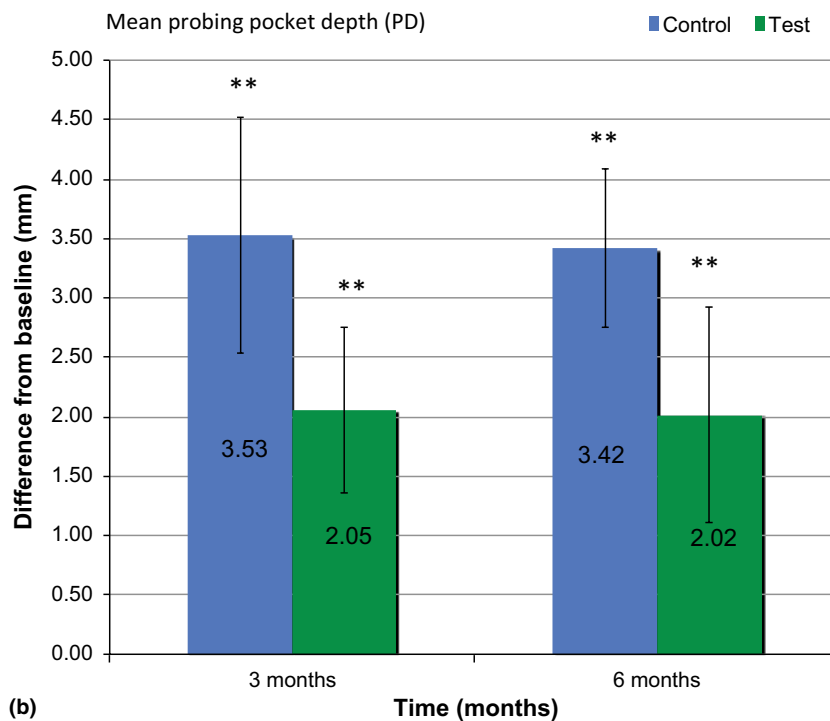
This study compared surgery alone or surgery combined with an initial phase of SRP. The findings from this study demonstrated that both treatments resulted in statistically significant CAL gain and PD reduction compared to baseline. However, the PD reduction observed in the control (SRP + S) group showed a statistically significant difference when compared to the test (S only) group at both 3- and 6-month follow-up examinations. The greater decrease in PD in the control group might be due to the two phases of instrumentation. As there was no difference in CAL gain observed between the two groups, this might be explained by the greater gingival recession noted

in the control (SRP + S) group. This suggests that the initial phase of SRP contributed to greater reduction of inflammation of the gingival tissues. One might also argue that the greater reduction in PD in the control group besides the treatment effect might also be in part due to the initially deeper probing depths found in this group. While the initial mean PD in the control group was 7.42 mm, the corresponding value in test group was 6.42 mm. This could have contributed to the greater reduction in PD observed as studies have shown that reduction in PD was related to the initial disease severity (Morrison et al. 1980, Badersten et al. 1984). Morrison et al. found that in cases of a 4–6 mm PD there was a reduction of 0.95 mm, while an initial PD of  $\geq 7$  mm yielded 2.22 mm of PD reduction (Morrison et al. 1980). By eliminating the initial SRP procedure one might think that it would offer additional benefits such as saving treatment time and minimizing potential treatment recession. Nonetheless, the following concerns have to be considered when selecting a direct surgical approach without an initial SRP: providing an over-treatment since surgery may not be required after the initial treatment. In addition, one should expect more demanding surgical procedure due to active inflammation and potential increased bleeding.

Although multiple studies have been conducted that compared the effectiveness of SRP alone to periodontal surgery (Hill et al. 1981, Isidor et al. 1984, Becker et al. 1988), this is the first study to investigate the surgical treatment outcome without performing the initial phase therapy. Even though a similar study design was conducted (Serino et al. 2001), patients in the non-surgical group did not receive a surgical therapy after the completion of the initial non-surgical phase. Instead of comparing these two therapies, we aimed to evaluate the advantages of performing SRP by eliminating this initial therapy in our test group and assess the feasibility of performing surgery as an initial therapy. In this study, SRP not only led to significantly greater reduction in PD but also eliminated the need for surgery in one patient in the control group. In addition, SRP



(a)



(b)

Fig. 2. (a) Changes in mean clinical attachment level (CAL) from baseline at different time intervals. (b) Changes in mean probing pocket depth (PD) from baseline at different time intervals. Longitudinal plots “error bars” = 95% confidence interval. \*Statistically significant difference between baseline and 3 months ( $p < 0.05$ ); \*\*Statistically significant difference between baseline and 3 months and between baseline and 6 months ( $p < 0.001$ ).

resulted in achieving greater percentages of closed pockets 60% compared to 40% in the group without an initial

SRP. Therefore, SRP as an initial phase may be a very important element of the periodontal therapy.

In addition to evaluating clinical parameters, this study also aimed at assessing changes in WF biomarkers within each group after treatment and compared the changes between the two groups. The use of GCF/WF components as a diagnostic aid has been extensively studied. Evidence suggests that the GCF/WF constituents can qualitatively and quantitatively reflect the severity of periodontal disease (Hou et al. 1995, Rescala et al. 2010, Teles et al. 2010). Hence, GCF/WF inflammatory cytokine levels can be used to study the course of the disease or the periodontal treatment outcomes.

Our results showed that the mean levels of VEGF increased after treatment when compared to baseline in both groups then decreased at 3 months. However, only in the test group was this difference statistically significant as it showed higher mean levels of VEGF at weeks 1 and 2 following treatment. This is in agreement with the results obtained by Cooke et al. (2006) who demonstrated that non-surgical sites had little change in the amount of VEGF released in the GCF. For the surgical sites, however, Cooke observed an immediate increase in the amount of VEGF released over the first 2 weeks following surgery.

In our study, the mean levels of IL-1 $\beta$ , IL-6, MMP-8 and MMP-9 showed no statistically significant difference, except in the test group at week 1 for IL-1 $\beta$  and IL-6, which was significantly higher when compared to baseline. This is in agreement with other studies that showed while SRP did not significantly reduce IL-1 levels (Al-Shammari et al. 2001), a surgical therapy resulted in significantly increased IL-1 $\beta$  levels (Reinhardt et al. 1993). These results may suggest a prolonged production of certain pro-inflammatory cytokines after a surgical procedure. This in turn may suggest a prolonged wound healing after a surgical procedure when compared to SRP only.

One of the limitations of this study was the small sample size that may have affected our ability to detect a difference for an effect of initial SRP on CAL gain. Another consideration is the relatively short 6-month follow-up period. The threshold of a 1-mm difference

Table 2. Clinical attachment level values, PD values (mm; mean  $\pm$  SE), percentage of sites with BOP for the two groups at baseline, 3 and 6 months post treatment ( $N = 21$  subjects)

Parameter	SRP + S group				S only group			
	Baseline	3 months	6 months	Difference from baseline	Baseline	3 months	6 months	Difference from baseline
CAL (mm)	7.3 $\pm$ 0.4	5.7 $\pm$ 0.9*	5.5 $\pm$ 0.6**	1.75**	6.4 $\pm$ 0.6	5.1 $\pm$ 0.49*	4.8 $\pm$ 0.5*	1.62**
PD (mm)	7.4 $\pm$ 0.3	3.9 $\pm$ 0.4**	4.0 $\pm$ 0.4**	3.42**	6.4 $\pm$ 0.5	4.4 $\pm$ 0.41**	4.4 $\pm$ 0.4**	2.02**
% of sites with BOP	55%	78% (NS)	30% (NS)		67%	45% (NS)	50% (NS)	

\* $p < 0.05$  for difference from baseline.

\*\* $p < 0.001$  for difference from baseline.

NS, no statistically significant difference from baseline.

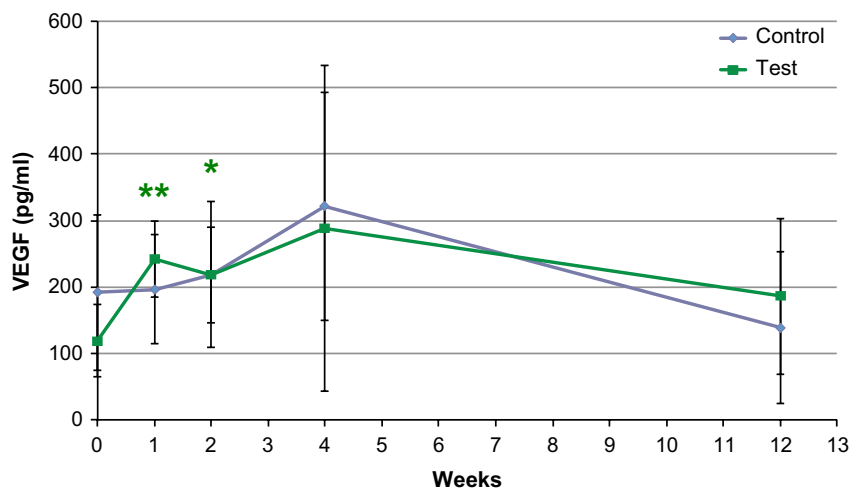


Fig. 3. Mean levels (pg/ml) of VEGF at Baseline, 1, 2, 4 and 12 weeks. Mean levels (pg/ml) of VEGF increased after treatment when compared to baseline in both groups then decreased at 3 months. However, this difference was statistically significantly higher when compared to baseline only in the test group at weeks 1 and 2 following treatment ( $p < 0.001$ ). Longitudinal plots "error bars" = 95% confidence interval. \*Statistically significant difference from baseline ( $p < 0.05$ ); \*\*Statistically significant difference between baseline and 1 week ( $p < 0.001$ ).

between test and control could also be clinically relevant, however, due to our study design and pre-set significance level, it shows no statistical significance difference. Hence, future studies should set significant differences below this benchmark (i.e.  $< 1$  mm) to determine if it makes an impact. Although we demonstrated that both treatments resulted in statistically significant CAL gain when compared to baseline, we found no difference between the two groups. The short-term follow-up might explain why we did not observe statistically significant differences in CAL gain between the two groups. Because of this, it may be premature to conclude that the adjunctive utilization of the initial

SRP therapy does not contribute additional improvement to CAL. Another consideration of our study was that only six sites of three teeth were evaluated for the clinical changes. This number of sites may have limited our ability to detect changes at other teeth in the experimental quadrant.

It is important to emphasize the value of the initial non-surgical phase in evaluating patient's ability to maintain good oral hygiene prior to surgery. It was demonstrated by classical studies that patient's oral hygiene had a critical role on the long-term outcomes of periodontal treatment. Patients who were able to maintain excellent oral hygiene showed stable attachment levels. On

the contrary, patients with poor oral hygiene showed additional loss of attachment and probing depth increase regardless if the patients were treated with non-surgical or surgical technique (Axelsson & Lindhe 1981, Lindhe et al. 1984). In this study, only patients with good oral hygiene were included to avoid the possible negative effects of performing surgery on plaque-infected dentition.

In conclusion, combined SRP and surgery resulted in greater probing pocket depth reduction as compared to periodontal surgery only without an initial phase of SRP. However, comparable results for clinical attachment level gain were achieved by the two treatments. These findings should be viewed with caution given the limited sample size.

## References

- Al-Shammari, K. F., Giannobile, W. V., Aldredge, W. A., Iacono, V. J., Eber, R. M., Wang, H. L. & Oringer, R. J. (2001) Effect of non-surgical periodontal therapy on C-telopeptide pyridinoline cross-links (ICTP) and interleukin-1 levels. *Journal of Periodontology* **72**, 1045–1051.
- Antczak-Bouckoms, A., Joshipura, K., Burdick, E. & Tulloch, J. F. (1993) Meta-analysis of surgical versus non-surgical methods of treatment for periodontal disease. *Journal of Clinical Periodontology* **20**, 259–268.
- Axelsson, P. & Lindhe, J. (1981) The significance of maintenance care in the treatment of periodontal disease. *Journal of Clinical Periodontology* **8**, 281–294.
- Badersten, A., Nilveus, R. & Egelberg, J. (1981) Effect of nonsurgical periodontal therapy. I. Moderately advanced periodontitis. *Journal of Clinical Periodontology* **8**, 57–72.
- Badersten, A., Nilveus, R. & Egelberg, J. (1984) Effect of nonsurgical periodontal therapy. II. Severely advanced periodontitis. *Journal of Clinical Periodontology* **11**, 63–76.
- Bass, C. C. (1954) An effective method of personal oral hygiene; part II. *Journal of the Louisiana State Medical Society* **106**, 100–112.

- Becker, W., Becker, B. E., Ochsnein, C., Kerry, G., Caffesse, R., Morrison, E. C. & Prichard, J. (1988) A longitudinal study comparing scaling, osseous surgery and modified Widman procedures. Results after one year. *Journal of Periodontology* **59**, 351–365.
- Caffesse, R. G., Mota, L. F. & Morrison, E. C. (1995) The rationale for periodontal therapy. *Periodontology* **2000** **9**, 7–13.
- Cooke, J. W., Sarment, D. P., Whitesman, L. A., Miller, S. E., Jin, Q., Lynch, S. E. & Giannobile, W. V. (2006) Effect of rhPDGF-BB delivery on mediators of periodontal wound repair. *Tissue Engineering* **12**, 1441–1450.
- Heitz-Mayfield, L. J., Trombelli, L., Heitz, F., Needleman, I. & Moles, D. (2002) A systematic review of the effect of surgical debridement vs non-surgical debridement for the treatment of chronic periodontitis. *Journal of Clinical Periodontology* **29** (Suppl. 3), 92–102; discussion 160–2.
- Hill, R. W., Ramfjord, S. P., Morrison, E. C., Appleberry, E. A., Caffesse, R. G., Kerry, G. J. & Nissle, R. R. (1981) Four types of periodontal treatment compared over two years. *Journal of Periodontology* **52**, 655–662.
- Hou, L. T., Liu, C. M. & Rossomando, E. F. (1995) Crevicular interleukin-1 beta in moderate and severe periodontitis patients and the effect of phase I periodontal treatment. *Journal of Clinical Periodontology* **22**, 162–167.
- Isidor, F. & Karring, T. (1986) Long-term effect of surgical and non-surgical periodontal treatment. A 5-year clinical study. *Journal of Periodontal Research* **21**, 462–472.
- Isidor, F., Karring, T. & Attstrom, R. (1984) The effect of root planning as compared to that of surgical treatment. *Journal of Clinical Periodontology* **11**, 669–681.
- Kaldahl, W. B., Kalkwarf, K. L., Patil, K. D., Molvar, M. P. & Dyer, J. K. (1996) Long-term evaluation of periodontal therapy: I. Response to 4 therapeutic modalities. *Journal of Periodontology* **67**, 93–102.
- Knowles, J., Burgett, F., Morrison, E., Nissle, R. & Ramfjord, S. (1980) Comparison of results following three modalities of periodontal therapy related to tooth type and initial pocket depth. *Journal of Clinical Periodontology* **7**, 32–47.
- Knowles, J. W., Burgett, F. G., Nissle, R. R., Shick, R. A., Morrison, E. C. & Ramfjord, S. P. (1979) Results of periodontal treatment related to pocket depth and attachment level. Eight years. *Journal of Periodontology* **50**, 225–233.
- Lang, N. P. (1983) Indications and rationale for non-surgical periodontal therapy. *International Dental Journal* **33**, 127–136.
- Lindhe, J., Westfelt, E., Nyman, S., Socransky, S. S. & Haffajee, A. D. (1984) Long-term effect of surgical/non-surgical treatment of periodontal disease. *Journal of Clinical Periodontology* **11**, 448–458.
- Lindhe, J., Westfelt, E., Nyman, S., Socransky, S. S., Heijl, L. & Bratthall, G. (1982) Healing following surgical/non-surgical treatment of periodontal disease. A clinical study. *Journal of Clinical Periodontology* **9**, 115–128.
- Morrison, E. C., Ramfjord, S. P. & Hill, R. W. (1980) Short-term effects of initial, nonsurgical periodontal treatment (hygienic phase). *Journal of Clinical Periodontology* **7**, 199–211.
- Nordland, P., Garrett, S., Kiger, R., Vanooteghem, R., Hutchens, L. H. & Egelberg, J. (1987) The effect of plaque control and root debridement in molar teeth. *Journal of Clinical Periodontology* **14**, 231–236.
- O'Leary, T. J., Drake, R. B. & Naylor, J. E. (1972) The plaque control record. *Journal of Periodontology* **43**, 38.
- Palys, M. D., Haffajee, A. D., Socransky, S. S. & Giannobile, W. V. (1998) Relationship between C-telopeptide pyridinoline cross-links (ICTP) and putative periodontal pathogens in periodontitis. *Journal of Clinical Periodontology* **25**, 865–871.
- Pihlstrom, B. L., Mchugh, R. B., Oliphant, T. H. & Ortiz-Campos, C. (1983) Comparison of surgical and nonsurgical treatment of periodontal disease. A review of current studies and additional results after 61/2 years. *Journal of Clinical Periodontology* **10**, 524–541.
- Pihlstrom, B. L., Ortiz-Campos, C. & Mchugh, R. B. (1981) A randomized four-years study of periodontal therapy. *Journal of Periodontology* **52**, 227–242.
- Ramfjord, S. P., Caffesse, R. G., Morrison, E. C., Hill, R. W., Kerry, G. J., Appleberry, E. A., Nissle, R. R. & Stults, D. L. (1987) 4 modalities of periodontal treatment compared over 5 years. *Journal of Clinical Periodontology* **14**, 445–452.
- Rateitschak-Pluss, E. M., Schwarz, J. P., Guggenheim, R., Duggelin, M. & Rateitschak, K. H. (1992) Non-surgical periodontal treatment: where are the limits? An SEM study. *Journal of Clinical Periodontology* **19**, 240–244.
- Rawlinson, A. & Walsh, T. F. (1993) Rationale and techniques of non-surgical pocket management in periodontal therapy. *British Dental Journal* **174**, 161–166.
- Reinhardt, R. A., Masada, M. P., Johnson, G. K., Dubois, L. M., Seymour, G. J. & Allison, A. C. (1993) IL-1 in gingival crevicular fluid following closed root planing and papillary flap debridement. *Journal of Clinical Periodontology* **20**, 514–519.
- Rescala, B., Rosalem, W. Jr, Teles, R. P., Fischer, R. G., Haffajee, A. D., Socransky, S. S., Gustafsson, A. & Figueredo, C. M. (2010) Immunologic and microbiologic profiles of chronic and aggressive periodontitis subjects. *Journal of Periodontology* **81**, 1308–1316.
- Serino, G., Rosling, B., Ramberg, P., Socransky, S. S. & Lindhe, J. (2001) Initial outcome and long-term effect of surgical and non-surgical treatment of advanced periodontal disease. *Journal of Clinical Periodontology* **28**, 910–916.
- Stambaugh, R. V., Drago, M., Smith, D. M. & Carasali, L. (1981) The limits of subgingival scaling. *International Journal of Periodontics and Restorative Dentistry* **1**, 30–41.
- Teles, R., Sakellari, D., Teles, F., Konstantinidis, A., Kent, R., Socransky, S. & Haffajee, A. (2010) Relationships among gingival crevicular fluid biomarkers, clinical parameters of periodontal disease, and the subgingival microbiota. *Journal of Periodontology* **81**, 89–98.
- Tomasi, C., Koutouzis, T. & Wennstrom, J. L. (2008) Locally delivered doxycycline as an adjunct to mechanical debridement at retreatment of periodontal pockets. *Journal of Periodontology* **79**, 431–439.
- Waerhaug, J. (1978) Healing of the dento-epithelial junction following subgingival plaque control. II: As observed on extracted teeth. *Journal of Periodontology* **49**, 119–134.
- Yusuf, W. Z. (1987) Rationale for non-surgical periodontal treatment. *Singapore Dental Journal* **12**, 13–22.

## Address:

Hom-Lay Wang  
1011 North University Avenue  
Ann Arbor, MI 48109-1078  
USA  
E-mail: homlay@umich.edu

**Clinical Relevance**

*Scientific rationale for the study:* Conventional periodontal therapy uses an initial non-surgical phase prior to surgical intervention. However, limited information exists regarding outcomes of surgi-

cal intervention performed without initial therapy.

*Principal findings:* Although no difference was found in clinical attachment level (CAL) gain between the two groups, the SRP plus surgery group showed a statistically significant improvement in probing depth

(PD) reduction when compared to the surgery without SRP group.

*Practical implications:* SRP is an important component of the periodontal therapy and its goal is resolution of inflammation evident by reduction of probing pocket depth and gain of clinical attachment level.