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The Use of Acellular Dermal Matrix for the Closure of Skin Defects

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Abstract

Background & Objectives: Skin substitutes are a diverse set of biologics, synthetics, and biosynthetic materials that can replace open skin wounds temporarily or permanently. Skin substitutes are designed to mimic the qualities of natural skin. One must select an option that accomplishes an excellent wound healing and closure. This study aimed to assess the reliability and effectiveness of acellular dermal matrix for potentially more pliable coverage of the wound and for better functional and aesthetic appearance of the skin defects.

Methods: A prospective cohort study performed on 20 patients with full-thickness skin defects who underwent surgery using acellular dermal substitute and skin grafting in Erbil Governorate from January 2017 to December 2019. Functional and aesthetic outcome has been evaluated in this study.

Results: The study included 20 patients with mean age of 18.8 ± 6.2 years, female to male ratio was 1.5:1, and the majority of the cases presented with burn (90%). The Vancouver Scar Scale score was significantly reduced after 1 month of follow-up in which it reduced by 4.12 mm (57.6% reduce from baseline), Mean healing score was 93.5%, and Re-epithelialization after 1 month Was 95.55%, Overall the complication rate is low with 5% had hematoma, 5% had infection and 5% had loss of graft.

Conclusion: The use of acellular dermal matrix in conjunction with split thickness skin graft result in substantial improvement in the quality of wound healing and tissue reconstruction.

Keywords: Acellular dermal matrix, Skin defects, Skin substitutes.

Introduction

Skin substitutes are a diverse set of biologics, synthetics, and biosynthetic materials that can replace open skin wounds temporarily or permanently. Skin substitutes are designed to mimic the qualities of natural skin. Skin replacements are a significant adjunct in the therapy of acute and chronic wounds, and can be used to cover defects caused by burns or other injuries, as well as for reconstruction, such as the release of severe post-burn contractures.[1]Each skin substitute has its own unique set of advantages and disadvantages. Since wound healing tends to be unique to the individual, the use of skin substitutes is highly personalized with the choice of skin substitute depending upon the type of wound, mechanism of injury, and the skin component that requires replacement. In addition, the desired functional and aesthetic outcomes need to be considered. Other factors that determine the choice is relied on whether its permanent or temporary coverage.[2]There was no commonly agreed classification system that allowed for straightforward categorization of all commercially accessible products. But a technology assessment report from the Agency for Healthcare Research and Quality (AHRQ) from January 2019 listed 74 products classified as skin substitutes.[3]In a later publication, a potentially universal classification system

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classifies skin substitutes based upon the following factors: Cellularity, Layering, replaced region, Material used, Permanence[4] , as shown in Figure (1).

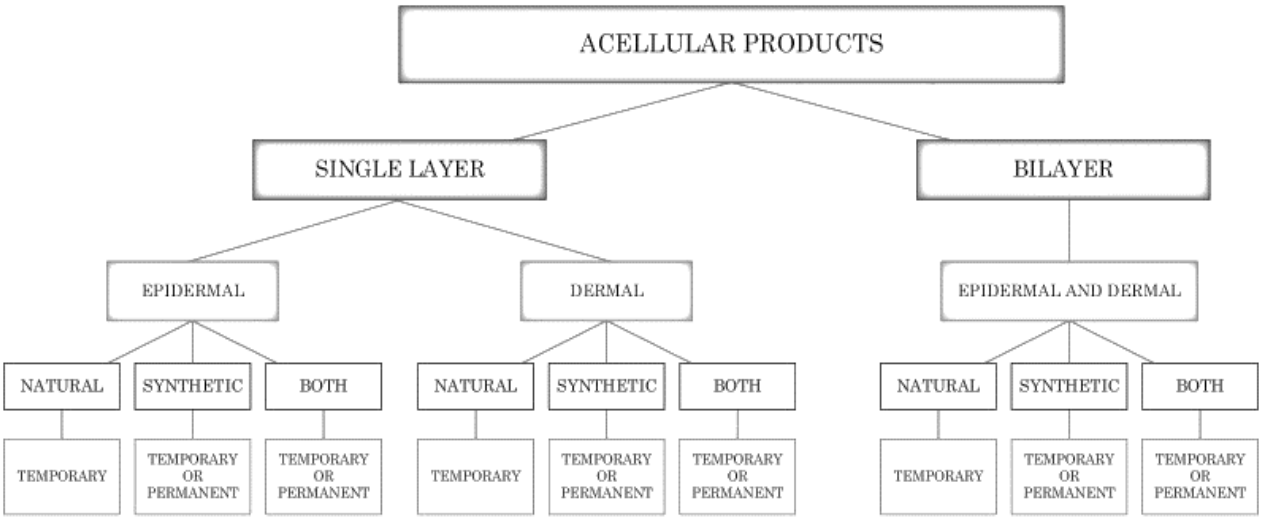

Figure (1): Davison-Kotler classification of skin substitutes .[4]

Acellular dermal matrix, a complex biomaterial formed by many types of fixed and free connective tissue cells, is one of the skin substitutes that has recently been employed as a wound closure option. It serves as a cell support surface. It's made up of a variety of proteins and protein fibers, including collagen and elastic or reticular fibers, that bind to both water-soluble and insoluble substances. The water-insoluble matrix, also known as the decellularized or acellular matrix / scaffold / graft, results from the removal of cellular components from connective tissue[5].Acellular dermal matrix is an allograft (also called homograft) product created from skin from a no genetically identical deceased human donor that has been processed to remove the epidermis using a sequential decellularization process. It (eg, Alloderm) can be distributed fresh or cryopreserved after glycerol preservation from cadavers. These decellularized matrices fully integrate into the wound bed after application, replacing lost dermal tissue and providing a scaffold into which the recipient's cells can grow and become vascularized, ultimately regenerating into normal skin.[6,7]Acellular matrices are employed for a variety of reasons, and their potential roles in repairing tissues or organs have been intensively researched[8.-10] Physiological cues are generated by the acellular matrix, which replicate the native tissue microenvironment.[11]Acellular dermal matrix is used in the reconstruction of skin defects, including burn wounds and abdominal wall defects, as well as for breast reconstruction. The application of acellular dermal matrix over superficial partial-thickness wounds can minimize pain and facilitate re-epithelialization. The aim of this study is to assess the reliability and effectiveness of acellular dermal matrix for potentially more pliable coverage of the wound and for better functional and aesthetic appearance of the skin defects.

Patients and methods

From January 2017 to December 2019, 20 patients with full-thickness skin defects underwent surgery with an acellular dermal substitute and skin grafting in Rizgary Teaching Hospital Erbil, Iraq. The age of the patients ranged between 6 to 60 years, and the exclusion criteria were any patient with hematologic disease, on anticoagulant medications, psychological disease, breast feeding and pregnancy, and uncooperative patients. We didn't include any patient who is uncooperative and couldn't be follow upped.The procedure was performed under general anesthesia, the recipient area was prepared after resection of undesired tissues and debris with good hemostasis. The defect size was measured to choose the right size of the acellular dermal matrix fitting the defect area. The acellular dermal matrix was then placed over the bed and irrigated with normal saline 0.9% to be settled on the wound. The harvested split thickness skin graft was next applied over it. The graft was fixed to the bed of the wound with sutures and tie-over dressing without using povidone-iodine in any layer. The first dressing was performed on the 5th day. Stitches were removed according to the regions of the body (1-2 weeks). At one month postoperatively, the healing quality was assessed using the Vancouver Scar Scale (VSS), a non-invasive scale that objectively measures four variables: vascularity, height/thickness, pliability, and pigmentation of the healed wound using a scoring system ranging from 0 to 13, as shown in Table (1), with a lower number being preferable[12, 13].

Table (1): Vancouver Scar Scale (VSS) [13].

Scar Characteristic		Score
Vascularity	Normal	0
	Pink	1
	Red	2
	Purple	3
Pigmentation	Normal	0
	Hypopigmentation	1
	Hyperpigmentation	2
Pliability	Normal	0
	Supple	1
	Yielding	2
	Firm	3
	Ropes	4
	Contracture	5
Height	Flat	0
	< 2 mm	1
	2-5 mm	2
	> 5 mm	3
Total score		13

The statistical analysis was performed using the SPSS 22.0.0 software package (Chicago, IL). Continuous variables were provided with their mean and standard deviation, whereas discrete variables were displayed with their number and percentage. A p value ≤ 0.05 was judged statistically significant in the paired t-test performed to examine the difference in VSS score. Written informed consent was obtained from all the participants prior to inclusion in the study, the study protocol carried out in accordance to Helsinki declaration for medical research 1964 and the institutional regulation board of Kurdistan Board for Medical Specialties.

Results

The study included 20 patients with mean age of 18.8 ± 6.2 years, female to male ratio was 1.5:1, and the majority of the cases presented with burn (90%), the rest are trauma (10%) as shown in figure 2.

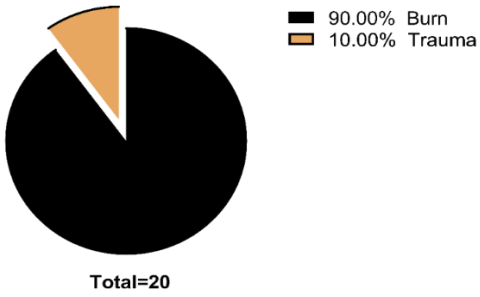

Figure (2): assessment of the cause of injury.

The mean VSS score of baselines was 7.15 ± 1.63, while after 1 month it became 3.05 ± 1.57, therefore it was significantly reduced by 4.12 mm (57.6% reduce from baseline), with a p-value of <0.001. Mean healing score was 93.5%, and Re-epithelialization after 1 month Was 95.55%. Acellular dermal matrix was used on 20 patients of variable indications. In the following figures, the results are shown after one, two and six months consecutively after surgery. In figure 3, the patient was concerned more about the aesthetic aspect and the result showed good improvement of the scar appearance with a VSS score of 2. In figure 4, the hypertrophic scar was the main complain and the patient was seeking aesthetic and functional improvement and the result showed very good pliability with VSS score of 4. In figure 5, patient presented with acute trauma to the volar surface of middle finger, the main problem was tendon exposure and the result showed excellent VSS score of 0.

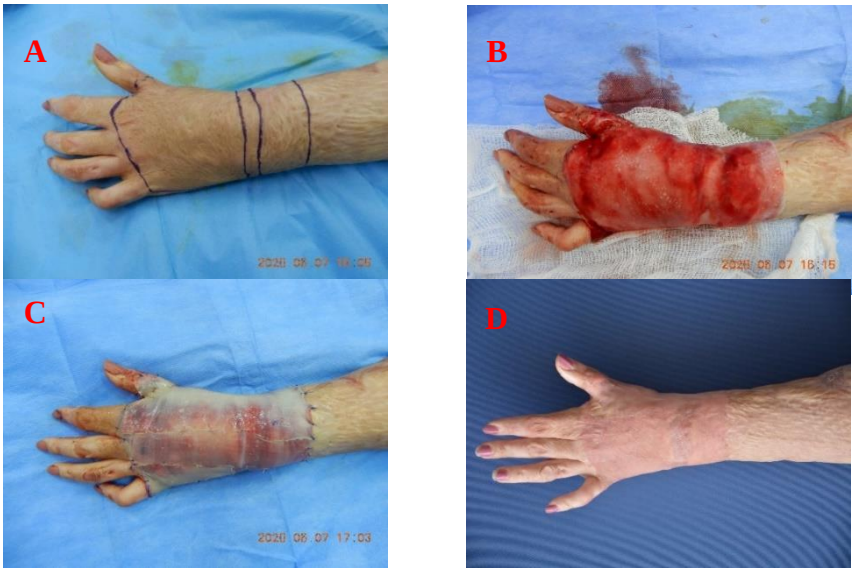

Figure (3): Patient with post-burn scar of the left hand. (A) planning. (B) application of acellular dermal matrix. (C) after grafting. (D) one month after operation, VSS score = 2.

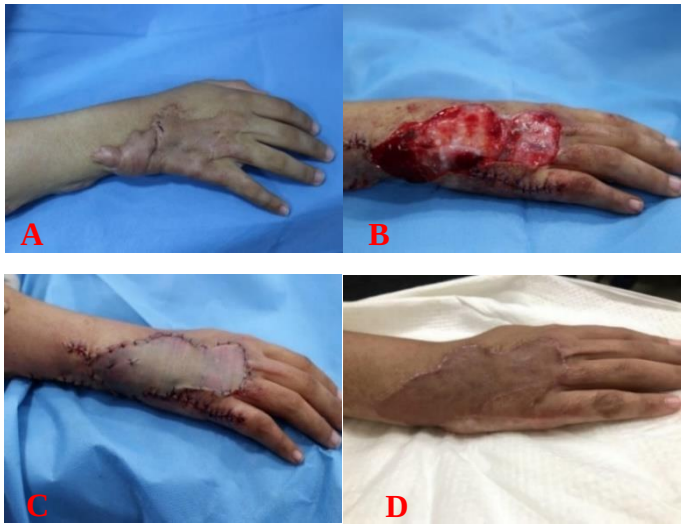

Figure (4): Patient with post-burn hypertrophic scar of the right hand. (A)before operation. (B) application of acellular dermal matrix. (C) application of split thickness skin graft. (D) after 2 months, VSS score = 4.

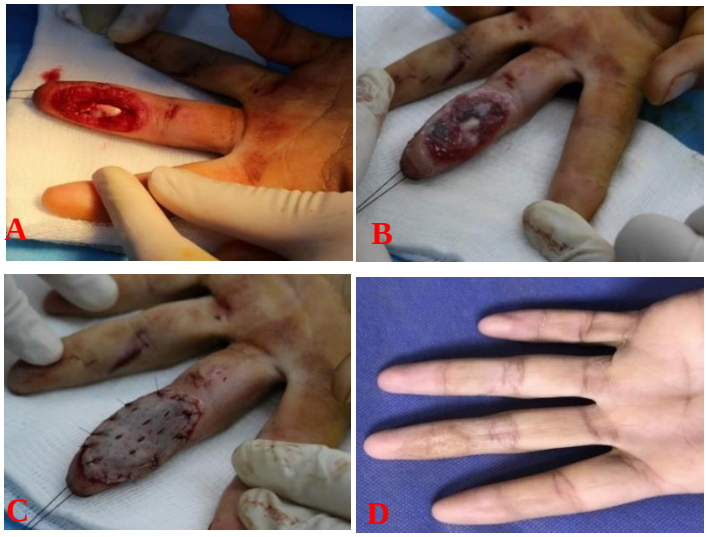

Figure (5): patient with trauma to the volar surface of the middle finger with exposed tendon. (A) before operation. (B) application of acellular dermal matrix. (C) Application of skin graft. (D) after 6 months of wound healing, VSS score = 0. Overall the complication rate is low with 5% had hematoma, 5% had infection and 5% had loss of graft, as illustrated in Table (2).

Table (2): Rate of complications, frequency.

Variables	Value
Hematoma	1 (5%)
Infection	1 (5%)
Loss of graft	1 (5%)

Discussion

Donor site dressings for split-thickness skin grafts (STSG) can help to reduce donor site morbidity. It's frequently utilized in reconstructive surgeries, particularly after a burn damage. The donor site is a superficial wound that heals through re-epithelialization, from which the skin graft is extracted. the benefit of adding Acellular dermal matrix to the procedure will result in further reduction in donor-site morbidity, since it will result in reducing the required thickness of the harvested skin which can be attributed to its unique property by acting as prosthetic skin[14-16].The depth, size, location, and kind of dressing used on the donor site all play a role in pain management[17]. In the present study, we used Vancouver Scar Scale score to assess the quality of wound healing in the recipient area where we used Acellular dermal matrix and STSG (split thickness skin graft), the Scale score was significantly reduced from 7.15 ± 1.63 to 3.05 ± 1.57 aftermonths with 57.6% overall reduction in the score1. This indicate that our procedure wassuccessful in improving the quality of the recipient area.Our findings corroborated those of others Han et al[18] They test the long-term therapeutic benefit and histologic outcome of an acellular dermal matrix mixed with an autologous thin split-thickness skin graft. The composite skin grafts became smooth three, six, twelve, and eighteen months following surgery, with no hypertrophic scar or hyperpigmentation. It was supple and pliable. The composite skin graft had a similar appearance to normal skin, according to the histologic investigation[18]. A study by Chen et al[19] is also similar, they look at the therapeutic effects of ADM combined with auto-skin grafting on deep burn wounds, as well as the results of long-term follow-up and histological investigation. They conclude that a heterologous acellular dermal matrix paired with an auto split-thickness graft can survive in the human body for a long time without showing signs of immune rejection. A concern worth investigating in the regeneration of skin function is the absence of intact tiny sweat glands or sweat gland cells in the dermis[19].Our findings were in agreement with Brolmann et al[20], Kaartinen et al[21], in which they examined 19 burn patients and used STSG procedure, and they reported mean Vancouver Scar Scale score of 3 after 1 month of surgery[13]. The tested dressing enhanced STSG donor site aesthetic outcomes at one month postoperatively in terms of healing quality.In the present study the rate of complications was low with only three patients presented with a complication; one patient had hematoma, the other one had infection and the last one had partial loss of grafted skin. These findings are in agreement with Lotan et al[22] In the meshed acellular dermal matrix group, the overall rates of minor and serious problems were 16.5 percent and 13 percent, respectively[22].

Conclusion

The study found that using an acellular dermal matrix in conjunction with a split thickness skin graft improves wound healing and tissue rebuilding significantly. For a better outcome, we propose using Acellular Dermal Matrix for skin defect restoration.

Conflicts of interest

There were no conflicts of interest.

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