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Original Article

Effectiveness of platelet-rich plasma on bone regeneration in oral implantology: a retrospective study

Guanghai Shang, Benhua Dai

Department of Stomatology, Yiling Hospital of Yichang (Affiliated Yiling Hospital of China Three Gorges University), Yichang 443100, Hubei, China

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Abstract: Objective: To evaluate the efficacy of platelet-rich plasma (PRP) in augmenting bone regeneration for oral implants and to assess its impact on bone regeneration parameters and complications. Methods: The clinical data of 175 patients with oral bone defects admitted to the Department of Stomatology, Yiling Hospital of Yichang from 2023 to 2025 were retrospectively collected. According to the treatment plan, patients were divided into a control group (implant bone augmentation using artificial bone powder alone, n=85) and an observation group (bone augmentation with platelet-rich plasma [PRP] in addition to the same artificial bone powder, n=90). Both groups received conventional oral implant bone treatment and were followed up for 6 months. Clinical efficacy was compared at 1 day postoperatively, and histological parameters of the implanted bone (bone tissue area, connective tissue area, residual artificial bone powder area) and bone defect regeneration parameters (bleeding index, probing depth, attachment loss, bone graft height, bone thickness) were compared at 6 months postoperatively, along with the incidence of complications within 6 months. Results: One day after operation, the overall clinical success rate in the observation group was 92.2% (83/90), significantly higher than 75.3% (64/85) in the control group (P<0.05). Histological examination at 6 months postoperatively revealed that the area of bone tissue in the observation group (3.86±0.54) mm^2 was significantly greater than that of the control group (2.91±0.48) mm^2 (P<0.05). The area of connective tissue was (1.52±0.38) mm^2 in the observation group and (1.48±0.41) mm^2 in the control group, with no significant difference between the two groups (P>0.05). The residual area of artificial bone powder was (0.35±0.12) mm^2 in the observation group and (0.38±0.14) mm^2 in the control group, with no significant difference between the two groups (P>0.05). Regarding bone defect regeneration parameters at 6 months postoperatively, the bleeding index (1.02±0.35), probing depth (2.15±0.42) mm, and attachment loss (1.08±0.31) mm in the observation group were significantly lower than those in the control group (1.58±0.44), (2.76±0.51) mm, and (1.56±0.38) mm, respectively (P<0.05). The bone graft height (4.82±0.67) mm and osteogenic thickness (3.24±0.45) mm in the observation group were higher than those in the control group (3.95±0.58) mm and (2.61±0.39) mm, respectively (P<0.05). Within 6 months postoperatively, the incidence of complications was 5.6% (5/90) in the observation group, lower than 16.5% (14/85) in the control group, with a statistically significant difference (P<0.05). Conclusion: Platelet-rich plasma effectively enhances bone regeneration in oral implantology, improving bone tissue area and bone graft-related parameters while reducing the incidence of postoperative complications. It is an effective strategy to improve the efficacy and safety of oral implant bone regeneration.

Keywords: Oral replantation, platelet rich plasma, effect study, effectiveness, complications

Introduction

It is well-established that oral bone defects are a common problem in oral implantology, and their bone regeneration outcomes directly influence the long-term stability and success rate of implants [1, 2]. Studies have confirmed that periodontal disease, trauma, tumor resection, congenital dysplasia and other factors can lead to insufficient local bone mass of teeth, thus increasing the difficulty and risk of dental implant treatment [3, 4]. Therefore, effectively promoting bone tissue regeneration in the bone defect area can improve the therapeutic effect [5].

Artificial bone powder, as a bone substitute material, is well-documented for its osteoconductive properties and biocompatibility, and is widely used in oral implant bone augmentation.

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However, the use of artificial bone powder alone still has limitations in terms of osteoinductive activity and the rate of new bone formation [6]. Platelet-rich plasma (PRP) exerts its biological effects by releasing various growth factors (such as platelet-derived growth factor, transforming growth factor-β, vascular endothelial growth factor, etc.) [7]. These growth factors act synergistically on the bone defect area to promote osteoblast proliferation, differentiation, and angiogenesis, thereby accelerating bone healing [8, 9]. Previous studies have demonstrated that PRP combined with bone substitute materials can effectively promote bone repair of jaw defects and improve bone mineral density and the quality of osseointegration [10]. However, systematic clinical evidence regarding the specific effects of PRP in oral implant bone regeneration, as well as its influence on bone tissue parameters and complications, remains limited. Based on this, this study retrospectively analyzed the clinical data of 175 patients with oral bone defects admitted to the Department of Stomatology of our hospital, and compared the application effects of artificial bone powder alone and PRP combined with artificial bone powder in oral implant bone regeneration, and evaluated its effects on bone regeneration parameters and complications, in order to provide a reference for the clinical treatment of oral implant bone regeneration.

Data and methods

General information

The clinical data of 175 patients with oral bone defects admitted to the Department of Stomatology of our hospital from January 2023 to June 2025 were retrospectively analyzed. According to different treatment schemes, they were divided into an observation group (PRP combined with artificial bone powder) and a control group (artificial bone powder alone). There were 90 cases in the observation group and 85 cases in the control group.

Inclusion criteria

1. Patients diagnosed with alveolar bone deficiency by oral cone beam CT (CBCT) and who required implant bone augmentation; 2. Age 18-70 years old, regardless of gender; 3. Patients who received oral implant bone treatment for the first time; 4. Patients receiving conventional oral implant bone augmentation therapy; 5. Complete clinical data, postoperative follow-up of 6 months.

Exclusion criteria

1. Patients with a history of oral implant failure; 2. Those suffering from serious systemic diseases (such as uncontrolled hypertension, diabetes, coagulation dysfunction, immune system diseases); patients with acute or chronic oral inflammation such as active periodontitis and oral mucosal disease; long-term use of anticoagulant drugs or immunosuppressive agents; pregnant or lactating women; patients who were allergic to platelet-rich plasma or artificial bone powder; or patients with incomplete clinical data or lost to follow-up. This retrospective study was approved by the Ethics Committee of Yiling Hospital of Yichang (Approval No. LW-2025-05-2003. The requirement for informed consent was waived due to the retrospective nature of the study, which involved no additional interventions beyond routine clinical practice, and all patient data were anonymized prior to analysis.

Treatment methods

All surgical procedures were performed by a single senior associate chief physician with over 10 years of experience in oral implantology, following a standardized operating protocol. Both groups received conventional oral implant bone treatment, and standard oral hygiene, disinfection, and local anesthesia were administered before surgery.

Materials used: The artificial bone powder was Bio-Oss® (Geistlich Pharma AG, Switzerland), a deproteinized bovine bone mineral matrix (particle size 0.25-1.0 mm). The barrier membrane was Bio-Gide® (Geistlich Pharma AG, Switzerland), a porcine-derived type I/III collagen resorbable membrane (25 × 25 mm). The implant system used was the Straumann® Bone Level Tapered Implant System (Institut Straumann AG, Switzerland), model BLT RC Ø 4.1 mm × 10 mm.

Control group: In the control group, the bone defect area was filled with an appropriate amount of artificial bone powder (Bio-Oss®), compacted, covered with a Bio-Gide® membrane, and the wound was sutured.

Observation group: In the observation group, platelet-rich plasma (PRP) was combined with the same artificial bone powder for bone augmentation. PRP preparation: 20 mL of autologous venous blood was collected preoperatively and subjected to a two-step centrifugation process (first at 2,000 rpm for 10 min, then at 3,000 rpm for 8 min) to obtain the PRP. After activation, PRP was mixed with artificial bone powder at a 1:1 ratio to prepare a PRP-bone powder complex, which was implanted into the bone defect area and covered with a Bio-Gide® membrane.

Both groups received routine oral antibiotics for 3-5 days postoperatively to prevent infection. Sutures were removed 1 week after surgery, and patients were followed up regularly within 6 months postoperatively.

Data acquisition

Patient baseline data were extracted from the electronic medical record system, including age, gender, bone defect site, bone defect size, smoking history, drinking history, systemic disease history (hypertension, diabetes, etc.), preoperative CBCT image data, and laboratory examination indicators.

To identify independent factors associated with treatment success, a multivariate logistic regression analysis was performed. The dependent variable was defined as clinical efficacy (coded as 0 = no, 1 = yes). Variables with a *P*-value <0.1 in the univariate analysis, along with clinically relevant covariates, were incorporated into the regression model using the Enter method. The included covariates were age, gender, bone defect type, bone defect area, smoking history, comorbidities (e.g., hypertension, diabetes), and surgeon experience level (categorized as attending physician vs. associate chief physician or above). Through this model, the adjusted odds ratios (aOR) and their corresponding 95% confidence intervals (95% CI) were calculated to evaluate the net effect of each factor.

Observation indicators

Primary outcomes: Clinical efficacy was assessed on the first postoperative day. Histological parameters (bone tissue area, connective tissue area, residual artificial bone powder area) and bone regeneration indices (bleeding index, probing depth, attachment loss, bone graft height, bone thickness) were compared between the two groups at 6 months postoperatively, and the effect of PRP on bone regeneration was analyzed.

Secondary outcomes: The incidence of complications (e.g., infection, peri-implantitis, bone resorption, rejection) was recorded during the 6-month follow-up in both groups.

Data statistics

SPSS 26.0 statistical software was used for data analysis. The Kolmogorov-Smirnov test was used to test the normality of the measurement data. Data were expressed as mean ± standard deviation (Mean ± SD) for normally distributed variables and as median (interquartile range) [M (IQR)] for non-normally distributed variables. The independent sample t test was used for comparison of normally distributed variables between the two groups, and the Mann-Whitney U test was used for non-normally distributed variables. The enumeration data were expressed as the number of cases (percentage) [n (%)]. The χ^2 test was used for comparison between groups, and Fisher's exact test was used when the theoretical frequency was less than 5. P<0.05 was considered statistically significant.

Results

Comparison of baseline data between the two groups

A total of 175 patients with oral bone defects were included in this study, with 85 patients in the control group and 90 patients in the observation group. As shown in **Table 1**, there were no significant differences in baseline characteristics between the two groups in terms of gender, age, bone defect site, bone defect type, bone defect area, smoking history, drinking history, hypertension history, diabetes history, or surgeon experience level (all P>0.05), confirming their comparability.

Comparison of the effective rate of treatment between the two groups

On the first postoperative day, the overall clinical success rate was significantly higher in the observation group than in the control group (92.2% vs. 75.3%, P=0.034) (See **Table 2**).

Table 1. Comparison of baseline characteristics between the two groups

Variable	Control group (n=85)	Observation group (n=90)	t/χ^2 value	*P*-value
Gender [n (%)]			0.032	0.858
Male	46 (54.1)	48 (53.3)		
Female	39 (45.9)	42 (46.7)		
Age (years, $\bar{x} \pm s$)	42.5±10.2	43.1±9.8	0.398	0.691
Bone defect site [n (%)]			0.001	0.975
Anterior teeth area	38 (44.7)	40 (44.4)		
Posterior teeth area	47 (55.3)	50 (55.6)		
Bone defect type [n (%)]			0.147	0.929
Horizontal type	28 (32.9)	30 (33.3)		
Vertical type	32 (37.6)	35 (38.9)		
Mixed type	25 (29.4)	25 (27.8)		
Bone defect size (mm^2, $\bar{x} \pm s$)	25.6±5.8	26.1±5.5	0.589	0.557
Smoking history [n (%)]	18 (21.2)	20 (22.2)	0.028	0.867
Drinking history [n (%)]	15 (17.6)	16 (17.8)	0.001	0.979
Hypertension history [n (%)]	12 (14.1)	13 (14.4)	0.004	0.951
Diabetes history [n (%)]	8 (9.4)	9 (10.0)	0.018	0.893
Surgeon experience level [n (%)]			0.037	0.848
Attending physician	52 (61.2)	54 (60.0)		
Associate chief physician or above	33 (38.8)	36 (40.0)		

Note: Data are expressed as mean ± standard deviation ($\bar{x} \pm s$) or number (percentage). All *P* values were calculated by independent-sample t-test for continuous variables and Chi-square test for categorical variables. There were no statistically significant differences between the two groups for all baseline characteristics (all P>0.05).

Table 2. Comparison of clinical outcomes between the two groups

Indicator	Control group (n=85)	Observation group (n=90)	χ^2 value	*P*-value
Clinical efficacy (1 day after surgery)			4.501	0.034
Markedly effective [n (%)]	38 (44.7)	56 (62.2)		
Effective [n (%)]	26 (30.6)	27 (30.0)		
Invalid [n (%)]	21 (24.7)	7 (7.8)		
Total effective rate [n (%)]	64 (75.3)	83 (92.2)	4.501	0.034

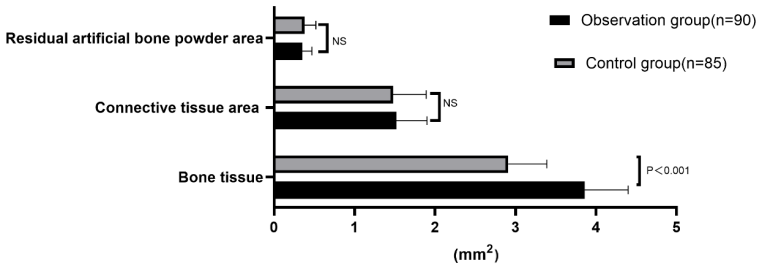


Figure 1. Comparison of implant bone tissue indexes between the two groups of patients. NS: Not Significant.

Comparison of implant bone tissue indexes between the two groups of patients

Histological examination at 6 months postoperatively revealed that the area of bone tissue in the observation group (3.86±0.54) mm^2 was significantly greater than that of the control group (2.91±0.48) mm^2 (P<0.05) (See **Figure 1**).

Comparison of bone defect regeneration indexes between the two groups

At 6 months postoperatively, the observation group exhibited significantly lower bleeding index, probing depth, and attachment loss, and significantly greater bone graft height and osteogenic thickness compared to the control group (all P<0.001) (See **Table 3**).

Table 3. Comparison of bone regeneration parameters between the two groups

Indicators	Control group (n=85)	Observation group (n=90)	t value	*P*-value
Bleeding index ($\bar{x} \pm s$)	1.58±0.44	1.02±0.35	6.234	<0.001
Probe depth (mm, $\bar{x} \pm s$)	2.76±0.51	2.15±0.42	5.789	<0.001
Attachment loss (mm, $\bar{x} \pm s$)	1.56±0.38	1.08±0.31	6.123	<0.001
Bone graft height (mm, $\bar{x} \pm s$)	3.95±0.58	4.82±0.67	6.234	<0.001
Osteogenic thickness (mm, $\bar{x} \pm s$)	2.61±0.39	3.24±0.45	6.789	<0.001

Table 4. Comparison of complication rates between the two groups [n (%)]

Complication	Control group (n=85)	Observation group (n=90)	χ^2 value	*P*-value
Infection	6 (7.1)	2 (2.2)		
Peri-implantitis	5 (5.9)	2 (2.2)		
Bone resorption	3 (3.5)	1 (1.1)		
Rejection reaction	0 (0)	0 (0)		
Total complications	14 (16.5)	5 (5.6)	4.332	0.037

Comparison of the incidence of complications between the two groups

The total incidence of complications within 6 months was significantly lower in the observation group than in the control group (5.6% vs. 16.5%, P<0.05) (See **Table 4**).

Comparison of other postoperative indicators between the two groups of patients

At 6 months postoperatively, the observation group demonstrated significantly higher implant stability quotient (ISQ), bone mineral density (BMD), and patient satisfaction scores (all P<0.05), alongside lower VAS scores and shorter swelling duration (both P<0.05) (See **Table 5** and **Figure 2**).

Comparison of postoperative quality of life between the two groups

At 6 months post-surgery, the Oral Health Impact Profile (OHIP-14) was used to assess quality of life. The observation group had a significantly lower total OHIP-14 score (15.2±2.8 vs. 24.1±3.5 points; t=13.567, P<0.001) than the control group. The scores for functional limitation, physiological pain, psychological discomfort, physiological disorder, psychological disorder, social disorder, and disability were significantly lower in the observation group than in the control group (all P<0.05), suggesting better postoperative quality of life in the observation group (See **Table 6**).

PRP as an independent predictor of treatment success: multivariate logistic regression analysis

Multivariate logistic regression analysis was performed to identify independent factors associated with treatment effectiveness. After adjusting for age, gender, bone defect type, bone defect area, smoking history, comorbidities, and surgeon experience level, PRP treatment remained the strongest independent predictor of treatment success (aOR=3.82, 95% CI: 2.15-6.79, P<0.001). Additionally, bone defect area was identified as a negative independent predictor (aOR=0.959, 95% CI: 0.924-0.995, P=0.027). Other variables did not reach statistical significance (all P>0.05). Detailed results are presented in **Table 7**.

Discussion

Oral bone defects are a critical factor influencing the long-term stability and success of dental implants [11, 12]. Platelet-rich plasma (PRP), which is rich in growth factors that promote bone regeneration, has shown efficacy in orthopedic applications [13, 14]. In this study, multivariate logistic regression analysis identified PRP treatment as an independent predictor of treatment effectiveness (aOR=3.82) after adjusting for age, gender, bone defect type and area, smoking, comorbidities, and surgeon experience, further supporting its protective role in bone regeneration. The total clinical effective rate was significantly higher in the observation group than in the control group after treatment with PRP combined with artificial bone powder. At the same time, the bone tissue area, bone graft height, and bone thickness were significantly better than those of the

Table 5. Comparison of postoperative recovery parameters between the two groups ($\bar{x} \pm s$)

Indicator	Control group (n=85)	Observation group (n=90)	t value	*P*-value
VAS score 3 days after surgery (points)	3.5±0.8	2.8±0.6	4.876	<0.001
Postoperative swelling duration (days)	5.2±1.5	3.5±1.2	6.123	<0.001
Patient satisfaction score (points)	84.3±6.8	92.5±5.6	6.567	<0.001

Note: VAS: Visual Analogue Scale.

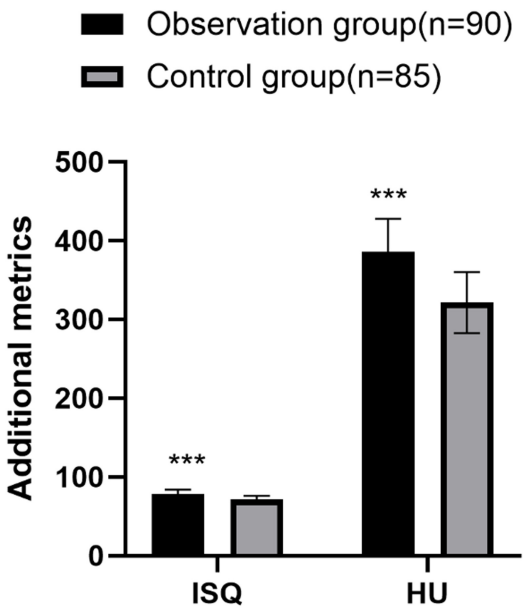


Figure 2. Comparison of ISQ and HU between the two groups of patients. ISQ: Implant Stability Quotient; HU: Hounsfield Unit. Data are presented as mean ± SD. ***P<0.001 versus the control group.

control group, consistent with previous findings [15].

The utility of PRP in oral implantology has been previously documented [16]. This study showed that the area of bone tissue, the height of bone graft, and the thickness of bone formation in the observation group were significantly higher than those in the control group. The underlying mechanism is as follows: Compared with pure artificial bone powder, PRP is rich in platelet-derived growth factor (PDGF), transforming growth factor-β (TGF-β), vascular endothelial growth factor (VEGF) and other growth factors that act synergistically on the bone defect to promote osteoblast proliferation, differentiation, and angiogenesis, thereby accelerating the process of bone healing. In addition, PRP not only provides bone conduction scaffolds but also exerts osteoinductive activity, thereby more effectively promoting new bone formation. Similar conclusions have been made in the past [17]. At the same time, there was no significant difference in the area of connective tissue and the residual area of artificial bone powder between the two groups, suggesting that the addition of PRP did not increase the proliferation of connective tissue or the residual area of artificial bone powder, and thus had good biocompatibility.

Previous literature has confirmed that the recent degree of pain and long-term indicators can reflect the therapeutic effect [18, 19]. At the same time, the results of this study showed that the bleeding index, probe depth and attachment loss in the observation group were significantly lower than those in the control group. The reasons are as follows: growth factors in PRP can promote soft tissue healing and angiogenesis, reduce postoperative inflammatory response, and thus improve the quality of local tissue healing [20]. At the same time, the anti-inflammatory effect of PRP can reduce the swelling and bleeding of gingival tissue and promote the regeneration and repair of periodontal tissue [21]. In addition, the VAS score at 3 days after operation and the duration of postoperative swelling in the observation group were significantly shorter than those in the control group, which further confirmed that PRP has the clinical advantages of reducing postoperative pain and swelling, which may be related to the growth factors in PRP promoting tissue repair and reducing the release of inflammatory mediators. Similar studies have been reported in the past [22].

Previous studies have confirmed that implant stability and bone mineral density are important factors in evaluating implant success and long-term survival of implants [23]. The results of this study showed that the implant stability coefficient and bone mineral density of the observation group were significantly higher than those of the control group. The potential mechanisms are as follows: PDGF and TGF-β in

Table 6. Comparison of postoperative quality of life between the two groups (OHIP-14 score, points, $\bar{x} \pm s$)

Dimension	Control group (n=85)	Observation group (n=90)	t value	*P*-value
Functional limitation	3.8±0.6	2.5±0.5	11.234	<0.001
Physical pain	4.2±0.7	2.8±0.6	10.567	<0.001
Psychological discomfort	3.5±0.8	2.2±0.5	9.876	<0.001
Physical disability	3.6±0.7	2.4±0.6	9.123	<0.001
Psychological disability	3.2±0.8	2.0±0.5	8.456	<0.001
Social disability	3.0±0.7	1.8±0.4	10.234	<0.001
Handicap	2.8±0.6	1.5±0.4	12.345	<0.001
Total score	24.1±3.5	15.2±2.8	13.567	<0.001

Table 7. Multivariate analysis of factors affecting treatment effectiveness

Variable	β	SE	Wald χ^2	aOR	95% CI	*P*-value
PRP treatment (Observation vs. Control)	1.341	0.294	20.83	3.82	2.15-6.79	<0.001
Age (per 1-year increase)	-0.015	0.022	0.46	0.985	0.943-1.029	0.497
Gender (Male vs. Female)	0.287	0.318	0.81	1.33	0.713-2.48	0.369
Bone defect type (Complex vs. Simple)†	-0.524	0.309	2.88	0.592	0.323-1.085	0.090
Bone defect area (per 1 mm^2 increase)	-0.042	0.019	4.89	0.959	0.924-0.995	0.027
Smoking history (Yes vs. No)	-0.613	0.358	2.93	0.542	0.269-1.092	0.087
Comorbidities (Yes vs. No)‡	-0.439	0.342	1.65	0.645	0.330-1.260	0.199
Surgeon experience (Senior vs. Junior)	0.357	0.325	1.21	1.43	0.756-2.71	0.272

Note: aOR: adjusted Odds Ratio; 95% CI: 95% Confidence Interval. †Bone defect type was categorized as complex (e.g., comminuted, segmental, or articular involvement) vs. simple (e.g., transverse, oblique, or isolated cortical defect). The specific classification criteria should be described in the Methods section. ‡Comorbidities included underlying systemic diseases such as diabetes mellitus, hypertension, cardiovascular disease, and/or osteoporosis. Details of the included conditions are provided in the Methods section.

PRP can synergistically promote the recruitment and proliferation of osteoblasts and increase bone matrix deposition, thereby increasing bone mineral density. At the same time, VEGF can promote the formation of new blood vessels, improve the blood supply in the bone defect area, provide sufficient nutrition and oxygen for bone healing, and enhance the bonding strength between the implant and bone tissue [24]. In addition, the results of this study showed that the satisfaction score of patients in the observation group was significantly higher than that in the control group, again suggesting that PRP treatment improved the subjective satisfaction of patients by increasing the clinical treatment effect, which was consistent with the previous research results [25].

Previous studies mostly used changes in quality of life to assess the effectiveness of treatment [26]. The results of this study showed that the total score of OHIP-14 in the observation group was significantly lower than that in the control group, and the scores of each dimension were significantly better than those in the control group. The reasons are as follows: the patients in the observation group had ideal bone regeneration after PRP treatment, and the stability of the implant promoted the recovery of chewing function, thus improving the daily diet of the patients. In addition, the postoperative pain degree and swelling time of the observation group were lower than those of the control group, which finally reduced the discomfort and psychological burden of the patients and improved the quality of life of the patients. Treatment safety is a fundamental consideration in clinical practice [27]. Finally, the results of this study showed that the total incidence of complications in the observation group was lower than that in the control group. The reasons are as follows: the growth factors in PRP have anti-inflammatory and antibacterial properties, which can reduce the risk of postoperative infection; at the same time, PRP promotes rapid healing of soft tissue and reduces bacterial invasion, thereby reducing the incidence of peri-implantitis [28]. In addi-

tion, PRP is derived from the patient's own in promoting new bone formation, reducing bone resorption, thereby reducing bone resorption-related complications and rejection.

Several limitations of this study warrant consideration. First, the retrospective design inherently carries risks of selection and information bias. Although we adjusted for multiple potential confounders (age, gender, bone defect type and area, smoking, hypertension and diabetes, and surgeon level) in multivariate models, residual confounding from unmeasured variables cannot be entirely excluded, and causal inferences should be drawn cautiously. Additionally, outcome assessors were not blinded due to the retrospective nature of this study, which may have introduced detection bias. Second, this single-center study had a relatively limited sample size (175 cases), which precluded robust stratified analyses by bone defect size, location, or etiology, and may limit the generalizability of our findings. Larger multicenter prospective studies are needed for validation. Although we have corrected the sample size reporting in all tables to reflect the full analysis set of 175 patients, the relatively high number of patients with incomplete data remains a concern; we have added a patient flow diagram (**Figure 1**) to enhance transparency. Third, the 6-month follow-up was insufficient to assess long-term outcomes such as implant survival rates or long-term bone resorption. Extended follow-up is required. Fourth, we did not measure specific growth factor concentrations in PRP or perform histological analyses, which limits mechanistic exploration. Future studies incorporating these objective indicators are needed to clarify the biological pathways underlying PRP-facilitated bone regeneration. Additionally, the lack of a standardized PRP preparation protocol may have introduced treatment variability. Furthermore, although we have now specified the brands and types of materials used (Bio-Oss® artificial bone powder, Bio-Gide® barrier membrane, and Straumann® implant system) in the Methods section, the use of a single product line may limit the generalizability of our findings to other biomaterials. Despite these limitations, our findings provide preliminary real-world evidence supporting the clinical utility of PRP in oral implant bone regeneration, demonstrating significant improvements in bone regeneration parameters and a reduction in complication rates, warranting further rigorous investigation. In conclusion, the combination of PRP and artificial bone powder significantly enhances bone regeneration in oral implantology, leading to improved clinical outcomes, implant stability, and patient quality of life, while reducing postoperative complications.

Disclosure of conflict of interest

None.

Address correspondence to: Guanghai Shang, Department of Stomatology, Yiling Hospital of Yichang (Affiliated Yiling Hospital of China Three Gorges University), No. 32 Donghu Avenue, Yiling District, Yichang 443100, Hubei, China. Tel: +86-07177827512; E-mail: ylrmyykjk3@ctgu.edu.cn

References

[1] Inchingolo AM, Marinelli G, Trilli I, Del Vecchio G, Di Noia A, Inchingolo F, Del Fabbro M, Palermo A, Inchingolo AD and Dipalma G. A histological and clinical evaluation of long-term outcomes of bovine bone-derived xenografts in oral surgery: a systematic review. J Funct Biomater 2025; 16: 321.

[2] Courtois B, L'Homme A and Labadie MP. Allogeneic bone paste versus bone powder for oral guided bone regeneration: a randomized, non-inferiority trial. J Periodontol 2026; 97: 411-421.

[3] Dugast S, Longis J, Anquetil M, Corre P, Komarova S and Bertin H. Assessing dental implant success: a systematic review and meta-analysis of primary versus secondary implantation in free bone flap reconstruction for malignant tumors. Head Neck 2025; 47: 1277-1290.

[4] Hassan SJ, Lappalainen OP, Marleena OA, Harila V and Näpänkangas R. Implant treatment modalities of non-syndromic congenitally missing premolars: a retrospective case series of 74 specialist care patients over an 11-year-cohort. Acta Odontol Scand 2025; 84: 528-534.

[5] Haque T. Assessment of bone regeneration around implants using different bone substitute materials. J Pharm Bioallied Sci 2025; 17 Suppl 2: S1258-S1260.

[6] Sun TC and Chang TK. Soft tissue management around dental implant in esthetic zone - the current concepts and novel techniques. J Dent Sci 2024; 19: 1348-1358.

[7] Giannelli A, Forte M, D'Albis G, Cianciotta G, Limongelli L, Stef L, Feier R, Alrashadah AO, Corsalini M and Capodiferro S. Utilization of platelet-rich plasma in oral surgery: a system-

atic review of the literature. J Clin Med 2025; 14: 2844.
[8] Chen J, Liu B, He J, Wei Y, He Y, Zhou H, Zhang Z, Weng Y and Cheng M. Multimodal mechanisms of platelet-rich plasma in bone defect repair: angiogenesis, inflammation modulation, and metabolic regulation. Regen Ther 2025; 30: 920-932.
[9] Chang WS, Huang CC, Chen TH, Chao SH, Lin CH, Chang CP and Chien CS. Hyperbaric oxygen potentiates platelet-rich plasma composition and accelerates bone healing. J Orthop Translat 2025; 51: 1-12.
[10] Zhang Y, Yang SS, Zhang NN and Huang GL. Effect of platelet-derived bone enhancers used as adjuncts to deproteinized bovine bone matrix in maxillary sinus floor elevation: a systematic review and meta-analysis. BMC Oral Health 2025; 25: 1120.
[11] Kaira LS, Srivastava V, Mazumdar S, Mudgal I, Singh K, Prajapati A and Patel M. A retrospective evaluation of bone graft success, implant survival rate and marginal bone loss. Bioinformation 2025; 21: 1534-1538.
[12] López-Valverde N, López-Valverde A and Blanco JA. Effectiveness of bone expansion, compacting and densification in narrow alveolar crests: a systematic review and a meta-analysis. Front Bioeng Biotechnol 2025; 13: 1630495.
[13] Amiri MA, Farshidfar N, Miron RJ, Dziedzic A, Hamedani S, Daneshi S and Tayebi L. The potential therapeutic effects of platelet-derived biomaterials on osteoporosis: a comprehensive review of current evidence. Int J Biomater 2023; 2023: 9980349.
[14] Bacevich BM, Smith RDJ, Reihl AM, Mazzocca AD and Hutchinson ID. Advances with platelet-rich plasma for bone healing. Biologics 2024; 18: 29-59.
[15] Niu G, Wang S, Chen J, Ma Z, Jie K, Yao J and Liao Z. Platelet-rich plasma enhanced therapy for aseptic atrophic tibial diaphyseal nonunion: a single-center retrospective controlled study of 90 cases. J Orthop Surg Res 2025; 20: 986.
[16] Acerra A, Caggiano M, Chiacchio A, Scognamiglio B and D'Ambrosio F. PRF and PRP in dentistry: an umbrella review. J Clin Med 2025; 14: 3224.
[17] Zapata-Sifuentes M, Quispe-Salcedo A, Watanabe T, Kawase T and Ohshima H. Effect of leukocyte and platelet-rich plasma on osseointegration after implant placement in mouse maxilla. Regen Ther 2024; 26: 741-748.
[18] Lian S, Mu Z, Yuan Z, Shafiq M, Mo X and Mu W. Methacrylated gelatin and platelet-rich plasma based hydrogels promote regeneration of critical-sized bone defects. Regen Biomater 2024; 11: rbae022.
[19] Velasco-Ortega E, Pato-Mourelo J, López-López B, Monsalve-Guil L, Moreno-Muñoz J, López-López J, Núñez-Márquez E, Matos Garrido N, Rondón-Romero JL, Jiménez-Guerra Á and Ortiz-García I. Long-term clinical study on sand-blasted-acid-etched surface dental implants: 12-year follow-up. Materials (Basel) 2025; 18: 183.
[20] Khandan-Nasab N, Torkamanzadeh B, Abbasi B, Mohajeri T, Oskuee RK and Sahebkar A. Application of platelet-rich plasma-based scaffolds in soft and hard tissue regeneration. Tissue Eng Part B Rev 2026; 32: 245-272.
[21] Kaur S, Saluja P, Baba SM, Khateeb SU, Arora S, Sainudeen S, Ali ABM, Khalil AA, Das G and Grover V. Platelet concentrates in periodontics: a journey through platelet-rich plasma, platelet-rich fibrin and their therapeutic uses: a literature update. Curr Opin Hematol 2026; 33: 25-33.
[22] Su L, Xie S, Li T, Jia Y and Wang Y. Pretreatment with platelet-rich plasma protects against ischemia-reperfusion induced flap injury by deactivating the JAK/STAT pathway in mice. Mol Med 2024; 30: 18.
[23] Gong T, Wang LQ, Tong X, Zhang Y and Shu LJ. Impact of age-related bone density variations on dental implant stability and success rates: a retrospective analysis. Int Dent J 2025; 75: 103942.
[24] Li Y, Liu Y, Bai H, Li R, Shang J, Zhu Z, Zhu L, Zhu C, Che Z, Wang J, Liu H and Huang L. Sustained release of VEGF to promote angiogenesis and osteointegration of three-dimensional printed biomimetic titanium alloy implants. Front Bioeng Biotechnol 2021; 9: 757767.
[25] Pattnayak A, Ramanna PK, Mahabala KY, Edathotty TT, Kumaraswamy AU and Duseja S. Impact of platelet-rich plasma and platelet-rich fibrin in mandibular third molar extraction: a systematic review. J Contemp Dent Pract 2024; 25: 904-910.
[26] Osagie O, Saheeb BD and Egbor EP. Do the bioactive effects of platelet-rich plasma and platelet-rich fibrin influence the oral health related quality of life following impacted third molar surgery? A randomized comparative study. Niger J Clin Pract 2021; 24: 712-717.
[27] Mohanty L, Harish A, Mangalekar SB, Jethlia A, Lunkad H, Jeevitha JY and Makkad RS. Evaluating the efficacy of platelet-rich plasma (PRP) in accelerating healing and reducing complications in oral surgery. J Pharm Bioallied Sci 2024; 16 Suppl 3: S2165-S2167.
[28] Ceresa C, Travagin F, Marchetti A, Tessarolo F, Fracchia L, Giovenzana GB and Bosetti M. An in vitro study on the application of silver-doped platelet-rich plasma in the prevention of post-implant-associated infections. Int J Mol Sci 2024; 25: 4842.