47 Plastic and reconstructive surgery

ABERRANT HEALING

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Scarring can be aberrant owing to a combination of genetic predisposition and environmental factors. The two main types of abnormal scarring are hypertrophic and keloid scars. Hypertrophic scars are elevated within the borders of the original scar and a ﬀ ect up to 15% of wounds. They tend to occur soon after injury , subsiding over time, and arise in areas of /uni00A0 tension, particularly ﬂ exor surfaces. They may be successfully treated with topical silicone, intralesional corticosteroid injection, compression therapy or surgical excision. Keloid scars, by contrast, extend beyond the original wound borders and can be locally destructive; in extreme cases, they are debilitating. They occur more commonly in darker skin types and may arise some months after the injury , most com monly a ﬀ ecting the face, earlobes, deltoid area and presternal region. They are more resistant to treatment and may require repeated excision with adjuvant radiotherap y . Scars may also be widened, thin and depressed owing to excess tension across the wound. Scars may also be unstable and prone to recurrent ulceration and breakdown; this is most frequently seen at mobile sites (such as overlying major joints or the neck) when healing has been achieved secondarily . These scars can be excised (serially if necessary) or resurfaced with a flap in order to provide more robust coverage. Wounds that fail to heal properly may become populated with unstable and highly vascular granulation tissue (‘over granulated’) that is fragile and prone to intermittent bleeding. These may be tr eated with topical silver nitrate or cortico steroid or may require formal excision and reconstruction. A traumatic w ound can lead to the development of a pyo genic granuloma. This is a benign proliferation of capillary blood vessels of the skin and presents as a painless red fleshy nodule that grows rapidly over several weeks and bleeds inter mittently (Figur e 47.5). It may be treated topically as per over- granulation tissue but frequently requires surgical excision. In chronic wounds, such as in pressure sor es, burns or osteomyelitis, the chronicity of the inflammatory environment can lead to the development of a Marjolin ulcer. This is a rare but aggressive form of squamous cell carcinoma that has a high propensity for distant metastasis. A low index of suspicion must be observed in chronic wounds that undergo sudden phenotypic change, so early biopsy is advocated.

Figure 47.5 Pyogenic granuloma following a glass laceration to the base of the right middle /f_i nger.

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FLAP MONITORING

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Following microvascular free-flap reconstruction, patients may be monitored in a high-dependency unit setting as it is crucial to keep the patient physiologically optimised in order that the flap remains well perfused at all times. The traditional adage is that the patient should be kept ‘wet, warm and comfortable’. - Strict fluid balance is monitored with the aim of keeping the circulation hyperdynamic; the flap is kept warm with a Bair ® Hugger device and analgesia is carefully controlled to mini - mise excessive catecholamine production as a result of pain. - The flap is monitored regularly by specialist nurses who assess - the colour, warmth and turgor of the flap. Pressure applied to the skin of a musculocutaneous flap enab les the capillary refill). time to be assessed; if necessary the flap can be pricked with a hypodermic needle to assess bleeding. The arterial and venous flow to a flap can often be monitored with a hand-help Doppler device, whereas some surgeons use an implantable Doppler (attached to the venous outflow of the flap), which is especially useful for muscle flaps (without the benefit of a skin paddle to monitor) or those flaps that are buried and thus not accessible for direct visual monitoring. The survival of a free flap is usually threatened by an interruption to arterial inflow or venous drainage; rapid iden tification of a problem is essential as an immediate return to theatre is required to salvage the flap. A pproximately 5% of free flaps will require exploration in theatre f or vascular com promise; of these, more than 60% can be salvaged. The earlier a flap is explored the greater the likelihood of salvage success. Approximately two-thirds of cases of vascular compr omise are venous in aetiology , with one-third being arterial; combined inflow and outflow issues are sometimes seen, and in some situ ations the vessels may be patent but compromised by external pressure (such as a haematoma or an excessively tight dress ing). Thus, when assessing a compromised flap at the bedside, the surgeon must ensur e that the dressings are loosened and any overly tensioned sutures released. Close flap monitoring is of most value in the first 48 hours with rapid detection of vascular compromise facilitating early salvage and improved flap survival. A free-flap survival rate in excess 95% is typical in rou tine elective reconstructive cases such as breast reconstruction using a transverse rectus abdominis (TRAM) or deep inferior epigastric perforator (DIEP) flap. Flap survival rates are slightly lower in, for example , cases of complex polytrauma or head and neck reconstruction.

(h) (c) (d) Figure 47.28 Replantation of digit. (a–c) Complete avulsions of the index and middle /f_i ngers at the distal interphalangeal joints. The avulsed middle /f_i nger was not salvageable. (d) The avulsed index /f_i nger was dissected and the digital arteries, veins and nerves were identi /f_i ed. Heterotopic replantation of the avulsed index /f_i nger to the middle. appearance with the range of motion demonstrated. (i) (j) (e–g) Immediate postoperative appearance. (h–j) One-year postoperative

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FUTURE DIRECTIONS

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Anatomical discoveries, such as a detailed understanding of the blood supply to the skin as well as technical and engineering innovations that brought about microsurgery , have enabled the field of reconstructive plastic surgery to blossom. As populations age and life expectancies continue to improve, the demand for reconstructive surgery , particularly among the elderly popula tion for chronic degenerative and neoplastic conditions, will continue apace. The key to the next phase of reconstructive plastic surgery advances will likely be a combined approach across multiple scientific and surgical disciplines. T he scientific areas that will lead to significant breakthroughs include wound healing, bioengineering, cancer treatment and immunotolerance for vascularised allotransplantation. Recent discoveries of the genetic, epigenetic and molecular mechanisms that under lie conditions such as craniosynostosis, cleft lip and palate, Dupuytren’s disease and delayed wound healing now Baron Guillaume Dupuytren , 1777–1835, Surgeon in Chief, Hôtel-Dieu, Paris, France. interventions. Bioengineering and tissue engineering will certainly play a major role in modern reconstruction; for example, smart tissue expansion for cleft palate reconstruction and biocompatible sca ff olds that simultaneously pr omote in situ tissue regeneration as well as deliver treatment by eluting antibiotics or chemotherapeutic agents for musculoskeletal and cancer reconstruction. Furthermore, as the cultural and political landscapes evolve, new areas of reconstructive surgery have emerged, including gender-a ffi rming surgery . One of the most exciting areas of reconstructive plastic surgery has been the increasing success of vascularised composite allotransplantation, including of the face and upper limb. Outcomes are expected to continue to improve with better understanding of immunological tolerance and increasing social acceptance of the donation of body parts. The field of robotic surgery continues to expand. It is par - ticularly useful to assist in surgical approaches where access is limited, such as cleft surgery . The latest devices are able to eliminate hand tremor, increase dexterity and range of motion, provide haptic feedback and thr ee-dimensional views that assist greatly in challenging dissections, and have been successfully adopted in oncological head and neck reconstruction. Reconstructive plastic surgery is unique in its creativity , breadth and variety of reconstructive techniques. While this a ff ords the specialty powerful means to serve the patient, it does also mean the practice of evidence-based surgery is challenging. There are often numerous techniques to treat the same conditions with a lack of high-quality evidence. Moreover, there are often situations where surgery may be technically feasible but not in the best interest of the patient. - For example, patients with complex multifragmentary open tibiofibular fractures and neurovascular compromise may have a better quality of life with a below-knee amputation than with a salvage reconstruction with free tissue transfer. Hence, well-designed pragmatic clinical trials and the development of rigorous tools to capture the most relevant data, such as patient-reported outcome measures, together with the building of large-scale clinical research networks at both national and international levels will be crucial to drive complex shared decision making between surgeon and patient. - FUTURE DIRECTIONS

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Flaps

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A flap is a block of tissue that contains an innate blood supply that may be transferred from a donor site to reconstruct a secondary defect; the pedicle is the ‘base’ of the flap that contains the blood supply . Unlike a graft, a flap can therefore be used to reconstruct a defect that does not have a vascu larised wound bed, such as exposed tendon, cortical bone or a prosthesis. There are numerous methods of classifying flaps: according to their blood supply , their proximity to the defect, the method by which they ar e transferred and the tissue that they contain. The five Cs methodology is a useful flap classification system based on their circulation, composition, contiguity , contour and conditioning (Figure 47.12). 1 Circulation : random pattern flaps have no dominant blood supply whereas axial flaps have a dominant feeding vessel. 2 Composition : cutaneous, fasciocutaneous, fascial, musculocutaneous, muscle, osseocutaneous, osseous, omentum/bowel. 3 Contiguity : local (where the flap shares a side with the defect) (Figure 47.13), regional (where the flap is near but not immediately adjacent to the defect) (Figures 47.14 and 47.15) and distant (where the flap is far from the defect and can be either pedicled or free) (Figures 47.16 and 47.17). Sydney Reese Coleman , contemporary , plastic surgeon, New Y ork, NY , USA. George Carl Cormack , contemporary , plastic surgeon, Cambridge, UK. Byrom George Harker Lamberty , contemporary , plastic surgeon, Cambridge, UK. Bengt Pontén , 1923–2007, Associate Professor of Plastic Surgery , Uppsala University , Uppsala , Sweden. Stephen John Mathes , 1943–2007, Professor of Surgery , University of California, San Francisco, CA, USA. Foad Nahai , contemporary , Professor of Surgery , Emory University , Atlanta, GA, USA. into the defect – advancement (Figures 47.18 and 47.19), transposition (Figure 47.20), rotation (Figure 47.21), interpolation, waltzing, crane principle and free. 5 Conditioning : whether the flap is delayed by partially elevating and resetting the flap prior to definitive elevation and transfer. Delay enables a larger flap to be harvested by - improving its blood supply . - Fasciocutaneous flaps comprise a fascial component that augments the flap blood supply owing to a network of sub - fascial, fascial and suprafascial vessels. Fasciocutaneous flaps may be classified according to Cormack and Lamberty (1984) (Figure 47.22): /uni25CF Type A: multiple perforators that can be direct or indirect (e.g. Pontén flap). /uni25CF Type B: single perforator that is usually direct and runs along the axis of the flap (e.g. the scapular or parascapular flaps). /uni25CF Type C: segmental perforators that arise from the same source vessel (e.g. the radial forearm and lateral arm flaps) (Figure 47.23). /uni25CF Type D: similar to type C; however, the flap is raised as an osteomyofasciocutaneous flap (e.g. the free fibular flap). In muscle and musculocutaneous flaps the motor nerve is always accompanied by a vascular pedicle, which is often the major source of the flap circulation. A dominant pedicle can sustain an entire muscle whereas a minor pedicle can nor - mally only sustain a portion of the flap. T he skin in a musculo - cutaneous flap is supplied by perforators. Muscle flaps are - classified by Mathes and Nahai (1981) (Figure 47.24): /uni25CF Type I: single vascular pedicle (e.g. tensor fascia lata and gastrocnemius). /uni25CF Type II: one dominant pedicle with one or more minor pedicles (e.g. gracilis, biceps femoris, sternocleidomastoid, soleus and trapezius); the flap cannot survive on the minor pedicle(s) alone.

/uni25CF Type III: dual dominant pedicles (e.g. gluteus maximus, pectoralis minor, rectus abdominis, serratus anterior and temporalis). /uni25CF Type IV: segmental pedicles (e.g. flexor hallucis longus, sar - torius and tibialis anterior). /uni25CF Type V: dominant pedicle with several smaller segmen - tal pedicles (e.g. latissimus dorsi and pectoralis major) (Figures 47.25 and 47.26); the flap can survive on the minor pedicles alone. A chimeric flap consists of multiple otherwise spatially independent flaps, each of which has an independent vascular supply , with all pedicles linked to a common source vessel. For example, the descending branch of the lateral femoral

TRANSPOSITION FLAP Donor defect (grafted or sometimes closed Defect primarily) Pivot point (b) BILOBED FLAP Uses a /f_l ap to close a convex defect, and a second smaller /f_l ap to close the donor site Secondary ap Flap (c) RHOMBOID Tissue FLAP defect a´ a´ a A parallelogram- shaped transposition Flap /f_l ap a Figure 47.12 Local /f_l ap diagrams. (a) Transposition and Z-plasty /f_l aps. (b) Bilobed and bipedicled /f_l aps. (c) Rhomboid and rotation /f_l aps. (continued overleaf) Z-PLASTY Tw o triangular transposition /f_l aps interposed 1 23 B A A B B A 45 6 B B B A A A BIPEDICLE FLAP A 'bucket-handle' /f_l ap supplied from both ends. Useful to rebuild the lower eyelid Flap RO TA TION FLAP a a b b

A DVANCEMENT FLAP ectangular Simple r (with or without Bur ow 's triangle excision at base) Defect Tw o Bu ro w's triangles can be excised at base of /f_l ap to make it slide V to Y e.g. cut /f_i ngertip Flap (e) 2 1 Mark a long Bu rn scar zig-zag along with long the scar ellipse around it 5 4 The cut lines The /f_i nished wound will look will look something something like like this this each becomes Pad it well, and be a a´ Advance the sure to splint open b´ b tips of the when not exercising zig-zags into the spaces Y to V Usually multiple Area of to r elease band scar scars over joint s shaded This is one of the fective most ef means of r eleasing moderate isolated band bur n scars over /f_l exion cr eases 3 Add in the horizontal lines to the zig-zag; a´ each becomes a b´ a 'Y' b Figure 47.12 (continued) Local /f_l ap diagrams. (d) Advancement /f_l aps. (e) Multiple Y-to-V plasty for burn scar.

Figure 47.13 Bilobed /f_l ap reconstruction of a nasal defect following excision of a basal cell carcinoma. raised. (c) Transposition of bilobed /f_l ap. (d) Immediate postoperative appearance. (a) (b) Figure 47.14 Forehead /f_l ap reconstruction of nasal defect following excision of multiple basal cell carcinomas. demonstrating the forehead /f_l ap based on the right supratrochlear artery. The pedicle position is con /f_i rmed using a hand-held Doppler probe. /uni00A0 (b) Flap inset to nose – note the bulky pedicle at the right medial eyebrow; donor site closed primarily except at the widest point, where it is allowed to heal by secondary intention. (c) The /f_l ap pedicle was divided at a second stage, allowing contouring of the /f_l ap. Appearance at 6 /uni00A0 months. (a) Excision markings. (b) Bilobed /f_l ap (c) (a) Preoperative markings

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(d) (f) Figure 47.17 The medial sural artery perforator (MSAP) /f_l ap can be used as a pedicled /f_l ap for regional defects or as a free /f_l ap for distant defects. (a) A longstanding diabetic foot ulcer of the left hallux with underlying osteomyelitis. (b) Marking of the MSAP /f_l ap. (c) Amputation of the hallux – direct closure would have neces

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Figure 47.19 Hatchet /f_l ap reconstruction following excision of a skin cancer of the right eyebrow. the tumour with a back cut to enable /f_l ap advancement. (c) Insetting of the /f_l ap. (a) (b) x x y y Figure 47.20 Reconstruction of a melanocytic lesion of the left pre- auricular region using a rhomboid (transposition) /f_l ap. (a) Preoperative markings. (b) Immediate postoperative appearance. (a) (b) Muscle Figure 47.22 Cormack and Lamberty classi /f_i cation of fasciocutaneous /f_l aps. small, segmental perforators. (d) Osteomyofascial perforators. (a) Preoperative planning. (b) Post excision of (d) Immediate postoperative appearance. (a) (b) Figure 47.21 Rotation /f_l ap reconstruction following excision of a pilonidal sinus. (a) Preoperative marking of the rotational /f_l ap with a back cut. (b) Immediate postoperative appearance. (c) (d) Bone Muscle /uni00A0 (a) Multiple large perforators. (b) Single large perforator. (c) Multiple,

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Figure 47.25 The latissimus dorsi /f_l ap can be used as a pedicled /f_l ap to reconstruct regional defects or as a free /f_l ap to reconstruct distant defects. (a) Dermato /f_i brosarcoma protuberans of the left breast. (a) (b) (c) (d) (e) Figure 47.26 (a, b) Limb-threatening, multiplanar degloving injury of the left foot and ankle from a road traf /f_i c accident. debridement, multiple skin defects with exposed extensor tendons and tibiotalar joint. /f_l aps as two separate free /f_l aps. (f, g) Immediate postoperative appearance with meshed split-thickness skin grafts laid over the muscle /f_l aps. (h, /uni00A0 i) /uni00A0 Postoperative appearance at 6 months with normal ambulation. (b) Reconstruction using a pedicled musculocutaneous latissimus dorsi /f_l ap. (f) (h) (i) (g) (c, d) Following wound (e) Harvest of left latissimus dorsi and serratus anterior

circumflex artery pedicle can support multiple skin and muscle flaps (Figure 47.27) or the subscapular vascular pedicle can support a scapular flap, a parascapular flap, a latissimus dorsi flap and a serratus anterior flap. This enables the reconstruction of complex composite defects involving di ff erent tissues. For example, following resection of a maxillary sinus tumour, a chimeric scapular flap can be used to reconstruct both the bony and skin defects. V enous flow-through flaps are based on a venous rather than arterial pedicle so that the vein delivers both inflow and outflow of blood. These flaps are thin and pliable but prone to venous congestion and partial necrosis as there is no arterial input and the flap survives on deo xygenated blood. There is minimal donor site morbidity . Examples include the saphenous flap and those based on the superficial veins of the forearm.

Figure 47.27 (a, b) Chimeric anterolateral thigh /f_l ap comprising spatially independent skin and muscle /f_l aps with all pedicles linked to a common source vessel (arrow), the descending branch of the lateral femoral circum /f_l ex artery.

Flaps

A flap is a block of tissue that contains an innate blood supply that may be transferred from a donor site to reconstruct a secondary defect; the pedicle is the 'base' of the flap that contains the blood supply . Unlike a graft, a flap can therefore be used to reconstruct a defect that does not have a vascu larised wound bed, such as exposed tendon, cortical bone or a prosthesis. There are numerous methods of classifying flaps: according to their blood supply , their proximity to the defect, the method by which they ar e transferred and the tissue that they contain. The five Cs methodology is a useful flap classification system based on their circulation, composition, contiguity , contour and conditioning (Figure 47.12). 1 Circulation : random pattern flaps have no dominant blood supply whereas axial flaps have a dominant feeding vessel. 2 Composition : cutaneous, fasciocutaneous, fascial, musculocutaneous, muscle, osseocutaneous, osseous, omentum/bowel. 3 Contiguity : local (where the flap shares a side with the defect) (Figure 47.13), regional (where the flap is near but not immediately adjacent to the defect) (Figures 47.14 and 47.15) and distant (where the flap is far from the defect and can be either pedicled or free) (Figures 47.16 and 47.17). Sydney Reese Coleman , contemporary , plastic surgeon, New Y ork, NY , USA. George Carl Cormack , contemporary , plastic surgeon, Cambridge, UK. Byrom George Harker Lamberty , contemporary , plastic surgeon, Cambridge, UK. Bengt Pontén , 1923–2007, Associate Professor of Plastic Surgery , Uppsala University , Uppsala , Sweden. Stephen John Mathes , 1943–2007, Professor of Surgery , University of California, San Francisco, CA, USA. Foad Nahai , contemporary , Professor of Surgery , Emory University , Atlanta, GA, USA. into the defect – advancement (Figures 47.18 and 47.19), transposition (Figure 47.20), rotation (Figure 47.21), interpolation, waltzing, crane principle and free. 5 Conditioning : whether the flap is delayed by partially elevating and resetting the flap prior to definitive elevation and transfer. Delay enables a larger flap to be harvested by - improving its blood supply . - Fasciocutaneous flaps comprise a fascial component that augments the flap blood supply owing to a network of sub - fascial, fascial and suprafascial vessels. Fasciocutaneous flaps may be classified according to Cormack and Lamberty (1984) (Figure 47.22): /uni25CF Type A: multiple perforators that can be direct or indirect (e.g. Pontén flap). /uni25CF Type B: single perforator that is usually direct and runs along the axis of the flap (e.g. the scapular or parascapular flaps). /uni25CF Type C: segmental perforators that arise from the same source vessel (e.g. the radial forearm and lateral arm flaps) (Figure 47.23). /uni25CF Type D: similar to type C; however, the flap is raised as an osteomyofasciocutaneous flap (e.g. the free fibular flap). In muscle and musculocutaneous flaps the motor nerve is always accompanied by a vascular pedicle, which is often the major source of the flap circulation. A dominant pedicle can sustain an entire muscle whereas a minor pedicle can nor - mally only sustain a portion of the flap. T he skin in a musculo - cutaneous flap is supplied by perforators. Muscle flaps are - classified by Mathes and Nahai (1981) (Figure 47.24): /uni25CF Type I: single vascular pedicle (e.g. tensor fascia lata and gastrocnemius). /uni25CF Type II: one dominant pedicle with one or more minor pedicles (e.g. gracilis, biceps femoris, sternocleidomastoid, soleus and trapezius); the flap cannot survive on the minor pedicle(s) alone. /uni25CF Type III: dual dominant pedicles (e.g. gluteus maximus, pectoralis minor, rectus abdominis, serratus anterior and temporalis). /uni25CF Type IV: segmental pedicles (e.g. flexor hallucis longus, sar - torius and tibialis anterior). /uni25CF Type V: dominant pedicle with several smaller segmen - tal pedicles (e.g. latissimus dorsi and pectoralis major) (Figures 47.25 and 47.26

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TRANSPOSITION FLAP Donor defect (grafted or sometimes closed Defect primarily) Pivot point (b) BILOBED FLAP Uses a /f_l ap to close a convex defect, and a second smaller /f_l ap to close the donor site Secondary ap Flap (c) RHOMBOID Tissue FLAP defect a´ a´ a A parallelogram- shaped transposition Flap /f_l ap a Figure 47.12 Local /f_l ap diagrams. (a) Transposition and Z-plasty /f_l aps. (b) Bilobed and bipedicled /f_l aps. (c) Rhomboid and rotation /f_l aps. (continued overleaf) Z-PLASTY Tw o triangular transposition /f_l aps interposed 1 23 B A A B B A 45 6 B B B A A A BIPEDICLE FLAP A ‘bucket-handle’ /f_l ap supplied from both ends. Useful to rebuild the lower eyelid Flap RO TA TION FLAP a a b b

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(e) (f) (a) (b) (d) Figure 47.16 The medial sural artery perforator (MSAP) /f_l ap can be used as a pedicled /f_l ap for regional defects or as a free /f_l ap for distant defects. (a) Traumatic defect of the anterior knee with a partially transected patellar ligament and cortical loss of the tibial tuberosity following wound debridement. (b, c) The MSAP /f_l ap is harvested – the perforator (arrow) is identi /f_i ed arising from the substance of the gastrocnemius muscle belly. (d, e) The /f_l ap remains attached to a pedicle and is transferred through a subcutaneous tunnel to the anterior knee defect. (f) /uni00A0 Appearance after inset of the /f_l ap. (g) Figure 47.15 Reconstruction of calcaneal osteomyelitis using a pedicled medial plantar artery /f_l ap. (a) Chronic wound over calcaneal osteomyelitis. (b) The medial plantar artery (MPA), a continuation of the posterior tibial (PT) artery, marked out using a Doppler probe and the skin /f_l ap designed accordingly. (c, d) Calcaneal wound debrided and /f_l ap raised. (e) Flap transferred onto the heel. (f) Immediate postoperative appearance of the /f_l ap inset with a meshed split-thickness skin graft laid on the donor site. (g) One-month postoperative appearance. (c) (e) (f)

(d) (f) Figure 47.17 The medial sural artery perforator (MSAP) /f_l ap can be used as a pedicled /f_l ap for regional defects or as a free /f_l ap for distant defects. (a) A longstanding diabetic foot ulcer of the left hallux with underlying osteomyelitis. (b) Marking of the MSAP /f_l ap. (c) Amputation of the hallux – direct closure would have neces

sitated proximal excision of the /f_i rst metatarsal bone, thereby compromising weightbearing. /uni00A0 (d) The MSAP pedicle (arrow) dissected. (e) The detached MSAP /f_l ap with the pedicle (arrow). appearance of the (f, g) Immediate postoperative /f_l ap, with indwelling Doppler monitoring (arrows) for venous anastomosis patency. (b) (a) Figure 47.18 Excision of a basal cell carcinoma of the right alar groove and reconstruction with a V-to-Y nasolabial advancement /f_l ap. /uni00A0 (a) Tumour excision margins and /f_l ap design markings. (b) The defect following excision of the basal cell carcinoma. /f_l ap. (d) Advancement and inset of the /f_l ap. (e) (g) (c) (d) (c) Raising the nasolabial

Figure 47.19 Hatchet /f_l ap reconstruction following excision of a skin cancer of the right eyebrow. the tumour with a back cut to enable /f_l ap advancement. (c) Insetting of the /f_l ap. (a) (b) x x y y Figure 47.20 Reconstruction of a melanocytic lesion of the left pre- auricular region using a rhomboid (transposition) /f_l ap. (a) Preoperative markings. (b) Immediate postoperative appearance. (a) (b) Muscle Figure 47.22 Cormack and Lamberty classi /f_i cation of fasciocutaneous

/f_l aps. small, segmental perforators. (d) Osteomyofascial perforators. (a) Preoperative planning. (b) Post excision of (d) Immediate postoperative appearance. (a) (b) Figure 47.21 Rotation /f_l ap reconstruction following excision of a pilonidal sinus. (a) Preoperative marking of the rotational /f_l ap with a back cut. (b) Immediate postoperative appearance. (c) (d) Bone Muscle /uni00A0 (a) Multiple large perforators. (b) Single large perforator. (c) Multiple,

(d) (e) (f) (g) Figure 47.23 Wound debridement and reconstruction with a pedicled /f_l ap based on a perforator arising from the posterior tibial artery. sinus overlying internal /f_i xation of a medial malleolar fracture. skin (X). (c) The perforator (arrow) and a pair of vena comitans were dissected and the fasciocutaneous /f_l ap islanded. 180° clockwise to reconstruct the defect. (g) The donor site was able to be closed primarily owing to local skin laxity. Type I Type II Gluteus maximus Gracilis Tensor fascia lata Figure 47.24 The Mathes and Nahai classi /f_i cation of muscle /f_l aps. /uni00A0 (a) Chronic (b) The perforator has been identi /f_i ed using a Doppler probe and marked on the (d–f) The /f_l ap is propellered Type IV Type V Type III Latissimus Sartorius dorsi

Figure 47.25 The latissimus dorsi /f_l ap can be used as a pedicled /f_l ap to reconstruct regional defects or as a free /f_l ap to reconstruct distant defects. (a) Dermato /f_i brosarcoma protuberans of the left breast. (a) (b) (c) (d) (e) Figure 47.26 (a, b) Limb-threatening, multiplanar degloving injury of the left foot and ankle from a road traf /f_i c accident. debridement, multiple skin defects with exposed extensor tendons and tibiotalar joint. /f_l aps as two separate free /f_l aps. (f, g) Immediate postoperative appearance with meshed split-thickness skin grafts laid over the muscle /f_l aps. (h, /uni00A0 i) /uni00A0 Postoperative appearance at 6 months with normal ambulation. (b) Reconstruction using a pedicled musculocutaneous latissimus dorsi /f_l ap. (f) (h) (i) (g) (c, d) Following wound (e) Harvest of left latissimus dorsi and serratus anterior

circumflex artery pedicle can support multiple skin and muscle flaps (Figure 47.27) or the subscapular vascular pedicle can support a scapular flap, a parascapular flap, a latissimus dorsi flap and a serratus anterior flap. This enables the reconstruction of complex composite defects involving di ff erent tissues. For example, following resection of a maxillary sinus tumour, a chimeric scapular flap can be used to reconstruct both the bony and skin defects. V enous flow-through flaps are based on a venous rather than arterial pedicle so that the vein delivers both inflow and outflow of blood. These flaps are thin and pliable but prone to venous congestion and partial necrosis as there is no arterial input and the flap survives on deo xygenated blood. There is minimal donor site morbidity . Examples include the saphenous flap and those based on the superficial veins of the forearm.

Figure 47.27 (a, b) Chimeric anterolateral thigh /f_l ap comprising spatially independent skin and muscle /f_l aps with all pedicles linked to a common source vessel (arrow), the descending branch of the lateral femoral circum /f_l ex artery.

Grafts

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(d) Figure 47.8 Power dermatome harvest of a split-thickness skin graft, with the correct method of providing skin tension (a–d) and applying a sterile dressing (e) . (e) Figure 47.9 Typical appearance of a split-thickness skin graft donor site on the left lateral thigh 6 months after harvest. The mild hyper- pigmentation is expected to fade over time.

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Learning objectives

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To be aware of: A variety of plastic surgical techniques used to restore • bodily form and function
To know: The relevant anatomy and physiology of skin • Learning objectives

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Lipotransfer

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Microsurgery is a surgical subspecialty that makes use of magni fication, precision tools and surgical techniques to enable the anastomosis of small blood vessels and coaptation of nerves. The diameter of a typical suture is between 0.01 and 0.03 /uni00A0 mm. The adv ent of microvascular anastomotic techniques renders it feasible to transplant tissue to every region of the body , thus vastly expanding the reconstructive armamentarium as it is no longer necessary to rely on grafts that must revascularise from an underlying wound bed or on pedicled flaps that are limited by size, length or the distance they can ‘travel’. Provided the course from the source vessel to the end organ is preserved, it is possible to transfer flaps from any region of the body to any recipient site provided an appropriate recipient vessel exists. This technique o ff ers a highly versatile and flexible approach to reconstructive surgery . Oncological reconstruction for head and neck cancer or mastectomy defects often requires the use of free flaps, provid ing superior functional and aesthetic outcomes. Typical flaps include the anterolateral thigh and deep inferior epigastric artery perf orator flaps, based on the descending branch of the lateral circumflex femoral artery and the deep inferior epi g astric artery , respectively . For complex limb injuries or osteo myelitis, microsurgical reconstruction has meant that limb salvage is now possible rather than amputation (Figure 47.26 Christian Andreas Doppler , 1803-1853, Director of the Institute of Physics, University of Vienna, Vienna, Austria. Common flaps used in this context include the gracilis or latis - simus dorsi muscle flaps. Microsur gical flaps are not always used to reconstruct skin defects. Free functional muscle flaps are used to reanimate the face or the upper limb in facial and brachial plexus palsies, respectiv ely . Free bone flaps such as the free fibular flap may also be used to reconstruct the mandible following oncological resection or to provide a strut following excision of an osteo - myelitic segment of tibia. Microsurgery has also made it possible to replant ampu - tated digits and limbs, or reconstruct missing fingers with free vascularised functioning and sensate toes (Figure 47.28). Fur - thermore, the technique has also made vascularised composite allotransplantation possible, including of the hand and face. Anastomoses are usually hand sewn (using specialist micro - instruments with the aid of an operating microscope), although the adoption of mec hanical coupler devices for venous anasto - moses is becoming increasing ly popular as they are often tech - - nically less demanding and faster than a hand-sewn approach. Supermicrosurgery involving microneurovascular anas - tomosis of vessels and coaptation of single nerve fascicles of the order of 0.3–0.8 /uni00A0 mm has further expanded the field. It has enabled the reconstruction of fingertip injuries, which traditionally would have been treated with amputation, and the crea tion of lymphaticovenous anastomosis for the treat - ment of chronic lymphoedema. MICROSURGERY

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RECONSTRUCTIVE TECHNIQUES

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- These range from the simple, including healing by secondary intention or skin grafting, to the complex, including free tissue - transfer or vascularised composite allotransplantation. They also include the use of autologous tissue, allograft material, biocompatible materials such as skin substitutes, internal and - external fixators and tissue expanders. Improved understand - ing of the blood supply to di ff erent tissue types including skin has vastly expanded the number of flap options (see below) available to reconstruct di ff erent parts of the body . The intro - duction of the operating microscope has ushered in the era of micro surgical reconstruction that has enabled free tissue trans - fer and replantation, procedures whereby the blood supply to a flap is detac hed from the donor site and re-established through vessel anastomosis to local source vessels at the recipient site. Reconstructive plastic surgery is almost always undertaken to impr ove healing. Without it, wounds may heal poorly with unacceptable consequences, including chronic or non-healing wounds, unsightly and debilitating scars or the risk of deep infection. A common scenario is a skin defect that is too large to be closed primarily , thus requiring surgical techniques or adjuncts to achieve wound closure. Several conceptual frame works exist for the appropriate selection of techniques, includ ing the now obsolete reconstructive ladder which advocates using the simplest methods first, and the patient-centred ‘recon structive elevator’. In essence, the modern patient-centred reconstructive technique emplo yed must be considered in the context of each individual case, including patient factors, available skills , resources and the consequences of success and failure to achieve the best long-term outcome. In acute burns, for example, split-thickness skin grafting is almost always used to restore skin as soon as possible in order to preserve life. Following facial tumour excision, a local flap is often superior to a skin graft in terms of contour and aesthetics such as skin quality and colour ma tch. For pressure sore recon struction, a local flap comprising both skin and muscle (for dead-space obliteration) would be more durable than a skin graft or primary closure, both of which would place the scar at the site of grea test pressure. For open lower limb fractures, free tissue transfer is often required as there is a lack of local tissue availability; this option provides healthy vascularised tissues to cover the fracture site (including any orthopaedic metalwork), Karl Thiersch , 1822–1895, Professor of Surgery , Leipzig University , Leipzig, Germany . thus significantly reducing the risk of limb-threatening deep infection or osteomyelitis.

Figure 47.6 Negative-pressure wound therapy to promote wound healing in an open abdomen. The system consists of a non-adherent dressing overlaid by a sponge that is sealed with an airtight membrane and connected to a suction device. (primary venous skin graft plexus) Subpapillary Hair

Deeper split-thickness plexus skin graft Papillary loops Thick split-thickness skin graft Epidermis Full thickness (Wolfe) skin graft Local /f_l aps Deep Subcutaneous Subcutaneous subdermal vessels tissue plexus Reticular dermis Papillary dermis Figure 47.7 Schematic anatomy of the skin and its relationship to harvesting skin grafts (of varying thicknesses) and raising local /f_l aps.

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WHAT IS RECONSTRUCTIVE PLASTIC SURGERY

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Reconstructive plastic surgery is a surgical specialty that aims to restore form and function. The word plastic derives from the ancient Greek plassein – to mould or shape. Unlike all other specialties, plastic surgery is not bound by anatomical or functional region. Instead, it involves the use of a wide array of surgical techniques to reconstruct tissues that have been damaged by congenital loss, infection, trauma, cancer or even the process of ageing. Hence the reconstructive plastic surgeon often works in collaboration with other specialists wherever necessary , including head and neck surgeons, oral surgeons, orthopaedic surgeons, ophthalmologists, urologists, paediatric surgeons, gynaecologists, general surgeons and dermatolo gists. Modern plastic surgery techniques enable clinicians to perform complex surgical procedures that would not have been previously possible, such as major oncological head and neck resections or skeletal fixation of open limb fractures with significant soft-tissue defects. Since plastic surgery involves the restoration of form, it is necessarily closely related to aesthetic (or cosmetic) sur gery , which has gained much attention in the media in recent decades. Many of the surgical techniques, including lipo suction, fat grafting, scar management, tissue expansion and flap contouring, are shared between the two specialties ever, plastic surgery also aims to achieve restoration of func tion. An example would be the use of a free neurotised gracilis muscle transfer from the thigh to the face to restore a smile in facial palsy , or the use of a jejunal free flap to restore swal lowing following a pharyngolaryngectomy f or squamous cell carcinoma. Indeed, the microsurgical techniques developed to Sir Harold Delf Gillies , 1882–1960, the ‘father of plastic surgery’, became the first President of the British Association of Plastic Surgeons in 1946. Sushruta , c . 600 /uni00A0 /b.sc/c.sc/e.sc , Indian surgeon; his eponymous Samhitá (‘compendium’) was translated into English in 1907. Gaspare Tagliacozzi , 1545–1599, Professor of Surgery , University of Bologna, Bologna, Italy . Carl Herman Manchot , 1866–1932, was born in Switzerland and studied medicine at the University of Strasbourg, Strasbourg, France. enable tissue transplantation within the same individual and the replantation of severed body parts (i.e . autografts) have, together with the discovery of immunosuppressive agents, heralded the field of composite tissue allotransplantation in the latter half of the twentieth century – including face, hand and abdominal wall transplants (i.e. homografts).

To understand: The different types of skin grafts • The principles and use of /f_l aps • The concept of microsurgical reconstructive surgery •

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WOUND DRESSINGS

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These are a vital part of wound care and are used to optimise healing. The most suitable dressing is selected based on the type Jean-Nicolas Marjolin , 1780–1850, Professor of External Pathology , Hôtel-Dieu de Paris, Paris, France. moist environment to facilitate epidermal migration, enable hange between the wound and environment, provide gas ex c protection against bacterial infection and be non-adherent (to avoid trauma on removal). Furthermore, the dressing should be sterile, non-toxic, non-allergenic and readily available at minimal expense. One of the most traditional dressings in regular use is gauze ® (tulle) impregnated with petroleum jelly (e.g. Jelonet); it is ideal for clean wounds with minimal exudate. Semipermeable foam ® dressings (e.g. Allevyn) are suitable for moderately to highly exudating wounds such as leg ulcers. Hydrocolloid dressings ® (e.g. Duoderm) contain an inner colloidal layer with an impermeable outer layer and are ideal for moderately exudating ® wounds such as minor burns. Alginate dressings (e.g. Kaltostat) are derived from seaweed and contain calcium salts that facilitate haemostasis; they can be used on moderate to heavily exudating wounds such as split-thickness skin graft donor sites. ® Mepitel is a non-adherent dressing comprising a perforated silicone sheet that is designed for prolonged applications of up to 2 weeks; it is therefore popular in paediatric wounds. Some dressings contain antimicrobial agents such as ionic silver (e.g. ® ® Aquacel Ag) or povidone iodine (e.g. Inadine) that may have - additional functionality in contaminated wounds. Negative-pressure wound therapy (e.g. vacuum-assisted ® closure; V AC) uses intermittent or continuous topical nega - tive pressure (up to –125 /uni00A0 mmHg) through a sealed foam dress - ing in order to stimulate the formation of granulation tissue, reduce local oedema and tissue exudate and reduce bacterial load. The technique has numerous applications, including as a dressing to secure a skin graft to its recipient bed, temporary coverage of a complex acute wound (e.g. an open abdomen; Figure 47.6) until definitive cover can be achieved or to man - age chronic wounds such as pressure ulcers. - WOUND DRESSINGS

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There are various ways in which a wound can heal (see Chapter 3). Plastic surgeons can a ff ect the way in which wounds heal. Primary healing, or ‘healing by primary inten - tion’, occurs when the wound is closed soon after the injury by reapproximating the wound edges. This is typically achieved - with sutures, although glue, tape and staples can also be used. Incisions are designed so that they lie along the lines of r elaxed skin tension to reduce the appearance of the scar, particularly on the face and in areas of tension (Figure 47.4). Secondary healing, or ‘healing by secondary intention’, occurs w hen the wound is left to heal from its base. The wound is typically kept clean with sterile non-adherent dressings. Over the course of days and weeks, the wound contracts and skin cells migrate across the wound through a process called epithelialisation. Secondary healing is typically employed for wounds that have poor healing potential, such as leg and pressure ulcers, in which surgery risks exacerbating the wound-healing burden. Every reconstructive procedure depends on the poten- tial for wound healing. Furthermore, m uch of reconstructive plastic surgery involves the creation of wounds to heal other wounds – hence the aphorism ‘rob Peter to pay Paul’. There- fore, the plastic surgeon must consider how to maximise the chances of success and adopt their approach accordingly . Edward Ehlers , 1863–1937, Professor of Clinical Dermatology , Copenhagen, Denmark. Henri Alexandre Danlos , 1844–1912, dermatologist, Hôpital St Louis, Paris, France, gave his account of this condition in 1908. Hippocrates of Kos , c . 460–375 /uni00A0 /b.sc/c.sc/e.sc , was a physician in Ancient Greece and considered to be the ‘father of medicine’. For example, in genetic conditions such as Ehlers–Danlos syndrome and epidermolysis bullosa (for which there is cur - rently no cure), the surgeon is required to be less aggressive in their approach as surgical intervention risks creating addi - tional iatrogenic wounds that may fail to optimally heal, thus potentially worsening the patient’s situation (Hippocra tes: primum non nocere ; fi rst, do no harm). Systemic comorbidities including diabetes, peripheral vascular disease, renal failure, corticosteroid use and immunodefi ciency are signifi cant causes of delayed wound healing and must be addressed preopera - tively . For example, diabetic control may be optimised with the help of an endocrinologist, and preoperative angioplasty may augment blood fl ow in a chronically ischaemic lower limb. Nutrition is essential for w ound healing; vitamin and protein defi ciencies should be addressed preoperatively with the guid- ance of a dietician. Smoking is particularly detrimental as it causes vasoconstriction and decreases local oxygen delivery to tissues, thus impairing healing; patients are therefore advised to cease smoking at least 6 weeks prior to elective surgery if possible. Furthermore, it is crucial to optimise a wound bed to promote healing. For example, the wound may require formal debridement and washout to minimise bacterial colonisation and hence the risk of surgical site infection. Perioperative antibiotics may also be necessary .

Subdermal plexus Superficial adipose tissue Deep adipose tissue Deep fascia Muscle Figure 47.3 Diagram of skin anatomy with vascular plexus. Figure 47.4 Lines of relaxed skin tension. Fasciocutaneous Musculocutaneous perforator perforator

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