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CASE REPORT
Reconstructive

Negative Pressure Wound Therapy as a Salvage Procedure in Venous Congestion of Microsurgical Procedures

Jorge I. Quintero, MD*
Laura L. Cárdenas, MD*
Adriana C. Achury, MD*†
Daniela Vega-Hoyos, MD*†
Julio Bermúdez, MD, MSc, PhD*,†
FSFB Hand and Microsurgery Research Group

Summary: Negative pressure wound therapy (NPWT) is widely used in skin defects, active infection, and surgical reconstruction; lately, it is being used after skin graft to improve the adhesion on the receptor area. During the last decade, another indication has been identified: the use of NPTW to avoid complications after free flaps such as venous congestion and the risk of necrosis. NPWT can be used in the initial complication of a free flap, and the venous congestions can be treated with this technique, with very good outcomes. NPWT can be established as a part of a postoperative protocol in microsurgical procedures to avoid major complications.
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Negative pressure wound therapy (NPWT) has been established as a part of the treatment of skin defects, active infections, and following skin grafts to promote their integration to the recipient area. Over the last decade, this therapy has been commonly used to avoid complications after free flap transfers[1,2] NPWT aids in decreasing complications such as venous congestion, and improves the neovascularization of the tissue in the recipient area.[3] Most of the existing literature refers to its usage for improving venous congestion; however, there are fewer studies on digital replantation or pediculate grafts. This case series aims to describe the outcomes of microsurgical procedures that led to immediate complications, and were treated using NPWT as a salvage procedure.

MATERIAL AND METHODS

Seven free flaps required NPWT due to venous congestion after surgery. We described demographics, flap characteristics, microsurgical technique, whether the patient required NPWT after surgery or not, the type of pressure used, and the treatment duration (in days). NPWT was initiated when venous congestion was clinically diagnosed. An anticoagulation protocol using nonfractioned heparin infusion was established after free flap surgeries. Complications after the heparin infusion were assessed. The integration of the free flap was described after the first, third, and the sixth month postoperative.

RESULTS

From 20 free flaps performed between 2010 and 2020, seven patients who underwent microsurgical intervention to cover skin defects and needed NPWT were included. Six men with an average age of 39.4 years (range 30–59 years) received six flaps to cover skin defects in the lower limb (Table 1) (Fig. 1).

All the patients were clinically diagnosed with venous congestion, and the NPWT was applied immediately after the identification. NPWT is applied peripherally in the skin of the free flap, in less than 180 degrees of its circumference away from the pedicle. Just one patient needed re-exploration of the microsurgical anastomosis prior to the application of the NPWT. The indication for the re-exploration was the rapid establishment of venous congestion, less than 24 hours after surgery; in our cases, this was the only venous congestion established rapidly with a high indication for venous exploration, with final result in thrombosis of one vein that needed irrigation and new anastomoses. Two cases with peripheral skin necrosis were identified at postoperative follow-up, and NPWT was initiated at 453 and 826 hours after surgery, respectively. The average time between the diagnosis of venous congestion and the application of the NPWT was 51.5 hours (range 24–125 hours). The use of the NPWT was incisional. Average duration of the NPWT was 7.8 days (1–24); four patients had continuous therapy

*From the *Hand and Microsurgery Division, Department of Orthopedics and Traumatology, Hospital Universitario Fundación Santa Fe de Bogotá, Bogota, Colombia; and †Universidad de los Andes, School of Medicine, Bogota, Colombia.*

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Table 1. Demographics

Case	Age	Gender	Diagnosis	Defect	Area of Defect	Smoker	Comorbidities	Type of Flap	Flap	Microsurgical Technique
1	38	Man	Open fracture GA IIIa proximal tibia	Ankle	10 × 11 cm			Free flap	ALT	1 artery 2 veins
2	54	Man	Segmental fracture radius and ulna IIIb	Forearm	6 × 7 cm		HBP	Free flap	Parascapular	1 artery 2 veins
3	31	Woman	Calcaneus fracture	Heel	5 × 10 cm	Yes		Free flap	ALT	1 artery 2 veins
4	34	Man	Patella fracture	Knee	9 × 15 cm			Free flap	ALT	1 artery 2 veins
5	30	Man	Skin defect, necrotic prior free flap	Knee	8 × 10 cm			Free flap	ALT	1 artery 2 veins
6	59	Man	Open fracture GA III B	Tibia	11 × 27 cm		HBP	Free flap	Parascapular	1 artery 2 veins
7	30	Man	Crush injury, exposed calcaneus	Foot	8 × 11 cm			Free flap	ALT	1 artery 2 veins

ALT, antero lateral DIP, distal interphalangeal joint; GA, Gustilo Anderson, HBP, high blood pressure; Thigh; IP, interphalangeal joint.

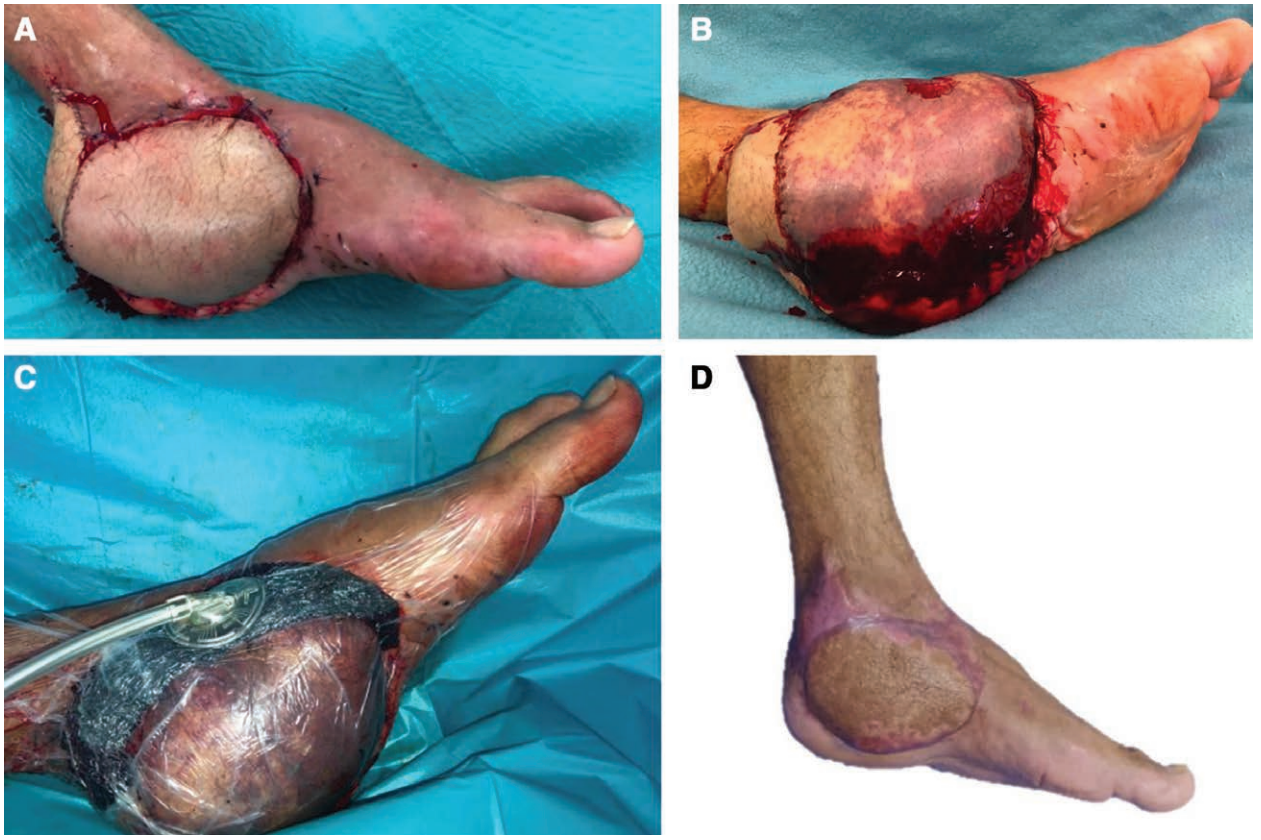

Fig. 1. Defect on the medial aspect of the heel. A, Immediate postoperative with ALT free flap. B, 24 hours postoperative with venous congestion. C, After exploration, vein thrombectomy and new anastomosis, NPWT. D, final outcome at 6 months follow-up.

and two had intermittent. Unfortunately, for one patient, we lacked information about the blood loss associated with the NPWT. Pressure was between 50 and 125 mm Hg. The variability of the pressure, intensity, and days of the therapy is due to the lack of information in the literature, and we followed the manufacture's recommendation (Table 2).

None of the patients had any late complications in the donor area, in the receptor area, or associated with the anticoagulation therapy. None of the patients needed blood transfusion secondary to active bleeding or the use of NPWT during the time in the hospital. At the end of the follow-up, none of the patients had flap necrosis, flap loss, or reimplanted finger loss. Full integration of the flap was seen in all the patients at 3 months postoperative, and final follow-up was 6 months (3–12 months) (Table 3).

DISCUSSION

To prevent venous congestion, different anticoagulation therapies have been described, but none are currently

Table 2. Description of the NPWT Therapy and Anticoagulation Protocol

Case	NPWT Immediately after Surgery	Anticoagulation Protocol	Immediate Complication of the Flap	Exploration	Time between Complication and Application of NPWT (h)	Duration of NPWT (d)	NPWT Type of Pressure	Pressure (mmHg)
1	No	Yes	Venous congestion	No	125	4	Intermittent	50
2	No	Yes	Superficial necrosis	No	826	5	No info	No info
3	No	Yes	Venous congestion	No	50	2	Continuous	125
4	No	Yes	Venous congestion	No	28	7	Continuous	125
5	No	Yes	Venous congestion	No	34	3	Continuous	125
6	No	Yes	Venous congestion	No	48	24	Intermittent	50
7	No	Yes	Venous congestion	Yes	24	10	Continuous	125

Anticoagulation protocol: The protocol consists of an IV bolus of 16–18 U/Kg of heparin, followed by 8 U/Kg/h continuous infusion. PTT is measured every 6 h, and the heparin bolus has to be modified by 2 U/kg/h to achieve a 1.5 PTT index. Platelet count is measured every 48 h. The infusion lasts 120 h and is replaced by aspirin 81 mg P.O. for 30 days.

Table 3. Percentage of Integration and Follow-up

Case	Skin Graft	Integration 1 month Follow-up	Integration 3 months Follow-up	Late Complication	Final Follow-up
1	No	100%	100%	None	12 months
2	Yes	100%	100%	None	3 months
3	No	100%	100%	None	12 months
4	No	100%	100%	None	6 months
5	No	100%	100%	None	3 months
6	No	100%	100%	None	6 months
7	Yes	100%	100%	None	3 months

accepted in the literature.[4] It is generally accepted in microsurgery that for one artery, two veins should be anastomosed to allow outflow. Another way to treat this complication is by using leeches, with major complications during and after their use. Recently NPWT has been established to treat venous congestion.[5–10] The main treatment initiated after venous congestion is observed is the exploration of microsurgical anastomosis, irrigation, thrombectomy, and new anastomosis; leeches are a very good option in this treatment.[11]

To our knowledge, there are fewer complications with the use of NPWT when venous congestion in a free flap is identified. The mechanical explanation for this is that the negative pressure allows tissue compression (decreasing the local edema and also reducing the pro-inflammatory response secondary to the intervention) and improves the neovascularization (decreasing the reperfusion ischemia ratio). With these microvascular events, the venous congestion seems to be unlikely, but attention should be given to assess if active bleeding is observed, whether the pedicle is injured, and whether an emergency surgery needs to be performed.[12–14]

Qiu[15] highly recommends NPWT as an incisional method to assess venous congestion. The device must be used exclusively after a mechanical obstruction of the microanastomosis is detected. Yu[16] described 137 free flaps in which he used the NPWT as an incisional therapy, leaving the NPWT about 5 days, with a constant pressure between −75 and −125 mm Hg with full integration. Agarwal[17] described that therapies using pressure as low as −25 mm Hg are unable to produce neovascularization and cannot decrease the number of bacterial colonies. Pressure as high as −500 mm Hg can lead to mechanical problems such as local deformation of the tissue and reduction of the the degranulation tissue. In this study, we used the continuous therapy in five patients, and the intermittent in four patients, and the pressure was between −50 and −125 mm Hg, with no differences in the final integration of the flap.

Chim[18] performed a clinical trial using free muscle transfer flaps during the reconstruction of lower limbs. Nine patients underwent NPWT immediately after the flap, and for the other group, he used a wet gauze. At the end of the follow-up, all the free muscle flaps that had NPWT showed a better and faster integration, lesser volume of the flap, and better inflow and outflow.

There are some major complications related to NPWT, including pain, arterial erosion leading to active bleeding, septic shock, and infection secondary to anaerobe bacteria.[13] We had no major complications in our series, attesting to the safety of this device. We identified that the NPWT applied after the diagnosis of venous congestion leads to a decrease in congestion—in particular, improving the outcomes and avoiding any extra reintervention at our institution.

The limitation of this case series is the number of patients and the lack of a control group. The patient population was heterogeneous and had immediate use of the NPWT after undergoing the surgical procedure or after the diagnosis of venous congestion, and after finger replantation (in two cases). Comparative prospective studies and randomized studies should be conducted in the future.

CONCLUSIONS

Venous congestion of the free flap or replanted finger is a preventable complication based on excellent microsurgical technique performance, thromboembolic prophylaxis, and strict postoperative follow-up. The findings of this study help us conclude that NPWT is a safe procedure that can be used either as a salvage method when the complication is identified, or as a primary treatment immediately after the microanastomosis to promote neovascularization.

Jorge I. Quintero, MD
Fundación Santa Fe de Bogotá
Carrera 7 # 123-35, piso 10
Bogota, Colombia 110111
E-mail: jorge.quintero@fsfb.org.co

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