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Prema Dhanraj



3rd Edition

Foreword
(Late) LBM Joseph

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CHAPTER

4

Skin Grafts

INTRODUCTION

Skin graft provides permanent skin replacement and acts as a biologic cover providing thermoregulation and maintains normal skin function.

HISTORY

Skin grafts originated in India 3,000 years ago. In the 19th century, various attempts at using different types of skin grafts were reported. Although skin graft began many centuries ago, the present knowledge differs only in the technique and accessory procedures.

1570 *Fioravanti* reported the successful tissue autograft.

1804 *Baronio* published his success on free transplantation of skin on sheep.

1817 *Sir Astley Cooper* grafted full-thickness skin from an amputated thumb onto the stump for coverage.

1821 *Bunger* reported free skin autografting using Indian method in which a piece of skin taken from the buttock was transplanted to the nasal stump.

1844 *Joseph Pancoast* grafted autogenous full-thickness skin from the arms to the nose and the earlobe.

1863 *Bert's* experimental work on animal grafts were successful and opened the way for the pioneers who contributed the free skin graft.

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1869 *Reverdin* stimulated worldwide interest in skin grafting with his report of successful pinch grafts.

1870 *Lawson, LeFort, and Wolfe* all used full-thickness grafts for eyelid ectropion.

1872 Ollier demonstrated the importance of dermis in skin grafting.

1872 *Reverdin* reported use of his own skin as homografts with good results.

1873 *Thiersch* used thin split-thickness grafts 0.005–0.01 inches in thickness.

1877 *Reverdin* discussed skin grafting from pig to human beings.

1881 *Girdner* reported the first clinical use of allograft by harvesting a suicide victim's skin to use for closure of a burn wound.

1888 *Hubscher* termed the early nourishment of skin grafts as plasmatic circulation.

1893 *Krause* popularized the use of full-thickness grafts and known as Wolfe–Krause grafts.

1910 *John Staige Davis* reported use of allografts and xenografts.

1938 *Bettman* reported successful use of allograft in two children with >60% total body surface area burn.

1940 *Medawar* pioneering work on the histochemical aspects of the epidermis.

1941 *Brown and McDowell* popularized thick split-thickness grafts for treatment of burns.

1944 *Webster* reported the successful take of the refrigerated skin graft.

1950 *Brown and Fryer* used allograft as biological dressing.

1951 *Storey and Leblond* reported that epidermis undergoes growth and replacement throughout life.

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1953 *Regnell* reported primary contraction to be greater in full-thickness grafts and least in thin split-thickness grafts.

1954 *Webster* described dermal overgrafting.

1957 *Silvetti* used bovine skin grafts as a temporary biological dressing.

1960 *Ponten* reported sensory pattern of skin grafts to become that of the recipient wound bed rather than that of the original graft donor site.

1961 *Mir Y Mir* reported serial dermabrasion or chemical peel to reduce graft hyperpigmentation.

1964 *Tanner, Vandeput, and Olley* expanded skin grafts using skin mesher to be expanded up to 12 times its original size.

1965 *Bromberg et al.* established the method of treating burns with pig skin.

1966 *Morris et al.* reported beneficial effects of allografts.

1975 Epithelial skin culture technology was published by *Rheinwald and Green*.

1976 *Rudolph* reported that the dermal component of grafted skin exerts the influence on wound contraction.

1976 *Rudolph and Milson* reported the use of trypsin to separate the two layers of the skin.

1979 Cultured human keratinocytes were grown to form an epithelial layer for grafting.

ANATOMY

Skin envelops the entire surface of the body. It is the largest organ in the body and constitutes 16% of the total body weight. As a result, its total destruction is incompatible with survival. Skin serves as a protective layer and controls temperature

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regulation. Skin varies in character with age and location on the body. The thickness of skin is dependent on age, sex, site, and race. Skin is thinner in infants and women compared to men. Skin varies from 5 to 150 thousandths of an inch in thickness. Skin is thin in the first decade and again in the fifth decade. In between skin thickens progressively. Skin is thin in certain areas of the body and thick particularly in the palm and soles. The skin also looses its elasticity with time.

The skin has two layers and differs in character. The outer most thinner layer is the epidermis and inner most thicker layer is the dermis. The two layers are connected by means of protoplasmic processes and elastic fibers.

Epidermis

- It is of ectodermal origin.
- It is avascular and depends on dermis for its survival.
- Epidermis is a stratified squamous epithelium.
- It has five layers and consists of stratum germinativum adjacent to dermis, stratum spinosum, stratum granulosum, stratum lucidum, and stratum corneum. The more superficial layer is stratum corneum, which is the dead and desquamating layer. Epidermis undergoes growth and replacement throughout life.
- The keratinized layer of the epidermis protects the body from the environment.
- The epidermal layer has two types of cells: (1) keratinocytes and (2) melanocytes and takes part in melanin synthesis to determine the color of the skin.

Dermis

- It is of mesodermal origin.
- It has extensive vascular supply.

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- The predominant components of dermis are collagen, elastic fibers, and ground substance.
- It has two layers: (1) superficial or papillary layer and (2) deep or reticular layer.
- The papillary layer is characterized by widely separated collagen fibers whereas the deep reticular dermis has dense coarser collagen fibers.
- The epidermal appendages such as hair follicles, sebaceous glands, and sweat glands invade the dermis.
- Sebaceous glands provide sebum which lubricates hair and skin.
- Sweat glands are of two types: (1) eccrine and (2) apocrine and are under nervous control. Eccrine glands respond to emotions and are important for temperature regulation and are odorless whereas apocrine gland secretes continuously and has odor.

FUNCTIONS OF SKIN

- Protection—protects the body from heat and cold
- Thermoregulation—prevents heat loss
- Immunological—prevents entry of microorganism
- Secretory
- Excretory
- Neurosensory—for pain, touch to hot and cold
- Metabolic—production of vitamin D.

SKIN GRAFTS

Definition

Skin graft is a segment of skin separated from the donor site and transplanted to the recipient site devoid of its blood supply.

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Classification

Skin grafts are classified as autograft: It is a piece of skin taken from one site of the body and transplanted to another site in the same person.

Allograft (Homograft)

- It is a piece of skin taken from another individual of the same species.
- It is used in extensive burns where autograft donor sites are scarce.
- It prevents protein and waterloss.
- It also decreases bacterial count and pain.
- It is used as a test of readiness of a wound to accept an autograft.
- It is used as a temporary biological dressing in patients too sick to undergo definitive autografting. Allografts though temporary they do get vascularized before the rejection reaction. Although O'Donoghue noted the difference in the angiogenic properties of fresh skin allografts, he also noted that in spite of this difference allografts were capable of neovascularization before it got rejected.
- Although it is an important skin cover, unfortunately the risk of HIV transmission through cadaver allografts may outweigh the benefits.

Isograft: It refers to genetically identical donor and recipient individuals such as twins in humans.

Xenograft: It is a graft taken from another species. It is used as a temporary biological dressing in cases of autograft and allograft shortage. The advantages are that it is relatively low cost readily available and can be easily stored. The most common temporary biological dressing is the pig skin.

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Types

Skin graft consists of whole of epidermis and a portion of dermis. Depending on the depth of dermal involvement, skin grafts can be either split-thickness or full-thickness grafts.

Split-thickness Grafts (Fig. 1)

- Involve the whole of epidermis and a small part of dermis.
- Depending on the depth of dermal involvement, it can be further divided into thin split-thickness skin grafts (STSGs) or thick STSGs.
- A very thin STSG composed of almost pure epithelium has great clinical application particularly in burn patient who have had cultured skin during the acute phase of care. Reconstruction on such patients is a challenge.
- The average thickness of the graft is between 5 and 12/1,000 of an inch. Use of Alloderm as a dermal component and a very thin epidermal graft as a cover can be successfully used in burn patients.
- *Advantages* of thin STSGs are that it can be used in less than ideal wound bed and requires less optimal vascularity.
- *Disadvantages*: It contracts and the graft is unstable.

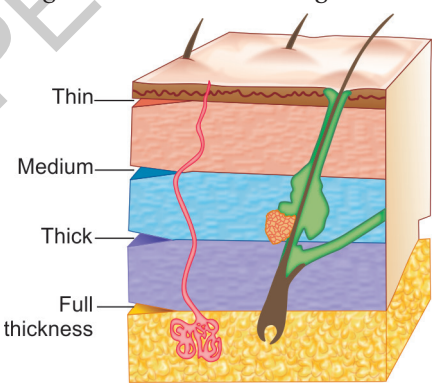

Fig. 1: Layers of skin.

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Partial Thickness Grafts

- Skin grafts are very useful in reconstruction of various burn deformities.
- It contains more dermis so contraction is less.
- The average STSG used is between 0.012 and 0.018 inch.
- STSGs have a large number of cut blood vessels on the undersurface of the graft and therefore "take" is excellent.
- The donor site for STSG can be anywhere in the body. Since it includes only a portion of the dermis, the epidermal appendages which are present in the dermis re-epithelialize and result in spontaneous healing of the donor site. Moreover skin can be harvested from the same site many times.
- *Advantages* are that it can be used in large wounds with questionable circulation. The grafted skin always maintains the epidermal characteristics of the donor area.
- *Disadvantages* are that it tends to contract and has hyperpigmentation of the graft. Depending on the setting of the dermatome, translucency of the graft and the bleeding pattern of the donor site one can refer to skin grafts as being either thin, medium, and thick. A very thin graft is transparent and has fine bleeding points at the donor site.

Full-thickness Skin Grafts (FTSGs) (Fig. 2)

- It includes epidermis and full thickness of dermis with varying portions of sweat glands, sebaceous glands, and hair follicles.
- Since it includes the entire thickness of the skin, it retains all the characters of the skin.
- It resists contraction.

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Fig. 2: Full-thickness graft.

- The texture and pigment closely resembles the normal skin.
- The *disadvantages* are that it requires excellent vascularity and therefore less useful in contaminated wounds, chronic wounds, and poorly vascularized bed.
- Donor site for FTSG—postauricular skin, supraclavicular skin, flexural skin, and abdominal skin.

Composite Graft

- It includes the full thickness of the skin and a portion of the underlying tissue such as subcutaneous tissue and cartilage.
- Common example of such a graft is for reconstructing the nasal ala, where a wedge of skin, cartilage, and skin is taken from the ear.

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- The risk of nonvascularization of this type of graft limits its size and uses as its blood supply comes through its margins instead of its base.
- The other examples are full-thickness eyelid and nipple grafts.
- The survival of composite grafts can be improved by cooling the graft to 5–10°C.
- The safe size of the graft can be from 1.5 to 3.0 cm^2.

Tissue Cultured Cells

- This technique requires a full-thickness skin biopsy consisting of a few square centimeter.
- The epidermal cells are separated from the dermis by using trypsin. *After an in vitro culture period of 3–4 weeks*. The autologous keratinocytes expand to approximately 1 cm^2 available for wound coverage.
- *The short comings of cultured epidermal cells are*:
  - It requires 3–4 weeks for culturing
  - Very fragile and must be handled with extreme care
  - Low rate of graft take
  - Requires prolonged immobilization in order to facilitate graft take
  - Can blister and slough leads to less than optimal long-term results and is very expensive.

Difference between STSG and FTSG

Differences between STSG and FTSG are given in **Table 1**.

Advantages and Disadvantages of Skin Graft

Advantages and disadvantages of skin graft are given in **Table 2**.

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TABLE 1: Differences between STSG and FTSG.

Characteristics	*STSG*	*FTSG*
Structure	Whole of epidermis and a small part of dermis	Whole of epidermis and whole of dermis
Graft survival	High chances of graft take	Less chances of 100% take
Cosmetic appearance	Poor cosmetic appearance, if good postoperative care is not given	Better appearance
Contraction	• Primary contraction is very little • Secondary contraction is very high	• Primary contraction is more • Secondary contraction is less
Uses	To cover extensive wounds	When esthetic concern is important
Donor site	From all over the body	For face it is nearby site that has similar color and texture
Donor site healing	By epithelialization from the epithelial structures such as hair follicle, sweat glands, and sebaceous glands	By primary closure or by STSG
Instruments	Humby knife/ dermatome	Scalpel/scissors
Color change	Becomes hyperpigmented	Retains color

(FTSG: full-thickness skin graft; STSG: split-thickness skin graft)

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Indications and Contraindications of Skin Grafts

Indications and contraindications of skin grafts are given in **Table 3**.

TABLE 2: Advantages and disadvantages of skin graft.

Type of graft	*Advantages*	*Disadvantages*
STSG	• Best survival • Technically easy • Graft can be overlapped • Easy to staple with skin staplers	• Does not resemble the original skin • Poor sensation • Secondary contraction is maximum • Will not take on bare bone, bare cartilage, bare tendon, and joint • Pain while removing skin staplers
FTSG	• Resembles the normal skin • Less contraction • Looks better • Sensation is good • Color match good	• Less graft survival • Slow healing • If donor site is large requires STSG • Can be used only for smaller areas • The skin edges have to be meticulously sutured edge-to-edge

(FTSG: full-thickness skin graft; STSG: split-thickness skin graft)

TABLE 3: Indications and contraindications of skin grafts.

Indications	*Contraindications*
• Acute skin loss • Chronic skin loss • Well granulated wound • Clean wounds	• Unhealthy granulation tissue • Streptococcal infection

Type of Skin Graft Dressing

Traditionally Vaseline gauze and saline soak have been the primary dressing for skin grafts. But this leads to pain and trauma on removal and the shredding of fibers into the wound. Gauze acts as a poor bacterial barrier and can promote infection when wet.

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The author has shared her collection of experiences of over the past 40 years. The image collection represents a wide variety of challenges the plastic surgeon faces. The purpose of this book is to explain many of the common cases. Due to huge amount of literature written on plastic surgery topics, the author found that summarizing these topics will give the reader a quick and easy reference. To understand the topics even better and clearer, more than 90 power point presentations with additional information has been provided. It hopes that this book will stimulate and inspire all undergraduate medical, paramedical, postgraduate students, plastic surgery trainees, oral and maxillofacial trainees, junior doctors and consultants to understand and put to practice their clinical acumen which in turn will benefit the patients.

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