Wound Evaluation and Management

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Objectives

• Review the physiology of wound healing
• Understand the essentials of wound assessment
• Review the evidence behind wound preparation prior to repair
• Review and practice suture techniques
  – Simple interrupted with instrument tie
  – Sutures for high tension wounds (mattress – vertical and horizontal)
  – Corner sutures
  – Deep sutures
  – Closure alternatives (adhesives, steri-strips)
• Understand post-repair wound care and suture removal
FIG. 2-1 Anatomy of the skin illustrating structures pertinent to wound repair.

Wounds and Lacerations, Trott AT, Mosby 1997
Four phases of healing

**ACTIVITY OF WOUND HEALING COMPONENTS**

**IMMEDIATE INJURY RESPONSE** (Vasospasm/Clot Formation)

- 6h
- 24h

**GRANULOCYTE ACTIVITY** (Inflammatory Phase)

- 6h
- 24h
- 3d
- 5d
- 7d

**EPITHELIAL CELL GROWTH**

- 6h
- 24h
- 3d
- 5d
- 7d

**MACROPHAGE ACTIVITY** (Inflammatory Phase)

- 24h
- 3d
- 5d
- 7d
- 14d
- 30d
- 60d

**NEW VESSEL FORMATION**

- 3d
- 5d
- 7d
- 14d
- 30d
- 60d

**FIBROBLAST ACTIVITY** (Collagen Formation)

- 3d
- 5d
- 7d
- 14d
- 30d
- 60d

**Acute vasospasm/clot**

**Epithelialization**

**Inflammation and ingrowth of structures**

**Collagen growth**

*FIG. 3-4* Graphic illustration of the various components of wound healing and their time frames.

Wounds and Lacerations, Trott AT, Mosby 1997
Tensile strength takes 3-4 months to recover

FIG. 3-5  Graphic illustration of the percentage of tensile strength that develops in a wound in the days and months following injury.
Patient assessment checklist

Exam

- Location
- Size
- Depth
- Neurovascular exam
- Tendon function
- Degree of contamination/FB
- Underlying fracture?
Timing of the repair

• Primary closure
  – Most sites within 6-8h
  – Up to 24hr for face

• Too late, or too contaminated
  – Delayed primary closure if cosmesis is important
  – Secondary intention (wound granulates in)
Risk factors for infection

- 3-6% incidence
- Increased Risk:
  - DM
  - Steroids
  - Foreign body
  - Elderly
  - Larger width/depth
  - Contamination
  - Jagged edges
  - Bites
  - Crush mechanism
  - Edema

- Consider:
  - Xray (open frx)
  - Td status
  - Rabies prophylaxis
  - ?Delayed closure
Animal bites

- **Dog** – suture face only
  - Infection rate 3-18% (Singer NEJM 2008)
  - *Pasturella, Eikenella, staph strep, GNR, anaerobes*
  - Onset of infection in 24 hours
- **Cat** – never suture
  - Infection rate 28-80% (Singer NEJM 2008)
  - *Pasturella multocida*
  - Onset in 12 hours
  - Tooth fragments
- **Antibiotic Prophylaxis** (5 days)
  - OR 0.10 [0.01, 0.86] (Medeiros Cochrane 2001)
  - Amox-clav, FQ + clinda, TMP/SMX + clinda
  - When combined with irrigation, infection rate was 5.5% (a study of 145 mammalian bites; Chen Acad EM 2001)
Wounds to think twice about

- 20% of closed malpractice claims (Karcz et al, Am J EM 1996)
- Foreign bodies
  - 2nd most common cause for malpractice claims
  - Non-radioopaque FB (including glass)
- Hand lacerations
  - 9th out of the top 10 closed claims (Brown Acad EM 2010)
  - Tendon and nerve involvement may not be obvious!
  - Careful hand examination is critical
- Facial lacerations
  - Nostrils
  - Vermillion border of the lip
  - Eyelids and medial canthus/lacrimal duct
  - Ear with exposed cartilage/hematoma
- Wound with high infection rates
  - Puncture wounds
  - Animal/Human bites (especially the fight bite!)
Preparing the wound for closure

Anesthesia, irrigation, and suture selection
**Table 2. Properties of Commonly Used Local Anesthetic Agents.**

<table>
<thead>
<tr>
<th>Agent</th>
<th>Trade Name</th>
<th>Class</th>
<th>Recommended Concentration</th>
<th>Maximal Safe Dose</th>
<th>Duration of Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Procaine with epinephrine</td>
<td>Novocain</td>
<td>Ester</td>
<td>0.5–1.0%</td>
<td>7 mg/kg</td>
<td>15–45 min</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>9 mg/kg</td>
<td>30–90 min</td>
</tr>
<tr>
<td>Lidocaine with epinephrine</td>
<td>Xylocaine</td>
<td>Amide</td>
<td>0.5–2.0%</td>
<td>4.5 mg/kg</td>
<td>(30cc) 1–2 hr</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7 mg/kg</td>
<td>(50cc) 2–4 hr</td>
</tr>
<tr>
<td>Bupivacaine with epinephrine</td>
<td>Marcaine</td>
<td>Amide</td>
<td>0.125–0.25%</td>
<td>2 mg/kg</td>
<td>(70cc) 4–8 hr</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3 mg/kg</td>
<td>8–16 hr</td>
</tr>
</tbody>
</table>

- Local or digital/regional block based on size and anesthetic volume
- Avoid epinephrine on tissue peninsulas
  - Nose, ear, fingers, etc.
- Procaine (ester) can be used for amide-allergic pts
Reducing Pain of Lidocaine Infiltration

• Pretreatment with topical anesthetics
  – LET solution – lidocaine, epinephrine, tetracaine
• Inject through wound margins
• Slow rate of injection
  – Small-bore needles (27G)
• Buffering and warming cuts pain by 40%
  (Brogan 1995)
  – Buffer with sodium bicarbonate 8.4% (1:10)
  – Warming the solution
    • Synergistic with buffering (Mader Ann EM 1994)
Irrigation

• High-pressure irrigation: 8-9 psi
  – Reduces wound bacterial counts and wound infection rates
  – Use 30-60 cc syringe with 18-20 gauge catheter or irrigation shield device
  – Tap water is as good as sterile saline! (Bansal Am J EM 2002)

• Volume: 100cc/1cm laceration

• Clean, non-contaminated face/scalp lacerations do not show reduced infection rates after irrigation -- 1% incidence (Hollander Ann EM 1998)
Choosing a suture material

- **Non-absorbable (nylon, prolene)**
- **Absorbable (chromic - intraoral)**
- Tissue reaction increases scarring
  - Braided >> monofilament
  - Absorbable >> non-absorbable
- Curved, cutting needle
- Suture size = tensile strength
  - Body – 3.0 or 4.0 (unless very small and intact dermis)
  - Digits – 5.0
  - Hand – 4.0
  - Head and neck – 6.0
Less than 2cm may not need sutures at all!

• 95 uncomplicated lacerations of the hand (n=91)
  – full thickness <2 cm
  – no tendon, joint, fracture, or nerve complications
• Randomized to suturing or conservative treatment
• No difference in
  – cosmetic appearance at 3 months
  – mean time to resume normal activities (3.4 days)
• Conservative management
  – less pain – VAS (100pt) score difference 18mm (12, 24)
  – shorter treatment time – 14min (10, 18)

Quinn *BMJ* 2002
Alternatives to sutures

- Wound Stapling
- Wound Adhesives (Cyanoacrylate)
  - tensile strength of 4-0 nylon
  - linear, short wounds
  - avoid flexural surfaces and tension wounds
  - no hemorrhage
  - make a bacitracin border to pool the glue
  - remove with petroleum jelly
- Wound Taping
  - Steri-strips (with benzoin)
Skin tear repair using steri-strip approximation

816 patients enrolled
Follow-up: 98% v. 96.6%
Infection rates
- Sterile gloves 6.1% (3.8%, 8.4%)
- Clean gloves 4.4% (2.4%, 6.4%)
- RR 1.37 (0.75, 2.52)
Closure Techniques

• Take a banana, suture kit, and a packet of suture.
• Practice as we review - ask questions!!!
Simple interrupted (NEJM 1997)

- 90 degree needle introduction ensures eversion/compensates for scar contracture

- Layer matching ensures minimal scar formation/step-off
Instrument tie (www.ethicon.com)
How many knots?
Vertical and Horizontal Mattress Sutures
Corner Stitch
Dressing the wound

• Pull knots to side
  – decreases FB reaction/easy removal
• Apply firm pressure (30sec) to aid coagulation and decrease edema
  – Educate patient on risks
    • Infection
    • retained FB
    • scarring
• Bacitracin to the suture line
• Dry dressing with tape/tegaderm
Follow-up

• Wound instructions
  – Dressing X 24-48 hrs until epithelialization
  – Topical bacitracin
  – UV protection: sunscreen after suture removal
  – Scar formation takes 4-6 months to complete

• Suture removal timing
  – Risk of suture scars “railroad tracks” >7-14d
  – Wound tape may remain for 10d
Suture removal in...

<table>
<thead>
<tr>
<th>Location</th>
<th>Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face/ear</td>
<td>4-5</td>
</tr>
<tr>
<td>Scalp</td>
<td>6-8</td>
</tr>
<tr>
<td>Trunk/arm/leg</td>
<td>8-10</td>
</tr>
<tr>
<td>Finger/extremity flexural surface</td>
<td>10-12</td>
</tr>
<tr>
<td>Back/foot</td>
<td>12-14</td>
</tr>
</tbody>
</table>
Critical summary points

- Document a careful history and exam (esp. hands)
- Assess for foreign body by feel and film
- Use high pressure irrigation to reduce infection
- Choose suture techniques that minimize wound tension
- Set expectations for FB, scarring, and infection
For a great review of laceration repair, go to NEJM online

http://content.nejm.org/cgi/video/355/17/e18/
References