Surgical Considerations in Lower Extremity Amputation

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Disclosures

• Consultant
  • ODI
  • Synthes
  • KCI
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
Indications

• Traumatic
• Infection
• Peripheral Vascular Disease
• Neurological
• Burns/soft tissue defect
• Congenital deformity
• Tumors
Trauma

- 130,000 new amputation/year
  - 15% are trauma related
  - Young males

- 16 million people with an amputation
  - 45% trauma
Trauma

• Acute trauma

• Chronic trauma
Trauma

• Acute trauma

• Chronic trauma
How Do We Make Our Decisions?

- Plantar sensation?
- Injury severity?
- Cost?
- Outcomes?
- Gut feeling?
Trauma

• LEAP
  • 569 patients
  • Prospective study
  • Amp vs limb salvage
  • 2 and 7 year data
  • Male (77%), white (72%)
  • Uneducated, poor, no insurance, heavy drinkers
LEAP

• Absent plantar sensation
  • Does not mean amputation
  • Over 50% of salvages regained sensation by 2 years
  • Salvage had similar rates of sensation at 2 years
    • Regardless of presentation
LEAP

• Mangled Extremity Severity Score
  • Historically >8=amputate

• Scoring systems NOT predictive of successful limb salvage
LEAP

• Amputations more cost effective
  • 2 year cost
    • Salvage $81,316
    • Amputation $91,106
  • Lifetime projection
    • Salvage $163,282
    • Amputation $509,275
LEAP

• People do better with an amputation
  • No difference in the Sickness Impact Profile
  • At both 2 and 7 years
LEAP

• Salvage does have higher
  • Depression
  • Anxiety
  • PTSD
  • Rates of complications
How Do We Make Our Decisions?

• Overall clinical picture
• Patient social situation
• Patient desired outcomes/expectations
Indications

• Infection
  • Diabetes

• Peripheral Vascular Disease
  • Diabetes (71%)
  • 80% of lower extremity amputations

• Neurological
  • Neuropathy (diabetes)
  • Contractures
Indications

• Burns/soft tissue defects
• Congenital deformities
• Tumors
  • Goal=Clear margins
Goals

• Initial
  • Debride to healthy tissue
  • Preserve soft tissue
  • Preserve length
  • Balance muscular forces
Goals

• Eventual
  • Early return to function
  • Painless residual limb
  • Prevention of contractures
  • Mobility vs stability
Goal

• Do it right the first time
Goals

• Debride to healthy tissue
  • Easiest part
  • May require multiple surgeries
Goals

• Preserve Soft tissue
  • Viable tissue
  • Atypical flaps
Goals

• Preserve length
  • Dependent on level
  • Important for function
  • Important for prosthetics
Goals

• Consider length
  • Dependent on level
  • Important for function
  • Important for prosthetics
Goals

• *Balance muscle forces*
  • *Prevent unopposed forces*
    • *Issues with prosthetics*
    • *Ulcers*
    • *Pain*
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
  - Minimal muscle stabilization
- Myoplasty
  - Opposing muscle groups
- Myodesis
  - Attached to bone
- Tenodesis
  - Tendon attached to bone
Nerves

- Avoiding painful neuromas
  - Separate from vessels
    - Pain generator
  - Traction on nerve and sharply transect
    - Retracts to safety
- Nerve preparation
  - Ligation
  - Injection
  - Transfer
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
Level of Amputation

• Factors
  • Soft tissue
  • Blood flow
  • Functional requirements
Level of Amputation

- Soft tissue
  - Trauma
  - Infection
  - Previous surgeries
Level of Amputation

- Blood flow
- Traumatic
- Vascular disease
Level of Amputation

- **Functional requirements**
  - Young, healthy
    - Preserve length
    - Be aggressive
      - Flaps
      - Skin grafts
  - Sick, low demand
    - Consider prosthetic odds
    - Preserve length for sitting
    - Goal is one surgery
- **Bilateral**
  - Consider atypical amps
Level of Amputation

• Metabolic Demand
  • Proximal = increased demand
  • Exception—Syme

• Must evaluate the patient
  • Diabetic with bilateral BKA won’t do well
Metabolic Demand

• Syme - 15%

• Transtibial
  • Traumatic - 25% average
  • Vascular - 40%
Metabolic Demand

• Transfemoral
  • Traumatic - 68%
  • Vascular - 100%

• Thru-knee amputation
  • Varies based on patient habitus
  • Between transtibial and transfemoral
Metabolic Demand

• Bilateral amputations
  • BKA + BKA - 40%
  • AKA + BKA - 118%
  • AKA + AKA - >200%
Preoperative Evaluation

• Nutrition labs
  • Albumin > 3 g/dL
  • Total lymphocyte > 1500/mm³
• Transcutaneous Oxygen
  • > 30 (45 ideal)
• Toe pressure
  • > 40 (< 20 absolute contraindication)
• ABI
  • > 0.45
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

Ng et al. JAAOS 2010
Negatives for Transmetatarsal

• Foot balance
• Prosthetic fit
• Wound healing
  • 33% primary wound closure
  • 56% may require revision to higher level
Diabetics and Foot Amps

• 75% get revised by 9 months
  • 87% revised to BKA
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
• Less metabolic demand than midfoot

Negatives
• Wound healing
• Heel pad instability
  • Major issue
• Can’t really walk barefoot
Symes

• Must preserve posterior tibial arterial supply

Ng et al. JAAOS 2010
Other Foot Amps

• Pirogoff
  • Remove all but calcaneus
  • Fuse calcaneus to tibia
  • No need for prosthesis

• Chopart
  • Leaves talus and calcaneus
  • Requires tendon transfers
  • Requires achilles lengthening
  • Poor prosthetic options

• Lisfranc
  • Leaves all tarsal bones
  • Preserve base of 5th
  • Requires tendon transfer
  • Same metabolic demand of BKA
Below Knee Amputation

- Most common
- Longer is better
  - Soft tissue
  - 8-12 cm from ground for most high-impact prosthetics
- 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
Below Knee Amputation: Techniques

• 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
Technique

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

Ng et al. JAAOS 2010
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
Why not Ertl?

• Outcomes
  • Functional scores = no benefit (Ng et al. JAAOS 2010)

• Increasing risk for:
  • Nonunion
  • Painful hardware
  • Infection
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
  - Gracillis rotation flap
Case Example

- Gracillis covering tibia
- STSG over muscle
Through Knee Amputation/Knee Disarticulation

- Prosthetists
  - Bulbous end
  - Knee axis lower to the ground
  - Self image issues
- End bearing residual limb
- Soft tissue coverage
  - Improved with posterior flap technique
Indications

• Trauma
• Infection
• Dysvascular
• Nonambulatory
  • Risk of knee contractures with BKA
• Unlikely to get into prosthesis with AKA
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
• Slower walking speeds (BKA)
• Worse performance on SIP (AKA and BKA)
Technique

- Suture patellar tendon to cruciates

- Patella not distal to femur
  - Not a cap
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
  • 12cm proximal to knee is ideal

• Energy expenditure
  • Increased

• Recurrent infected total knee arthroplasty
  • Alternative = knee fusion
Technique

• Fish mouth incision
• Modify to not be end bearing if soft tissues allow
• Myodesis adductors
• Myodesis 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

• 13% overall (20% BKA)
Amputation Site Breakdown

Late

• Deep infection
  • Usually associated with PVD, DM
  • Trauma=34% rate

• Adherent skin

• Poor prosthetic fit
Infection

- Debridement
- Antibiotics
- Local wound care
- Secondary healing
  - Prolonged wound healing
- Revision amputation
Amputation Site Prominence

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

Indications for Revision Amputation

• Poor prosthetic fit

• Limited function

• Pain

• Skin at risk
Neurological Complications

• Neuroma
  • 20-30% amputations

• Phantom limb pain
  • 53-100% of traumatic amputations
Neuroma

- All nerve transections form neuromas

- Painful
  - Positive Tinel’s

- Causes
  - Poor surgical technique
  - Scar formation
  - High pressure area
Neuroma

• Avoid
  • Nerve stump retracts into soft tissue away from scar and prominent areas
  • Can suture to muscle

• Management
  • Prosthetic adjustment
  • Injection
  • Scar massage
  • Surgical resection
    • Targeted muscle reinnervation
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
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
Summary

• Several Indications for amputations
  • Consider your patient and all factors
• When possible, optimize your patient
• Preserve length is typically the correct answer
  • BKAs do better functionally than TMAs
  • Symes require less oxygen than TMAs
• Surgical technique is as important to complications as optimization
References


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

3. Ng and Berlet. Evolving Techniques in Foot and ankle Amputations. JAAOS April 2010

4. Lower Extremity Assessment Project (LEAP) – The Best Available Evidence on Limb-Threatening Lower Extremity Trauma. Higgins
Thanks

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