Application of negative wound pressure therapy to skin grafts after coverage of uncertain granular sites: a case series

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ABSTRACT – REZUMAT

Application of negative wound pressure therapy to skin grafts after coverage of uncertain granular sites: a case series

The split thickness skin graft (STSG) is one of the most popular tools used in reconstructive surgery. Developed for the first time by Olier in 1872, with perpetually improving techniques, this graft has since facilitated the reconstruction of skin defects. Negative wound pressure therapy (NPWT) is a therapeutic procedure that has been widely used for decades; it stabilizes the wound environment, improves tissue perfusion by stimulating granulation and angiogenesis, and reduces bacterial load and, consequently, wound edema. This case series of 3 patients aimed to show the advantages of applying NPWT over STSGs after the coverage of uncertain granular sites. The intake rate was 95% on average, with rapid wound healing, no hematoma formation, no need for regrafting, and no pain or signs of infection.

Keywords: *split thickness skin graft, negative wound pressure therapy, uncertain granular sites*

Aplicarea terapiei cu presiune negativă a plăgii pe grefe de piele după acoperirea zonelor granulare incerte: studiu de caz

Grefa de piele cu grosime parţială (STSG) este unul dintre cele mai populare instrumente utilizate în chirurgia reconstructivă. Dezvoltată pentru prima dată de Olier în 1872 şi îmbunătăţită în mod continuu, această grefă a facilitat de atunci reconstrucția defectelor pielii. Terapia cu presiune negativă a plăgii (NPWT) este o tehnică terapeutică utilizată pe scară largă de zeci de ani, care stabilizează mediul plăgii, îmbunătățește perfuzia tisulară prin stimularea granulaţiei și a angiogenezei și reduce încărcătura bacteriană și, în consecință, edemul plăgii. Aceast studiu de caz realizat pe 3 pacienți și-a propus să demonstreze avantajele aplicării NPWT față de STSG, după acoperirea zonelor granulare incerte. Rata de admisie medie a fost de 95%, cu vindecare rapidă a rănilor, fără formare de hematom, fără necesitatea de regrefare și fără durere sau semne de infecție.

Cuvinte-cheie*: grefă de piele cu grosime parţială, terapie cu presiune negativă a plăgii, zone granulare incerte*

INTRODUCTION

Skin grafting is an indispensable procedure in reconstructive surgery that is used in the surgical treatment of traumatic and burn defects, oncologic resections, diabetic foot ulcers, chronic venous leg ulcers, release of skin contracture and pressure sores [1].

The procedure of skin grafting involves transferring free tissues that are nonvascularized with different thicknesses from a donor site to a remote recipient site anywhere else in the body [2]. Grafts can be classified according to their thickness or their host-donor relationship. The most popular type of graft used in practice is the autogenous graft, which is harvested from the same person who receives it. Skin grafts can be either split or full-thickness, each of which has its advantages and disadvantages. Split-thickness grafts usually require expensive equipment and are less aesthetic but have better take-in rates than full-thickness grafts [3].

There are several factors on which graft survival depends, including the patient's general status, bed quality and healing environment [4].

The patient's status, including hematological parameters (hemoglobin, thrombocytes), albumin and total protein concentrations and inflammatory parameters, is generally very important and needs to be optimized before surgery [5]. The bed quality and healing environment directly affect the graft intake rate since the graft does not have its blood supply. The survival of the grafts consists of the following 3 common steps: imbibition, inosculation [6, 7] and revascularization. The most critical phase is the revascularization step, which can be influenced by many factors [8]. The most common causes of STSG loss are hematoma or seroma formation underneath, friction/shear forces between the bed and the graft, malpositioning of the graft and infection.

Currently, there are no methods that can ensure a successful graft intake rate of 100%. Conventionally, STSGs are covered with dressings [9], that maintain moisture balance and are nonadherent, with or without a tie-over dressing. Nevertheless, in the last decade, the technique of negative pressure wound therapy (NPWT) using reticulated open cell foam has gained more popularity in this area [10].

The main aim of this research was to assess the positive impact of negative wound pressure therapy on skin grafts made from textile material after coverage of uncertain granular sites.

MATERIALS AND METHODS

In addition to vacuum-assisted wound closure, negative pressure wound therapy using reticulated open-cell foam (NPWT/ROCF) is a technique that consists of a versatile closed sealed system that applies continuous or discontinuous underatmospheric pressure through a reticulated open cell foam over a surface. NPWT/ROCF can be used to manage different types of acute or chronic open wounds, but in more recent years, it has also been adapted for closed wounds, such as skin grafts or closed surgical incisions [11].

NPWT aims to stabilize the wound environment, improve tissue perfusion by stimulating granulation and angiogenesis, reduce the bacterial load and consequently wound edema, prevent surgical dehiscence and reduce the risk of seroma or hematoma formation [12, 13].

Considering that there are now lighter, disposable NPWT systems, such as the KCL V.A.C. therapy system, an important advantage of using them over grafts is earlier postoperative patient discharge, shorter hospital stays and lower expenses [13–15].

Based on the scientific design, a multidisciplinary team of specialists within the INCDTP developed a biomaterial with elastomeric yarn (with longitudinal direction elasticity and physicomechanical characteristics – table 1) that responds to the following requirements imposed by its usage in the clinical field (postsurgical recovery): nonirritant surface in contact with the skin; comfort – lack of coarse material seams and joints; tolerance at human body contact; malleability – adaptability; resistance to chemical and thermal agents; and reusability (table 2). The main purpose of noninvasive medical devices with an elastopsis is to ensure external and controllable pressure against the application location of the body.

Table 1

THE PHYSICOMECHANICAL CHARACTERISTICS OF THE TEXTILE YARNS

Characteristic		Cotton yarn	Elastomer yarn
Length density	dtex	24	No. 32/36
	Nm	1/4	
Breakage load (gf)		867.2	958.3
Break elongation (%)		12.1	785
Twist (t/m)		250	-

Table 2

THE SPECIFIC TECHNICOFUNCTIONAL REQUIREMENTS OF THE TEXTILE MATERIAL

Characteristic	The usage domain symbol		
	RPO	TRL	TAC
Elasticity	very good	very good	very good
Compactness	very small	very large	very large
Handle	very soft	soft	soft
Compression capacity	very good	very good	very good
Permeability to			
– liquids	very good	good	good
– vapours	good	good	good
– perspiration	good	good	good
– air	very good	very good	very good

Note: RPO – postsurgical recovery; TRL – treatment and recovery of the locomotor, muscular and bone systems; TAC – circular system treating and recovering.

The programming scheme of the textile structure used for this application is presented in figure 1.

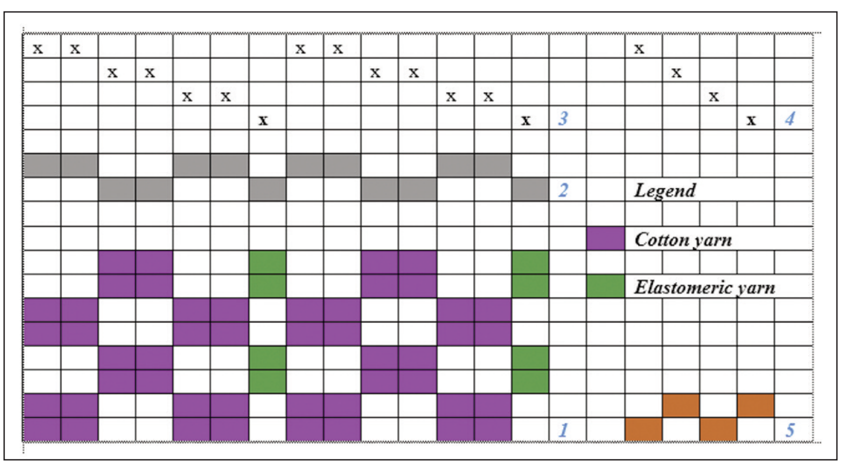


Fig. 1. The programming scheme of the textile structure: 1 – pattern (with yarn symbolizing on shedding); 2 – drawing in reed; 3 – drawing in the leaves; 4 – leaves (hardness) piecing; 5 – cams

This research was focused on the complex and complete design of the woven fabric and was conducted on technological lines, including specific laboratory pieces of equipment and machinery. This type of material bears upkeeping treatments, which can be performed through successive washing, drying, and autoclaving cycles. Its technical, biofunctional and biomedical characteristics are suitable for foreseen application and fulfil the requirements imposed by the legislation in force for this category of medical devices.

RESULTS AND DISCUSSION

Patient 1

A 70-year-old male was referred to our clinic because of an extended cutaneous defect of the abdomen after eventration. The patient had undergone open cholecystectomy 11 months prior and experienced postoperative complications such as eventration and skin necrosis 10 months later. The abdominal wall was covered with Prolene mesh, followed by a necrectomy, after which the defect in the abdominal wall was extended (figure 2, *a*).

The patient was known to have multiple pathologies, such as arterial hypertension, class II NYHA heart failure, aortic insufficiency, tricuspid insufficiency, atherosclerosis, anemia, undergoing was receiving treatment for all of the above conditions. On admission to our clinic, his blood analysis revealed moderate microcytic anemia (*Hb* = 9.8 g/dl, *MCV* = 69.6 fl) and a normal serum ALB concentration (3.7 g/dl).

The defect was covered with NPWT/ROCf for 5 weeks and was changed every 7 days before the patient was admitted to our clinic. The hospitalization time was 2 nights. The surgery was performed under general anesthesia; the wound was degranulated and covered with an STSG harvested from the anterolateral side of the left thigh. A few staples were affixed to the graft margins, and NPWT was applied (50 mmHg). The patient was discharged the next day after surgery, with no local or general immediate postoperative complications. The NPWT was continued for 5 days and then stopped (figure 2, *b*). He achieved 98% integration of the graft, with good epithelization and no further complications (figure 2, *c* and *d*).

Patient 2

A 46-year-old female presented to the emergency department (ER) for distal 1/3 left calf fasciitis (figure 3, *a*) after local trauma that had occurred 6 weeks prior. The patient had neglected the local wound and was highly uncooperative in the ER.

The patient was known to have untreated type 2 diabetes mellitus, Cluster A personality disorder and poor personal hygiene. On admission to our clinic, blood analysis revealed severe leukocytosis (39000/ml), thrombocytosis (778000/ml), hypoalbuminaemia (3.3 g/dl), hyponatremia (128 mmol/l), severe hyperglycaemia (553 mg/dl) and coagulopathy (*PT* = 17.3 sec, *INR* = 1.46).

The patient underwent multiple surgical interventions in which the infected tissues were removed, resulting in a large cutaneous defect on the antero-lateral side of the left calf and the dorsal forefoot (figure 3, *b*). The defect was covered with NPWT/ROCf at 75 mmHg for 3 weeks, which was changed every 4–5 days. Immediately before STSG coverage, blood analysis revealed that the patient's leukocyte count was normal, and mild anemia (*Hb* = 10.6 g/dl), thrombocytosis (590.000/ml), hypoalbuminaemia (3.3 g/dl), and hyperglycemia (210 mg/dl) were detected.

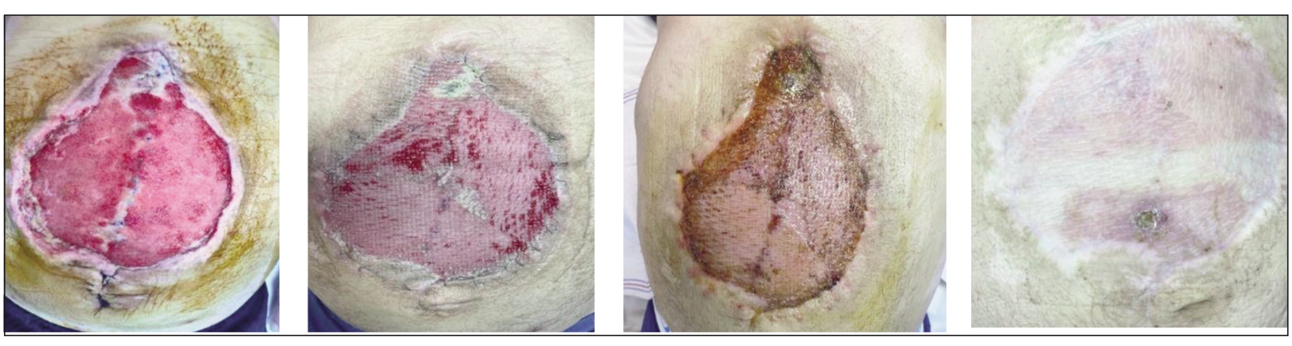
Considering the improvement in the patient's general status and local wound site and her good blood analysis results, she was treated by surgery in which the defect was covered with an STSG harvested from the anterolateral side of her right thigh (figure 3, *c*) and on which NPWT was applied with a pressure of 50 mmHg. The NPWT was removed after 5 days. The graft had a 95% integration rate (figure 3, *d*) and good epithelization, especially at uncertain granular sites.

The patient was discharged after another 5 days. This long hospitalization period was due to the septic pathology, the need for multiple operations and, moreover, her difficult compliance.

The staples and sutures were removed after 21 days, and the local evolution was favourable with no further local or general complications (figure 3, *e*).

Patient 3

A 21-year-old female who was a victim of a car crash presented with polytrauma in the ER, hemorrhagic shock, dissection of the aorta at the emergence of the iliac artery, haemodynamic instability, severe craniocerebral trauma, severe vertebral trauma (L3 fracture), severe pulmonary contusions, urinary bladder and vaginal rupture, severe pelvic trauma with extended abdominal wall ischemia and quasiamputation of the tongue. The patient had an unfavourable



a *b* *c* *d*

Fig. 2. Stages of wound healing – Patient 1

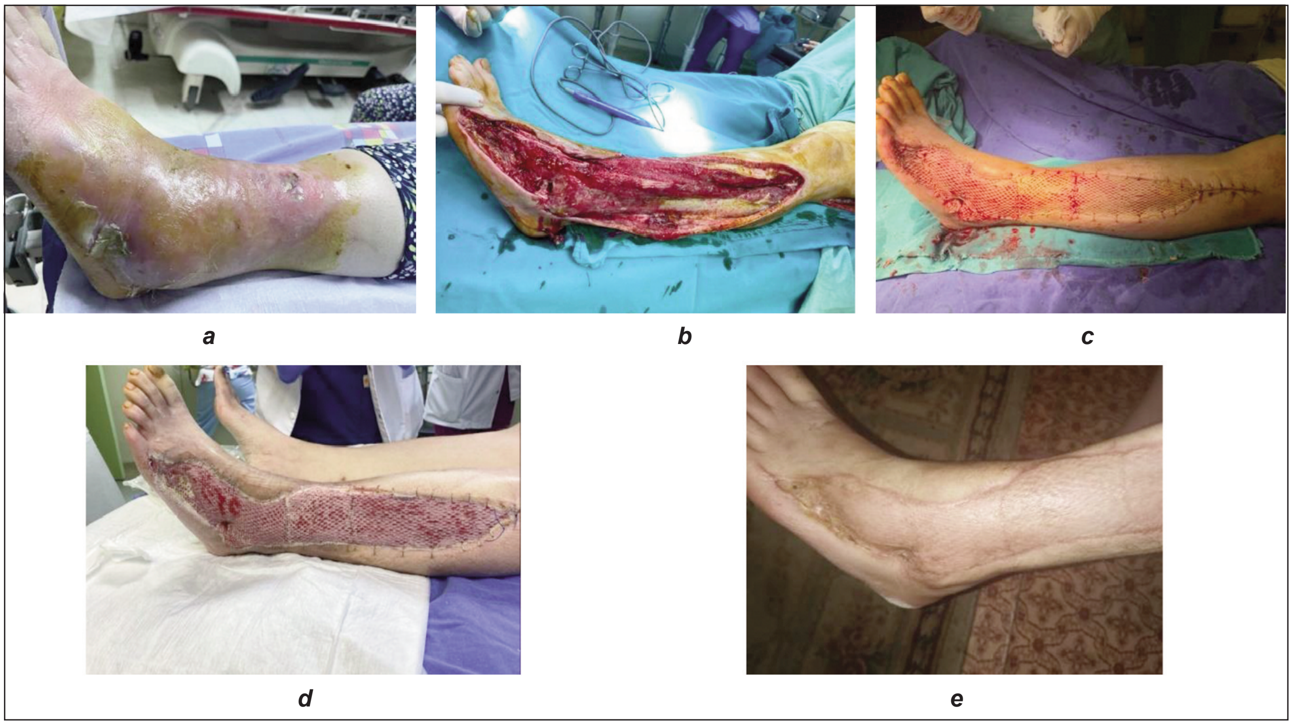


Fig. 3. Stages of wound healing – Patient 2

evolution and underwent multiple surgeries, including ileostomy (due to bowel necrosis), an amputated left lower limb (middle third level) and vertebral osteosynthesis (L3).

The area of extended abdominal wall ischemia became necrotic, and the patient developed a large abdominal defect (figure 4, *a*). The necrotic tissue was excised and debrided, and the defect was covered with NPWT/ROCf at 50 mmHg pressure for 3 weeks, which was subsequently changed every 5 days (figure 4, *b*).

After 3 weeks, the wound was clean and granulated, with no local inflammation or pathological secretions (figure 4, *c*). Blood analysis revealed moderate normocytic anemia (*Hb* = 9.81 g/dl), mild leukocytosis (10000/ml) and normal albuminemia (4.13 g/dl). Consequently, the defect was covered with an STSG harvested from the anterolateral side of the patient's

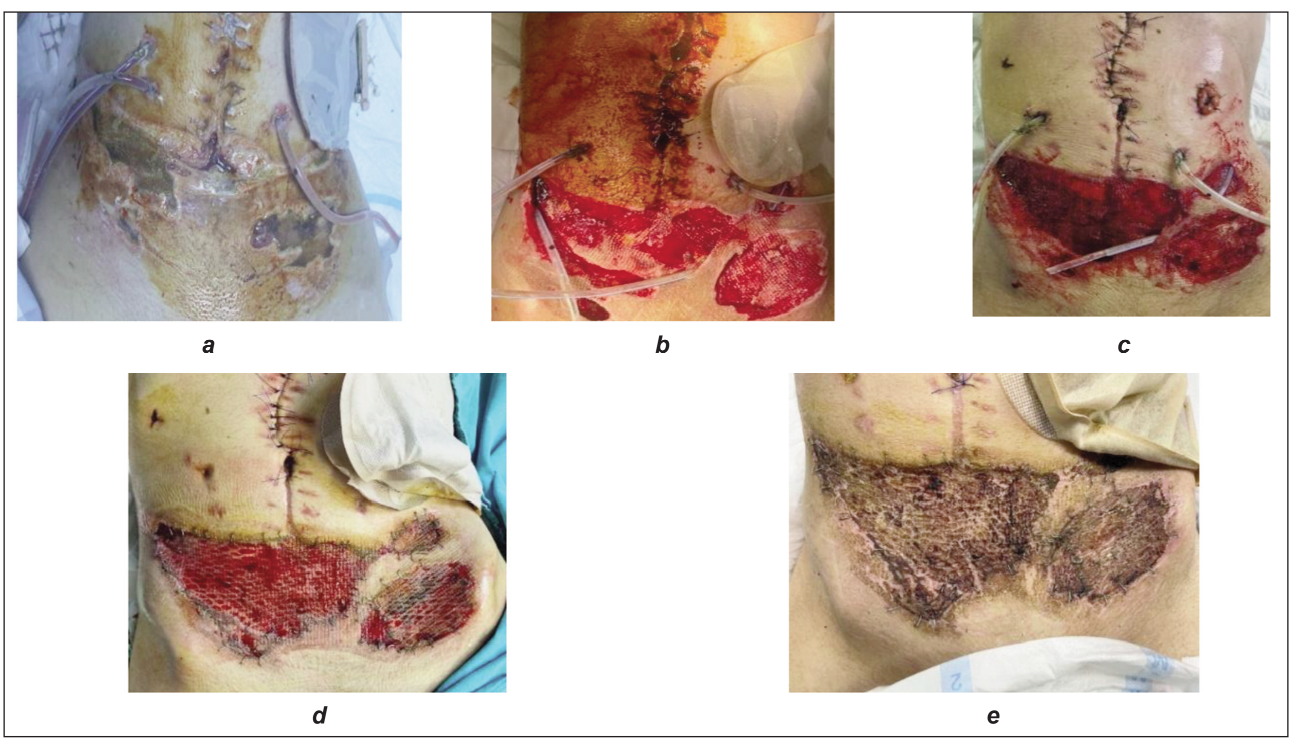


Fig. 4. Stages of wound healing – Patient 3

right thigh on which NPWT was applied with 50 mmHg pressure. The NPWT was removed after 7 days. The graft had a 98% integration rate and good epithelization with local complications (figure 4, *d*).
Even though the patient had multiple comorbidities due to the polytrauma she endured, the local abdominal evolution was favourable, with good results 3 weeks after surgery when the staples were removed (figure 4, *e*).
The intake rate was approximately 95–100 %, with rapid wound healing, no hematoma formation, no need for regeneration, and no pain or signs of infection.

CONCLUSION

The use of NPWT over STSGs after covering uncertain granular sites in patients with multiple pathologies resulted in uniform graft adherence, most likely due to improved inosculation, no hematoma or seroma formation, no need for regrafting, early ambulation of the patients due to the stabilizing effect of NPWT with shorter hospital stays and therefore lower expenses. Nevertheless, it is important to consider specific characteristics, such as the extent of the wound, the presence of infection, the amount of exudate and, most importantly, the patient's compliance, before applying NPWT. In our opinion, NPWT/ROCF can be considered a first-line pre- and postoperative therapy for STSGs.

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