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Role of Scaffold in Paediatric Scald Burns

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Abstract

Collagen is the main structural protein of most hard and soft tissues in animals and the human body, which plays an important role in maintaining the biological and structural integrity of the extracellular matrix (ECM) and provides physical support to tissues. Collagen can be extracted and purified from a variety of sources and offers low immunogenicity, a porous structure, good permeability, biocompatibility and biodegradability. Collagen scaffolds have been widely used in tissue engineering due to these excellent properties. However, the poor mechanical property of collagen scaffolds limits their applications to some extent. To overcome this short coming, collagen scaffolds can be cross-linked by chemical or physical methods or modified with natural/synthetic polymers or inorganic materials. Biochemical factors can also be introduced to the scaffold to further improve its biological activity. Here we present the use of scaffold in the management of paediatric thermal injury.

Keywords: Paediatric Scald Burns; Scaffold.

INTRODUCTION

Tissue engineering aims to reconstruct living tissues for replacement of damaged or lost tissue/organs, hoping to maintain, restore or enhance part or whole organ function of livingorganisms.[4] An ideal scaffold for tissue engineering is integral to achieve this goal. In natural tissue, extracellular matrix (ECM) is a collection of extracellular molecules secreted by cells that provides spatial and mechanical signals to cells and physical support to tissues.[5,6] It acts not only as a benign scaffold for arranging cells within the connective tissue, but also has a dynamic and flexible role that defines cellular behaviors and tissue function.[5,6] Therefore, it is a rational strategy to fabricate a scaffold that can mimic the ECM of damaged tissue or organ to repair it sequentially[5,6] Collagen is the most abundant protein in the ECM and has been considered to be a group of proteins with a characteristic molecular structure—fibrillar structure, which contributes to the extracellular scaffolding.[5] That is to say, collagen plays an important role in maintaining the biological and structural integrity of ECM and provides physical support to tissues. Collagen possesses extensive sources (such as bone, cartilage, tendon, ligament, blood vessel, nerve, skin), as it is the main structural protein of most hard and soft tissues.[6] In addition, collagen offers low immunogenicity, a porous structure, permeability, good biocompatibility and biodegradability and has functions to regulate the

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morphology, adhesion, migration and differentiation of cells.[7,8] All of these good performances make this natural polymer seem to be a promising biomaterial for scaffolds in tissue engineering. However, the collagen scaffolds lack mechanical strength and structural stability upon hydration, which limit their applications in particular tissues. Intermolecular cross-linking of collagen scaffolds can be achieved by physical or chemical methods, which can improve the mechanical properties of the scaffold. Besides, blending collagen with other materials, such as natural, synthetic polymers and inorganic materials is also frequently used to enhance the mechanical strength of collagen scaffolds. Meanwhile, biochemical factors could be added into or modified onto the scaffold selectively according to the damaged region to improve the cellular outcome.

MATERIAL AND METHODS

This study was conducted in the Department of Plastic Surgery in a tertiary care institute. Informed consent was obtained from the patient under study. Department scientific committee approval was obtained. It is a single center, non-randomized, non-controlled study. The patient under study was a 1-year old male child, (Figure 1) with no

Fig. 1: Child with superficial burns on presentation.

other known co morbidities. Patient was analyzed systematically and was found to have second degree superficial burns to his chest, abdomen and right upper limb. Wound bed was prepared in accordance with TIME concept mentioned in the guidelines, the ulcer was serially assessed and documented according to bates – Jensen wound assessment tool. Non-viable necrotic tissue was managed with multiple sessions of surgical & hydro debridement. Infection was managed with local antimicrobials & antibiotics according to culture sensitivity. Scaffold was applied on the wounds during dressing. (Figure 2)

Fig. 2: Scaffold dressing.

RESULTS

Wound bed gradually improved, clinical decision was taken to reconstruct with skin grafting. (Figure 3)

Fig. 3: Skin graft, after wound bed preparation.

DISCUSSION

Since its emergence in the mid-1980s, tissue engineering has continued to evolve as an exciting and multidisciplinary field aiming to develop biological substitutes to restore, replace or regenerate defective tissues. Cells, scaffolds and growth-stimulating signals are generally referred to as the tissue engineering triad, the key components of engineered tissues. By virtue of their inherent mechanical, biological and architectural properties, scaffolds assist in tissue engineering and regeneration by providing a support matching the original extracellular material in terms of its mechanical properties, promote specific cellular lineage regeneration and differentiation by using the principle of durotaxis, and can , be engineered to contain adhesion lig ands establishing topography and promote correct cell deposition and alignment, or biological cues such as growth factors, nucleic acids, and cytokines that promote tissue proliferation 1, In breast surgery, a cellular dermal matrix improves surgical and aesthetic outcomes by providing tissue support to the mastectomy skin flaps.[1]

Scaffolds are effective when they inhibit wound contraction and its sequelae, scar formation, and their effectiveness can be modified by varying their pore structure, degradation rate, and surface biochemistry. Hence, they have been used in the treatment of partial- and full thickness wounds, pressure ulcers, diabetic foot ulcers, chronic vascular ulcers, surgical wounds, venous lower extremity ulcers, and burns. In breast surgery, a cellular dermal matrix improves surgical and aesthetic outcomes by providing tissue support to the mastectomy skin flaps. It can minimize peri-prosthetic fibrosis and appears to lessen the inflammatory response associated with prosthetic devices1Use of a cellular dermal matrix in the setting of radiation therapy is useful in the short-term but may not ameliorate soft tissue–related morbidities in the long term. In abdominal surgery, the use of biological meshes in the repair of hernias is a matter of debate. As an advantage, it carries lower risk of infection,1it can be used in the management of parastomal hernia 2,and can be used in the management of hiatal hernia. However biological meshes are expensive, recurrence rates are high3and long-term results are not favorable in terms of abdominal wall laxity.

CONCLUSION

Scaffolds and growth-stimulating signals are generally referred to as the tissue engineering triad, the key components of engineered tissues. Hence, they have been used in the treatment of partial- and full thickness wounds, pressure ulcers, diabetic foot ulcers, chronic vascular ulcers, surgical wounds, venous lower extremity ulcers, and burns.Hence we were able to manage a case of paediatric scald burns using scaffold successfully however it needs large scale randomized trials for application in clinical practice.

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