

Principles of Wound Healing

DR.ALI AL BAZZAZ

PLASTIC SURGON

wounds

■ Definition;-

■ Wound is a tear in normal tissue continuity resulting in a variety of biological sequelae.

■ Causes of wounds are many

■ e.g. trauma, whether accidental or surgical, also physical & chemical agents & thermal as burn.

Effect of wounds

■ Wounding has a variety of effects on tissues;-

■ 1- Mechanical separation of functional structures such as blood vessels resulting in bleeding, deformities occurs due to tissue tension result in gaping of skin wounds, creation of dead space in which blood is collected.

■ 2- biological; this commences immediately as in the resulting inflammatory response from the wounding process itself, these effects influenced by platelets in a thrombus & by macrophages in tissue & circulation.

■ 3- secondary effects;-occur at later stages due to infection because once wounds take place it will

expose deeper tissues to the danger of bacterial infection & this danger will persist until the healing process restore an intact surface.

■ TYPES OF WOUNDS:

■ **Tidy wounds**

these are clean wounds caused by injury with sharp objects such as knives & stabs, these are usually singles heals by primary closure. Nerves ,blood vessels & tendons are commonly involved by this type of injuries but fractures are uncommon.

■ Untidy wounds :

These are unhealthy wounds, caused by crush ,tearing, burn injuries & avulsions. These wounds are usually containing devitalized dead tissue , if treated by primary closure ,infection will be inevitable . They are usually multiple, fracture are common ,these wounds should be converted into tidy wounds then closed by secondary closure

Types of Wounds

■ **Acute;-**

- A/ **Closed wound** ;result from blunt trauma as falls, sport injuries or assaults & this include;

- -**Bruises & contusions**; these are discoloration due to extravasations of blood.
- -**Hematomas**; due to collection of larger amount of blood in the soft tissue.

■ **B/ Open wounds;-**

- - puncture wounds(nails & needles)
- - abrasions & friction , burns.
- - lacerations result of contact with sharp objects include incised wounds & household injuries.

• **C/Complex wounds;-**

- - Crush & avulsions
- - Injury of internal organs.
- - War wounds & gunshot injuries.
- - Wounds with tissue loss.

• **Chronic:**

- - **ulcers**: can be defined as a break in the epithelial continuity.
- A prolonged inflammatory phase leads to overgrowth of granulation tissue, and attempts to heal by scarring leave a fibrotic margin. Necrotic tissue often at the ulcer centre is called slough.

-

Pressure sores):

these are areas of tissue necrosis caused by prolonged immobilization in bed in patients with paraplegia & impaired sensation

Aetiology of leg ulcers

- Venous disease leading to local venous hypertension (e.g. varicose veins)
- Arterial disease, either large vessel (atherosclerosis) or small vessel (diabetes)
- Arteritis associated with autoimmune disease (rheumatoid arthritis, lupus, etc.)
- Trauma – could be self-inflicted
- Chronic infection – tuberculosis/syphilis
- Neoplastic – squamous or basal cell carcinoma, sarcoma

■ Clinical features of Wounds

- -- bleeding, external or internal bleeding.
- -- pain & swelling.

- -- loss of function; due to injury itself or due to associated injury of nerves.
- -- inflammation, which adds erythema to many of the above features.
- -- systemic effects, particularly wound may interfere with vital functions such as chest& head injury, also shock due to bleeding.

MANAGING THE ACUTE WOUND

1. The surgeon must remember to examine the whole patient according to acute trauma life support (ATLS) principles.
2. The wound itself should be examined, taking into consideration the site and the possible structures damaged).
3. It is essential to assess movement and sensation
4. A bleeding wound should be elevated and a pressure pad applied. Clamps should not be put on vessels blindly as nerve damage is likely and vascular anastomosis is rendered impossible.
5. In order to facilitate examination, adequate analgesia and/or anaesthesia (local, regional or general) are required. General anaesthesia is often needed in children.
6. In limb injuries, particularly those of the hand, a

tourniquet should be used.

After assessment, a thorough debridement is essential.

7. brush or even excision under magnification. A wound should be explored and debrided to the limit of blood staining. Devitalised tissue must be excised until bleeding occurs with the obvious exception of nerves, vessels and tendons. These may survive

In a tidy wound, repair of all damaged structures may be attempted. A fascicular repair of nerves under magnification (loupes or microscope) using 8/0 or 10/0 monofilament nylon is usual. Vessels such as the radial or ulnar artery may be repaired using similar techniques.

9. Repair of structures

- Replacement of lost tissues where indicated
- Skin cover if required
- Skin closure without tension
- All of the above with careful tissue handling and meticulous technique

Wound Healing

Definition:-

- It is a spontaneous process initiated by injury to replace destroyed tissues by living one , the whole process will stopped when healing process of the wound is complete

Factors influencing healing of a wound

- Site of the wound
 - ■ Structures involved
 - ■ Mechanism of wounding
 - Incision
 - Crush
 - Crush avulsion
 - ■ Contamination (foreign bodies/bacteria)a
 - ■ Loss of tissue
 - ■ Other local factors
 - Vascular insufficiency (arterial or venous)
 - Previous radiation
 - Pressure
 - ■ Systemic factors
 - Malnutrition or vitamin and mineral deficiencies

- **Disease (e.g. diabetes mellitus)**
- **Medications (e.g. steroids)**
- Immune deficiencies [e.g. chemotherapy, acquired
- immunodeficiency syndrome (AIDS)]
- Smoking
- a. In explosions, the contamination may consist of tissue such as bone

in human being w. healing has 2 aspects;-

A/ wound contraction ;- which is a mechanical reduction in size of the defect occurring in first few days.

B/ replacement of lost tissues;- this is done by migration & division of cells to provide extra tissue to fill the gap & this include;-

Heamostatic phase

Characterized by redness, heat, pain and swelling

- Last approximately 4 to 5 days
- Initiates the healing process by stabilizing the wound through platelet activity that stops bleeding & triggers the immune response

Inflammatory phase

Within 24 hours of the initial injury, lasts 2-3 day
neutrophils, monocytes and macrophages are on the scene
to control bacterial growth and remove dead tissue

- Characteristic red color and warmth is caused by the capillary blood system increasing circulation & laying foundation for epithelial growth

Proliferation phase

- Begins from the third day of the initial injury and may continue for up to 21 days
- It is characterized by three events:
 - Epithelialization
 - Granulation
 - Collagen synthesis

Granulation: Formation of new capillaries that generate and feed new tissue

Granulation tissue is the beefy red tissue that bleeds easily

Epithelialization

- Formation of an epithelial layer that seals and protects the wound from bacteria and fluid loss
- It is essential to have a moist environment to fasten growth of this layer

- It is a very fragile layer that can be easily destroyed with aggressive wound irrigation or cleansing of the involved area

Collagen Synthesis

- Creates a support matrix for the new tissue that provides it with its' strength
- Oxygen, iron, vitamin C, zinc, magnesium & protein are vital for collagen synthesis
- This stage is the actual rebuilding and is influenced by the overall patient condition of the wound bed

Remodelling phase

- Final stage of wound healing
- Begins around day 21 and may continue for up to 2 years
- Collagen synthesis continues with eventual closure of the wound and increase in tensile strength
- Tensile strength reaches only about 80% of pre-injury strength
- Type 1 collagen replacing type 3 until a ratio 4:1 achieved
-
-

A classification of wound closure and healing

■ ■ By primary intention

Wound edges opposed. Normal healing. Minimal scar

■ ■ By secondary intention

Wound left open. Heals by granulation, contraction and epithelialisation

Increased inflammation and proliferation

Poor scar

■ ■ By tertiary intention (also called delayed primary intention)

Wound initially left open

Edges later opposed when healing conditions favourable

ABNORMAL HEALING

Delayed healing may result in loss of function

or poor cosmetic outcome. The aim of treatment is to achieve healing by primary intention and so reduce the inflammatory and proliferative responses .

Hypertrophic scars and keloids

- Excessive healing processes- increase in net collagen synthesis raised thickened scar

- Keloid- Extension beyond wound margin, familial, may develop up to 1 year, rarely subside
- Hypertrophic scar- Confined to wound margin, light skinned, early after injury, may subside, cause contractures
- Tx- excision, steroid injection, pressure garments, radiation tx

■ **Compartment syndromes**

- Compartment syndromes typically occur in closed lower limb injuries.

They are characterized by

1. severe pain,
2. pain on passive movement of the affected compartment muscles,
3. distal sensory disturbance and,
4. finally, by the absence of pulses distally (a late sign). They can occur in an open injury if the wound does not extend into the affected compartment.

Compartment pressures can be measured using a pressure monitor and a catheter placed in the muscle compartment. If pressures are constantly greater

than 30 mmHg or if the above clinical signs are present, then fasciotomy should be performed.

Fasciotomy

Involves incising the deep muscle fascia and is best carried out via longitudinal incisions of skin, fat and fascia . The muscle will be then seen bulging out through the fasciotomy opening. The lower limb can be decompressed via two incisions, each being lateral to the subcutaneous border of the tibia. This gives access to the two posterior compartments and to the peroneal and anterior compartments of the leg. In crush injuries that present several days after the event,

Pressure sores

These can be defined as tissue necrosis with ulceration due to prolonged pressure. occur in approximately 5% of all hospitalised patients (range of 3%to 12% in published literature). There is a higher incidence in paraplegic patients, in the elderly and in the severely ill patients.

Pressure sore frequency in descending order

- Ischium
- Greater trochanter
- Sacrum
- Heel
- Malleolus (lateral then medial)
- Occiput

MANAGEMENT

- Eliminate or minimize intrinsic and extrinsic factors of pressure ulcer development
- Provide nutritional support and monitor nutritional status
- Create and maintain a clean, moist wound environment with adequate circulation and oxygenation
- Wound excision
- Reconstruction by big flap preferably myocutaneous flaps