Surgical anatomy of the skin

Sarah A Mohamed
Rachel Hargest

Abstract

The skin is the largest organ in the body and forms the interface between the body and the environment. Its structure is highly adapted to protect the body from many forms of noxious agents, to maintain homeostasis in several physiologic domains and to allow the individual to appreciate various modalities of sensation. The skin is divided into three layers – the epidermis, dermis and hypodermis or (subcutaneous fat). The epidermis is a continually regenerating structure formed mainly from keratinocytes which account for the majority of cells in the epidermis. The pigment melanin, produced in the melanocyte cells of the epidermis is a major factor in determining skin colour. The dermis supports and gives strength and flexibility to the epidermis. It contains multiple blood vessels, lymphatics and nerves within its connective tissue architecture. The hypodermis is composed of various amounts of subcutaneous fat which plays a role in thermoregulation and water storage. It is essential that surgeons have a good knowledge of the structure of skin in order to choose the optimum site for surgical incisions, to understand the best methods of wound closure and to anticipate potential problems with wound healing.

Keywords Dermis; epidermis; hypodermis; wound closure

Introduction

The skin is a large and complex organ accounting for a total area of approximately 20 square feet. It compromises 15% of the total adult body weight.[1] It is highly adaptive with various thickness and specialized functions throughout the human body. Anatomically, it is divided into three layers: epidermis, dermis and hypodermis. This article will describe the anatomy of the skin taking into consideration its anatomical function, structure, blood supply and clinical significance. It is vital that surgeons have an in-depth knowledge of skin and surgical considerations such as wound closure techniques, sutures and technical factors to optimize wound healing.

The aim of this chapter is to provide an overview of the anatomy of the skin and its implications for surgery. Anatomical features are specialized in relation to multiple functions of the skin and have implications for surgical considerations, such as scar placement and wound care. The physiology and pathology of wound healing will be covered in detail in other chapters of this issue.

Sarah A Mohamed ***MBBS MRCS*** *is a Specialist Registrar in Surgery at the University Hospital of Wales, Cardiff, Wales, UK. Conflict of interest: none declared.*

Rachel Hargest ***MD FRCS*** *is a Senior Lecturer / Consultant Colorectal Surgeon at the University Hospital of Wales, Cardiff, Wales, UK. Conflicts of interest: none declared.*

Functions of skin

The skin has six main functions which are discussed in greater detail on pages 8–12 of this issue. The anatomical features which enable and enhance these six functions listed below are indicated in this article.

- **Protection**: The skin interfaces directly with the environment, acting as a barrier separating the internal organs and external environment. It prevents harmful chemicals and pathogens from entering the body, in addition to cushioning the impact of mechanical, thermal or physical injuries. It also protects against the effects of ultraviolet radiation (UVR) and is water resistant. The skin is also a large immunological organ which plays a role in protecting the body against infection.
- **Thermostat**: Skin can adapt to changes in body temperature. It uses mechanisms such as insensible perspiration, eccrine sweating, and dilatory or constrictive changes in the cutaneous vasculature to preserve or disseminate body heat.
- **Neural relay network**: An extensive network of nerve cells detects and relays changes in the environment. Receptors detect stimuli of various sensations such as touch, pain and temperature. Touch includes light touch, two-point discrimination and vibration modalities. There is also a motor component to the innervation of the skin, which includes the involuntary smooth muscle associated with hair follicles and the specific striated muscles which are directly attached to skin, such as the muscles of facial expression and dartos.
- **Expression and communication**: A more social function is the ability for skin to enable individuals to display emotions. It acts as an indicator of one's physical state. Skin is an important component of the stress response as it acts as an immediate stress perceiver and as a target of stress responses.
- **Water store**: Skin acts a storage centre for water. This is mainly in the dermis layer of skin and accounts for 18–20% of total body water volume.
- **Synthesis of vitamin D**: The skin is the main site of vitamin D production but is dependent on exposure to ultraviolet light.

Anatomy of the skin

From the outside inwards, the skin consists of three layers

- epidermis
- dermis
- hypodermis, also known as the subcutaneous tissue.

Each layer has a functional role and is an integral part the skin.

Epidermis

The epidermis is a physical and biological barrier, preventing pathogens and irritants from penetrating the body. The main cell type in the epidermis is the keratinocyte. At least 80% of cells in the epidermis are ectodermally derived keratinocytes. The

differentiation process, that occurs as the cells migrate from the basal layer to the surface of the skin, results in keratinization, a process in which the keratinocyte first passes through a synthetic and then a degradative phase.[2] When the keratinocytes eventually reach the most superficial layer they are shed (desquamated) from the surface. The process takes approximately 30–40 days in total.

The epidermis is not a flat layer. Its deep margin is characterized by a series of projections, known as rete pegs, which pass downwards into the dermis. This gives the lower border of the epidermis an undulating appearance when a section of the skin is viewed under the microscope (Figure 1).

The epidermis consists of five histological layers which are shown in Figure 2. From deepest to most superficial, these layers are:

- **Stratum basale**: This layer is also known as the stratum germinativum since mitosis of keratinocytes occurs here. The keratinocytes in this layer are columnar in shape with their long axis perpendicular to the dermis. They have dark staining oval or elongated nuclei and basophilic cytoplasm. They are joined by intercellular bridges formed by desmosomes, which are two part structures responsible for adhesion, on adjacent cell membranes. Cells of the stratum basale are attached to the basement membrane by similar but single structures – the hemi-desmosomes. The stratum basale also contains melanocytes, which are dendritic cells arising from the neural crest, containing melanin, the pigment which protects against ultraviolet (UV) light and accounts for varying skin tones. Melanocytes are arranged horizontally above the dermal junction.
- **Stratum spinosum**: This layer is also known as the Malpighian layer or prickle cell layer. As they migrate up to this layer, the columnar keratinocytes lose water and become polyhedral in shape, but maintain intercellular contact or bridges sometime referred to as 'prickles'.
- **Stratum granulosum**: This layer is also known as the granular layer. It consists of one to four rows of diamond-shaped cells containing basophilic granules.
- **Stratum lucidum**: This layer is also known as the lucid layer or hyaline layer. It is a clear layer containing hyaline which is only present in the palms and soles.

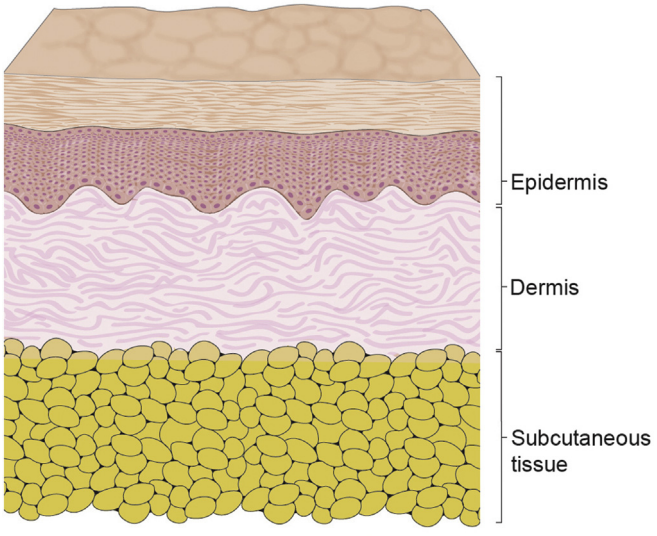

Figure 1 Layers of the dermis

- **Stratum corneum**: This is also known as the horny layer. It is the outermost layer and predominately contains anuclear cells containing significant amounts of keratin. The epidermal appendages (see below) are also present in this layer.

Other non-keratinocyte cells are also found in the epidermis. These include melanocytes, Langerhans cells and Merkel cells.

- **Melanocytes** are dendritic cells which produce melanin which is responsible for skin pigmentation. They are derived from the neural crest embryologically. They are located in the stratum basale. Skin colour is determined by the amount of melanin produced and not the number of melanocytes in any given individual.
- **Langerhans cells** are specialized dendritic cells found predominantly in the stratum spinosum of the epidermis. Smaller numbers are found in the stratum basale but they have not been demonstrated in the stratum granulosum or stratum corneum in normal health. Langerhans cells have characteristic ultrastructural features which include clear cytoplasm, lobulated nucleus, absence of melanosomes, and the presence of a special type of organelle known as the Birkbeck granule, which is shaped like a tennis racket. Langerhans cells also contain common cytoplasmic organelles such as Golgi apparatus, endoplasmic reticulum, mitochondria and centrioles. The cytoplasm appears clear due to the absence of tonofilaments, keratin and other fibrils. Langerhans cells do not contain desmosomes and therefore they are not anchored to adjacent cells as are the keratinocytes in the stratum spinosum. Much like macrophages, these cells are derived from bone marrow monocytes and are capable of antigen presentation.[3] Langerhans cells play a key role in the immune response of skin against pathogens. They are able to phagocytose particles less than 1 micron in diameter and have the ability to migrate from the epidermis to draining lymph nodes.
- **Merkel cells** are granular epidermal cells, situated in the stratum basale. They have clear cytoplasm with few microfilaments, many free ribosomes and poorly developed endoplasmic reticulum and Golgi apparatus structures. They are attached to free nerve endings, which are sensitive to touch. The terminal axons which innervate Merkel cells lose their myelin sheath close to their end which is expanded as a flat structure containing multiple mitochondria and vesicles. The cell membrane of this flat terminal exon plate contacts the cell membrane of the Merkel cell on its dermal aspect. Merkel cells are found in the digits, lips, mucosa of the oral cavity, and outer root sheath of the hair follicle. They may be found as isolated cells within the epidermis, but some are assembled into specialized sensory structures known as tactile discs or touch domes.[4]

There are also several epidermal appendages such as nails, hair and sweat glands which originate in the epidermis but pass into the deeper layers of the skin. They will be considered in a separate section below.

Dermis

The dermis gives skin its durability, strength and flexibility. It is mainly composed of connective tissue and contains numerous blood vessel, lymphatics and nerves.

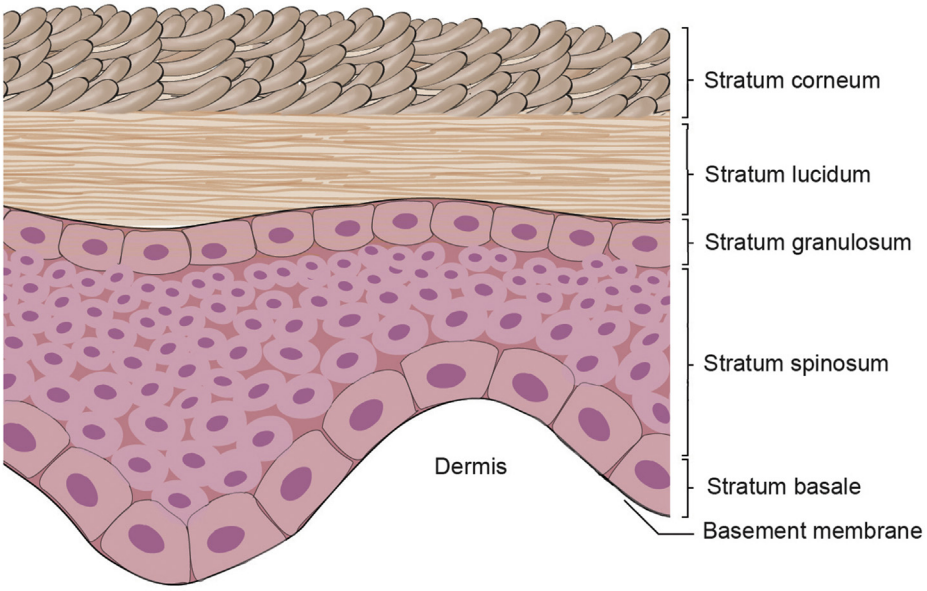

Figure 2 Structure of epidermis

It lies beneath the epidermis and is divided into two layers:

- **The papillary dermis**: this is the more superficial part of the dermis and is considerably thinner since it comprises the tissue interdigitating between the epidermal rete pegs. It consists of loose connective tissue, elastic fibres and some collagen containing blood vessels and nerves.
- **The reticular dermis**: this is the deeper and more substantial part of the dermis. It contains thick collagen bundles and larger blood vessels, in addition to fibroblasts, mast cells, nerve endings, lymphatics and the muscles which insert into skin.

Dermal connective tissue contains three types of fibres:

- **Collagen fibres** – account for 75% of the total. Collagen fibres appear wavy and are arranged in bundles with fibroblasts between the bundles.
- **Elastin fibres** – enclose the collagen bundles and may run parallel or obliquely.
- **Reticulin fibres** – comprised of collagen fibrils, they ensure stability between dermis and epidermis.

There are also a number of fixed and transient cellular elements to the dermis. Fixed cells include the fibroblasts (mentioned above in relation to collagen bundles) and mast cells. The latter are spindle shaped histiocytic cells which produce heparin and histamine. They are relatively few in number in normal skin but may increase in disease. Several cell types may pass through the skin dermis during various stages of development, health or disease. These include extravasated leucocytes, which may be found close to blood vessels or lymphatics. They are particularly common during episodes of inflammation or infection. Histiocytes, also known as reticulin cells, are found in the dermis.

During disease, there are many other cell types which may be found in the skin, as part of either the disease process or part of the body's reaction to it. Examples include:

- Eosinophils which are found in conditions such as dermatitis herpetiformis.
- Macrophages which are a form of histiocyte with the capacity to phagocytose other material. They are found in many conditions and when fused, appear as multinucleated foreign body giant cells.
- Epithelioid cells are another form of histiocyte and may be found in conditions such as sarcoid, tuberculosis and syphilis.
- Foam cells are histiocytes which have phagocytosed lipids and are seen in lesions of xanthoma.
- Leucocytes and lymphocytes are the most commonly found migratory cells in the skin and occur in many forms of inflection and inflammation.

Hypodermis

The hypodermis (also known as subcutaneous fat) acts as the main structural support of the skin. It plays a vital role in thermoregulation and shock absorption. The amount of fat in this layer varies widely between individuals. It is a highly vascular layer and interlaced with blood vessels.

Epidermal appendages

Epidermal appendages are derived from the epidermis but descend into the dermis during embryological development. They include hair follicles, nails, sebaceous and sweat glands.

Hair

Hair is a skin appendage present on most parts of the body. Areas of the body typically devoid of hair include the palmar and plantar surfaces, lips, and urogenital orifices.[5] Hair functions to protect the skin against minor trauma, assists thermoregulation, is sensitive to tactile stimuli and has specific functions such as filtering of inspired air (nasal hairs) or eye protection (eyelashes).

Hair is composed of the visible **hair shaft** formed by dead, keratinized cells and the **hair root** formed from non-keratinized cells below the skin surface. The hair shaft extends from the skin surface to the free end of the hair. This visible part of the hair is comprised exclusively of dead cells and, therefore, no specific application of hair products or hair care regimes will enhance the physiological condition of these cells. Good hair health depends on the health of the individual leading to growth of healthy hair.

The hair root is that part of the hair lying below the skin surface. The proximal end of the hair root is the **hair bulb** which lies deep in the dermis, despite its epidermal origin. The **hair bulb** is a sac pit where hair grows. A layer of mitotically active basal cells can be seen here, and this is called the **hair matrix**. The hair bulb surrounds the **hair papilla**, which is made of connective tissue and contains blood capillaries and nerve endings from the dermis (Figure 3). The hair papilla also contains a variable amount of melanin, responsible for different hair colours.

There are three types of hairs:

- Lanugo/downy hair: This type of hair is found on the face (except for the male beard/moustache), hands and limbs.
- Long soft hair: This type of hair is found on the scalp, beard, moustache, axilla and pubes.
- Stiff hair: This type of hair is found in the eye lashes, eyebrows, nose and ears.

Nails

Nails are translucent, solid plates of keratin found overlying the distal phalanxes. They play an important role in increasing sensitivity and sensation in addition to enabling certain functions such as extended precision grip.

The nail unit includes the nail plate, nail matrix, nail bed, hyponychium and isthmus (Figure 4). The nail plate is the main part of the nail. It is a rigid, keratinized structure composed of around 196 rows of compact, well-differentiated keratinocytes that are called onychocytes.[6] The average growth rate for nails is approximately 0.1 mm per day but may be affected by disease, trauma and nutrition. The nail matrix is the germinative region where the nail plate originates. It is contiguous with the nail bed which is located below the nail pate, it contains collagen bundles and elastic fibres. A rich vascular network also lies there. The area where the skin of the dorsum of the distal phalanx encroaches over the proximal end of the nail plate is known as the nail fold which terminates at the epinychium. The hyponychium refers to the epidermis surrounding the free margin of the nail. Clinically it is of significance as pathogens can be harboured here and lead to infection transmission. The isthmus is a transitional zone between the nail bed and hyponychium, it aids in sealing the under surface of the nail plate.

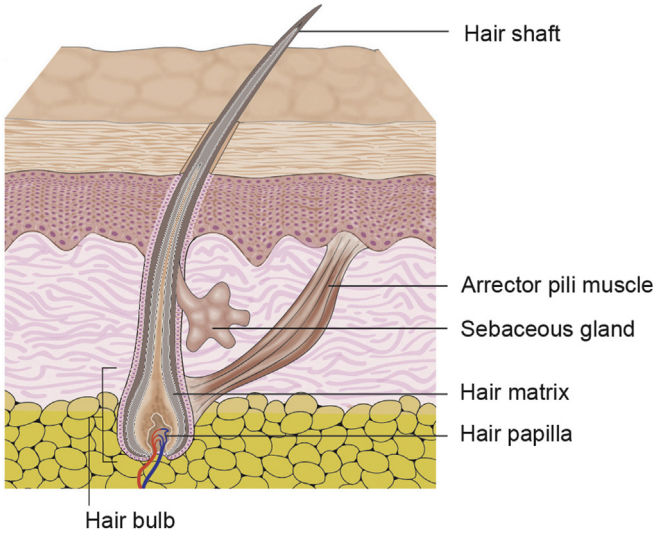

Figure 3 Structure of hair follicle

Sweat glands

Sweat glands are found across the entire surface of the body and play a role in lubricating the skin, temperature regulation, salt and water balance and are essential for the maintenance of normal physiology.

There are three types of sweat glands;

- **Eccrine glands**: These glands account for the majority of sweat glands and are seen in all skin except the mucous membranes. It is estimated that there are between 2 and 5 million eccrine glands in each individual. They are involved in the regulation of heat and are most abundant on the soles of the feet and least plentiful on the back.[7] Eccrine glands comprise a spiral-shaped basal coil, located in the dermis, and a duct which traverses both to dermis and epidermis to open onto the skin surface. They secrete clear, odourless sweat which is 99% water containing chloride, lactic acid, urea and nitrogen in dilute quantities.
- **Apocrine glands**: These glands are larger in size and are located in the axilla, nipple, areolar and anogenital regions. They commonly release their secretions into the hair follicle shaft and rarely open onto the skin surface. They secrete a thicker, whitish fluid containing protein, carbohydrates and other substances. Secretions occur in response to stress, pain, fright or sexual activity and contribute to producing body odour.
- **Sebaceous glands**: Although called glands, these structures produce a 'secretion' which is comprised of desquamated dead cells. Sebaceous glands are usually multilobulated and found adjacent to hair follicles. Their products are extruded through the sebaceous duct into the pilosebaceous follicle below the entrance of the duct from apocrine glands. Sebaceous glands are found in the greatest number on the face and scalp but are present on nearly all other locations of the body, with the exception of the tarsal plate of the eyelids, the buccal mucosa and vermilion borders of the lip, the prepuce and mucosa lateral to the penile frenulum, the labia minora, and the female areola.[8]

Blood supply of skin

The superficial vascular plexus is a network of arterioles and venules, interconnected together in the dermis and running just below the epidermis. Capillaries formed here extend more superficially within the papillary dermis. The deep vascular plexus is located in the deeper reticular dermis layer, these capillaries are distributed around the hair follicles and sweat glands. This dynamic network aids in the delivery of nutrients

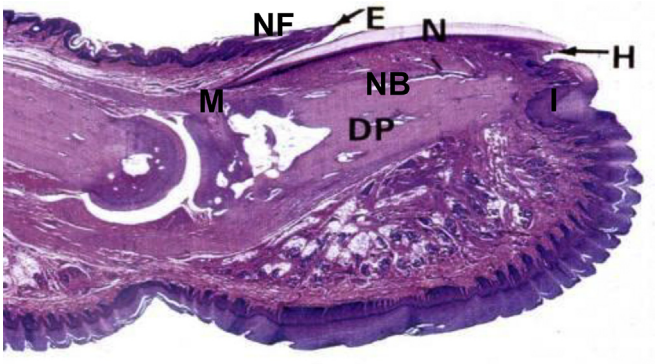

Figure 4 Nail Structure. (DP, distal phalanx; E, Eponychium; H, Hyponychium; I, Isthmus; M, Matrix; N, Nail Plate; NB, Nail bed; NF, Nail Fold.)

and excretion of waste products, in addition to having a major role in thermoregulation.

Nerve supply of the skin

Numerous nerve cells and fibres are present throughout the skin, which is the body's largest sensory organ. The skin provides the individual with the sensations which relate to one's environment, in respect of potential threats of harm from trauma, heat or cold, pressure, foreign bodies or infection. Nerve bundles lie in the subcutaneous tissue and, from these, multiple fibres pass into the skin layers. These fibres may be myelinated or not and form a loose plexus in the mid dermis. They transmit various modalities of sensation along with a smaller motor component, such as innervation of the muscles of facial expression and erector pilae. Myelinated fibres are mostly destined to supply encapsulated receptors while, more superficially, there are small groups of unmyelinated fibres which may be surrounded by a single perineural cell.

Free nerve endings are thought to mediate sensations in hairless skin such as the palms, soles, lips and genital areas. However, there is debate as to whether any nerve endings are completely 'free', as electron microscopy studies suggest that axons within the dermis have at least some cover from surrounding Schwann Cells. Within the epidermis, unmyelinated fibres appear to terminate in association with Merkel cells as described above.

Surgical considerations

Placement of surgical incisions

The main goals when planning a surgical incision are establishing adequate surgical access, optimizing wound healing and minimizing scarring, to ensure a natural, cosmetically pleasing appearance.

To achieve this, surgical incisions are most commonly placed within or parallel to Langer's lines (Figure 5). Langer's lines (also known as cleavage lines) are lines that run parallel to the natural orientation of collagen fibres in the dermis. Incisions made along Langer's lines tend to provide improved healing and are less likely to scar when compared to those made across Langer's lines.[9]

Closure of surgical incisions

Where possible, surgical wounds should be closed using a tensionless technique. The wound edges should be everted appropriately, ensuring the skin edges are approximated together. Factors to consider include wound type (i.e. laceration and tissue loss), wound depth (i.e. muscle or bone involvement), level of contamination and blood supply. In general, clean surgical incisions with no loss of tissue should be closed primarily with the appropriate choice of sutures/staples/dressings. This is to facilitate healing by primary intention which is discussed in detail in the article on *The pathology of healing and repair on* pages 13–19. Wounds which are contaminated, or where there has been loss of issue which would lead to tension on opposed wound edges, should be allowed to heal by secondary intention (as discussed in *The pathology of healing and repair* in this issue).

Choice of suture techniques for wound closure

Suturing techniques for wound closure can be either interrupted or continuous. There is a variety of suturing styles for each type (Table 1). Interrupted sutures are often used for repairing potentially infected wounds, for fine work on the nose, ears, parts of the face or across joints where mobility is essential. Continuous sutures are particularly appropriate for longer straight wounds such as abdominal incision or wounds on the breast, groin or back.

Choice of suture types for wound repair

There is a wide variety of suture types available for closure of wounds. Choice will depend on wound type, risks of contamination, tissues involved, surgeon choice and financial considerations. This section is not an exhaustive treatise on suture types, but some important principles related to the anatomy of the skin are considered here.

Suture types can be classified in two ways:

- absorbable or non-absorbable.
- monofilament or polyfilament.

The advantages and disadvantages of each type are shown in Table 2.

In view of the diverse nature of the readership of this journal we have deliberately not provided examples of each type. Many hospitals purchase only a small number of sutures of each class. Readers should familiarize themselves with a few sutures of each type in order to obtain reproducible optimum results.

Non-suture alternatives

Topical adhesives and skin staples are more recent closure methods which have been developed to use either alone or in combination with traditional suturing techniques.[10]

Staples are often used to close long skin wounds, particularly in emergency situations when wound contamination is more likely.

Steri-strips: These adhesive strips can be used to bring wound edges together. They are suitable for small wounds, where there is little likelihood of wound dehiscence. The wounds should also

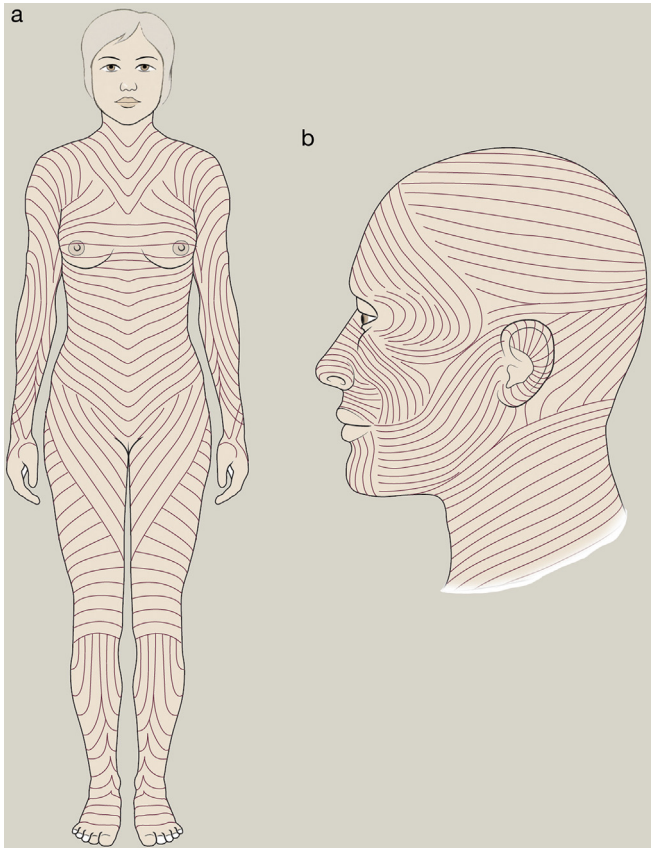

Figure 5 Langer's lines of head and body

be clean, dry and on a relatively flat and immobile area of the body.

Skin adhesives: In recent years, a great deal of research has occurred to try to produce a reliable skin adhesive. Many products are now on the market, but none has achieved universal uptake. They can be used alone or with sutures. They are water resistant and are commonly used in paediatrics for facial lacerations and as an adjunct in breast surgery.

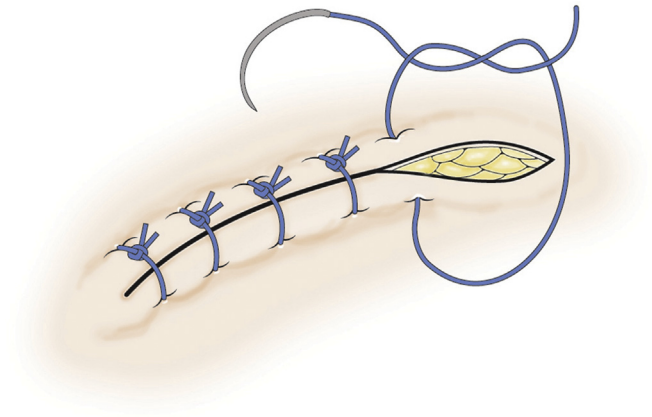

Figure 6 Interrupted simple loop suture

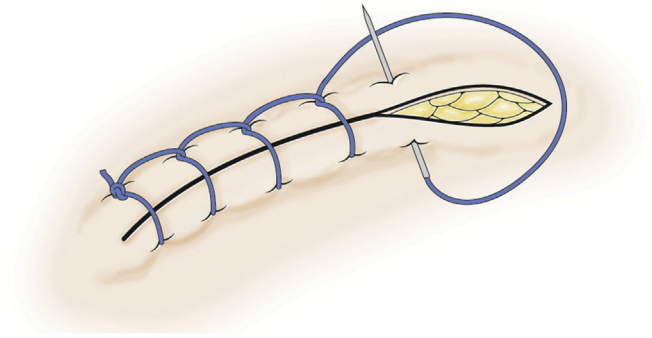

Figure 7 Continuous blanket stitch

Large defects

It is sometimes not possible to close a large wound by primary suture. Alternative reconstructive options will then need to be considered. These include healing by secondary intention, skin grafts (see *Management of burn injury* on pages 62–69), myocutaneous flaps and free flaps. In each case the anatomy of the defect, along with the anatomy of the surrounding skin should be considered, in order to obtain optimum skin coverage and avoid fibrosis and contracture. Specialist experts from plastic or reconstructive surgeons should obtained for patients with these types of wounds.

Suturing styles – advantages and disadvantages

Suture technique	Advantages	Disadvantages	Stitch styles
Interrupted	Precise placement of each suture Equalization of tension at different points along wound Individual stitches can be removed in event of localized wound infection	Slower to insert and remove	Simple loop (Figure 6) Mattress Buried loop (staples)
Continuous	Quicker to insert and remove	Risk of tension (particularly in long or circumferential wounds	Over and over Blanket stitch (Figure 7) Subcuticular

Table 1

Advantages and disadvantages of suture types

Suture Type	Advantages	Disadvantages
Absorbable	No need for removal No long-term risk of foreign body reaction	Not permanent
Non-absorbable	Permanent fixation	Need for removal Risk of foreign body reaction Nidus for infection
Monofilament	Smooth passage through tissue No surface crevices – less infection risk	Risk of cutting through friable tissue Less easy to handle
Polyfilament	Easy to handle Secure knots	Braided surface – nidus for infection

Table 2

Conclusion

The skin is a vital organ for survival. Its multiple functions protect from environmental pathogens and harmful UV radiation. It plays a major role in thermoregulation ensuring the body can adapt to changes in temperature.

Successful wound closure requires an in depth understanding of wound anatomy, physiology, and phases of healing. Surgeons must apply this knowledge in clinical practice to optimize wound healing and cosmetic outcomes, while minimizing any complications. ◆

REFERENCES

1 Kanitakis J. Anatomy, histology and immunohistochemistry of normal human skin. *Eur J Dermatol* 2002 Jul-Aug; **12:** 390–9. quiz 400-1.

2 Chu DH. Overview of biology, development, and structure of skin. In: Wolff K, Goldsmith LA, Katz SI, Gilchrest BA, Paller AS, Leffell DJ, eds. Fitzpatrick's dermatology in general medicine. 7th edn. New York: McGraw-Hill, 2008; 57–73.

3 Yousef H, Alhajj M, Sharma S. StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing, Jul 27, 2020. Anatomy, Skin (Integument), Epidermis.

4 Moll I. Merkel cell distribution in human hair follicles of the fetal and adult scalp. *Cell Tissue Res* 1994; **277:** 131–8.

5 Brown TM, Krishnamurthy K. StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing, May 10, 2021. Histology, Hair and Follicle.

6 André J, Sass U, Richert B, Theunis A. Nail pathology. *Clin Dermatol* 2013 Sep-Oct; **31:** 526–39.

7 Murphy GF. Histology of the skin. In: Elder D, Elenitsas R, Jaworsky C, Johnson Jr B, eds. Lever's histopathology of the skin. 8th edn. Philadelphia: Lippincott Williams & Wilkins, 1997; 5–45.

8 James WD, Berger TG, Elston DM. Andrews' diseases of the skin: clinical dermatology. 10th edn. Philadelphia: Elsevier Saunders, 2006.

9 Langer K. On the anatomy and physiology of the skin. I. The cleavability of the cutis. (Translation from German in 1861). *Br J Plast Surg* 1978; **31:** 3–8.

10 Hochberg J, Meyer KM, Marion MD. Suture choice and other methods of skin closure. *Surg Clin N Am* 2009; **89:** 627–41. https://doi.org/10.1016/j.suc.2009.03.001.

Practice points

- The skin is the largest organ of the body. It performs many vital functions, including protection against external physical, chemical, and biologic toxins, as well as prevention of excess water loss from the body and a role in thermoregulation
- Skin is anatomically divided into three layers: epidermis, dermis and hypodermis. The dynamic epidermis produces a protective outer layer by a process of keratinization and terminal differentiation. Collagen and elastin filaments of the dermal layer provide the underlying tensile strength of the skin, whereas the layer of subcutaneous fat provides a store of energy for the body and contributes to heat retention
- Serious consideration should be given to the exact site of surgical incisions, as factors such as wound location, patient comorbidities, tissue mobility and blood supply all have a great impact on wound healing and cosmetic results
- Choice of sutures and suturing technique should be appropriate for the individual wound and its expected course of healing. Each suture type has specific advantages and disadvantages which should be considered
- Many non-suture alternatives are available for clinical use. Surgeons should familiarize themselves with alternative products and techniques in order to optimize wound closure and healing