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Split-Thickness Skin Grafting of Traumatic Wounds in an Ecuadorian Center

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Abstract **Original Research Article**

Introduction: Split-thickness skin grafting is generally used for temporary or permanent coverage of cutaneous defects, including traumatic wounds; they are suitable for large areas of skin loss, granulating tissue beds, tissue loss across joints in areas where contraction will cause deformity, and where epithelialization alone will produce an unstable wound coverage. ***Objective:*** Describe graft size, wound location, associated complications, and hospitalization costs in patients who underwent split-thickness skin grafting for traumatic wounds ***Materials and Methods:*** retrospective, observational study conducted at Luis Vernaza Hospital during 2022. Data was obtained from the electronic medical records of the patients and organized using Microsoft Excel ®, later they were analyzed using SPSS 25.0 ®. A descriptive report of the clinical-demographic characteristics was made. The qualitative variables were described through frequencies and percentages. ***Results:*** 130 patients were included, 25.38% were female and 74.72% male. Most frequent age group was < 40 years (n = 73; 56.15%), most wounds presented in the lower extremities (n = 115; 88.46%) and were mostly caused by road traffic accidents (n = 72; 55.38%). In 86.15% of patients 100% of the grafts were integrated in less than 7 days. Total hospitalization costs averaged $1181.77, including the surgical procedure; maximum length-of-stay was 30 days with an average hospitalization cost of $3183.67. Comorbidities included type 2 diabetes mellitus and hypoproteinemia (40.59%). Complications included infection (22.77%), hematoma (0.99%) and one patient had a total graft loss. ***Conclusions:*** split-thickness skin grafting represents a reliable procedure for coverage of many cutaneous injuries, including traumatic wounds, with an acceptable success rate. By following the basic precepts of wound healing along with meticulous tissue handling, split-thickness skin grafting has the potential to play an important role in wound management and limb salvage.

Keywords: Skin Transplantation, Surgical Flaps, Wounds and Injuries.

INTRODUCTION

According to history, skin grafting originated in India about 2500 years ago, to later gradually migrate westward; in 1823, German physician named Bünger, was the first to report a successful human skin graft (transferring skin from the buttock to the nose); in 1869, Reverdin presented pinch grafts as a method to accelerate granulating wound healing; a few years later, Ollier de Lyon described the first split-thickness skin graft and in 1875, Wolfe described the first full-thickness skin graft [1]. In 1987, the term tissue engineering was coined at a National Science Foundation meeting, in 1988, Apligraf, a dual strain membrane product of neonatal forehead fibroblasts, keratinocytes and bovine collagen was the first engineered skin tissue to gain FDA approval [2].

The Ecuadorian Society of Reconstructive and Aesthetic Plastic Surgery (SECPRE) considers skin grafting as a primary closure in post-traumatic wounds in which the defect, due to its nature and size, does not allow a simple approximation of its edges.

Skin grafts consist of fully detached pieces of skin proceeding from an anatomic site and positioned in a wound elsewhere [3]. Split-thickness skin grafts are versatile options for wound closure, especially in large ones such as burns, trauma, reconstruction, etc., where there are limited donor sites [4]; and refer, by definition, to a graft containing the epidermis and a portion of the dermis (that provides strength and stability), in contrast to a full-thickness skin graft which comprises the epidermis and entire dermis.

Unlike flaps, they lack an autonomous perfusion, relying on a well-vascularized wound bed for graft in-growth; they can be obtained from multiple sources (autograft, homograft, allograft, or xenograft), multiple anatomical locations, and in various thicknesses (thin: 0.15 to 0.3mm, intermediate: 0.3 to 0.45mm, and thick: 0.45 to 0.6mm) [5].

The primary indications for a skin graft are a wounded area or open wound with a viable surface; wounds can be the result of a fresh surgical excision or the granulated area of an old wound including dermis, fat, fascia, muscle, peritoneum as well as the surfaces of an internal viscus. Most of the grafts are used to permanently cover a wound, providing stable epithelial coverage, and in some cases temporarily, i.e., to regulate and eliminate infection or vital organ coverage.

Commonly, they are subtracted from the lateral thigh or trunk, as they are both aesthetically hidden and easy to harvest due to their broad surfaces; these donor sites retain portions of the dermis, including dermal appendages, facilitating new skin regrowth in 2 to 3 weeks; so, they can be used more than once after appropriate healing. Considerations of proper skin graft selection should include graft take, contracture of skin graft, donor site morbidity, aesthetic match, and durability [4].

Split-thickness skin grafts must be placed on well-vascularized beds with low bacterial counts to prevent infection and must be immobilized to prevent shearing and the formation of hematoma or seroma. The skin should be vented by fenestration ("pie crusting") or meshing and may require evacuation of excessive fluid cumulus (i.e., by aspiration) to prevent its shed [6]. They will not attach to poorly vascularized structures (bare tendons, cortical bone without periosteum, heavily irradiated areas, or infected wounds), however, once cultivated, virtually any tissue type with a vascular granulating stroma could be an acceptable bed for grafting [6].

Graft survival will also depend on a well-established perfusion; in the first 24 hours of healing, the graft will be sustained by “plasmatic imbibition”, where it absorbs transudate from the recipient bed and becomes edematous, while fibrin stands as a physiologic adhesive holding it in place, to later be replaced by granulation tissue [7]. About 48 to 72 hours after grafting “inosculation” takes place, where vascular anastomoses between the recipient bed and the graft begin to develop; within 4 to 7 days, full circulation will be restored to the graft [8], as well as restoration of lymphatic circulation. Approximately 2 to 4 weeks after grafting reinnervation of the graft will occur, however, the return to normal full sensation may require several months or even years [9].

Complete or partial graft failure may occur as complications caused by hematoma, seroma, disruption of base-graft contact, infection, smoking, or excessive intra-operative electrocoagulation. If necrosis develops, it is best to not remove the graft, but preserve it for new skin growth as "scaffolding". Longer-term complications include graft and recipient bed contraction with high risk of nearby free margins distortion or functional impairment, graft fragility, and poor cosmesis [1].

OBJECTIVE

Describe graft size, wound location, associated complications, and hospitalization costs in patients who underwent split-thickness skin grafting for traumatic wounds at Luis Vernaza Hospital during 2022.

MATERIALS AND METHODS

This was an observational and retrospective study. All patients admitted and hospitalized at Luis Vernaza Hospital from January to December 2022, who met the inclusion and exclusion criteria, were included.

Inclusion Criteria

1. Age 20 to 60 years.
2. Patients with acute traumatic wounds.
3. Wound surface between 2 and 45% of the body surface.

Exclusion Criteria

1. Old sequels.
2. Missing information from the clinical record.
3. Pregnancy.
4. > 1 cm areas of exposed bone or cartilage.
5. Patients with any type of cancer.

Data was obtained from the electronic medical records of the patients and organized using Microsoft Excel ®, later they were analyzed using SPSS 25.0 ®.

A descriptive report of the clinical-demographic characteristics was made. The qualitative variables were described through frequencies and percentages and the quantitative variables with percentages and central tendency measures.

Surgical Technique

Pressure downward and forward was applied firmly against the selected dermatome. An assistant

used forceps to gently grasp and apply traction to prevent the graft from folding in. Subsequently, the graft was meshed, applied to the defect, and contoured to fit. Posteriorly, it was anchored in place using sutures or staples, it was covered with petrolatum gauze and bandages.

The grafted area was uncovered 48 to 72 hours after implantation and observed thoroughly, leaving the graft in place for one week, maintaining direct contact with the underlying wound bed, and remaining immobile during this period. A secure pressure dressing was applied over the surgical site.

RESULTS

During 2022, 322 patients were admitted to the Plastic Surgery service in Luis Vernaza Hospital, after inclusion and exclusion criteria, a total of 130 patients were included in this study, 25.38% (n = 33) were female and 74.72% (n = 97) were male. Most frequent age group was < 40 years (n = 73; 56.15%), most wounds presented in the lower extremities (n = 115; 88.46%) and were mostly caused by road traffic accidents (n = 72; 55.38%).

Table 1: Demographic characteristics

	Sex	
	Female (n, %)	**Male (n, %)**
Age (years)		
< 40	15 (45.45)	58 (59.79)
40 to 60	6 (18.18)	26 (26.80)
> 60	12 (36.36)	13 (10)
Wound location		
Upper extremities	8 (24.24)	4 (4.12)
Lower extremities	24 (72.72)	91 (93.81)
Abdomen	1 (3.03)	2 (2.06)
Trauma cause		
Motorcycle accident	10 (30.30)	25 (25.77)
Pedestrian hit by car	9 (27.27)	14 (14.43)
Road traffic accident	14 (42.42)	58 (59.79)

Graft Size

Most used graft size was from 4 to 9 cm^2 (n = 57, 53.85%), followed by > 15cm^2 (n =12, 9.23%).

Table 2: Graft size

Graft size	**n, %**
< 3 cm^2	27, 20.77
4 to 9 cm^2	57, 43.85
10 o 15 cm^2	34, 26.15
>15 cm^2	12, 9.23

Hospitalization Costs

Total hospitalization cost, including split-thickness skin grafting and all surgical procedures were 1181.77 USD per patient in 86.15% (n = 122) patients whose length-of-stay was less than 7 days. In 3 patients with a > 30 days-length-of-stay total costs averaged 3183.67 USD per patient.

Table 3: Hospitalization costs according to the length-of-stay

Length-of-stay	**n, %**	**Average hospitalization cost according to days (USD)**	**Average hospitalization cost for each patient (USD)**
1 to 7 days	112(86.15)	132358.40	1181.77
7 to 15 days	12 (9.23)	17845.40	1487.12
15 to 30 days	3 (2.31)	6703.60	2234.53
>30 days	3 (2.31)	9551.00	3183.67

Hydrocolloidal patches that stimulate skin generation such as Askina Calgitrol Ag (BRAUN ®; 40.00 USD per unit), Cutimed Hydro B (BSN medical; 56.00 USD per unit), Duoderm (CONVATEC; 61.60 USD per unit) or Aquacel (HIDROFYBER; 40.00 USD), were applied in patients with larger wounds, improving the granulation tissue to have a better prepping before skin-grafting, although, increasing costs and the risk for nosocomial diseases.

Comorbidities and Complications

Hypoproteinemia was the most frequent comorbidity, due to a poor nutritional status (40.59%, n = 41). Complications included infection (22.77%, n = 23), hematoma (0.99%, n = 1) and total graft loss in one patient.

Table 4: Comorbidities and complications

Pathology	**n, %**
Type 2 diabetes mellitus	36 (35.64)
Hypoproteinemia	41 (40.59)
Complications	
Hematoma	1 (0.99)
Infection	23 (22.77)
Total graft loss	1 (0.99)

DISCUSSION

Skin grafting has been performed for over 100 years, and the importance of its type (split-thickness, full-thickness, or composite) has been well established, but, the importance of an appropriate donor site selection according to the type of graft and to the patient's age and sex has received limited attention, even though, in many cases, the scar at the donor site may be of greater long-term concern to the patient than the initial injury [10].

Split-thickness skin grafts remain the mainstay for treatment of large skin defects. Despite their many advantages, some critical disadvantages such as unfavorable scar and graft contracture are present, and it cannot be used on exposed structures such as tendons and bones [11].

Advances during the 20th century have developed parallel to the understanding of wound healing and immunology in transplant rejection. Bioengineered skin substitutes are currently a novel therapeutic alternative, as well as cryopreserved human skin allografts, that aid in wound healing because of their natural components found in human skin, eliminating the potential pathergy as no graft harvesting from the host is performed; these can be applied numerous times and allow a more rapid and complete epithelialization [12]. Despite this, autologous skin grafts remain as the gold standard.

On the other hand, the prevalence of wounds with substance loss among the population, whether acute or chronic, is very high and has various causes including traumatic, surgical, vascular, etc. In the United States, only chronic wounds affect 0.78% of the population (> 265000 people) in which traumatic wounds are more frequent [13]. Similarly, to the results of a retrospective study in Mexico describing split-thickness skin grafts in 81 patients where the main cause was also traumatic (46%), followed by burns (27%) and neoplasms (14%), with the most frequent areas being the upper and lower extremities [14]. As reported in this study, where wounds were mostly located in the lower extremities followed by upper extremities and main cause were road traffic accidents. Although, in Ecuador, national statistics for this topic are missing.

Split-thickness skin graft success depends on the speed with which perfusion of this tissue is reconstituted, therefore resulting in shorter hospital stay, better recovery and less physical and emotional impact. The result of these "mesh grafts" is very acceptable, except in cases in which hypertrophic scars occur in the mesh spaces that deteriorate the aesthetic appearance of the transplant. Currently, the use of elastic garments in the immediate postoperative period improves the appearance by exerting pressure on recent scars, therefore reducing the possibility of hypertrophic scars (keloids) [15].

Other treatments like Integra ® synthetic skin (Integra Lifesciences Corp., Plainsboro, NJ, USA), an artificial skin substitute consisting of 2 membranes: one mesh of porous three-dimensional fibrin of bovine tendon collagen together with conditrin-6-sulfate and an external thin silicone sheet, may be used. It integrates after 7 days approximately and costs around 5000 USD: higher, when compared to split-thickness skin graft use, which is autologous [16]. In this study, for 3 patients with a > 30 days-length-of-stay total costs averaged 3183.67 USD per patient: one presented graft loss, thus greater need of additional interventions, still being a lower cost than the previously mentioned alternative.

Also, split-thickness skin grafts usually become adherent to the wound bed during the following 5 to 7 days. Some authors refer that the dressings placed intraoperatively should be kept in place during this time to minimize shear and traction to the healing skin graft [4], in contrast to this study, where they were removed 48 to 72 hours after the procedure, however, with adequate evolution.

After this time, the graft should be pink, indicating successful inosculation and revascularization. For the next 7 to 14 days, dressing changes should be performed by the patient, home nursing care, or wound clinic, every 24 to 72 hours, consisting of petroleum-infused gauze, bulky gauze/kerlix, ACE wrap, or VAC. At 2-to-3-weeks postoperative, the skin grafts should be adherent and epithelialized so the patient may shower/bathe and stop frequent dressing changes [4].

The requirement for an interprofessional team including experienced nurses, techs, social workers, and therapists, needs to be highlighted. Especially, nurses should be fully aware of the post-operative management and closely monitor the wounds for bleeding, infection, and ischemia, so any change can be immediately communicated to the surgeon, this, however, doesn't

happen, sometimes making wound follow-up even harder.

Also, the donor and recipient sites, and date of next dressing changes should be delineated in medical notation so the entire healthcare team can treat the patient appropriately; this measure should be implemented in this study's healthcare facility, to improve results.

Additionally, since many of these patients remain immobile, the possibility of deep vein thrombosis should be assessed constantly and prevented.

CONCLUSIONS

Split-thickness skin grafting represents a reliable procedure for coverage of many cutaneous injuries, including traumatic wounds, with an acceptable success rate. By following the basic precepts of wound healing along with meticulous tissue handling, split-thickness skin grafting has the potential to play an important role in wound management and limb salvage.

Autologous split-thickness skin graft should be preferred over other artificial skin substitutes; however, more studies should compare outcomes with bioengineered skin substitutes, i.e., cryopreserved human skin allografts.

Finally, the requirement for an interprofessional team including experienced nurses, techs, social workers, and therapists for the management of skin grafting, needs to be highlighted.

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