Evaluation, Repair and Treatment of Wounds

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Composition of skin

- Skin consists of four layers
  - Epidermis
  - Dermis
  - Superficial fascia (SQ layer)
  - Deep fascia
Anatomy of the Skin

- **Epidermis**
  - The outermost layer of the skin
  - Made of squamous epithelial cells
  - Protects against entrance of bacteria and exit of water and chemicals
  - The keratanized layer gives the skin its cosmetic appearance

- **Dermis**
  - Lies just below the epidermis
  - Much thicker layer and consists of connective tissue
  - Cells involved in wound healing reside here
  - Provides the anchoring for percutaneous and deep sutures
Anatomy of the Skin – cont’d

- **Superficial Fascia (SQ or SC)**
  - Loose connective tissue that encloses fat
  - Provides insulation
  - Local anesthetic is directed along the plane between dermis and superficial fascia

- **Deep Fascia**
  - Thick fibrous layer
  - Acts as the enclosure for the muscle groups
  - Laceration of the fascia requires separate closure to provide protective function
Wounds

Assessment:
- History of present condition
- Type of injury
- Blunt vs. penetrating
- Extent of contamination
- Location of injury
- Time since injury
- Mechanism of injury
- Care and treatment after injury
  - Prior to arrival
  - Occurred at work or home
- Past medical history
- If hand injury
  - Which hand is dominant
- Immunizations – tetanus
- Allergies
- Medications
- Alcohol / other drug ingestion
Wound Assessment and Documentation

- Length of wound
- Anatomic location
- Depth of wound
- Foreign body
- Function of area and region distal
- Neuromuscular and vascular assessment of the area around and distal to the wound
  - Do prior to anesthesia
- Jewelry
Stages of Healing

- Hemostasis
  - Trauma to the skin causes wound edges to retract and tissue to contract
  - Leads to compression of small veins and arterioles
  - Vasoconstriction of vessels
  - Platelets aggregate on the exposed skin surfaces
Microscopic stages of healing

- Inflammatory phase
  - Initiated by the injury
  - Leakage of histamine, enzymes, proteins and blood cells into surrounding tissues
  - Edema at the site
  - PMN’s (polymorphonuclear leukocyte) begin removing debris
    - Reach peak efficiency at 12-24 hour
    - Stimulates the fibroblast reproduction and neovascularization
Microscopic wound healing

**Epithelialization:**
- The original cuboid shape of the epithelial cells are regained
- Within 12 hr of injury
- If primarily closed, the epithelium is sealed in 24-48 hrs

**Neovascularization:**
- Brings oxygen and nutrients to area of injury
- Present by day 3; peak at day 7; decreasing by day 21
Microscopic wound healing

- **Collagen synthesis:**
  - Occurs by fibroblasts
  - Accelerated by increased vascular supply
  - Present by 4\textsuperscript{th} day; Continues for 6 weeks

- **Scar Maturation (Remodeling):**
  - At 6 weeks = 50% of original tensile strength
  - Process continues up to 1 year
  - Site never achieves 100% of original tensile strength
Risk factors in Wounds

- **Risk factors for wounds**
  - Sporting activities
  - Gang activities
  - Walking / running outside in bare feet
  - Not wearing helmets or pads for activities

- **Limits to healing**
  - Diabetes
  - Chronic steroid use
  - Host immunocompromised
  - Poor tissue perfusion
  - Extended time between injury and treatment
  - Pre-existing poor nutritional status
Wounds – Physical exam

- Is bleeding controlled?
- Depth, length, width, & nature of wound
- Extent of bruised or necrotic tissue
- Flaps of skin too thin for adequate vascularity
- Obvious skin / wound contamination
- Function preserved or lost in affected part
- Underlying fracture
- Possible foreign body

- The 6 P’s of evaluation
  - Pain
  - Pallor
  - Pulses
  - Paresthesia
  - Paralysis
  - Pressure
Decisions before closure

- What is the proper closure management?
- Is there a potential for foreign body?
- Is there a potential for a fracture below the wound?
- Is there a tendon injury?
- Is there adequate hemostasis at the wound site?
- Will drains / packing be required?
- Consultation considerations?
Decisions before closure

- Antibiotics?
  - Routine wound with primary closure
  - Bite
  - Puncture wound
  - Suspected / known fracture
  - Delayed closure
  - Amount of contamination
  - Pre-morbid conditions
  - Existing medications
Anesthesia- injectable

- Act by diffusing across neural sheaths and interfere with depolarization
  - Given subdermal
  - Blocks c-fibers only; still have vibration
- Esters (Novacaine)
  - Rarely used unless “amides” contraindicated
- Amides (lidocaine, sensorcaine)
  - Most common usage
Local Anesthesia

- **Esters**
  - Cocaine
  - Procaine (Novocaine)
  - Benzocaine (Cetacaine)
  - Tetracaine (Pontacaine)
  - Chloroprocaine (Nesacaine)

- **Amides**
  - Lidocaine (xylocaine)
  - Mepivacaine (Polocaine, Carbocaine)
  - Bupivacaine (Marcaine)
  - Etidocaine (Duranest)
  - Prilocaine
Pharmacology of Local Anesthetics

- Local anesthetics have a lipid soluble hydrophobic aromatic group and a hydrophilic amide group
- Ester linkage more easily broken than ammide
- Amide is heat stable
- Esters produce para-aminobenzoate (PABA) which causes allergic reactions.
- Work by interfering with sodium influx across the nerve membrane
- High lipid solubility allows for neural sheath solubiity
- Drug passes through lipid membrane if unionized
- Alkaline environment required for drug to be unionized
Injectable Anesthesia

- **Lidocaine**
  - Tolerated to a dose of 4 mg/kg
  - For 70 kg patient what is a potentially lethal subdermal injection?
  - Small gauge needle
  - Combine with NaHCO₃ at 1:10 ratio
  - Can be combined with epinephrine
    - Avoid blood flow sensitive areas

- **Toxicity**
  - **Cardiovascular**
    - Myocardial inhibitory effects cause hypotension and bradycardia
  - Excitatory central nervous system
  - Can induce seizures
  - Vasovagal syncope
    - Most common reaction
    - Condition transient
    - Patient should lie down during suturing
Alternate Anesthetic Methods

- **Topical**
  - Comes in several forms
  - Most common:
    - TAC = Tetracaine, Adrenaline, Cocaine
    - LET = Lidocaine, Epinephrine, Tetracaine
  - Use with caution:
    - Around mucous membranes
    - Areas where adrenaline is contraindicated

- **Nerve Blocks**
  - Causes depolarization as local infiltration
  - Advantages:
    - No distention of area
    - Less pain in sensitive areas
    - Know your anatomy
Digital block
Palmar hand anatomy
Single injection digital blocks

Figure 1  Single injection subcutaneous digital nerve block technique. (A) Landmark. Identify the proximal skin crease on the volar aspect of the injured finger. (B) After cleaning the skin, use one hand to gently pinch the soft tissues of the finger just distal to the skin crease. (C) Insert the needle (25G) just beneath the skin at the midpoint of the skin crease. Inject 2–3 millilitres of warmed 0.5% bupivacaine into the soft tissues. (D) Massage the anaesthetic into the soft tissues.
One injection digital block
Dorsal foot anatomy
3 sided great toe block
Instruments

- Needle holder
  - 4 ½ inch Webster or “Philippines” model
  - Load the needle at a right angle
- Forceps
  - Called “pick-ups”;
  - Use one with teeth on the skin
- Scissors
  - Hold them like the needle holders
  - Open the tip only
  - Tail of skin sutures should be distance to next suture
- Hemostats
  - Keep track of excess suture tails
- Scalpel
  - Use at right angle to skin
  - Sizes # 10, # 11, & # 15 will suit most applications
Needle holder
Needle placement
Needle types
Needles

- An array of sizes and designations
  - P = plastic and is sharper & less traumatic
  - C = cuticular
  - FS = for skin – can be used on scalp
Sutures

- **Non-Absorbable**
  - Used for percutaneous skin closure
  - High tensile strength, low reactivity
  - Easy to work with
  - Monofilament nylon (Ethilon)
  - Polypropylene (Prolene)
  - Silk - not generally used
    - Higher risk of infection

- **Absorbable**
  - Absorbed by an inflammatory response, hydrolysis and phagocytosis
  - Do not use on the skin
  - Various absorption rates
    - Gut (5-10 days)
    - Chromic gut (20 days)
    - Polyglactin (Vicryl) (40 days)
    - Polyglycolic acid (Dexon) (40 days)
Closure pearls

- Close all structural layers
- Treat the tissues gently
  - Do not add trauma
- Approximate the dermal – dermal interface
  - This layer is the only wound edge to heal by primary intention
- If area of tension or possible inversion
  - Vertical mattress suture
Suture Alternatives

- **Steri-strips:**
  - Forehead
  - Face
  - Thorax

- **Wound adhesive:**
  - Superficial lacerations

- **Staples:**
  - Sharp, linear lacerations
  - Scalp
  - Trunk
  - Extremities
  - Temporary closure
Steri-strips

- Fast and painless
- Good cosmesis
- Work well on patients with fragile skin
- Limitations:
  - Lower strength
  - Cannot be used with surface hair
Tissue adhesive

- **Advantages**
  - Less painful application
  - More rapid application and repair time
  - Cosmetically similar results at 12 months post-repair
  - Waterproof barrier
  - Antimicrobial properties
  - Better acceptance
  - No need for suture removal or follow-up

- **Avoid**
  - Oral mucosa
  - Areas in need of high cosmesis
  - Puncture wounds
  - Bites
  - Over joint spaces
  - Hands or feet

- **Limitations**
  - No time for edge approximation
  - Low tensile strength
Staples

- Use on linear laceration with sharp, straight edges
- Much faster than sutures
- Equivalency in infection rate
- Good for scalp lacerations

**Limitations**
- Avoid face, neck, hands, & feet
- Can’t be used if having CT scan or MRI
Anesthesia administration

https://www.youtube.com/watch?v=mDjBwzn53x4
Simple interrupted

https://www.youtube.com/watch?v=y2X52XSQZmA
Running Stitch

https://www.youtube.com/watch?v=9sJshF2ib6g
Subcuticular stitch
https://www.youtube.com/watch?v=rNmtk25HHXM
Vertical Mattress
Wound eversion

Proper technique

Improper technique
Closure pearls

- Beware of puncture wounds
- Beware of bites
  - Particularly human
  - Cosmesis a concern
- Close the vermillion border of the lip first
  - Use chromic inside of the wet-dry line
Closing the vermillion border
## Suture removal - guideline

<table>
<thead>
<tr>
<th>Location of Sutures</th>
<th>Average length of time before suture removal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facial, neck, scalp</td>
<td>4-5 days</td>
</tr>
<tr>
<td>Upper extremity</td>
<td>7-10 days</td>
</tr>
<tr>
<td>Trunk</td>
<td>10 days</td>
</tr>
<tr>
<td>Lower extremity</td>
<td>14 days</td>
</tr>
<tr>
<td>Over a joint</td>
<td>10-14 days</td>
</tr>
</tbody>
</table>
Wound care

- Protect the wound until epithelialization has occurred
- Daily gentle cleaning enhances epithelialization
- Ointments – controversial
- Moist environments encourage:
  - Maceration
  - Infection
  - Delayed epithelialization

- Education on scar appearance
  - Red, raised and noticeable
  - Protect from sun
  - Smooth out and blend with surrounding tissues at about 6 months
Other Considerations

- Tetanus – within 72 hours
- Tetanus Immunoglobulin
- High risk wounds
- Education
  - Dressings
  - Wound care
  - Signs of infection
  - Analgesia
  - Suture removal

- Wound Healing
  - Collagen formation peaks at day 7
  - Wound has 15-20 % of full strength in 3 weeks
  - Strength 60 % at 4 months
  - Mature scar in 6-12 months
  - Site of scar never full strength again
Consultation considerations

- Large defects
- Grossly contaminated wounds
- Tendon, nerve or vessel damage
- Open fracture, amputation, joint penetration
- Laceration over a fracture
- Compression wound

- Paint and grease gun injuries
- Concern about cosmetic outcome
- Some facial lacerations:
  - Nasal septal hematoma
  - Cartilage injury of the ear
  - Complex vermilion border
  - Eyelid
  - Cheek laceration