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Research Article

Clinical Study on the Treatment of Diabetic Foot with a Combination of Dermal Matrix, Adipose-Derived Stem Cells, and Platelet-Rich Plasma

Enfeng Wang[1], Haizhen Liu[2]*

[1] *Department of plastic and Burn, Hainan Western Central Hospital, Danzhou 571700, Hainan Province, China.*

[2] *Dental Center, Hainan Western Central Hospital, Danzhou 571700, Hainan Province, China.*

Abstract Objective: To explore the clinical efficacy of using a combination of dermal matrix, adipose-derived stem cells, and platelet-rich plasma in the treatment of diabetic foot, and to provide insights for the treatment of chronic wounds in clinical diabetes. Methods: Eighty patients with diabetic foot wounds, treated at our hospital from January 2023 to January 2024, were selected for the study. The patients were divided into two groups based on the treatment methods: the control group and the observation group (n=40 each). After controlling for underlying diseases and granulation tissue culture of the wounds, the control group received treatment with simple dermal matrix transplantation, while the observation group was treated with a combination of dermal matrix, adipose-derived stem cells, and platelet-rich plasma. General patient information, wound healing status, and granulation tissue survival rates were observed and compared between the two groups. Results: There were no significant differences in general patient information between the two groups (P>0.05). The wound healing status of patients in the observation group was significantly better than that of the control group, with a significant difference (P<0.05). Both groups showed granulation tissue survival at 3 days and 7 days post-treatment, but the granulation tissue survival rate in the observation group was significantly higher than that in the control group, and the granulation tissue mortality rate was significantly lower, with a significant difference (P<0.05). Conclusion: A single treatment method is insufficient to meet the needs of patients with diabetic foot. The combination of dermal matrix, adipose-derived stem cells, and platelet-rich plasma yields better treatment outcomes and wound healing, making it worthy of further clinical promotion and application.

Keywords:Dermal matrix transplantation; Adipose-derived stem cells; Platelet-rich plasma; Diabetic foot; Wound healing

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In recent years, the incidence of diabetes has been increasing annually, posing a serious threat to human health. With the rapid rise in the number of diabetic patients, the prevalence of diabetic foot ulcers has also surged[1]. Prolonged abnormal glucose and lipid metabolism reduce the body's antioxidant capacity, and coupled with neurological disorders and various degrees of lower limb vascular diseases, this leads to local tissue hypoxia, which are the main factors causing this condition. The symptoms primarily include ulcers, infections, and gangrene[2]. The economic loss caused by diabetic foot ulcers and surgical excisions is enormous, comparable to the total number of all other diseases. Therefore, effective prevention and treatment are of great significance[3]. Currently, the incidence of diabetes in China is increasing yearly, but effective preventive and treatment measures are still lacking. Diabetic foot (DF) is the most common diabetic complication, characterized by extremely slow wound healing and severe cases being difficult to cure, making it a significant clinical challenge[4]. Chronic wounds are the

*Correspondence: Haizhen Liu,Dental Center, Hainan Western Central Hospital, Danzhou 571700, Hainan Province, China. Email: 473988451@qq.com

main cause of limb disability in patients. Therefore, proactive treatment and accelerated wound healing are crucial measures to reduce postoperative limb dysfunction[5]. In recent years, the individual use of dermal matrix transplantation, adipose-derived stem cells (ADSCs), and platelet-rich plasma (PRP) has become a research focus in the field of wound repair. However, the mechanisms of action remain unclear. Increasing research suggests that PRP can promote the proliferation of ADSCs. Therefore, we explored the combined use of dermal matrix, ADSCs, and PRP in the treatment of diabetic foot, and the results are reported as follows.

1 Materials and Methods

1.1 General Information

Eighty patients with diabetic foot wounds, treated at our hospital from January 2023 to January 2024, were selected for the study. The patients were divided into two groups based on the treatment methods: the control group and the observation group (n=40 each). In the control group, there were 23 males and 17 females, with an average age of (60.2±10.2) years. In the observation group, there were 20 males and 20 females, with an average age of (59.6±9.0) years. Inclusion criteria: Patients clinically diagnosed with diabetes whose chronic diabetic wounds did not heal after 20 days of dressing changes. This study was approved by the Medical Ethics Committee, and informed consent was obtained from both the patients and their families. There were no significant differences in general information between the two groups (P>0.05), as detailed in Table 1.

Table 1 Comparison of general data between the two groups (cases, %)

Clinical indicators	Observation group	Control group	X^2/T	P-value
Gender (male/female)	20/20	23/17	0.637	>0.05
Average age (years)	59.6±9.0	60.2±10.2	1.772	>0.05
Wound area (cm^2)	15.38±7.88	15.29±5.23	0.282	>0.05
Glycated hemoglobin (%)	7.71±1.16	7.66±1.29	1.222	>0.05

1.2 Methods

Two groups of patients after basic diseases under control, wound granulation cultivation, on the basis of the control group were treated by pure pulp skin grafting treatment, observation group using skin paste with fat glue, platelet rich plasma treatment. The specific measures were as follows: ① For granulation wounds, microparticle skin grafting was used, and a medium thickness skin graft (including epidermis and dermis surface) with a fine thickness was cut from the thigh, and the skin grafting was performed according to the ratio of donor site to recipient site of 1:5[6]. ② Preparation of platelet-rich plasma: After blood collection, about 50 ml of blood was collected by traditional method, and then it was mixed upside down; The anticoagulant was thoroughly mixed with the blood in the vein. In the first round of centrifugation, the collected venous blood were placed on a centrifuge, which was better because the coverage of platelets on the inclined plane was increased. Easy to pull out. The first centrifuge is 2500 per minute, and then you pull out the venous blood, and you can clearly see a layer, a layer of plasma on top. The platelets are in between, and in the bottom layer, the blood is red. First, the upper layer of plasma was withdrawn, and then a centrifuged vein was removed. Then a long needle was connected to a syringe, and one layer of plasma and the middle layer were withdrawn and injected

into another collection syringe. After secondary centrifugation, the second collected venous blood was subjected to 3200 RPM for 8 min. The collected vein was then removed with plasma on top, PRP in the middle, and a small fraction of red blood cells at the very bottom. For extraction, the supernatant was aspirated using a 5-ml syringe, retaining only the bottom liquid. The remaining PRP was aspirated using a 1-ml syringe. If necessary, it can be activated. (3) In order to facilitate the attachment of epidermal particles to the wound and reduce the damage to the skin, 2 ml of PRP was added, then 1 unit of insulin was added, and the epidermis was minted with ophthalmic surgical scissors until use[7]. Ten minutes after surgery, gentamycin saline gauze was applied for compression to prevent bleeding. Cream-colored particles and make good platelet rich plasma and associativity fat glue together, smear evenly on the area, with a small amount of oil gauze covering, filled with cotton ball, and then bandage and fixed pressure[8]. The first change for 24 hours, keep the inner layer of less oil gauze, and add Qingbig bandage. Replace the wound daily until no bleeding occurs.

1.3 Observation Indicators

Clinical curative effect comparison: heal: all wounds heal. * : wound healing rate of 70% or more; Effective: the wound healing rate was over 30%, up to 70%. Ineffective: the wound healing rate was 30%, and tended to increase.

Comparison of wound granulation survival rate: the wound granulation survival rate and wound healing time of the two groups were observed 3d and 7d after treatment.

1.4 statistical methods

The results of the study adopts SPSS26.0 for statistical analysis. Expression was used for count data, and two independent sample t test was used for comparison between groups. Measurement data were expressed as case (%), and chi-square test was used for comparison between groups. Wound healing was evaluated using the Kaplan-Meier method, and $P<0.05$ was considered a significant difference.

2 the results

2.1 two groups of patients with wound healing of contrast

The wound healing of the observation group was significantly better than that of the control group, and the difference was statistically significant ($P<0.05$). The specific data are shown in Table 2.

Table 2 Comparison of wound healing between the two groups (cases, %)

Group	Number of cases	Recovery from illness	Conspicuous effect	Effective	Invalid	Recovery rate	Total effective rate
Observation group	40	36	2	1	1	90.0%	97.5%
Control group	40	20	10	4	6	50.0%	85.0%
X^2	-	6.494	5.383	4.002	5.203	7.383	7.009
P	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

2.2 the survival rate of two groups after treatment in patients with wound granulation is compared

The survival rate of wound granulation in the observation group was significantly higher than that in the control

group, and the mortality rate of wound granulation was significantly lower than that in the control group, with significant differences (P<0.05). The specific data are shown in Table 3.

Table 3 Comparison of wound granulation survival rate after treatment between the two groups (cases, %)

Group	Number of cases	After treatment 3d		After treatment7d	
		Survival rate	Mortality rate	Survival rate	Mortality rate
Observation group	40	37 （92.5）	3（7.5）	30 （75.0）	10 （25.0）
Control group	40	26 （65.0）	14 （35.0）	19 （47.5）	21 （52.5）
X^2	-	7.483	8.883	6.930	5.398
P	-	<0.05	<0.05	<0.05	<0.05

3 Discussion

Diabetes mellitus is one of the most common diseases in the world, and its incidence and prevalence are increasing year by year, posing a great threat to human health[9]. It is predicted that by 2045, the number of people with Diabetes will reach 629 million, and according to the "Diabetes Map" recently published by the International Diabetes Association, China has 114 million diabetes patients, ranking first in the World[10]. According to the Chinese Guidelines for the prevention and Treatment of type 2 diabetes published in 2017, the prevalence of type 2 diabetes in adults aged 18 years and above has exceeded 10%, and the prevalence of type 2 diabetes in people aged 60 years and above has exceeded 20%. About 63% of patients with type 2 diabetes have not been clearly diagnosed, and most patients have complications when diagnosed, which has become a serious social and medical burden. Diabetic foot is a serious disease caused by diabetes and it is a serious disease. Diabetic foot treatment cost is high, a single therapy curative effect is not good, easy to relapse, therefore, the study of its regulatory mechanism needs to be deeper[11]. To seek a new treatment to accelerate wound healing in diabetic patients.

The number of platelet in PRP need plasma in 3-6 times, is the ideal treatment concentration. Studies have shown that cytokines such as PDGF and VEGF secreted by PRP can be secreted to the surface of platelets after activation. In addition, it is rich in collagen, which can be used as a membrane forming material to promote wound healing. Chen Da-Kang et al. used platelet-rich plasma to treat chronic refractory ulcers with good clinical effect. Yang Ronghua et al. conducted PRP intervention on 22 diabetic patients, and the results showed that PRP could significantly accelerate wound repair[12]. An RCT study showed that PRP could significantly improve the wound repair rate in diabetic patients. Qin new wish to PRP transplantation in trauma, better treatment for diabetic foot, its effect is significantly higher than the PRP. Liu Wei et al. performed dot transplantation on 174 patients with diabetic foot and proved that dot transplantation could significantly accelerate the recovery of wounds[13]. Jun-jie hou on 30 cases of patients with ventricular septal defect with skin grafting, and also achieve good curative effect[14]. Compared with conventional skin graft pressure fixation, VSD can make the skin closely fit the wound and increase the survival rate of skin graft.

Adipose-derived mesenchymal stem cells (MSCS), which are derived from adipose tissue, have strong self-renewal, multi-directional differentiation and paracrine abilities. The mechanism is as follows: (1) Adipose-gel can directly differentiate into repair cells such as fibroblasts and keratinocytes at the wound site. ② Through paracrine effect, TGF-β, VEGF, KGF, FGF and other cytokines are secreted, which play a key role in wound repair. ③ In the

ischemia/hypoxia environment, it can capture free radicals and protect fibroblasts. Fat gel has important application value in the process of wound repair. However, if the local blood supply is insufficient, its efficacy will be affected. Platelet-rich plasma can significantly improve its activity and proliferation ability: previous studies have shown that the survival rate of platelet-rich plasma in sites without blood supply defect is very low, which seriously restricts its clinical application. And after platelet rich plasma and its compound, can significantly increase their survivability. At the same time, it can also promote the proliferation of collagen fibers and early vascularization. Platelet-rich plasma promoted the proliferation of platelet-rich plasma in a dose-dependent manner. The higher the concentration of platelet-rich plasma, the stronger the proliferation ability, but beyond this range, the proliferation activity was negatively correlated with the concentration of platelet-rich plasma[15].

Therefore, in order to explore the clinical effect of skin paste combined with fat glue and platelet-rich plasma in the treatment of diabetic foot, we conducted a study on the patients admitted to the hospital. The results showed that the wound healing of the observation group was significantly better than that of the control group after treatment, and the difference was statistically significant ($P<0.05$). The survival rate of wound granulation in the observation group was significantly higher than that in the control group, and the mortality rate of wound granulation was significantly lower than that in the control group, and the difference was statistically significant ($P<0.05$). Therefore, the degree of wound healing was high in the patients treated with skin paste combined with fatty acid and platelet-rich plasma. And wound healing time shortened, has obvious advantages.

In conclusion, the treatment of diabetic foot is costly, the efficacy of single therapy is poor, and it is easy to relapse. Therefore, the research on the regulatory mechanism of diabetic foot is urgently needed. Looking for a new and better treatments, to accelerate the wound healing of diabetic patients. At present, in addition to conventional skin transplantation, simple application of adipose-derived stem cells or platelet-rich plasma has become a research hotspot in wound treatment, but the specific mechanism is still unclear. Since platelet-rich plasma and fat glue can promote each other and improve the quality of survival after transplantation, this project intends to combine them with autologous skin paste to achieve better wound repair effect, so as to improve the diagnosis and treatment process of diabetic chronic wounds. To solve the problem of lower limbs of diabetic foot caused by chronic traumatic injury, brought in patients with heavy social and economic burden.

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None

Conflict of Interests

None

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