Clinical effect of platelet-rich fibrin in combination with narrow-band ultraviolet B treatment in patients with small area deep burn wounds

Jianhua Yang¹, Xue Li², Hao Liu³, Xiaodan Zhao¹*
¹Imaging Center, Shandong Provincial Third Hospital, Shandong University, ²Department of Cosmetic Surgery, Jinan Airong Plastic and Cosmetic Hospital, ³Department of Burn Reconstruction Surgery, The 960th Hospital of the PLA, Jinan, 250000 Shandong, China

*For correspondence: Email: feixie11118383927@163.com

Abstract

Purpose: To investigate the influence of the combined use of platelet-rich fibrin and narrow-band UV B (NB-UVB) treatment on small-area deep burn wounds in patients.

Methods: A total of 86 patients with small area deep burn wounds were assigned to control and study groups (n = 43/group). The control patients received routine drugs in combination with NB-UVB, while the study group was administered a combination of platelet-rich fibrin and NB-UVB therapy. Clinical efficacy indices were.

Results: In the study group, the pre and post-treatment serum levels of TNF-α were 222.75 ± 4.86 and 65.42 ± 5.33 ng/L, while those in control group were 221.45 ± 6.84 and 114.68 ± 2.53 ng/L, respectively. The study group serum concentrations of IL-8 at pre- and post-treatment were 120.75 ± 4.53 ng/L and 45.39 ± 8.26 ng/L, while the control group values were 122.38 ± 2.65 and 79.52 ± 2.34 ng/L, respectively. After treatment, the serum levels of TNF-α and IL-8 were significantly down-regulated in both groups, relative to pre-treatment values, with lower levels in the study group (p < 0.001). Wound healing time and frequency of dressing change in the study group were 20.6 ± 3.6 days and 7.1 ± 2.5 times, respectively, which were significantly lower than the corresponding control group values of 40.3 ± 10.7 days and 20.5 ± 5.6 times (p < 0.001). There was a significantly higher incidence of scars in the control group than in study group (p < 0.05).

Conclusion: Combined use of platelet-rich fibrin and NB-UVB in the treatment of small area deep burn wounds lowers the serum levels of inflammatory factors. However, the combined therapy should be subjected to further clinical trials prior to application in clinical practice.

Keywords: Small-area deep burn wounds, Platelet-rich fibrin, Narrow-band ultraviolet B (NB-UVB)

INTRODUCTION

In clinical research, deep burns which comprise deep 2nd-degree and 3rd-degree burns, refer to necrosis range reaching the deep dermis or deeper tissue. Generally, deep second-degree burn heals through changing of dressing, and it leaves obvious scars and pigmentation at later
stages, whereas patients with severe conditions suffer from dysfunctions. However, patients with deep second-degree burn in some special areas are treated with surgical methods. Patients with third-degree burns have difficulties in healing through change of dressing. Thus, surgery is needed for these patients to recover from the wounds, usually in the late stage [1-3]. Deep burns bring painful physical trauma to patients, and damaged full-thickness skin leads to a long healing time, and in severe cases, it is difficult for the wound to heal. The quality of wound healing has crucial impact on patients. Therefore, the choice of therapy is very important to patients.

Platelet-rich fibrin is a platelet preparation that contains a large number of growth factors with the potential of promoting wound healing, and its unique trimolecular stereo-reticular structure provides a framework for the rapid growth of granulation tissues [4-7]. Narrow-band ultraviolet B (NB-UVB), a phototherapy method that employs ultraviolet radiation at a wavelength of 311-312 nm, is an important treatment for dermatoses [9-11]. Not much is known about the use of platelet-rich fibrin in combination with NB-UVB for treating deep burns. In this study, a total of 86 patients with small-area deep burn wounds admitted to Shandong Provincial Third Hospital were selected for an in-depth investigation on the clinical effect of the use of platelet-rich fibrin in combination with NB-UVB in treating small-area deep burn wounds.

**METHODS**

**General patient information**

A total of 86 patients with small-area deep burn wounds admitted to Shandong Provincial Third Hospital, Shandong, China from June 2017 to December 2018 were assigned to control and study groups, each with 43 patients. The male: female ratio in control group was 25:18, among whom 19 patients had hand burns, 18 patients had foot burns, 4 had lower limb burns and 2 had upper limb burns. The study group had 27 males and 16 females, 18 patients had hand burns, 17 had foot burns, 6 had lower limb burns and 2 had upper limb burns. Table 1 shows that baseline data were comparable in both groups.

**Criteria for inclusion**

The included patients were those who satisfied the clinical diagnostic conditions for deep burns; those with burn surface area of 3-30 cm², and those with complete clinical medical records.

**Exclusion criteria**

Patients with peripheral vascular diseases; those receiving cytostatics or immunosuppressants; those with mental and other cognitive disorders, and patients who refused to cooperate with the researchers, were not included.

**Ethical approval**

This research was approved by the ethics committee of Shandong Provincial Third Hospital (approval no. 20220568587), and met the criteria in the Declaration of Helsinki [12]. All subjects were briefed in detail on the study protocol, purpose, processes, and significance, and signed consent forms for treatment of patients in the study.

**Treatments**

Firstly, patients admitted to Shandong Provincial Third Hospital underwent routine treatments such as anti-infective therapy, nutrition adjustment, etc. The necrotic tissues of skin surface were removed using a scalpel or ultrasonic debridement machine after disinfecting the wound surface, based on patient’s specific conditions. Then, the wounds were rinsed repeatedly with hydrogen peroxide solution, povidone-iodine solution as well as normal saline, and electrocoagulation was performed to stop bleeding thoroughly.

<table>
<thead>
<tr>
<th>Table 1: Baseline information on both groups</th>
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<tr>
<td><strong>Group</strong></td>
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<tr>
<td><strong>Gender</strong></td>
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<tr>
<td>Male</td>
</tr>
<tr>
<td>Female</td>
</tr>
<tr>
<td><strong>Age (years)</strong></td>
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<tr>
<td><strong>Burn surface area (cm²)</strong></td>
</tr>
<tr>
<td><strong>Bacterial culture</strong></td>
</tr>
<tr>
<td>Positive</td>
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<tr>
<td>Negative</td>
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After debridement, 5 mL of vacuum blood collection tube without anticoagulant was used to collect venous blood from median cubital vein, and 40-80 mL of venous blood was collected on the basis of the required amount for centrifugation at 3000 rpm for 10-12 min. After centrifugation, the blood was divided into 3 layers: the top layer of pale-yellow platelet-poor plasma clarifying liquor, the bottom layer of dark red cell fragments, and the middle layer of pale-yellow platelet-rich fibrin [13]. A Cellogel strip was taken out with a sterile syringe needle, thus remaining tail section alternating with erythrocyte. If columnar platelet-rich fibrin could not be placed on patient's trauma, sterile gauze in flake shape obtained by squeezing was used to cover the wounds. In young patients or those with poor physical conditions, venous blood consistent with cross-matching from healthy immediate family members was collected.

All patients were irradiated using a topical NB-UVB treatment equipment at 1-day intervals, with first irradiation dose of 0.4 - 0.6 J/cm². During the treatment, the patients were required to wear special goggles to protect their eyes, and the medical staff observed whether erythema, edema, or other unwanted events occurred. Irradiation dose was increased by 10% of the original dose, based on patients' conditions. Additional dose was not used if a patient had erythema. If erythema appeared, the irradiation was stopped. However, once erythema was reduced, the irradiation started from 50% of the original dose, and the dose was increased gradually.

**Parameters evaluated**

Pre- and post-treatment fasting venous flood (3 mL) was collected from each patient for the determination of serum indicators. The blood was spun using a centrifuge (manufacturer: Jinan Bokun Science and Technology Co., Ltd.; model: TD-4X) at 3000 rpm for 10 min, and the supernatant obtained was kept in a refrigerator at −80 °C. Serum levels of TNF-α and IL-8 were assayed with ELISA kits from Shanghai Enzyme-linked Biotechnology Co., Ltd. and Wuhan Fine Biotech Co., Ltd., respectively, with operations in line with the kit instructions. The wound healing time, the frequency of dressing changes, and the hyperplasia of scars were recorded and compared statistically between both groups.

**Statistical analysis**

Results were processed with SPSS version 20.0 software, while GraphPad Prism 7 was applied for graphics. Counted data were analyzed with χ² test and normality test, while measured data were analyzed with t-test. Values of p < 0.05 indicated statistically significant differences.

**RESULTS**

**Serum levels of TNF-α and IL-8**

Pre- and post-treatment serum concentrations of TNF-α were 222.75 ± 4.86 and 65.42 ± 5.33 ng/L, respectively, in study group, while the control group values were 221.45 ± 6.84 ng/L and 114.68 ± 2.53 ng/L, respectively. The post-treatment serum TNF-α concentrations were significantly reduced, relative to pre-treatment concentrations, but serum TNF-α after treatment was significantly lower in study group (Figure 1).

**Figure 1:** Comparison of the pre- and post-treatment serum TNF-α levels between both groups (n = 43). *p < 0.001, **p < 0.001, ***p < 0.001

Before and after treatment, the serum IL-8 levels of the study group were 120.75 ± 4.53 and 45.39 ± 8.26 ng/L, respectively, while those in the control group were 122.38 ± 2.65 and 79.52 ± 2.34 ng/L, respectively. After treatment, serum IL-8 levels in both groups were significantly reduced, but serum IL-8 level was lower in the study group (Figure 2).

**Wound healing time and frequency of dressing changes**

The wound healing time and frequency of dressing changes were significantly lower in study group (p < 0.001; Table 1).

**Table 1:** Comparison of wound healing time and frequency of dressing changes between the two groups (n = 43)

<table>
<thead>
<tr>
<th>Group</th>
<th>Wound healing time (days)</th>
<th>Frequency of dressing change (times)</th>
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<tbody>
<tr>
<td>Study group</td>
<td>20.6±3.6</td>
<td>7.1±2.5</td>
</tr>
<tr>
<td>Control group</td>
<td>40.3±10.7</td>
<td>20.5±5.6</td>
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*p-value*<0.001 <0.001
DISCUSSION

Platelet-rich fibrin, an autologous platelet concentrate, is rich in cytokines and growth factors. It effectively promotes the healing of multiple pathological wounds and has significant efficacy in clinics. Thus, it takes advantage of regulatory effect of cytokines, immunomodulatory effects of leukocytes, and support effect of fibrin, thereby achieving wound healing [15-18]. Growth factors contained in platelet-rich fibrin regulate the expressions of proteins and promote the proliferation of fibrocytes, thereby healing wounds and repairing damaged tissues.

Furthermore, platelet-rich fibrin gel's organizational structure is similar to human natural tissues. Characterized by a large gap and good elasticity, it plays the role of cell scaffold in cytothesis and provides a good transport pathway of oxygen and nutrients for cell proliferation. At the same time, platelet-rich fibrin entraps a large number of leukocytes that were activated during centrifugation; it constantly releases immunoregulation-related cytokines during the degradation of platelet-rich fibrin and plays a good anti-infective role in the wounds [19-22]. The present study has demonstrated significantly lower serum concentrations of inflammatory factors in the two groups after treatment than in pre-treatment, with significantly lower levels in study group. This suggests that activated leukocytes in platelet-rich fibrin exerted a better anti-infective effect and greatly reduced the levels of inflammatory factors in the wounds.

The results of the present study also revealed that the study group had significantly shorter wound healing time, lower frequency of dressing changes, and higher incidence of scars than the control group, with statistically significant differences. The reason for these differences may be that a variety of growth factors in platelet-rich fibrin regulate the expression of proteins and proliferation of fibrocytes, and promote wound healing and tissue repair.

NB-UVB irradiation produces immunosuppressive effects and has good efficacy, high safety, and light toxicity, without an increase in the incidence of skin cancer after irradiation. It induces apoptosis of T lymphocytes and keratinocytes, thereby producing mediators with anti-inflammatory or immunomodulatory effects in the irradiated site, down-regulating cytokines such as IL-2, IL-8, and IL-10; reducing inflammatory response, and alleviating the clinical symptoms in burn patients. It was also found that its combination with NB-UVB produced a better therapeutic effect. Yoshimura et al [23] reported that the platelet-rich fibrin prepared from autologous blood had high safety and unique therapeutic advantages for small-area deep burns. Compared with conventional drugs, it significantly reduced the number of dressing changes, accelerated wound healing, reduced pain during dressing changes, and improved the long-term healing quality of skin, with high clinical application value. This report further indicates that platelet-rich fibrin in combination with NB-UVB has a high clinical value in the treatment of small-area deep burns.

Limitations of this study

Limited by research conditions, this single-center study used a small sample size. At the same time, no long-term follow-up observation was performed on patients. Therefore, in the follow-up study, the sample size will be increased in multi-center research, and the clinical follow-up time will be extended to provide more evidence-based data for the treatment of patients with small-area deep burns.

CONCLUSION

The combination of platelet-rich fibrin and NB-UVB irradiation in the treatment of small-area deep burns has obvious clinical significance and high potential for clinical application.
deep burn wounds decreases the serum levels of inflammatory factors, reduces serum levels of TNF-α and IL-8, decreases the frequency of dressing change and incidence of scars in patients. It also promotes rapid healing of deep burn wounds. Therefore, the combined therapy has a potential for use in clinical practice but validation of the findings of this study in further clinical trials is necessary.

DECLARATIONS

Acknowledgements

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Funding

None provided.

Ethical approval

This work was approved by the Ethics Committee of Shandong Provincial Third Hospital, Shandong (approval no. 20220568587).

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Conflict of Interest

No conflict of interest associated with this work.

Contribution of Authors

We declare that this work was done by the authors named in this article and all liabilities pertaining to claims relating to the content of this article will be borne by the authors. Jianhua Yang and Xiaodan Zhao designed the study and drafted the manuscript. Xue Li, Hao Liu, and Xiaodan Zhao were responsible for the collection and analysis of the study data. Jianhua Yang and Xiaodan Zhao revised the manuscript critically for important intellectual content. All authors read and approved the final manuscript.

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REFERENCES


