

By the Name of ALLAH the Most Gracious the Most Merciful



Wounds, Tissue Repair and Scars Part II

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To be read in

Bailey & Love's Short Practice of Surgery 28th Edition.

Wounds, healing and tissue repair Ch 3.

Wound Complications

- Surgical Site Infection.
- Necrotising Fasciitis (Soft-Tissue Infections)
- Wound Dehiscence.
- Compartment syndrome.
- Chronic Wound.
- Scar and Contracture.

Postoperative wound Infection (Surgical Site Infection)

- Early and late.
- Management
 - Open the wound.
 - Wound swab for culture and sensitivity.
 - Broad spectrum antibiotics till the result of the wound swab.
 - Wound Toilet/Debridement/Excision.
 - Daily dressing .
 - Healing by (Tertiary or Secondary Intention).



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Necrotising Fasciitis

- This is a severe, rapidly progressing infection of the soft tissue and fascia associated with significant morbidity and mortality .
- The infection is commonly polymicrobial but monomicrobial presentation with *Streptococcus pyogenes* (group A streptococcus) is also frequent. Examples of other organisms include *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas*, *Clostridium* and *Bacteroides*.

- There is usually a history of trauma or surgery with wound contamination. Diabetes mellitus is the most common comorbidity, although up to 30% of patients may not have any comorbidities.
- Clinical features are shown in (next page). A scoring system to aid clinical decision making has been developed, but its performance remains questionable.
- It remains primarily a clinical diagnosis and surgical treatment should not be delayed if suspicion is high.
- Treatment consists of broad spectrum intravenous antibiotics till the results of (Culture & Sensitivity). with urgent radical surgical debridement (Wide wound excision
- A second look operation is usually planned in 24–48 hours depending on clinical response. Multiple debridements may be required.
- Vacuum assisted closure.

Signs and Symptoms of Necrotising Fasciitis

● ● Local

- Unusual pain
- Erythema, oedema, warm
- Crepitus
- Blisters, bullae
- Greyish drainage ('dishwater pus')
- Fixed staining
- Necrosis, gangrene

Systemic

- Fever, tachycardia, tachypnoea
- Shock
- Coagulopathy
- Multiorgan failure



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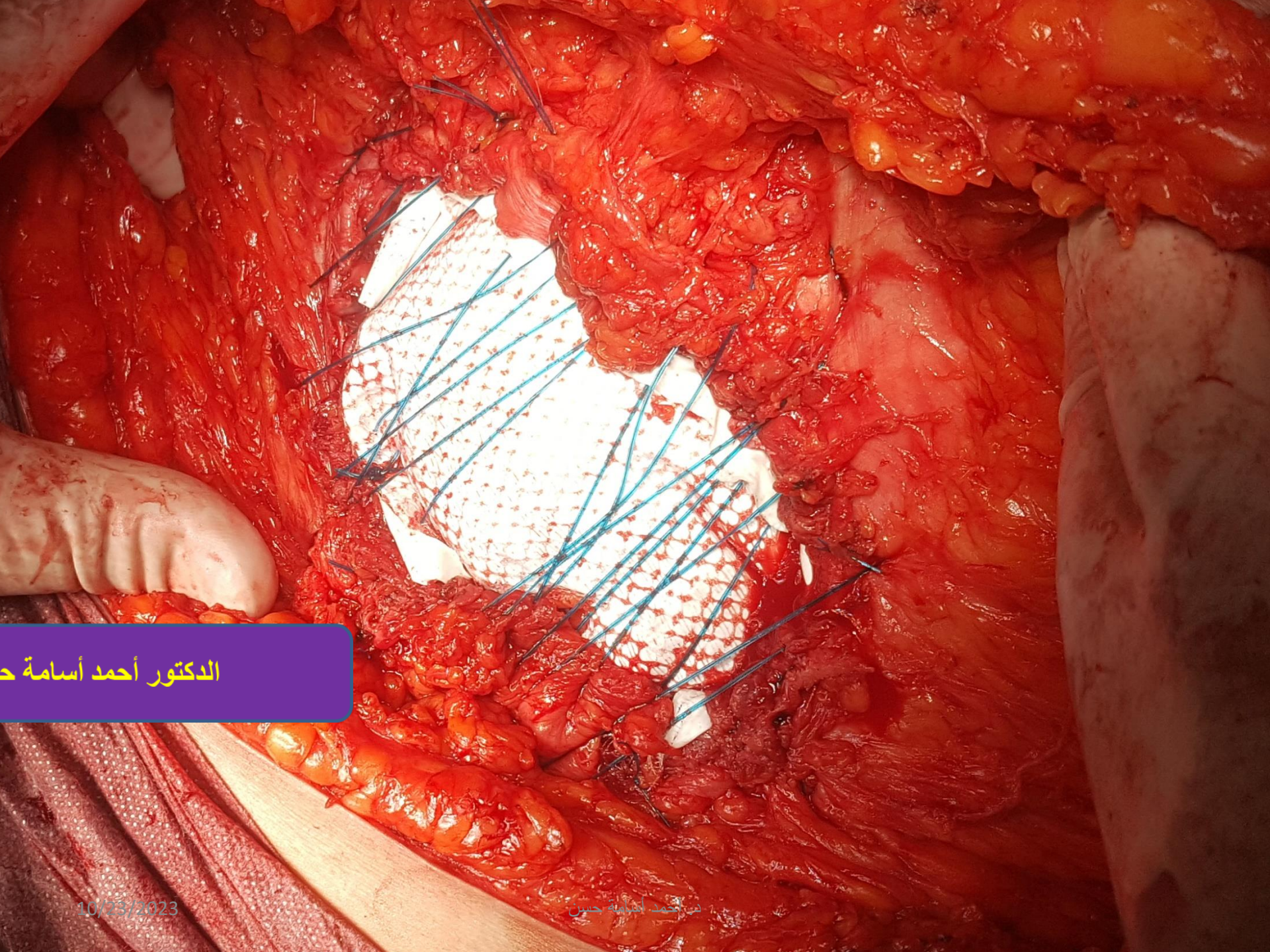
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Fournier's gangrene

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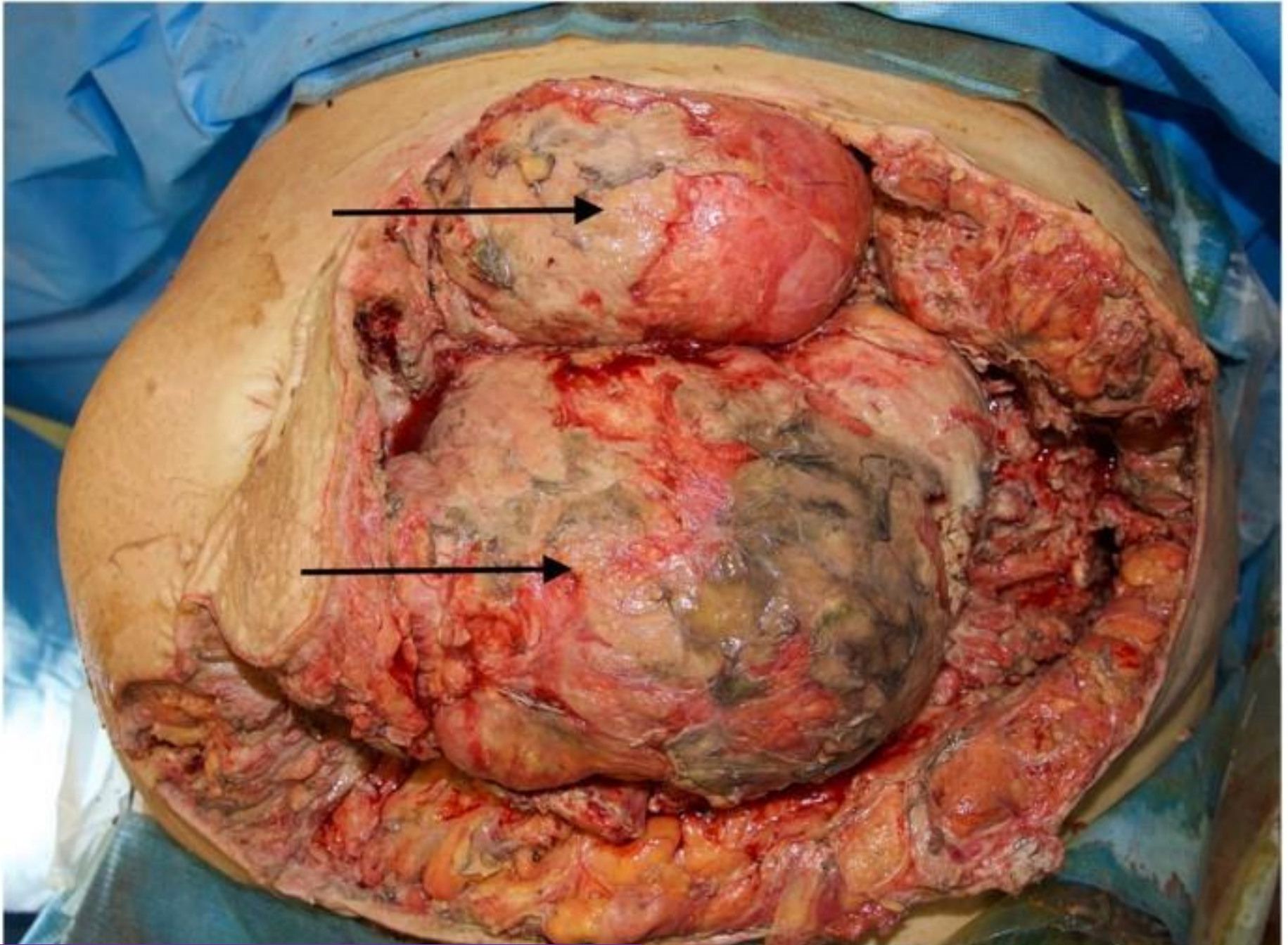
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Meleney's Synergic Gangrene

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Meleney's Synergic Gangrene

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Wound Dehiscence

- Separation of the incision line prior to complete healing, resulting in an open wound.
- Partial (incisional hernia).
- Complete : Need for (Vacuum Assisted Closure (V.A.C.) (Negative Pressure Wound Therapy)



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Partial Wound Dehiscence with intact skin (Incisional Hernia)



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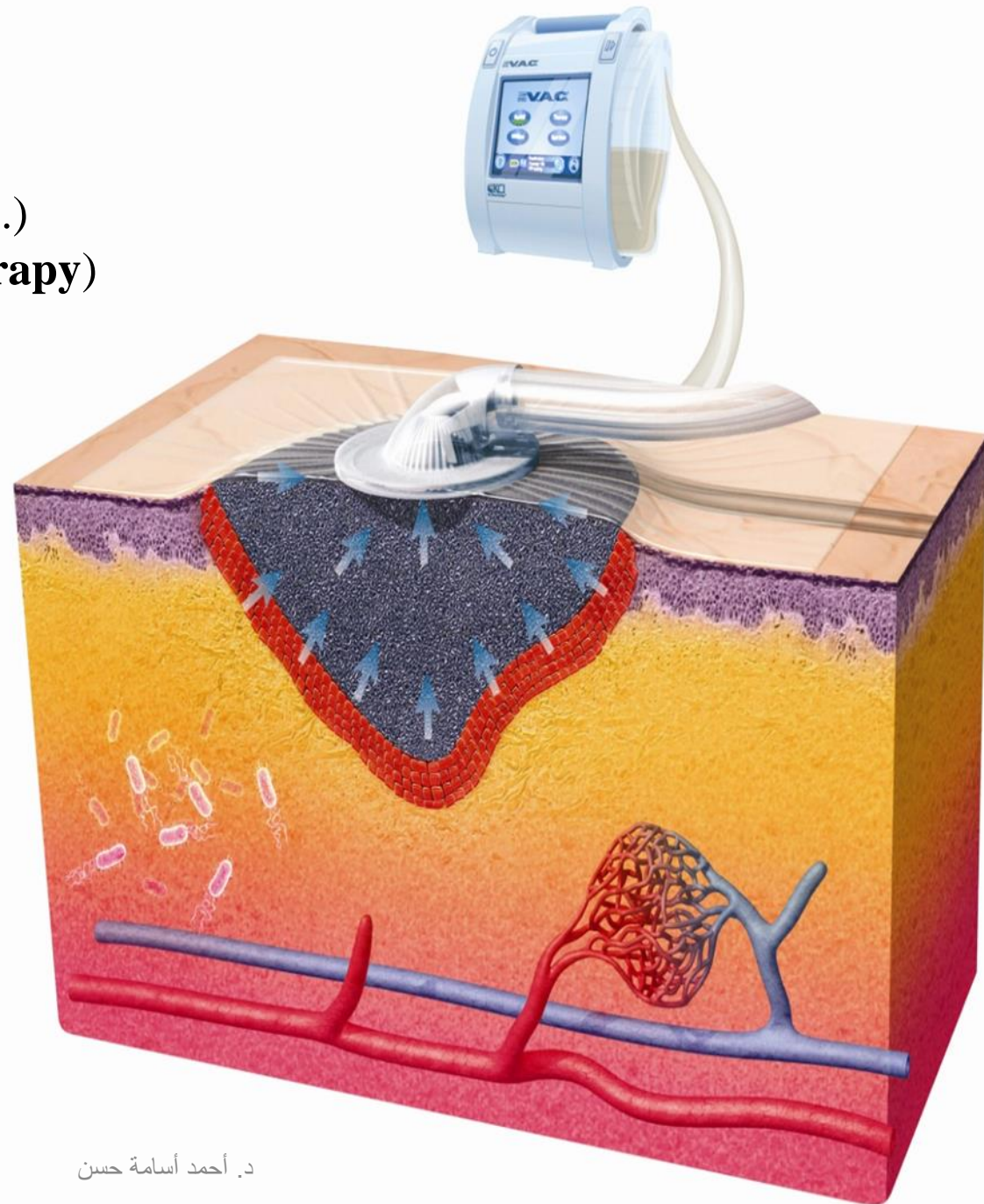
Complete Wound Dehiscence



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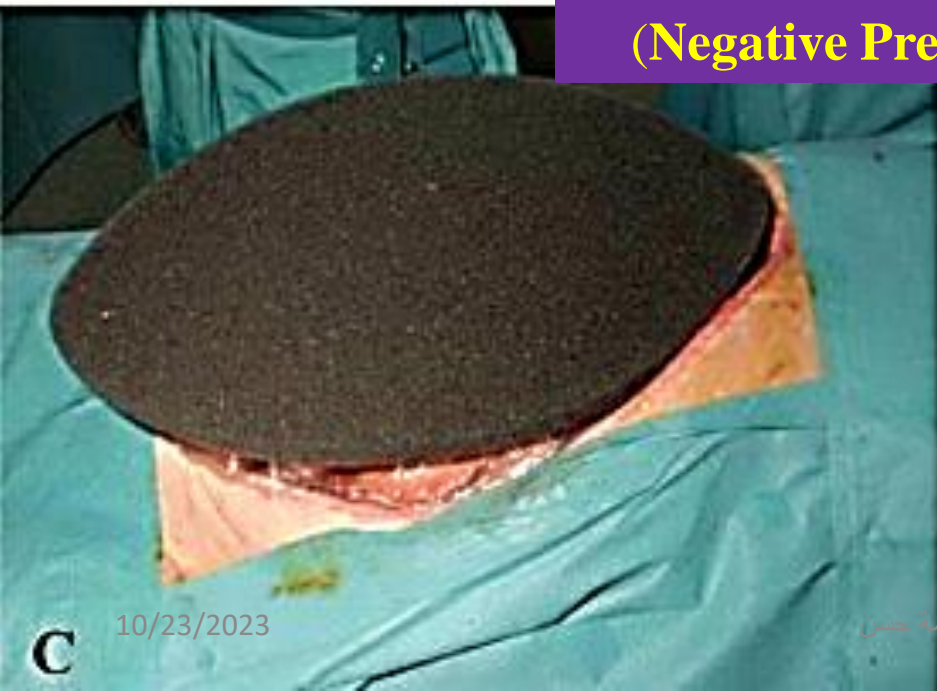
Complete Wound Dehiscence with through and through Technique

Vacuum Assisted Closure (V.A.C.) (Negative Pressure Wound Therapy)





Vacuum Assisted Closure (V.A.C.)
(Negative Pressure Wound Therapy)



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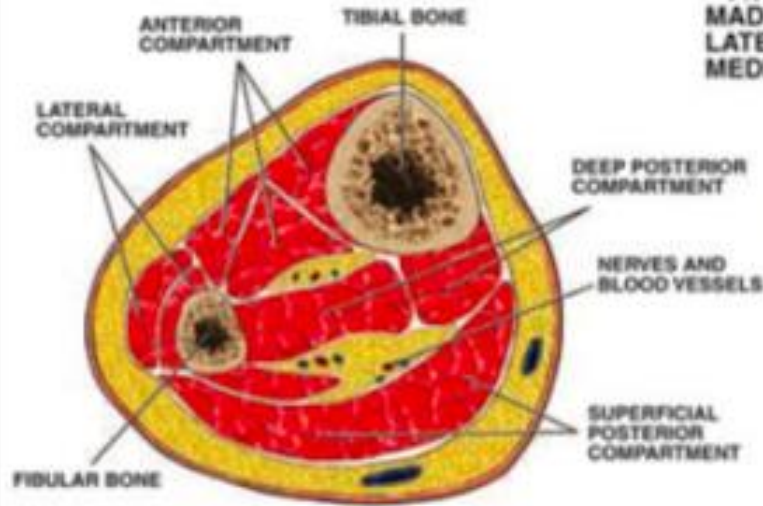
Acute Compartment Syndrome

- It occurs when there is increased interstitial pressure within a closed osteofascial compartment, which results in microvascular compromise.
- It is a surgical emergency as delayed treatment may lead to irreversible muscle ischaemia and significant long-term morbidity.
- It most commonly occurs after lower limb fractures, both open and closed. It also occurs in the upper limb, buttock and abdomen. Other causes include soft-tissue trauma, arterial injuries, burns and prolonged compression.
- It is characterised by **pain** out of proportion to the injury, particularly with passive movement of the affected compartment muscles. **Paraesthesia** is another early sign. Absent pulses are uncommon and suggest the possibility of vascular injury.

- It is generally a clinical diagnosis. It can be difficult to diagnose in the presence of impaired consciousness, in children and in patients with regional nerve blocks. Monitoring intracompartment pressures (ICPs) can sometimes help to guide management. A pressure of ≤ 30 mmHg between the diastolic pressure and ICP has been recommended as the threshold for fasciotomy.
- Fasciotomy involves incising the skin and deep fascia with long axial incisions. If the compartment pressure was high, the muscle will then be seen bulging out through the fasciotomy opening. The lower limb is reliably decompressed via two incisions. A medial longitudinal incision 1–2 cm posterior to the medial border of the tibia decompresses the superficial and deep posterior compartments. A lateral longitudinal incision 2 cm lateral to the anterior tibial border decompresses the peroneal and anterior compartments.
- Late diagnosis of compartment syndrome is a management dilemma as a late fasciotomy may result in rhabdomyolysis, infection, need for amputation and even death.

Compartment syndrome with fasciotomy

TWO LONG INCISIONS ARE MADE IN THE LOWER LEG, ONE LATERAL TO THE TIBIA AND ONE MEDIAL.



CROSS-SECTION THROUGH NORMAL CALF SHOWING MUSCLE COMPARTMENTS



COMPARTMENT SYNDROME: SWELLING OF MUSCLES CAUSING COMPRESSION OF NERVES AND BLOOD VESSELS



Anterior View



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CHRONIC WOUNDS

Leg Ulcer
Bed Sore

- These wounds fail to progress through the normal stages of wound healing in a timely manner. They are often characterised by a prolonged inflammatory phase and persistent infections.
- The management of chronic wounds therefore often involves debridement , control of infection and inflammation and appropriately selected dressings to correct moisture imbalances.
- Chronic wounds can be categorised into vascular ulcers (venous or arterial), diabetic ulcers and pressure ulcers.

Leg ulcers

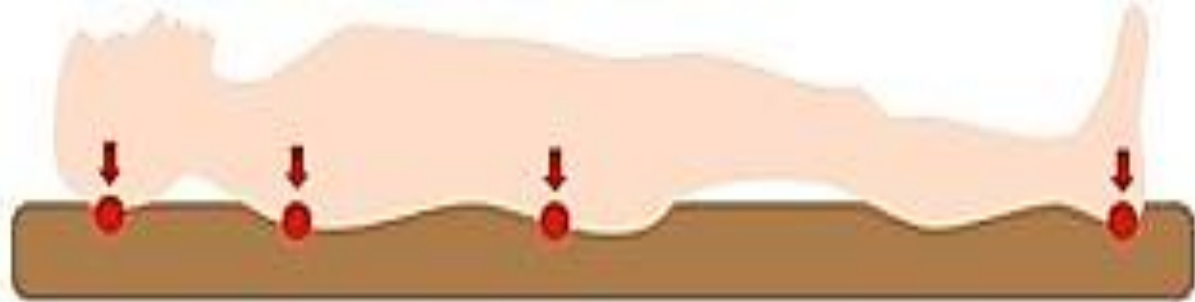
- In developed countries, the most common chronic wounds are leg ulcers. An ulcer can be defined as a break in the epithelial continuity. A prolonged inflammatory phase leads to overgrowth of granulation tissue and attempts to heal by scarring leave a fibrotic margin. Necrotic tissue, often at the ulcer centre, is called slough.
- A chronic ulcer that is unresponsive to dressings and simple treatments should be biopsied to rule out neoplastic change, a squamous cell carcinoma known as a Marjolin's ulcer being the most common.
- Effective treatment of any leg ulcer depends on treating the underlying cause, and diagnosis is therefore vital. Arterial and venous circulation should be assessed, as should sensation throughout the lower limb. Surgical treatment is only indicated if non-operative treatment has failed.

Aetiology of leg ulcers

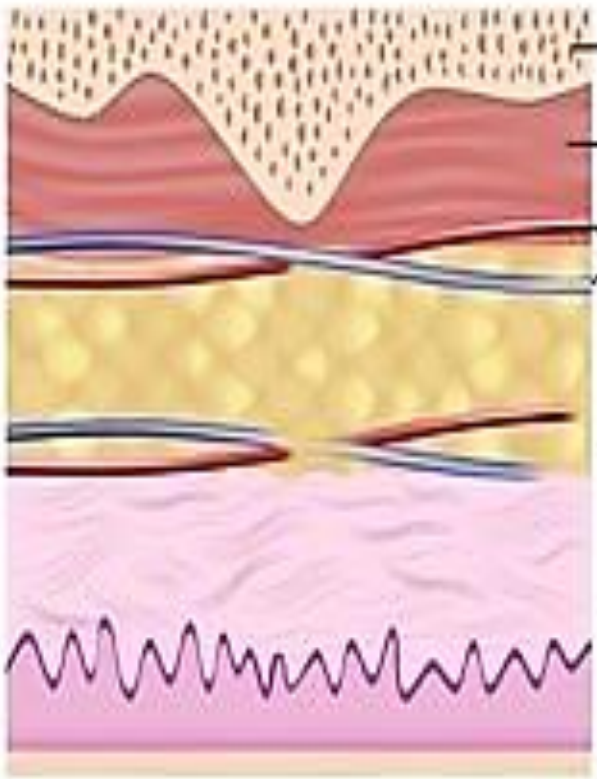
- Vascular (venous, arterial, mixed)
- Trauma (bites, self-inflicted, burns)
- Infection (bacterial, fungal, mycobacterial, syphilis)
- Metabolic disorders (diabetes mellitus, gout, calciphylaxis)
- Autoimmune disorders (vasculitis, systemic sclerosis, rheumatoid arthritis)
- Neoplastic (squamous cell carcinoma, basal cell carcinoma)

Pressure ulcer (Bed sores / decubitus ulcers)

- It occurs over a bony prominence or under a medical or other device, due to prolonged pressure exceeds the capillary occlusive pressure (over 30 mmHg) causing (tissue necrosis with ulceration) .
- The US National Pressure Injury Advisory Panel has replaced the term 'pressure ulcer' with '**pressure injury**' in its staging system to provide a more accurate description of injuries to both intact and ulcerated skin.
- It is regarded as preventable.
- There is a higher incidence in(who are severely ill, those who have impaired mobility or those with a significant loss of sensation.



Pressure of bone against hard surface

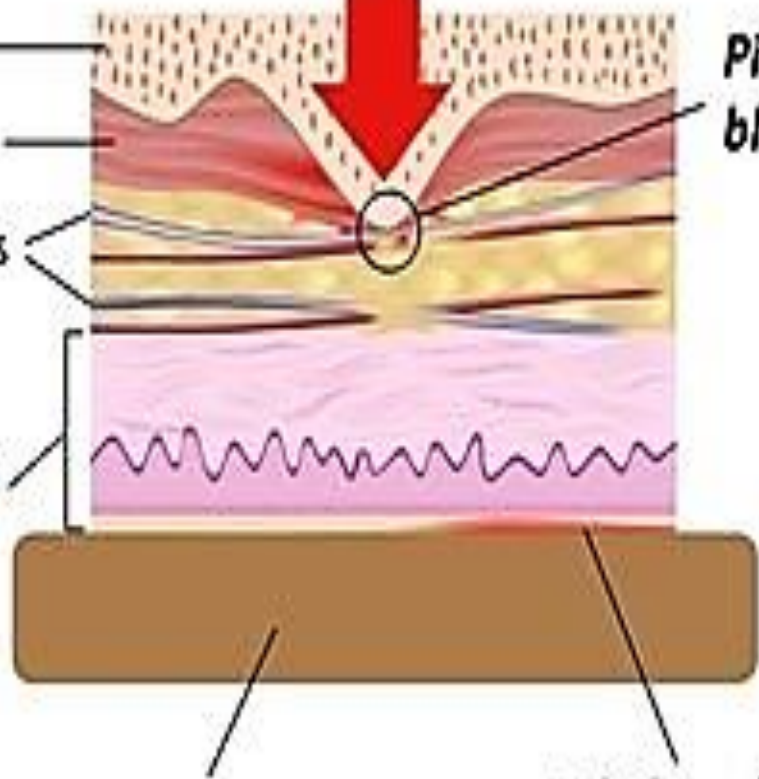


Bone

Soft tissue

Blood vessels

Skin layers



Pinching off of blood vessels

Hard surface (bed)

Friction of skin against the surface

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Normal

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Pressure sore frequency in descending order

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

US National Pressure Injury Advisory Panel staging of pressure injuries

Stage	Description
1	Non-blanchable erythema of intact skin
2	Partial-thickness skin loss with exposed dermis
3	Full-thickness skin loss
4	Full-thickness skin and tissue loss
Unstageable full thickness pressure injury	Obscured full-thickness skin and tissue loss
Deep tissue pressure injury	Persistent non-blanchable, deep red, maroon or purple discoloration

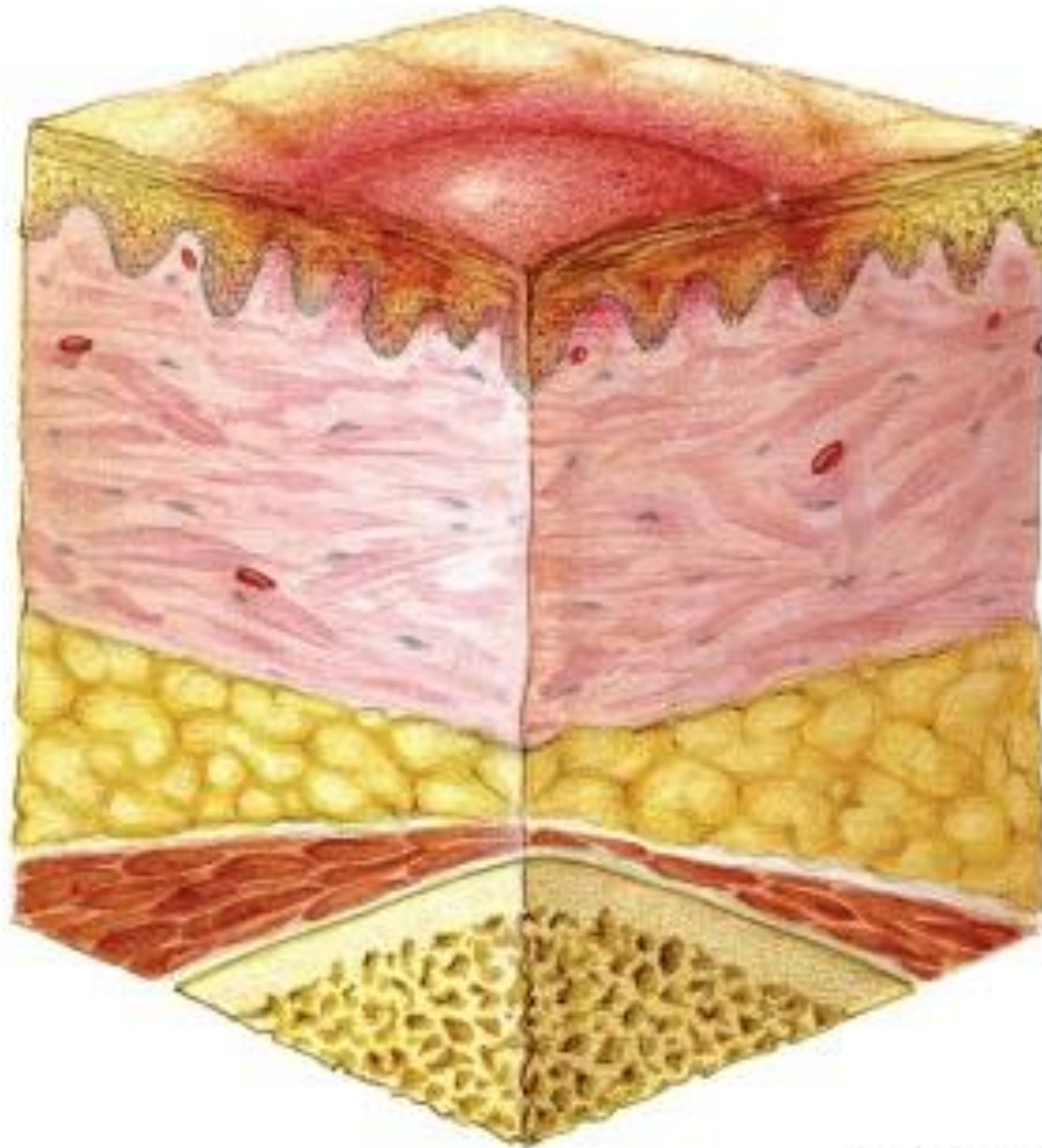
Prevention

- **Risk assessment** using a validated score to support clinical judgement such as the Braden scale, Waterlow score or Norton risk assessment scale.
- **Patients at risk** of developing pressure injuries should have :
 - a skin assessment, regular repositioning every 2–4 hours and the use of pressure distributing devices as appropriate.
 - Patients should receive education on self-care and risk factors need to be addressed, such as providing nutritional support for any deficiencies.

Treatment

- Patient optimisation (nutrition and ongoing poorly managed medical problems to address any risk factors).
- Preventative measures are used and debridement may be appropriate.
- Dressings should be chosen to create an optimum wound-healing environment and appropriate antibiotics given if there are signs of infection.
- Surgery is not first-line treatment and is only considered when the above measures have been fully implemented.
- Patients must also be well motivated and able to fully comply with postoperative preventative measures.

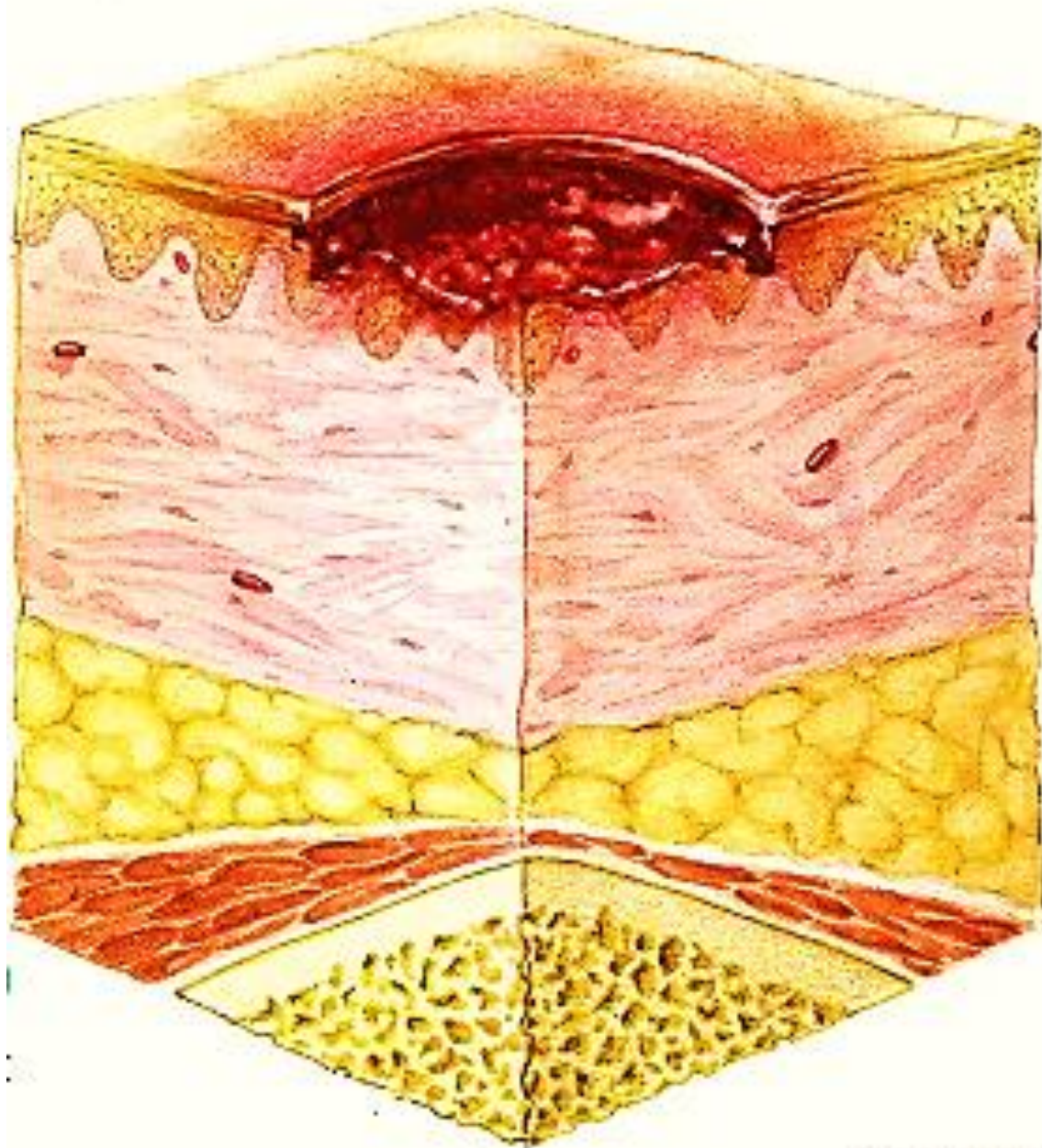
- Surgical management follows the same principles described for wound management.
- Primary closure and skin grafting should be avoided as they are likely to fail.
- In suitable patients, successful reconstruction options include the use of large fasciocutaneous or musculocutaneous flaps. If possible, use a flap that can be advanced further if there is recurrence and that does not interfere with the planning of neighbouring flaps that may be used in the future.





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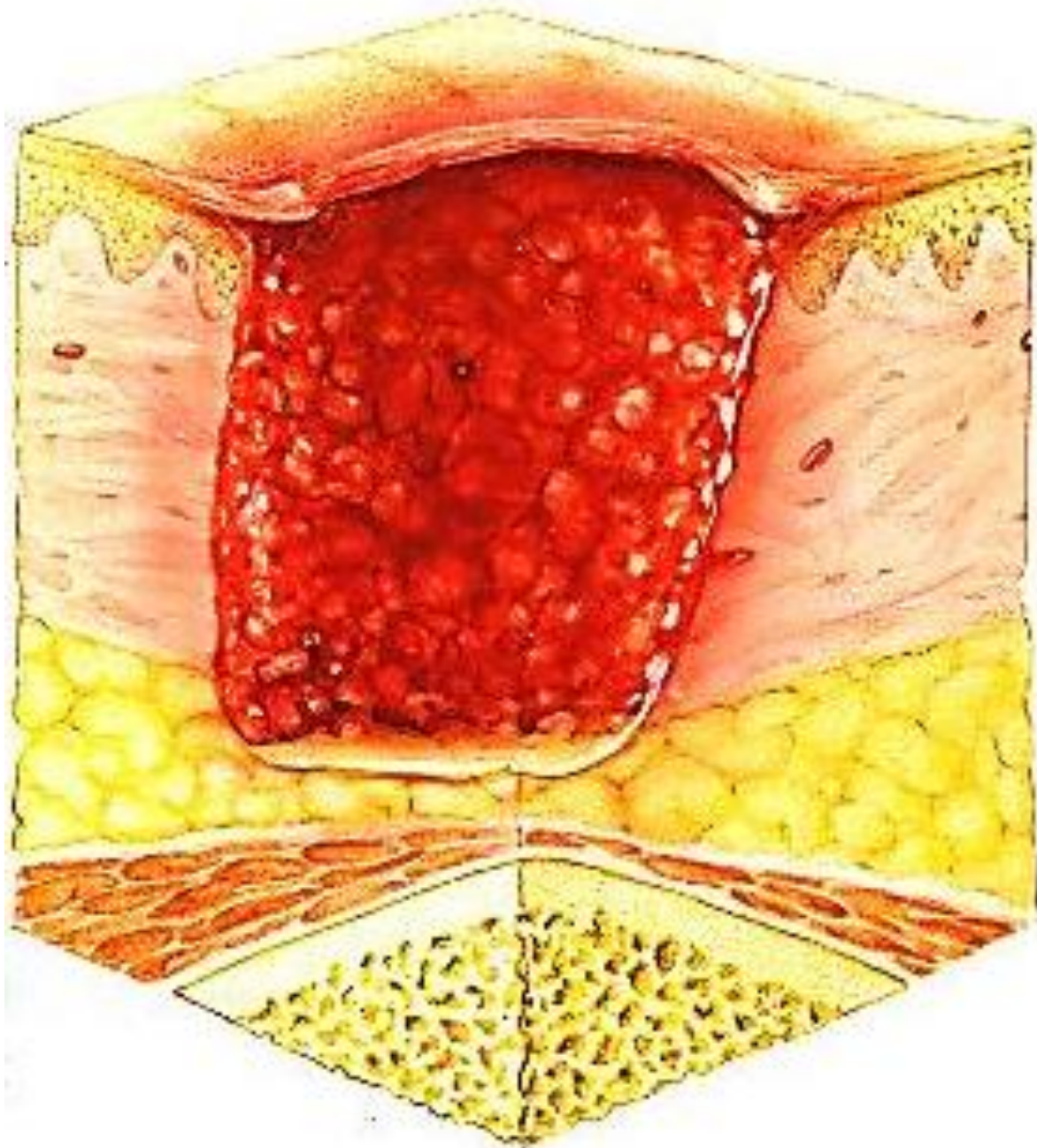


STAGE 2



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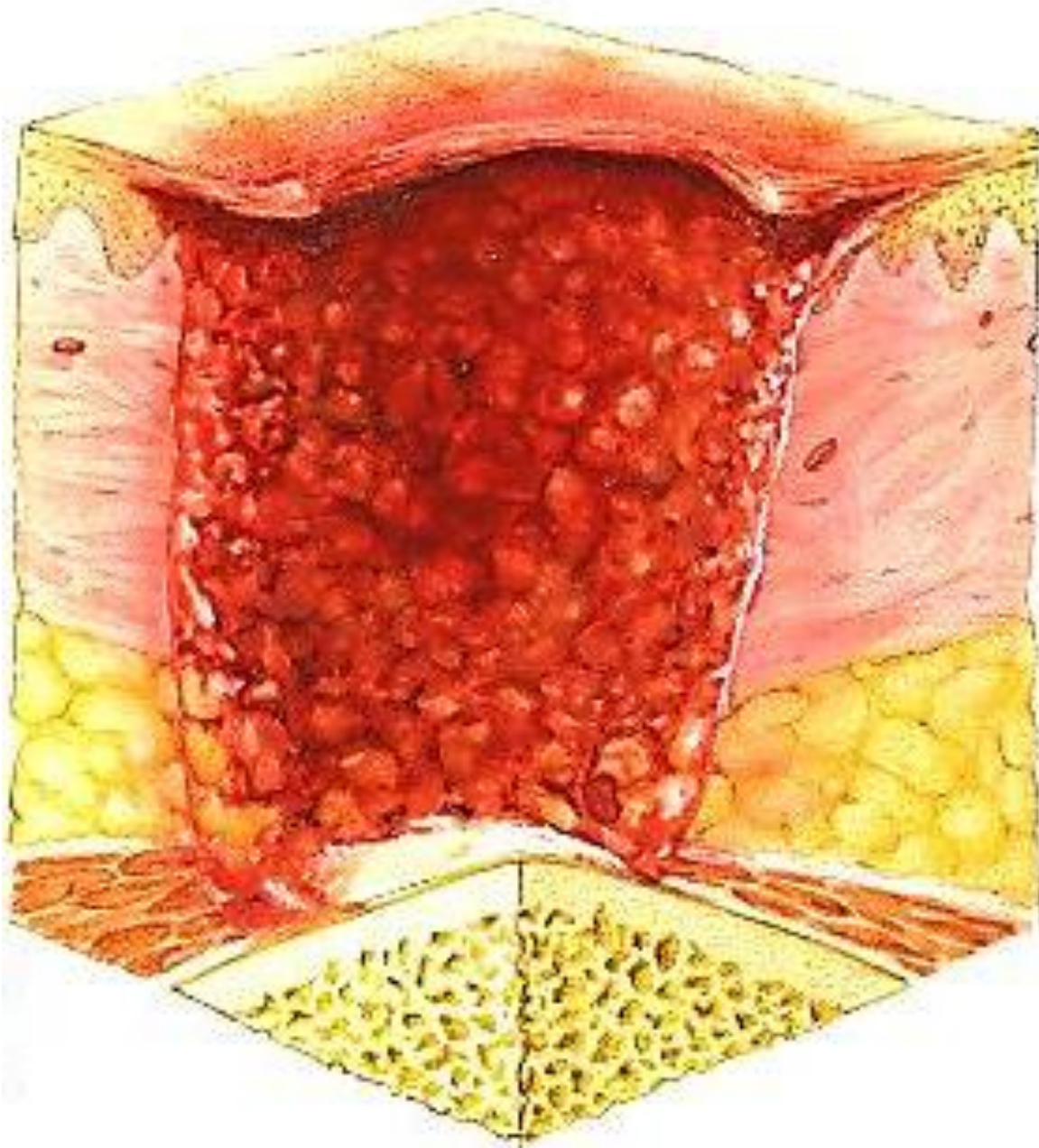
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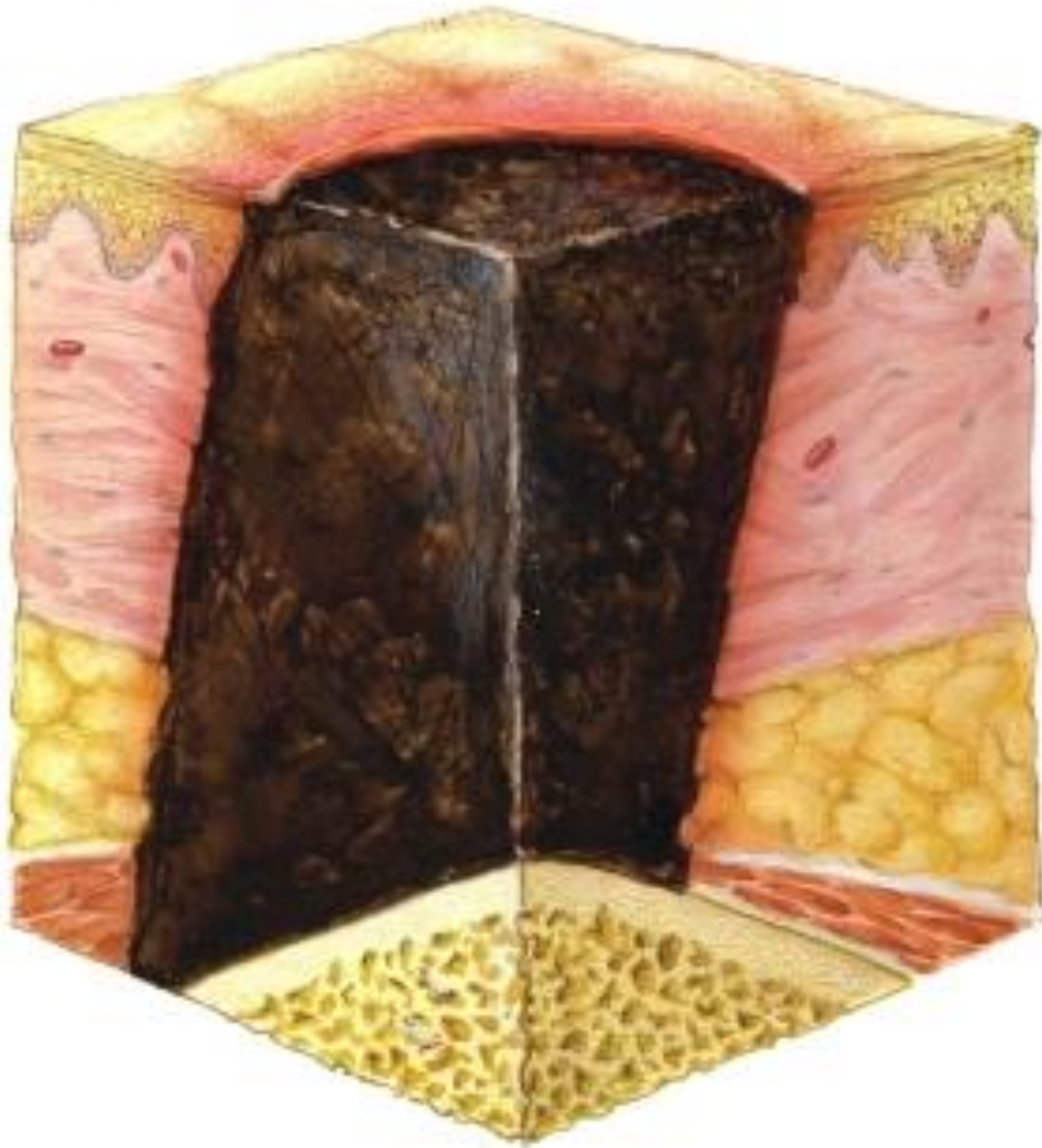
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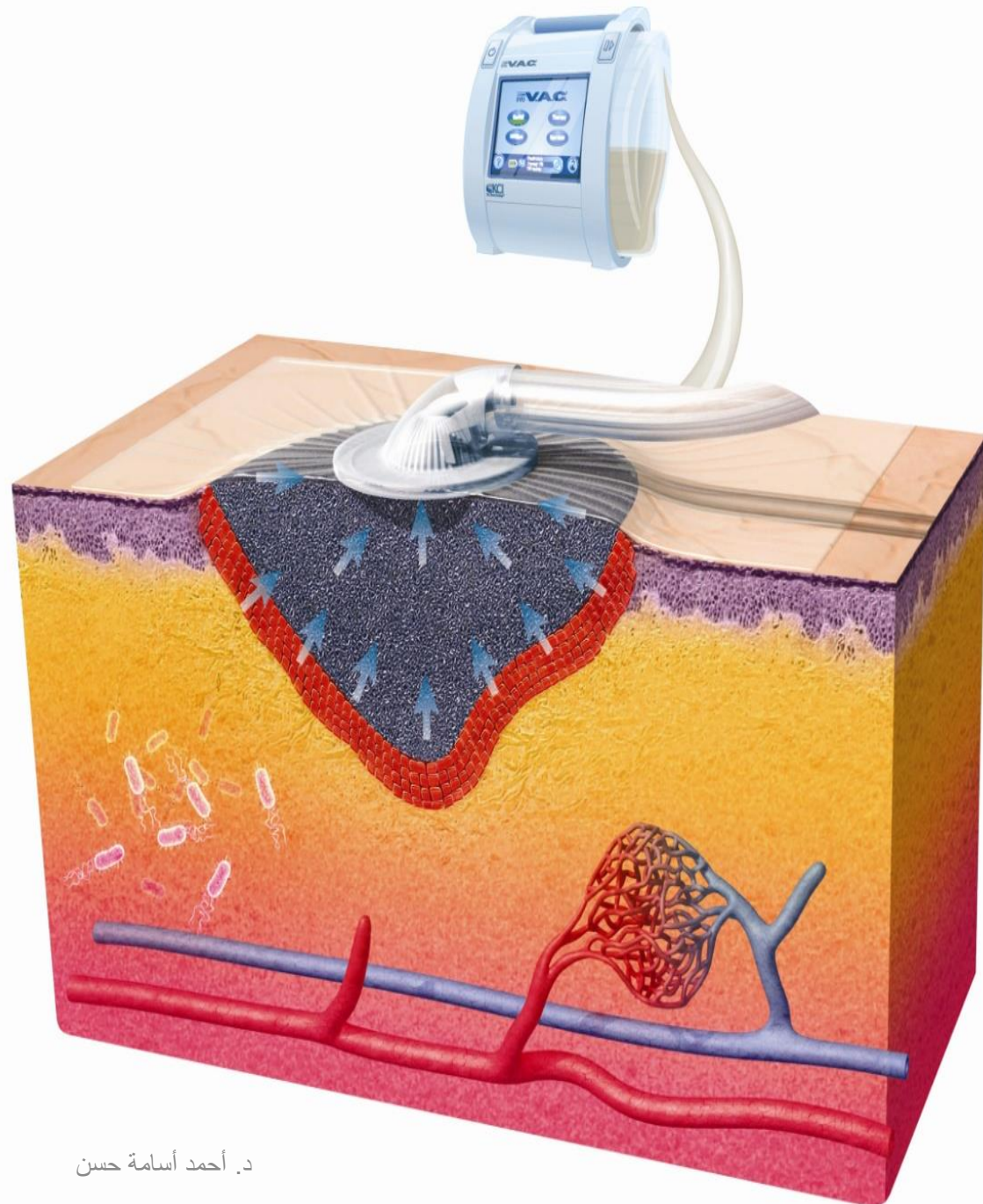


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Treatment of Bed Sore

- ❖ Swab for culture and sensitivity.
- ❖ Surgical debridement.
- ❖ Antibiotics (Broad spectrum).
- ❖ Continuous rolling the patient to each side every 2-4 hrs .
- ❖ ﴿وَنُقَلِّبُهُمْ ذَاتَ الْيَمِينِ وَذَاتَ الشِّمَالِ﴾ [الكهف: ١٨] (and We turned them on their right and on their left sides).
- ❖ Daily changing dressing and keeping the ulcer moist.
- ❖ Pneumatic Bed Sore Prevention.
- ❖ Topical tissue growth factor.
- ❖ Vacuum Assisted Closure (V.A.C.) (Negative Pressure Wound Therapy) Baily & Love 26th edition (P 29, 406, 584).
- ❖ Hyperbaric Oxygen Therapy.
- ❖ Rotational Flap.
- ❖ Urinary or faecal diversion in selected cases.
- ❖ Treatment underlying cause.



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Hyperbaric Oxygen Therapy For Bed Sores

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Rotational Flap

Wound Complications

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- **Scar and Contracture.**

SCARS

- Skin (Atrophic, Hypertrophic and Keloids) .
- Intestinal Obstruction (Adhesions) .
- Liver (Cirrhosis) .
- Common bile duct injury (Stricture) .
- Injury to ureter (Stenosis) .

SCARS (Skin)

- **Atrophic.**
- **Hypertrophic.**
- **Keloid.**

ABNORMAL WOUND HEALING

- A scar is the body's natural way of healing and replacing lost or damaged skin.
- Failure to heal in a timely and orderly manner, resulting in chronic non-healing wounds, significant morbidity and poor cosmeses. aberrations of normal wound healing such as prolonged inflammation can result in excessive scar tissue, for example hypertrophic and keloid scars.
- These abnormal scars contain excess collagen, which is arranged in a disorganised pattern in keloid scars as opposed to a parallel pattern in hypertrophic scars.

Atrophic scar

- An atrophic scar is pale, flat and stretched in appearance, often appearing on the back and in areas of tension. It is easily traumatised as the epidermis and dermis are thinned.
- Excision and re-suturing may only rarely improve such a scar.

Hypertrophic scar

- A hypertrophic scar is defined as excessive scar tissue that does not extend beyond the boundary of the original incision or wound. It results from a prolonged inflammatory phase of wound healing and from unfavourable scar siting (i.e. across the lines of skin tension). In the face, these are known as the lines of facial expression.
- It does not extend beyond the boundary of the original incision or wound and eventually regress. It is more common in areas of increased tension, wounds crossing tension lines, deep dermal burns and wounds left to heal by secondary intention (longer than 3 weeks).

keloid scar

- A keloid scar is defined as excessive scar tissue that extends beyond the boundaries of the original incision or wound.
- Its aetiology is unknown, but genetic predisposition is implicated (an inherited tendency) and it is associated with elevated levels of growth factor, deeply pigmented skin, and certain areas of the body (e.g. a triangle whose points are the xiphisternum and each shoulder tip).
- It does not spontaneously regress and are difficult to treat. The aetiology is unknown.
- They often occur as a result of relatively minor trauma and mainly in those with darker skin pigmentation.

- The histology of both hypertrophic and keloid scars shows excess collagen with hypervascularity, but this is more marked in keloids where there is more type III collagen.
- Hypertrophic scars improve spontaneously with time, whereas keloid scars do not.



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SCAR MANAGEMENT

Principles

- The remodelling and maturation phase of wound healing results in scar formation.
- The immature scar is at first pink, hard, raised and often itchy. As the collagen matures, the scar becomes almost acellular as the fibroblasts and blood vessels reduce. The external appearance of the scar becomes paler, while the scar becomes softer, flattens and its itchiness diminishes. Most of these changes occur over the first 3 months but a scar will continue to mature over 1–2 years, and sometimes more.
- Tensile strength will continue to increase but would not be expected to exceed around 80% that of normal skin.
- There is well-established evidence for managing scars with pressure /compression therapy, silicone sheets and gels, intralesional corticosteroid injection and surgery. Other treatment modalities include massage therapy, psychological counselling, laser therapy, radiotherapy, cryosurgery and intralesional injection of other products.

- Prevention is better than treatment, so it is important to correctly manage wounds .
- Optimal surgical management starts with careful planning, tissue handling and meticulous technique, i.e. (placing incisions along relaxed skin tension lesions (Langer's lines / Langer lines of skin tension / cleavage lines,) and avoiding straight-line incisions across flexion creases.
- Early debridement reduces the risk of infection and allows for earlier wound closure.
- It is important to recognise normal anatomical landmarks to avoid misaligned scars, such as at the lip vermilion border where even a 1-mm discrepancy is noticeable at a distance.

- Skin closure should be without tension and allow for postoperative oedema typically associated with injury and healing.
- Wounds should be sutured in layers unless they are very small.
- Deep dermal absorbable sutures hold the skin edges together to allow subsequent subcuticular or skin sutures. Large and deep wounds also require closure of the fascial layer, for example Scarpa's fascia in the abdomen. Subcuticular suturing avoids skin suture marks.
- If skin sutures are used, suture marks may be minimised by using monofilament sutures that are removed in a timely fashion depending on anatomical location. For example, sutures are typically removed by 5 days in the face versus 10–14 days in the lower limb.

- Following wound closure, scar prevention measures include :
- Tension relief, taping, hydration and ultraviolet protection.
- Silicone sheeting or gel as the first-line prophylactic and treatment option for hypertrophic and keloid scars.
- Later scar treatment includes intralesional corticosteroid injections, typically using triamcinolone acetonide 10–40 mg/mL every 4–6 weeks until the scar has flattened.
- Revisional scar surgery, for correcting alignment of scars.

Immature hypertrophic
(red, slightly raised)

Linear hypertrophic
(red/raised, itchy)

Initial Management

Apply prevention algorithm
(i.e. silicone gel or sheeting,
hypoallergenic paper tape
or onion extract cream)

Silicone gel or sheeting
(2 months)

Intralesional
corticosteroid injection^b
(repeat monthly)

Secondary Management

If persists for >1 month, treat
as a linear hypertrophic scar

PDL^a or fractional
laser therapy

Pressure therapy

Severe scars

a
PDL^a or fractional
laser therapy

Surgical excision +
postoperative silicone
gel or sheeting

Surgical excision + corticosteroids
5-FU + corticosteroids
or alternative therapies^c
c

Widespread burn
hypertrophic (red/raised)

Initial Management

Admission to a specialty
burn unit^d

Silicone gel or sheeting,
pressure garments and/or
onion extract cream

Secondary Management

Fractional laser therapy

Combination or alternative
therapies^e

Management algorithm for hypertrophic scars

- a Preferred initial option.
- b 2.5–20 mg/mL (face); 20–40 mg/mL (body).
- c Alternative therapy options for severe lesions include bleomycin, mitomycin C, laser therapy and cryotherapy.
- d Scar prevention and treatment should not begin before epithelium and wound stabilisation.
- e Combination and alternative therapies include massage, physical therapy, corticosteroids, tension-relieving surgical intervention, excision, grafting or oap coverage, hydrocolloid dressings, antihistamines and laser therapy.
- 5-FU, 5-Flouorouracil; PDL, pulsed-dye laser

Minor keloid
(red/raised)

Major, high-risk keloid
(dark/raised)

Initial Management

Cryotherapy

Silicone gel/sheeting +
intralesional corticosteroids^a

Intralesional corticosteroids^a

5-FU + intralesional
corticosteroids

Secondary Management

Fractional^b or pulsed-dye laser therapy

Secondary Management

Ablative fractional lasers are the preferred initial laser therapy option for patients with minor keloids. Fractional[®] or pulsed-dye laser therapy

Patient counselling regarding recurrence rate and expectations

Surgical excision with adjuvant

- Silicone gel or sheeting or intralesional corticosteroids or both
- Radiotherapy
- Alternative therapies (bleomycin, mitomycin C, imiquimod)

Treatment of hypertrophic and keloid scars

- Pressure – local moulds or elasticated garments
- Silicone gel sheeting (mechanism unknown)
- Intralesional steroid injection (triamcinolone)
- Excision and steroid injections^a
- Excision and postoperative radiation (external beam or brachytherapy)^a
- Intralesional excision (keloids only)
- Laser – to reduce redness (which may resolve in any event)
- Vitamin E or palm oil massage (unproven)

^aAll excisions are associated with high rates of recurrence.

AVOIDABLE SCARRING

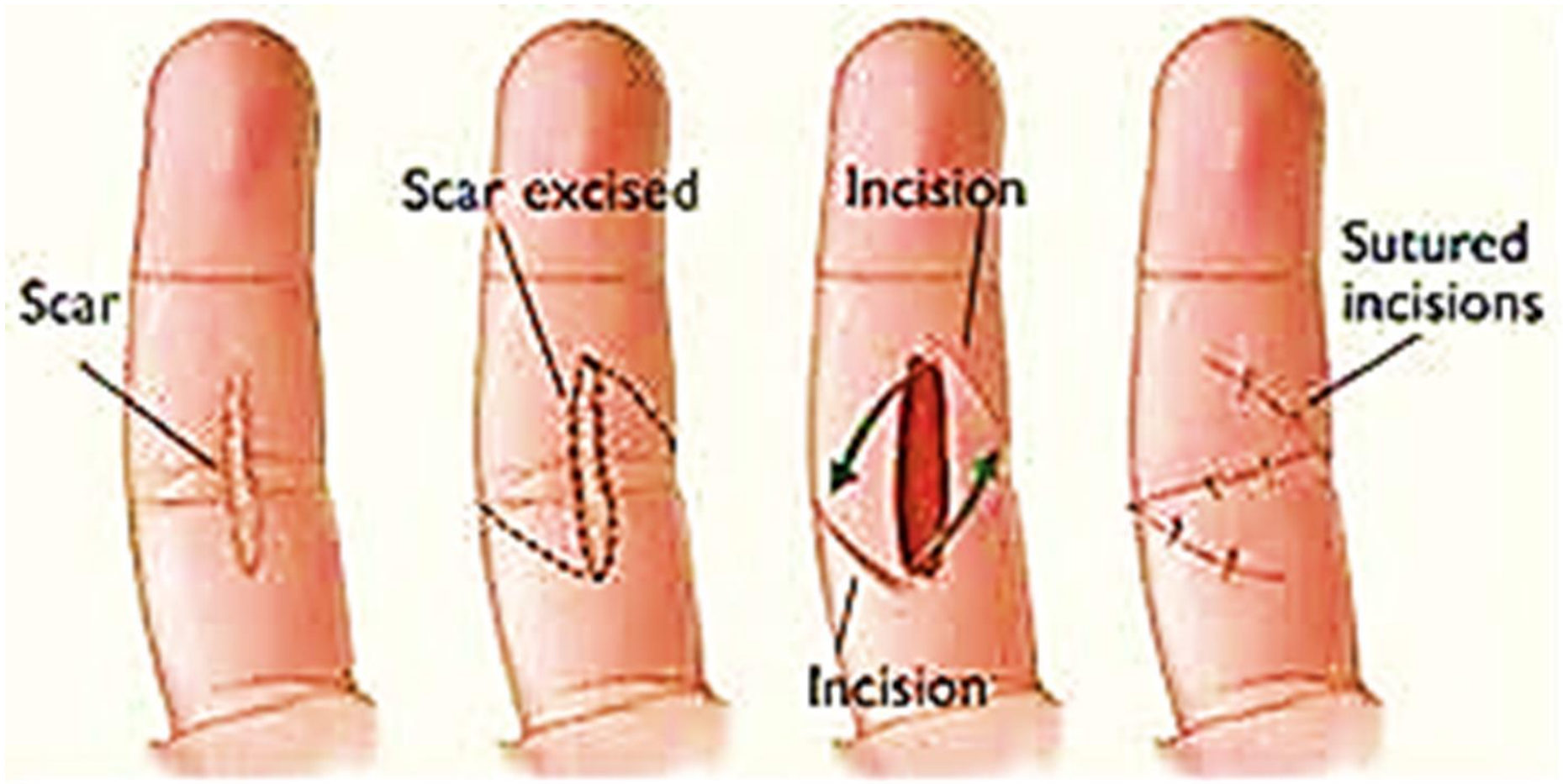
- Circumferential wound can be excised initially. Late treatment consists of scar excision and correct alignment of deeper structures or, as in the
- An excision of the scar margins and repair using W or Z plasty techniques.
- Suture marks may be minimised by using monofilament
- sutures that are removed early (3–5 days).
- Sutures inserted under tension will leave marks.
- Wounds can be strengthened post suture removal by the use of sticky strips.
- Fine sutures (6/0 or smaller) placed close to the wound margins tend to leave less scarring.
- Subcuticular suturing avoids suture marks either side of the wound or incision.
- Local therapy.

Contracture (A tight web)

- The scar formation pulls the edges of the skin together, causing a tight area of skin. The decrease in the size of the skin can then affect the muscles, joints, and tendons, causing a decrease in movement.
- Shortening , stiffness and tightness.
- Trauma and burn.
- Severe functional, psychological and aesthetic problems
- If across joints may restrict full passive range of movement, leading to hyperextension or hyperflexion deformity, impairment and disability.
- Differential growth pattern between scar and surrounding tissues.

- Surgical contracture release and reconstruction can be an effective treatment option.
- A key principle is the replacement of scar tissue with healthy tissue.
- A wide range of reconstructions typically involve skin grafts or skin flap .
- **Local flaps** such as Z- plasty. and its variants can be used to lengthen and transpose the scar, others including Y–V, V–Y and W-plasty.
- **Free flaps** may be required for resurfacing severe contractures.
- **In general**, flaps are preferable to skin grafts because of graft contracture. When skin grafts are used, full thickness is preferred to split thickness as they have a better texture and contract less during healing.

Z-plasty





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**Post-traumatic
(chainsaw) midline
neck contracture**

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بِحَمْدِ اللَّهِ
جَمَلًا

PRAISE BE TO ALLAH