Wound Assessment, Treatments, & Basic Suturing Techniques
-Suturing skills lab-
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Objectives...

Didactic

- Wound healing principals
- Disorders of wound healing
- Surgical Site Infection & Antibiotic Use
- Wound healing management
- Anesthetic Techniques
- Wound Closure principals

Skills lab

- Basic Suturing and knot tying techniques
Skin Layers & Function

- **Epidermis**
- **Dermis**
  - Comprised mostly of connective tissue & dermal appendages. Offers structural support via fibroblasts, collagen, & elastin
  - Is the key layer for achieving proper wound repair
“Normal” Wound Healing

Hemostasis & Inflammation (2-5 days)

Proliferation (5 days – 3 weeks)

Maturation & Remodeling (3 weeks – 2 years)
“Normal” Wound Healing

Hemostasis/Inflammation

- Disruption of basal lamina of vessels, bleeding, clotting & platelet activation. Brief period of vasoconstriction (minutes)
- Followed by histamine & vasodilation, Interleukin & cytokine release
- Release of growth factors from platelets & macrophages “begets” extracellular matrix...
  - PDGF-Platelet derived growth factor is the chemoattractant for
  - TGF-B-Transforming growth factor B which is the chemoattractant for..
  - Epidermal Growth factors-by fibroblasts – epithelialization
  - Vascular Endothelial growth factor- Angiogenesis
Normal wound Healing: Proliferation

- **Macrophages** engulf foreign bodies & recruit fibroblasts & stimulate angioneogenesis
  - **Fibroblasts** produce **glycosaminoglycans** is hydrated & turns into an amorphous gel (ground substance)
  - Fibroblasts secrete **collagen** type II
  - Collagen bed fills the defect allows for **new capillaries**.
- **Myofibroblasts** facilitate contraction & granulation
  - Align themselves along lines of tension & pull wound edges closer together facilitating **contraction** of the wound/incision
  - **Granulation tissue** is rapidly budding new blood capillaries surrounded by newly generated collagen fibrils
Maturation

- Starts approximately 3 weeks after “wounding”
  - Collagen cross-linking, remodeling and contraction.
  - Glycosaminoglycans ground substance is dehydrated & degraded.
- Tensile strength is 20% @week 3
- Collagen production peaks around week 6
- Tensile strength is 50% @week 6
- Type III collagen (raised pruritic red scar) is replaced by type I over time. Type I is the most abundant type of collagen in normal dermis.
- Collagen synthesis & degradation continue at elevated rates for approximately 1yr.
- **Tensile strength never exceed 80%**
Disorders of Wound Healing

Chronic Disorders
- Diabetes - ischemic microvascular disease, decreased efficiency of immune response & increase in infection
- Renal Disease – uremic toxins, venous congestion, calcium–phosphorus metabolism, including calciphylaxis
- Peripheral Vascular Disease - poor oxygen & nutrient delivery
- Obesity - Poor perfusion & oxygenation of subcutaneous adipose tissue

Congenital /Inherited Disorders
- Cutis Laxa
- Pseudoxanthoma Elasticum
- Ehler-Danlos Syndrome

“Other Factors”
Cutis Laxa

- Autosomal dominant, recessive, or x-linked.
- Rare disorder, skin hangs in loose folds $2^\circ$ to inadequacy of elastic tissue of skin, lungs & aorta.
- Non-functioning elastase inhibitor resulting in premature elastic fiber degeneration
  - However...normal wound healing
  - excision of redundant tissue widely successful.
Pseudoxanthoma Elasticum

- Autosomal Recessive
- Increased collagen degradation
- Deposits of Ca2+ and fat on elastic fibers manifest with extreme laxity of the skin with small yellow papules pebbled appearance on groin, axilla, & neck.
- Retinal & CV complications
- Surgical excision if the patient desires, but delayed healing and scarring have been reported secondary to trans-epidermal extrusion of calcium
- Fractional carbon dioxide laser may improve texture, volume, dispensability, and irregularity of skin lesions.\cite{46}
Ehler - Danlos syndrome

- Ehler Danlos Syndrome- “Cutis Hyperelastica”
- Autosomal Dominant
  - but rare
- 6 types;
- Fragile, soft, hyper-elastic, easily bruised, joint hypermobility, & aortic aneurysm.
- Defect in the structure, synthesis & abnormal molecular cross-linking of collagen, low tensile strength, & does not hold suture.
Disorders of Wound Healing...

“Other” Factors

Medications
- *Steroids* negatively affect the inflammatory phase by inhibiting macrophages & consequently fibrogenesis, angiogenesis, contraction, epithelialization & collagen production
- Anticoagulants & antiplatelet
  - Can be reversed by vitamin A 25000IU qd

Nutrition albumin
- Low albumin < 2.5gm/dl
- Vitamin deficiencies (A,C, & Zinc) - immature fibroplagia, delayed tensile strength

Hypoxia
- Degradation of hyaluronic acid

Hypothermia
- Wound healing is retarded at low core body T (95F / 35C)

Hydration
- Wounds heal best in warm moist environment (healing under the scab.. Occlusive drsg hasten epithelial repair)

Infection

Age

Cancer, chemotherapy agents

Radiation
- Arterial fibrosis, vascular destruction & necrosis- impaired O2 delivery
- Cytoplasmic & nuclear damage to fibroblasts limiting proliferation

Oxygen free radicals
- Degradation of collagen & hyaluronic acid & protein enzyme systems

Tension- “stretch marks” dermis stretched to point of collagen disruption, but epidermis remains intact. Scarred dermis is visible through translucent epidermis

Ischemia / Tissue Necrosis

Smoking
- Nicotene- vasoconstriction
- C.O.- left oxyhemoglobin shift & binding of oxygen to carbon creating reduced supply.
Disorders of “Excessive” Wound Healing
.. 5-15% of all wounds, 5 to 15 times > non-whites

**Hypertrophic**
- Excessive collagen deposition that occurs in the boundary of the scar
- Develops in first month
- Upper torso & flexor surfaces
- Young patients
- Equal sex distribution
- Black & Asians > White
- Improves with pressure, massage, silicone sheeting or excision.. Or subside independently

**Keloid**
- Excessive collagen deposition extends beyond boundary of the scar
- Face, earlobes, & chest
- Predominately Black with genetic disposition
- Women > Men
- Rarely subsides without therapy
- Combination of re-excision, steroid injection + radiation therapy

**Widespread Scars**
- Normal collagen deposition over a greater surface area related to prolonged or repeated mechanical stress during the maturation phase during the first 6 months. Arms, legs, & abdomen.
Surgical Site Infection

Infection can be defined as $10 \times 5^\text{th}$ organisms per gram of tissue. Burden of pathological organisms overwhelms body to combat them (leukocyte chemotaxis, migration, phagocytosis).

Surgical infection site rate nationally is 1.9% .. 2-5%.

Delays in wound cleaning is the most important factor.

- Infection decreases oxygenation & increases collagenolysis.
- Prolongs inflammatory phase.
- Decreases wound tensile strength.
- Impairs angioneogenesis & epithelialization.
Do I need to prescribe antibiotics?

“We recommend that healthy patients with minor wounds, other than bite wounds, who undergo laceration repair with sutures not be prescribed prophylactic antibiotics”

Facial wounds do not need empiric antibiotic tx.

Grossly contaminated, crush injury, exposed bone & joint older than 8 hours

PCN intra-oral wounds

Prophylactic antibiotics in patients with

- Soil or H20 contamination
  - Salt H20- Vibrio vulnificans
  - Fresh or Brackish H20 – Aeromonas hydrophobia
  - leeches

- Vascular insufficiency, peripheral artery disease, Devascularized wound

- Immunocompromised patients

- Wounds extending into joints, bone or nasal cartilage

- Bites
Bites...

**All bites**
- Wound exploration, debridement, & irrigation
- 5 day course of antibiotics
- Treat with a PCN

**Penicillin-**
- Augmentin (amoxicillin-clavulanate)
- (IV/IM Unasyn (Ampicillin + sulbactam)
- cephalexin.
- If penicillin allergy - Clindamycin
- Doxycycline, Erythromycin, and fluoroquinolone

**Dog Bite** - 5% risk
- Capnocytophaga canimorsus

**Cat Bite** – 80% risk
- Pasteurella Multocida,

**Human Bite** - 10-15% become infected
- Eikenella corrodens - gm neg anerobe
- Group A Streptococcus
### Empiric oral antibiotic therapy for animal bites

<table>
<thead>
<tr>
<th>Antibiotic agents</th>
<th>Adults</th>
<th>Children</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Agent of choice</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amoxicillin-clavulananate</td>
<td>875/125 mg twice daily</td>
<td>20 mg/kg per dose (amoxicillin component) two times daily (maximum 875 mg amoxicillin and 125 mg clavulanic acid per dose)*</td>
</tr>
</tbody>
</table>

**Alternate empiric regimens include:**

**One of the following agents with activity against *P. multocida*:**

<table>
<thead>
<tr>
<th>Drug</th>
<th>Dose</th>
<th>Children Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doxycycline</td>
<td>100 mg twice daily</td>
<td>Not recommended in children &lt;8 years of age</td>
</tr>
<tr>
<td>TMP-SMX</td>
<td>1 double strength tablet twice daily</td>
<td>4 to 5 mg/kg (trimethoprim component) per dose twice daily (maximum 160 mg trimethoprim per dose)</td>
</tr>
<tr>
<td>Penicillin VK</td>
<td>500 mg four times daily</td>
<td>12.5 mg/kg per dose four times daily (maximum 500 mg per dose)</td>
</tr>
<tr>
<td>Cefuroxime</td>
<td>500 mg twice daily</td>
<td>10 mg/kg per dose twice daily (maximum 500 mg per dose)</td>
</tr>
<tr>
<td>Moxifloxacin</td>
<td>400 mg once daily</td>
<td>Use with caution in children &lt;18 years of age</td>
</tr>
</tbody>
</table>

**PLUS**

**One of the following agents with anaerobic activity:**

<table>
<thead>
<tr>
<th>Drug</th>
<th>Dose</th>
<th>Children Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metronidazole</td>
<td>500 mg three times daily</td>
<td>10 mg/kg per dose three times daily (maximum 500 mg per dose)</td>
</tr>
<tr>
<td>Clindamycin</td>
<td>450 mg three times daily</td>
<td>10 mg/kg per dose three times daily (maximum 450 mg per dose)</td>
</tr>
</tbody>
</table>

**The following agents have poor activity against *P. multocida* and should be avoided:**

- Cephalexin
- Dicloxacillin
- Erythromycin

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*TMP-SMX: trimethoprim-sulfamethoxazole.

* In patients with infected bites, the clinician may increase the dose to 45 mg/kg per dose (amoxicillin component) twice daily (maximum 875 mg amoxicillin and 125 mg clavulanic acid per dose).

† May also be active against methicillin-resistant *Staphylococcus aureus* (check susceptibility testing).
Cellulitis or Cutaneous abscess

- **Pyogenic** (*pus producing*)
  - cover *staphylococcus*

- **Non-pyogenic**
  - cover *streptococcus*
  - Amoxicillin-clavulanate, Cephalexin, clindamycin if PCN allergy

- **MRSA**
  - Bactrim (TMP/SMX) or
  - Doxycycline or
  - Clindamycin

- Foot or Puncture Wounds:
  - *Psuedomonas aeruginosa*
    - 3 days or 3 days past clearance of wound inflammation
    - (Cipro, Levaquin, Piperacillin/tazobactam)

**Resources**
- “The Sandford Guide to Antimicrobial Therapy”
- UptoDate
  - www.uptodate.com
- IDSA (Infectious Disease Society of America)
- Individual Hospitals
- Antibiogram
Tetanus & Rabies

Clean or Minor wounds
- Incomplete tetanus series of 3 doses – Tetanus Toxoid (Td)
- Uncertain – Tetanus toxoid (Td)
- > 10 years since last tetanus – Tetanus Toxoid (Td)

Dirty Wound or “All other” wounds
- Incomplete tetanus series of 3 doses – Tetanus Td AND Tetanus Immunoglobulin
- Uncertain – Tetanus toxoid (Td) AND Tetanus Immunoglobulin
- > 5 years since last tetanus – Tetanus (Td)

Rabies vaccination for animal bites
Wound Healing Management...

Categories of Wound Healing

**Primary Intention**
- Halts bleeding, brings wound edges together, preserves tissue by providing rapid healing, prevents infection & better cosmetic outcome.
- Primary closure contraindicated in any grossly contaminated wound.

**Secondary Intention**
- Healing by spontaneous granulation, contraction, and epithelialization.

**Tertiary- Delayed Closure**
Considered when wound bed clean
Secondary Intention; Silver nitrate sticks

- Antimicrobial cauterizing agent: Free silver ions precipitate bacterial proteins by combining with chloride in tissue forming silver chloride; coagulates cellular protein to form an eschar.

- Silver ions can inhibit the growth of both gram-positive and gram-negative bacteria.
Wound Healing Management

- Moist & Warm environment
- Remove all non-viable tissue
- Clean Environment; infection free
  - Wash & remove dried blood to reduce bacterial proliferation & infection.
  - Copious irrigation
- Adequate blood supply
  - Quit Smoking (2-3 weeks before & after surgery)
  - Vascular Repair

When the above factors are controlled, then suture material and technique are important for primary or delayed primary closure
Pneumonic for Wound Repair

LACERATE:

- **Look (Assess)** the wound for function, provide hemostasis and determine repair options
- **Anesthetize** the wound
- **Cleanse / Debride**
- **Equipment setup**
- **Repair**
- **Assess results, Anticipate complications**
- **Tetanus immunization**
- **Educate the patient about wound care**
Wound Assessment / Patient History

- Location of injury
  - face, extremity, trunk, joint

- Size of wound injury
  - Exposed structure (skin, fat, muscle, bone)
  - What & how much tissue is missing?

- Mechanism of Injury
  - Crush, stab, or GSW
  - Foreign body?

- Degree of contamination

- Timing of injury

- Factors predisposing to poor wound healing:
  - immunosuppression, diabetes, collagen disorders

- Allergies: antibiotics, betadine, anesthetics, latex
Wound Healing Algorithm

Classic Reconstructive Ladder

Spontaneous Healing
Primary Closure
Skin Graft
Tissue Expansion
Local /Rotational Flap

Pedicle/ Rotational Flap

Free Flap
Repair Time Limits ...

Primary Repair (bacterial count increased by 3 hours)

- Face: Repair within 24 hours (18 hours preferred)
- Body: Repair within 18 hours (6 hours preferred)
- Tertiary/ Delayed primary closure 3-5 days (when wound’s clean & necrosis free)
"Special Wounds"

Face
- Eyelids
  - align “grey line”, close in layers, tarsorrhaphy stitch in lower lid
- Cheeks
  - examine for parotid duct or facial nerve injury
- Intra-oral
  - tongue, lips, mucosa
- Ears
  - hematoma- I&D, molded pressure drsg, 3-layer closure including cartilage if thru-n-thru..
  - Sulfamylon
  - Cauliflower ear deformity

Animal Bites
- Debridement, irrigation & antibiotics (oral PCN). May opt to not close deep puncture wound.

Human Bites
- Infected w/ Staph aureus, Strept Viridans & Eikenella Corrodens. TX exploration, debridement, irrigation, & antibiotics (oral Augmentin)

Open fracture, joint space, exposed tendon, nerves, vessels or unsure about

Amputated Parts
- place in saline soaked gauze in a bag. Put this bag on ice.
  - Re-transplant in 4-6 hrs.
“Langer’s”
Relaxed Skin Tension Lines

Plan placement of incision along natural lines of resting skin tension.
Wound Assessment

Function

Before anesthesia, perform Circulatory, Motor, & Sensory functional exams.
- may reveal significant injury needing consultation and/or operative repair.

After anesthesia, repeat functional exam with exploration for foreign bodies or further injuries.
Anesthetic Techniques

All local injectable ‘caines are weak bases & Work by limiting the influx of Na, thus propagation of the action potential of the neuron.

Topical
  - Betacaine, lidocaine, tetracaine (20%, 8%, 4%)
  - Onset 45 minutes to 1hr.

“Buzzy” the bee... scratch or rub skin proximal to the wound

Direct & Regional Blocks
Esters & Amides

**Ester**
- No “i” before -caine
- Short acting
- Metabolized in plasma
- Secreted in urine
- Used on patients with cirrhosis

**Amide**
- “i” before -caine
- Long acting
- Metabolized in liver
- Secreted in urine
- Rarely cause allergic reaction

**Cocaine, Procaine, Tetracaine, Benzocaine**

**Lidocaine, Bupivacaine, Ropivacaine,**
## Wound Preparation - Anesthesia

<table>
<thead>
<tr>
<th>Drug</th>
<th>Max Dose</th>
<th>Onset</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cocaine</td>
<td>6.6 mg/kg</td>
<td>Rapid</td>
<td>1 hour</td>
</tr>
<tr>
<td>Procaine</td>
<td>10-15 mg/kg</td>
<td>Rapid</td>
<td>30min-1hr</td>
</tr>
<tr>
<td>Tetracaine</td>
<td>1.5 mg/kg</td>
<td>Moderate</td>
<td>2 hours</td>
</tr>
<tr>
<td>Lidocaine</td>
<td>5 mg/kg</td>
<td>5-30 min*</td>
<td>2 hours</td>
</tr>
<tr>
<td>(…with Epi)</td>
<td>7 mg/kg</td>
<td>5-30 min</td>
<td>2-3 hours</td>
</tr>
<tr>
<td>Bupivacaine (Marcaine)</td>
<td>2 mg/kg</td>
<td>7-30 min</td>
<td>&gt; 6 hours</td>
</tr>
</tbody>
</table>
Solutions & Dilutions...
What does it mean ???

**Solutions**
- Percentages Concentrations:- x % of a drug denotes x-grams of the drug (or solute) in 100 milliliters of the solution. Eg. 1% lidocaine contains 1g of lidocaine in 100 mL of solution or 10mg/1ml

**Dilutions**
- Anything represented in an x : y (eg. 1:1000) = x-grams of drug (or solute) divided by y-milliliters of solution.
  - 1:1000 of an epinephrine solution contains 1g of epinephrine in 1000 mL of the solution or 1000mg in 1000ml or 1mg per 1cc
  - 1:100,000 Epi contains 1g in 100,000 ml or 1000mg in 100,000ml or 1mg per 100 ml
Anesthetic Techniques

- **Direct Infiltration**.. Into the wound edges.. slowly
  - Lidocaine 1-2% with or without epinephrine
    - Max dose with 7mg/kg (500mg)
    - Max dose without 4.5mg/kg (300mg)
  - Marcaine 0.25-0.5% with or without epinephrine
    - Max dose 2mg/kg (400mg/24hr)
  - 25, 27, 30 gauge needles

- **Buffering Solution Na HC03**
  - Decreases pain & time of onset of anesthetic
  - Increases the intensity of the blockade
  - Increase the pH by adding sodium bicarbonate
    - 1ml standard 8.3% NaBiCarb + 10ml of anesthetic

- **Regional Blocks**
  - Infra-orbital
  - Mental nerve
  - Modified Transthecal Block (fingers)

- **Others**
Facial Blocks:

- Supraborital & Supratrochlear Nerve
- Infra-orbital nerve
- Mental Nerve
- Inferior Alveolar Nerve
Lower facial blocks

- Inferior Alveolar Block
- Mental Nerve
Digital Blocks
Wound Preparation & Closure Principals

- **Infection free**
  - Cleanse the wound with chlorhexidine soap (scrub brushes used to cleanse skin prior to donning sterile gown & gloves) or betadine “scrub” to remove debris
  - Paint with betadine or chlorhexidine solution
  - Irrigate with psi of 5-8, 60ml for every 1cm of wound.
  - Clip Hair

- **Necrosis free**
  - Extend the inflammatory phase and wound healing.
  - Remove ALL dead tissue.

- **Free of Bleeding**
  - Deliberate control of bleeding during surgery to decrease risk of hematoma.
  - Avoid overzealous cauterization

- **Tension free**
  - Avoid excessive tension on skin edges to prevent ischemia
  - Avoid overly tight knotted sutures creating incisional edge ischemia
Methods of Primary Closure

- Staples
- Tissue Adhesives
- Sutures
Staples

Advantages of staples - rapid speed of closure by 70-80 %, decreased risk of infection, improved wound eversion, and minimal tissue reactivity.

Disadvantages - need for a second operator to ever and re-approximate skin edges during staple placement, greater risk of crosshatch marking, and less precise wound approximation. The cost is usually more than that of suture material.
Tissue Adhesives

- Octylcyanoacrylate (Dermabond; Ethicon)
  - 3-4 layers
- N-butyl-2-cyanoacrylate (Indermil; Syneture) polymerize
  - 1 layer
- Exothermic reaction on contact with fluid to form a 3-dimensional, strong, flexible bond, with uses comparable to those of 5-0 monofilament nylon.
- Simple lacerations, children, uncooperative patients, under casts, risk of no follow-up
- Reinforce incisions, antimicrobial & good cosmetic outcome
- Waterproof coating – but repeated washing removes adhesive
Pearls for Adhesive Placement

- Before application- skin must be defatted with alcohol or acetone.
- Appose wound edges tightly
- Steri-strips can be used to help hold wound edges together
- DO NOT GET ADHESIVE IN THE WOUND!!!
Surgical Instruments
Suture Size

0
2-0
3-0
4-0
# Suture Characteristics

## Characteristics of Sutures

<table>
<thead>
<tr>
<th>Suture Type</th>
<th>Knot Security</th>
<th>Wound Security</th>
<th>Tissue Reactivity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Absorbable Sutures</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surgical Gut</td>
<td>Poor</td>
<td>5-7 days</td>
<td>moderate</td>
</tr>
<tr>
<td>Chromic Gut</td>
<td>Fair</td>
<td>10-14 days</td>
<td>moderate</td>
</tr>
<tr>
<td>Polyglactin (vicryl)</td>
<td>Good</td>
<td>30 days</td>
<td>mild</td>
</tr>
<tr>
<td>Polyglycolic (dexon)</td>
<td>Best</td>
<td>30 days</td>
<td>mild</td>
</tr>
<tr>
<td>Polydixanone (PDS)</td>
<td>Fair</td>
<td>45-60 days</td>
<td>least</td>
</tr>
<tr>
<td>Polyglyconate (Maxon)</td>
<td>Fair</td>
<td>45-60 days</td>
<td>least</td>
</tr>
<tr>
<td><strong>Nonabsorbable Sutures</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nylon</td>
<td>Good</td>
<td>Good</td>
<td>Minimal</td>
</tr>
<tr>
<td>Polypropylene</td>
<td>Least</td>
<td>Best</td>
<td>Least</td>
</tr>
<tr>
<td>Silk</td>
<td>Best</td>
<td>Least</td>
<td>Most</td>
</tr>
</tbody>
</table>
Sutures

Absorbable & Non-absorbable, Monofilament & Multifilament, Synthetic & “Natural” material
Surgical Needles

- Wide variety with different company’s naming systems

- 2 basic configurations for curved needles
  - Cutting: cutting edge can cut through tough tissue, such as skin
  - Reverse cutting, skin closure
  - Tapered: no cutting edge. For softer tissue inside the body
## Needles

<table>
<thead>
<tr>
<th>Needle Shape</th>
<th>Point type</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Round bodied</td>
<td>🎀</td>
</tr>
<tr>
<td></td>
<td>Curved cutting</td>
<td>🔽</td>
</tr>
<tr>
<td></td>
<td>Reverse cutting</td>
<td>🔽</td>
</tr>
<tr>
<td></td>
<td>Reverse cutting prime</td>
<td>🔽</td>
</tr>
<tr>
<td></td>
<td>Taper cutting</td>
<td>🎀</td>
</tr>
<tr>
<td></td>
<td>Micro point reverse cutting</td>
<td>🎀</td>
</tr>
<tr>
<td></td>
<td>Micro point spatula curved</td>
<td>🎀</td>
</tr>
<tr>
<td></td>
<td>CSU Spatula</td>
<td>🎀</td>
</tr>
<tr>
<td></td>
<td>SBR Spatula</td>
<td>🎀</td>
</tr>
<tr>
<td>Location</td>
<td>Suture</td>
<td>Closure</td>
</tr>
<tr>
<td>----------</td>
<td>--------</td>
<td>---------</td>
</tr>
<tr>
<td>Face</td>
<td>5-0 or 6-0 nonabsorb monofil</td>
<td>Simple interrupted Layered of full-thickness</td>
</tr>
<tr>
<td>Scalp</td>
<td>Staples, 3-0 monofilament, nonabsorbable</td>
<td>Running or Locking</td>
</tr>
<tr>
<td>Lip</td>
<td>4-0 gut oral mucosa &amp; wet vermilion 6-0 monofil dry vermilion</td>
<td>Simple interrupted/ running Horizontal mattress mucosa</td>
</tr>
<tr>
<td>Eyebrow</td>
<td>5-0 synthetic absorbable</td>
<td>Inverted (Buried) dermal Running subcuticular</td>
</tr>
<tr>
<td>Eyelid</td>
<td>Skin 8-0 silk Tarsus 8-0 vicryl Fast-gut</td>
<td>Simple Interrupted</td>
</tr>
<tr>
<td>Hand</td>
<td>3-0 or 4-0 nonabsorbable monofilament</td>
<td>Simple Interrupted Horizontal mattress Single layer closure</td>
</tr>
<tr>
<td>Nailbed</td>
<td>5-0 Chromic</td>
<td>Simple Interrupted</td>
</tr>
<tr>
<td>Ear</td>
<td>Cartilage 5-0 synthetic absorbable Skin 6-0 mono nonabsorb</td>
<td>Simple Interrupted Sulfamylon to exposed cartilage</td>
</tr>
<tr>
<td>Trunk</td>
<td>Dermis 2-0 to 4-0 synthetic absorbable 3-0 synthetic absorbable staples @ skin</td>
<td>Inverted (Buried) dermal</td>
</tr>
</tbody>
</table>
Basic Suturing Techniques

- **Interrupted knot**
  - Simple interrupted
  - Vertical mattress
  - Horizontal mattress
- **Buried knot**
- **Running suture closure**
  - Locked (baseball stitch)
  - Unlocked
- **Hand Tie**
- **Instrument Tie**
Hand Positioning

Gripping a suture needle with a needle driver
Simple Suture Placement

The needle enters at 90° and is rolled in an arc resulting in equidistant entry and exit points. Taking more depth than width gives desired edge eversion.
Simple Suture Placement

- Can be used to close any wound with excellent cosmesis
- Divide the wound in halves to avoid dog ears
- Do not position the knot directly over the wound edge.

Repeat 3-4 throws to ensuring knot security.
- On each throw reverse the order of wrap.
“Buried” Dermal Sutures

Note that the knot is buried in the depth of the wound & the suture is in the dermis not fat.
Vertical Mattress Sutures

Useful to take tension off wound edges without using dermal sutures

Everts wound edges
Horizontal Mattress

Good for closing wound edges under high tension, everting wound edges... And for hemostasis.
Running Subcuticular

Needle passes parallel to incision along the dermal-epidermal junction, alternating sides
Running Suture
Locked & Unlocked

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Suturing Pearls

- Careful Hemostasis
- Tension Free Closure
  - Undermine wound edges to relieve tension (separate the dermis from the fat)
- Gently tissue handling with instrumentation.
- Gentle apposition with slight Eversion of wound edges
- Make yourself comfortable
  - Adjust the chair & the light
Suturing Pearls

- Tensile strength of a suture should not need to exceed that of the tissue it is securing.
- “Change” the laceration or wound
  - Approximate sharp clean tissue edges
  - Place incision parallel with natural lines of resting skin tension.
- Accurate alignment of “like with like” tissue
- Sutures placed on the face should be approximately 2–3 mm from the skin edge and 3–5 mm apart.
- Sutures placed elsewhere on the body should be approximately 3–4 mm from the skin edge and 5–10 mm apart.
**Timing For Suture Removal**

<table>
<thead>
<tr>
<th>Location</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face</td>
<td>3 - 5 days</td>
</tr>
<tr>
<td>Torso</td>
<td>7 days</td>
</tr>
<tr>
<td>Scalp</td>
<td>7 days</td>
</tr>
<tr>
<td>Extremities</td>
<td>7 - 10 days</td>
</tr>
<tr>
<td>Joints</td>
<td>14 - 21 days</td>
</tr>
</tbody>
</table>

*Secure wounds with adhesive tapes or tissue adhesive after removal*
Absorbable vs Non-absorbable

**Absorbable sutures**
- Leave dressing in place 24 hours
- Keep dry “theoretical” risk of loss of tensile strength & dehiscence
- Antibiotic ointment BID
- Avoid swimming in natural bodies of water potential risk of infection.

**Non-Absorbable sutures**
- Leave dressing in place 24 hours
- Ok to shower & wash with soap and water (Complete bridging of the wound occurs within 48 hours after suturing)
- Antibiotic ointment BID until suture removal.
- ½ strength H2O2 to remove crusting over suture knots.
- Avoid swimming in natural bodies of water
Patient Education and Wound healing Management after closure

- Keep incision line clean
- Keep incision line moist.
  - Dressings should provide protection, maintain moisture, absorb drainage
- Leave dressing in place for 24-48 hours.
- Shower after 24-48 hours
  - Gently cleanse with soap & rinse with H2O
  - Bacitracin BID, thin layer
- Splint the incision if possible
- Hyperglycemia- modification of proteins & enzymes at the basement membrane altering permeability.
- Signs of infection
  - Do not immerse in water; No swimming, tub baths, or hot tubs

Yes, the patient WILL have a scar
- Scar revision considered in 3 to 6 months.. Scar is not fully mature for at least a year.
What about those lotions & potions

- Vitamin A - stimulate collagen deposition
- Vitamin E - may be anecdotal (anti-oxidant, anti-inflammatory)
- Onion Extract (Mederma- dermal collagen organization)
- Zinc - co-factor for RNA & DNA polymerase - epithelialization & fibroblast proliferation
- Vitamin C -
  - essential co-factor in synthesis of collagen
  - Synthesis extra-cellular fibrin matrix
  - Angiogenesis
  - Wound tensile strength
Suturing Skills Lab

- Hand Tie
- Instrument Tie
- Single Interrupted
- Buried Knots (upside down & single interrupted)
- Running Suture
  - Unlocked & Locked
- Subcuticular
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Digital blocks:

Modified Transthecal

Ulnar & Radial Blocks

Antibiotics?

- Yes - if grossly contaminated, crush injury, exposed bone & joint or older than 8 hours.
- Cover staphylococcus – cephalexin, clindamycin if PCN allergy, Bactrim, or Doxycycline
- PCN for intra-oral wounds

All bites –
- Wound exploration, debridement, & irrigation.
- 5 day course of antibiotics
- can be treated with IV/IM Unasyn (ampicillin + sulbactam)
- Oral treatment with Augmentin (amoxicillin + clavulanate)

Human Bites
- 50% risk of infection
- Infected w/ Staph aureus, Strept Viridans & Eikenella Corrodens exploration, debridement, irrigation, & antibiotics (oral Augmentin)

Dog Bites
- 5% risk of infection, Augmentin

Cat Bites
- 80% risk of infection, Pasturella Multocida (gm – rod)

Oral lacerations

Foot Wounds / Puncture wounds

Pseudomonas aeruginosa 3 days or 3 days past clearance of wound inflammation. (Ciprofloxacin. Levaquin, Piperacillin/tazobactam)