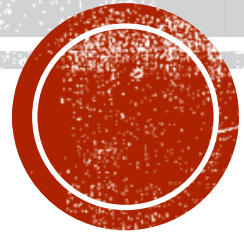
WOUND COVERAGE TECHNIQUES FOR THE INJURED EXTREMITY

(FOR THE ORTHOPAEDIC TRAUMA SURGEON)



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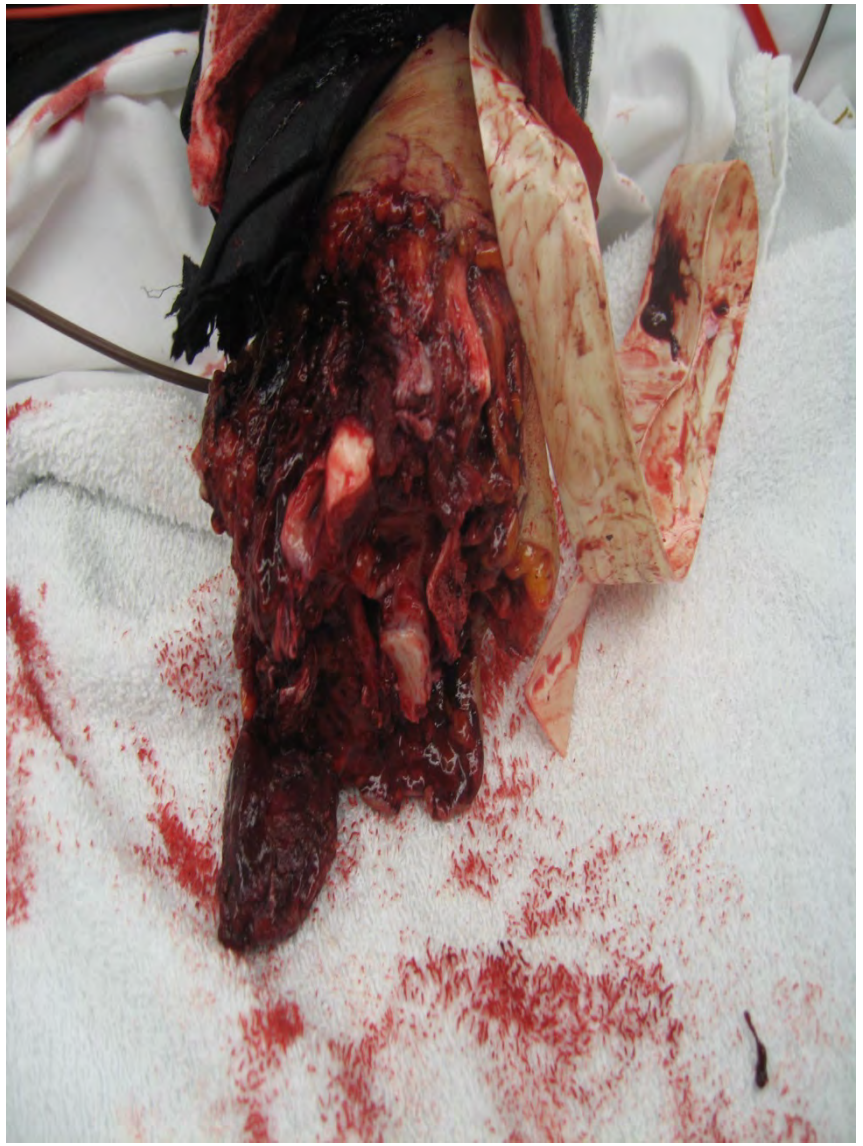
OBJECTIVES:

- Review multi-disciplinary approach to evaluation and treatment of Soft Tissue injuries

- Review methods of coverage we can employ
  - Primary vs. Secondary closure and healing
  - Skin grafting
    - STSG
    - FTSG
    - Skin Graft Substitutes
  - Rotational Flap Options

ASSESSMENT OF PATIENT

- History
  - Time and mechanism of injury
  - Patient variables
    - Age
    - Diabetes
    - Malnutrition
    - Obesity
    - Infection
    - Smoker
    - Medications
    - Underlying physiology
  - Functional Demands of the Patient
  - Occupation



ASSESSMENT OF PATIENT

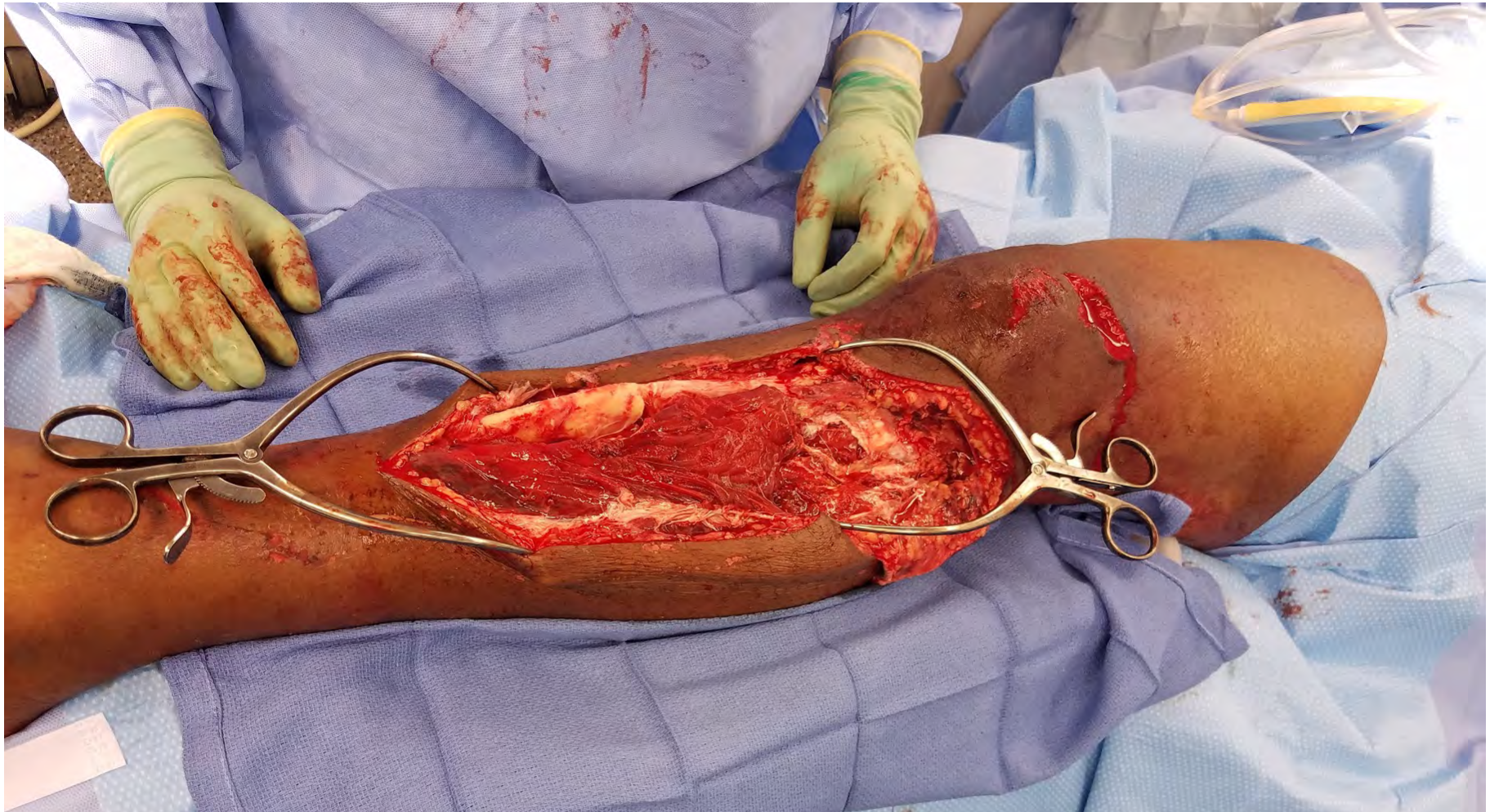
- Physical exam
  - Severity of Injury
  - Energy of Injury
  - Morphology of associated fracture
  - Bone loss
  - Blood supply
  - Location

INITIAL TREATMENT

- **Management of soft tissue injury requires:**
  - Early intravenous antibiotics
    - Work going on to have EMS administer
    - Within 1hr of injury decreases infection risk
  - **Tetanus prophylaxis**
  - Early aggressive debridement in OR
  - Skeletal stabilization
  - Timely soft tissue coverage
    - Less than 72hrs best
    - Less than 7 days a must

INITIAL OPERATIVE TREATMENT

- Debridement:
  - Conversion of traumatic wound to a "surgical" wound with debridement of all devitalized tissue – skin, fascia, and bone



Debride, Debride, Debride!!!!!!!!!

SUBSEQUENT OPERATIVE TREATMENTS:

- Restore Vascularity
  - No Blood…No Heal
- Stabilize skeletal injury – Stops ongoing trauma; Provides pain relief
  - Splinting
  - External Fixation
  - Early Appropriate Care vs. Damage Control Orthopaedics
- Repair nerves – If an option
- Repair musculotendinous units – If possible
- PLAN reconstruction
  - When patient is best physiologically stable
  - When best team is available for reconstruction(s)

RECONSTRUCTIVE LADDER

RECONSTRUCTIVE LADDER

Methods	Types
Direct closure	Primary Secondary
Skin Grafts	STSG FTSG
Local and Regional Flaps	Gastroc, Soleus, Reverse Sural
Distant Pedicle Flaps	Cross Leg
Free Flaps	Rectus, Latissmus, ALTF

WOUND BED PREPARATION

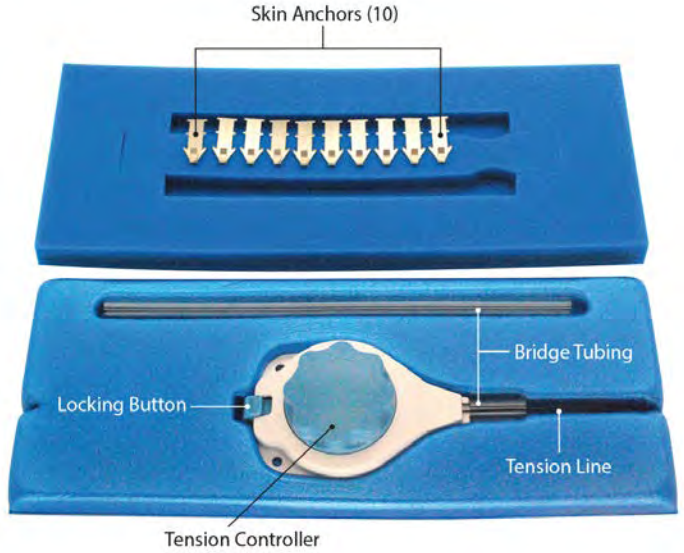
- Vascularity
- Hemostasis
- Debride all necrotic tissue
- Optimize
  co-morbid conditions

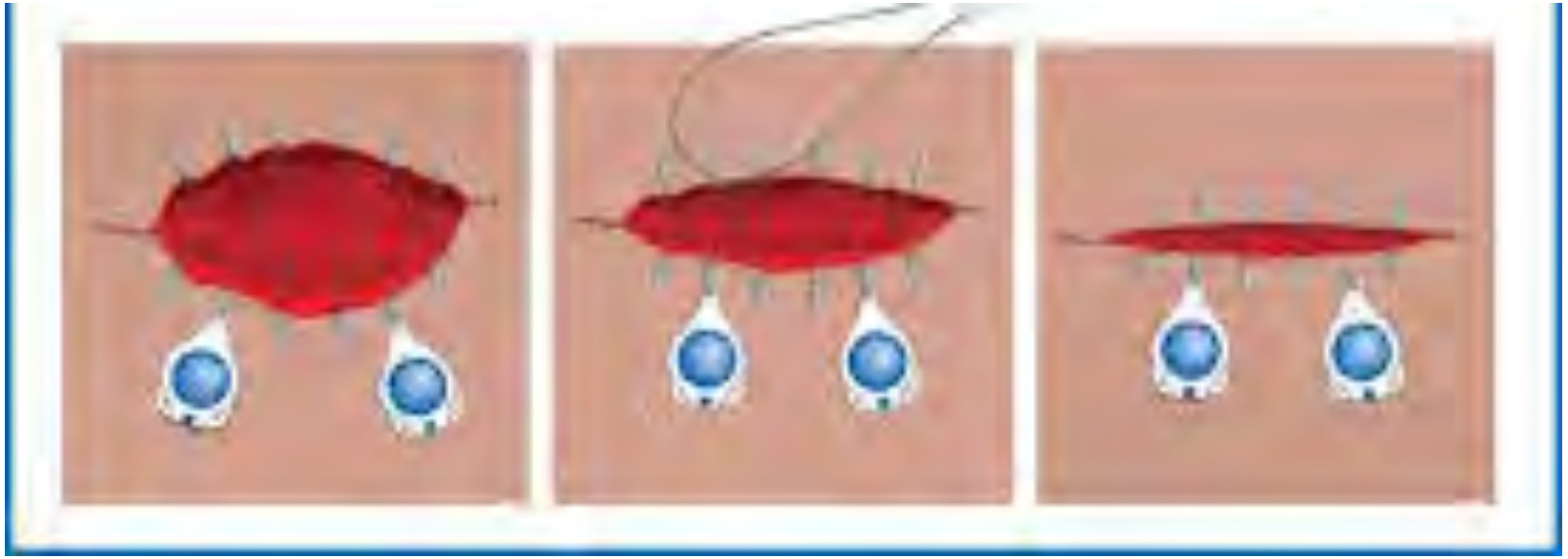
PRIMARY CLOSURE

- Direct closure is simplest and often most effective means of achieving viable coverage
- May need to "recruit" more skin to achieve a tension free closure
- Decreasing wound tension can be accomplished by:
  - Relaxing skin incisions
  - "Pie crusting" of the skin under tension (perpendicular to the direction of tension)
  - Application of negative pressure wound therapy

PRIMARY CLOSURE/TISSUE EXPANSION

Dermaclose





SKIN GRAFTS

- STSG
  - 0.015 inches thick (thickness #15 scalpel)
  - Lateral buttock
  - Ant. and Lat. Thigh
  - Lower abdomen
  - Avoid medial thigh and forearm
- FTSG
  - Depends on area to be covered
  - Large grafts-lower abdomen and groin
  - Small- medial brachium and volar wrist crease
  - Plantar skin from instep

SPLIT THICKNESS SKIN GRAFT

- Advantages
  - May be meshed
  - Can cover a large area
  - Require less revascularization
  - Can be used as temporary coverage
- Disadvantages
  - Poor cosmesis
  - Limited durability
  - Contracts over time
  - Does not typically "take" over tendons, nerves, vessels, bone
  - Donor site problems
    - Pain
    - Infection

FULL THICKNESS SKIN GRAFT

- Advantages
  - No wound contracture
  - Increased sensibility
  - Increased durability
  - Better cosmesis
  - Primary closure of donor site
- Disadvantages
  - Longer to revascularize
  - Cannot mesh
    - Less area can be covered
  - Recipient site must have rich vasculature

SPLIT VS FULL THICKNESS SKIN GRAFT

SKIN HARVEST FOR STSG

- Figure out how much you need and mark skin
- Lubricate – Mineral Oil
- Set depth (0.012 inch most common)
- Traction with tongue blade
- Start dermatome off skin
- Continuous slow movement with gentle pressure
- Cut with Metzenbaums if does not amputate when at end of harvest
- Mesh

SKIN HARVEST FOR FTSG

- Use template of your wound
- Cut out full thickness harvest of desired size
  - Taking all layers from skin down fascial layer but leaving fascia
  - Use ellipse if possible as donor site closes easier
- Defat after harvest
  - If necessary
- Apply and compress with moist bolster or wound vac
- Immobilize

SKIN GRAFT SUBSTITUTES

- Can be used in lieu of or in conjunction with more typical skin grafts
- Can be used first to cover vessels, nerves, and tendons so that a typical skin graft will take
- Come in bovine and porcine variants as well as autologous composites
- Wide variety of sizes and some can be cut to size
- Wide variety of thicknesses and layers both meshed and unmeshed

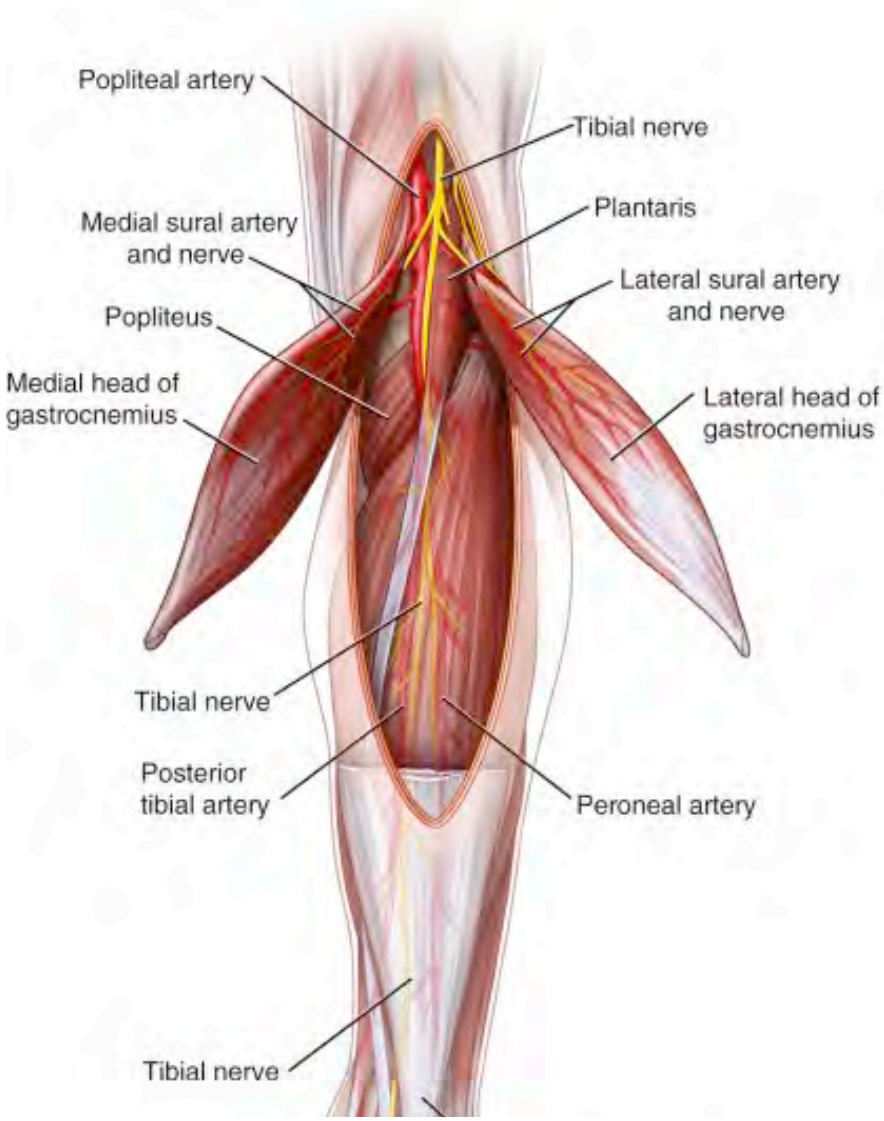
SKIN GRAFT SUBSTITUTES

SKIN GRAFT SUBSTITUTES

SKIN GRAFT SUBSTITUTE

MEDIAL GASTROCNEMIUS FLAP

- Good for proximal 1/3rd tibial wounds, anterior knee wounds, possible distal femur wounds
- Arterial flow comes from the sural artery, a branch off the popliteal artery
- Flow comes from a proximal to distal direction
- Can use lateral head but smaller, less excursion, harder to rotate, and MUST consider the peroneal nerve



MEDIAL GASTROCNEMIUS FLAP

- Technique:
  - Wound bed is clean and ready
  - Medial incision similar to fasciotomy incision
  - Incise superficial posterior compartment fascia
  - Digitally separate medial head of gastroc from skin and subcutaneous layer more posteriorly and from soleus musculature more anteriorly
  - Identify midline and 2 heads of the gastroc
    - Can be done from anterior or posterior surface of gastroc musculature
    - Sural nerve
  - Elevate about 1cm cuff of fascia off Achilles distally
  - Use curved Mayo scissors to cut fascial cuff and curve up and medially and superiorly along midline separating the 2 heads of the gastroc

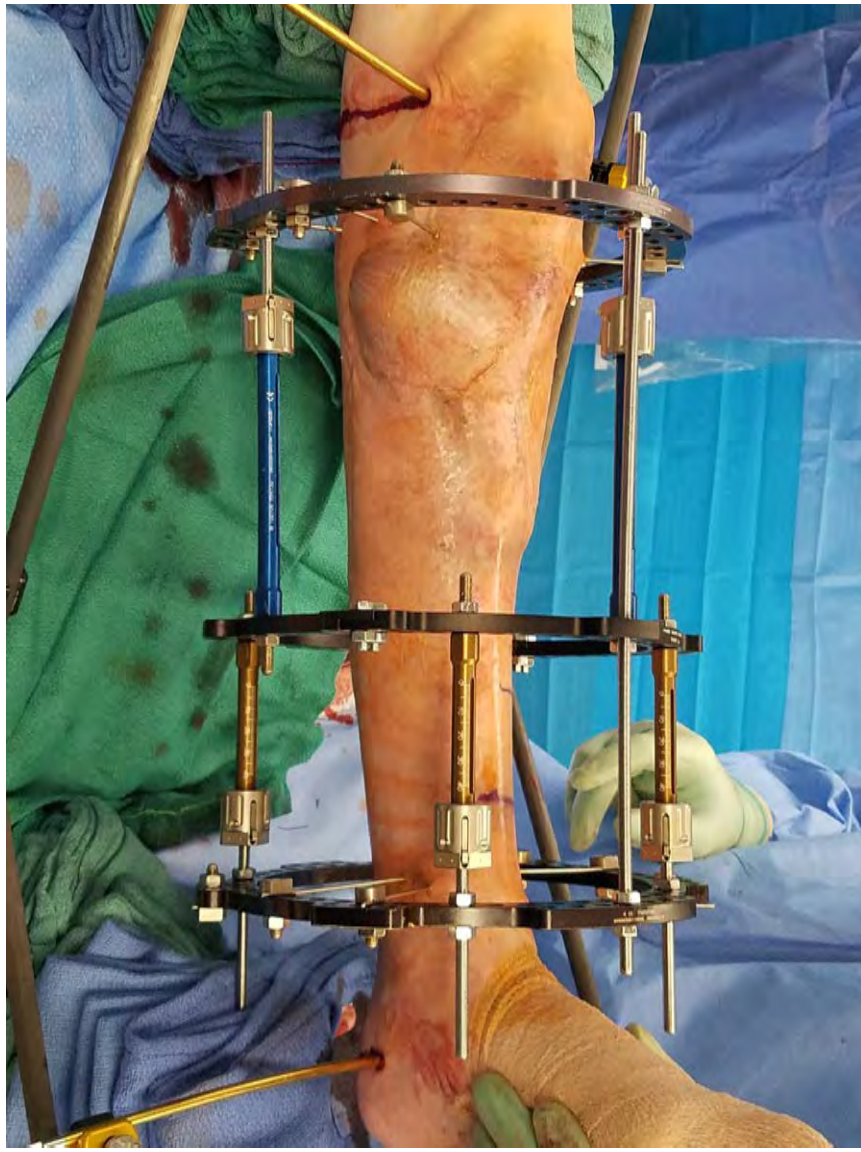
MEDIAL GASTROCNEMIUS FLAP

- Technique Cont:
  - Use fingers to break up adhesions proximally all the way to the posterior femoral condyle
    - Maximizes excursion of flap
  - If going to tunnel flap, create a wide subcutaneous tunnel from flap to defect
    - Can also incise skin and lay flap in

MEDIAL GASTROCNEMIUS FLAP

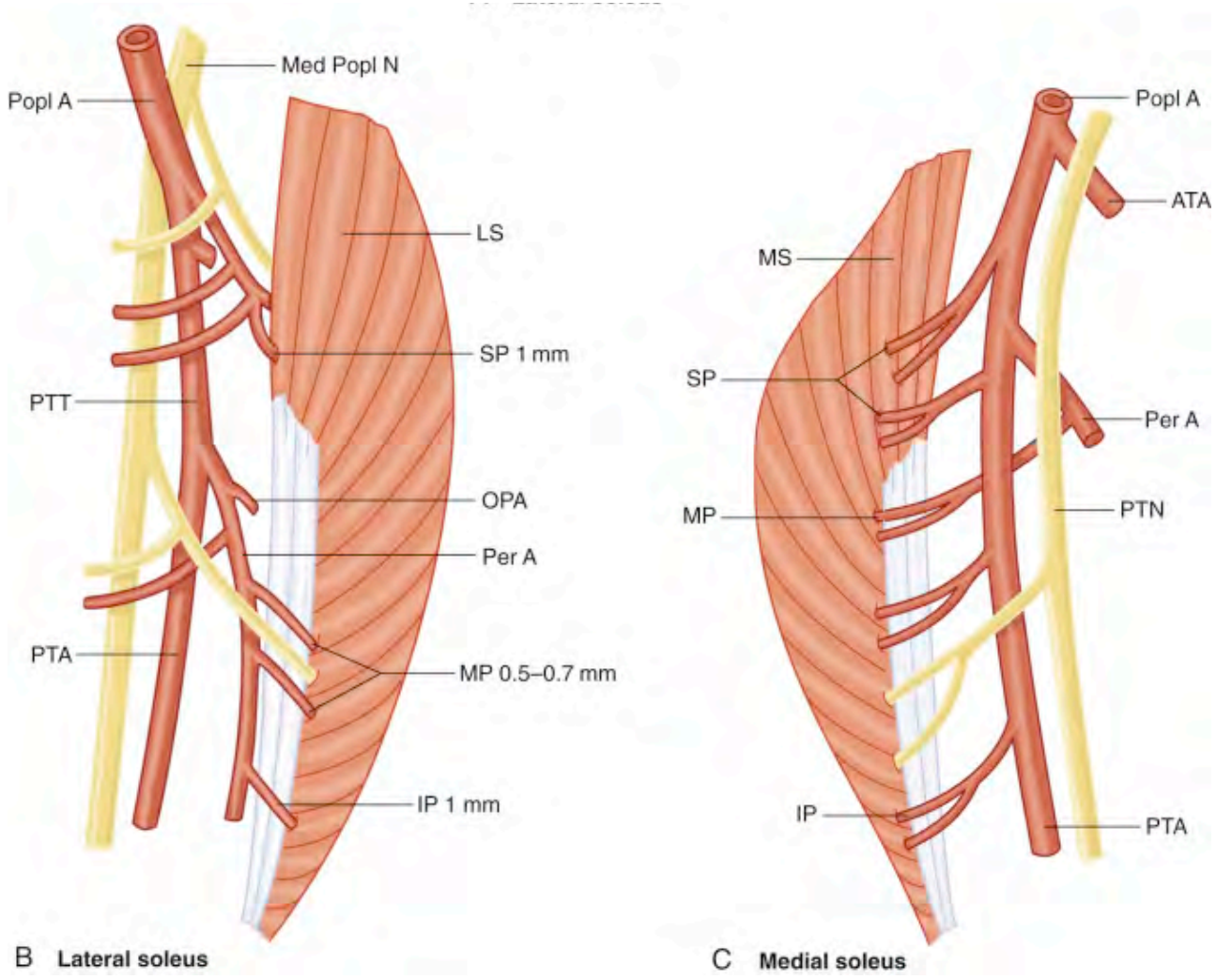
- Technique Cont:
  - At the lateral extent of the defect, elevate the skin and subQ to be able to inset flap
  - Place heavy suture to inset flap
    - Sutures go in tendonous/fascial cuff that you harvested with flap
    - May need to trial several times to make sure flap in good position and gong to cover defect
    - Use multiple inset sutures
  - Place sutures around flap to tension share and hold flap in position
  - If more width or length required of flap, can score underside of flap but DO NOT go deep with scoring or you will get into the blood supply
  - Skin graft flap
  - Immobilize knee joint for a few weeks to allow healing

MEDIAL GASTROCNEMIUS FLAP



SOLEUS FLAP

- Appropriate for middle 1/3rd tibial defects
- Can be taken as a whole soleus or hemi soleus
  - Does have a medial and lateral muscle belly but no distinct midline like the Gastroc flap
- Supplied by perforators from the popliteal artery superiorly and posterior tibial artery distally
- Narrower muscle belly compared to gastroc and a somewhat less robust vascular supply
- Less tolerant of tension compared to gastroc flap so harvesting and mobilization of muscle belly can be technically demanding

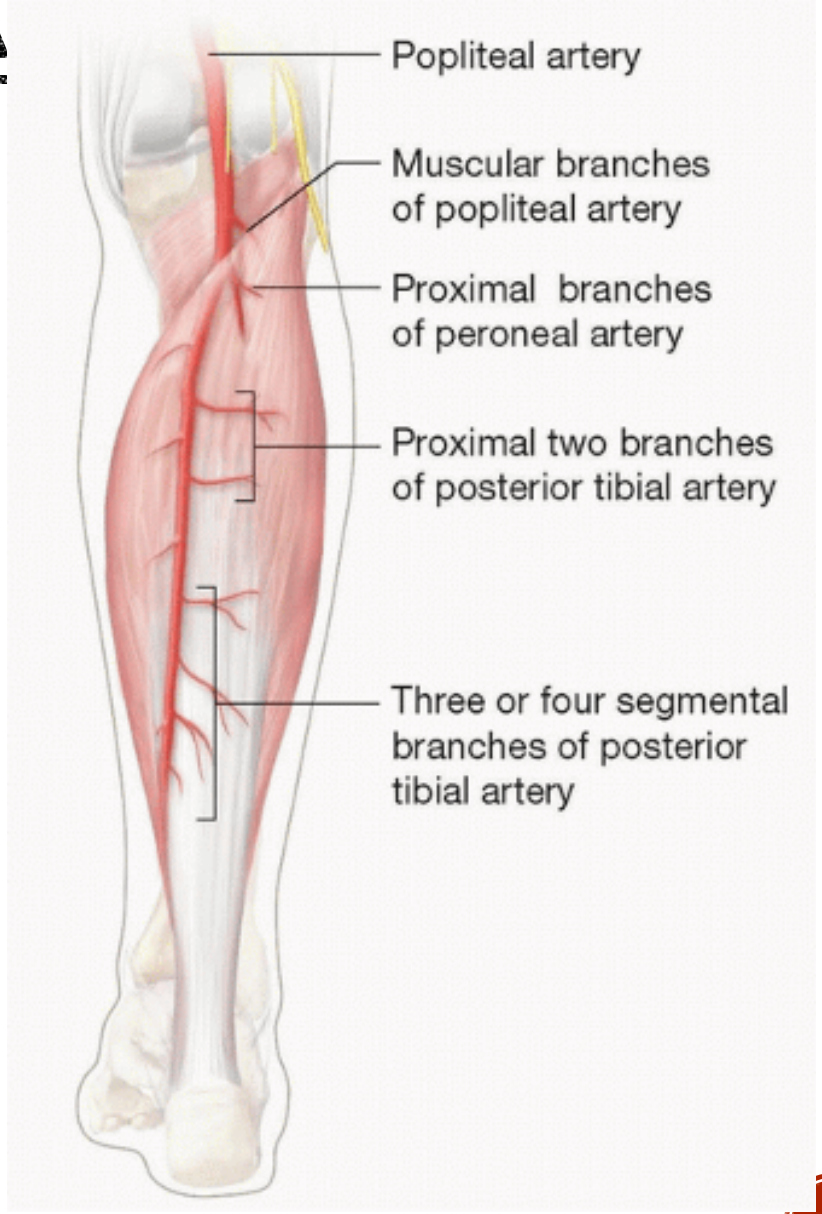


SOLEUS FLAP

- Can be amputated from the bottom at the Achilles and rotated up (Soleus Flap) or from the top and rotated down (Reverse Hemi Soleus Flap)

- Tip necrosis is common due to less robust blood flow compared to Gastroc Flap

- Best to leave as many perforating vessels as you can but still be able to have excursion to cover defect
  - Must leave at least the last 2 perforators depending on which way you are rotating flap

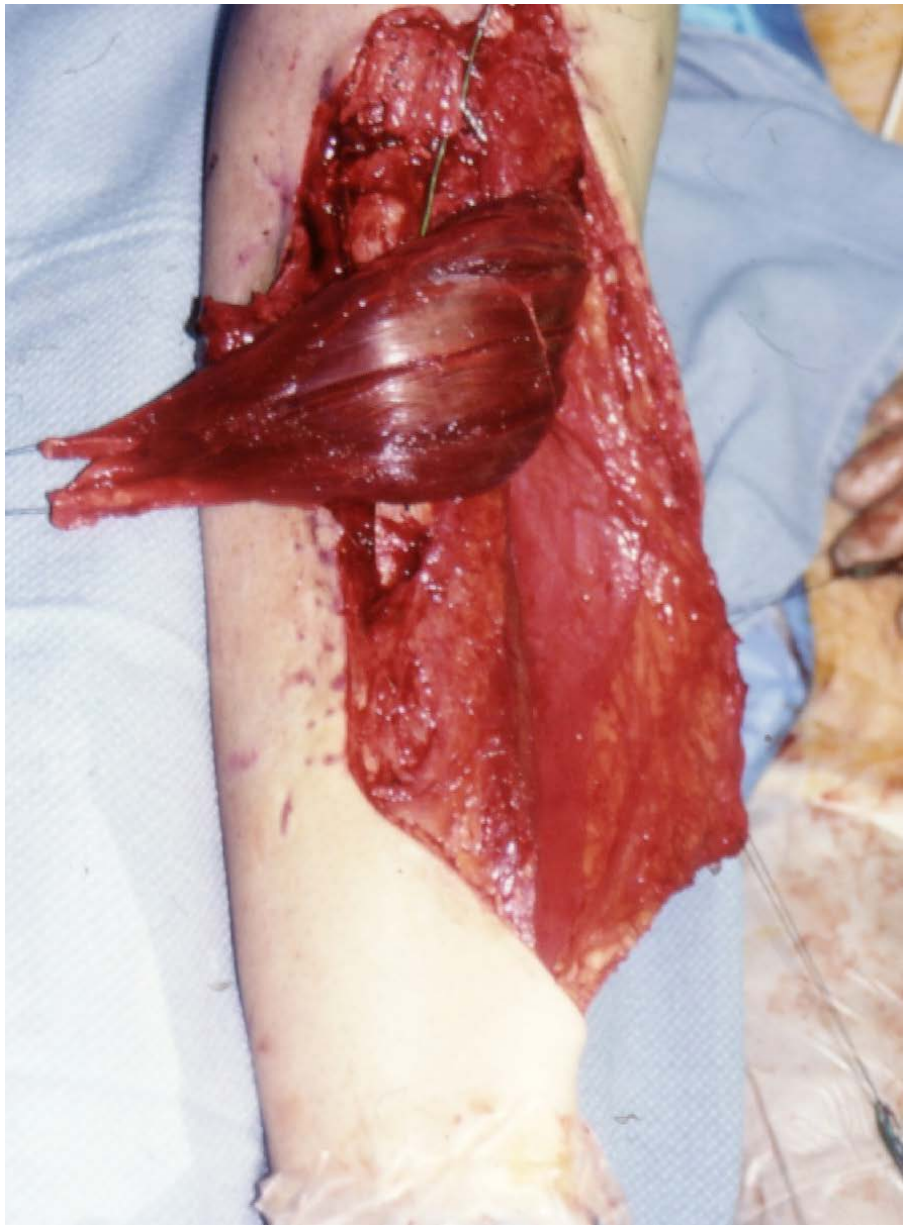


SOLEUS FLAP

- Technique:
  - Same medial incision as you do for gastroc flap
    - Typically include the defect in the incision if you can.
  - Separate gastroc from soleus with finger dissection as you would do for gastroc flap
  - Carefully separate anterior aspect of soleus from the deep posterior compartment
  - KEY: While separating from deep posterior compartment you have to be looking for the perforators and the posterior tibial neurovascular bundle
  - Ligate necessary perforators to be able to rotate flap

SOLEUS FLAP

- Technique Cont:
  - Amputate with curved mayo scissors and free adhesions to be able to rotate
  - Can tunnel if your defect is more anterior but remember it is not a robust flap so does not take pulling on it very well
  - Inset flap and try to suture down to anterior compartment fascia
  - Skin graft



REVERSE SURAL FLAP

- Option for mid- to distal tibia, medial and lateral ankle and hindfoot, as well as heel
- Supplied by most distal perforating artery of peroneal artery which is located approximately 5-7 cm above tip of lateral malleolus
- Offers technical advantages such as easy dissection with preservation of more important vascular structures in limb, variable paddle size allowing complete coverage of soft tissue defect without need of microsurgical anastomosis

REVERSE SURAL FLAP

- Technique:
  - If previous trauma or surgery to the lateral side of ankle or hindfoot, consider supercharging/staging flap as a 2-stage process
    - Elevate proximal 2/3rds of proposed paddle, ligate antegrade artery and sural nerve
    - Suture paddle back down
    - Let sit for 10 days and then check paddle for skin necrosis
      - If necrosis, abandon flap option and move to another option
    - Evaluating retrograde flow to flap
  - Demarcate planned flap
    - "No go/cut" zone 5cm up from tip of lateral malleolus
      - Also called "pivot point"
    - Pedicle length
      - Distance from midline pivot point to defect +1cm or 2cm if going to plantar foot
      - Can use paper ruler or suture to gauge needed pedicle length
    - Paddle length and width
      - Measured from defect
      - Add some extra so paddle not sewn in in tension
    - Midline of posterior leg
    - 2cm line on each side of midline of leg

REVERSE SURAL FLAP

- Technique Cont:
  - Incise superior aspect of paddle full thickness skin, subQ, and fascia of gastroc
    - KEY – Do not separate layers. Must be kept as whole to insure blood flow to tip of flap
  - Ligate antegrade artery as well as vein and sural nerve
    - If supercharging, stop here and sew back down and wait 10 days
  - Incise paddle to 2cm pedicle lines previously drawn
  - Incise oblique skin lines of paddle to midline of leg mark
    - SKIN ONLY
  - Incise midline leg mark down to pivot point
    - SKIN ONLY

REVERSE SURAL FLAP

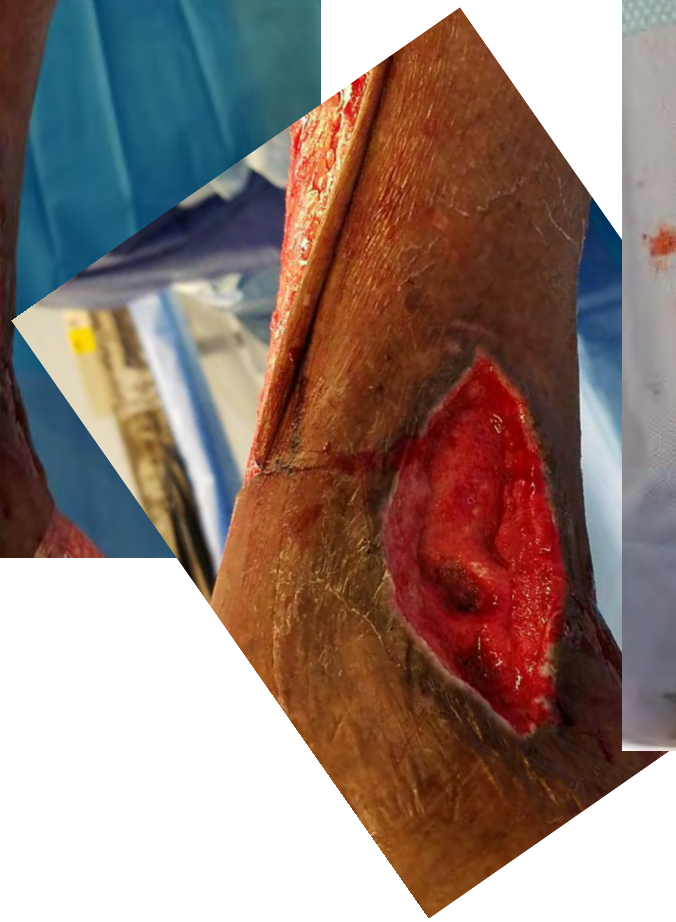
- Elevate SKIN ONLY in subdermal layer medial and laterally to the 2cm marks revealing what will be the pedicle
  - All fat should be kept with pedicle
  - Should be able to see follicles on undersurface of skin (peau d' Orange appearance)
- Elevate pedicle by incising at medial and lateral 2cm marks going from proximal to distal all the way down to 5cm "No Go" line
  - Can use knife, Metzenbaum, or curved mayo scissors
- Should be at same depth as paddle and include subQ and underlying fascia of gastroc and expose Achilles tendon distally

REVERSE SURAL FLAP

- Technique Cont:
  - Paddle and pedicle now ready to be placed in defect
  - THIS FLAP CANNOT BE TUNNELED
    - You will compress arterial flow to flap and kill it
  - From "No Go" line to defect, incise skin and elevate in subdermal fashion as you did pedicle skin flaps above
    - Wide enough elevation to lay your pedicle width into
  - Rotate pedicle and paddle into defect and assess fit

REVERSE SURAL FLAP

- Sew flap in with ~~no touch technique~~
- Close skin over pedicle harvest site but DO NOT CLOSE SKIN OVER PEDICLE
- Close skin over paddle donor site if possible; and if not skin graft
- Skin graft pedicle and paddle site as necessary
- Vac over skin grafted areas
- Immobilize in bulky jones splint with no weight bearing or dependent positioning for 4 weeks





THANK YOU