Suturing Skills Workshop

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Ideally wound closure should be effective: simple, efficient, inexpensive, and painless, and should achieve optimal cosmetic results.

OBJECTIVES
Review the Anatomy and Physiology of the Wound Healing Process

Discuss the Guidelines for Seeking Surgical Consultation for Laceration Repair

Assess, Inspect and Evaluate the Patient and Wound

Outline Commonly used Anesthetic Agents, including Pharmacology, onset of action, and duration of action.

Demonstrate administration of local anesthesia for wounds including digit and toe blocks.

Identify the various types and sizes of suture material.

Review and demonstrate basic wound closure techniques including skin lines

Develop a wound care plan and follow-up for suture removal.

Demonstration and Discussion

ANATOMY / SKIN and FASCIA

Epidermis

Dermis

Superficial Fascia

Deep Fascia
THE WOUND HEALING PROCESS

The entire wound healing process is a complex series of events that begins at the moment of injury and can continue for months to years. The wound healing process includes:

I. Hemostasis
   - Vascular constriction
   - Platelet aggregation, degranulation, and fibrin formation (thrombus)

II. Inflammatory (Preparative) Phase
   - Inflammation, Vasodilation, Phagocytosis
   - Neutrophil infiltration
   - Monocyte infiltration and differentiation to macrophage
   - Lymphocyte infiltration
   - Process: 3-7 days

III. Proliferative Phase
   - Re-epithelialization
   - Angiogenesis
   - Collagen synthesis
   - Extracellular matrix formation

IV. Remodeling Phase
   - New collagen forms which increases tensile strength to wounds
   - Scar tissue is only 80 percent as strong as original tissue
   - Collagen remodeling
   - Vascular maturation and regression
   - Process: 3 weeks to 2 years
Guidelines for Seeking Surgical Consultation for Laceration Repair

Deep wounds of the hand or foot
Full-thickness lacerations of the eyelid, lip, or ear
Lacerations involving nerves, arteries, bones, or joints
Penetrating wounds of unknown depth
Severe crush injuries
Severely contaminated wounds requiring drainage
Wounds leading to a strong concern about cosmetic outcome

ASSESS / EVALUATE / PLAN
WOUND MANAGEMENT

ASSESS / EVALUATE / PLAN (cont’d)

Contradictions to Wound Closure

Lidocaine (with or without Epinephrine)
Most commonly used, Rapid Onset
Strength 0.5%, 1%, 2%
Max Dose 5mg/kg
* Can use with Epinephrine for prolonged effect and decreased bleeding. Dosage is 7mg/kg.
DO NOT USE EPINEPHRINE ON EYES, NOSE, FINGERS, TEETH, PENIS, SCROTUM, OR EARS.
Marcaine (with or without epinephrine)
Slow onset, long duration
Max Dosage 2mg/kg
0.5% and 1%
### Agent Concentration Infiltration Block in Minutes Duration of Action Maximum allowable for single dose

- **Lidocaine 1%, 2%** (Xylocaine)
  - Immediate
  - 1% - 2%
  - 4-10 minutes
  - 30 - 120 minutes
  - 1%: 4.5 mg/kg (30 mls in avg adult)

- **Lidocaine 1%, 2% with Epinephrine** (Xylocaine)
  - Immediate
  - 1%
  - 4-10 minutes
  - 60 - 240 minutes
  - 7 mg/kg

- **Mepivacaine** (Carbocaine)
  - Immediate
  - 1%
  - 6-10 minutes
  - 90 - 180 minutes
  - 5 mg/kg

- **Bupivicaine** (Marcaine or Sensorcaine)
  - Slower
  - 0.25% - 0.5%
  - 8 - 12 minutes
  - 240 - 480 minutes
  - 3 mg/kg

- **Topical Agents LET**
  - 5-15 minutes
  - 20 - 30 minutes
  - 2 - 5 mls

### INJECTION TECHNIQUES

***CHECK for ALLERGIES! (True allergies are uncommon, but do occur.)***

In persons who are allergic to amides use: 1 ml diphenhydramine (50 mg/ml) to 4 ml sterile saline for local anesthetic effects.

Use 25 gauge needle or smaller to decrease sting of injection.

Insert needle at inner edge of wound.

Aspirate.

Inject anesthetic as you pull the needle out.

Buffering with 1 ml of 8.4% sodium bicarbonate (1 ml / 10 ml local anesthetic) to 10 ml of local anesthetic significantly reduces pain of injection.

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**DIRECT WOUND INFILTRATION**

**DIGITAL BLOCK**

**TOE BLOCK**
IDENTIFY the various types and sizes of suture material

Absorbable vs. non-absorbable
Natural vs. synthetic
Monofilament vs. multifilament

ABSORBABLE SUTURE

Degraded and eventually eliminated in one of two ways:
Inflammatory reaction utilizing tissue enzymes
Hydrolysis

Examples:
"Catgut" (Untreated Chromic): Very fragile and non-reactive
Chromic (Catgut treated with chromium salt solution to aid in resisting breakdown): Absorption in 90 days; TSR: 28 days
Vicryl (Polyglactin): TSR: 75% at 2 weeks, 50% at 3 weeks, 25% at 4 weeks
Monocryl: High tensile strength in the first few weeks. TSR: 60 - 70% at 1 week, 30 - 40% at 2 weeks
PDS: Longest retention of the absorbable sutures. 70% at 2 weeks. 50% at 4 weeks. 25% at 6 weeks

NON-ABSORBABLE

Not degraded, permanent

Examples:
Prolene: Does not adhere to tissue (Blepharoplasties)
Nylon: Skin closures
Stainless steel: Now used primarily in sternal closures
Silk*: Poor tensile strength if wet

(*not a truly permanent material; known to be broken down over a prolonged period of time—years [1 year plus])

NATURAL SUTURE

Biological origin
Cause intense inflammatory reaction

Examples:
"Catgut"—purified collagen fibers from intestine of healthy sheep or cows
Chromic—coated "catgut": facial wounds, lip/intraoral mucosa, children’s wounds. Lasts 7-14 days at most.
Silk

SYNTHETIC SUTURE

Synthetic polymers
Do not cause intense inflammatory reaction

Examples:
Vicryl / SH
Monocryl / SH / PS-2
PDS
Prolene
Nylon FS-2

MONOFILAMENT SUTURE

Grossly appears as single strand of suture material; all fibers run parallel
Minimal tissue trauma
Resists harboring microorganisms
Ties smoothly
Requires more knots than multifilament suture
Possesses memory

Examples:
Monocryl, PDS, Prolene, Nylon
Fibers are twisted or braided together
Greater resistance in tissue
Provides good handling and ease of tying
Fewer knots required

Examples:
Vicryl (braided)
Chromic (twisted)
Silk (braided)

<table>
<thead>
<tr>
<th>SUTURE SIZES</th>
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</thead>
<tbody>
<tr>
<td>Sized according to diameter with &quot;0&quot; as reference size</td>
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<tr>
<td>Numbers alone indicate progressively larger sutures (&quot;1&quot;, &quot;2&quot;, etc)</td>
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<tr>
<td>&quot;1&quot;: VERY LARGE, USED TO CLOSE THE ABDOMINAL WALL</td>
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<tr>
<td>Numbers followed by a &quot;0&quot; indicate progressively smaller sutures (&quot;2-0&quot;, &quot;4-0&quot;, etc)</td>
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<tr>
<td>&quot;10-0&quot;: very tiny (fine as a human hair, used for microvascular anastomoses and corneal sutures)</td>
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<td>COMMON SIZES: 2-0 to 5-0</td>
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<tr>
<th>NEEDLE TYPES</th>
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<td>CURVED</td>
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<td>Designed to be held with a needle holder</td>
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<td>Used for most suturing</td>
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<td>CUTTING: Used primarily for suturing skin</td>
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<td>TAPERED: Used to suture soft tissue, excluding skin (e.g. GI tract, muscle, fascia, peritoneum)</td>
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<td>STRAIGHT</td>
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<td>Often hand held</td>
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<td>Used to secure percutaneously placed devices (e.g. central and arterial lines)</td>
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<td>FS, PC, PS, SH, RV, UR,</td>
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<table>
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<tr>
<th>NEEDLES</th>
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<tr>
<td>Cutting Needle</td>
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<tr>
<td>Triangular body</td>
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<tr>
<td>Sharp edge toward inner circumference</td>
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<tr>
<td>Used to suture skin or tough tissue</td>
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<tr>
<td>Taper-point Needle</td>
</tr>
<tr>
<td>Round body</td>
</tr>
<tr>
<td>Used to suture soft tissue, excluding skin (e.g. GI tract, muscle, fascia, peritoneum)</td>
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Wound Closure

Primary
Secondary
Tertiary

Primary Closure
Face or Scalp: Repair within 24 hours (18 hours preferred)
Body: Repair within 12-18 hours (6 hours preferred)

Secondary Closure
(Older Wounds with Infection Risk)
Step 1: Initial Evaluation
Option 1: Loose approximation with simple interrupted closure
Option 2: Pack wound with sterile wet to dry dressings changed twice daily
Step 2: Reevaluation at 3-5 days
No infection: Primary wound closure
Infection: Treat infection and healing by second intention as below
Healing by second intention
Pack wounds with sterile wet to dry dressing bid
Granulation and contraction risk without suturing

Tertiary Closure
Two surfaces of granulation tissue are brought together after debridement of nonviable tissues and left open
Contaminated, dirty and infected traumatic wounds with extensive tissue loss and a high risk of infection wound gradually gains sufficient resistance to infection which permits an uncomplicated closure takes place 4 to 6 days postinjury.

REVIEW SKIN LINES
Two types of skin tension lines
Important impact on final healing
Static (Langer’s Lines) skin is under constant tension
Dynamic (Kraissl’s Lines) forces created by muscles and correspond to wrinkles
Parallel repairs are less likely to scar
Repairs under minimum tension are less likely to scar

KNOT TYING PRINCIPLES
Simple knots are best
Smaller knots are better than big ones
Use the minimum ties per knot
Tension should be as horizontal as possible (don’t lift)
Excessive tension will cause tissue damage
The two-handed square knot is the easiest and most reliable knot for tying most suture material
Start on the side of the wound opposite and farthest from you to ensure that you are always sewing toward yourself. By sewing toward yourself, the suturing process is made easier from a biomechanical standpoint.

1. Start from the outside of the skin, go through the epidermis into the subcutaneous tissue from one side, then enter the subcutaneous tissue on the opposite side, and come out the epidermis above.

2. To evert the edges, the needle tip should enter at a 90° angle to the skin. Then turn your wrist to get the needle through the tissues.

3. You can use simple sutures for a continuous or interrupted closure. The needle tip should enter the tissues perpendicular to the skin. Once the needle tip has penetrated through the top layers of the skin, twist your wrist so that the needle passes through the subcutaneous tissue and then comes out into the wound. This technique helps to ensure that skin edges will evert.

The SIMPLE INTERRUPTED is the technique of choice if you are worried about the cleanliness of the wound. If the wound looks like it is becoming infected, a few sutures can be removed easily without disrupting the entire closure.

Interrupted sutures can be used in all areas but may take longer to place than a continuous suture.

**REVIEW SIMPLE SKIN CLOSURES**

**VERTICAL MATTRESS SUTURE**

Affords precise approximation of skin edges with eversion

Two-step stitch:

Simple stitch made – “far, far” relative to wound edge (large bite)

Needle reversed and 2nd simple stitch made inside first – “near, near” (small bite)

**DEMONSTRATE ADVANCED SKIN CLOSURES**

**VERTICAL MATTRESS SUTURE**

**HORIZONTAL MATTRESS SUTURE**

**RUNNING SUBCUTICULAR SUTURE**
HORIZONTAL MATTRESS SUTURE

Provides hemostasis and added strength in fascial closure; also used in calloused skin (back, palms, soles)

Two-step stitch:

Simple stitch made

Needle reversed and 2nd simple stitch made adjacent to first (same size bite as first stitch)

SUBCUTICULAR SUTURE

Usually a running stitch, but can be interrupted

Intradermal horizontal bites

Allow suture to remain for a longer period of time without development of crosshatch scarring
Alternatives to Suture

Skin Closure Tapes

Proxi-Strips
Steri-Strips

Adhesive Glues

Dermabond

Staples

Skin Closure Tapes

Skin closure tapes are an effective alternative to sutures or staples when tensile strength and resistance to infection are not critical factors.

Sterile adhesive tapes
Available in different widths
Frequently used with subcuticular sutures
May be used following staple or suture removal
Can be used for delayed closure
Disadvantages
Do not bring deeper tissues together
Do not control bleeding from wound edges

Skin Closure Tape Application

The tape is placed on one side of the wound at its midpoint, while grasping it with forceps in the dominant hand.

The opposite wound edge is then gently apposed by pushing with a finger of the nondominant hand. The wound edges should not be apposed by pulling on the free end of the tape. This can result in unequal distribution of skin tension, causing erythema or even blistering of the skin.

Additional strips are then placed perpendicular to the laceration on either side of the original tape, bisecting the remaining open wound with each strip until the space between tapes is no more than about 2 to 5 mm.

Additional strips are then placed over the ends of the other strips, parallel to the laceration.

Adhesive tapes should be left in place and allowed to come off as they will (as long as possible)

Tissue Adhesives

Dermabond, Octylseal

Safe for topical application
Inexpensive and painless
Easy to apply & significantly decreases the time of treatment for wound closure
Support the approximated skin edges and maintain the skin edge eversion necessary for maximum wound healing and acceptable cosmesis
Eliminates the need for postoperative suture removal
Low rate of dehiscence and a low infection rate
Provide excellent cosmetic results
Tissue adhesives should not be used as a replacement for proper subcutaneous closure

Tissue Adhesive Application Application

With the applicator tip pointed upward, apply pressure at the midpoint of the ampule, crushing the inner glass ampule. Insert applicator tip gently and express the liquid through the applicator tip. Skin closure with tissue glue allows use of adhesive immediately.

Position the wound in a horizontal plane to prevent inadvertent run-off of adhesive

Manually approximate the wound edges with forceps or gloved fingers. Use gentle rubbing strokes to apply the film of liquid to the approximated wound edges, and friction proper eversion of the skin edges. Do not apply tissue adhesive. The adhesive should extend at least 1/2 centimeter on each side of the apposed wound edges. Apply tissue adhesive from above the wound.

Avoid seepage into the wound as it may delay healing.

When using tissue adhesive on the face, it is important to prevent the patient from holding onto the applicator tip for dead ends and to apply the tissue adhesive in a single quick and accurate direction. The patient will be told that the area will be slightly sensitive to touch any tissue adhesive, away from the application site.

Gradually build up three or four thin layers of adhesive. Ensure the adhesive is evenly distributed over the wound. Maintain the tension of the wound edges as the adhesive sets and forms a flexible film. This should occur about 1 minute after applying the last layer.

Do not apply ointments or medications on top of tissue adhesive.
Staples

Rapid closure of wounds (NOT ON FACE)
Scalp lacerations not involving the galea, linear and large, lacerations of the torso and extremities
Easy to apply
Cost effective
Can be used to evert tissue when placed properly
Staple removal follows suture removal guidelines

WOUND CARE

Keep dressing clean, dry, and intact for the first 48 hours.
On day 3 begin to clean wound with normal saline solution and cotton tips (wash and dry hands thoroughly before performing wound care.
Reapply antibiotic ointment or white petroleum jelly (Vaseline) and light dressing

Call your health care provider or the emergency department if:
The skin around the wound becomes red, swollen, hot or painful
The edges of the wound leak blood or pus or become malodorous
You have a fever of 100.5 F or higher
You notice red streaks in the skin around the wound
A suture “pops open”, and the edges of the wound pull away from each other
Keep all follow up and suture removal appointments

TIME TABLE FOR SUTURE REMOVAL

- FACE: 3-5 Days
- SCALP: 5 Days
- TRUNK: 7 Days
- HAND, ARM, OR LEG: 7-10 Days
- FOOT: 10 - 14 Days

SUTURE REMOVAL STEPS

Cleanse skin with normal saline solution
Grasp one of the ends of the suture and elevate suture
Gently elevate the suture with pick-ups, snip the suture with a scissors
Remove suture by gently pulling with forceps
Consider reinforcing wound with adhesive tape (ie. Proxi-strips or Steri-strips)
Provide well written wound care instructions with appropriate follow up
ANESTHETIZE, CLEAN, AND CLOSE WOUNDS WITH SUTURE

- Anesthetize wound
- Choose appropriate anesthetic agent
- Clean wound (wound preparation)
  - High-pressure irrigation: Recommended irrigation pressure is 5 to 8 psi which can be achieved by using a 30 to 60 ml syringe and a 19 gauge needle
  - Use 50 to 100 ml of irrigant per cm of laceration. If saline is not available for irrigation, tap water may be a good alternative.
  - Detergents, hydrogen peroxide, and concentrated povidone-iodine should be avoided in wound irrigation.
- Close wound
  - Choose suture method for wound closure

LET'S PRACTICE!

- Close Wound
  - Clasp needle in the needle driver 1/2-2/3 back from the tip
  - Rule of Halves
  - Start in Center and work way out this is the rule of halves
  - Needle enter 1/4 inch from edge at 90 degree angle
  - Evert wound edges
  - Take equal bites on both sides of wound
  - Tie knot to the side. Do not tie knot on the top of the wound.

References