ORIGINAL ARTICLE

Evaluation of The Effect of PRP Injection in Survival of Venous Flaps in Upper Extremity Reconstruction

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Abstract

Background: ***Traumatic injuries to the upper limbs may lead to severe and complex lesions affecting several compartments, including bone, skin, tendons, and neurovascular structures.***

Aim: ***To assess the validity and application of the use of autologous platelet-rich plasma (PRP) in veno-cutaneous free tissue transfer survival for reconstruction of upper extremity defects (Hand, forearm).***

Patients and methods: ***This prospective cohort investigation comprised twenty cases with upper extremity abnormalities (hand and forearm) selected among cases admitted to the Department of Plastic and Reconstructive Surgery at Al-Azhar University Hospitals. This study included 20 patients with Upper extremity defects (hand and forearm), who were subdivided randomly into two groups: Group A: 10 patients with hand and forearm defects who underwent Free Veno-cutaneous tissue transfer with PRP injection, and Group B: 10 patients with hand and forearm defects who underwent Free Veno-cutaneous tissue transfer without PRP injection.***

Results: ***As regards the comparison of flap parameters between the studied groups, the result was statistically significant regarding capillary refill and time of healing (days) (p value <0.05). Regarding the comparison of flap complications among the examined groups, the results were statistically significant regarding partial necrosis (p-value <0.05).***

Conclusion: ***PRP significantly improved the survival rate of venous flaps in upper extremity reconstruction, with a lower rate of adverse events and better long-term functional outcomes. It also demonstrated that PRP was superior to normal flap care without PRP injection in terms of flap survival.***

Keywords: PRP; venous flaps; reconstruction

1. Introduction

Traumatic injuries to the upper limbs may lead to severe and complex lesions affecting several compartments, including bone, tendons, skin, and neurovascular structures. Limb functionality may be impaired. Complex wounds are typically the result of road traffic accidents and work. Or domestic incidents, electrical, thermal, or chemical burns, and firearm injuries.[1]

Upper limb abnormalities are distinctive, and an ideal reconstruction must ensure the mobility of tendons and joints while being sufficient for heavy work, all the while preserving hand sensitivity. The predominant reconstructive alternatives consist of advancement or rotation flaps, regional flaps, and free flaps.[2]

A viable approach for handling such situations is the venous flap. The veno-cutaneous free tissue transfer was initially presented in an experiment performed by Nakayama et al.,[3] characterized by a composite flap of skin and subcutaneous veins, relying only on the venous system for flap perfusion. In contrast to traditional arterial flaps, venous flaps neither compromise a donor site artery nor require deep dissection. This leads to a simplified process and a reduction in donor site morbidity. Moreover, they are thinner and more elastic as they comprise only venous plexus, skin, and subcutaneous fatty tissue. They may also be concurrently transplanted as a composite flap to reconstruct deficits in damaged vessels and tendons. The venous flap provides a particularly advantageous form for repairing defects involving segmental vascular loss, especially when donor locations for conventional flaps are restricted.[4]

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The advantages of venous flaps render them particularly suitable for addressing soft tissue abnormalities in the upper limbs, particularly when local and other traditional flaps are available. A possible reason for the viability of venous flaps is the infusion of PRP, which markedly enhances their life span and is closely associated with angiogenesis. The infusion of PRP may serve as a crucial method for initiating angiogenesis by attracting the endothelial cells that line the blood vessels.[5]

The principal mechanisms behind PRP-induced neovascularization include the release of pro-angiogenic factors (VEGF), activation of stem cell secretory activities, differentiation of stem cells into endothelial cells, and direct stimulation of endothelial cell proliferation. The angiogenic features of PRP could lower the danger of necrosis in veno-cutaneous free tissue transfers by enhancing intra-flap vascularization.[6]

Numerous accounts exist about the utilization of venous flaps in diverse upper limb restorations. Nevertheless, due to their atypical perfusion patterns and variable survival rates in certain cases, the clinical application of venous flaps remains subject to further investigation.[7]

The objective of this study is to assess the efficacy and applicability of PRP in enhancing the survival of veno-cutaneous free tissue transfers for the reconstruction of upper extremity deformities. (Manual extremity, antebrachium)

The objective of the work is to assess the validity and application of the use of PRP in veno-cutaneous free tissue transfer survival for reconstruction of upper extremity defects. (Hand, forearm).

2. Patients and methods

This prospective cohort research involved 20 cases with upper extremity defects (hand and forearm), which were chosen from cases admitted to the Department of Plastic and Reconstructive Surgery, Al-Azhar University hospitals. This research involved twenty cases with Upper extremity defects (hand and forearm), which were subdivided randomly into two groups: Group A: Ten cases with hand and forearm defects who underwent Free Veno-cutaneous tissue transfer with PRP injection, and Group B: 10 patients with hand and forearm defects who underwent Free Veno-cutaneous tissue transfer without PRP injection.

Ethical Considerations: The research protocol has been submitted for permission to the Institutional Review Board of the Department of Plastic and Reconstructive Surgery at Al-Azhar University. Informed written consent has been secured from each participant involved in the trial, incorporating the risks of operations, donor site morbidity, and flap failure. Confidentiality and personal privacy were maintained at all levels of the research.

Inclusion criteria: Age: up to 65 years. Sex: both sexes and patients with upper extremity defects (hand and forearm) that are amenable to venous flap coverage.

Exclusion criteria: Any comorbidity that affects the vascular wall, cases with a severe status of chronic illness such as uncontrolled diabetes mellitus, chronic renal failure, hypertension, liver failure, or unhealthy skin conditions. (Infection, allergy, eczema), severe mental or psychological disorders and previous deep scar or surgery at flap donor sites.

Methods:

All cases have been exposed to: History taking, examinations, and investigations.

Preparation of platelet-rich plasma:

The method used was freshly drawn 20 ml venous autologous blood. This blood was then transferred to 4 ethylene-diamine-tetra-acetic acid bulbs so that each contains 5 ml of blood. Blood was then centrifuged at 2000 revolutions per minute for 10 min. This divided the venous blood into two parts: the upper part contains plasma, and the lower part contains red blood cells. The upper part of the test tube, i.e., plasma, was collected in a separate test tube. This plasma was then again centrifuged at 1200 revolutions per minute for 10 min. By this second centrifugation, plasma gets divided into two parts: the upper part, called the buffy coat, and the lower part, which is rich in platelets. From 20 ml of venous blood, approximately 2–4 ml of PRP was extracted.

Operation technique:

Type of anesthesia: General anesthesia in 15 patients and brachial plexus block in 5 patients.

Marking of the flap and flap design: Single venous pedicle was identified by applying slight compression at the proximal forearm to identify tributaries of veins (basilic, cephalic), the skin paddle was centralized around the venous pedicle according to the size of the defect.

Sterilization: The operative field, including donor and recipient sites in all patients, was sterilized with povidone-iodine.

Two teams approach: First team for preparation of the defect (debridement and transformation for geometric shape and second team for preparation of veins + harvesting of veno-cutaneous free flap.

Flap Harvesting: Incision was made around the skin paddle (template). Dissection was done to identify the venous pedicle supplying the flap. Good hemostasis was maintained. The venous pedicle was completely dissected and The flap was ready for microvascular transfer.

Preparation of the recipient site:

Two teams were beginning at the same time to prepare the recipient site and elevation of the flap, especially if preparation would take a long time, e.g., other procedures include debridement of necrotic tissue after extensive posttraumatic tissue loss. Maintaining a bloodless field throughout the procedure has been achieved. Preparation of the recipient veins to be ready for microvascular anastomosis. The veno-cutaneous free flap and soft tissues were kept moist all the time by irrigation, and the exposed vessels were periodically irrigated with diluted lidocaine to keep them moist and minimize vasospasm.

Veno-cutaneous free tissue transfer: Once the flap was raised and isolated on supplying veins, securing the flap in place, and taking a break for 15 minutes was done, and upon return, assessment of the flap color and capillary refill time was performed. Dividing the recipient vein, preparing its wall, and irrigating with heparinized saline (5000 IU in 200 mL saline) was done. Making sure that the venous pedicle length was enough to reach the area planned for anastomosis was done before dividing the flap. Dividing the flap. Liga clips on the veins and is divided by sharp scissors. Preparing the venous wall was done through a clean cut, removal of adventitia, dilatation, irrigation, and placement within an approximated double clamp. End-to-end anastomosis of the veins using a surgical magnifying loop (X6) and microscopic magnification (X22) and Prolene 10-0, beginning by the anterior wall, then the posterior wall.

Injection of PRP: 2 ml of PRP was used for infiltration at the epidermal junction along the margins of the veno-cutaneous free flap, all around. 1 ml is preserved for the first and second postoperative for injection at the site of congestion.

Closure of the donor site: Direct closure was possible if the width of the skin paddle didn't exceed 3-4 cm, split thickness skin graft was done for larger defects.

Proper dressing without any pressure of fap and anastomosis, and Splinting. The patient wakes up pain-free and without nausea, with the flap protected when moving the patient.

Follow-up: Patients stayed in the hospital 10-14 days, and then were followed up on a regular basis for 3-6 months, and assessments were divided into:

Functional: range of motion of fingers and hand, functional deficit of donor sites.

Aesthetic: recipient site: flap bulkiness, scars, contour defect, color, and texture match

Donor site: scar pigmentation and contour defect

CASE PRESENTATION

A case of male patient 25 years old presented with a posttraumatic crushing injury at the dorsum of the left thumb with loss of skin and a segment of the EPL.

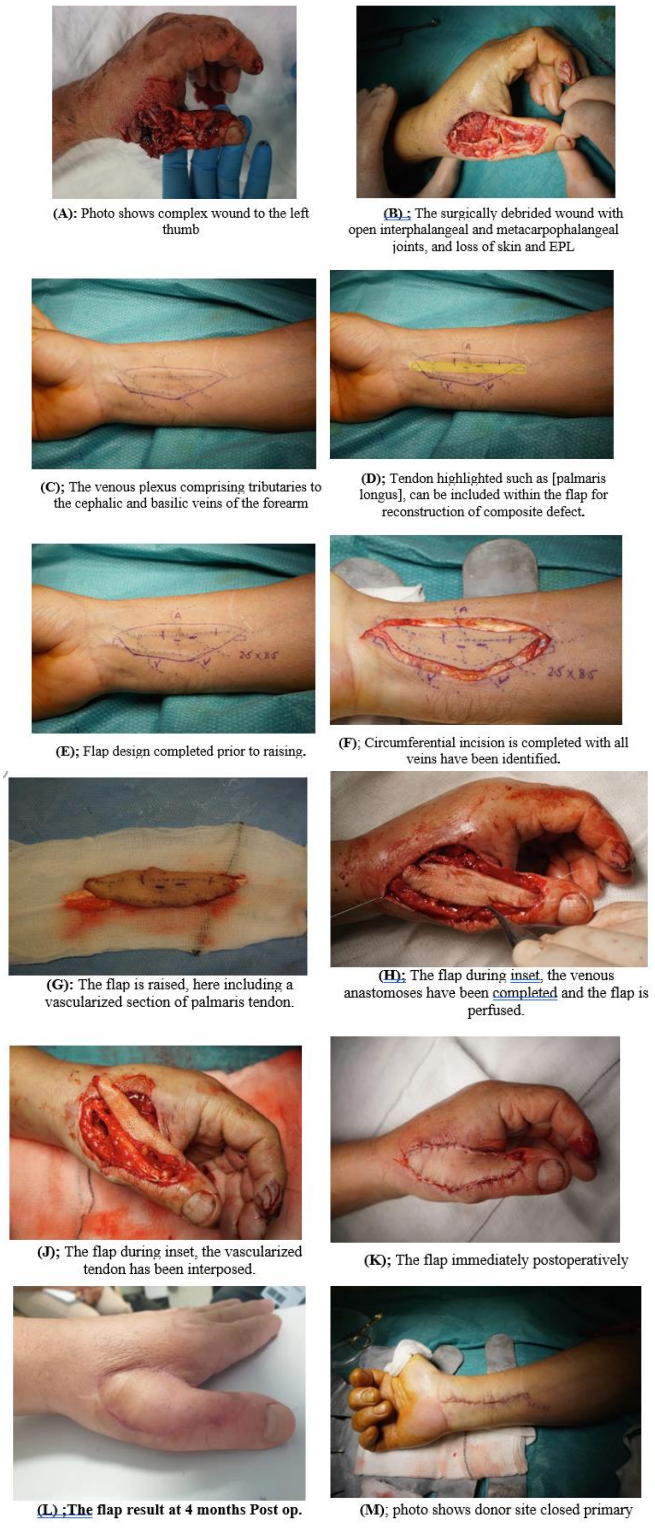

Figure 1. Case presentation.

3. Results

As regard the comparative analysis of baseline data among studied groups, it has been discovered that, there was non-statistically significant difference regarding age, gender, smoking, comorbidities, and dominant hand (p-value over 0.05).

Table 1. comparative analysis of baseline data among examined groups

	(GROUP I) VENO-CUTANEOUS FREE TISSUE TRANSFER WITH PRP INJECTION (N=10)	(GROUP II) VENO-CUTANEOUS FREE TISSUE TRANSFER WITHOUT PRP INJECTION (N=10)	P VALUE
AGE MEAN ±SD RANGE	40.2±5.5 22-65	38.8±6.6 20-65	0.61
GENDER MALE FEMALE	6(60%) 4(40%)	7(70%) 3(30%)	0.63
SMOKING NO EX-SMOKER CURRENT SMOKER	5(50%) 1(10%) 4(40%)	4(40%) 2(20%) 4(40%)	0.80
COMORBIDITIES NO CONTROLLED DM CONTROLLED HTN	9(90%) 0(0%) 1(10%)	9(90%) 1(10%) 0(0%)	0.90
DOMINANT HAND RIGHT LEFT	8(80%) 2(20%)	9(90%) 1(10%)	0.53

As regard the comparison of flap parameter between studied groups, the result was statistically significant regarding capillary refill and time of healing (days) (p value <0.05), the result was non-statistically significant regarding temperature and color (p value >0.05).

Table 2. comparative analysis of Clinical flap survival between studied groups

CLINICAL FLAP SURVIVAL	(GROUP I) VENO-CUTANEOUS FREE TISSUE TRANSFER WITH PRP INJECTION (N=10)	(GROUP II) VENO-CUTANEOUS FREE TISSUE TRANSFER WITHOUT PRP INJECTION (N=10)	P VALUE
COLOR NORMAL COLOR (PINK) CYANOSED BLACKISH DUE TO NECROSIS	80(80%) 1(10%) 1(10%)	6(60%) 1(10%) 3(30%)	0.30
TEMPERATURE NORMAL HYPOTHERMIA	8(80%) 2(20%)	6(60%) 4(40%)	0.32*
CAPILLARY REFILL (SEC) MEAN ±SD RANGE	3 ±0.5 2-5	4.1 ±0.6 3-7	0.003*
HEALING TIME (DAYS) MEAN ±SD RANGE	20±5.4 14-30	28±6.7 20-35	0.008*

As regard the comparative analysis of flap complication among studied groups, the results were statistically significant regarding partial necrosis (p value below 0.05). conversely, there was insignificant distinction according to congestion, total flap loss, re-exploration, bleeding, dehiscence, adhesion, contracture and thrombosis (p value >0.05).

Table 3. comparative analysis of Flap complication among studied groups

FLAP COMPLICATION	(GROUP I) VENO-CUTANEOUS FREE TISSUE TRANSFER WITH PRP INJECTION (N=10)	(GROUP II) VENO-CUTANEOUS FREE TISSUE TRANSFER WITHOUT PRP INJECTION (N=10)	P VALUE
CONGESTION	2(20%)	4(40%)	0.32
TOTAL FLAP LOSS	2(20%)	4(40%)	0.32
PARTIAL NECROSIS	1(10%)	4(40%)	0.01*
RE-EXPLORATION	2(20%)	5(30%)	0.47
DEHISCENCE	1(10%)	2(20%)	0.53
ADHESION	1(10%)	2(20%)	0.53
CONTRACTURE	0(0%)	3(30%)	0.21
THROMBOSIS	0(0%)	2(20%)	0.47

Regarding wound closure of donor site in patients who underwent veno-cutaneous free tissue transfer, wound closure was non-statistically significant. As regard the comparison of donor site complication among examined groups, the results were non-statistically significant regarding Dehiscence, Infection, Seroma and Abnormal sensation (p value >0.05).

Table 4. comparative analysis of donor site closure and complication among studied groups.

		(GROUP I) VENO-CUTANEOUS FREE TISSUE TRANSFER WITH PRP INJECTION (N=10)	(GROUP II) VENO-CUTANEOUS FREE TISSUE TRANSFER WITHOUT PRP INJECTION (N=10)	P VALUE
WOUND CLOSURE	direct	7 (70%)	8(80%)	0.38
	Graft	3(30%)	2(20%)	
COMPLICATIONS AT DONOR SITE	Wound Dehiscence	2(20%)	1(10%)	0.53
	Infection	1(10%)	2(20%)	0.53
	Seroma	1(10%)	0(0%)	1
	Abnormal sensation	2(20%)	1(10%)	0.53

As regard the comparison of overall flap survival between studied groups, the results were statistically insignificant (p value =0.32).

Table 5. comparative analysis of Overall flap survival between studied groups

OVERALL FLAP SURVIVAL	(GROUP I) VENO-CUTANEOUS FREE TISSUE TRANSFER WITH PRP INJECTION (N=10)	(GROUP II) VENO-CUTANEOUS FREE TISSUE TRANSFER WITHOUT PRP INJECTION (N=10)	P VALUE
SURVIVED	8(80%)	6(60%)	0.32
NOT SURVIVED	2(20%)	4(40%)	

As regards the comparison of overall satisfaction about the procedure between studied groups, the

results were statistically insignificant (p-value below 0.05).

Table 6. comparative analysis of Overall satisfaction about the procedure between studied groups

OVERALL SATISFACTION ABOUT THE PROCEDURE	(GROUP I) VENO-CUTANEOUS FREE TISSUE TRANSFER WITH PRP INJECTION (N=10)	(GROUP II) VENO-CUTANEOUS FREE TISSUE TRANSFER WITHOUT PRP INJECTION (N=10)	P VALUE
SATISFIED	7(70%)	4(40%)	0.63
NOT SATISFIED	3(30%)	6(60%)	

4. Discussion

In the comparison of baseline data across the study groups, a statistically insignificant distinctions were observed concerning gender, age, smoking status, comorbidities, and dominant hand (p value over 0.05).

The comparison of flap parameters across the examined groups revealed a statistically significant difference in capillary refill and healing time (days) ($p < 0.05$), whereas temperature and color showed statistically insignificant variations (p-value over 0.05).

Consistent with the present research, Jeon et al.[8] evaluated the impact of platelet-rich plasma on skin graft viability and demonstrated that blood perfusion was significantly greater in the platelet-rich plasma group relative to the control group. Consequently, they concluded that platelet-rich plasma reinstates the perfusion of composite grafts by promoting revascularization and may have therapeutic implications for the survival of composite grafts.

In alignment with the present research, Wang et al.[9] aimed to investigate the therapeutic efficacy of surgical treatment utilizing platelet-rich plasma in conjunction with a skin flap transplant for open fractures accompanied by soft tissue defects. The findings indicated that platelet-rich plasma combined with a skin flap transplant may shorten the healing duration of fractures and wounds. The mean wound healing duration in the PRP group (22.40 ± 2.10 days) was significantly less than that in the control group (32.20 ± 3.30 days) (P-value over 0.05). The mean fracture healing duration in the PRP group (6.50 ± 2.20 months) was significantly less than that in the control group (7.51 ± 2.33 months) (P-value over 0.05).

The comparison of flap complications across the examined groups revealed statistically significant findings for partial necrosis (p-value below 0.05). Conversely, there is no statistically significant distinction concerning congestion, entire flap loss, bleeding, re-exploration, adhesion, dehiscence, contracture, and thrombosis (p value > 0.05).

Consistent with the present investigation, Wang et al.[9] demonstrated that the occurrence of adverse responses in the PRP-treated flaps was much lower than in the control group. In the PRP group, there was one instance of infection, resulting in a total incidence rate of 2.70 percent. The control group exhibited two cases of infection, one case of significant vascular injury, and one case of ischemic muscular contracture, resulting in a total incidence rate of 11.43 percent.

The wound closure of the donor site in cases where veno-cutaneous free tissue transfer was not statistically significant. The comparison of donor site complications among the examined groups yielded statistically insignificant findings for Infection, Dehiscence, Seroma, and Abnormal sensation (p-value over 0.05).

Fang et al.[10] showed that PRP gel can enhance wound healing, mitigate scar formation, and reduce pain at the donor site following skin graft operations.

Slaninka et al.[11] observed that PRP had an advantageous impact on skin transplant donor sites, since it reduced healing time. The application of PRP for wound healing may prove advantageous for cases who have not responded to conventional therapy, as well as for high-risk populations susceptible to complications in wound healing.

The comparison of total flap survival across the examined groups yielded no statistically significant findings (p-value equals 0.32).

In alignment with the present work, Chai et al.[12] examined the impact of autologous platelet-rich plasma on skin flap viability and discovered that PRP administration enhanced the survival rate of the skin flap. Moreover, it diminishes the inflammatory response in skin flap transplantation as well as has a higher effectiveness in promoting the formation of new soft tissue.

The comparison of overall satisfaction regarding the process among the groups studied yielded statistically insignificant results (p-value below 0.05).

Maghsoudi et al.[13] showed that the efficacy of platelet-rich plasma in skin flap transplantation is satisfactory.

4. Conclusion

The study found that PRP significantly improved the survival rate of venous flaps in upper extremity reconstruction, with a lower rate of adverse events and better long-term functional outcomes. It also demonstrated that PRP was superior to normal flap care without PRP injection in terms of flap survival.

Disclosure

The authors have no financial interest to declare in relation to the content of this article.

Authorship

All authors have a substantial contribution to the article

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