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The Effectiveness of Autologous Platelet-Rich Plasma vs Conventional Mechanical Suture Fixation in Skin Graft Transfer for Deep Burn Patients: An Intra-Patient Controlled Study

Lisa Hasibuan[1,*], Miradz Hudaya[2]

[1]Plastic and Reconstructive Surgery Division, Department of Surgery, Rumah Sakit Hasan Sadikin, Bandung, Indonesia
[2]Department of Surgery, Plastic and Reconstructive Surgery, Rumah Sakit Hasan Sadikin, Bandung, Indonesia
*Corresponding author: lisahasibuanjurnal@gmail.com

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Abstract **Background:** Autologous platelet-rich plasma (PRP) is a patient-derived treatment containing fibrin and high concentrations of growth factors, often known for its adhesive and hemostatic abilities. PRP has been used for various types of wounds, including chronic and burn wounds. Autologous PRP is an affordable and practical modality that has been advocated by multiple publications due to its effect in improving clinical outcomes and wound healing time in regard to skin graft in burn patients. The aim of this study is to compare the effectiveness of PRP to conventional suture fixation in skin graft transfer for deep burn patients through objective "take" percentage analysis. **Methods:** This controlled prospective single center study included 15 deep burn patients with a total burn area of 5 – 30% on their extremities. Each patient received skin graft treatments using both methods: autologous PRP and conventional sutures. Pictures and analysis were taken on the third day after surgery to compare the open wound area between the two methods. **Result:** There was no significant "take" percentage difference between the autologous PRP and conventional suture group. The mean percentage of skin graft "take" for autologous PRP was 84.36% ± 13.82%, and the result for suture fixation was 84.16% ± 15.33%. **Conclusion:** The use of autologous PRP in this study did not improve the "take" percentage of skin grafts compared to conventional suture fixation. However, the use of autologous PRP did reduce the surgery duration and is still a treatment modality with high potential.

Keywords: *burns, skin transplantation, platelet-rich plasma, sutures, graft survival*

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1. Introduction

Burns are a significant and serious health problems, accounting for an estimated 180,000 deaths annually. According to data taken from the Bi-National Burn Repository of the Australasian-New Zealand Burn Association (ANZBA), the incidence of burns from 2009-2012 reached 7,408 people. [1] In the United States, 450,000 patients receive medical treatment related to burns every year, with up to 40,000 hospital admissions and 3,500 deaths. [2] Most cases occur in low-moderate income countries, and almost two-thirds occur in the Southeast Asian and African regions. [3] Significant burn mortality rates resulted in initial burn studies to focus on improving the overall survival rate. However, the understanding of the pathophysiology of burns has led to enhanced resuscitation techniques with a drastic reduction in mortality rates. Recent focus has shifted towards minimizing the morbidity and improving the quality of life of burn patients. [4]

Deep partial thickness burns involve the entirety of the epidermis and the reticular portion of the dermis. Therefore, the wound will not be completely re-epithelialized in 3 weeks, and operative excision and grafting is recommended. [5,6] Skin grafting's success or "take" depends on the skin's capability to obtain nutrition from local vascularization, whether or not wound infection exists, as well as hemostasis and adhesion of skin graft to the wound bed. [7]

Skin grafts are conventionally fixed to wound beds by sutures, staplers, fibrin glue, or cyano acrylate glue. However, it is reported that these methods added to operating time, cost, and are sometimes inadequate. [7,8]

Autologous platelet-rich plasma (PRP) is a patient-derived treatment containing fibrin and high concentrations of growth factors, often known for its adhesive and hemostatic abilities. PRP contains a platelet concentration above baseline and also the full complement of clotting

factors. Autologous PRP helps achieve stable hemostasis and brings instant adhesion of graft to bed, preventing collection of hematoma or seroma. Hematomas or seromas are able to disrupt the revascularization process and plasma imbibition that may lead to local infection of the transplanted skin or to the whole skin graft area. [8] Furthermore, growth factors released by PRP promotes angiogenesis, collagen synthesis, epithelialization, improve scars, and facilitates remodeling that reduces the overall time required for wound healing. [7,9] There have been several reports of the use of autologous PRP for burns, mostly reporting beneficial results. Research by Waiker et al compared the use of conventional mechanical fixation and the use of autologous PRP in wound beds with split thickness skin grafts and reported PRP as a great adjuvant in the management of wounds due to its safety, low cost, ease of preparation, hemostatic, adhesive, and healing properties. Complications such as edema and hematoma were significantly reduced in the experimental group compared to the control group, and PRP patients required fewer amounts of dressing change, shorter hospitalization duration, and no hypertrophic scar post-operatively. [7] However, this study did not directly measure the 'take' percentage success of the different methods.

Skin graft 'take' however is also affected by the wound location (lower extremities had higher failure rates), high body mass index, immunosuppressant drug use, and peripheral blood vessel disease. [11,12] Therefore this experiment aims to analyze the effectiveness of autologous PRP in comparison with conventional suture fixation in skin graft transfer for deep burn patients. We conducted an intra-patient study to avoid differing risk factors between the test subjects. Furthermore, autologous PRP is readily available and affordable. If beneficial results are observed, then this method use should be advocated in resource-constrained countries such as Indonesia.

2. Materials/Subjects and Methods

This research is a controlled, intra-patient experimental study, with consecutive sampling based on hospital patient enrollment. Both autologous PRP and conventional sutures were applied to fixate a skin graft on a single patient. Fixation results were observed on the day of the surgery, and on the third day post-surgery to observe the results. Pictures were taken and analyzed using ImageJ (public domain, BSD-2) to compare the take percentage of the skin graft. Take percentage was calculated using the formula:

$$1-\left[\frac{open\ wound\ area}{total\ wound\ area}\right]\times 100\%$$

Subjects were obtained from a single center, the Dr Hasan Sadikin Hospital in Bandung. Inclusion criteria for the subjects were 1) Deep burn patients (grade IIB-III); 2) Burns due to flame, scald, electricity, or chemical agents that require skin grafts; 3) Burns were located on the extremities with a total burn surface area of 5-30%; 4) There is no local wound infection; 5) Patients' age between 14-50 years old; 6) Patients agreed to participate in this study. Patients were excluded if 1) Patients had inhalation trauma, severe sepsis, septic shock, and/or multiple organ dysfunction; 2) Hemoglobin levels ≤ 10 g/dL; 3) Platelet levels ≤ 10^5/µL; or 4) Immunosuppressed patients. The sample size for this study was 13 subjects, calculated using analytical numerical paired comparison analysis. The Shapiro-Wilk test was used to test the normality distribution and data results were calculated using the Wilcoxon test. Data was processed using *Statistical Package for Social Sciences* (SPSS) version 24.

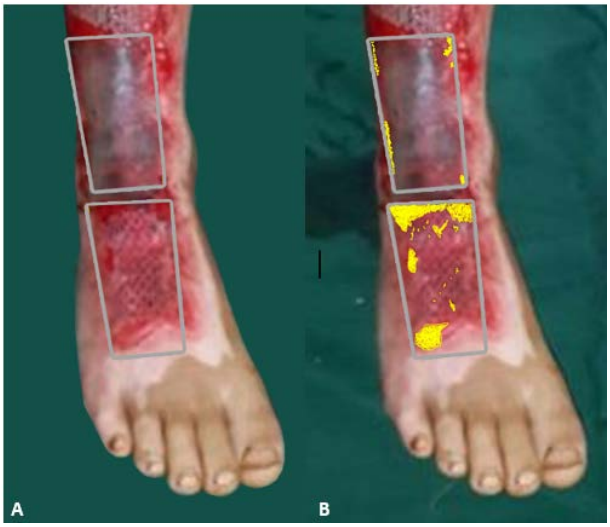

Figure 1. Example of skin graft take analysis using two experimental methods. The total wound area was marked grey, and the open wound area was marked yellow. The upper wound area was given autologous platelet-rich plasma, and the bottom fixated with conventional sutures

A) Post-op image of skin grafted burn wound on the right lower extremity
B) Day 3 post-op of skin grafted burn wound on the right lower extremity.

3. Results

Table 1. Demographic characteristics of the subjects

Variable	N = 15
Age (Year)	
Mean±STD	33.06±18.07
Gender	
Male	12 (80%)
Female	3 (20%)
Etiology of Burns	
Scald	2(13.3%)
Flame	9(60%)
Electrical	4(26.7%)
Burn Depth	
2B	6(40%)
2B and 3	9(60%)
Site of Burn	
Right Lower Extremity	3(20%)
Right Upper Extremity	5(33.3%)
Left Lower Extremity	4(26.7%)
Left Upper Extremity	3(20%)
Total Burn Area (%)	
Mean±SD	16.73±7.99

Notes: Categorical data was presented with frequency and percentage, numerical data was presented with mean, median, range and standard deviation.

Table 2. Comparison of "Take" Percentage of Skin Grafts Using Conventional Suture Fixation and Autologous PRP

Variable	Groups of Treatment		p-value
	Fixation with Sutures	**Autologous PRP**	
	N= 15	**N= 15**	
"Take" of skin graft (%)			
Mean±SD	84.16±15.33	84.36±13.83	**0.753**
Median	85	85	
Range (min-max)	44.4-98.9	63.0-97.9	

Normally distributed data was tested by dependent t-test meanwhile the abnormally distributed data was tested by Wilcoxon test using significant p-value < 0.05

Fifteen deep burns patients were included in the experiment. Each patient received equal amounts of experimental treatments. The mean patient age was 33.1 ± 18.1 years old; most of the patients were male (80%) and the largest cause for burns was flame (60%). Other causes for burns in this study were scald (13.3%) and electricity (26.7%). The majority of burns were observed in the right upper extremity (33.3%), with a mean burn percentage of 16.73% ± 7.99 (Table 1). The mean skin graft 'take' percentage using autologous PRP was 84.36% ± 13.83% and 84.16% ± 15.34% using suture fixation. Wilcoxon tests comparing the two experimental treatments showed no statistically significant difference, with a p-value of 0.753. In this study, autologous PRP was not superior than suture fixation.

4. Discussion

PRP is defined as a thrombocyte concentration of at least 10,000,000 thrombocytes/**µl** in 5 ml of plasma. [13] Through the increase of platelets, PRP contains 3-5 times the amount of normal growth factors and bioactive proteins. [14] The results in this study showed no statistically significant difference of intra-patient skin graft 'take' percentage in the two experimental groups; PRP and conventional suture fixation. A similar study comparing the effectivity of PRP vs conventional fixation methods was analyzed by Waiker et al, with statistically significant results advocating the benefits of PRP. [7] In the study however, different outcomes were analyzed such as post-operative graft adverse effects (hematoma, seroma, edema, re-grafting requirement), post-operative dressing requirements, pain, length of hospital stay, and scar formation. Difference in results may also be caused by to the variability of patients in Waiker's study, where there was a wide range of age, wound cause, anatomical distribution, and patient co-morbidities.

A study by Marck et al obtained similar insignificant result when applying PRP in the treatment of deep dermal burns. There was no significant difference between the mean take rate or the mean epithelialization rate between PRP-treated and control areas. However, this study analyzed the additive effect of PRP for split thickness skin grafts, not PRP as the main fixation method. [8] Furthermore, when compared to another study using PRP, there may be a difference in results due to varying techniques in processing the plasma. Waiker et al processed the PRP by collecting the blood sample into anti-coagulant vacutainers and then centrifuged the sample at 1000 rpm for five minutes. [7] In our study, drawn blood was collected into citrate-containing tubes and centrifuged at 1000 rpm for 12 minutes. Various factors which influence the yield of PRP are blood drawing; speed, time, and temperature of centrifugation; and the use of anticoagulants. [15] Different protocols may produce varying concentrations of PRP, which may affect the effectiveness of the treatment. At the moment there are varying centrifugation guidelines and a wide variation in platelet concentrations in PRP processing, and each protocol has their own standardized parameters and results. Platelet concentration may also be different between our study and the study by Waiker et al because of the low systemic platelet counts in burn patients, compared to other chronic wound patients. [7,8]

Although there was no statistically significant 'take' difference, the researchers argued that time required to work on skin grafts are significantly reduced when using autologous PRP compared to suture fixation. Plasmatic nutrition produced by the autologous PRP to affix the skin graft acts as a natural adhesive material that no longer requires fixation of wound edges using sutures, staplers, or other fixation methods. After a skin graft, the autologous PRP group no longer needs suture removal, thus conserving time and energy. [16,17]

Future intra-patient research using autologous PRP compared to conventional suture should increase sample size, process the plasma using a two-step spin centrifugation, record time spent on the surgery, and collect more post-operative data (hospital length of stay, post-operative wound care, granulation tissue, and follow-up complications).

5. Conclusion

The percentage of skin graft 'take' using autologous PRP on a deep burn wound bed was not significantly different compared to conventional suture fixation. This study showed different results compared to available studies, and the difference may be due to varying PRP processing technique and outcome variables. The use of PRP helped save time and effort intra- and post-operatively because of its instant adhesive abilities, and because there was no need for suture/stapler removal afterwards.

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