Skin graft for abdominal wall reconstruction due to necrotizing fasciitis: A case report

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Background: The reconstruction of the abdominal wall, particularly in the context of complex defects, represents an area within plastic and reconstructive surgery that has undergone significant advancements in recent years. The integration of split-thickness skin grafts, free tissue transfer, and mesh-assisted reconstruction has provided surgeons with a versatile and effective toolkit to address a wide range of clinical challenges.
In this context, split-thickness skin grafts (STSGs) and advanced reconstructive techniques, such as free tissue transfer and mesh-assisted reconstruction, have emerged as fundamental pillars in the armamentarium of the plastic and reconstructive surgeon. These modalities offer versatile solutions for restoring abdominal wall continuity, providing soft tissue coverage, and improving long-term functional and aesthetic outcomes.

Keywords: Abdominal wall reconstruction.

Abdominal wall reconstruction represents a complex surgical challenge, particularly in the presence of massive or contaminated defects. These defects may result from trauma, oncological resections, severe infections, or recurrent and complicated ventral hernias. The loss of abdominal wall integrity not only compromises the containment function of the abdominal viscera but also affects the patient's quality of life, body aesthetics, and can lead to serious complications such as evisceration or intestinal incarceration [1].

In this context, split-thickness skin grafts (STSGs) and advanced reconstructive techniques, such as free tissue transfer and mesh-assisted reconstruction, have emerged as fundamental pillars in the plastic and reconstructive surgeon's armamentarium. These modalities offer versatile solutions for restoring abdominal wall continuity, providing soft tissue coverage, and improving long-term functional and aesthetic outcomes [2].

The present theoretical framework aims to provide a systematic and updated review on the use of split-thickness skin grafts in abdominal wall reconstruction, with a specific focus on free tissue transfer techniques and mesh-assisted reconstruction. The review will address the technical fundamentals, patient selection, surgical techniques, potential complications, and functional outcomes, to serve as a solid theoretical basis for future clinical case reports in this field.

Technical Fundamentals of Split-Thickness Skin Grafts

Split-thickness skin grafts (STSGs) are an essential reconstructive tool in plastic surgery, particularly in the management of abdominal wall defects. These grafts are characterized by the inclusion of the epidermis and a variable portion of the dermis, which confers unique properties in terms of viability, donor site management, and functional and aesthetic outcomes [3].

Types and Characteristics of STSGs
The classification of STSGs is based on the thickness of the included dermal portion. Traditionally, three main categories are distinguished [3]:

- Thin: With a thickness ranging from 0.15 to 0.3 mm. These grafts have a high "take" rate due to their lower metabolic demand but are more prone to secondary contracture and pigment changes. Their thinness makes them suitable for areas with less vascularized recipient beds.
- Intermediate: With a thickness of 0.3 to 0.45 mm. They represent a balance between the "take" rate and dimensional stability, being the most commonly used in clinical practice.
- **Thick:** With a thickness ranging from 0.45 to 0.6 mm. They offer greater stability, less secondary **contracture**, and superior aesthetic results but require a well-vascularized recipient bed to ensure their viability.

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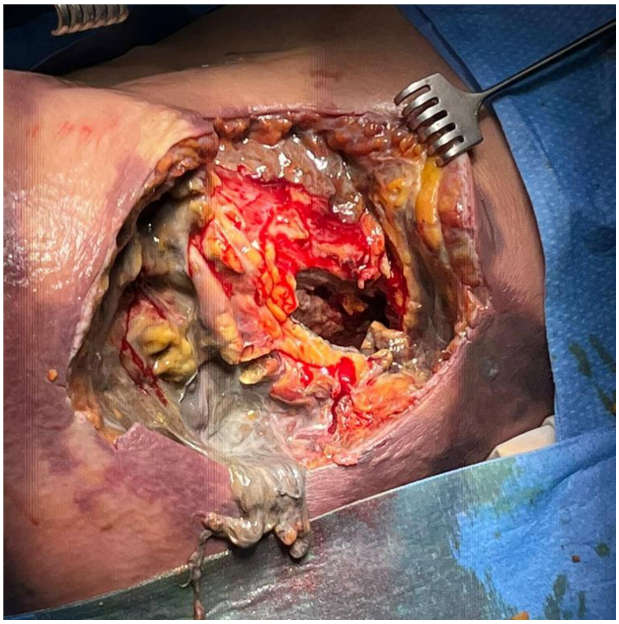

Figure 1. Necrotizing fasciitis.

Donor sites for STSGs are selected based on skin availability, accessibility, and the minimization of morbidity. The lateral thigh and the trunk are commonly used areas due to their large surface area and the ability of their donor sites to **re-epithelialize** rapidly, typically within 2 to 3 weeks. This capacity for re-epithelialization is due to the retention of dermal appendages and multipotent stem cells in the donor site, allowing for its reuse in cases of extensive or multiple defects [3].

A distinctive characteristic of STSGs is the possibility of being **meshed** or **unmeshed**. Meshing the graft involves creating small incisions on its surface, allowing for its expansion and coverage of a larger area. Furthermore, meshing facilitates fluid drainage, reducing the risk of hematoma and seroma formation, which could compromise graft **"take"** or **"integration."** However, meshed grafts are more fragile, require a longer epithelialization time, and can result in a less aesthetic reticulated appearance. In contrast, unmeshed grafts offer greater durability, flexibility, and a superior cosmetic outcome, with faster healing and potentially better nerve regeneration [3].

Figure 2. Surgical debridement.

Preparation of the Recipient Bed

Adequate preparation of the recipient bed is a critical factor for the success of STSG **"take"** or **"integration."** An ideal recipient bed must be well-vascularized, free of infection, and consist of healthy granulation tissue. The presence of necrotic tissue, **slough**, active infection, or a poorly vascularized bed will compromise graft survival. Thicker grafts, due to their higher metabolic demand, require a recipient bed with even more robust vascularization to ensure adequate diffusion of nutrients and growth factors [3].

The vascularization of the recipient site also influences graft viability. STSGs, unlike flaps, lack an intrinsic blood supply and depend entirely on **neovascularization** from the recipient bed. Therefore, optimizing the conditions of the recipient bed, including adequate **debridement** and infection control, is paramount to maximizing graft **"take"** rates [3].

Considerations Regarding Contraction

A primary limitation of STSGs is their tendency to contract. This occurs in two phases: an immediate primary contraction upon harvest, due to the elastic recoil of elastin fibers, and a progressive secondary contraction over time, mediated by the activity of myofibroblasts in the recipient bed. Secondary contraction is more pronounced in STSGs compared to full-thickness skin grafts (FTSGs). This characteristic is particularly relevant in aesthetically sensitive areas, such as the face or joints, where excessive contraction can lead to deformities or functional limitations. In these areas, full-thickness skin grafts or flaps may be more suitable options [3].

Indications in Abdominal Wall Reconstruction

Abdominal wall reconstruction is a complex surgical procedure indicated in a variety of clinical situations where the integrity of the abdominal wall has been compromised. The primary objectives are to restore the containment function, protect the abdominal viscera, improve aesthetics, and prevent long-term complications. The indications for abdominal wall reconstruction are diverse and often require a multidisciplinary approach, involving plastic surgeons, general surgeons, and other specialists [1].

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Figure 3. VAC system placement.

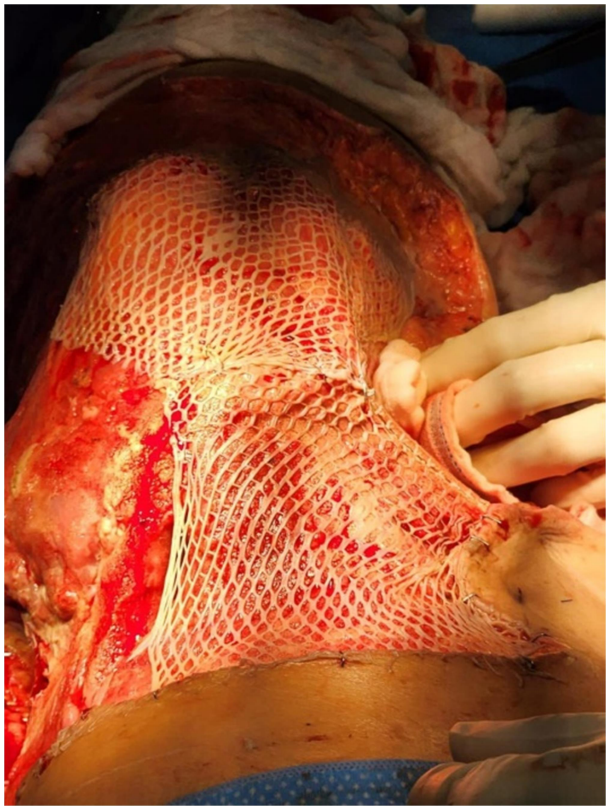

Figure 4. Meshed skin graft.

Massive Abdominal Wall Defects

Massive abdominal wall defects, defined by the loss of a significant portion of the fascia and/or skin, are a primary indication for complex reconstruction. These can result from:

- Oncological Resections: Following the excision of extensive abdominal tumors involving the abdominal wall, such as sarcomas or desmoid tumors [4].
- Severe Trauma: Penetrating or blunt abdominal injuries resulting in substantial tissue loss [2].
- Necrotizing Infections: Such as necrotizing fasciitis, which requires extensive debridement and leaves large soft tissue defects [1].
- Giant or Recurrent Ventral Hernias: Especially those that have failed previous repairs or present with "loss of domain," where a large portion of the abdominal contents resides outside the abdominal cavity [1].

In these cases, split-thickness skin grafts (STSGs) can be used to provide cutaneous coverage, particularly when the recipient bed is adequate and there is no need for significant tissue volume or intrinsic vascularization. However, for full-thickness defects or those with exposure of vital structures, free tissue transfer becomes an indispensable option to introduce vascularized tissue and restore structural integrity [2].

Exposure of Vital Structures

When abdominal wall defects expose intra-abdominal organs, major blood vessels, or prosthetic implants (such as meshes or cardiac devices), reconstruction is imperative to protect these structures from desiccation, infection, and trauma. Free flaps, with their capacity to provide voluminous, well-vascularized tissue, are often the preferred option in these situations [2].

Contamination or Infection

In the presence of contamination or active infection at the defect site, the selection of a reconstructive technique is crucial. Permanent synthetic meshes are contraindicated in contaminated fields due to the high risk of infection and explantation. In these scenarios, biological or biosynthetic meshes, which have greater resistance to infection and allow for tissue integration, are the preferred options for reinforcement. Free muscle or myocutaneous flaps are also advantageous in infected environments due to their rich vascularization, which helps combat infection and obliterate dead space [1, 4].

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Figure 5. Late postoperative result

Restoration of Function and Aesthetics

Beyond defect closure, abdominal wall reconstruction aims to restore the containment function and muscular dynamics. This is particularly important for preventing hernia recurrence and improving the patient's quality of life. Techniques such as component separation, often combined with mesh placement, allow for the approximation of fascial edges and restoration of the midline. Free flaps, especially muscular ones, can contribute to the dynamic function of the abdominal wall through reinnervation [1, 4].

Aesthetic improvement is also a significant objective, as abdominal wall defects can have a substantial impact on body image and patient quality of life. The choice of reconstructive technique must consider the final aesthetic outcome, including the minimization of scarring and the restoration of a natural abdominal contour [1].

In summary, the indication for abdominal wall reconstruction is multifactorial, ranging from the need to cover massive defects and protect vital structures to the management of infection and the restoration of function and aesthetics. The combination of split-thickness skin grafts, free tissue transfer, and mesh-assisted reconstruction offers a spectrum of solutions tailored to the complexity of each case [1, 2, 3, 4, 5, 6, 7, 8].

Comparative Outcomes and Discussion

The choice between split-thickness skin grafts (STSGs), free tissue transfer, and mesh-assisted reconstruction in abdominal wall reconstruction is not mutually exclusive but is often complementary. The decision is based on the complexity of the defect, the status of the recipient bed, the presence of contamination, and the functional and aesthetic goals. A comparative discussion of the outcomes of these techniques is essential to guide evidence-based clinical practice.

Split-Thickness Skin Grafts (STSGs)

STSGs are a valuable option for covering abdominal wall defects, especially when a large surface area of skin is required and the recipient bed is adequate and well-vascularized. Their main advantages include ease of harvest, low donor site morbidity, and the donor site's ability to re-epithelialize. However, STSGs present significant limitations, such as secondary contracture, which can lead to deformities and functional limitations, and pigment changes that affect the aesthetic outcome [3]. They are less suitable for full-thickness defects or those with exposure of vital structures, where they do not provide the necessary structural support.

Free Tissue Transfer

Free tissue transfer is the technique of choice for complex abdominal wall defects requiring a large volume of vascularized tissue, space obliteration, or restoration of muscular function. Free flaps offer excellent viability, with high survival rates even in challenging environments [2, 4]. They enable the reconstruction of full-thickness defects, coverage of exposed structures, and, in the case of muscular flaps, restoration of the dynamic function of the abdominal wall. Complications, although possible, are manageable, and hernia recurrence rates can be significant, but the technique is fundamental for achieving closure in complex cases [2, 4]. Donor site morbidity, while present, is generally acceptable and well-tolerated by patients.

Mesh-Assisted Reconstruction

Mesh is an indispensable component in most abdominal wall reconstructions, especially for ventral hernia repair. Its primary benefit is the reinforcement of the fascial closure, drastically reducing recurrence rates. The evolution of mesh materials (synthetic, biological, biosynthetic) allows the reconstructive strategy to be adapted to the patient's condition and the defect, including the presence of contamination or infection [1, 5]. Mesh placement techniques, such as the retromuscular (sublay) position and component separation techniques like the Transversus Abdominis Release (TAR), have improved outcomes by providing robust support and minimizing mesh-related complications [1, 6, 7]. However, meshes are not without risks, such as infection, erosion, and chronic

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pain, which must be carefully considered in patient selection and postoperative management [1, 5, 8].

Comparative Discussion and Integration of Techniques

The integration of these techniques is key to optimizing outcomes in abdominal wall reconstruction. For example, a complex defect requiring soft tissue coverage and fascial reinforcement could benefit from a free flap for the soft tissue component, combined with a mesh (synthetic or biological, depending on the environment) for fascial reinforcement. The mesh can provide the necessary scaffolding for the free flap, especially in full-thickness defects [2, 4].

In cases of contaminated defects, the combination of a free muscle flap (which has greater resistance to infection) with a biological or biosynthetic mesh may be the most suitable strategy [1, 4, 5]. For large hernia defects, component separation with retromuscular mesh placement has proven superior in terms of reducing recurrences and improving quality of life [1, 6, 7, 8].

Functional outcomes and patient quality of life are primary considerations. Studies show that patients experience significant improvements in quality of life after abdominal wall reconstruction, regardless of the initial complexity of the defect [1, 8]. Preoperative optimization and rigorous postoperative management are essential to minimize complications and ensure lasting results [1, 8].

In conclusion, there is no one-size-fits-all solution for all abdominal wall defects. Successful reconstruction is based on a deep understanding of the properties of STSGs, free flaps, and meshes, as well as the ability to integrate these techniques in a manner individualized to each patient. Ongoing research into new materials and techniques, along with a multidisciplinary approach, will continue to improve outcomes in this challenging field of plastic and reconstructive surgery.

Case report

Relevant Patient History: A 49-year-old female patient from Mexico, with a past medical history significant for systemic arterial hypertension (HTN) managed with Atenolol 50 mg every 24 hours. Active smoker since the age of 18, with a daily consumption of 6-10 cigarettes. Completed SARS-CoV-2 vaccination schedule (2 doses of Pfizer and 1 dose of AstraZeneca). Denies recent history of vaccination or travel.

Relevant unintentional weight loss of approximately 20 kg over the past 3 years. This was accompanied by changes in eating habits and mood, related to recent widowhood (15 days prior to admission), suggesting a depressive episode without formal treatment at the time of admission.

Gynecological Context: Menopause at 48 years of age. Recent mammogram and Papanicolaou (Pap) smear studies were reported without malignant findings at the time of admission.

History of Present Illness:

The clinical condition began approximately 3 weeks prior to admission, following physical activity, with pain in the left lumbar region. Progression to a mass in the left thigh/psoas region was noted. It was initially managed with local remedies without improvement.

On April 15, following a session with a chiropractor and instruction to apply local ice, the condition evolved unfavorably with increased swelling, hyperthermia, local pruritus, and extension of the inflammatory process to the vulvar region.

On April 25, she presented with clinical deterioration featuring syncope, asthenia, adynamia, night sweats, and functional limitation for ambulation. In the emergency department, severe hypotension (BP 56/30 mmHg), HR 73 bpm, RR 25 rpm, Glasgow 15, poor reactivity, mucocutaneous dehydration, and pallor were documented.

On physical examination: Cellulitis, an indurated hematoma with a hyperemic halo, purulent drainage, and crepitus in the left lumbar, inguinal, and thigh regions (Fig. 1).

Following a poor response to intravenous fluids, norepinephrine was initiated for a state of severe hypoperfusion, and she was transferred to the ICU. Subsequently, additional vasopressors and broad-spectrum antibiotics were added due to suspicion of necrotizing fasciitis.

Hospital Course & Diagnostic Findings:

During her hospital stay, the following findings were documented:

- Abdominopelvic CT Scan: Presence of gas in the psoas muscle and subcutaneous tissue at the lumbar, lumbosacral, and left vulvar regions → consistent with necrotizing fasciitis and a retroperitoneal abscess.
- Thoracic CT Scan: Massive right atelectasis, bilateral pleural effusion.
- Echocardiogram: No signs of pulmonary thromboembolism, preserved systolic function (LVEF 68%).
- Ultrasound: Inferior Vena Cava (IVC) collapsibility >50%, B-lines pattern at the lung bases.
- On 04/24/23: The first surgical debridement was performed with extensive tissue removal (Fig. 2) (resection of approximately 3 kg of necrotic tissue) and

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placement of a VAC system (Vacuum-Assisted Closure) (Fig. 3). The patient remained on mechanical ventilation due to septic and hypovolemic shock.

- On 04/25/23: A second surgical debridement was performed with drainage of the retroperitoneal abscess, resection of additional necrotic tissue, and change of the VAC system. The negative pressure wound therapy (NPWT) system was changed on multiple subsequent occasions.
- On 05/05/23: A right colostomy was performed due to evidence of intestinal output via the VAC system.
- On 05/09/23: A skin graft was harvested from the left leg. An abdominal skin flap advancement was performed, along with further resection of necrotic tissue and placement of a new VAC system.
- On 05/16/23: The final surgical procedure was performed, involving wound debridement, flap advancement, dressing changes, and removal of the VAC system.

Conclusion

Abdominal wall reconstruction, particularly in the context of complex defects, represents an area within plastic and reconstructive surgery that has undergone significant advancements in recent years. The integration of split-thickness skin grafts, free tissue transfer, and mesh-assisted reconstruction has provided surgeons with a versatile and effective armamentarium to address a wide range of clinical challenges.

Split-thickness skin grafts, though limited by contraction and a lack of structural support, remain valuable for covering large surface areas with minimal donor site morbidity. Their application is most suitable for superficial defects or as an adjunct to more complex reconstructions.

Microvascular free tissue transfer has been established as the technique of choice for reconstructing massive full-thickness defects, covering exposed vital structures, and restoring muscular function. The high survival rates of flaps and the capacity to introduce healthy, vascularized tissue into compromised environments make it an indispensable tool, despite its technical complexity and potential for complications.

Mesh-assisted reconstruction is a fundamental pillar in preventing hernia recurrence and reinforcing the abdominal wall. The diversity of mesh materials (synthetic, biological, biosynthetic) and advanced placement techniques, such as the retromuscular position and component separation, allow for precise adaptation to the characteristics of the defect and the patient. However, careful selection of the material and technique is crucial to minimize risks such as infection and chronic pain.

Ultimately, success in abdominal wall reconstruction lies in an individualized and multidisciplinary approach. The strategic combination of these techniques, based on a deep understanding of their indications, advantages, and limitations, is essential to optimize functional and aesthetic outcomes, improve patient quality of life, and reduce recurrence rates. Ongoing research into new biomaterials, surgical techniques, and postoperative management approaches will continue to drive the evolution of this field, offering increasingly refined solutions for patients with complex abdominal wall defects.

Conflicts of interests

The authors have no conflicts of interests.

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