

Surgical Considerations in Lower Extremity Amputation

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Disclosures

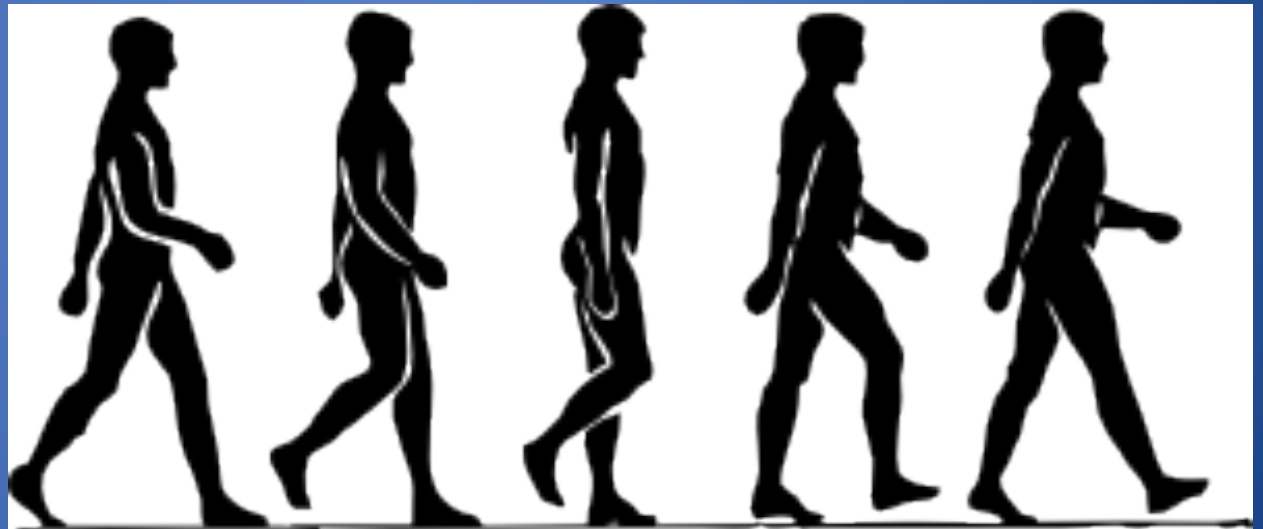
- None
- Original presentation by Brett Crist, MD

Objectives

- Understand the indications for lower extremity amputation
- Understand the principles and goals of lower extremity amputation
- Review specific levels of amputation and important considerations for each
- Review special considerations involving lower extremity reconstruction

Lower Extremity: Purpose

- Ambulation/locomotion



Indications for Amputations

- Trauma
 - Acute
 - Chronic
- Medical Co-morbidities



Amputation Due to Trauma

- Trauma
 - 20-40 y/o males
 - 16% of amputations
 - 45% of amputees



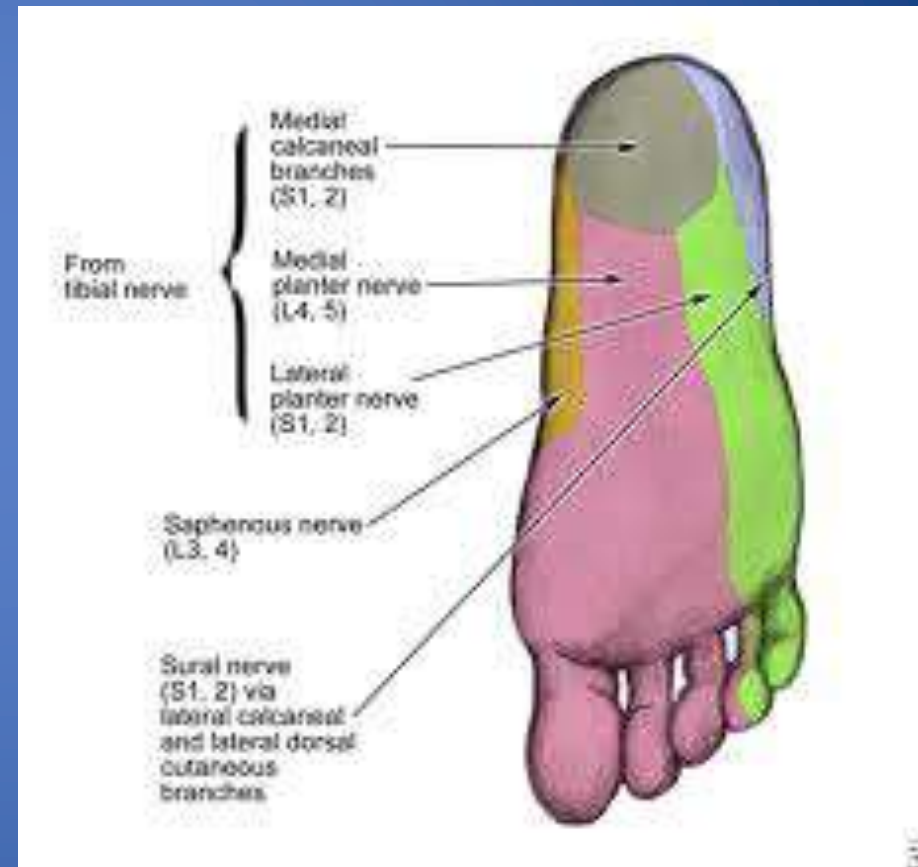
Indications for Amputation

- LEAP
 - 569 patients followed prospectively
 - Amp vs. limb salvage
 - 2 and 7 year data
 - Hospitalization
 - White collar
 - =?



Indications for Amputation

- Lack of plantar sensation
 - Not equal automatic amputation
 - >50% of salvages with initial lack of plantar sensation recovered by 2 years



Indications for Amputation

- Military
 - Pushing the envelope
 - Extremity War Injuries Symposia



Amputations Among Military

- Increased number of 3 and 4 extremity amputees
- IED's = infection
- Soldiers with tourniquets
- Significant psychological and societal implications



Indications for Amputations

- Infection
 - 2^o to diabetes
- Peripheral Vascular Disease
 - 2^o to diabetes (71%)
 - 80% of lower extremity amputees

Indications for Amputations

- Neurological disorders
 - Peripheral neuropathy 2^o to diabetes
 - Lack of protective sensation
- Burn
- Congenital deformities
- Malignant tumors
 - Clear margin

Successful Amputation

- Removal of dysfunctional/devitalized tissue
 - easy
- Reconstruction of a durable residual limb
 - challenging



Goals of Amputation Surgery

- Preservation of Length
 - Prevention of adjacent joint contractures
- Preservation of function
 - Minimize energy expenditure
- Early return to function
 - Early prosthetic fitting when possible
- Painless residual limb
 - Prevention of symptomatic neuromas
 - Minimize phantom limb pain
- Preservation of Life



Energy Expenditure

- Normal energy expenditure
 - Walking
 - O₂ consumption
- Level of amputation
 - Higher = more energy

Amputation Level	Energy Above Baseline (%)	Speed (m/min)	O ₂ Cost (mL/kg/m)
Long transtibial	10	70	0.17
Average transtibial	25	60	0.20
Short transtibial	40	50	0.20
Bilateral transtibial	41	50	0.20
Transfemoral	65	40	0.28
Wheelchair	0-8	70	0.16

General Amputation Principles

- Skin
- Muscle
- Nerves
- Blood Vessels
- Bone



Skin

- Painless, pliable, nonadherent scar
- Scar placement and prosthetic wear
 - Viable level
- Coverage:
 - Flap coverage
 - Skin graft

Muscle

- Myofascial closure
 - Provides minimal muscle stabilization
- Myoplasty
 - Balances opposing muscle groups
- Myodesis
 - Attach muscle to bone
- Tenodesis
 - Attach tendon to bone

Nerves

- Avoiding painful neuromas
 1. Separate nerve from vessels
 2. Traction nerve and sharply transect
 - Retracts to safety
 3. Nerve preparation
 - Injection of alcohol

Blood Vessels

- Suture ligate major vessels
- Full-thickness skin flaps
 - Minimize wound necrosis
- Hemostasis prior to closure
 - Drains

Bone

- Minimize sharp edges
 - Beveling/filing
- Narrow metaphyseal flare/condyles
- Cap intramedullary canal
 - Minimize bleeding
- Minimize periosteal stripping
 - Exostosis

Levels of Amputation

Levels of Amputation

- Toe
- Ray resection
- Partial forefoot
- Transmetatarsal
- Symes
- Modified Symes
- BKA
- Through knee
- AKA
- Hip Disarticulation
- Hemipelvectomy

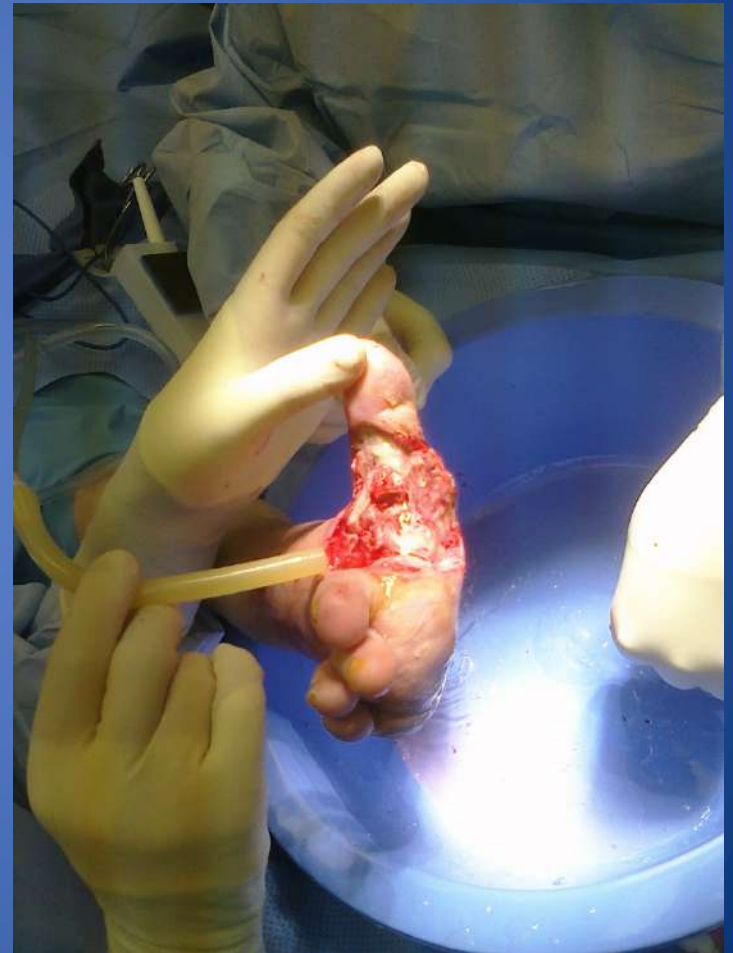
Toe

- Interphalangeal
 - Leave cartilage
 - Trim condyles
- Transect tendons and nerves
 - Do not sew tendons together
- Great toe
 - Leave 1cm
 - Foot balance and function



Ray Resection and Partial Foot

- Includes toe and part of metatarsal
- Preserve 1st MT length
 - Orthosis
 - Foot balance
- Avoid sharp bony prominences
- Multiple lateral rays

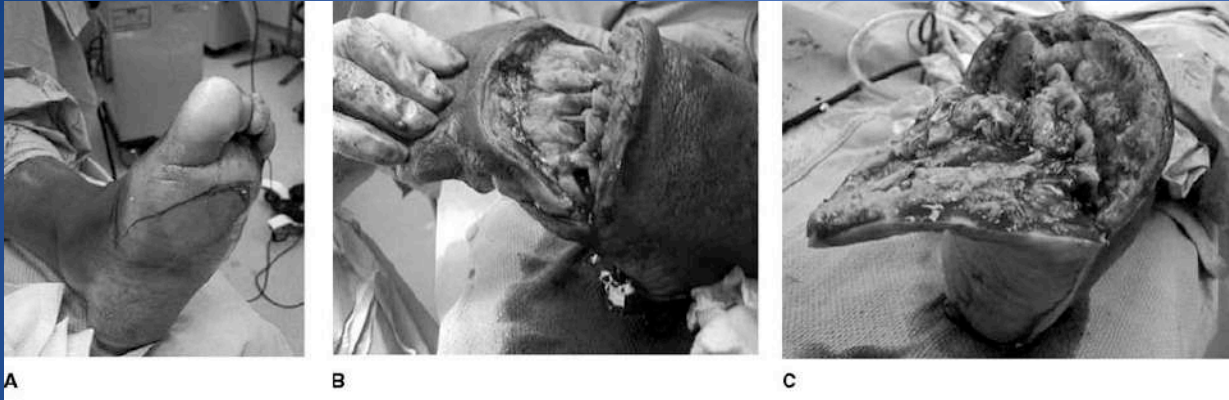


Transmetatarsal

- Considered
 - 2 or more medial rays
 - More than one central ray
- Preserve length
- Maintain arch and metatarsal cascade
- Avoid Achilles contracture
 - Achilles lengthening



Transmetatarsal



Negatives for Transmetatarsal

- Foot balance
- Prosthetic fit
- Wound healing
 - 33% primary wound closure
 - 56% may require revision to higher level

Symes

- Ankle disarticulation
- Required
 - Viable heel pad
- Modifications
 - Malleoli excision
 - Incision

Symes

Benefits

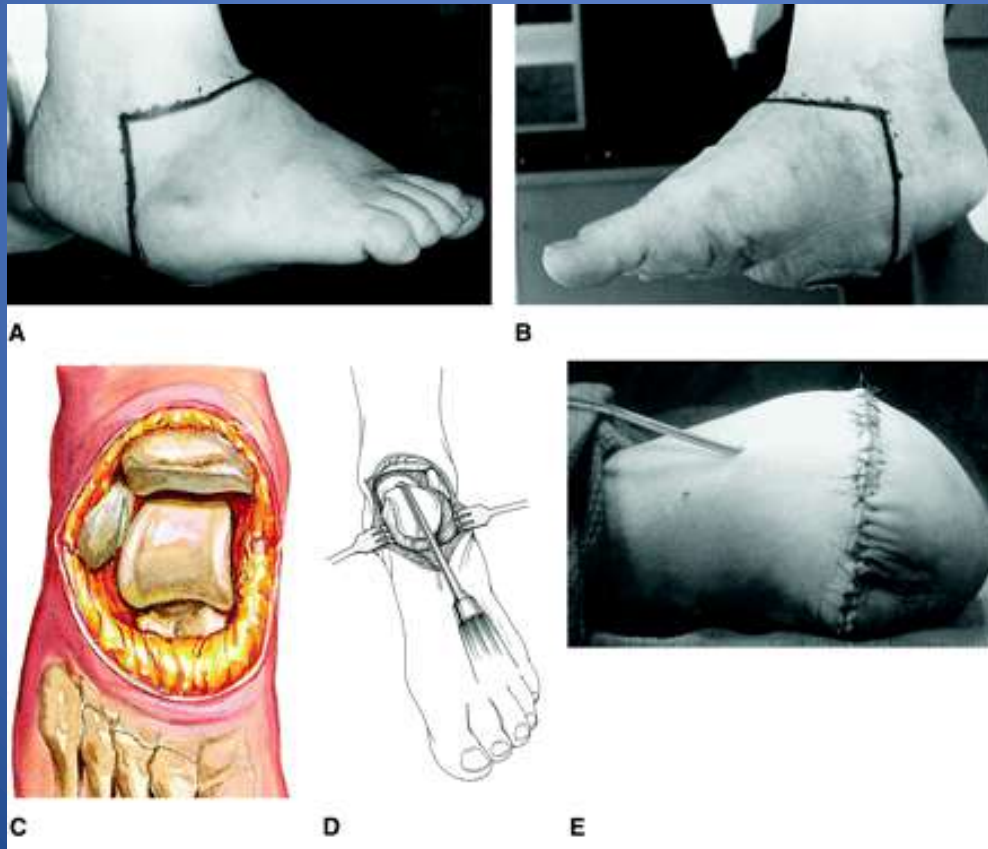
- Longer limb/less energy
- High level walkers
- End bearing for obese patients
- Ambulate without prosthesis

Negatives

- Wound healing
- Compliance
- Heel pad instability

Symes

- Must preserve posterior tibial arterial supply



Below Knee Amputation

- Most common
- Longer is better
 - Always?
 - Soft tissue
- Minimum to utilize BKA prosthesis
 - 2.5 cm per 30cm pt height
 - 5cm distal to the tubercle



Below Knee Amputation: Techniques

- Long posterior myocutaneous flap
- Modify skin flaps based upon available skin
- ID neurovascular structures
- Isolate fibula and transect 1.5cm above tibia

- Tibial cut
- Bevel bone cuts
- Ligate vessels and transect nerves
- Myodesis vs. myoplasty

Below Knee Amputation

Staged

- Traumatic or infection
- Guillotine
 - Allows soft tissues and bone to declare



Ertl Procedure

- Tibiofibular synostosis
- Indication
 - Young
 - Proximal tib/fib instability
 - High activity level
- Outcomes
 - Functional scores = no benefit (Ng et al. JAAOS 2010)

Technique

- Fibula cut at same level
- Leave medial periosteal hinge
- Connect to tibia
 - Metal
 - Suture



A



B

Case Example

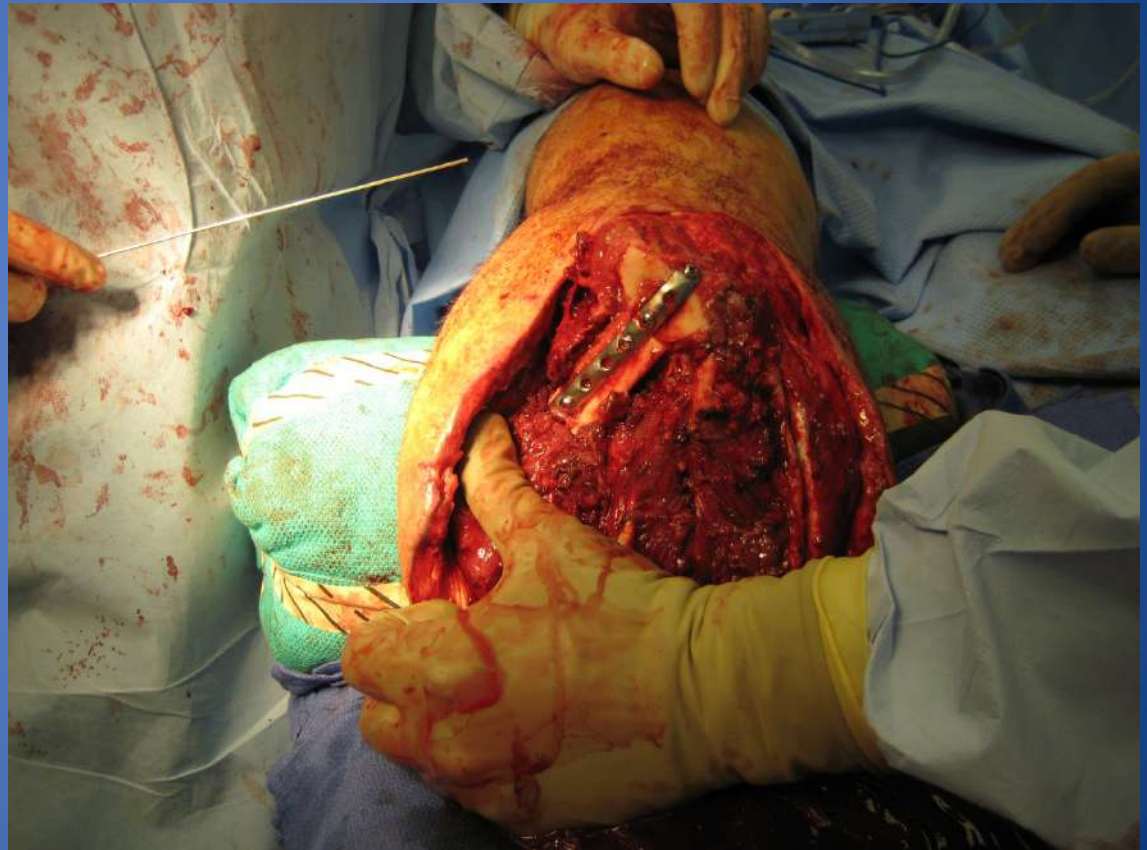
- 45y/o s/p MCC
- Police officer
- Right open femur fx
- Right open tib/fib with vascular insufficiency
- Ex-fix
- Multiple debridements
- Progressive necrosis



Case Example



Case Example



Case Example



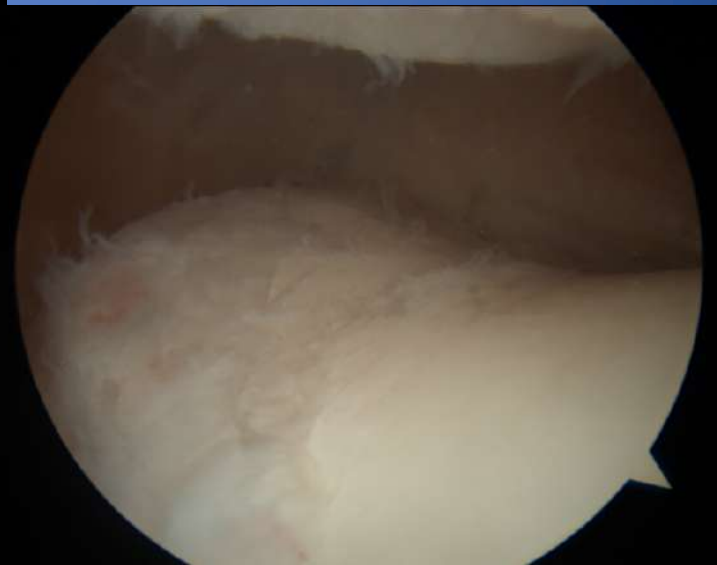
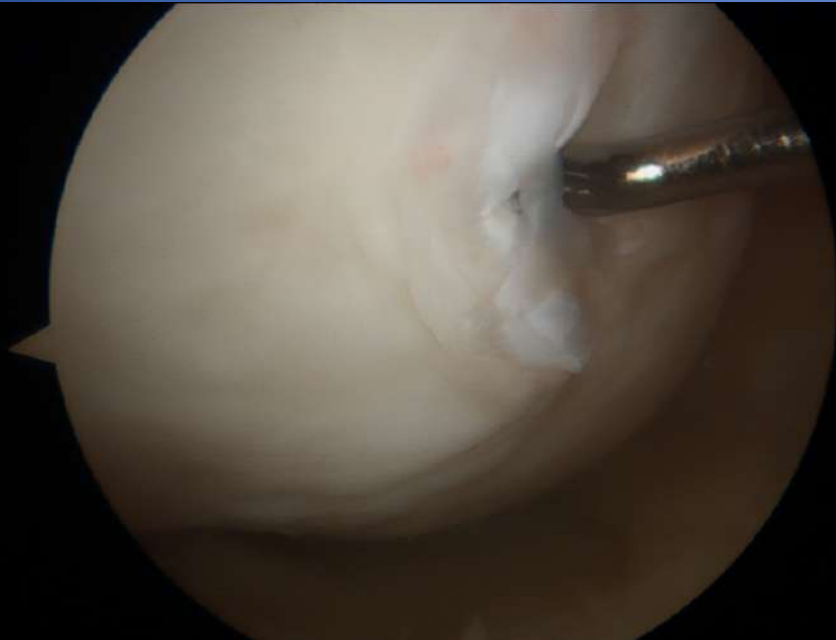
Case Example

- Femur infected
 - ABX beads
 - IV abx
 - debridements
- 2 STSG
- Suture removal
- 11mo



After prosthesis

- c/o knee pain and crepitance



BKA at all costs

- Improved energy expenditure
- Soft tissue reconstruction to maintain length and knee function
 - Skin graft or substitute
 - Muscle flap
- More functional prosthesis

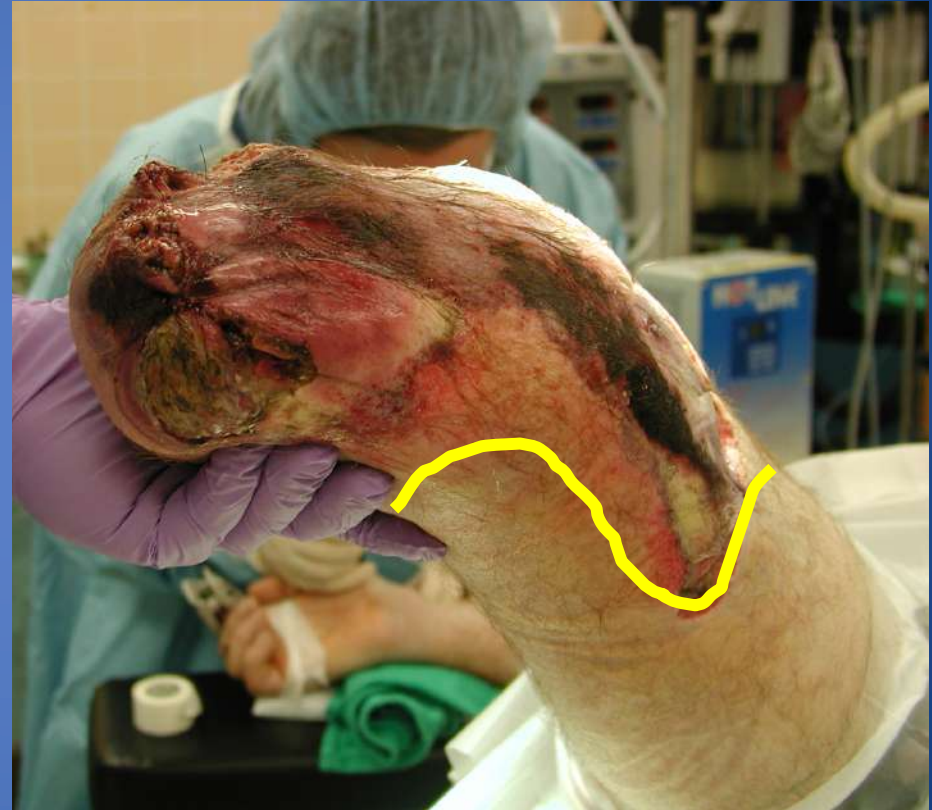
Case Example

- 40y/o male s/p BKA due to mangled lower extremity after go-cart accident
- Within 2 weeks of BKA and DPC
 - Infected
 - Necrotic skin



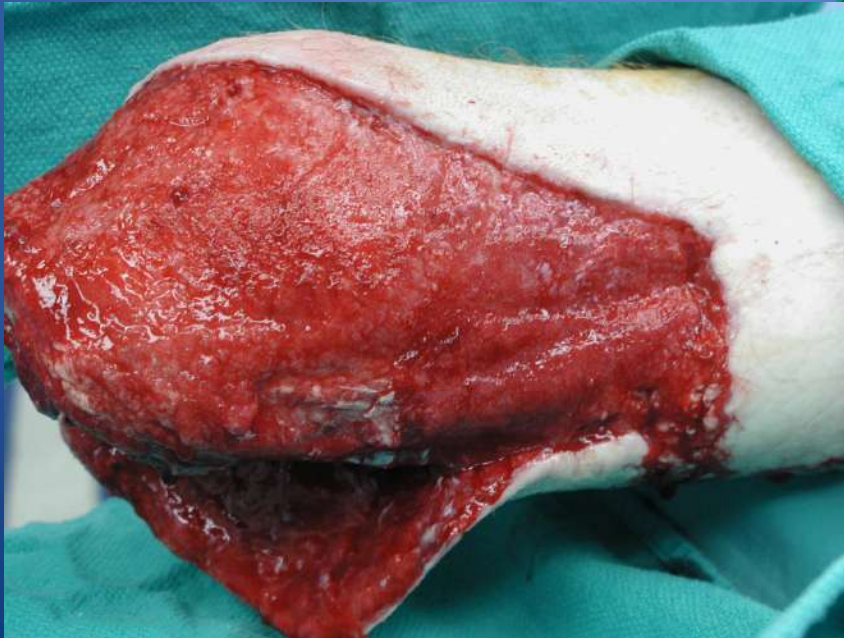
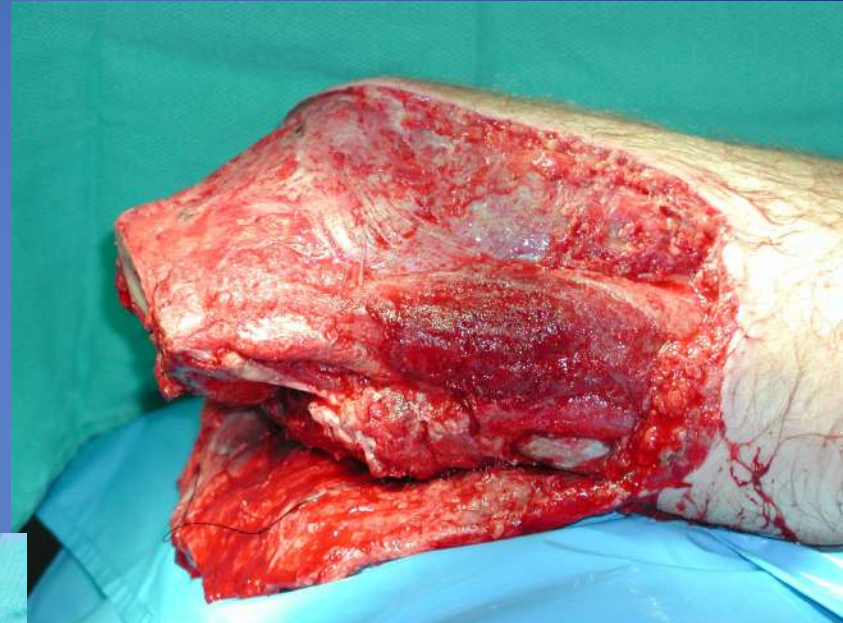
Options

- Revision to AKA
- Reconstruct soft tissue weight-bearing surface



Case Example

- Multiple debridements
- Negative pressure wound therapy (NPWT)



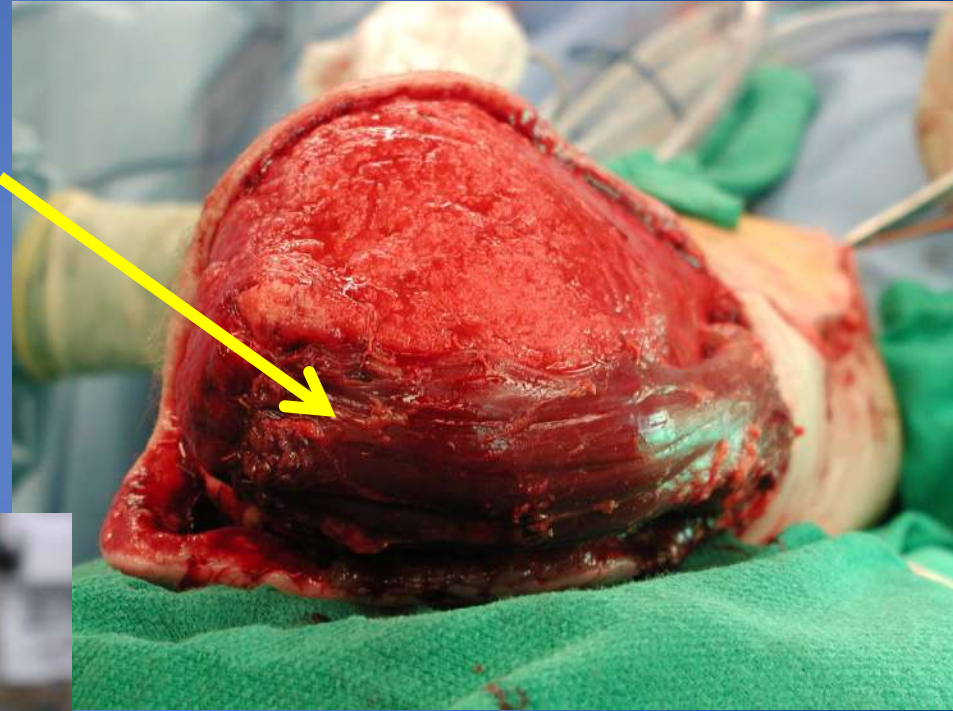
Case Example

- STSG low probability
- Muscle flap required
 - Gracilis rotation flap



Case Example

- Gracilis covering tibia
- STSG over muscle



Through Knee Amputation/Knee Disarticulation

- Prosthetists
 - Thumbs up or down
- End bearing residual limb
- Soft tissue coverage
 - Improved with posterior flap technique

Indications

- Trauma
- Infection
- Dysvascular
- Nonambulatory
 - *Risk of knee contractures with BKA

Through Knee Amputation/Knee Disarticulation

Benefits

- End bearing surface
- Sitting comfort
- Longer lever arm
- Balanced thigh muscles
- Prosthetic suspension (femoral condyles)

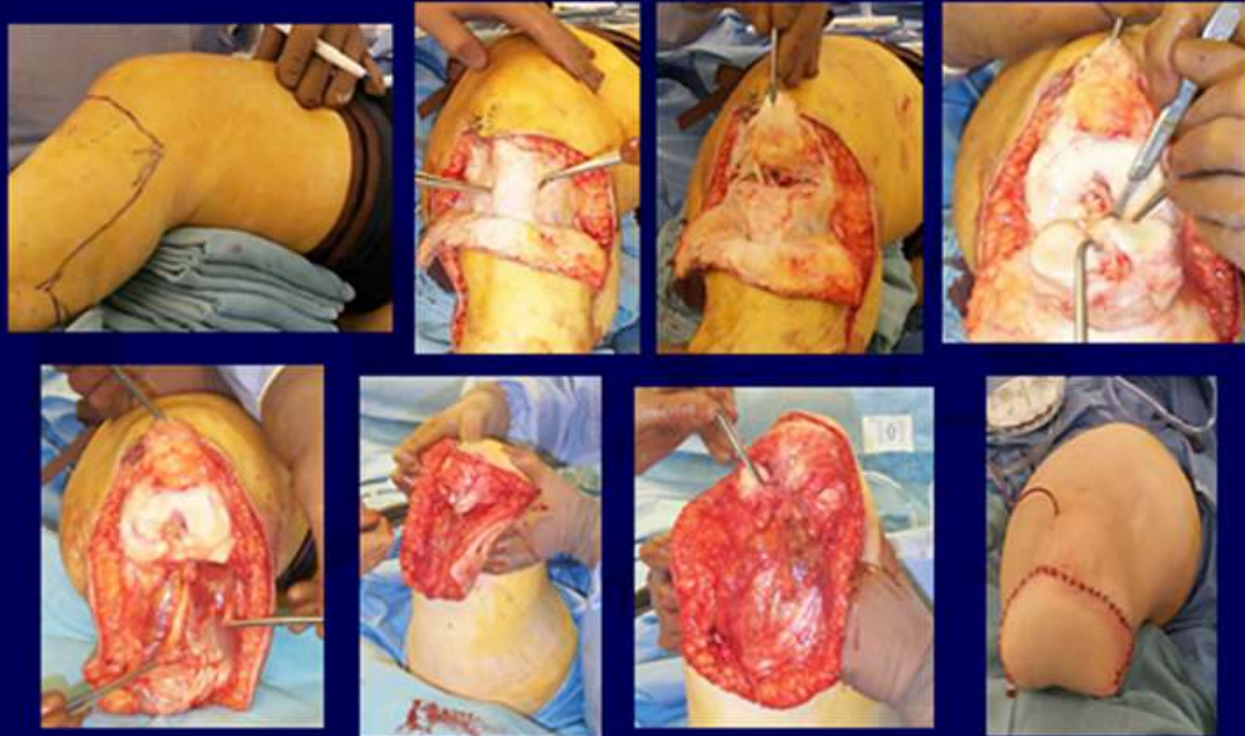
Negatives

- Knee height
- Soft tissue coverage

Technique

- Suture patellar tendon to cruciates
- Patella not distal to femur

Posterior Flap Technique



Through Knee Amputation/Knee Disarticulation

- LEAP study
 - Slowest walking speed
 - Least satisfaction
 - 12/18 no gastroc coverage->poor prosthetic tolerance

Mackenzie et al. JBJS 2004

Above Knee Amputation

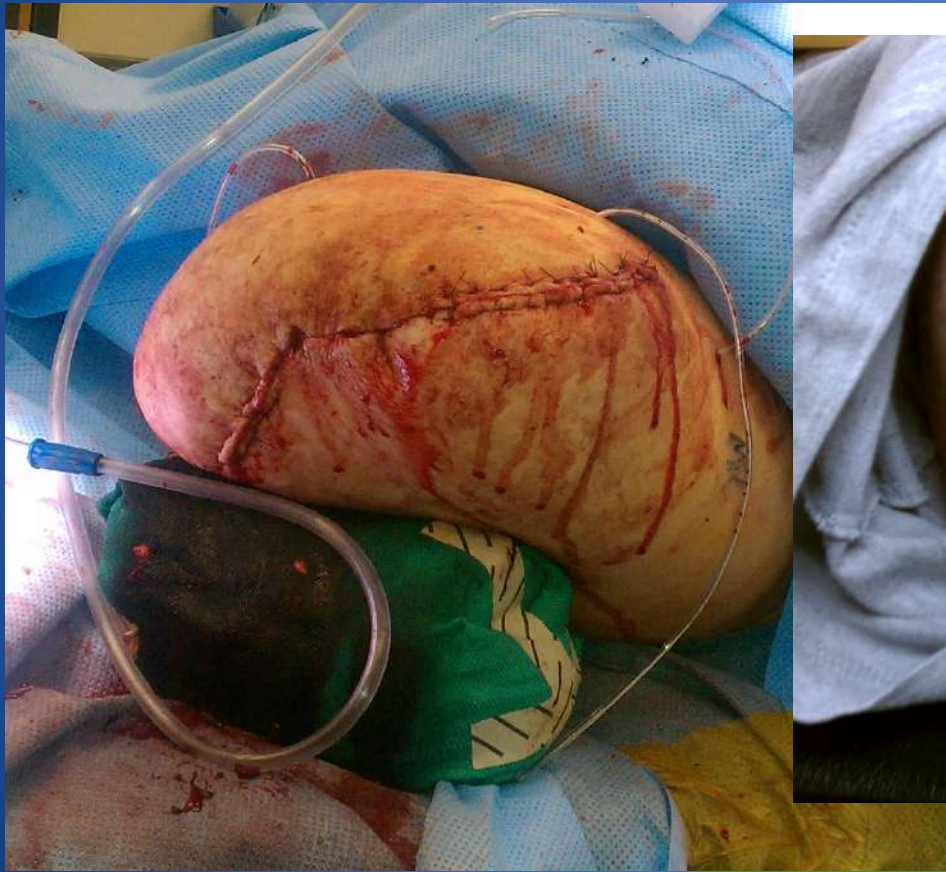
- Maintain length
- Energy expenditure
- Recurrent infected total knee arthroplasty
 - Alternative to knee fusion



Technique

- Fish mouth incision
 - Modify to prevent weight bearing on incision
- Myodese adductors
- Myodese quad and hamstrings
- No myodesis = poor function and pain
 - Femur moves within muscular sleeve

Above Knee Amputation

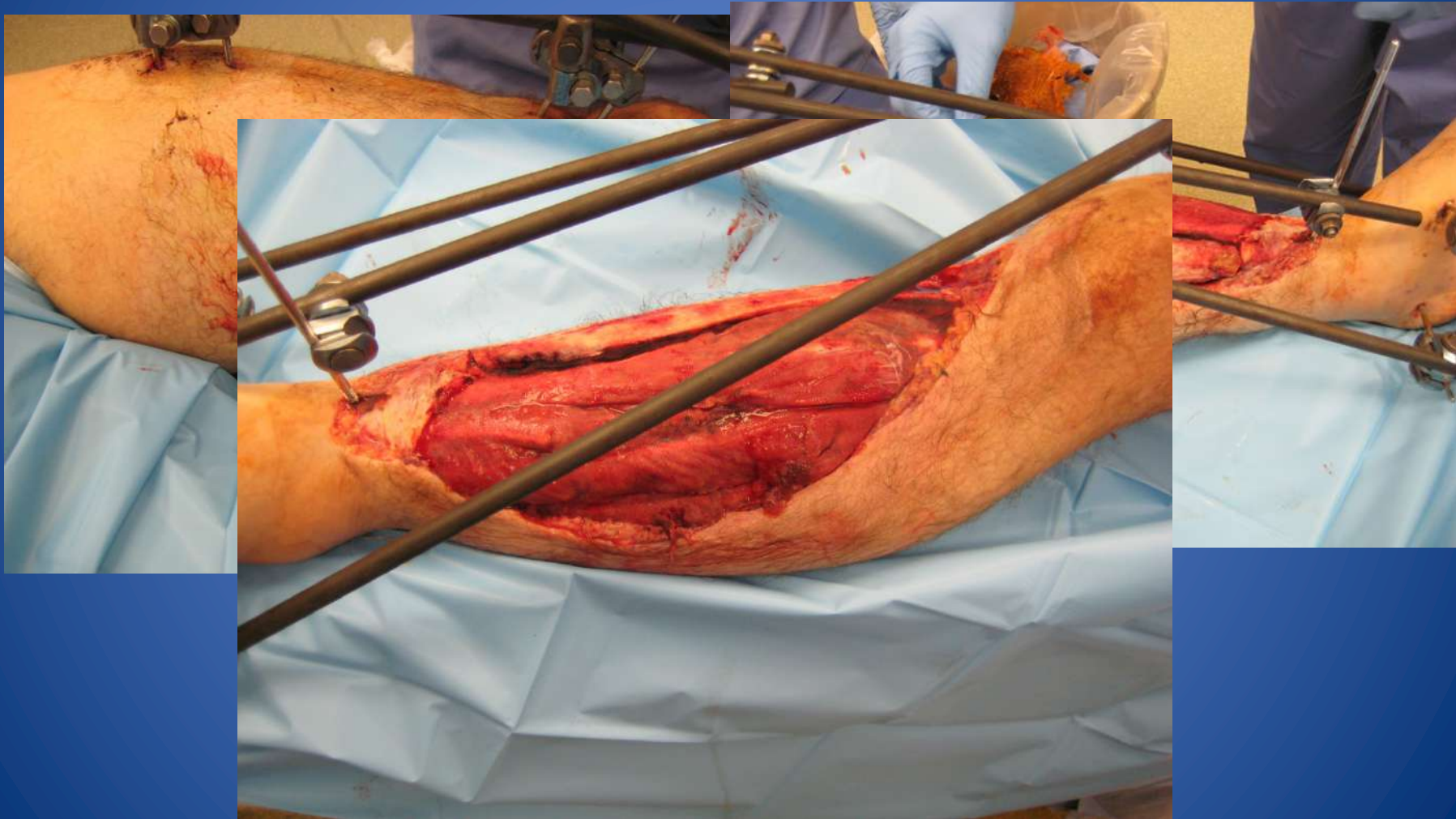


Case Example: Maintain length at all cost

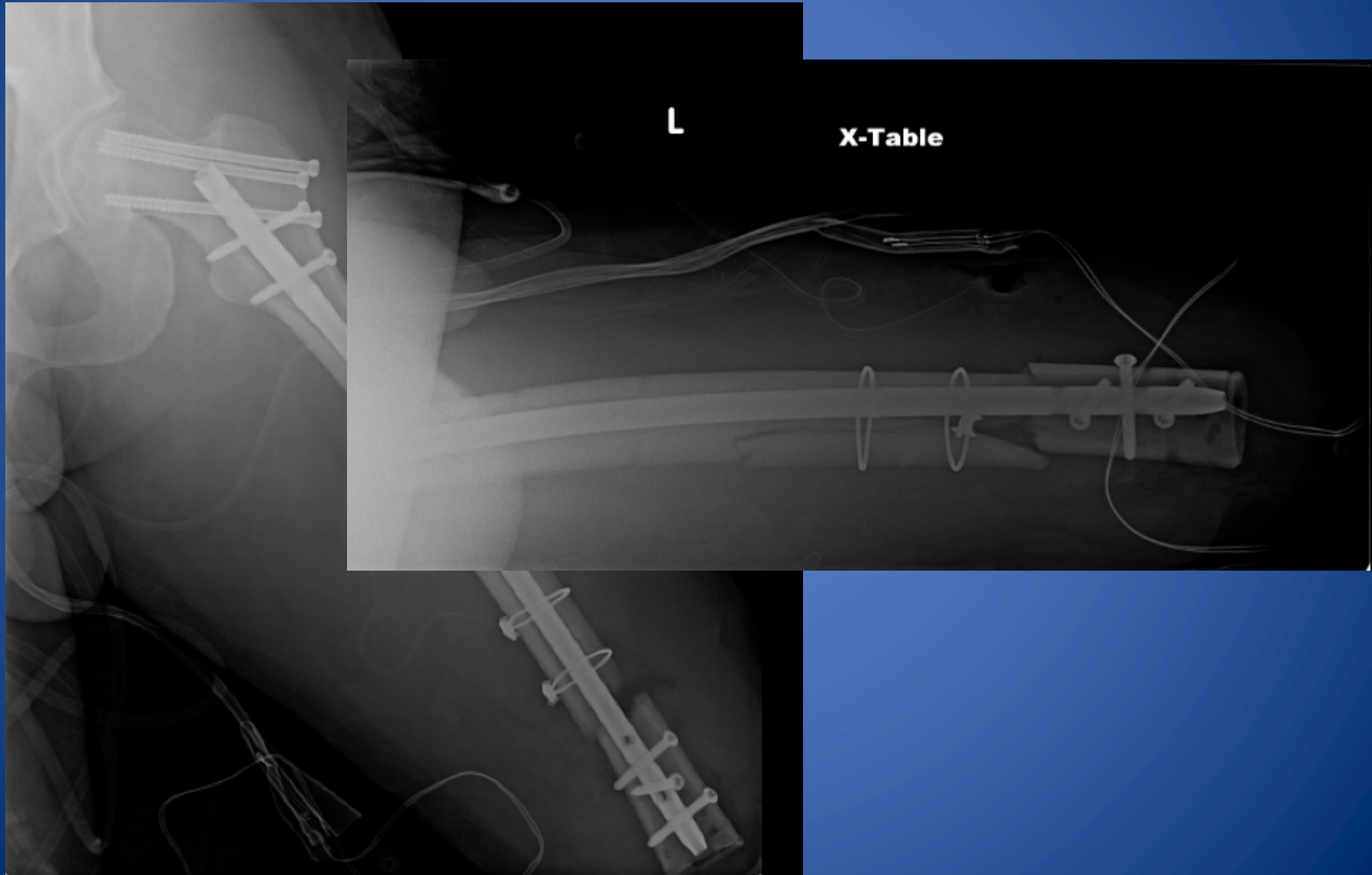
- 32 y/o s/p MCC
- Left open tibial shaft fx
- Left open bicondylar tibial plateau fx
- Left open femoral shaft fx
- Left femoral neck fx
- Left clavicle fx
- Left ulna fx



Case Example

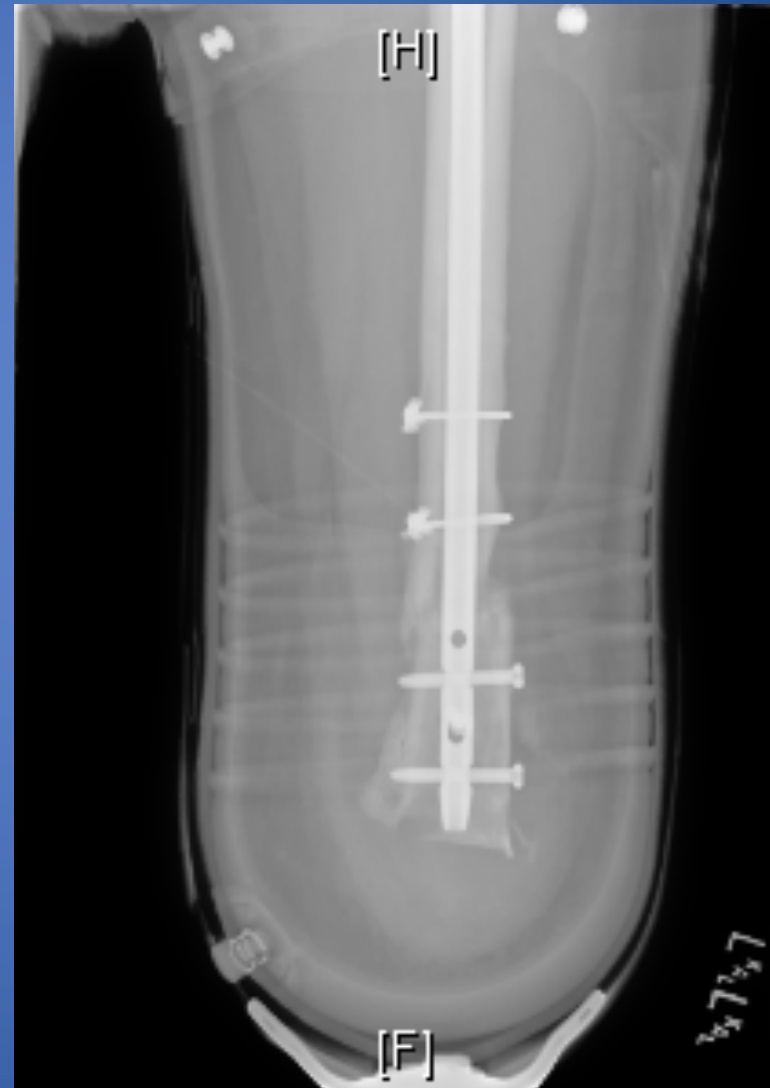


Case Example



Case Example

- Rides horses
- No residual pain



Hip Disarticulation

Indications

- Preservation of life
- Co-morbid pt with infection and sepsis
- Necrotizing fasciitis
- Non-ambulators (paraplegics)
- Advanced ischemic disease
- Tumor

Hip Disarticulation

- Problems
 - Wound management
 - Sitting balance
 - No prosthesis?
 - May choose not to wear
 - Use crutches anyway

Technique

- Lateral position
- Medial and lateral skin flaps
- Use muscles to fill dead space
- Wound complications



Hemipelvectomy

- Indications
 - Same as hip disarticulation
 - Tumor more common
 - More common in military recently
- Procedure of last resort
- Poor functional outcome

Technique

- Semi-lateral position
- Large posterior flap
- Keep as much of the hemi pelvis as possible for sitting balance





Complications



Amputation Site Breakdown

Early

- Delayed wound healing
 - Immunocompromised
 - Malnourished
 - Infection
- Marginal necrosis
 - Appropriate surgical technique



Amputation Site Breakdown

Late

- Deep infection
 - Usually associated with PVD/DM/amputation for infected hardware
- Adherent skin
- Poor prosthetic fit

Infection

- Debridement
- Antibiotics
- Local wound care
- Secondary healing
 - Prolonged wound healing
- Revision amputation



Amputation Site Prominence

- Overgrowth
- Bone spur
- Muscle atrophy
- Failed myoplasty/myodesis
- Skin hypertrophy
- Bursitis
- Bulbous/floppy residual limb
 - Poor surgical technique



Indications for Revision Amputation

- Tissue prominence
 - Poor prosthetic fit
 - Limited function
 - Pain
 - Skin at risk

Heterotopic Ossification/Bone Spur

- Associated with:
 - Severe trauma
 - Excessive manipulation of periosteum
 - Residual bone after osteotomy
- May require surgical resection if problematic
 - Recurrence of HO



Indications for Revision Amputation

- Neurologic Complications
 - Neuroma
 - Phantom limb sensation

Neuroma

- All nerve transections form neuromas
- Painful
 - Positive Tinel's
- Causes
 - Poor surgical technique
 - High pressure area
 - Crush injury

Phantom Limb Pain

- May be nonpainful
- Painful
 - Up to 85% in LE
 - ~40-69% in UE

Phantom Limb Pain

- Surgical
 - Dehydrogenated alcohol and marcaine into epineureum
- Non-surgical
 - Neurontin
 - Shown effective
 - Vitamin C?
 - Regional anesthetics perioperatively?

Joint Contracture

- Usually related to short lever arm
- Contracture release and tenolysis may be required if fixed deformity

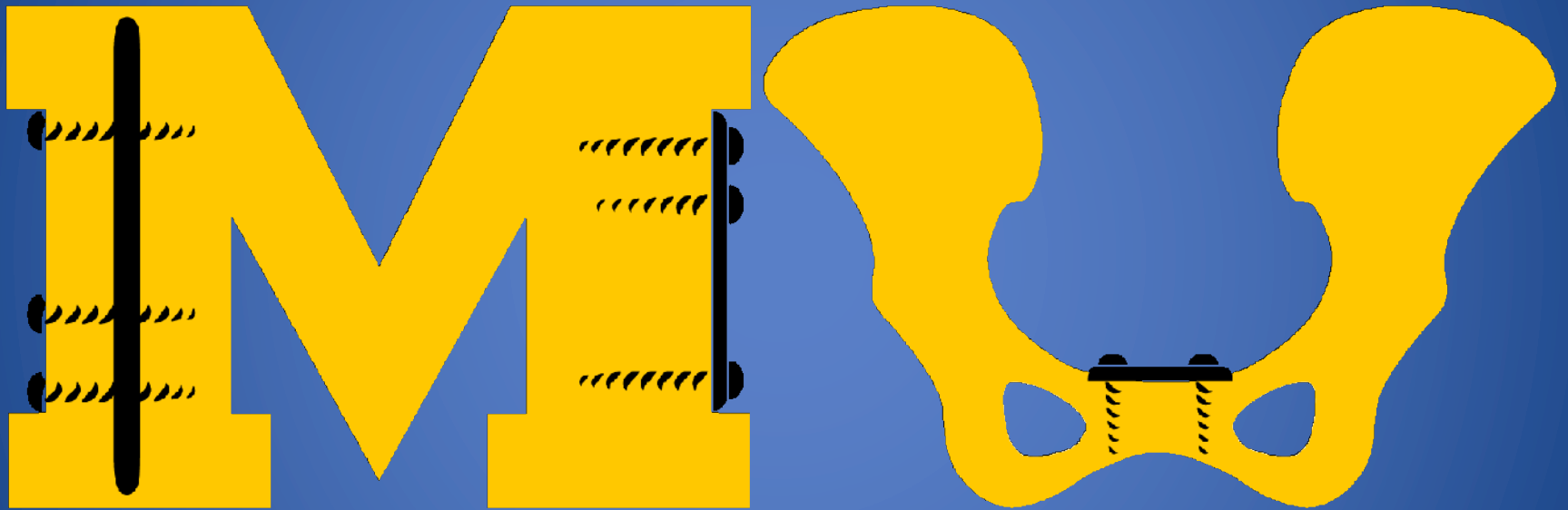
Summary

- Lower extremity amputations are much more common than upper extremity
- Restoring function is important
 - Reconstruction
 - Prosthesis
- Preserve length and joint motion
- Avoid complications
- Patient counseling/support

Questions?



Thank You



ORTHO TRAUMA

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References

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2. Scott et al. Traumatic and Trauma-related Amputations I and II. JBJSAm Dec 2010
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