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Original Article

Effects of platelet-rich fibrin combined with guided bone regeneration in the reconstruction of peri-implantitis bone defect

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Abstract: Objective: To investigate the clinical effect of platelet-rich fibrin (PRF) combined with guided bone regeneration (GBR) in the reconstruction of peri-implantitis bone defect. Methods: This prospective study included 80 patients with peri-implantitis who underwent implant restoration in the Department of Stomatology in our hospital. The eligible patients were randomly divided into control group and observation group, with 40 cases in each group. Patients in the control group were treated with flap curettage combined with GBR, while those in the observation group received a mixture of PRF and bone powder implanted with GBR and covered with PRF biofilm. The differences of pain 24 hours after surgery, bleeding at 7 days after surgery, and the degree of bone defect between the two groups at 60 days after surgery were compared. At 60 days and 120 days after surgery, separately, the regenerated bone density of patients in the two groups was measured, analyzed and compared. The degree of regenerated bone defect in transverse and longitudinal directions after 60 days was compared between the two reconstruction procedures. Results: The pain at 24 hours after surgery and the bleeding at 7 days after surgery in the observation group were milder than those in the control group ($P<0.001$). There was significant difference in the degrees of bone defect at 60 days after surgery ($P<0.05$). Compared with the control group, the regenerated bone density of the observation group was significantly higher both at 60 days and 120 days after surgery ($P<0.001$). Conclusion: The combination of PRF and GBR technology has an obvious effect in repairing bone defects in patients with peri-implantitis, and can reduce the pain of patients during the repair process.

Keywords: Platelet-rich fibrin, guided bone regeneration, reconstruction of bone defect, peri-implantitis

Introduction

With the development of society and the improvement of living standards, more and more oral cavity problems occur in people. The number of patients with tooth loss and injury is also increasing year by year. Therefore, dental implant has attracted more and more attention [1-3]. Peri-implantitis is mainly caused by the progressive bone loss around the implant denture. It is also a big problem that should be dealt with during dental implant. Restoration of dental implant and reconstruction of bone defect caused by peri-implantitis have become the radical treatment for peri-implantitis [4-6].

Platelet-rich fibrin (PRF), was derived from platelet-rich plasma (PRP) and created by French physician Choukroun in 2001 [7-10]. In order to explore the effect of PRF in the reconstruction of implant bone defect, this study explored the role of PRF combined with GBR in the reconstruction of peri-implantitis bone defect.

Materials and methods

Patient information

In this study, 80 patients with peri-implantitis who underwent implant restoration in the Department of Stomatology in our hospital were selected. The general information of the patients were collected after coming to our hospital, including their age, gender, medical history and basic conditions. According to the patient's condition, those who complied with

the principle of inclusion, were randomly divided into control group and observation group, with 40 cases in each group in accordance with the random number table. Patients in the control group were treated with flap curettage, while those in the observation group were implanted with a mixture of PRF and bone powder and covered with PRF biofilm. All participants signed informed consents. The study was approved by the Academic Ethics Committee of the hospital.

Inclusion and exclusion standards

Inclusion criteria: (1) The diagnosis of peri-implantitis met the general diagnostic criteria [11]; (2) There were indications of dental implants (single) and the peripheral bone loss was ≥4 mm.

Exclusion criteria: (1) Those who could not bear implant surgery due to serious systemic diseases [12]; (2) Patients with severe diabetes and poorly controlled blood glucose; (3) Patients with bone diseases such as osteoporosis; (4) Patients with cardiopulmonary insufficiency, diabetes or other vital organ diseases; (5) Patients with mental illness.

Preparation of PRF

The process was as follows: 20 mL of venous blood was collected [13]. The venous blood was centrifuged at 3,200 rpm/12 min by TD-4M Desktop low-speed centrifuge (Shandong Biobase Scientific Instrument Co., Ltd.). After centrifugation, platelet-depleted plasma (PPP) was in the top layer, PRF was in the middle layer, and red blood cell was in the sublayer. PPP in the top layer was mixed up with bone powder FDBA (Haiao prosthodontics bone powder, XCT005149), which was used to fill up the defect area. The PRF in the middle layer was directly filled in the wound, or mixed up with bone powder FDBA, or compressed as a regenerative membrane.

Surgical procedure

Preoperative computerized tomography (CT) examination was performed to determine the patient's condition and confirm the inflammatory bone condition after implantation [14]. The patient's gingivitis was controlled before surgery. The main approach was as follows: The affected area was flushed, and local anti-swelling and anti-inflammatory adjuvant antibiotics (Clindamycin phosphate, HYB1064-2, Hangzhou Haoxin Biotechnology Co., Ltd.) were administered for 3-5 days. Patients in the control group was treated with flap curettage. The granulation tissue on the surface of alveolar bone and implant was removed. After repeated rinsing with gentamicin solution (Beijing Yita Biotechnology Co., Ltd., SY0024) and normal saline, tight suture was performed. Infected part of patients in the observation group were treated with flap curettage and filled up with a mixture of PRF and bone powder, then it was covered with PRF biofilm and sutured.

Outcome evaluation

Comparison of pain 24 hours after surgery: Patient's pain was assessed 24 hours after treatment, and was classified into four levels according to their pain levels: I painless [15]; II mild pain, tolerable without medication; III moderate pain, tolerable, persistent, affecting sleep and requiring medication to reduce it; IV severe pain, intolerable, could only be improved with medication. The pain level was statistically analyzed.

Periodontal index measurement 7 days after surgery: Peri-implant sulcular fluid (PISF), modified plaque index (mPLI), modified sulcular bleeding index (mSBI) and periodontal probe depth (PPD) were measured and analyzed [16].

Comparison of postoperative regenerated bone density: Micro-CT was used to perform CT scans on the repaired part of inflammatory bone defect after dental implantation in the two groups at Day 60 and Day 120. The bone defect area was selected as the region of interest (ROI) area to determine the defect depth of teeth and the regenerated bone density [17].

Statistical analysis

All data were compared and analyzed with SPSS 22.0. The measurement data conformed to the normal distribution were expressed as the mean ± standard deviation ($\bar{x} \pm sd$), and independent-samples t-test was used for comparison between groups. The count data were expressed as the number of cases (percentage) [n (%)], and chi-square (χ^2) test was ap-

Table 1. Patient information before surgery

Items	Observation group	Control group	t/χ^2	P
Gender (n)			0.220	0.639
Male	27	25		
Female	13	15		
Age (years old)	38.9±6.2	35.4±10.8	1.780	0.079
Marital status (n)			1.593	0.451
Married	32	30		
Unmarried	7	10		
Divorced or widowed	1	0		
Bone defect (mm)				
DD value	3.93±1.57	3.97±1.46	0.118	0.906
DW value	4.73±1.03	4.97±1.21	0.955	0.342
Bleeding on probing	2.88±0.32	2.97±0.36	1.182	0.241
Periodontal probe depth	5.43±0.23	5.38±0.38	0.711	0.478

Note: DD: defect depth; DW: defect width.

Table 2. Pain questionnaire 24 hours after surgery (n)

Grouping	Control group	Observation group
I	11	26
II	24	14
III	5	0
IV	0	0
Z	3.621	
P	<0.001	

plied. In addition, Z-test was conducted on the frequency of pain levels in the two groups for the difference of the two independent samples. The sample sizes in the two groups were both more than 30, the probability of difference was inferred based on standard normal distribution, so as to compare whether the differences between the two groups. P<0.05 was considered statistically significant.

Results

Patient information

Patients were evaluated for the following data before surgery. The results indicated that there was no significant difference between the two groups in age, gender, bone defect before surgery, bleeding on probing and periodontal probe depth (P>0.05), see **Table 1**.

Comparison of pain 24 hours after surgery

The pain levels of the two groups 24 hours after surgery were classified and collected. Through the comparison of the two groups, it can be seen that there were 26 patients with type I pain in the observation group while only 11 patients in the control group. There was a significant difference in pain levels in the two groups by frequency analysis (P<0.001). The pain levels in the observation group were milder than those in the control group, see **Table 2**.

Periodontal index measurement 7 days after surgery

The basic periodontal indexes of patients in both groups were summarized. And the four indexes expressed by $\bar{x} \pm sd$ were summarized and analyzed. The results showed that there was significant difference in the amount of PISF, mPLI, mSBI and PPD (all P<0.001), indicating that covering with PRF biofilm in the observation group after filling with a mixture of PRF and bone powder could significantly accelerate the patient's recovery, see **Table 3**.

The patient's regenerated bone density 60 days and 120 days after surgery

The results of regenerated bone density showed that there was significant difference in regenerated bone density at 60 days and 120 days after surgery (P<0.05), see **Figure 1** and **Table 4**.

Comparison and analysis of bone defect depth and defect width 60 days after surgery

Dental implants would still wear out after the reconstruction for different inflammatory bone

Table 3. Comparison of periodontal index measurement 7 days after surgery

Items	PISF (μL)	mPLI	mSBI	PPD (mm)
Control group	0.51±0.03	0.68±0.01	1.03±0.05	2.11±0.58
Observation group	0.35±0.05	0.88±0.05	0.71±0.03	1.71±0.28
t	14.103	24.812	34.714	3.926
P	<0.001	<0.001	<0.001	<0.001

Note: PISF: peri-implant sulcular fluid; mPLI: modified plaque index; mSBI: modified sulcular bleeding index; PPD: periodontal probe depth.

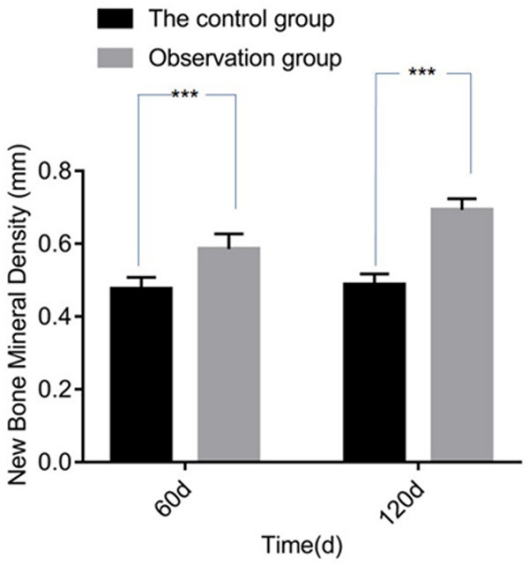

Figure 1. Comparison of regenerated bone density. Compared with control group, ***P<0.05.

defects. There was no difference between the two groups in the baseline DD and DW values (P>0.05). There was statistically significance in DD and DW values between baseline and 60 days after surgery (P<0.001). The bone defect in the observation group was significantly different from that of the control group in both defect depth and defect width (P<0.001). The results indicated that the wear of the implants after restoration was significantly reduced by using the PRF combined with GBR technology, see **Tables 5** and **6**.

Discussion

Peri-implantitis bone defect is a very common phenomenon in the process of dental implant restoration. How to reduce and eliminate this inflammation has become the research focus of many scholars in this field. Although peri-implantitis has little influence on the success rate of dental implants, it still has certain influence on the treatment and postoperative quality of life [18]. Various studies have been carried out on it, including the application of GBR technology, as well as the use of GBR combined with hyperbaric oxygen (HBO) in the reconstruction and treatment of peripheral bone defects caused by peri-implantitis [19]. However, there are relatively few studies on the treatment with PRF combined with GBR technology.

It has been reported that the growth factors in PRF play an important role in the process of wound healing [20]. At the same time, it has been shown that PRF is very suitable for being used as filling materials and base materials during sinus lifting surgery. PRF is also suitable for general dental implant surgery, which can reduce inflammation, enhance osteoblasts adhesion, induce osteocyte regeneration, improve the effect of bone grafting, accelerate the repair and regeneration of soft tissue, and help with wound healing [21].

In this study, PRF combined with GBR technology was used to reconstruct peri-implantitis bone defect. The results indicated that the pain in the observation group during the reconstruction of the peri-implantitis bone defect was less than that in the control group. In the measurement of periodontal index, it can be seen that there was significant difference in the four indexes of PISF, mPLI, mSBI and PPD, indicating that patients in the observation group had better mid-term recovery effect after repair. Meanwhile, the defect degree 60 days after repair in the observation group was relatively low, and the regenerated bone density in the later period increased significantly compared with the control group. The above results support that PRF could promote the growth of soft tissues of the mucosa in the operation area of oral cavity at all stages. PRF could relieve the pain during the surgery, have a better medium-term recovery effect, reduce the reinfection of peri-implantitis and rejection, as well as accelerate the growth of regenerated bone and increase the regenerated bone density, so as to reduce wear and tear on the patient's defect site. The results were consistent with previous report that PRF com-

Table 4. Comparison of regenerated bone density

Items	Control group	Observation group	t	P
Regenerated bone density (mm)				
60 days after surgery	0.48±0.03	0.59±0.04	11.191	<0.001
120 days after surgery	0.49±0.03	0.69±0.03	30.536	<0.001

Table 5. Comparison of bone defect depth 60 days after surgery

Items	Control group	Observation group	t	P
DD value				
Baseline	3.93±1.57	3.97±1.46	0.121	0.906
60 days after surgery	2.27±1.20	1.01±0.18	6.568	<0.001
t	5.311	12.732		
P	<0.001	<0.001		

Note: DD: defect depth.

Table 6. Comparison of bone defect width 60 days after surgery

Items	Control group	Observation group	t	P
DW value				
Baseline	4.73±1.03	4.97±1.21	0.964	0.342
60 days after surgery	3.52±1.22	1.28±0.28	11.318	<0.001
t	4.788	18.792		
P	<0.001	<0.001		

Note: DW: defect width.

bined with GBR in the reconstruction of peri-implantitis bone defect [18].

This study was conducted by patients who came to our hospital for treatment in this region. Although there were some positive results, a comprehensive clinical study on PRF is still needed in the following process of promotion and application. At the same time, this technology has been applied to periodontal bone defects, but the follow-up time of this study was still short, and its long-term treatment effect still needed to be studied in depth with a larger sample size.

Disclosure of conflict of interest

None.

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