Periapical radiographic evaluation of infra-bony pocket surgery outcomes using platelet-rich fibrin with and without bone grafts

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Abstract. New innovations to enhance periodontal tissue regeneration include the use of platelet-rich fibrin (PRF) and bone graft material. A clinical experimental design was used for this study. This study aimed to evaluate the differences in alveolar bone height following periodontitis therapy using PRF with and without bone grafts. Periapical radiograph evaluation before and after periodontitis therapy using PRF only compared to PRF in combination with bone graft was performed by assessing alveolar bone height. There were no significant differences in alveolar bone height following periodontitis therapy with PRF compared to treatment with PRF in combination with bone graft. Periodontitis therapy using PRF with and without bone graft yields similar results in the radiographic evaluation of alveolar bone height.

1. Introduction

Periodontitis is an inflammation of periodontal tissues characterized by apical migration of junctional epithelium, as well as loss of tooth attachment and the alveolar crest. During clinical examination, increased pocket depth, bleeding on probing, and physiologic contour changes can be observed. Hemorrhage and edema may also be found. The objectives of periodontal therapy are to eliminate the pathologic pocket wall, create a stable and maintainable condition, and increase the regeneration of periodontal tissue such as alveolar bone, cementum, and the periodontal ligament. Three factors related to the treatment result that must be taken into consideration for periodontal healing are regeneration, repair, and new attachment [1].

One of the techniques used to achieve bone regeneration over the past 30 years is bone graft or the use of substitute bone to repair bone damage [2]. Alternative treatments have been developed focusing on peptide, protein, and growth factor (GF) use, such as the use of enamel matrix derivatives (EMDs) and platelet-rich plasma (PRP). Other methods use growth differentiation factors such as bone morphogenic protein. The first PRP application was described by Whitman et al. in 1997, and PRP has since been widely adopted, especially in periodontology, for the regeneration of tissue in alveolar bone defects [3].
The advantages of PRP are quick bone regeneration along with the release of growth factors from human platelets. However, PRP has some disadvantages such as difficulties with clinical application because growth factors will likely be washed away during the separation phase of surgery in conventional PRP. Due to the difficulties of applying PRP, the use of platelet-rich fibrin (PRF) was introduced [4,5]. PRF application is easy and the technique was developed by Dohan et al. in France. PRF is the second generation of platelets intended to obtain fibrin in which rich with platelet and growth factor, also independent of anticoagulant. PRF looks like fibrin tissue [6]. Radiographic imaging plays a substantial role in the evaluation of periodontal tissue. Intraoral radiography in dentistry can be performed using conventional and digital methods. One way to diagnose periodontal disease is to evaluate alveolar bone height on radiographic images [7]. Matteson (1996) stated that loss of alveolar bone height was one of the indicators of periodontal tissue damage [8].

The angle between the root surface and the bone wall in infra-bony defects is one of the factors that affect the healing process. According to Lang, bone growth occurs if the defect angle in radiographic images is ≤45°, but changes in the bone and bone loss are unlikely if the angle is larger [9]. Stevenson and Weber (1989) reported that bone growth potency was greater with small defect angles (0°–45°) than with larger angles (45°–90°) [10].

Periodontal surgery therapy for infra-bony bone defects using PRF has yet to be performed at the Teaching Dental Hospital Faculty of Dentistry, Universitas Indonesia. The success of periodontal therapy can be evaluated using periapical radiographic imaging. However, there are no reports on this topic to date. Therefore, in this study, periapical radiographic imaging was used to evaluate the outcomes of surgical treatment of infra-bony pockets with defect angles of 30°–60°. The patients were treated using PRF and PRF in combination with bone grafts.

2. Methods

This was an experimental study in which periodontal flap surgery using PRF or a combination of PRF and bone graft was performed for the treatment of chronic periodontitis with a pocket depth >5 mm. Subjects were selected using consecutive sampling. All subjects who satisfied the criteria were included until the required number of subjects (n = 9) was reached. Measurements were obtained from periapical radiographic images at the Periodontology Department in the Teaching Dental Hospital, Faculty of Dentistry, Universitas Indonesia, using a parallel technique with a millimeter grid. The inclusion criteria were healthy and have premolars and molars [11].

The plaque index, calculus index, oral hygiene index, and pocket depth were determined before surgery using periapical radiographic images. The bone height and the magnitude of the infra-bony defects were measured on periapical radiographic images using a millimeter grid and arc with a radiographic viewer. The surgical procedure was performed with PRF or a combination of PRF and bone graft. Bone height was measured again using radiographic images obtained 3 and 6 months after surgery, and the differences were calculated. Increased alveolar bone height was assumed to indicate periodontal regeneration.

Measurement was performed from the CEJ toward the interproximal alveolar crest. Alveolar crest bone was determined from the point where the periodontal ligament space ended on the root surface. The magnitude of the defect angle (B1D1A1) was then measured, specifically, the angle between the root surface and the infra-bony bone wall defect on radiographic images using Tsitoura’s method (2004) (Figure 1):
A1: CEJ of infra-bony defect tooth
B1: Alveolar crest bone
D1: Defect base

If tooth restoration had been performed, the apical margin of the restoration could be used as the CEJ.

Periapical radiographic imaging was conducted before and after periodontal surgery. The images were used for bone height examination before and after surgery. The data were analyzed using the unpaired T-test, Wilcoxon test, and Shapiro–Wilk test.

3. Results
3.1. Univariate Analysis

Table 1. Age and gender demographic data distribution of research subjects.

| Variable      | N  | Percentage | Cumulative |
|---------------|----|------------|------------|
| Age in years  |    |            |            |
| 30–40         | 1  | 11.11      | 11.11      |
| 40–50         | 6  | 66.67      | 77.78      |
| 50–60         | 2  | 22.22      | 100.00     |
| Gender        | 9  |            |            |
| Male          | 4  | 44.44      | 44.44      |
| Female        | 5  | 55.56      | 100.00     |

Table 1 shows the variables used for univariate analysis. Among the nine patients evaluated, one was 30–40 years of age (11.11%), six were 40–50 years of age (66.67%), and two were 50–60 years of age (22.22%). The subjects consisted of four men (44.44%) and five women (55.56%).
3.2. Bivariate Analysis

Table 2. Healing outcomes for platelet-rich fibrin and combination of platelet-rich fibrin and bone graft treatment according to examination time.

| PRF + BG and PRF Treatment | N  | p value |
|-----------------------------|----|---------|
| 3d-1d Down                  | 12 | 0.002   |
| Up                          | 0  |         |
| Stable                      | 2  |         |
| 6d-1d Down                  | 13 | 0.001   |
| Up                          | 0  |         |
| Stable                      | 1  |         |
| 6d-3d Down                  | 7  | 0.132   |
| Up                          | 1  |         |
| Stable                      | 6  |         |
| 3m-1m Down                  | 14 | 0.001   |
| Up                          | 0  |         |
| Stable                      | 0  |         |
| 6m-1m Down                  | 14 | 0.001   |
| Up                          | 0  |         |
| Stable                      | 0  |         |
| 6m-3m Down                  | 5  | 0.065   |
| Up                          | 3  |         |
| Stable                      | 6  |         |

Wilcoxon test; p < 0.05: statistically different; 1/3/6: examination time (months); m/d: mesial or distal aspect.

Based on the Wilcoxon test results shown in Table 2, following treatment using PRF and a combination of PRF and bone graft, there were statistically significant differences 3 and 6 months after treatment.

Table 3. Differences in platelet-rich fibrin and bone graft treatment according to defect angle.

| PRF + BG | Angle | N  | Mean ± SD (mm) | Levene’s Test | p Value |
|----------|-------|----|----------------|---------------|---------|
| 1m       | ≤ 45° | 5  | 8.60 ± 2.191   | 0.202         | 0.009*  |
|          | > 45° | 2  | 4.00 ± 0.000   |               |         |
| 3m       | ≤ 45° | 5  | 5.40 ± 1.673   | 0.283         | 0.026*  |
|          | > 45° | 2  | 2.50 ± 0.707   |               |         |
| 6m       | ≤ 45° | 5  | 4.80 ± 1.483   | 0.469         | 0.047*  |
|          | > 45° | 2  | 2.50 ± 0.707   |               |         |
| 1d       | ≤ 45° | 5  | 8.00 ± 2.915   | 0.736         | 0.054*  |
|          | > 45° | 2  | 1.50 ± 1.212   |               |         |
Based on the unpaired T-test results shown in Table 3, treatment using PRF and bone graft showed statistical differences in the mesial aspect by the third and sixth month if the defect angle was \( \leq 45^\circ \). However, the difference in the distal aspect was not statistically significant. The increase in bone height was greater when the defect angle was \( \leq 45^\circ \) than when the angle was \( >45^\circ \).

**4. Discussion**

The youngest subject in this study was in the 30- to 40-year-old age range \( (n = 1, 11.11\%) \), and most subjects were 40–50 years of age \( (n = 6, 66.67\%) \). Therefore, the subjects were all mature with balanced resorption and bone formation and stable bone mass. This was important for the investigation of alveolar
bone height, which was the objective of this study. Based on radiographs, the alveolar crest was generally 1–1.5 mm beneath the CEJ [12,13,14].

Table 2 shows that the alveolar bone increased in length three and six months after treatment with both PRF alone and a combination of PRF and bone graft. The difference between the outcomes of the two therapies was not significant. This was attributed to the lack of a control group and the small number of samples.

The results of this study contradict those obtained by Marx et al., who reported that the combination of PRF and bone graft gave better results than PRF alone because of advantages in wound healing, bone growth and maturation, graft stabilization, hemostasis, and stabilized graft material [15].

The unpaired T-test results in Tables 3 and 4 also show that treatment using both PRF alone and a combination of PRF and bone graft showed significant differences in the third and sixth month in the mesial aspect, but not the distal aspect (p < 0.05). Significant bone growth occurred in the distal direction before and after flap surgery with both therapies. This finding was consistent with the results obtained by Tsitoura et al. (2004), who stated that bone growth in defects with small angles (0°–45°) is more potent than that in defects with large angles (45°–90°) [10]. The results confirmed that wide and narrow defects have different healing capabilities. Healing would be more difficult in wide defects due to the greater tissue loss. Additionally, only the superficial part of a wide defect is exposed to the oral cavity environment [16], which can lead to bacterial contamination and mastication-induced trauma, as well as oral hygiene procedure [10].

Although this study was carefully designed and conducted, there were still some limitations. These include the lack of a stringent selection process for the subjects, limitations in radiographic quality as the images were processed manually, and the limits of individual interpretation with regard to detecting small changes in alveolar bone on conventional intraoral radiographs [17].

To limit the potential for bias, result interpretation was performed by two examiners in the morning with a one-day interval between examinations to avoid eye tiredness and ensure objectivity. The limitations of conventional radiographs include the dependence of radiographic interpretation on human vision and the image quality. The limited human eyes can only differentiate up to 40 gray scales and cannot perform precise radiographic measurements and visualization [11].

Evaluations in this study were performed using conventional radiographic imaging with a two-dimensional aspect. Therefore, the bone growth could only be visualized in two dimensions. The study was conducted qualitatively and quantitatively based on conventional radiographic imaging, but surgical re-entry would be necessary to ensure definite bone growth for a more accurate result [18].

5. Conclusion
A significant bone height increase was observed in radiographic images 3 and 6 months after treatment using PRF and a combination of PRF and bone graft. However, the difference between the two treatments was not statistically significant. The increase in alveolar bone height for defects with angles ≤45° was better than that for defects with angles >45° after flap surgery treatment using PRF and a combination of PRF and bone graft.

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