Laceration Repair in the ED

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Epidemiology of Wounds

- In 2005 there were 11.8 million wounds treated in US EDs
- 7.3 million lacerations
- Half a million burns
- 2 million outpatient visits for cutting or piercing wounds
- 4.7 million animal bites
- 1.5 million skin tears in the elderly
- 20-90 million surgical incisions

Lacerations in the Emergency Department: National Perspective

- Annual ED visits in the US 120 Million
- Estimated number of lacerations 7-8 Million

Monthly distribution

Location

- Upper Ext
- Face
- Lower Ext
- Head
- Trunk

Chart showing estimated number of laceration visits per month.
Laceration Closure in the ED: Local Experience

- Retrospective chart review
- Suburban, academic ED
- Summer 2008
- 755 lacerations
- 76% male, 24% female
- Mean age 28

Location

- Forehead
- Scalp
- Fingers
- Other
Multiple Logistic Regression

- Adhesives more likely to be used in children
  - OR 1.8 (95% CI, 1.1-3.0)
- Adhesives more likely to be used on the face
  - OR 10.0 (95% CI, 5.5-18.0)
- Decreased use of TSA with increased length
  - OR 0.5 (95% CI, 0.3-0.6)
- Use of TSA NOT associated with
  - Gender, race, laceration edges
- 43% of glued wounds required no anesthetic
- 87% of sutured wounds required anesthetic
  - P<0.001
Patient Satisfaction and Preferences

- 52 patients with H&N incisions closed with DB
- 40/47 highly satisfied
  - Ability to shower (40), no sutures (5), no allergic reaction (2)
  - Laccourreye et al. Ann Chir 2005;130:624
- A survey of patients in the UK showed 90% would prefer wound closure by an adhesive in relation to traditional sutures
  - Roberts AC. Acta Chir Plast 1998;40:22
## Goals of Wound Management

<table>
<thead>
<tr>
<th>Goals</th>
<th>Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optimize aesthetics and function</td>
<td>Gentle handling of tissues</td>
</tr>
<tr>
<td>Minimize infection</td>
<td>Avoid further trauma</td>
</tr>
<tr>
<td>Rapid care</td>
<td>Clean wound</td>
</tr>
<tr>
<td>Minimal pain and discomfort</td>
<td>Relieve tension</td>
</tr>
<tr>
<td>Maximize patient satisfaction</td>
<td>Moist wound healing environment</td>
</tr>
<tr>
<td>Reduce need for follow-up</td>
<td></td>
</tr>
<tr>
<td>Simplify wound care</td>
<td></td>
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</table>
History

- Etiology
- Time of injury
- Predisposing conditions
  - Diabetes, CRF, immunosuppression
- Allergies
  - Latex, antibiotics
- Immunizations
- Prior healing
  - Keloids, hypertrophic scarring
Physical Examination

- Hemostasis
- Adequate lighting
- Neurovascular exam
- FROM
- Foreign bodies
- Tendon injuries
Local anesthesia

- **Advantages:**
  - Safe
  - Quick
  - Local hemostasis

- **Disadvantages:**
  - Distorts anatomy
  - Requires large doses
  - Requires multiple injections
Minimizing pain of infiltration

- Small needle
- Inject through wound edge
- Inject slowly
- Buffering
- Warming
- Pretreatment with topical anesthesia
Hair removal

- Skin hair source of contamination
- Hair removal facilitates closure
- Preoperative shaving increases infection
  - with razor prep - 5.6% infection
  - after a depilatory - 0.6% infection
- Wounded hair follicles access for bacteria
- Hair clipping preferred
- Do not remove eyebrows

Wound débridement

- Cornerstone of therapy
- Contaminated wounds
- Sharp removal of foreign material, devitalized or necrotic tissue
- Minimize in cosmetically important areas
Wound scrubbing

- Effective removal of debris and bacteria
- Tissue trauma increases susceptibility to infection
- High porosity sponges cause less damage
- Addition of non-toxic surfactant minimizes damage without affecting efficacy
- Reserved for highly contaminated wounds

Wound irrigation

- Irrigation effective cleansing method
- High pressure irrigation > 8 PSI
  - more effective than low pressure irrigation in removing bacteria
  - more effective for removal of soil infection-potentiating factors
Disadvantages of high pressure irrigation

- Tissue trauma makes wounds more susceptible to infection
- May cause dissemination of bacteria into wound
- Increases occupational risk due to splatter and needle sticks
- Limit to high risk wounds
  - Heavy contamination
  - Extremities
<table>
<thead>
<tr>
<th>Method</th>
<th>Pressure</th>
<th>Duration</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>35mL, 19g</td>
<td>35 psi</td>
<td>160 sec</td>
<td>$1.27</td>
</tr>
<tr>
<td>65mL, 19g</td>
<td>27.5 psi</td>
<td>138 sec</td>
<td>$1.37</td>
</tr>
<tr>
<td>IV bag</td>
<td>4 psi</td>
<td>67 sec</td>
<td>$1.36</td>
</tr>
<tr>
<td>IV bottle</td>
<td>2.3 psi</td>
<td>100 sec</td>
<td>$1.04</td>
</tr>
<tr>
<td>Cuff, 19g</td>
<td>10 psi</td>
<td>340 sec</td>
<td>$1.57</td>
</tr>
<tr>
<td>Cuff, 16g</td>
<td>6 psi</td>
<td>65 sec</td>
<td>$1.94</td>
</tr>
</tbody>
</table>

Is irrigation of facial and scalp lacerations necessary?

- Irrigation lowers infection in contaminated animal wounds
- No evidence that irrigation effective in clean low risk human wounds
- Concerns: wound distortion, splatter
- Objective
  - to compare infection rates and cosmetic outcome of low risk wounds based on whether they were irrigated or not
Is irrigation of facial and scalp lacerations necessary? - Infections

P=0.28

- Irrigated: 0.9%
- Not Irrigated: 1.4%

Is irrigation of facial and scalp lacerations necessary? - Cosmesis

![Graph showing the percentage of optimal cosmesis for irrigated and non-irrigated lacerations.](image)

- Irrigated: 76%
- Not Irrigated: 82%

P = 0.07

Choice of irrigation solution

Prospective Trial of 531 Patients

- **NS**: 7%
- **Iodine**: 4%
- **ShurCl**: 5%

P = 0.57

Saline

- Readily available
- Nontoxic
- Inexpensive
- No antibacterial activity
- Similar efficacy to more expensive solutions
Wound irrigation in children: saline or tap water?

- Randomized controlled trial
- 530 wounds in pediatric patients
  - Saline (271) vs. tap water (259)
- Similar baseline characteristics
- More wounds in tap water group on hands

Wound irrigation in children: saline or tap Water?

Infection Rates

P=NS

2.8% 2.9%

Types of Closure

- **Primary**
  - Immediate approximation
  - Rapid healing
  - Minimal scarring

- **Secondary**
  - Spontaneous closure
  - Delayed healing
  - Increased scar formation
  - Reserved for infected, highly contaminated wounds

- **Delayed Primary (Tertiary)**
  - Approximation after 3-5 days
The Golden Period of the Wound

- Time interval from injury to closure with low risk of infection
- Dependent on patient and wound factors
  - Location
  - Etiology
  - Timing
  - Underlying comorbidities

Healing Rates

Wound Closure Techniques

- Sutures
- Staples
- Adhesive tapes
- Tissue adhesives
Sutures

- Strand of material used to approximate tissues or tie vessels
- Used by ancient civilizations 4,000 yrs ago
- Same basic principles apply today
- Suture characteristics
  - Tensile strength, ease of handling, sterility
<table>
<thead>
<tr>
<th>Sutures</th>
<th><strong>Advantages</strong></th>
<th><strong>Disadvantages</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Meticulous closure</td>
<td>Painful</td>
</tr>
<tr>
<td></td>
<td>Greatest tensile strength</td>
<td>Risk of needle stick</td>
</tr>
<tr>
<td></td>
<td>Lowest dehiscence rate</td>
<td>High cost</td>
</tr>
<tr>
<td></td>
<td>Time honored</td>
<td>Slow</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Operator dependent</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Learning curve</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Greatest tissue reactivity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Requires removal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>May leave suture marks</td>
</tr>
</tbody>
</table>
Suture Classification

- Absorbable/Non-absorbable
  - Absorbable sutures absorbed through enzymatic or hydrolytic processes within 60 days
- Natural/Synthetic
  - Lower infection rates with synthetic
- Braided/Monofilament
  - Braided sutures consist of several strands either braided or twisted together
  - Monofilament sutures are a single strand of material, lower infection rates
Monocryl
(Poliglecaprone 25)

- Superior pliability and handling
- Copolymer of glycolide and epsilon-caprolactone
- Inert in tissues
- For procedures that require high initial tensile strength diminishing over 2 weeks
  - Tensile strength at 7 days 60%, 14 days 30%
  - Strength lost by 28 days
  - Subcuticular closure and soft tissue approximation
  - Not for high tension wounds
Smart Closure Devices

- Not just a mechanical closure device
- Incorporate “active” agents
  - Antibacterial
  - Growth factors
  - Anti-scarring agents
  - Analgesics
What is this?
Vicryl (Monocryl/PDS) Plus Antibacterial Suture

- Incorporates an antibacterial agent, Triclosan
- *In vitro* has a zone of inhibition effective against the pathogens that most often cause surgical site infection
  - *Staph A*, *Staph E*, *MRSA*, and *MRSE*
- Same performance and handling as regular coated VICRYL/MONOCRYL/PDS suture
Suturing Tips

- Gentle tissue handling
- Match corresponding layers
- Wound edge eversion
- Equal bites and distances
- Enter skin at 90°
  - Bigger bite as you go deeper
- Bisect wound to avoid “dog ears”
- Avoid tension
  - Use deep dermal sutures
  - Undermine tissue
Wound Bursting Strength

HEALING OF RAT SKIN WOUNDS

- Breaking Strength of DSI as Percent of Strength of Unwounded Rat Skin
- Breaking Strength of DSI Strip (Kg)

Days Postoperative

0 7 14 21 28 35 42 49 56 63
### Staples

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rapid</td>
<td>Less meticulous closure</td>
</tr>
<tr>
<td>Low reactivity</td>
<td>May interfere with imaging</td>
</tr>
<tr>
<td>Low cost</td>
<td>May not allow adequate visualization of wound</td>
</tr>
<tr>
<td>Low risk of needle stick</td>
<td>Requires removal</td>
</tr>
<tr>
<td>Not operator dependent</td>
<td>Painful</td>
</tr>
</tbody>
</table>

- Rapid
- Low reactivity
- Low cost
- Low risk of needle stick
- Not operator dependent
- Less meticulous closure
- May interfere with imaging
- May not allow adequate visualization of wound
- Requires removal
- Painful
## Surgical Tapes

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Least reactive</td>
<td>• Falls off</td>
</tr>
<tr>
<td>• Lowest infection rates</td>
<td>• Low tensile strength</td>
</tr>
<tr>
<td>• Rapid</td>
<td>• High dehiscence rate</td>
</tr>
<tr>
<td>• Comfortable</td>
<td>• Requires toxic adjuvant</td>
</tr>
<tr>
<td>• Lowest cost</td>
<td>• Cannot get wet</td>
</tr>
<tr>
<td>• No risk of needle stick</td>
<td>• Cannot be used over hair</td>
</tr>
<tr>
<td></td>
<td>• Blister formation</td>
</tr>
</tbody>
</table>
Cyanoacrylates are the only TSA available for wound closure
Formed from cyanoacetate and formaldehyde
Monomers in liquid formulation
Polymerize on contact with tissue to form strong bond holding apposed wound edges together
First synthesized at Kodak in 1949
First reported for wound closure in 1959
Introduced in the US in 1998
Strength related to length of side chain and plasticizers
Structure of TSA

Octylcyanoacrylate

Butylcyanoacrylate

Ethyl-2-cyanoacrylate

Methyl-2-cyanoacrylate

2-octyl cyanoacrylate

2-butyl cyanoacrylate
### Why Use TSAs?

- Simple
- Rapid
- Strong closure
- Effective microbial barrier
- Occlusive dressing
- Excellent cosmesis

- Ease of wound care
- Reduced follow up
- Reduced needle-stick risk
- Less pain & anxiety
- Gentle on tissues
  - Fragile skin, flaps, skin tears, grafts
Comparison of TSA and Sutures

- Faster
- Similar infection rates
- Similar dehiscence rates
- Similar cosmetic results
- More cost effective
- Greater patient satisfaction

**Speed, min (P<0.001)**

![Graph showing speed comparison between OCA and Standard](chart)

**Optimal cosmesis (P=0.67)**

![Graph showing optimal cosmesis comparison between OCA and Standard](chart)

*Singer et al. Surgery 2002;131:270*
The Use of OCA in Wound Closure: Any Location, Any Length
Facial Lacerations
Why Use OCA

- Strength
- Flexibility
- Durability
  - Remains intact over time maintaining microbial barrier
  - Reasonable water resistance
- Viscosity
- Transparency
- Storage
Optimizing Use of TSA

- Obtain wound hemostasis
  - Pressure, topical vasoconstrictor
- Achieve complete wound edge apposition
- Horizontal positioning of wound
- Controlled expression of thin layer
  - Avoid pooling or excessively thick 1st layer
- Avoid pressure on wound
  - May separate wound edges
- Cover adjacent vital areas
- Use assistant or tape for long or complex wounds
Method of Application: “Drop and Glide”
Closure of Hand Laceration
Repair of Facial Laceration: Avoiding Run-off
Closure of Long Wounds

Strength of OCA plus tapes greater than either device alone

Closure of high tension laceration: use of adjunctive deep sutures.
Closure of a Skin Tear
Closure of Skin Tear
<table>
<thead>
<tr>
<th>Indications</th>
<th>Contraindications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easily approximated lacerations and incisions</td>
<td>Infection</td>
</tr>
<tr>
<td>Closure of flaps</td>
<td>Heavy contamination</td>
</tr>
<tr>
<td>Lacerated fragile skin</td>
<td>Mucosal surfaces</td>
</tr>
<tr>
<td>Attachment of grafts</td>
<td>Hair bearing area</td>
</tr>
<tr>
<td>Nail bed repair</td>
<td>High tension areas</td>
</tr>
<tr>
<td>Finger tip amputations</td>
<td>High friction areas</td>
</tr>
<tr>
<td></td>
<td>Allergy to CA, formaldehyde</td>
</tr>
</tbody>
</table>
Post op care for OCA

- May shower same day
- Avoid prolonged soaking or scrubbing
- Do not apply creams or ointments
- No need to remove adhesive
- Sloughs off in 5-10 days
- May be removed with ointment or SSD
Meta-Analysis: prophylactic antibiotics

- 7 randomized trials
  - (n = 1,734)
- Odds ratio for infection in treated patients calculated
- No effect of antibiotics
  - odds ratio for infection, 1.16 (0.77-1.78)
- Prophylactic antibiotics do not protect against infection of non-bite wounds

Clinical Trial of 426 Minor Lacerations

$P = 0.0034$

BAC, NEO, SILV, PTRL

Dire et al. Acad Emerg Med 1995;2:4
Topical antibiotics

Clinical Trial of 922 Dermatology Wounds

\[ P = 0.37 \]

Indications for prophylactic antibiotics

- Highly contaminated wounds
- Open fractures
- Exposure of vital organs
  - tendon, bone, nerve
- All human bites which break skin
- Dog bites to extremities
- Endocarditis or indwelling catheter prophylaxis
Tetanus Prophylaxis

- **Clean minor wounds**
  - If had original booster series
    - Td if > 10 years since booster
  - If did not have original booster series
    - Give Td

- **Other wounds**
  - If had original booster series
    - Only if > 5 years since last booster
  - If did not have original booster series
    - Give Td and TIG
Can sutures get wet?
Prospective randomized controlled trial of wound management in general practice

- Many recommend keeping repaired wounds dry and covered for 24-48 hr
- 857 patients after minor non-facial excisions randomized to keep their wound dry (442) or wet the wound (415)
- The incidence of infection in the intervention group (8.4%) was not inferior to the incidence in the control group (8.9%) (P < 0.05)

Heal et al. BMJ 2006;332:1053
Post Op Care for TSA

- Clean and Dry
- Dressings
  - Occlusive
  - Topical Antimicrobial
- Timing of Device removal
  - Face: 3-5 days
  - Extremities: 10-14 days
  - Elsewhere: 7 days
- For TSA
  - No topical agents
  - Avoid scrubbing and prolonged immersion