

Evaluation of the use of Single Stage Dermal Substitutes in acute and chronic wounds of the Hand

Thesis

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AHMED AWAD

Dedication

*To those who have always been there for me
My Parents for their support, my wife for her
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List of Abbreviations

ADM	Acellular dermal matrix
BCC	Basal cell carcinoma
CEA	Cultured epidermal allograft
ECM	Extra cellular matrix
EDTA	Ethylene diamine tetra a citic acid
FDA	Food and drug administration
FTSG	Full thickness skin graft
GAG	Glycosamino glycan
MM	Malignant melanoma
NPD	Negative pressure device
NPWT	Negative pressure wound therapy
POSAS	Patient and observer scar assessment scale
SCC	Squamous cell carcinoma
STSG	Split thickness skin graft
TBSA	Total body surface area
TC	Trans cyte
VAC	Vacuum assisted closure
VSS	Vancouver scar scale

Introduction

Skin substitutes were developed as an alternative to skin grafts, especially for burn patients. Autologous skin grafting is a painful procedure, and often the extent of damaged skin is too large to be covered by autologous tissue graft in existence of limited donor skin (**Chern *et al.*, 2009**).

A true “skin substitute” would act like an autologous skin graft in adhering to the wound bed while providing the physiological and mechanical functions of normal skin. Skin substitutes, either cellular or a cellular components intended to stimulate the host to regenerate lost tissue and replace the wound with functional skin (**Bloemen *et al.*, 2010**).

Skin substitutes can be divided into two broad categories: biomaterial and cellular. Biomaterial skin substitutes do not contain cells (a cellular) and are derived from natural or synthetic sources. Natural sources include human cadaveric skin processed to remove the cellular components and retain the structural proteins of the dermis and collagen matrix obtained from bovine and porcine sources. Synthetic sources include degradable polymers

such as polylactide and polyglycolide (**Dieckmann *et al.*, 2009**).

Whether natural or synthetic, the biomaterial provides an extracellular matrix that allows for ingrowth of surrounding cells. Cellular skin substitutes are distinguished by their origin: xenogeneic (from nonhuman species), autologous (from the patient), and allogenic (from another person) (**van Zuijlen *et al.*, 2001**).

The aims of management of wound healing are rapid wound closure with good functional and cosmetic scars. Using dermal substitutes in acute and chronic wounds is thought to lead to better scar elasticity, mechanical stability and appearance. This could be attributable to the fact that dermal substitutes serve as support structure for the ingrowth of vessels and autologous fibroblasts (**Ryssel *et al.*, 2008**).

Pelnac (**Smith and Nephew, Japan**) is a collagen matrix with silicone top layer. It helps to promote the regeneration of damaged dermal layers as an alternative to using the patient's own dermis which may not be available with extensive injuries. Matriderm (MedSkin Solutions Dr. Suwelack AG) is a scaffold consisting of a native bovine type I, III and V collagen fibre template incorporating

elastin hydrolysate that is converted into native host collagen within weeks following application. Integra[®] (Integra Lifesciences Corporation) is made of a thin outer silicone layer and the inner layer is constructed of a porous matrix of cross-linked fibers. This porous material acts as a scaffold for regenerating dermal skin cells. Hyalomatrix[®] (Anika Therapeutics) is comprised of a non-woven pad made entirely of HYAFF[®], a benzyl ester of hyaluronic acid, and a semi permeable silicone membrane. The HYAFF wound contact layer provides a three dimensional scaffold for cellular invasion and capillary growth (**Frame *et al.*, 2004**).

Two well-known methods of application of dermal substitutes on wounds include either a single- or two-staged procedure. The successful application of a dermal substitute in a one-stage procedure implies that only one operation is needed, less pain and the risk of infection is reduced. Second, a statistically significant increase of elasticity and less incidence of stiffness, especially in old aged, was seen in chronic wounds treated with the a single-stage compared with wounds treated with two-staged dermal substitutes or split-skin graft alone (**Lee *et al.*, 2008**).

The use of pelnac, matriderm, hyalomatrix and Integra as dermal substitutes represents a promising

treatment for acute burns and chronic wounds. Their use has obviated the need for more complex flap reconstruction in many cases (**Soejima *et al.*, 1997**).

In Al Noor specialized Hospital (Macca), we are dealing with a huge number of hand-injured patients mostly post-traumatic either separate hand injuries or as a part of poly-trauma. Most patients are the pilgrims and the visitors of the Holy Mosque (Almasjid Alharam, Holy Makkah). There were no established protocol to manage those patients in term of rapid procedures due to increased casualties, short stay, and most of them are coming from long distances. So, we want to establish an applicable protocol of definitive wound management for the sake of rapid, functional, less donor site morbidity and high quality wound healing. The present study evaluates the effectiveness of single layer dermal substitutes in treatment of these injuries as an alternative to the usual reconstructive techniques (**Heimbach *et al.*, 2003**).

Aim of the Work

The aim of this study is to evaluate the use of dermal substitutes in the treatment of acute and chronic wounds of the hand and to establish an applicable protocol of definitive wound management.

Chapter (1):

Functional and Surgical Anatomy of the Hand

The surgeon planning reconstructive surgery on the hand must be aware not only of the complex anatomy of the hand and arm, but also of the physiologic interplay of balanced muscular functions under the influence of complex central nervous coordination. The maintenance of physiologic viability by the central and peripheral circulatory and lymphatic systems must also concern the reconstructive surgeon (**Burke et al., 1981**).

Skin, subcutaneous tissue, and fascia

There is great disparity in the character of the skin and soft-tissue envelope covering the dorsum of the hand and that covering the palm. Dorsal skin is thin and pliable, anchored to the deep investing fascia by loose, areolar tissue (**Jiong et al., 2010**).

These characteristics, coupled with the fact that the major venous and lymphatic drainage in the hand courses dorsally, serve to explain why hand edema is first evident dorsally (**MacLeod et al., 2004**).

The prominent, visible veins in the subcutaneous tissue make it the standard site in which to evaluate venous filling and limb venous pressure on physical examination. The same characteristics make the dorsum of the hand vulnerable to skin avulsion injuries (**Feng et al., 2007**).

Palmar skin, in contrast, is characterized by a thick dermal layer and a heavily cornified epithelial surface. The skin is not as pliable as dorsal skin, and it is held tightly to the thick fibrous palmar fascia by diffusely distributed vertical fibers between the fascia and dermis (**Brusselaers et al., 2010**).

Stability of palmar skin is critical to hand function. At the same time, if scar fixation or loss of elasticity occurs in palmar skin, contractures and functional loss result. The skin of the palm is laden with a high concentration of specialized sensory end organs and sweat glands. The surgeon must understand the relationship of the palmar skin creases and the underlying joints in order to plan precise placement of skin incisions for exposure of joints and their related structures (**Jiaqi et al., 2006**).

Kaplan's cardinal line is drawn from the apex of the first web space to the distal edge of the pisiform bone (**Fig. 1**). Two longitudinal lines are drawn from the ulnar aspect