"A CLINICAL TRIAL TO ASSESS THE EFFICACY OF HYDROCOLLOID VERSUS PARAFFIN GAUZE DRESSING FOR SPLIT THICKNESS SKIN GRAFT DONOR SITE TREATMENT"

By

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Dissertation submitted to the
KLE University, Belgaum, Karnataka

In Partial Fulfillment
of the requirements for the degree of

M. S. GENERAL SURGERY

Under the Guidance of

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MAY - 2009

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DECLARATION

I hereby declare that this dissertation titled **"A CLINICAL TRIAL TO ASSESS THE EFFICACY OF HYDROCOLLOID VERSUS PARAFFIN GAUZE DRESSING FOR SPLIT THICKNESS SKIN GRAFT DONOR SITE TREATMENT"** is a bonafide and genuine research work carried out by me under the guidance of **Dr. S.M.UPPIN M.S,F.I.C.S** Professor, Department of Surgery, Jawaharlal Nehru Medical College, Nehru Nagar, Belgaum-590010.

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Dr.Shaileshkumar.M.E

LIST OF ABBREVIATIONS

STSG – Split Thickness Skin Graft

HTN- Hypertension

DM- Diabetes Mellitus

Hypopro- Hypoproteinaemia

TE-Tangential Excision

rHGH- Recombinant Human Growth Hormone

mm – millimeters

F- Female

M- Male

B/K- Below knee

RT- Right

LT- left

ABSTRACT

Inspite of newer advances, split thickness skin grafts (STSG) still have an important place in many areas of plastic surgery. Though the technique of skin grafting is more or less standardized the treatment of the donor site differs greatly and has been a topic of debate. The management of split-thickness skin graft donor site is targeted towards promoting the healing process, while minimizing adverse effects and complications.

Objective: To compare the percentage of epithelialization achieved by Hydrocolloid in comparison to Standard meshed Paraffin gauze on the Split thickness donor site on 12th post operative day.

Design: Clinical control trial

Setting: KLES Dr.Prabhakar Kore Hospital and Medical Research centre, Belgaum, Karnataka, India

Population: 30 adult patients requiring STSG for various etiologies between December 2006 to December 2007.

Materials and Methods: The study included 30 adult patients. Half of the skin graft donor site in the proximal thigh was dressed with Hydrocolloid dressings and the rest with Standard paraffin Gauze dressing. The extent of epithelialization achieved by each of these dressings was assessed on 12^{th} post op day after skin grafting.

Results: The number of donor areas that achieved complete (100%) epithelialization on the 12^{th} post operative day by Paraffin gauze dressing was 7 (23.3%), whereas Hydrocolloid dressing achieved complete epithelialization in 18 donor sites (60%) (P = 0.016).

Conclusion: Hydrocolloid dressings are superior to Standard meshed Paraffin gauze dressings in the treatment of Split thickness skin graft donor areas.

KEY WORDS: Split skin donor sites, Hydrocolloid, Paraffin gauze, dressings

TABLE OF CONTENTS

LIST OF TABLES

LIST OF CHARTS

LIST OF COLOUR PLATES

"A CLINICAL TRIAL TO ASSESS THE EFFICACY OF HYDROCOLLOID VERSUS PARAFFIN GAUZE DRESSING FOR SPLIT THICKNESS SKIN GRAFT DONOR SITE TREATMENT"

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INTRODUCTION

Dressing of wounds is a practice carried through centuries in order to protect the wound from the harmful external environment. The act of covering a wound mimics the function of the epidermis. Haemostasis aided by a dressing limits blood loss and minimises the dissemination of microbes and toxins, limits oedema, reduces pain and improves gas and solute exchange between blood and tissue [1]

In spite of newer advances split thickness skin grafts (STSG) still have an important place in many areas of plastic surgery. Though the technique of skin grafting is more or less standardized the treatment of the donor site differs greatly and has been a topic for debate. The STSG donor site usually receives little attention and is often a source of delayed healing with considerable pain and discomfort to the patient. Thus it is not uncommon for patients to complain more about pain at the donor site than at the site of surgery. To overcome this various dressing materials have been used.[2]

Skin is a natural barrier that prevents penetration of pathogens and escape of interstitial fluid. The harvest of a split thickness skin graft causes a partial thickness injury and an outflow of blood and protein rich exudate from the wound. This exudate and coagulated blood combine to form an eschar which provides a temporary cover to the wound and underlying regenerating epithelium. However the eschar does not prevent tissue desiccation and infection at the donor site which can thus convert a partial thickness injury to a full thickness loss.[1] After the harvest of STSG, the new epidermis arises from proliferation of the remaining epithelial cell layer at the donor site periphery and reserve cells in the remaining hair follicles, sebaceous glands and sweat glands. This

is the first phase in the healing of a donor site. The process of cell proliferation is followed by migration of the cells outward until the wound is re-epithelialised.[2] Complete re-epithelialization occurs in 10-14 days, although the rate may be affected by the local wound environment.[3]

Split thickness skin graft donor sites have been treated with open or closed dressings.[4] The open technique of donor dressing has been long abandoned in favour of the closed method since occlusive dressings have shown better results with shorter healing time, superior quality of the regenerated epithelium and more patient comfort. It has also shown the added advantage of protecting the donor site from desiccation, mechanical trauma and contamination.[5] A more traditional method is dressing the donor site with fine mesh gauze beneath a closed absorbent dressing. The gauze may be dry but is usually impregnated with bismuth, scarlet red or petroleum jelly. Though the gauze initially provides a moist environment it gradually becomes desiccated and an eschar forms which acts as a mechanical barrier and impairs cellular migration. However these dressings can also become permeable to bacteria if wound exudate soaks through the entire thickness of the dressing. Furthermore movement of the donor site dressing produces shearing forces that may cause pain, dislodge the dressing and impair the migration of epithelial cells. At the time of removal, the dressing is adherent and liable to damage the fragile re-grown epithelium.[6, 7]

Studies have shown that a moist environment promotes healing in a partial thickness skin loss. The use of polyurethane film, a semi permeable dressing maintains a moist environment allowing diffusion of oxygen and water vapour while providing a barrier to the passage of wound exudates. It has claimed to reduce the healing time and

donor site pain. However it has proved difficult to use as wound exudate collects beneath the film and is liable to leak out. [6, 7]

Other experiments have used silicone gel sheets, also a semi permeable dressing with similar results.

During the last decade newer dressing materials have been developed which interact with the wound exudate to form a moist non adherent gel. Commonly used dressings are calcium alginate and bilaminate hydrocolloid membranes. They both have been reported to accelerate healing at the donor site. However the main drawback of both dressings is the time required to apply the dressing. The hydrocolloid dressing has the added disadvantage of leakage of wound exudate which requires redressing.[6]

OBJECTIVES

To compare the percentage of epithelialization achieved by Hydrocolloid in comparison to Standard meshed Paraffin gauze on the Split thickness donor site on 12th post operative day.

REVIEW OF LITERATURE

Ever since the historic days of skin grafting the search for an ideal donor site dressing continues. Although such a dressing is yet to be found, there is no dearth of studies exploring this possibility.

The studies started with the questioning of the concept of keeping the donor site open to air for healing (open method). Pioneering studies by Zhang J et al concluded that moist occlusive dressings achieve quicker epithelialization and accelerated wound healing[8]. It was also concluded that patients with their donor sites treated with moist occlusive dressing had significantly lower pain scores as per the study done by Joel.W.Beam et al.[9]

The meshed paraffin gauze has for years been the primary choice of surgeons for the coverage of split thick skin donor areas, given its ease of application and minimal cost. However it has been found to be inferior in many other aspects – it is a painful adherent dressing under which the donor site does not heal rapidly- Barnea et al[10]

Based on results of many well designed randomized control studies, meshed gauze dressings are proven to be inferior to moist wound products in terms of healing, pain & discomfort.

Recent advances in wound healing have advocated the use of Hydrocolloids which are a form of moist wound dressing. They are polymers of sodium hydroxy-methylcellulose and are claimed to have high absorbent properties. Such high fluid absorption helps in managing the wound exudate while providing a moist healing

environment, a clearly beneficial feature to the wound healing process.[11-18] .They are opaque and gas impermeable. These dressings form a highly absorbent gel that retains moisture and growth factors and facilitates its removal, thereby reducing trauma during dressing changes.

Excellent results were reported by Vloemans et al after their use in burn wound treatment. These products have been extensively used because of these properties in the treatment of pressure sores, venous ulcers and as ostomy barriers.[19]

Santamaria.A.B et al did a review of studies of hydrocolloid dressings in small and medium thickness split thickness skin donor sites in 1992 and concluded that hydrocolloid is a good option as a split thickness skin donor site dressing because the time necessary for the healing of donor sites is shorter and the cost cheaper than the traditional dressings.[1]

Another similar study was done by Feldmann.D.L et al comparing Biobrane (temporary wound dressing), Duoderm(hydrocolloid) and Xenoform(conventional fine mesh gauze dressing) in 30 donor sites in the same number of patients . They concluded that Duoderm was ideal for smaller donor sites when pain could be significantly reduced with minimal increase in overall costs.[21]

Porter.J.M et al conducted a comparative investigation of re-epithelialization of split thickness skin graft donor areas after application of hydrocolloid and alginate dressings in 65 patients. The mean time from operation to the observation of complete healing was 10.0 days for the donor areas dressed with the hydrocolloid and 15.5 days for the donor areas dressed with the alginate: this difference was found to be statistically

significant. The discomfort experienced by the two groups of patients was comparable. The rapid healing associated with the hydrocolloid dressing was thought to be of greatest benefit to inpatients; alginate dressings were thought to be more suitable for outpatients, as they proved to be simpler to use.[6]

Smith.J Jr et al of Michigan School of Medicine's study comparing infectious complications with different dressings concluded that hydrocolloids caused fewer infectious wound complications and more rapid donor site healing.[21]

A similar conclusion was derived by a systematic review study done by Beam.J.W . He said that the data on specific types of moist dressings revealed that days to complete healing were lesser with hydrocolloids compared with nonmoist and other moist dressings.[9]

A prospective Randomized controlled study by Cadier.M.A et al compared Jelonet (paraffin gauze) with Dermasorb (hydrocolloid). The dressings were applied on contiguous donor sites in 21 patients that required skin grafting for burn wounds. Pain experienced with the dressing in situ was assessed on days 2, 4, 7, and on two subsequent occasions. During dressing changes, pain experienced was again assessed, bacteriologic swabs were taken, and the percentage of epithelialization was recorded. Questionnaires completed by investigators and patients were used to assess the perceived performances of both dressings. The results showed that Dermasorb is a less painful dressing than Jelonet, in which wounds heal faster. Dermasorb was preferred by both investigators and patients. No clinical or laboratory evidence of any differences of colonization or infection were found. All results were statistically significant.[11]

Another prostective clinical comparative study was done at Tel-Aviv Sourasky Medical centre by Barnea.Y et al. they compared Aquacel, , a carboxymethylcellulose-based hydrofiber dressing, and the standard mesh paraffin gauze dressing. The study included 23 adult patients. Half of the skin graft donor site in the proximal thigh was dressed with paraffin gauze and the rest with Aquacel. The results indicated that patients treated with Aquacel experienced significantly less pain and a more rapid rate of epithelialization compared with patients treated with mesh paraffin gauze dressing. Final scarring (ie, after the 1-year follow-up) was significantly lesser with the Aquacel dressing. They concluded that Aquacel dressing is superior to the standard mesh paraffin gauze dressing for split-thickness donor site area in pain relief, ease of treatment, promotion of epithelialization, and the quality of scarring.[10]

HISTORY AND BASIC SCIENCES

History of skin grafting

Baronio [22] performed the first successful skin graft in 1804 in a lamb. But Jacques Reverdin, a Swedish medical student studying in Paris placed a 2-3mm epidermal graft on a granulating wound in 1869. This heralded a new era in the arena of auto transplantation of skin. This demonstrated that auto transplanted survived better & also hastened wound healing[23]. This led to a great deal of enthusiasm in skin grafting throughout Europe. Surgeons attempted grafts on all wounds and used skin from animals & predictably results were poor. Subsequently, the initial enthusiasm began to waiver.

Carl Theirsch, a prominent German surgeon was the first to recognize the importance of preparing the recipient bed. Theirsch[24] described removal of the granulation tissue from the wound before applying the graft, which dramatically improved the graft take. Otto Lanz, a Swedish surgeon described the method of meshing the harvested skin to obtain some additional length.[25]

It was not until 1929 when Vilray Papin Blair and James Barret Brown, from St Louis, described their technique and success with split thickness skin grafting that reliable results could be expected. Blair and Brown differentiated between full thickness, intermediate thickness and epidermal (Theirsch) grafts. They also identified the advantages and disadvantages of each. They described wound preparation, graft harvest, graft application, contraindications, and post operative care. They dispelled the misconception that donor sites would not heal if part of the dermis were removed with the graft. These fundamental principles described by Blair and Brown still hold true today.[26, 27]

Once surgeons discovered the principles of successful grafting procedure, the challenge was in obtaining the harvest. Grafts were generally cut from the donor sites with a razor or a long freehand blade, which was both imprecise and technically difficult. This led to development of a host of instruments that could be used for obtaining grafts. The first among these was the knife devised by Humby. A Humby's knife was a razor with a guard which prevented the surgeon from cutting deep during the harvest[25]. Although this dermatome allowed faster and safer harvests, surgeons still did not have a precise control over the thickness of graft. With the beginning of World War-II in 1941, there was an urgent need in the Army for a consistent and quick method to harvest skin. Earl Padgett[28], an American surgeon in association with an engineer named Hood, designed a dermatome that could be set at specific thickness in 1939. Just six years later James Barret Brown introduced the first power driven dermatome. All three above referred dermatomes are still in use today, but by far the power driven dermatome is the most popular. Because of the works of Riverdin, Theirsch, Lanz, Blair, and Brown, Surgeons today approach skin grafting with confidence, expecting success with each graft.

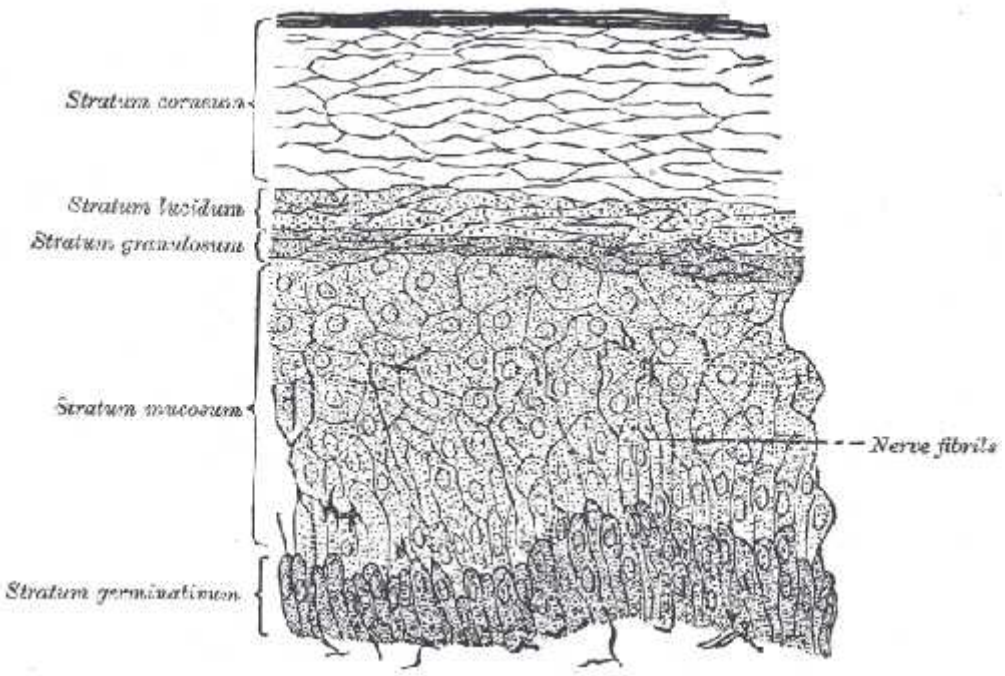
Anatomy and Physiology of skin [29]

The skin covers the entire surface of the body and is continuous with the epithelium of the digestive, respiratory and urogenital systems. It plays an important role as a sensory organ and is important in Vitamin-D metabolism. This epithelial layer performs two essential functions. It provides a physical barrier to the mechanical, chemical and microbiologic insults of the environment. The skin also plays an important role in thermoregulation.

The skin consists of two distinct layers, an epidermis and dermis. The epidermis, the outermost layer, is essentially avascular. The principal function of epidermis is a process called cornification, which develops a tough layer of dead cells that are capable of withstanding the rigors of the environment. The dermis is the vascular bed to the epidermis, and the capillaries present are able to regulate temperature by either vasodilatation (heat loss) or vasoconstriction (heat preservation).

Epidermis

The epidermis varies in thickness from 0.04mm on the eyelids to 1.6mm on the palms. It's made up of four distinct cells: the keratinocyte, the melanocyte, the Langerhans cell, and the Merkel cell. The epidermis first appears emryologically at 3 weeks as a single layer of epithelial cells and is derived from ectoderm.



Section of epidermis

The primary purpose of the epidermis is to provide a protective layer between an organism and its environment. Through the process of cornification, a layer of dead cells envelopes the organism and acts as a barrier. Cornification begins in the basal layer, where the cells are columnar or cuboidal. These cells in the basal layer contain large oval nuclei and basophilic cytoplasm. Within this layer, the cells synthesize tonofilaments. The tonofilaments aggregate throughout the cells' ascent through the epidermis and become the keratinous protein that fills the mature cornified keratinocyte. In the next layer, the cells take on a polygonal because of cell to cell connections called desmosomes. These cell to cell connectins resemble spines on electron microscopy, hence the name stratum spinosum. Near the top of the spinous layer, the keratinocyte begins producing keratohylin granules, which become prominent as the cell ascends to stratum granulosum. These granules contain histidine rich protein called profilaggrin. As the cell matures, the profilaggrin is degraded to filaggrin, which acts as a glue to hold the keratin filaments together. A second type of granule forms near the top of the spinous layer. The lamellar granule contains free sterols, polar lipids, and several hydrolytic granules. This granule fuses with the keratinocyte cell membrane, discharging its contents into the intercellular space. These granules establish a hydrophobic crystalline sheet within the intercellular space of the cornified layer, which is thought to give skin its impermeable quality.

While the keratohylin and lamellar granules are forming, lysosomes are released into the cell. It's thought that the enzymes effectively digest the intracellular organelles and nuclei. Tonofilaments and keratohylin are thought to be resistant to the lysosomal digestive enzymes and subsequently fill the mature corneocyte.

Near the top of the granular layer, a thickening develops along the upper portion of the keratinocyte's plasma membrane. This thickening, called the marginal band or the cornified envelope, is formed from numerous disulfide bonds and other resistant chemical bonds between keratohylin and involucrin and multiple neutral lipids. This marginal band provides the epidermis with an integrity that allows it to withstand the chemical and physical insults of the environment.

The process of cornification is an orderly sequence of events. It starts at the basal layer where a cell begins producing tonofilaments. These are the precursors to α-keratin. As the cell ascends, it flattens out and loses the intracellular organelles and nuclei, which are replaced keratohylin granules. Hydrophobic lipids are released and form crystalline sheets in the stratum corneum that provide the epidermis its impermeable nature. The outermost layer of keratinocyte's plasma membrane thickness through a series of chemical bonds to construct an impermeable and resistant barrier to the environmental insults. The entire process takes about 19 days. The cornified layer is pliable and soft on normal skin; on the nail bed, the cornified layer is hard and thick to form the nail.

Melanocytes reside in the basal layer of the epidermis, in the ratio of 1 melanocyte every 10 keratinocytes. The primary function of melanocyte is to produce melanosomes. These vesicles migrate to the tips of the dendrites of the melanocyte where they are phagocytosed by the surrounding keratinocyte. There are two types of melanin: eumelanin, with a characteristic brown or black color; and pheomelanin, which accounts for lighter colors like blonde or reddish brown. The amount of melanin is greater on face compared to the trunk. The primary function of melanin is to protect the skin from

harmful effects of sunlight. There is also some evidence that melanin acts as a biochemical neutralizer of oxygen free radicals.

The Langerhans cell is a specialized cell that resides in the middle layers of epidermis. This cell provides the immune characteristics of the skin and plays a large role in contact dermatitis, allograft rejection, and neoplasia surveillance.

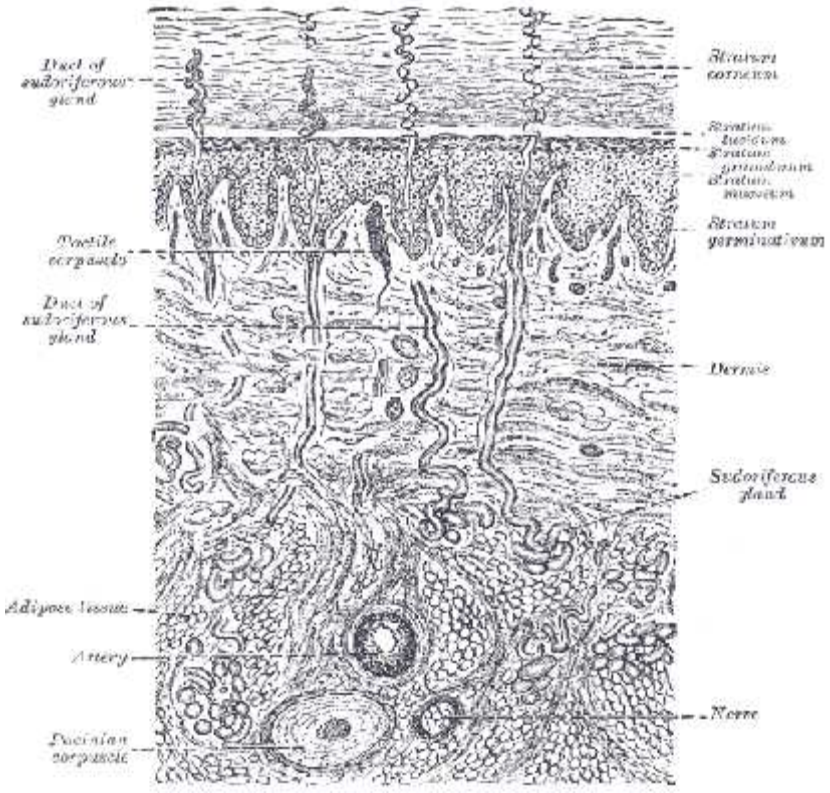
Also within the epidermis are specialized cells called Merkel cells. Most of these cells are found in the epidermis of the palms and soles, nail beds, and oral and genital epithelium. Merkel cells are found close to neuritis. They act as mechanoreceptors, and are able to transmit mechanical forces into action potentials along an associated nerve. Merkel cells have been found in the dermis away from any neural elements, and the entire function of Merkel cells is still unclear.

Dermis

The dermis is composed of collagen, elastic fibers and ground substance. It is relatively non cellular compared to the epidermis. The dermis contains all nerves, vessels, and lymphatics of the skin and also most of the glandular elements of the skin. The dermis is 15 to 40 times thicker than the epidermis, but because of its decreased cellularity it consumes much less energy than the epidermis. The free cells found in the dermis are, in descending order of frequency, fibrocytes, mast cells, histiocytes, Langerhans cells, lymphocytes, and rarely eosinophils.

The mature dermis can be divided into two layers, a superficial papillary layer and a deeper reticular layer. The papillary layer contains disorganized collagen bundles, elastic fibers, fibrocytes and ground substance and has a highly developed

microcirculation. The microcirculation in the papillary dermis provides the blood supply for the metabolically active epidermis. The reticular dermis is composed of thick bundles of coarse collagen arranged in orthogonal pattern. Coarse elastic fibers are interspersed between the collagen fibers. The reticular dermis is cellular than papillary dermis and contains less ground substance.



A diagrammatic sectional view of the skin

The dermis immediately adjacent to hair follicles, apocrine glands, and eccrine glands resembles papillary dermis despite the deep nature of some of these glandular elements. This dermis is called periadnexal dermis and along with the papillary dermis can be referred to as adventitial dermis.

The ground substance found in the papillary dermis and to lesser degree in the reticular dermis is composed primarily of the mucopolysaccharides hyaluronic acid and chondritin sulfate. Ground substance tends to have a gel like consistency. Through the process of ageing, ground substance decreases and is replaced by fibrous tissue.

Dermal-Epidermal junction

The dermal- epidermal junction is the specialized site of attachment between the epidermis and papillary dermis. The most abundant cells in the dermo-epidermal junction are the basal keratinocytes. Other cells present include melanocytes and Merkel cells.

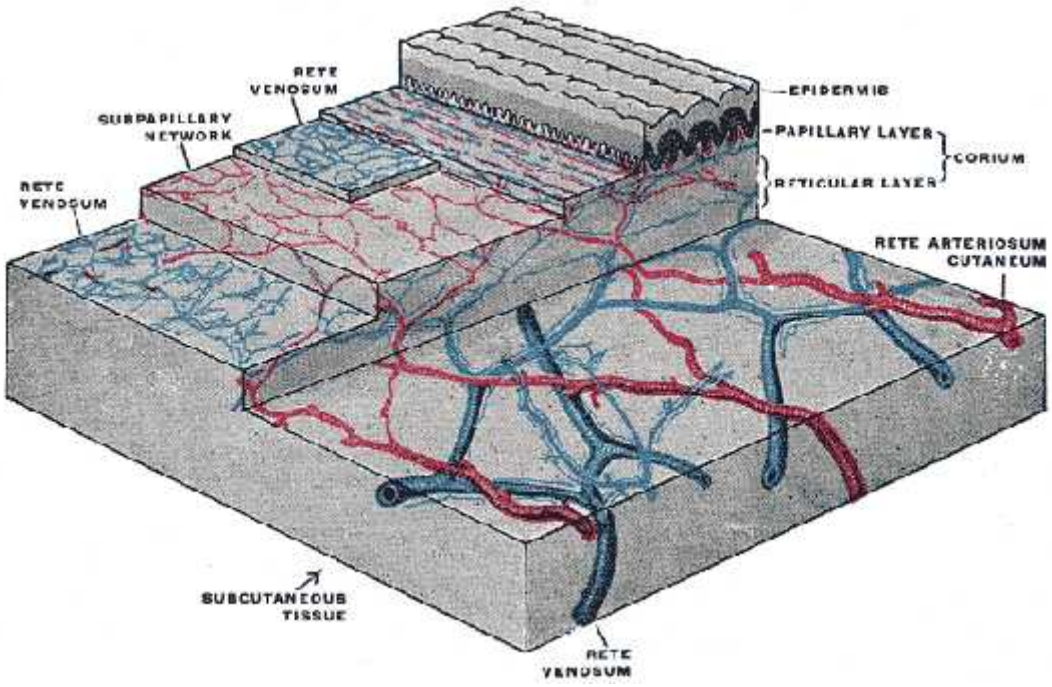
Electron microscopy has identified four layers in the dermo-epidermal junction. The first layer is made of hemidesmosomes. These are electron dense structures located above the plasma membrane of basal keratinocytes. Tonofilaments from basal keratinocytes are attached to the hemidesmosomes and run perpendicular into the cell. The lamina-lucida is the second layer of the dermo-epidermal junction. It lies beneath the hemidesmosomes and forms a 30-nm electron-lucent layer. Within the lamina-lucida rest the sub-basal dense plaques, which rest directly beneath the hemidesmosome. Anchoring filamanets run through the lamina-lucida to connect hemidesmosomes with the underlying basement membrane or lamina densa. The lamina densa makes up the third layer. It’s an electron dense 40-nm layer made predominantly of type IV collagen. Directly beneath the lamina densa is the fourth layer, a fibrous zone composed of anchoring fibrils, type III collagen, and dermal microfibril bundles. Anchoring fibers, which are not synonymous with anchoring filaments, are composed largely of type VII collagen. This interacts with the collagen type IV of the lamina densa and helps it attach to the underlying dermis.

The dermal-epidermal junction provides the major functions for the skin. First, being the attachment between epidermis and the dermis. Second, the basement provides all support for the overlying dermis. Third, anionic proteoglycans such as heparin sulfate rest on both the dermal and epidermal sides of the lamina densa. These proteoglycans provide a chemical barrier to the penetration of anionic macromolecules. The prime barrier to chemical penetration is the cornified epidermis, and the dermo-epidermal junction plays a minor role.

Blood supply

The cutaneous blood supply refers to the vascular arrangement superficial to deep fascia. After perforating the deep fascia, the arteries may run fir various distances in the superficial fascia before sending branches towards the dermis. The subdermal arterial plexus is the major blood supply to the skin. Branches from the subdermal plexus supply the skin appendages and end in a plexus located in the superficial layer of papillary dermis. Capillary loops in the dermal papillae provide blood supply to the epidermis. Because of the interconnecting nature of the subdermal plexus, no portion of skin is directly dependent on the proximal cutaneous perforator.

The venous drainage of the skin mirrors the arterial supply. Efferent loop capillaries in the papillary dermis empty into a subdermal plexus. The venous subdermal plexus then drains into the segmental veins, which carry the venous return into the larger subcutaneous veins.

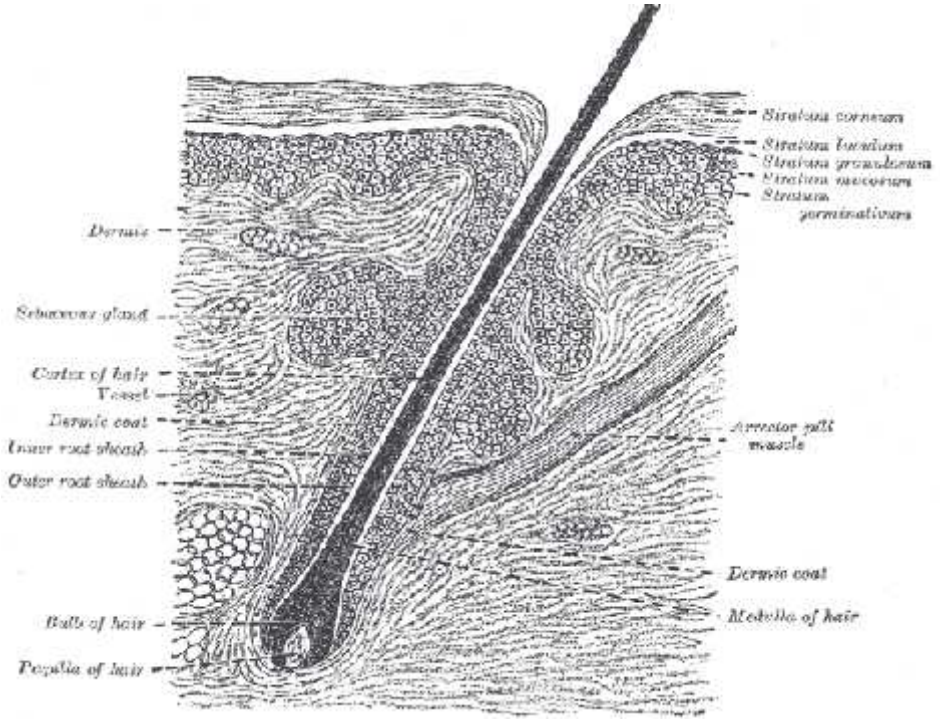


The distribution of the blood vessels in the skin

The blood supply the subdermal arterial plexus comes from two types of cutaneous perforators. First, the musculocutaneous perforators arise from vessels deep to the underlying muscle and pierce the fascia to terminate in the subdermal plexus. Second, the direct cutaneous arteries run parallel to the surface of the skin superficial to the muscle fascia. These arteries receive blood from segmental perforators that penetrate the muscle at various intervals. The direct cutaneous arteries terminate into the subdermal plexus.

Hair Follicles

Hair differentiation is first noted at 9 weeks of gestation as aggregates of mesenchyme beneath plaques of elongated epithelial cells. The process starts on the head and moves in the cranial-caudal direction. The mesenchyme begins to grow downward into the dermis as the epithelial cells proliferate upward through the epidermis, creating a canal called acrotrichia. On reaching the base of the developing hair follicle, the epithelial plaque forms into a bulbous structure that encompasses the underlying mesenchyme. Once fully developed, hair follicle consists of a follicular matrix, derived from an underlying follicular papilla, derived from mesoderm.



Section of skin, showing the epidermis and dermis; a hair in its follicle; the erector pilae muscle; sebaceous glands

As the hair follicle is developing, three bulges form on its sidewalls. The deepest bulge is the site of attachment of the hair follicle to the erector pilae muscle. The middle bulge forms into the sebaceous gland. The most superficial one develops into an apocrine unit, consisting of subcutaneous fat and the apocrine duct, which connects the gland to the hair follicle. As these structures are developing, the follicular matrix forms an inner and outer sheath, eventually creating embryonal hair.

The hair follicle can be straight spiral, helical, or wavy. The morphologic character of the hair follicle varies with race; blacks have spiral hair, whereas Asians frequently have straight hair follicles.

The hair follicle can be divided into 4 histological layers or zones. The infundibulum extends from the skin to the entrance of the apocrine gland. The isthmus resides between the apocrine gland Ostia and the sebaceous gland Ostia. The stem of the hair follicle is between the sabecous gland entrance and the attachment of erector pilae muscle. The portion of the follicle deep the erector pilae insertion is the bulb. The bulb contains the follicular matrix and the follicular papilla and is principally responsible for the hair development.

Hair development goes through three distinct phases in an adult. Active growth takes place during the anagen phase Involution of the hair follicle occurs during the catagen phase. The resting cycle of the hair growth is the telogen phase.

The characteristics of hair growth in a skin graft resemble those of the donor site. This must be considered in choosing a donor site. Hair follicles often grow in a slanted

direction through the dermis. Incisions in the hair bearing areas should be beveled in the direction of hair growth to prevent undue destruction of the hair follicles.

Sebaceous Glands

Most sebaceous glands develop in the fourth week of gestation and arise from a maturing hair follicle. They are fond in the greatest concentration on the forehead, back, and nose. They almost always are associated with a hair follicle. However in the oral mucosa, lip vermilion, internal fold of prepuce, labia minora and eyelids, the association is only of an infundibulum. No follicular stem or bulb is present.

Sebogenesis begins at the base of the sebaceous gland lobule. A germ layer exists at the periphery of the sebaceous lobule. As the cells mature, they fill with lipid and eventually lyse, releasing their contents into the sebaceous duct. As the cell and its contents are released in toto, it's called as a holocrine gland. The content of sebaceous ducts is called sebum. It contains multiple lipid components, including triglycerides, wax esters, squalene, cholesterol esters and cholesterol. Bacteria (*propionobacterium*) in the infundibulum of the associated hair follicle break down some of the lipids to free fatty acids. It has been suggested that these free fatty acids lead to inflammation associated with the acne-vulgaris.

Sebum production is a continuous process that does not rely on the nervous system. Sebaceous glands are active during infancy but quickly involute. At the age of 8 to 10 yrs, they become active again, coinciding with the onset of puberty. It appears that androgenic steroids control the sebum production. The exact function of the sebaceous gland is still uncertain.

Apocrine Glands

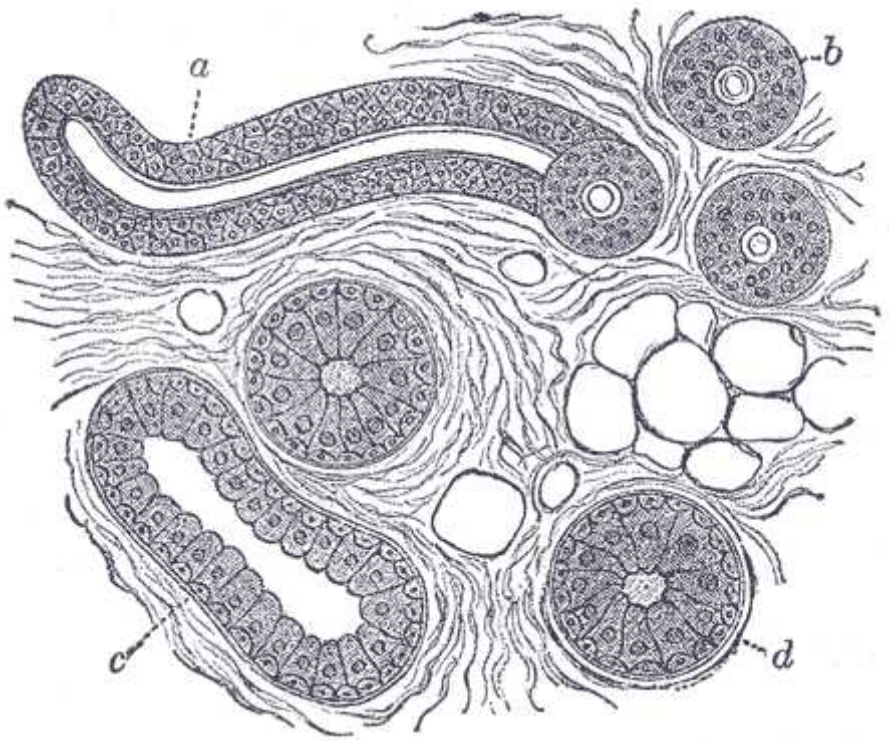
Apocrine glands are found in the axillae, areola, scalp, periumbilical region, perianal and circumanal areas, prepuce, mons pubis, labia minora, external auditory meatus and eyelids. The gland itself typically rests in the dermis or subcutaneous tissue and is attached to an associated hair follicle, where it inserts just above the entrance of the sebaceous gland. The apocrine gland is a coiled gland whose cells continuously secrete its contents into the apocrine duct through a decapitation process. Apocrine secretion is controlled by the autonomic nervous system. Both unmylelinated adrenergic and cholinergic nerves innervate myoepithelial cells surrounding the secretory cells. Catecholamines can also stimulate apocrine secretion. Bacteria in the follicular infundibula and on the skin surface act on the apocrine secretion to produce sort –chain fatty acids, ammonia, and other malodorous products.

The exact content of apocrine secretion is currently unknown. Apocrine secretion in some primates acts as a sexual attractant or pheromone. Some believe it serves this function in humans; however there is no proven function for apocrine glands in humans at this time. Inflammation and obstruction of apocrine gland leads to a clinical condition called hidradenitis suppurativa.

Eccrine Glands

The eccrine gland is the only true sweat gland in humans. They are present over the entire surface of the skin except the lips, clitoris, labia minora, and external auditory canal. The glands are typically tubular and are located at the base of the dermis and empty into the skin. They develop independently into folliculosebaceous apocrine unit and are of epidermal origin. An infant is born with approximately 3 million eccrine sweat glands from after birth.

The eccrine gland is a coiled secretor gland, with a coiled dermal duct, a straight duct that passes through the dermis, and a spiraled duct called the acrosyringium. The secretary gland releases isotonic solution that is a precursor of sweat. The duct absorbs sodium in partial exchange for potassium, resulting in a hypotonic sweat consisting of sodium, chloride, potassium, urea, lactate, bicarbonate, ammonia, calcium, phosphorous, magnesium, iodide, sulfate, iron, zinc, amino acids, proteins, and immunoglobulins. The pH of the sweat is between 4.5 and 5.5 and generally increases as the amount of sweat increases. Eccrine glands are innervated b both adrenergic and cholinergic fibers from the sympathetic nervous system.



Body of a sudoriferous gland cut in various directions. a. Longitudinal section of the proximal part of the coiled tube. b. Transverse section of the same. c. Longitudinal section of the distal part of the coiled tube. d. Transverse section of the same

The principal function of the eccrine gland is to control body temperature through the process of evaporation. An increase in the body temperature of 0.01^0 C will activate the hypothalamic system. This will activate the sympathetic nervous system, causing the number of eccrine glands actively secreting to increase. In extreme temperature exposures, 2 to 3 liters of sweat can be produced in an hour. During prolonged exposure to high temperatures, eccrine glands become acclimatized and are able to secrete larger amounts of sweat at a greater rate in response to a relatively smaller elevation in body temperature.

Eccrine glands on palms, soles axillae, and forehead tend to respond to emotional stimuli as opposed to heat. This explains the familiar "cold clammy hands" that develop during particularly stressful situations.

Wound Preparation

Before the skin graft is applied, it is essential that the recipient site be prepared for grafting. Many skin graft failures can be attributed to inadequate recipient preparation. It's important to ensure that the wound being grafted has a vascular bed free of infection or malignant disease and that hemostasis has been achieved. If these conditions have not been met, it may be prudent to delay the grafting until the wound is better prepared.

Wounds can be divided into acute and chronic wounds. Acute wounds are the ones less one week old. Most acute wounds are a result of traumatic injuries, burns, or oncologic resections. These wounds may contain an eschar but are generally devoid of granulation tissue. The nature of the injury, such as a crushing type may not be suitable for immediate skin grafting.

In approaching an acute wound, the first step is to debride all devitalized tissue from the wound. All eschar is removed and the wound bed is debrided till it bleeds actively. The wound bed is then examined. Fat peritenon, and periosteum, are poorly vascularised, but they will generally support a split-thickness graft. If the bed has a series of irregularities, a meshed graft may be used as it will adhere better than an unmeshed graft. If hemostasis cannot be achieved, a pressure dressing can be applied, and the grafting can be delayed.

Chronic wounds offer the surgeon a great challenge to skin grafting. A chronic wound is the one which is exposed for more than a week. Chronic wounds may contain eshar and also frequently granulation tissue. Any traumatic wound that has been treated open, venous stasis ulcers, vasculitis ulcers, radiation ulcers, and pressure ulcers represent chronic wounds.

Chronic wounds have been exposed to the environment for a prolonged time; consequently, the infection rate is higher than in acute wounds. The wound should be examined for the signs of infection, which include drainage, surrounding erythema, and grey or tan granulation tissue. Should infection be suspected, a tissue biopsy specimen can be sent for quantitative wound cultures. If there are more than 10^5 organisms per gram of tissue, the wound is infected, and grafting has to be delayed. Infected wounds can be treated with topical or systemic antibiotics till the infection clears. One report indicates that fibrin glue may allow successful grafting onto an infected wound.

Ideally, the chronic wound should have healthy pink or red granulation tissue and signs of epithelial migration at the wound margins. Some wounds never develop such an

ideal bed. Assuming the underlying cause is non infectious, a trial of Becaplermin (Regranex) may stimulate granulation tissue and improve chances of skin grafting success. Becaplermin is a recombinant human platelet derived growth factor that has been reported to stimulate wound healing. Becaplermin has been used to stimulate and expedite granulation tissue before grafting. Vacuum dressings have also demonstrated an ability to stimulate granulation tissue.

The underlying medical condition of the patient has to be optimized before definitive grafting. In general, all active infections should be treated before graft application. Wounds due to vasculitis frequently require aggressive medical management before grafting. Wounds due to arterial insufficiency may require angioplasty or vascular bypass. Good long term results are very difficult to obtain in cases of grafting for pressure ulcers and radiation ulcers, and hence these wounds are best treated with flaps whenever feasible.

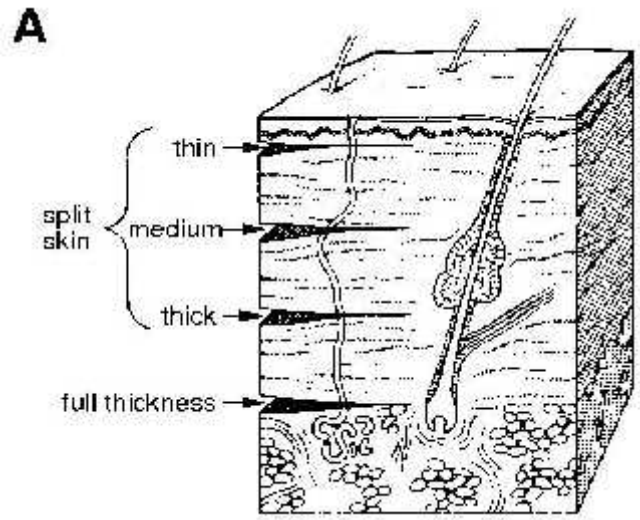
In the operating room, a chronic wound should be debrided of any eschar or debris. Because granulation tissue harbours bacteria, some advocate a tangential debridement of the granulation tissue. If the granulation tissue is not sharply sharply debrided, it can be mechanically debrided with saline gauze. There is often significant bleeding after debridement, and hemostasis has to be achieved using electrocautery, ligation, or pressure. In burns topical epinephrine impregnated gauze is used in combination with pressure to obtain hemostasis. Topical thrombin and fibrin glue can also be used for the same. Fibrin glue is completely absorbent and has an additional benefit in graft take. Oxycel and Gelfoam are to be avoided because they provide a barrier to graft adherence.

SKIN GRAFTS

Skin grafts are used in a variety of clinical situations. The essential indication for skin grafting being wound closure. In general full thickness grafts are applied to the areas of face, ears and hands. Split skin grafts are placed on trunk and genitalia. Skin grafts are an option for many wounds which cannot be closed primarily. Grafting offers the simplest method of wound closure in the reconstructive ladder, assuming that primary closure is not possible or would lead to undue tension. Various forms of skin grafts are also useful in releasing contractures, in certain forms of vitiligo, during syndactyly release, and in treating hair loss. Skin grafts are generally avoided in the management of more complex wounds. Conditions with deep spaces and exposed bones, such as sternal wounds, pressure sores, and open fractures, normally require the use of muscle flaps for stable wound coverage. Skin grafts have limited success in wounds with a compromised blood supply, such as irradiated wounds and ischemic ulcers.

Split Versus Full Thickness

Skin grafts can include either a portion of dermis or the entire dermis. When a graft includes only a portion of the dermis, it is referred to as split thickness skin graft. When the graft contains the entire dermis, it is called a full thickness skin graft. The amount of dermis included in the graft determines both the survival and the amount of contracture. Split thickness grafts can tolerate less vascularity but have greater amount of contracture. Full thickness skin grafts require better vascular bed for survival but undergo less contracture. Sensory recovery of the full thickness graft is superior to that of the split thickness graft.



Split thickness and Full thickness graft

A typical split thickness skin graft is 0.30 to 0.45 mm (0.012- 0.018 inch). Blood vessels typically arborize as they through the dermis; thus the cut vessels on the undersurface of the graft can easily absorb nourishment for the survival. Therefore, when a skin graft is applied to close a wound with a tenuous vascularised bed, such as over periosteum, peritenon, or perineurium, split thickness grafts are less likely to survive. After a split thickness graft is harvested, the donor site generally heals spontaneously. Epithelial cells deep in the hair follicles and sweat glands generally cover a typical split graft site in 7 to 21 days, depending on the thickness of the graft. If necessary, the donor of the split thickness graft can be harvested again after the wound epithelialization. This is often necessary in treatment of patients with large surface area burns.

Full thickness grafts contain both epidermis and the full thickness of dermis. Unlike in split thickness graft donor sites, there are no residual epithelial cells to resurface the donor area. Full thickness graft donor sites must be closed primarily. Thus, full thickness grafts are not normally used for large wounds. The degree of vascularity in the full thickness graft is greater than for thinner split thickness graft.

Donor Sites

Split thickness skin grafts can be taken from any area on the body, including the scalp. Despite the ability to heal spontaneously donor site is frequently scarred or discolored. Donor sites are frequently in areas hidden by modern day clothing. Popular areas for split thickness graft harvest include thigh, trunk, and buttocks. Donor sites containing suspicious lesions are avoided to prevent transfer of a malignant neoplasm with the skin graft.

Defects on the face are frequently closed with either local flaps or full thickness grafts. On occasion, a split thickness graft can be used. When placing a split thickness graft on the face, one should use a donor site from the “blush zone”. This gives a graft with the best color match. The blush zone is above the shoulders and consists of the scalp, neck, and the supraclavicular area. In taking a graft from a hair bearing area, it is important to take a thin graft because thicker grafts will contain undesired hair follicles and eventually lead to hair in the graft.

In choosing a harvest site, it is important to keep in mind the thickness of the donor site. Skin is typically thin in infants and the elderly. Men typically have thicker skin than women do regardless of anatomic location. Skin is typically thicker on the trunks and the thighs and thinner on the eyelids and post auricular areas.

A frequently overlooked source of skin grafts in the trauma situation is avulsed skin. This skin can be harvested in either a full or split thickness fashion and can be applied to the resulting wound primarily or stored used later. In patients with combined polydactyly and syndactyly, the removed accessory digit may also be a source of skin for syndactyly release.

The donor site of a split thickness skin graft generally heals in 7 to 21 days. The most common treatment of a split thickness graft donor site is fine mesh gauze impregnated with a lubricant and, possibly an antibiotic. The gauze is applied immediately after harvesting of the graft and is left on the donor site until it falls off. The gauze provides a protective layer over the donor site and helps with pain control during the healing process. Re-epithelialization reliably occurs in 12 days with this method of treatment.

The optimal treatment of the donor site is auto grafting. When excess skin is available after grafting, it can be placed onto the donor site rather than discarded. It is possible to mesh a skin graft so that there is available skin for both the defect and the donor site. A variety of donor site dressings are available for the management of the donor site in a split thickness skin donor area.

Calcium alginates

There were insufficient studies of sufficient quality to make any judgment between the performance of calcium alginates and other moist wound healing products or between specific products within the calcium alginate group. Well designed clinical trials should be conducted to compare calcium alginates with other moist wound healing products.

Hydrocolloids

Hydrocolloids were found to be superior to non-moist wound products in relation to healing, pain, and infection. The studies comparing hydrocolloids with other non-moist products in relation to healing are insufficient to indicate that they are superior to other moist wound healing products. The results for the outcomes of pain and rates of infection suggest that hydrocolloids are not superior to other moist products.

The overall cost of any of the treatments used in wound management is greatly affected by frequency of dressing changes. It has been suggested that when hydrocolloids leak that reinforcement rather than changing the dressing outright is appropriate and has no greater risk of morbidity, this should be more rigorously tested. Further research is required to determine if hydrocolloids have any clinical advantage over other moist wound products, however they can be recommended for use in the management of STSG donor sites.

Polyurethane semi permeable transparent films

The results for polyurethane films relating to healing in comparison to non-moist products are mixed. Polyurethane films fared better with regard to pain and infection suggesting they are superior to non-moist products. When compared to other moist wound products on balance there is no strong evidence to suggest one group is superior to another for any of the outcome categories. Polyurethane films can be recommended for use in the management of STSG donors and it can be suggested that polyurethane films are more suited to wounds with light to moderate amounts of exudate.

Polyurethane foams

Whilst no recommendations can be made with regard to polyurethane foams and the management of STSG donors it is recommended that these products be subjected to further clinical trials in comparison to other moist wound products.

Hydrogels

As these products are designed for wounds with only a low level of exudate these products would not be recommended for use in the management of STSG donors when alternative moist products are available.

Scarlet Red

This particular product was analyzed separately to other non-moist wound products. Of all the non-moist products analyzed the results relating to Scarlet Red, although not convincing, did hold some promise. Further clinical studies may clarify the potential of this product and this should be considered in light of its level of use.

Growth factors

Results suggest that rHGH is most promising in relation to improving healing times for STSG donors, however as an emerging technology the cost/benefit of these products is a major concern and should be further investigated.

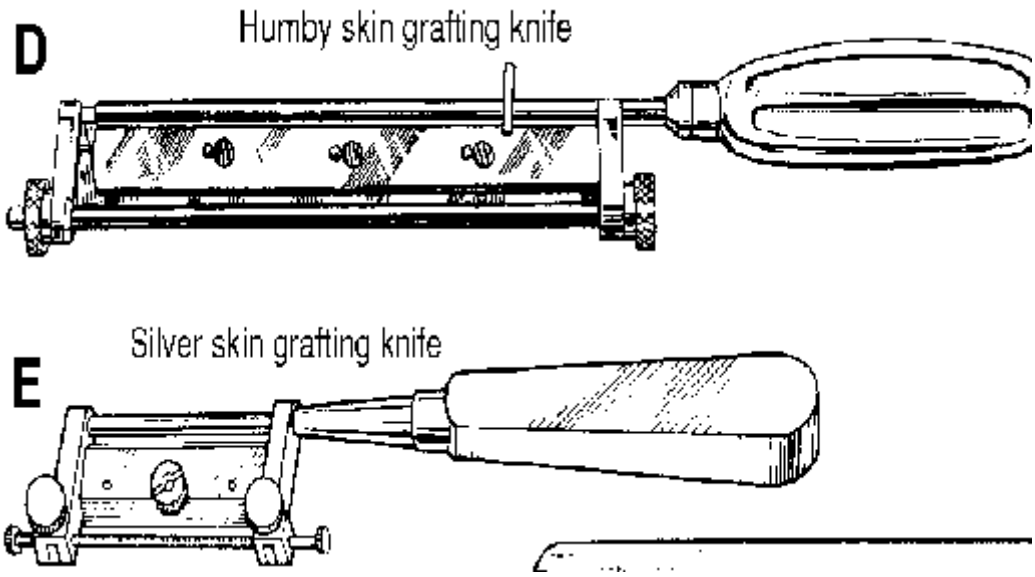
Cultured epidermal allografts

These technologies are not being suggested for routine use but in cases where conventional therapy is inadequate. In these circumstances there may be a valid argument for their use despite their cost. Cost utility analysis should be conducted to more accurately determine the overall effectiveness of these products.

Harvesting Split Thickness Grafts

The process of harvesting a split thickness skin graft entails cutting the skin at some point through the dermis. This can accomplished with two different types of instruments, freehand and power driven dermatomes.

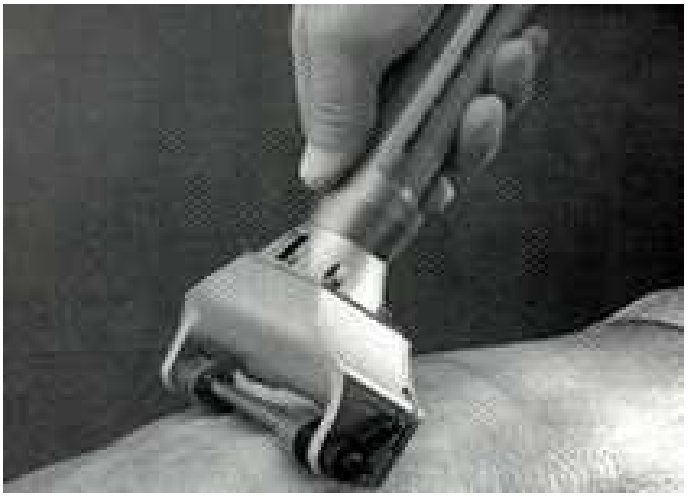
Freehand dermatomes include the Weck blade, the Humby knife, the Blair knife, and a simple scalpel. A freehand dermatome offers a quick method of harvesting a skin graft that does not depend on electricity or pneumatic power. However, with freehand dermatomes, one has difficulty in controlling the exact thickness and depth of the graft



Freehand dermatomes used for obtaining split skin

Once the donor site has been identified, the area can be anaesthetized with local anaesthetic with or without adrenaline. Adrenaline can help control the bleeding and lengthen the duration of the local anaesthetic. Donor sites can also be anaesthetized with regional nerve blocks, general anaesthesia, or frost induced anaesthesia. A template can be used to help identify the amount of skin needed for the graft. If a larger template is used, the graft should be cut to 5% larger than the template to account for the skin contraction that occurs after the graft is harvested. The Weck blade, the Humby knife, and the Blair knife are equipped with a guard, which limits the depth of the skin graft. Typically, the guard is set at 0.30 to 0.45 mm for a split thickness skin graft harvest. This should be verified by passing the beveled end of a no.15 blade scalpel between the guard and the knife. If the guard is set 0.3mm, the beveled end of the blade will snugly fit between the guard and the knife. An assistant applies tension to the donor site, and the area is lubricated with mineral oil or saline. The surgeon then passes the knife parallel to the epidermis in back and forth direction, much like a musician playing a violin. The assistant gently withdraws the resulting graft from the dermatome as the surgeon continues the harvest.

In 1940, James Barret Brown introduced the first electrically driven dermatome. Because of the simplicity and reliability, the motorized dermatome has largely replaced the freehand dermatome for large split thickness skin harvests. A power driven dermatome uses a rapidly vibrating blade and works like a wood planar. The air Zimmer dermatome, powered by compressed water pumped nitrogen, produces uniform grafts of predetermined depth and width. It is the most commonly used motorized dermatome today.



Power driven Dermatome

In using a motorized dermatome, the first step is to assemble the dermatome. In general, a disposable blade must be attached to the dermatome, followed by a guard of predetermined width. The depth of the harvest is set and can be assessed by passing a no.15 blade between the guard and the blade. The dermatome is connected to a power source, unless the dermatome is battery driven. The dermatome is then checked to ensure that the instrument is receiving adequate power before the actual harvest begins.

In general, when a power driven dermatome is being used to harvest a split thickness skin graft, the patient is under general anesthesia. However, regional blocks, and local anesthesia with or without adrenaline can also be used with a power dermatome. The donor site is shaved and prepared with a standard operative scrub. The area is then lubricated with saline or mineral oil. An assistant may apply traction to provide a taught donor site. The dermatome is then brought in contact with the donor site at a 30 to 45 degree angle, and the throttle is pressed, initiating a cut. Gentle downward

pressure is applied to the dermatome as the machine is advanced flat to the skin. An assistant may lift the graft from the pocket area of the dermatome during the harvest so that the surgeon can assess the depth of the cut Once the harvest is complete, the surgeon angles the dermatome upward and lifts off the donor site while continuing to advance to cut the graft. This technique provides reliable grafts of a predetermined depth and width, especially in flat donor sites like the thigh. Some modifications must be made in harvesting over a bone prominence like the iliac crest or scalp to ensure a uniform graft.

Subcutaneous tissue infiltration with Ringer lactate solution can facilitate skin harvest over a bone prominence. One or 2 liters of fluid can be infiltrated beneath the donor site. The infiltrate will stiffen the skin and make for an easier and more predictable harvest. Adrenaline (2ml of 1:1000 adrenaline per liter of ringer lactate solution) can be added to the tumescent fluid. This will significantly limit the blood loss from the donor site after the harvest. This technique is particularly useful in burn surgery.

During the harvest, the surgeon should inspect the graft to ensure appropriate depth. Graft thickness can be determined by observing the graft and the donor site. An ideal split thickness graft should be slightly translucent. An opaque graft indicates a deep split thickness or possibly a full thickness harvest. The donor site will also give clues to the depth of the graft. Thinner harvests leave behind a multitude of small bleeding points because the blood vessels arborize as they travel through the dermis. Deeper harvests leave relatively fewer and larger bleeding points in the remaining dermis. If the donor site contains areas of exposed fat, the harvest is full thickness in those areas.

There is no standard depth setting used in harvesting of a split thickness skin graft. This is because each patient's skin thickness varies. Infants and elderly typically have a thin skin. The thickness of the skin also varies according to the anatomic location on the same individual. In certain patients, disease or medication causes significant tinning of dermis, example, patients taking corticosteroids generally have a thin dermis. It is important to assess the donor site during the harvest to prevent an unexpected full thickness defect.

Motorized and freehand dermatomes can also be used for debridement of the eschar of full thickness burns. It has been shown that tangential excision of the burns eschar allows the surgeon to remove the eschar to a level of normal bleeding tissue. Dermatomes also have been used to remove hypertropnhic scar to prepare for overgrafting.

A third type of dermatome for harvesting split thickness skin grafts is the drum dermatome. The Reese and Padgett-Hood dermatomes are the two best known examples of drum dermatomes. Drum dermatomes use a set of finely calibrated shims for harvesting split thickness skin grafts. The drum dermatomes are more difficult to modify the depth of the cut during the skin graft harvest. Drum dermatomes can be useful in harvesting of split thickness grafts from difficult areas, such as the back of the neck or the buttocks. Because the drum dermatome is more difficult to use and to adjust, it has largely been replaced by motorized dermatomes.

Preparing the graft

When the defect to be grafted is extensive or has a multitude of convoluted surfaces, split thickness skin grafts can be meshed to expand the graft so that the entire defect can be covered. Meshing a split thickness graft is an optional step that increases the surface area that can be covered by the harvested graft. It can also allow the graft to better adhere to the convoluted wound. A meshed graft heals in checkerboard fashion, leaving an aesthetically less attractive scar. Also, the areas between the lattices heal by some degree of secondary intention, causing contraction of the wound. This is important if the wound is over a joint or on the dorsum of the hand. Contracture in these areas can lead to functional problems. Therefore, meshing is indicated for large wounds or wounds with convoluted surfaces.

Meshing of split thickness skin grafts is accompanied by passing the skin through a device that cuts the graft into lattice pattern. The graft can be expanded in a 1:1, 1.5:1, 2:1, 3:1, or 9:1 pattern. Expanding a skin beyond 3:1 is technically possible; however, this often leaves the graft friable and difficult to inset. The greater the ratio, the greater amount of skin expansion is possible. Contracture is also directly proportional to graft expansion. With the exception of extensive burns, most split thickness skin grafts are meshed in a 1.5:1 fashion.

Meshing a skin graft does not prevent the formation of hematoma and seroma. It is important that hemostasis be achieved before application of the skin graft to prevent graft loss from hematoma. If a hematoma or seroma is identified in early post operative time frame, it can be expressed through the meshed graft without disrupting the entire graft.

Once the bed is prepared, the skin graft is placed on top of the bed. It is important to maintain the appropriate orientation of the graft, which is simple in heavily pigmented individuals. It can be confusing in lightly pigmented patients. The dermis has a typical shiny appearance in comparison to the dull epidermis. The graft is then positioned over the entire wound. This can be accomplished by suturing the graft to one corner of the wound while using the back of a forceps to gently spread the graft over the wound. The graft has a tendency to fold over on itself, and this can be avoided by paying close attention to the graft periphery. Any excess graft is trimmed. The graft can then be held in place with suture, surgical staples, or fibrin glue.

Before dressing is applied, the graft should be inspected for hematoma formation. Meshing a graft does not eliminate the possibility of graft hematoma. All hematomas should be drained, and it may be necessary to remove the graft to obtain hemostasis to prevent further hematoma formation. Flushing beneath the graft with saline removes blood clots and provides for better adherence of the graft.

Postoperative Care

Good postoperative care begins with the dressing. The first step is to apply a no adherent dressing over the graft. Adaptic, Telfa, Xenoform, petrolatum gauze is applied directly over the graft. The non adherent properties of these types of dressing s prevent the skin graft from being debrided off the wound at the time of the first dressing change. The reminder of the dressing should apply gentle pressure on the graft to promote adherence without causing pressure necrosis. Cotton balls or fluffed gauze is then pressed onto the wound to conform on the underlying bed. On an extremity, a circumferential wrap can be applied snugly across the wound to ensure contact between the graft and the

host bed. The extremity may then be immobilized with a sp0lint, although early mobilization has not shown to delay wound healing.

For the grafts to the trunk and neck, a bolus tie-over dressing can be used. To use a bolus dressing, the graft must be fixated with a permanent suture, which is intentionally cut long. This leaves strands of suture that will be used to hold the dressing on. Once the sutures are placed, petrolatum gauze is applied on top of the graft. Fluffed gauze or cotton balls are gently pressed onto the graft. The suture strands are then tied together so that they hold the dressing firmly onto the graft. The bolus dressing minimizes the risk of hematoma or seroma formation and also prevents shearing forces from disrupting the graft.

A bolus dressing can be left in place for 7 to 14 days. If there is great concern about the graft, then additional sutures can be placed at the time of surgery and preserved for the next dressing change. This allows the tie overdressing to be changed and reapplied with the extra or spare sutures. Alternatively, the original bolster dressing can be applied by use of one of the two strands of each suture. The second strand can be saved to reapply the bolus dressing after the first dressing change. When the bolster dressing is removed, the gauze should be gently peeled from the wound to prevent disruption of the graft from the host bed.

The first dressing change is important for the graft survival. The timing of the first dressing change varies. In heavily colonized wounds, early dressing changes are preferred (1-3 days). Once the dressing is carefully removed, the graft is examined. At 2-3 days, the graft may still appear pale. However, vascular in growth has already begun,

and the grafts obtain a pink hue around the third or fourth post operative day. Seromas and hematomas are expressed through nicks in the skin graft. It is better to cut a small hole in the graft over the hematoma than to dislodge surrounding adherent graft to express the fluid through the graft periphery. Eschar is debrided because it offers an excellent medium for the bacteria. Once all seromas and hematomas have been evacuated, a new dressing is applied in a fashion similar to the original dressing. If a bolus dressing is being removed at 10 or 14 days, a second dressing may not be necessary and the graft may be treated with moisturizing cream.

In general, grafts should be covered and immobilized for at least 5 to 7 days. Graft adherence occurs rapidly during the first 8 hours after surgery and continues until the fourth postoperative day. After a minimum of 5 to 7 days, the extremity splints can be removed, and the patient may be allowed to bathe, assuming the patient is cooperative.

In infants or in sedated or immobile patients, grafts can be treated open. This allows early and frequent examination of the graft. Arm splints may be necessary in small children to prevent them from manipulating the graft. Fibrin glue can be used to fix the graft to the underlying bed, preventing the need for suture removal. This is an attractive alternative in young children. This is a relatively simple manner of treating a skin graft because there is no need for dressing changes.

Storage

When excess graft is harvested, it may be prudent to store the excess graft for a later operation. The easiest method of preserving a graft is to replace it on the donor site. This will preserve the graft up to 5 days. The graft will ultimately take and will become difficult to elevate after 5 days.

If the graft needs to be preserved for more than 5 days, it can be placed in a saline solution at 4^0 C. antibiotics can be added to the solution, and this method of storage will preserve a graft for around 21 days. Under normal circumstances, freezing should be avoided. Various solutions are being studied to lengthen graft preservation without refrigeration. A solution containing a combination of growth factors, steroids, insulin, and adenine called ready mix currently achieves 60% keratinocyte viability at 30 days of incubation.

Long term storage and allograft storage depend on freezing techniques. Glycerol or dimethyl sulfoxide is added to the solution to prevent tissue destruction by the freezing process, and the grafts are rapidly frozen with liquid nitrogen. When the grafts are needed, they can be thawed and easily applied.

Graft survival

A skin graft is essentially skin transplantation. The graft is completely severed from its blood supply, drainage system, and sensory innervations. The graft is placed onto a vascular bed so that the graft will become vascularized and sensate. The process of graft survival has been well studied during the past century. Immediately after grafting, the graft is dependent on the serous exudates from the recipient site for survival in a process called serum imbibitions. Ultimately, however, hoe the graft becomes vascularized is still unclear.

Hübscher and Goldmann were the first physicians to recognize the importance of serum nourishment for graft survival. They termed this process “plasmatic circulation” of the graft. Subsequently, numerous studies have been performed that demonstrate how a skin graft survives during the first 48 hours after transplantation.

Immediately after a graft is placed onto the recipient site, it begins to gain weight and appears edematous. It is thought that plasma leaks from recipient venules and, to a lesser extent, from capillaries and arterioles. This plasma then fills the space between the graft and the underlying host bed. The fibrinogen, within the plasma, settles out and forms glue like substance anchoring the graft to the bed. The remaining plasma is absorbed by the graft and provides temporary nourishment for the graft. Studies of this serum have revealed that it also contains erythrocytes and polymorphonuclear leukocytes. Because the fliud taken up by the graft is free of fibrin, it is technically termed serum. Thus, Converse, Ulschmid, and Ballantyne's proposed terminology "phase of serum imbibitions" has largely replaced Hübscher and Goldmann's original plasmatic circulation.

METHODOLOGY

Source of Data:

All eligible patients undergoing split thickness skin grafting at KLESPK Hospital & MRC from December 2006 to December 2007.

Inclusion criteria:

1. Suitable enrollees were adult non diabetic patients between the age group of 19 to 65 yrs, requiring split thickness skin grafting for various etiologies at KLES Dr. Prabhakar Kore Hospital and Medical Research Centre, Belgaum during the period of December 2006 to Dec 2007.
2. The donor area being restricted to anterior thigh measuring between 10x8 to 20x8 cm.

Exclusion criteria:

1. If a split thickness skin graft has already been taken from the same donor area
2. Donor site wound of non uniform depth

Method of the Collection of the Data:

Total Sample Size: A sample size of 30 was taken based on KLES Hospital statistics

Study design: Non randomized Clinical comparative trial.

Method: In all suitable enrollees split thickness skin graft of approximately 0.3 mm thickness was taken from the anterior thigh using a Humby's knife. Immediately after taking the graft, the donor site was covered with saline soaked gauze for haemostasis. The donor area was then divided into two equal halves, the proximal half being marked

"A" and the distal being "B". On area "A", 10x10 cm Hydrocolliod dressing was placed & on area "B", a 10x10cm Standard meshed paraffin gauze was placed. A pad & roller bandage were then applied over the primary dressing .The outer dressing was inspected on the 3rd post operative day, noting any signs of infection, If any then those patients were excluded from the study & were treated accordingly. Then the donor site was inspected by a treatment blinded observer after removal of dressings on 12th post operative day to assess the epithelialization & was graded as none (1), less than 50 %(2), more than 50% but not complete(3), or complete(4). A numeric score given to each rating is indicated in the brackets. Also photographs of donor site after removal of dressings on 12th post operative day were obtained. These photographed images were rated on the same scale by an independent treatment blinded senior surgeon of the Hospital, & an average of these readings was taken.

All the data collected was recorded calculated & compared using Chi-square test.

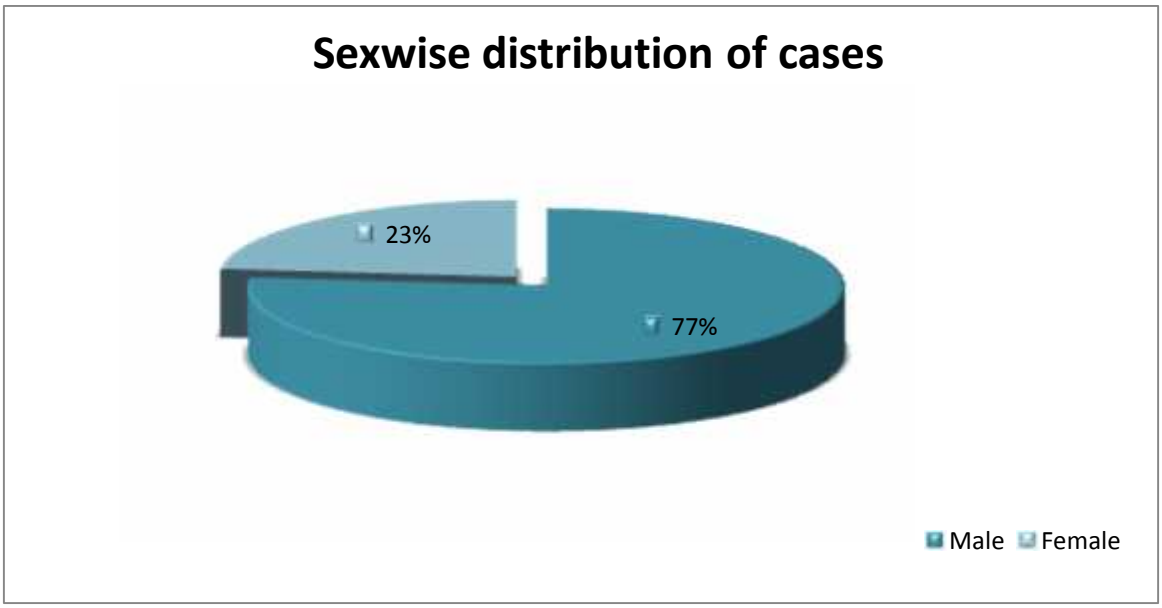
RESULTS

Thirty paired side-by-side donor sites were studied. The donor site was divided into two equal halves A (proximal half) and B (distal half). On area A, a 10x10 cm Hydrocolliod dressing was placed & on area B, a 10x10cm Standard meshed paraffin gauze was placed. A pad & roller bandage were then applied over the primary dressing and the outer dressing was inspected 3 days later to note any signs of infection. The donor site was inspected by a treatment blinded observer and a senior surgeon, after removal of dressings on 12^{th} post operative day to assess the epithelialization percentage and scoring was done according to the predefined criteria. All data was analyzed using Chi-square test.

The study cohort consisted of a total of 30 patients meeting the predefined inclusion and exclusion criteria. 23 of them were males and 7 were females. The mean age of the study population was 38.5+/-14.59 yrs (40.6+/-13.22yrs for males and 31.7+/-17.86yrs for females). The sex distribution of the patients has been summarized in TABLE NO.1

TABLE NO.1: SEX DISTRIBUTION

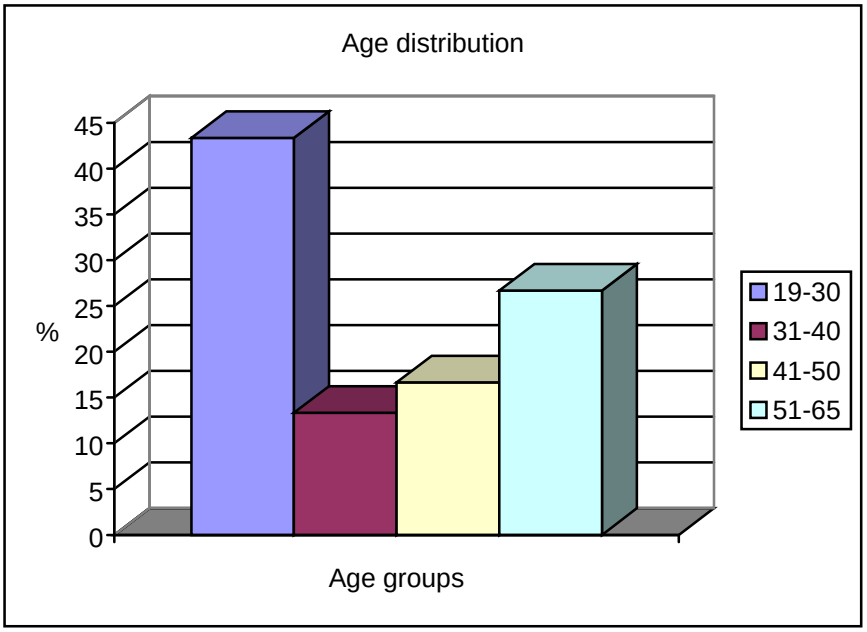
Sex	Number	Percentage%
Male	23	76.66
Female	07	23.33



The age distribution of the study population was concentrated in the age group between 19 to 30 yrs. The numbers of patients between 19-30 yrs were 13 (43.33%), between 31 to 40yrs were 4 patients (13.33%), between 41 to 50 yrs were 5 patients (16.66%), between 51 to 65 yrs were 8 patients (26.66%).This has been summarized in TABLE NO.2.

TABLE NO.2: AGE DISTRIBUTION

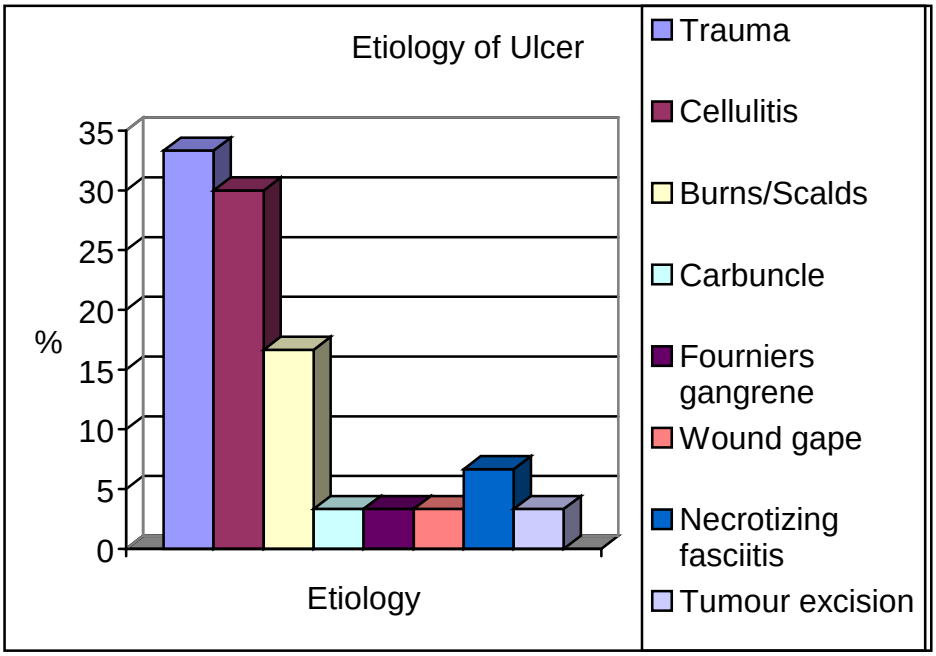
Age group(yrs)	Numbers	Percentage %
19-30	13	43.33
31-40	04	13.33
41-50	05	16.66
51-65	08	26.66



The etiology for the required skin graft included Traumatic injuries in 10 patients (33.33%), Cellulitis in 9 patients (30%), Burns/Scalds in 5 patients (16.66%), Carbuncle in single patient(3.33%), Fourniers gangrene in one patient (3.33%), Wound gape in one patient (3.33%), Necrotizing fasciitis in 2 patients (6.66%) and Tumour excision in one patient (3.33%). These have been summarized in TABLE NO.3.

TABLE NO.3: ETIOLOGY OF THE ULCERS

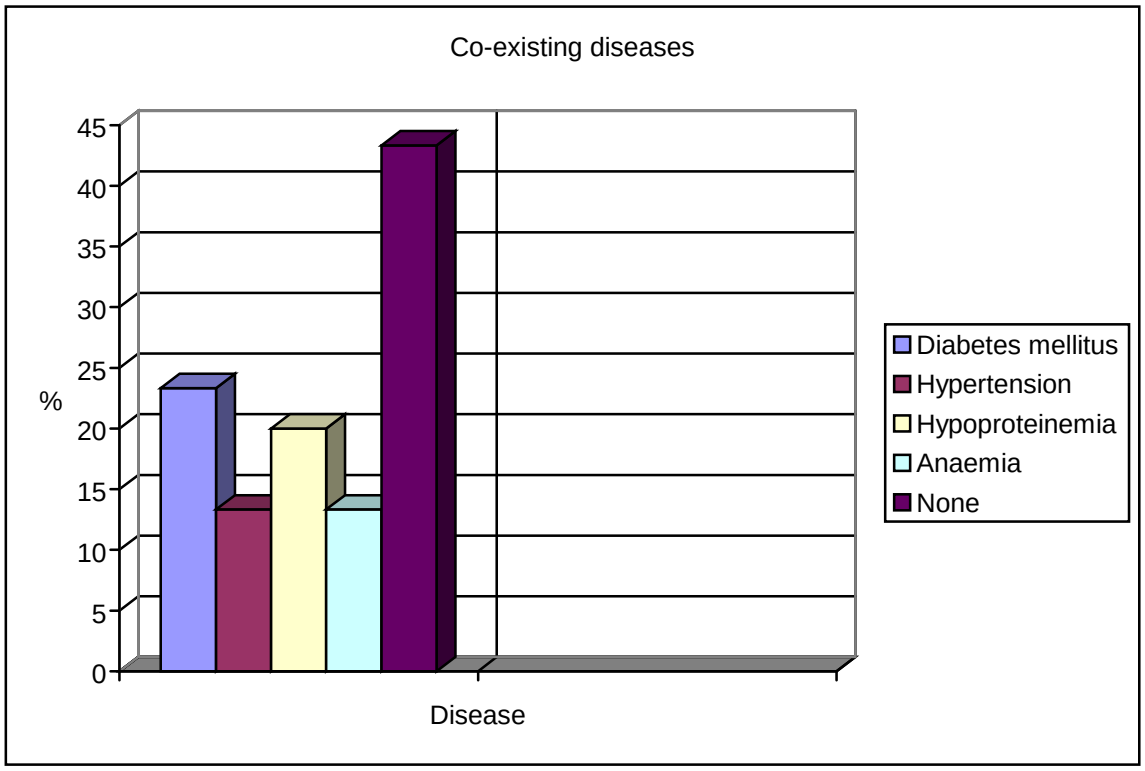
Etiology of ulcer	Numbers	Percentage%
Trauma	10	33.33
Cellulitis	09	30.00
Burns/Scalds	05	16.66
Carbuncle	01	3.33
Fourniers gangrene	01	3.33
Wound gape	01	3.33
Necrotizing fasciitis	02	6.66
Tumour excision	01	3.33



Diabetes mellitus was the most common coexisting disease in the study population i.e. in 7 patients (23.33%), followed by Hypoproteinemia in 6 patients (20%), Hypertension in 4 patients (13.33%), Anaemia in 4 patients (13.33%) and none in 13 (43.33%). This is summarized in TABLE NO.4

TABLE NO.4: COEXISTING DISEASES

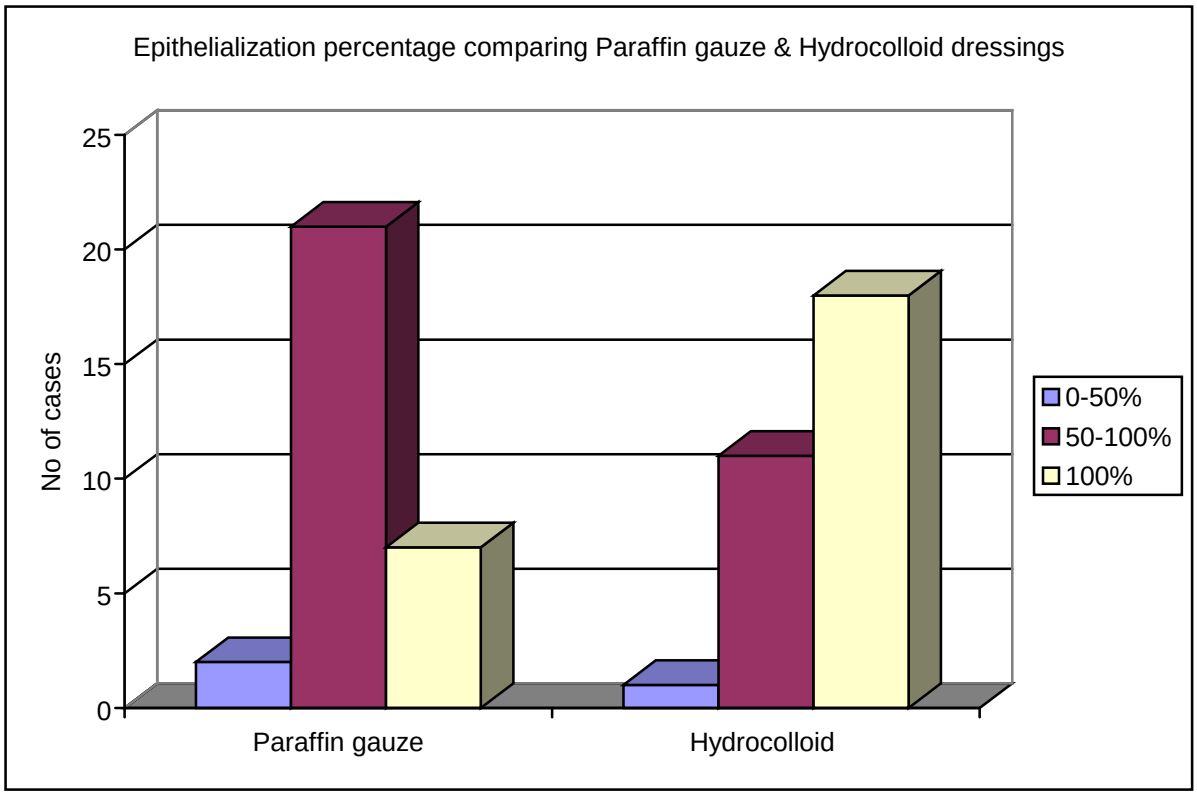
Co.ex Disease	Number	Percentage%
DM	07	23.33
HTN	04	13.33
Hypoproteinemia	06	20.00
Anaemia	04	13.33
None	13	43.33

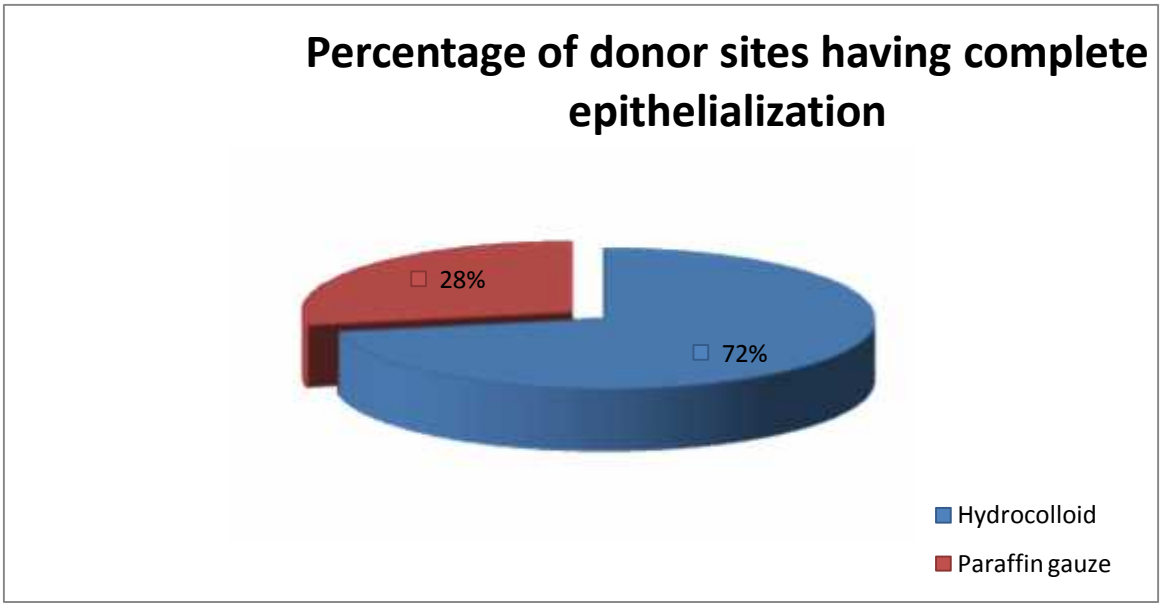


The number of donor areas that achieved complete (100%) epithelialization on the 12th post operative day by Paraffin gauze dressing was 7 (23.3%), whereas Hydrocolloid dressing achieved complete epithelialization in 18 donor sites (60%) (P = 0.016). Intermediate i.e. between 50 to 100% epithelialization was obtained in 21 (70%) donor areas treated with Paraffin gauze dressing, whereas in Hydrocolloid treated donor areas it was in 11 (36.7%) . Poor or <50% epithelialization was seen in 2(6.7%) donor areas of the Paraffin gauze group and only 1(3.3%) donor area treated with Hydrocolloid dressing had this result. These results have been depicted in TABLE NO.5 below.

TABLE NO.5: EXTENT OF EPITHELIALIZATION BY THE DRESSINGS

% Healing	**Paraffin gauze**	**Hydrocolloid**	**Total**
< 50%	2(6.7%)	1(3.33%)	3
50 – 100%	21(70%)	11(33.33%)	32
100%	7(23.3%)	18(60%)	25
Total	30(100%)	30(100%)	60


Epithelialization percentage comparing Paraffin gauze & Hydrocolloid dressings
No of cases
25
20
15
10
5
0
Paraffin gauze
Hydrocolloid
0-50%
50-100%
100%



There was no clinical evidence of donor site infection in both the groups, as judged by surrounding erythema or purulent exudate. No difference was found between Hydrocolloid dressings and Paraffin gauze dressing in terms of exudate secretion, skin maceration, or hemorrhage from the donor site. It was also noted that the patient tolerance and ease of dressing change was much better with Hydrocolloid dressings.

DISCUSSION

Skin is an organ designed to protect the body from the harmful external environment. When injured, the skin must consistently and rapidly repair itself in order to maintain this external defense system. The donor site too is a superficial wound on the body and needs to be treated in lines with any other superficial wound, like a graze or an abrasion. After donating split thickness skin graft to the recipient area it loses full thickness of epidermis and a part of the dermis depending on the graft thickness obtained.

The challenge in managing these kinds of wounds is to promote healing as quickly as possible while minimizing adverse effects and complications. If complicated by infection, split-thickness defect may convert to a full-thickness loss, analogous to a third-degree burn. Of the various methods used to manage split-thickness skin graft donor sites, [11,14,17] none is considered as being the optimal choice of dressing. Although numerous dressings have been devised for the treatment of the donor site there is no clear agreement as to which is the best.

The mesh paraffin gauze dressing has for years been the primary choice of surgeons for the coverage of split-skin donor sites, given its ease of application, conformability, low risk of infection, and minimal cost.[11,14] It has, however, been found inferior in many other important aspects: it is a painful, adherent dressing under which donor sites do not appear to heal rapidly.

Measuring donor site healing is very difficult. There are many confounding factors, such as graft depth, anatomic location, patient age, and skin quality. The use of

contiguous sites in the same patient serves to control and even helps to eliminate some of them. Our current study involved a direct side-by-side comparison of two treatment modalities to ensure identical anatomic location, depth, and size. Both sites were assessed and graded using identical methods and criteria.[10]

In this study we compared the donor site treatment with Meshed Paraffin Gauze and Hydrocolloid dressings. Thirty paired side-by-side donor sites were studied. The study population consisted of 23 males and 7 females. The mean age of the study population was 38.5+/-14.59 yrs (40.6+/-13.22yrs for males and 31.7+/-17.86yrs for females). The age distribution of the study population was concentrated in the age group between 19 to 30 yrs. The Standard Meshed Paraffin Gauze dressing is an age old and time tested method of treating the donor site. Although very widely used for this purpose, it has many disadvantages like sticking to the wound surface, causing pain at removal, higher pain levels to the patient etc. The Hydrocolloid dressings are a newer variety of moist to moist dressings which claim to be superior to the older moist to dry dressings. The advantages claimed by these newer dressings include faster healing of the donor site, lower pain levels experienced by the patient. But however the Hydrocolloids are more expensive than the Paraffin Gauze dressings and can lead to exudate accumulation under the dressing. In our study the availability of Hydrocolloids was not a problem as they are widely used in our Hospital for treating pressure sores.

Overall wound healing, as measured by percentage of epithlialized dermis, was faster with Hydrocolloid than with Paraffin gauze dressing. The number of donor areas that achieved complete epithelialization on the 12^{th} post operative day by Standard paraffin gauze dressing were 7 (23.3%), whereas Hydrocolloid dressing achieved

complete epithelialization in 18 patients (60%) (P = 0.016). This was similar to the results obtained by the earlier studies. The faster re-epithelialization rate that has been seen with the Hydrocolloid dressing can partially be explained by its physical properties. Hydrocolloid was found to form a fibrin layer between the dressing and the wound, creating a physical barrier that retains cytokines, particularly intrinsic growth factors.[31,32] Furthermore, epithelial cell proliferation and migration are believed to be optimal in a moist environment.[33] This concept seems to be supported by evidence from many skin-graft donor site studies which have shown faster re-epithelialization rates when moist-environment dressings are compared with the traditional dry dressing.[33,17,31,34] Hydrocolloid dressing helps in keeping the wound moist, inducing a favorable environment that facilitates recruitment of vital host defenses and necessary cell population for better wound healing.[34,35]

Although Hydrocolloid absorbs wound fluid and keeps a moist environment, there was no difference in the extent of skin maceration on the periphery of the donor site compared with paraffin gauze. There was also no difference in wound secretion, bleeding, or wound infection between the 2 dressings.

Although pain assessment was not an objective in this study, it was noted that the patients tolerated the Hydrocolloid dressings much better than the Paraffin gauze dressings. Hydrocolloids were also noted to be much easier to remove or change in contrast to the Paraffin gauze dressings which became adherent to the wound surface and caused discomfort and pain during removal. Pain assessment in the donor site wounds is usually done using the standard visual analogue scoring. And many studies done in this regard favour Hydrocolloid as a less painful donor site dressing.[10]

The cost of treatment was higher in the Hydrocolloid group as compared to the Paraffin gauze group. However it was noted that the Paraffin gauze group needed more analgesics and early mobilization was affected. Although cost effectiveness was not assessed in this study earlier studies done in this regard concluded that, the more rapid healing, less pain, and less scarring found with Hydrocolloid treatment reduces postoperative morbidity, which in turn affects the global cost-effectiveness.[10]

Based on the results above study it can be concluded that Hydrocolloid dressings achieve faster epithelialization of the donor site and are hence preferable to the paraffin gauze dressings.

CONCLUSION

Hydrocolloid dressings are superior to Standard meshed Paraffin gauze dressings in the treatment of Split thickness skin graft donor areas.

SUMMARY

Inspite of newer advances, split thickness skin grafts (STSG) still have an important place in many areas of plastic surgery. Though the technique of skin grafting is more or less standardized the treatment of the donor site differs greatly and has been a topic of debate. The management of split-thickness skin graft donor site is targeted towards promoting the healing process, while minimizing adverse effects and complications.

The primary objective of this clinical comparative study was to compare the percentage of epithelialization achieved by Hydrocolloid in comparison to Standard meshed Paraffin gauze on the Split thickness donor site on 12th post operative day.

The study was conducted at KLES Dr.Prabhakar Kore Hospital and Medical Research centre, Belgaum, Karnataka, India. The study included 60 side by side donor sites of 30 adult patients requiring STSG for various etiologies between December 2006 to December 2007.

Half of the skin graft donor site in the proximal thigh was dressed with Hydrocolloid dressings and the rest with Standard paraffin Gauze dressing. The extent of epithelialization achieved by each of these dressings was assessed on 12^{th} post op day after skin grafting. The results indicated that the donor sites treated with Hydrocolloid dressings achieved a faster epithelialization than those treated with Paraffin gauze dressing.

Hence it was concluded that Hydrocolloid dressings are superior to Standard meshed Paraffin gauze dressings in the treatment of Split thickness skin graft donor areas.

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CONSENT FOR PARTICIPATION IN RESEARCH

Mr./ Mrs. ._____we are requesting you to enroll yourself in study titled**" A CLINICAL TRIAL TO ASSESS THE EFFICACY OF HYDROCOLLOID VERSUS PARAFFIN GAUZE DRESSING FOR SPLIT THICKNESS SKIN GRAFT DONOR SITE TREATMENT"** conducted by DR SHAILESKUMAR M.E, postgraduate student in M.S General Surgery under the guidance of DR S.M UPPIN at J.N Medical College, Belgaum under KLE ACADEMY OF HIGHER EDUCATION AND RESEARCH. You have been requested to participate in research because you are into the study group. During the study you will be asked some questions and you are supposed to answer to the best of your knowledge.

Your participation in research is voluntary. Your decision whether or not to participate in the study will not affect your relationship with J.N.M.C. Even if you decide to participate you are free to withdraw at any time.

The purpose of research is to compare the efficacy of two different types of dressings over split thickness skin donor area

PROCEDURE INVOLVED:

Two different types of dressings will be applied over the split thickness skin donor area to assess the amount of healing achieved by each of them.

RISKS AND BENEFITS:

There are no extra risks involved and the likely benefits being reduced pain & faster healing of skin donor site.

ALTERNATIVES:

Even if you decline the participation, you will get the routine line of management.

PRIVACY AND CONFIDENTIALITY:

The only people to know that you are a research subject are members of the research team. No information about you or provided by you during the research will be disclosed to others without your written permission except:

1.In emergency to protect your rights and welfare.

2.If required by law.

AUTHORIZATION TO PUBLISH RESULTS:

When the results of the research are published or discussed, in a conference, no information will be displayed that would disclose your identity. Any information that is obtained in connection with this study and that can be identified with you will remain confidential.

FINANCIAL INCENTIVES FOR PARTICIPATION:

You will not be paid/offered any free gifts for participating in the research. You will not be reimbursed for expenses.

CONSENT STATEMENT:

I undersigned_____ have been explained in my vernacular language about the study and my participation in the study is voluntary. If I want, I can withdraw

at any time. Also I have been given enough time to clear my doubts and rights as study participant.

In case you have any questions related to the study, you can contact Dr Shaileshkumar M.E (Phone No 9986308914)

In case you have any questions about my rights as a study participant, you can contact Dr V.D Patil (0831-2471350), Principal, J. N. Medical College, Belgaum.

Signature or the Left Thumb print of Participant or legally authorized representative

Participants Name_____ Signature_____

Witness Name_____ Signature_____

Experimenter's Name_____ Signature_____

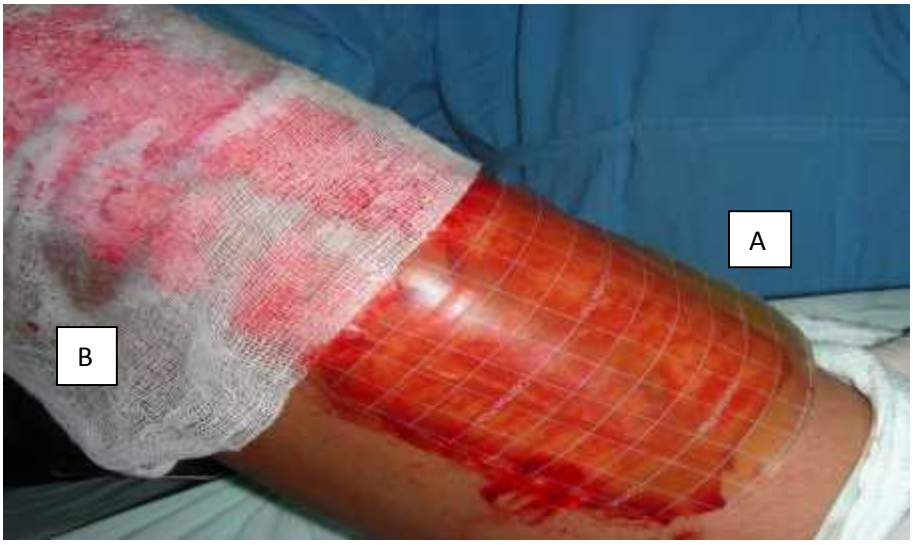
Date_____Place_____

MASTER CHARTS

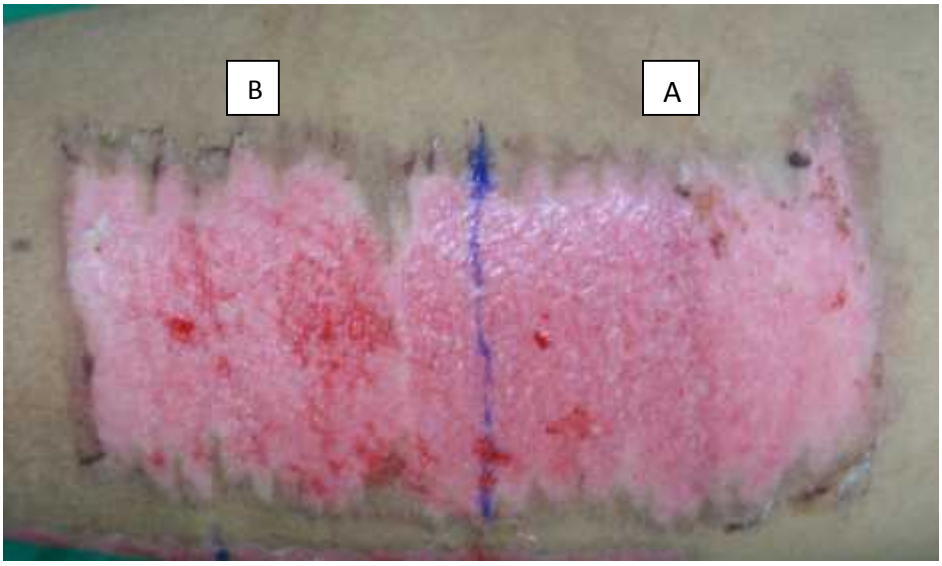
Sl. No	*NAME*	*IP.No*	*AGE*	*SEX*	*INDICATION FOR SKIN GRAFTING*	*PARAFFIN GAUZE*	*HYDRO COLLOID DRESSING*	*CO-EXISTING DISEASES*	*D.O.S*	*ETIOLOGY OF ULCER*
1	PALLAVI	211751	19Y	F	ULCER OVER LT FOOT	04	04		30.12.06	TRAUMATIC
2	GOURAWWA	220286	55Y	F	ULCER OVER RT LEG LOWER THIRD	03	04	HTN	29.03.07	CELLULITIS
3	NAZEER	224115	52Y	M	ULCER OVER B/K AMPUTATION STUMP	03	03	ANEMIA, HYPOPR	02.05.07	WOUND GAPE
4	SIDDRAMAPPA	215212	65Y	M	ULCER OVER SCROTUM & PENIS	02	03	DM,HTN	05.05.07	FOURNIERS
5	MEENAJI	229371	55Y	M	ULCER RT LEG LOWER THIRD	03	04	ANEMIA	24.05.07	CELLULITIS
6	KALPANA	228999	25Y	F	ULCER OVER LT LUMBAR REGION	03	03	ANEMIA	26.05.07	NECROTIZING FASCITIS
7	VITTHAL	230880	50Y	M	ULCER OVER DORSUM LT FOOT	03	04	DM	29.05.07	CELLULITIS
8	RUDRAPPA	230552	45Y	M	RT LEG LATERAL ULCER	03	03	HTN	28.06.07	CELLULITIS
9	PUNDALIK	244617	26Y	M	ULCER OVER LT ANKLE	03	03	DM,HYPO PR	14.07.07	TRAUMATIC
10	CHATRU	234348	51Y	M	LT LEG ULCER UPPER THIRD	03	04		04.08.07	CELLULITIS
11	GODAVARI	238306	60Y	F	ULCER OVER RT THIGH	03	04	ANEMIA, HYPOPR	01.09.07	NECROTIZING FASCITIS
12	SIDDANAGOUD	241125	22Y	M	PB RAW AREA OVER LOWER BACK	03	04		07.09.07	SCALDS
13	ROHIT	238462	24Y	M	LOWER THIRD LEG ULCER	03	03		07.09.07	TRAUMATIC
14	DEEPA	243783	19Y	F	PB RAW AREA OVER TRUNK & BACK	04	04		08.09.07	BURNS
15	RUKMINI	242530	21Y	F	PB RAW AREA TRUNK	03	04		12.09.07	BURNS

SI.No	*NAME*	*IP.No*	*AGE*	*SEX*	*INDICATION FOR SKIN GRAFTING*	*PARAFFIN GAUZE*	*HYDRO COLLOID DRESSING*	*CO-EXISTING DISEASES*	*D.O.S*	*ETIOLOGY OF ULCER*
16	DUNDAYYA	241579	30Y	M	AVULSION INJURY LT LEG ANTEROMEDIAL	04	04		13.09.07	AVULSION INJURY
17	BASAVARAJ	245004	40Y	M	DEFECT OVER RT LEG UPPER THIRD	04	04		19.09.07	TRAUMATIC
18	MUBARAK	245549	37Y	M	P.B.R.A OVER RT ARM & ELBOW	03	04	DM	24.09.07	ELECTRIC BURNS
19	MEHBOOB	239000	45Y	M	ULCER OVER RT FOOT DORSUM	03	04	HTN	24.09.07	POST CELLULITIS
20	SUNITHA	238065	23Y	F	PBRA OVER BACK	04	04	HYPOPR	24.09.07	TRAUMATIC
21	ASHOK	245207	44Y	M	RAW AREA OVER CHEST	03	04		26.09.07	T.E OF BURNS
22	VIJAY	246132	24Y	M	ULCER OVER DORSUM RT FOOT	03	03	HYPOPR	29.09.07	AVULSION INJURY
23	ARIF	244168	23Y	M	RT CALF RAW AREA	04	04		13.10.07	TUMOUR EXCISION
24	ASHOK	247307	34Y	M	ULCER LT GLUTEAL REGION	03	03	HYPOPR	18.10.07	GUNSHOT INJURY
25	MADIWALAPPA	256441	40Y	M	ULCER OVER POSTERIOR NECK	02	03	DM	02.12.07	POST CARBUNCLE
26	CHIDANAND	257984	30Y	M	ULCER RT LEG POSTEROLATERAL	04	02		05.12.07	POST SNAKE BITE CELLULITIS
27	KALLAPPA	267107	50Y	M	ULCER OVER ATERIOR RT LEG	03	04		10.12.07	TRAUMATIC ULCER
28	VEERABHADRA	257147	61Y	M	ULCER RT LEG & FOOT	03	03	DM	17.12.07	CELLULITIS
29	SIDDU	263003	28Y	M	ULCER OVER LT FOOT	03	03		21.12.07	TRAUMATIC
30	BHIMAPPA	262468	58Y	M	ULCER RT ANTEROLATERAL LEG	03	04	DM	28.12.07	CELLULITIS

The Humby's knife and the Silver knife used for obtaining split skin grafts



Peri-operative photograph showing the donor site divided into two equal halves and treated with the two dressings, A-Hydrocolloid dressing, B- Paraffin gauze dressing



Extent of epithelialization on 12th post op day

A-Hydrocolloid dressing, B-Paraffin gauze dressing

PROFORMA

Patient name:

Patient number:

Age /Sex:

I.P.number:

D.O.S:

Chief complaints:

Indication for skin grafting:

Ulcer details (graft recipient site):

Donor site details:

EPITHELIALIZATION SCORE

Post op day 12	**Site A**	**Site B**
Observer score		
Senior surgeon's score		
Average score		