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The Role of Indigenous Four Layer Regenerative Scaffold in the Management of Post Burn Raw Area

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Abstract

The understanding of wound healing has led to the inclusion of tissue regeneration therapy as an armamentarium to deal with both acute and chronic wounds. The bio constructs that aid in wound regeneration was made using natural, artificial, or a combination of both, widely known as regeneration scaffolds. The components of regeneration scaffolds promote the inherent self-renewal property of the skin and speed up the healing process by providing growth factors/stem cells. The scaffolds are in use for so many years. But the commercially available scaffolds are very expensive. Hence an indigenous scaffold was made use of multiple components like non-cultured keratinocytes, amniotic membrane, collagen, and silicone. Which was found to be in no way inferior to any of the commercially available scaffolds.

Keywords: Regeneration Scaffold; Post Burn Raw area; Dermal Regeneration; Regenerative Therapy.

Introduction

The World Health Organization(WHO) estimates that, annually, over 3 lakh deaths are due tothermal burn injuries. Millions are suffering from the physical andemotional consequences of burns.[1] 6.5 millionindividuals suffer from chronic skin ulcers caused by prolonged pressure, venous stasis, or diabetes mellitus.[2] Regeneration therapy is a good option that can be considered in the management of wounds. Regeneration of wounds is done bystimulating the innate ability of the skin for self-renewal. The gradual understanding of the biological processes of wound healing has led to the development of biological constructs that actively promote tissue regeneration using regeneration platforms, or scaffolds, as well as the incorporation of cell-signaling elementssuch as Growth Factors and Stem Cells. But the commercially available Regeneration scaffolds are very expensive, the cost may range between Rs. 20000 to Rs 30000. Hence we decided to make an indigenous regenerative scaffold using the materials available in the ward. In this article, we share our experience of making a regenerative scaffold with four layers in the management of a post-burn raw area patient.

Materials and Methods

This study was conducted in the Department of Plastic Surgery at a tertiary care center after getting the departmental ethical committee approval. Informed written consent was taken from the patient. The details of the patient in the study are as follows: A young femalewas admitted with

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a history of thermal flame burns involving 23% TBSA second-degree superficial and a few second-degree deep burns. Mostly involving the parts of anterior and left lateral aspect of torso, left axilla, and left upper limb (Figure 1a and 1b). After the initial fluid resuscitation, she was initially managed with dry collagen heterografting, and later the dry collagen was replaced with a 4-layer regeneration scaffold. The regeneration scaffold was prepared in the department of Plastic surgery using materials already available in the department.

Fig. 1: a and b.

The four layers from outer to inner are as follows:

1. Silicone
2. Collagen
3. Amniotic membrane
4. Non-cultured keratinocytes

The description of each layer is as follows.

Fig. 2: Silicone Layer.

A self-Adhesive collagen dressing sheet was used.

Fig. 3: Collagen Layer.

The Collagen we used was in the form of dry sheets, commercially available bovine origin, multiple layers of the collagen were used.

Fig. 4: Amniotic Membrane Layer.

Amniotic membrane was harvested from the Obstetrics Department of the same institution. The amniotic membrane was taken from a healthy woman, who had a healthy pregnancy, who was screened for Hepatitis B and C, HIV 1 and 2, and VDRL, taken after a Cesarean birth. The amniotic membrane was irrigated with Saline and treated with Heparin, antimicrobials, antifungals, and stored in glycerol under refrigeration.

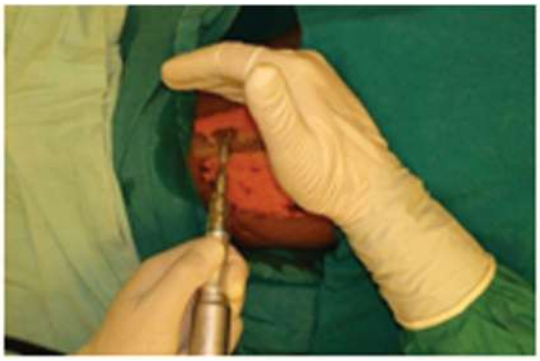

Fig. 5: Non-Cultured Keratinocyte Layer.

The Non-cultured Keratinocytes were harvested using microdermabrasion, and the keratinocytes were mixed with Mupirocin ointment to make a paste.

Steps of Preparation

Fig. 6: Scaffold sutured together.

All the three layers from out to in were placed one over the other and were sutured together using absorbable undyed 4.0 polyglactin sutures (Figure 6) and Non-cultured keratinocyte -mupirocin paste was applied evenly over the third layer to complete all the four layers. The Four-layer regeneration Scaffold was applied once a week under anesthesia after debridement and the patient was treated with antibiotics according to culture and sensitivity and also nutritional support.

Result

The four layers regeneration scaffold is effective in regenerating the wound following the flame burns (Figure 7).

Fig. 7: Healed Raw area.

Fig. 8: Materials Required.

The length of hospital stay was almost identical to patients who underwent allografting. No complications were noted during the study.

Discussion

Thermal wounds have been divided into three zones by Jackson; Zone of coagulation, Zone of stasis Zone of hyperemia. Inadequate fluid resuscitation wound infection or poor perfusion can lead to a superficial burn developing into a more severe and deeper wound.The treatment of the wound may be conservative or surgical, usually followed surgical treatmentsare: excision of eschar to prevent wound infection, wound coverage with an autologous split-thickness skin graft. In case of larger parts of the total body surface area have been involved then, autologous skin grafts meshed toenlarge the size of the graft.

The disadvantages of such practices are morbidity, like pain at the donor site, corrugated scar as the recipient site. In cases of total or near-total full-thickness skin injuries, donor sites may be inadequate. In that case, other treatment options like allograft, or heterograft are used. Such allografts represent temporary measures for immediate wound coverage in the acute stages post-injury. Allografts can be live donor skin grafting ora cadaveric skin graft. Disadvantages of using allografts with live or cadaveric human skin are donor shortage, limited availability,moral objections, risk of viral transmission, etc. All these disadvantages of allografts make space for fully synthetic,biocompatible skin bio-construct which can help in the regeneration ofscar-free skin.Tissue-engineered skin grafts aim toenable complete and natural and accelerated wound regeneration.

A scaffold or template is a 3-Dimensional supporting framework for tissue regeneration, alsopreventing wound bed contraction throughout thestages of healing.[3] The framework, or scaffold, shouldfurther serve as a platform for cellular localization, adhesion, and differentiation, as well as guide the developmentof new functional tissues.[4] Scaffold materials may be ofnatural, synthetic, or composite origin. The mixing of materials of different classes toobtain composite scaffolds helps to overcome the individual limitations of a single material scaffold.[5] The ideal skin regeneration scaffoldshould actively direct tissue formation and prevent scarring. Thus, much focus has been channeled into creating suitable biomimetic structures that can act as delivery vehicles for steam cells or Growth factors.

The synergistic tissue regenerating effects of a smart scaffold cocktail comprises scaffold surface patterns, growth factors, and stem cells which have the realistic potential of overcoming current barriers and enabling fast and completeskin regeneration. During natural wound healing,interactions between components of the extracellular matrix and surrounding cell-signaling molecules are

responsible for the expression of growth factors and cytokines. These interactionselicit cellular responses that ultimately lead to new tissue formation. Over whelming activation of the inflammatory system and prolific recruitment of contractile cells typically leads to scar formation, often resulting in disfigurement and functional disability. Now a days, some wounds are closed aseptically using sutures that obviatethe need for a vigorous contractile response, creating moretime for complete tissue regeneration. Here, external modulation of cell-signaling events via a finely tuned deliveryof Growth factors or stem cells is thought to alter the wound environment, enabling orderly regeneration.

In our study, we have materials of different origins to make a composite scaffold which can help to overcome the limitations of each. All four components are already well documented and proven.

Conclusion

The four-layer regeneration scaffold is simple, cost-effective, easy to prepare, and without any complications. The length of hospital stay was almost identical to the patients who were treated with allograft. The quality of scar formed is good. Buta multi-center and larger volume study is required to comment on the exact findings.

Competing interest: None

Declarations: Author's contributions

All authors made contributions to the article

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References

1. Burke, J.F. et al. (1981) Successful use of a physiologically acceptableartificial skin in the treatment of extensive burn injury. Ann. Surg. 194,413–428.
2. Jones, I. et al. (2002) A guide to biological skin substitutes. Br. J. Plast.Surg. 55, 185–193.
3. Chevallay, B. and Herbage, D. (2000) Collagen-based biomaterials as3D scaffold for cell cultures: applications for tissue engineering andgene therapy. Med. Biol. Eng. Comput. 38, 211–218.
4. Kim, B.S. and Mooney, D.J. (1998) Development of biocompatiblesynthetic extracellular matrices for tissue engineering. TrendsBiotechnol. 16, 224–230.
5. Kannan, R.Y. et al. (2007) Silsesquioxane nanocomposites as tissueimplants. Plast. Reconstr. Surg. 119, 1653–1662.