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Original Article

Role of autologous platelet-rich plasma in treatment of femoral neck fractures

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Abstract: Background: Few studies have investigated the outcome of the use of platelet-rich plasma (PRP) in the treatment of femoral neck fractures. The aim of this study was to evaluate the efficacy of PRP in management of femoral neck fractures. Materials and methods: This study included 64 cases in PRP group and 64 cases in control group. After clinical evaluation, patients in control group only underwent closed reduction and internal fixation and patients in PRP group received addition of PRP to internal fixation. Results: Mean length of hospital stay was 13.7 days in the PRP group and 18.1 days in the control group, which was found significant difference between the two groups (P = 0.042). Similarly, the PRP group obtained a shorter union time, compared to the control group (P = 0.005). No statistically significant differences were observed in functional outcomes regards HHS or VAS between the 2 groups (Table 2). There was no difference in the presence of complications (P > 0.05) using Fisher's exact test. Conclusions: Although no differences in functional outcomes were observed between the groups, PRP could obtain a decreased hospital stay and bone union time.

Keywords: Platelet-rich plasma (PRP), femoral neck fractures, closed reduction and internal fixation, outcomes

Introduction

Hip fractures are evenly divided between femoral neck and intertrochanteric fractures, with an incidence of over 250,000 cases per year in the United States [1]. Femoral neck fractures are one of the greatest challenges for nearly all orthopaedic surgeons due to huge medical and economic cost [2]. For the elderly patients, the replacement of the femoral head by arthroplasty surgery is the optimal treatment [3-5]; for the younger patients (less than 60 years of age), internal fixation is considered as the best treatment option by most authors [6-8]. However, failure of internal fixation for these hip fractures is common, with up to 35% of displaced fractures requiring revision surgery [9-11]. Therefore, it is necessary to search for any adjunct that can accelerate fracture healing and reduce the rate of failure of fixation with the potential to change patient care.

Platelet-rich plasma (PRP) was first described by Whitman et al. in 1997 [12], as an autologous blood product with a greater concentration of platelets than physiological whole blood [13]. These preparations are usually used to promote bone and soft tissue healing [13]. It contains multiple growth factors, including transforming growth factor, insulin-like growth factor, fibroblast growth factor, and platelet derived growth factor and therefore have positive effects on stimulation of bones, blood vessels, and the formation of chondrocytes [14].

Up to now, only two studies [2, 15] have investigated the effects of PRP in treatment of femoral neck fractures. Griffin et al. in their study [15] demonstrated that PRP had no effect on bone healing. However, Samy et al. found median clinical and radiographic healing time were lower in patients with PRP compared to controls. Therefore, the purpose of this study was to investigate if PRP has any advantageous effect in bone healing for patients with femoral neck fractures.

Materials and methods

This retrospective study was approved by the Institutional Board Review of Provincial Hospital

Table 1. Patient Demographic characteristics

	Cases	Controls	*P* value
Sample size (n)	64	64	-
Age (years)	37.2±9.6	36.7±10.1	.834
Gender (f/m)	39/25	35/29	.474
Body mass index (kg/m^2)	23.9±4.2	23.6±3.9	.755
Side, No. left/right	41/23	38/26	.585
Smoking status	17 (26.6%)	21 (32.8%)	.439
Follow-up (m)	13.2	14.7	-

Affiliated to Shandong University. Written informed consent was obtained from all patients.

The patients were included if they met with the criteria as follows: 1) age range from 20 to 45 years; 2) patients with femoral neck fractures being able to receive closed reduction and internal fixation; 3) early presentation of the fracture (within first 24 h). Patients were excluded if they underwent other treatments, presented late following their injury, had pathological fractures, and had chronic disorders and autoimmune disease. According to these criteria above, a total of 64 subjects who received addition of PRP for therapy were included in this study, and the same amounts of patients who only underwent closed reduction and internal fixation were employed. They all were treated in Provincial Hospital Affiliated to Shandong University between September 2011 and April 2014. All demographics and operative data were collected from the hospital records.

All participants underwent closed reduction of their fracture which was performed by one surgical team. The surgical procedure was previously described by Cao et al. [16]. Internal fixation was carried out under C-arm X-ray, with a small incision in the lateral femur, which was then internally fixed with three hollow compression screws. For those cases allocated to platelet-rich therapy, each screw was advanced up to but not beyond the fracture such that no compression was achieved before the platelet-rich plasma was injected. The preparation of PRP is the same to the description from Mishra et al. [17]. Postoperative administration was the same for both groups of patients. All patients started functional training of the hip from the second day postoperatively and were ambulated with non-weight bearing crutches until there was radiological evidence of union followed by partial weight bearing for an additional one month. Full weight bearing was allowed after that guided by the radiological follow up. All participants received routine prophylaxis against deep vein thrombosis. All participants were followed up at 1, 3, 6, 12 months postoperatively. The clinical evaluation included visual analogue score (VAS) [18], Harriship score (HHS) [9], and the status of radiographic bone union. Non-union was defined if signs of bony union were showed on the anteroposterior or lateral radiograph 1 year after surgery [10]. The radiographic data were evaluated separately by two senior professors. Other outcomes including length of hospital stay and complications of the treatment were also recorded.

All statistical analyses were conducted using SPSS version 19.0 software. Quantitative variables were displayed by means and standard deviation. The outcomes between two groups were compared by Pearson chi-square test and Fisher's exact test. A *P* value of less than 0.05 was considered significant.

Results

In current study, we included a total of 128 patients who were followed up for an average of 14.0 months. All demographics are listed in **Table 1**. With regard to age, gender, and body mass index, there was no difference between the two groups.

Table 2 displays the clinical and functional outcomes at 1 year postoperatively for the two groups. Mean length of hospital stay was 13.7 days in the PRP group and 18.1 days in the control group, which was found significant difference between the two groups ($P = 0.042$). Similarly, the PRP group obtained a shorter union time, compared to the control group ($P = 0.005$). In both groups, all united cases had good-to-excellent clinical outcome as regards HHS or VAS at the end of the follow up; however, no statistically significant differences were obtained between the 2 groups (**Table 2**).

The presence of complications is presented in **Table 3**. In the PRP group, one patient developed a superficial wound infection, 6 with pulmonary embolus, 4 with urinary tract infection, and 2 with deep vein thrombosis. In control

Table 2. Clinical outcomes at 1 year postoperatively

	Cases (n = 64)	Controls (n = 64)	*P* value
Radiographic non-union (%)	1 (1.6)	3 (4.7)	.310
Radiographic avascular necrosis (%)	1 (1.6)	2 (3.1)	.559
Time of union (months)	3.37±1.1	4.56±1.4	.005*
Hospital stay (d)	13.7±3.1	18.1±4.5	.042*
VAS	1.8±0.8	1.9±1.1	.131
HHS	90.14±4.46	89.82±4.59	.119
Satisfaction			.257
Excellent/good	59 (92%)	55 (86%)	-
Fair/poor	5 (8%)	9 (14%)	-

Abbreviations: VAS, visual analogue score; HHS, Harriship score. **P* value was considered significant.

Table 3. Complications between the two groups

	Cases (n = 64)	Controls (n = 64)	*P*-value
Wound infection	1	2	-
Pulmonary embolus	0	2	-
Pneumonia	6	8	-
Urinary tract infection	4	5	-
Blood transfusion	0	2	-
Cerebrovascular	0	1	-
Deep vein thrombosis	2	2	-
Total	13	22	0.074

group, 2 patients experienced a wound infection, 2 with pulmonary embolus, 11 with pneumonia, 5 with urinary tract infection, 2 with blood transfusion, 1 with cerebrovascular, and 2 with deep vein thrombosis. At last, all infections were completely controlled by intravenous antibiotics and daily dressing.

Discussion

In present study, the results revealed difference in time of bone union between subjects receiving platelet-rich therapy and those only with internal fixation of femoral neck fractures. With respect to hospital stay, it indicated that platelet-rich therapy might decrease the length of hospital stay. However, our results showed no difference in functional scores between the two groups.

Although great advances have been made in surgical techniques and medical care, the risk of nonunion and a vascular necrosis after surgery in treatment of femoral neck fractures have not been improved appreciably in the last decades [19]. With the advances in the field of molecular biology, a lot of regenerative medicines have been developed and the healing environment of the fractures recently has obtained much attention causing better understanding of the exact pathophysiology of bone repair failure. A number of studies have reported positive results in the management of fractures by using growth factors alone or in conjunction with other traditional methods which can Improve the local fracture environment [20].

Recently, a breakthrough has been achieved in PRP applying in the stimulation and acceleration of bone and soft tissue healing. The activated platelets release a number of growth factors and differentiation factors, including platelet derived growth factor (PDGF), transforming growth factor (TGF-b), platelet factor 4 (PF4), interleukin-1 (IL-1), platelet-derived angiogenesis factor (PDAF), vascular endothelial growth factor (VEGF), epidermal growth factor (EGF), platelet-derived endothelial growth factor (PDEGF), epithelial cell growth factor (ECGF), insulin like growth factor (IGF), osteocalcin, osteonectin, fibrinogen, vitronectin, fibronectin and thrombospondin-1, which have an important influence in intracellular signaling pathways that induce the production of proteins needed for the regenerative processes and fracture healing, such as cellular proliferation, matrix formation, osteoid production and collagen synthesis [21-24].

Samy et al. [2] reported a noticeable difference comparing both groups in favor of group B with a significant decrease in non-union rate (6.7%) compared to group A (16.67%). Ort et al. [25] reported a 90.4% union rate after fixation of femoral neck fractures. In our study, the overall non-union rate reach to 3%, and there was no difference in non-union rate between the two groups. However, the application of PRP could decrease time of bone union and obtain a shorter hospital stay.

In current study, several limitations had to be mentioned. First, it should be noted that retrospective analysis in this study might weaken the evidence of the study. Second, the follow-up period was not enough long to observe long-term effect of PRP in management of fractures. Then, the small sample size in this study may have an influence in the power in statistical analysis. Finally, the choice of therapy ways depending on the surgeon's preference might result in some bias.

Conclusion

In summary, although no differences in functional outcomes were observed between the groups, PRP could obtain a decreased hospital stay and bone union time. However, in view of some limitations, future work with better design involving larger sample size should investigate the effectiveness of platelet-rich therapy in different fracture types.

Disclosure of conflict of interest

None.

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