

# **Surgical Treatment of Peri-implantitis: Treatment Results -a pilot study**

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## **ABSTRACT**

Peri-implantitis is an infectious disease and one of the treatment methods involves surgical debridement of the infected area. The aim of this pilot study was to investigate treatment outcome after surgical treatment of peri-implantitis in humans. Outcome measures were reduction in pocket probing depth (PPD) and bleeding on probing and/or suppuration (BOP/Sup). Eight patients, with a total amount of 28 implants, who were diagnosed with peri-implantitis were surgically treated with a non regenerative surgical method including debridement and removal of granulation tissue combined with osteoplasty. Oral hygiene instructions were given and after 6 to 18 months a clinical re-examination was performed by two dental students at Umeå University. PPD and BOP/Sup data at the re-examination were retrospectively compared to baseline data.

The results of the study showed a reduction in mean PPD and BOP/Sup after surgery at patient level. A significant reduction in mean PPD was shown ( $p < 0.05$ ), while the reduction in BOP/Sup was not significant. At patient level, the mean reduction in mean PPD was 1.6 mm and in BOP/Sup 26%. Results varied among patients, suggesting that treatment outcome is influenced by several different factors. Tendencies that risk factors such as smoking and poor oral hygiene may have affected the treatment result were noted. In conclusion, our study shows that surgical therapy may be a beneficial treatment method for peri-implantitis in terms of reduction of PPD and BOP/Sup.

## **INTRODUCTION**

Periodontal disease is a common infectious disease, which causes an inflammatory response in the tooth surrounding tissues, which leads to loss of tooth supporting connective tissue and bone. The ultimate consequence of severe periodontal disease can be tooth loss. Implant therapy is sometimes indicated as a treatment of tooth loss. In analogy with inflammation in the gingiva, inflammation surrounding implants can be seen as redness and swelling of the peri-implant mucosa. Bleeding on probing (BOP) surrounding an implant, without loss of implant supporting bone, is diagnosed as peri-implant mucositis (Lindhe *et al.*, 2008, Lindhe and Meyle, 2008), which corresponds to the diagnosis of gingivitis surrounding teeth. If loss of implant supporting bone is present, a more serious form of peri-implant disease is seen, which is called peri-implantitis. The term peri-implantitis was first introduced in 1987 and was then described as a site-specific infection in which microbial pathogens may play an important role (Mombelli *et al.*, 1987). However, the definition has been redefined several times since then. The current definition of peri-implantitis states that it is an infectious disease, which is characterized by mucosal inflammatory lesions combined with loss of the implant supporting bone. Suppuration and deepening of peri-implant pockets are common clinical findings in peri-implant lesions (Lindhe and Meyle, 2008).

### **Prevalence**

The prevalence of peri-implant disease is still a debated topic. A recently published systematic review suggested a prevalence of peri-implant mucositis in 63.4% of individuals and 30.7% of implants. The prevalence of peri-implantitis was estimated to 18.8% of individuals and 9.6% of implants (Atieh *et al.*, 2012). Other studies have shown higher prevalence of peri-implantitis (Romanos and Weitz, 2012). However, the definition of peri-implantitis varies in different studies and that is one explanation to the varying prevalence reported.

### **Risk factors**

Patients with poor oral hygiene have shown greater marginal bone loss around implants than patients with good oral hygiene (Lindquist *et al.*, 1997) and the association between plaque index scores (PI) and peri-implant disease appears to be dose dependent (Ferriera *et al.*, 2006). Furthermore, peri-implantitis is more often found at implant sites where access to oral hygiene is limited (Serino and Ström, 2009). Plaque accumulation

evokes an inflammatory response in the tissues surrounding the implant and as maintaining a healthy peri-implant mucosa is a key factor for long-term success (Esposito *et al.*, 2012), plaque accumulation should be avoided.

It has been demonstrated that patients with poor oral hygiene who are smokers show about three times greater bone loss than patients without smoking habits. The effect of smoking in combination with poor oral hygiene on bone loss was studied over time in partially edentulous patients, who received mandibular implants. Smoking is associated to more pronounced marginal bone loss around implants (Lindqvist *et al.*, 1997) and has also been shown to be significantly associated with both peri-implant mucositis and peri-implantitis (Roos-Jansåker *et al.*, 2006). A negative effect on implant survival by smoking has also been demonstrated (Stoker *et al.*, 2012).

Patients with a history of periodontitis have an increased risk to develop peri-implantitis. It was concluded in a systematic review that peri-implantitis was more frequently found in patients with a history of tooth loss as a result of periodontitis compared to patients without periodontitis-associated tooth loss (Schou *et al.*, 2006). Similarly, another review showed that patients with a history of periodontitis had greater PPD, peri-implant marginal bone loss and incidence of peri-implantitis compared to individuals without a history of periodontitis. However, there were no differences in short- or long-term implant survival between the patient groups (Karoussis *et al.*, 2007).

## **Treatment**

There are different treatment regimens for peri-implant diseases, two common treatment methods are non-surgical debridement and surgical treatment. Surgical treatment can be combined with different bone regenerative procedures, such as autologous or allogenic bone grafts (Esposito *et al.*, 2012) and enamel matrix derivative (Froum *et al.*, 2012). There are also bone graft substitute materials such as nanocrystalline hydroxyapatite (Schwarz *et al.*, 2006). In addition to bone grafts, resorable and non-resorable membranes can be used (Khoury and Buchmann, 2001).

Non-surgical treatment includes mechanical debridement and cleaning of implant surfaces. It is performed by dentists or dental hygienists, often as a supportive therapy.

As treatment of peri-implant mucositis non-surgical therapy can be effective (Renvert *et al.*, 2008), but for peri-implantitis non-surgical treatment has not been found to be efficient (Karring *et al.*, 2005). According to a recent consensus report the current evidence suggests that non-surgical therapy is considered unpredictable (Lindhe and Meyle, 2008).

Surgical treatment of peri-implantitis involves flap surgery undertaken to reach access to the infected area and enable debridement, mechanical cleaning of the implant and removal of granulation tissue. Alveolar bone can be removed in order to recreate a physiological shape of the bone, so called osteoplasty (Lindhe *et al.*, 2008). Guided tissue regeneration (GTR) is performed by using barrier membranes (Claffey *et al.*, 2008). The membrane is used to prevent connective tissue from growing into the bone defect. It is also used for stabilization of the blood clot and to create a space around the defect to promote bone regeneration (Nguyen- Hieu *et al.*, 2012). Hydroxyapatite can be added and is claimed to promote bone healing through osteoconduction (Lindhe *et al.*, 2008). In addition to surgical treatment, bone grafts are used as an osteoconductive scaffold in order to promote bone regeneration (Shou *et al.*, 2004). Enamel matrix derivative (EMD) is also used to improve bone and tissue regeneration through several cellular mechanisms (Qu *et al.*, 2011). Additionally, different strategies for cleaning the implant surfaces at surgery are used, one example being the use of hydrogen peroxide as a cleaning agent (Leonhardt *et al.*, 2003).

### **Outcome of surgical treatment**

There is a lack of reliable evidence regarding which strategy is the most effective in treatment of peri-implantitis. There are no randomized controlled studies comparing non-surgical mechanical treatment to surgical treatment of peri-implantitis (Esposito *et al.*, 2012). The evidence regarding the outcome of surgical treatment of peri-implantitis is also very limited (Graziani *et al.*, 2012). However one study showed that healing, described as arrested progression in bone loss or gain of bone registered in radiographic examinations, occurred in 58% of the implants five years after surgical treatment of peri-implantitis in combination with systemic antibiotics and cleaning of implant surfaces with 10 % hydrogen peroxide. In this study, peri-implantitis was defined as bone loss of more than 3 threads compared to radiographs at baseline one year after implant installation. All patients in this study had earlier been treated for periodontitis

(Leonhardt *et al.*, 2003).

There is no current evidence suggesting that regenerative procedures give additional beneficial effects on treatment outcome after surgical treatment of peri-implantitis (Lindhe and Meyle, 2008). In one study, peri-implantitis was surgically treated in combination with nanocrystalline hydroxyapatite and was compared to control sites, which were surgically treated with bovine bone xenografts in combination with bioresorbable membranes. Patients with PPD >6 mm and radiographic bone defects >3 mm were included. Six months after surgery, the result showed a similar mean reduction in both PPD and BOP in both groups. Additionally, there was a gain in clinical attachment level for both groups after treatment (Schwarz *et al.*, 2006).

### **Aim of the study**

The aim of the study was to summarize the outcome of surgical treatment of peri-implantitis in terms of reduction in BOP and PPD and to evaluate the influence of different clinical factors on the healing process. Our general hypothesis was that surgical treatment leads to a reduction in BOP as well as a reduction in PPD and that oral hygiene and the access to clean the implant is of great importance to achieve healing.

## **MATERIALS AND METHODS**

Consecutive patients scheduled for re-examination 6-18 months after surgical treatment of peri-implantitis at the Department of Periodontology, Umeå University and Norrlands universitetssjukhus in year 2012-2013 were enrolled in the study.

### **Patient sample**

No exclusion criteria were set and therefore all of the examined patients were included in the study. The number of patients included was eight, of which six were men and two were women. The age of the patients examined varied from 60 to 80 years and the average age was 70 years. All patients enrolled had been diagnosed with peri-implantitis prior to surgery. Peri-implantitis was defined as radiographic marginal bone loss around implants, when compared to baseline radiographs one year after implant placement, in combination with presence of bleeding on probing and/or suppuration (Lindhe and

Meyle, 2008). Implants diagnosed with peri-implantitis and surgically treated for peri-implantitis were included in the study. The number of included implants per patient varied from one to seven and the total amount of implants included in the study were 28. No radiographic examination was performed at the re-examination. At the baseline examination prior to surgery, three patients were identified as smokers. The daily cigarette amount ranged from 5-12. The patient sample is described in Table 1.

## **Ethics**

The ethics Forum at the Department of Odontology in Umeå finds that appropriate ethics consideration have been integrated into this degree-project. Information was given before the re-examination and written consent was obtained from all patients enrolled. The patients were informed that their clinical data would be analyzed and presented as a written report. One ethical consideration of the study was the management of oral treatment needs, which may be registered during the examination. If treatment needs were noted at the re-examination patients were referred to a specialist or to their dentist for treatment. Another ethical dilemma was patient confidentiality. All operators were bound to secrecy and all personal data was decoded in the report. All data was stored locked at the Department of Periodontology.

## **Surgical procedure**

At baseline, the following parameters had been registered: PPD, BOP/Sup and radiographic signs of bone loss. In some cases PI had been registered. Anamnestic information regarding medical history and smoking habits was collected. All baseline examinations were performed by senior consultants in periodontology at the Department of Periodontology, Umeå University and Norrlands universitetsjukhus. After baseline examination and subsequent diagnosis of peri-implantitis oral hygiene instructions were given, the supraconstructions were removed and surgical treatment of peri-implantitis was performed. A non-regenerative surgical method was used including debridement, removal of granulation tissue and cleaning of implant surfaces by flossing with gauge and sodium chloride. Osteoplasty was performed on all patients. No antibiotics were administered.

After surgery, flaps were sutured and supraconstructions replaced. The patients were instructed to rinse with an antibacterial mouth-rinse, chlorhexidine (GUM Paroex, Sunstar, Etoy, Schweiz), twice a day for 2-4 weeks. Sutures were removed after 7-10 days. After four weeks a follow-up control was performed and oral hygiene instructions were given. After six months a clinical re-examination was performed by two dental students of Umeå University during their seventh and eight semester. Examination was checked by a senior consultant in periodontology. In some cases the re-examinations were performed after more than six months after surgical treatment, at most 18 months after surgery. In addition to the clinical examination, anamnestic information regarding oral hygiene routines, smoking and general health was collected and patients were given oral hygiene re-instructions.

### **Clinical examination**

The following clinical parameters were recorded:

- PPD was measured to the closest full millimetre with a manual periodontal probe (Hu-Friedy PCP-11, Hu-Friedy Mfg. Co., Chicago, USA) at four sites per implant; mesial, distal, buccal and lingual. Values  $\geq 3$  mm were registered.
- BOP or Sup from the bottom of the pocket was registered 30 seconds after probing with a force of 0.25 N (Schwarz *et al.*, 2011, Lang *et al.*, 1991). Non-bleeding sites were registered as zero (0) and bleeding sites were registered as one (1).
- Full-mouth PI was measured according to the Lenox-Kopzyk index. The presence of plaque was registered on four sites of all implants; mesial, distal, buccal and lingual, and presented as a percentage. Plaque was visually registered on the implant using a colour solution (Rondell Röd, Nordenta AB, Enköping, Sweden) and at the gingival margin by scraping with a periodontal probe (Hu-Friedy PCP-11, Hu-Friedy Mfg.Co. Chicago, USA).
- Hygienic accessibility around implants was determined by examining the patient's ability to reach all sites of the implant with an interdental brush sized 1.1 mm. The implants were then registered as accessible (1) or not accessible (0).

## **Statistical method**

Outcome measures were reduction in PPD and BOP/Sup. Clinical recordings were made at site level and from these data standard deviations were calculated as standard deviations could not be calculated on subject level in patients with only one implant. From values at site level mean values per subject were calculated. Results in figures show means at subject level. Statistical analyses were performed at subject level using the non-parametric Wilcoxon Signed Rank test for related samples by the use of the SPSS software program (SPSS Inc., Chicago, USA). Statistically significant differences were noted at  $p$ -values  $\leq 0.05$ .

## **Information sources**

The electronic database PubMed was used for article search. A combination of MeSH terms and free text words were used. Examples of searching terms used were "peri-implantitis prevalence", "peri-implantitis epidemiology" and "peri-implantitis definition". Additionally, hand search was made in the textbook Clinical Periodontology and Implant Dentistry (Lindhe *et al.*, 2008).

## **RESULTS**

A number of eight patients were included in the study. No implants were lost during the follow-up time. The post-operative healing period elapsed uneventful in all patients included and no major complications occurred. All patients who were smoking at baseline, patient number 3, 5, and 7, were still smoking at the re-examination. Distributions of subject characteristics are shown in Table 1.

Only one of the 28 implants studied was considered to lack accessibility to oral hygiene at the re-examination. Oral hygiene routines as well as hygienic standard varied among patients and PI at the re-examination varied from 3- 75%. However, PI had not been registered in all patients at baseline, why a comparison of PI at baseline and re-examination could not be made. All patients except one used interdental brushes. In general, a tendency to use smaller interdental brush sizes than 11 mm was noted among

the patients studied.

Table 2 summarizes clinical data at baseline and at the re-examination at site level. BOP/Sup, PPD and standard deviations are shown. A general reduction in both BOP and PPD was seen at the re-examination. The reduction in BOP/Sup was not significant ( $p= 0.13$ ) (Figure 1). A reduction in mean BOP/Sup of 26% was seen at patient level. However, a significant reduction in mean PPD was found at patient level ( $p = 0.03$ ), as shown in Figure 2. The mean reduction in mean PPD at patient level was 1.6 mm.

## DISCUSSION

The aim of this study was to investigate the treatment outcome after surgical treatment of peri-implantitis and the results indicate that surgical treatment can be beneficial, since a reduction in both BOP/Sup and PPD was shown. The results varied among patients, indicating that treatment outcome is influenced by several factors.

In one study where bone regenerative methods were used, a reduction in both PPD and BOP/Sup was demonstrated six months after surgical treatment of peri-implantitis (Schwarz *et al.*, 2006). Another study by Schwarz *et al.* (2011) showed a mean reduction in PPD of 1.7 mm at patient level six months after surgical debridement with laser device and mean BOP was reduced with 55%. For surgical debridement with plastic curettes the mean PPD reduction after six months was 2.4 mm at patient level and the mean BOP was reduced with 48%. It was noted that some bleeding sites persisted in both test groups after treatment. These results are quite in analogy with the results of our study where mean reduction of PPD was 1.6 mm and mean BOP was reduced with 26% at patient level. This indicates a beneficial effect of surgery. In the study by Schwarz *et al.* (2011) however, regenerative methods were used. Although reductions in PPD and BOP are seen in some studies using regenerative methods, there is no evidence supporting an additional effect of regenerative treatment protocols on the outcome of surgical treatment of peri-implantitis (Lindhe and Meyle, 2008).

Already three months after surgical therapy a reduction in PPD and BOP/Sup was seen in a study evaluating non-regenerative surgical treatment combined with systemic antibiotics (Heitz-Mayfield *et al.*, 2012). Additionally, in another study a reduction in BOP/Sup was shown at one and five years after surgical therapy combined with

systemic antibiotics, suggesting a beneficial effect of surgical treatment. In this study PPD was not measured (Leonhardt *et al.*, 2003). There is no consensus that the use of systemic antibiotics in surgical therapy is beneficial (Lindhe and Meyle, 2008).

For all periodontal diseases oral hygiene is essential for the healing process. Plaque accumulation is related to the inflammatory process surrounding an implant and treatment should include plaque removal (Lindhe and Meyle, 2008). Adequate oral hygiene is important to establish periodontal stability after treatment and it is of great importance that patients receive proper individual oral hygiene instructions. In our study, plaque index scores at the re-examination varied among the patients. One patient, subject number one, showed an initial PI of 17 % at baseline and a reduction in PI to 3% at the re-examination. The same patient showed a mean reduction in PPD of 1.7 mm after treatment and BOP was reduced with 32%. Oral hygiene standard may be one factor explaining successful treatment outcome in this case. In addition, this patient was not smoking.

As efficient plaque removal is essential for the treatment outcome, access to perform oral hygiene around implants becomes crucial. This factor has not been thoroughly studied. In the present study, access to oral hygiene was defined as ability for the patient to reach all sites of the implant with an 1.1 mm interdental brush. In another study, access to oral hygiene was defined as ability to brush the implant surfaces by means of oral hygiene instruments. In the latter study 53 of 58 implants with the diagnosis peri-implantitis had no hygienic access (Serino and Ström, 2009). This is not in analogy with the results of our study, where only one of the 28 implants studied was considered to lack access to oral hygiene. It has been suggested that changes in design and shape of the supraconstructions may be beneficial to healing after surgery (Serino and Turri, 2011). However, any previous adjustment to the supraconstructions before the re-examination has not been taken into account in the present study. Interestingly, a general tendency was noted that patients used smaller brush sizes, even when there was space available for larger brush sizes beneath the supraconstructions. This stresses the difficulty for the patients to properly clean the implant surfaces.

The effect of smoking on treatment outcome after surgical treatment of peri-implantitis has not been thoroughly studied. One study showed that treatment outcome after

surgical treatment of peri-implantitis was negatively influenced by smoking habits (Leonhardt *et al.*, 2003). In the present study three patients were smoking before as well as after treatment and a tendency was noted to a poorer treatment outcome in terms of PPD and BOP/Sup reduction (observational, data not shown). Residual signs of inflammation were seen around several implants in the three smoking patients at the re-examination. One of the smoking patients exhibited a plaque index score of 66% at the re-examination and exhibited persisting signs of severe inflammation as well as pathological peri-implant pockets. In a study by Lindquist *et al.* (1997) smoking patients with poor oral hygiene showed more bone loss at implants than patients with no smoking habits. Therefore, it is of great importance that smoking cessation is considered a part of the treatment plan, along with improved oral hygiene standards.

In the present study a reduction in BOP/Sup after surgical treatment of peri-implantitis was found, although not significant. The limited patient sample investigated may be one probable reason to the lack of significant effect on BOP/Sup. However, the study is a pilot study performed as a first exploratory analysis of treatment outcome at the Department of Periodontology, Umeå University and Norrlands universitetssjukhus. Small patient numbers is a common observation in this field of research. In a study by Leonhardt *et al.* (2003) treatment outcome following surgical treatment of peri-implantitis was evaluated in nine patients. Consequently, studies evaluating treatment of peri-implantitis with larger patient samples are requested.

The present study is retrospective, based on patient record data collected at the baseline examination and at the re-examination. As all retrospective studies, it is dependent on accurate registration. Several of the studies within this field show lack of description of the degree of pathology, such as marginal bone loss, and also demonstrate high risk of bias as well as short follow-up time. Results in studies regarding treatment outcome of peri-implantitis are also difficult to compare as inclusion criteria differ and treatment plans vary among caregivers. Furthermore, varying treatment methods are used simultaneously, making it difficult to determine between effective and non-useful treatment protocols (Esposito *et al.*, 2012). Many studies lack appropriate control groups since adequate control groups would request that some patients were left untreated, which is an intractable ethical dilemma.

Some error sources can be identified in the present study. Supra constructions were not removed at the re-examination, which may have resulted in incorrect PPD registration. The time for examination after surgical treatment ranged from 6-18 months. One reason for the difference in follow-up time was the long distance travel that many of the patients had to do in order to attend the re-examination. Therefore, strict conclusions regarding the outcome six months after surgical therapy is therefore not possible to draw. As plaque data at the baseline examination was not registered in all patients this parameter could not be analyzed statistically. No assessment of the marginal bone level was made at the re-examination, as standardized radiographic examinations had not been performed at baseline. A standardized examination protocol at baseline as well as standardized radiographic examinations before and after treatment would have improved the study, as would a longer follow-up time. PI should have been registered in all patients at baseline as well as at the re-examination to make a comparison possible. Additionally, information on previous history of periodontal disease would have improved the study, as it has been shown that a history of periodontitis is related to an increased risk of peri-implantitis (Karoussis *et al.*, 2003). The medical history of the patients could also have been taken into consideration.

In conclusion, this study indicates that surgical treatment of peri-implantitis can be beneficial in terms of reduction of PPD and BOP/Sup. It also clearly demonstrates the importance of consistency in patient record registrations as well as examination- and treatment regimens. This is essential if investigations are to be possible to make in retrospect and, moreover, to ensure treatment quality. Accurate long-term prospective studies of treatment of peri-implantitis are very important in order to ensure that patients receive the best treatment available.

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## TABLES

Table 1. Distribution of subject characteristics

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Number of patients	8
Number of implants	28
Men	6
Women	2
Smokers	3 (subject number 3, 5 and 7)

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Table 2. Clinical data before and after surgical treatment of peri-implantitis. Data represent min, max and standard deviation (SD) for BOP/Sup (a) and PPD in millimetres (b) at site level.

a)

Subject	Number of implants	Baseline			Re-examination		
		BOP min	BOP max	SD	BOP min	BOP max	SD
1	7	0	1	0.48	0	1	0.51
2	1	1	1	0.00	1	1	0.00
3	6	0	1	0.28	0	1	0.38
4	3	1	1	0.00	0	0	0.00
5	5	0	1	0.31	0	1	0.51
6	4	0	1	0.25	0	1	0.40
7	1	1	1	0.00	0	1	0.50
8	1	0	1	0.50	0	1	0.58

b)

Subject	Number of implants	Baseline			Re-examination		
		PPD min	PPD max	SD	PPD min	PPD max	SD
1	7	3	8	1.66	3	5	0.69
2	1	3	9	2.71	6	8	1.00
3	6	3	8	1.47	4	8	0.97
4	3	3	9	1.98	3	6	1.22
5	5	3	6	1.22	3	6	0.86
6	4	4	8	1.24	3	4	0.40
7	1	7	8	1.50	3	7	1.83
8	1	3	8	2.36	3	3	0.00

## FIGURES

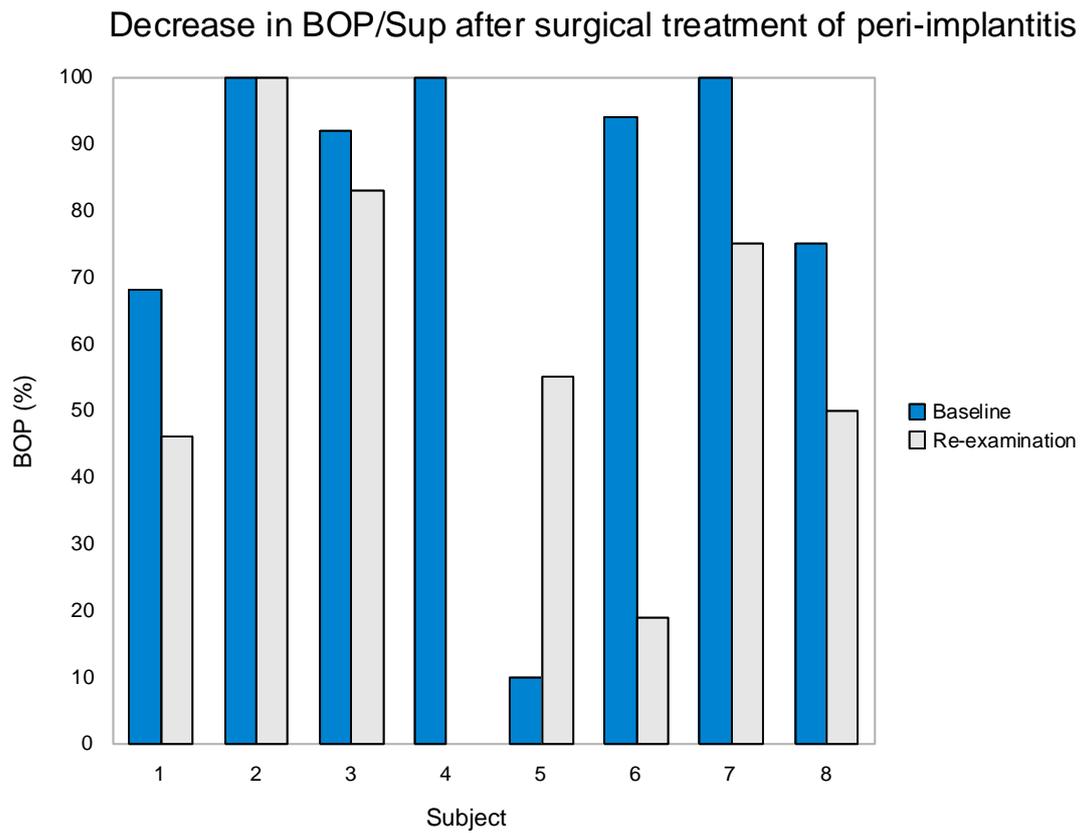


Figure 1. Data represent reduction in BOP/Sup (%) in subjects 1-8. Significant decrease in BOP/ Sup was not shown.

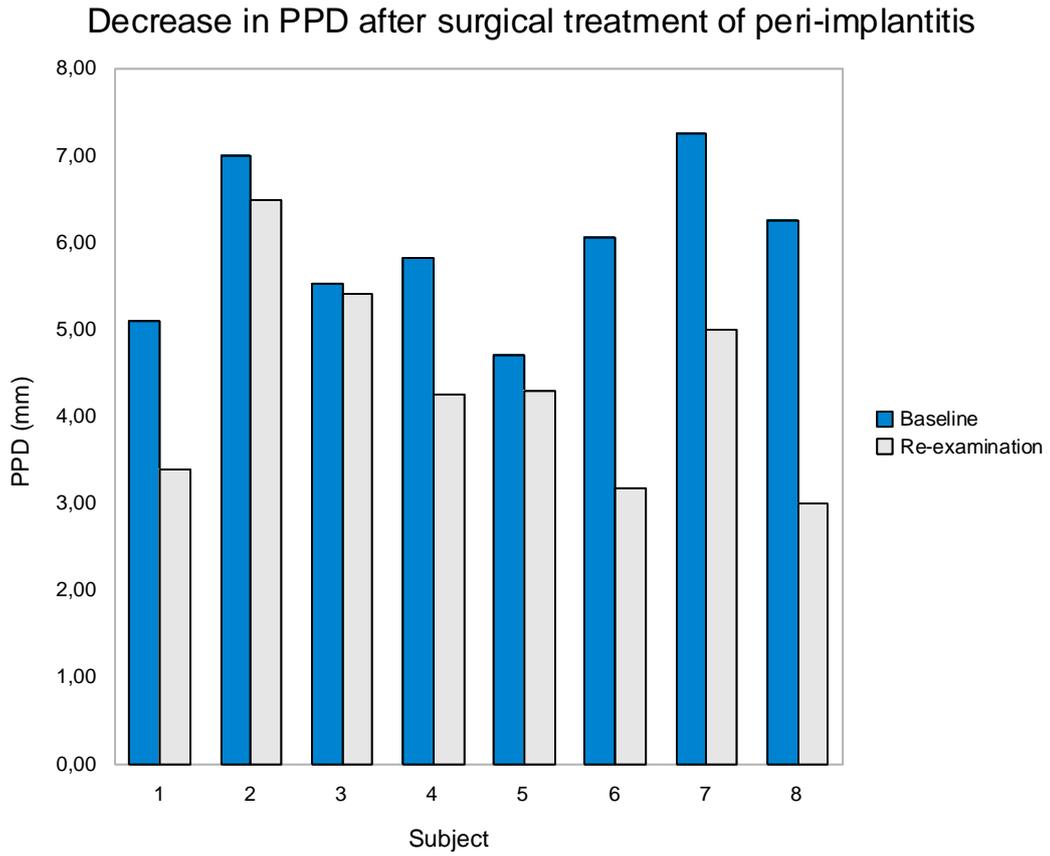


Figure 2. Data represent reduction in mean PPD (mm) in subjects 1-8. Significant decrease in PPD was shown ( $p < 0.05$ ).