Wounds

Wounds and their management are fundamental to the practice of surgery. Any elective surgical intervention will result in a wound in order to gain access to and deal with the underlying pathology. In the surgery of trauma the wound is the primary pathology.

Wound Healing

In human regeneration is limited to epithelium and the liver; most tissues heal by repair resulting in scarring. Wound healing is the summation of a number of processes which follow injury including coagulation, inflammation, matrix synthesis and deposition, angiogenesis, fibroplasia, epithelialisation, contraction, remodeling and scar maturation. Where wound edges are opposed healing proceeds rapidly to closure; this is known as healing by first intention or primary healing. Where the wound edges are apart, such as when there has been tissue loss, the same biological processes occur, but rapid closure is not possible. Angiogenesis and fibroblast proliferation result in the formation of granulation tissue. This contracts to reduce wound area and allows epithelialisation across its surface to achieve wound closure. This is known as healing by second intention. This process is slower, the contraction involved may cause contracture and functional restriction, and the resultant healed surface is a thin layer of epithelium on scar tissue that may not prove durable in the long term. In general, healing by second intention will give a worse aesthetic outcome.

Classification of wound

The most useful classification of wounds from a practical point of view is that of Rank and Wakefield into: tidy and untidy wounds.

Tidy wounds are caused by sharp instruments and contain no devitalized tissue; such wounds can be closed primarily with the expectation of quiet primary healing. Examples are surgical incisions, cuts from glass and knife wounds. Skin wounds will usually be single and clean cut. Tendons, arteries and nerves will commonly be injured in tidy wounds, but repair of these structures is usually possible. Fractures are uncommon in tidy wounds. Most tidy wounds that do not involve loss of tissue can be closed directly.

Untidy wounds result from crushing, tearing, avulsion, vascular injury or burns, and contain devitalized tissue. Skin wounds will often be multiple and irregular. Tendons, arteries and nerves may be exposed, and might be injured in continuity, but will usually not be divided. Fractures are common and may be multifragmentary. Such wounds must not be closed primarily; if they are closed wound healing is unlikely to occur without complications.
At best there may be wound dehiscence, infection and delayed healing, at worst gas gangrene and death may result.
The correct management of untidy wounds is wound excision, by this is meant excision of all devitalized tissue to create a tidy wound. Once the untidy wound has been converted to a tidy wound by the process of wound excision it can be safely closed or allowed to heal by second intention.

**Wound excision**
This process is sometimes called ‘wound toilet’ or ‘debridement’. The former implies washing and the latter laying open or fasciotomy, all of which may be important in wound management but do not describe excision of devitalized tissue which is the most important process. For this reason the term ‘wound excision’ is preferred.

**Types of wound**

**Bruise, contusion and haematoma**
A closed blunt injury may result in a bruise or contusion. There is bleeding into the tissues and visible discoloration. Where the amount of bleeding is sufficient to create a localized collection in the tissues, this is described as a haematoma. Initially this will be fluid, but it will clot within minutes or hours. Later, after a few days, the haematoma will again liquefy. There is a danger of secondary infection. A haematoma should be evacuated by open surgery if large or causing pressure effects (such as intracranial), or aspirated by a large-bore needle if smaller or in a cosmetically sensitive site. Bruises require no specific management, and no treatment is of proven value.

**Puncture wound** is an open injury in which foreign material and organisms are likely to be carried deeply into the underlying tissues. Common causes are standing on a nail or other sharp object. Radiological examination may detect metal fragments or glass. Treatment is essentially by wound irrigation, antibiotic treatment and tetanus prophylaxis. Large foreign bodies should be removed, but small particles may be difficult to find without a destructive dissection and are better left undisturbed. The danger of puncture injuries is that they may give rise to an abscess deep within the tissues and on such occasions drainage may be required. It is likely that it will take 24—48 hours for an abscess to declare itself and arrangement should be made for review.

**Bites** are a particular type of puncture wound associated with a high incidence of infection, presumably from mouth organisms. Such wounds are best treated by open surgical exploration excision of skin margins, irrigation and antibiotic therapy.

**Abrasions and friction burns**
An abrasion is a shearing injury of skin in which the surface is rubbed off. Most are superficial and will heal by epithelialisation, but some may result in full-thickness skin loss. Abrasions may be dirt ingrained and if this dirt is not removed at the time of primary treatment permanent tattooing of the skin will result. Treatment is by cleaning with a scrubbing brush, gently brushing along the grain of the scratch lines.

**Laceration**
A laceration or cut is the result of contact with a sharp object (the surgical equivalent is an incised wound).
Once the cutting implement has gone deep to the dermis, there is less resistance in the subcutaneous tissues and the cut may therefore penetrate to a considerable depth.
The ideal form of management of an incised wound is surgical inspection, cleaning and closure.

**Avulsion injuries** are open injuries where there has been a severe degree of tissue damage. Such injuries occur when hands or limbs are trapped in moving machinery, such as in rollers, producing a degloving injury.
Degloving is caused by shearing forces that separate tissue planes, rupturing their vascular interconnections and causing tissue ischemia.
This most frequently occurs between the subcutaneous fat and deep fascia.
The danger of degloving or avulsion injuries is that there is devascularization of tissue and skin necrosis may become slowly apparent in the following few days.
Treatment of such injuries is to identify the area of devitalized skin and to remove the skin, defat it and reapply it as a full-thickness skin graft.

**Crush injuries** are a further variant of blunt injury and are often accompanied by degloving and compartment syndrome.
Injury to tissues within a closed fascial compartment leads to bleeding, exudates and swelling of these tissues, and increased interstitial pressure.
As the interstitial pressure rises above capillary perfusion pressure the blood supply to the viable tissues is reduced, resulting in further ischemic tissue injury and swelling.
This cycle causes a worsening compartment syndrome with muscle ischemia and nerve ischemia progressing to muscle necrosis, skin necrosis and limb loss.
Muscle necrosis may result in renal failure.
This process can be arrested by early recognition and decompression of the affected compartment(s) by fasciotomy. The most reliable clinical sign of compartment syndrome is pain worsened by passive stretching of affected muscles.
Where any doubt exists compartment pressure measurements can be carried out.
Loss of peripheral pulses is not a sign of compartment syndrome, but indicates major vessel damage. Where compartment syndrome is suspected or confirmed fasciotomy is advised. Longitudinal incisions are made in the deep fascia and it may also be necessary to make extensive longitudinal releases in the skin. It is important to release the fascia over each individual compartment in a limb.
War wounds and gunshot injuries
Gunshot injuries are associated with different severity of tissue damage depending upon whether the injury is of low or high velocity. Low-velocity injuries, such as from a hand gun, result in an entry and exit wound, the latter being the larger, and damage along the tract of the missile. Such injuries are often associated with severe tissue contamination from clothing, dirt or other foreign materials. High-velocity injuries (from modern assault rifles) cause explosive pressure and decompression effect, such that there is widespread tissue damage, with injury to major vessels, nerves and other structures situated some distance from the tract of the missile.

Injuries to bone and joints
Fractures may be closed where the skin is intact or open where there is a wound. Open fractures may have a skin wound due to penetration from the outside or, more frequently, due to bursting of the skin from within by bone fragments. The usual principles of wound management apply in that an adequate excision of the wound is necessary followed by antibiotic treatment and appropriate treatment of the fracture.

Injury to nerves
Glass does not bruise nerves. Where there is an open wound, nerve division must always be suspected. Clinical examination should be undertaken to assess the motor and sensory function of every nerve in the region of the open wound, and it must be assumed that an underlying nerve has been divided until its function can be demonstrated to be intact. Where there is doubt the nerve should be explored and visualized. Divided nerves should be repaired.

Injuries to arteries and veins
Where a wound is associated with much bleeding there is the possibility that a significantly large vessel has been divided. As a first aid measure, bleeding will almost always be controlled by direct pressure, and elevation of the part where practicable. Limb tourniquets should not be applied as a first aid measure. In the emergency department it is never desirable to plunge vascular clamps or artery forceps into a wound without a proper view of the bleeding point, as grasping nerves can inflict great harm. Where a major limb vessel has been damaged it may be necessary to apply direct manual pressure while the patient is taken into an operating room. Under anaesthesia, the appropriate way to deal with bleeding in the limb is to explore the wound under pneumatic tourniquet control.