Lower Extremity Amputations

Orthopedic Rounds
MUMC
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Presenters:
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Classification of Amputations

- 1) Traumatic (~ 15%)
  - Usually healthy
  - Limb salvage
  - Often grafted tissues
  - May require revision surgery/debridement
Classification of Amputations

1) Traumatic
   - Limb salvage can lead to multiple surgeries
   - End result may be a fragile limb with less function than with an amputation
   - Complications of infection and fracture are common
Classification of Amputations

1) Trauma
- A lower limb without sensation functions poorly
- Limb salvage may be worse than prosthetic replacement unless the residual limb:
  - can tolerate full weight bearing
  - is painfree
  - has durable skin and soft tissue coverage that doesn’t break down when walking is attempted
Classification of Amputations

1) Trauma

Decision Making in Trauma
- Base decision on providing a limb that can tolerate weight bearing; have enough sensation to provide protective feedback; and have durable skin and soft tissue cover.
Classification of Amputations

2) Tumor (~ 5%)
   - Amputation level is determined by extent of cancer
   - Goal is to avoid violating anatomic compartments where the tumor is located
Classification of Amputations

3) Vascular and Diabetic (~ 70 -80%)
- Pre-op evaluation very important
- Vascular assessment necessary
Classification of Amputations

Ask: Is the foot worth saving?
-soft tissues – will ulcer heal, stay healed, or new ulcers form?
deformities – claw toes, bunion, Charcot collapse
sensation – to protect after salvage
contractures – Achilles tendon, knee, toes
rehab goals – does/will patient ambulate?
The Most Distal Amputation is not Always the Wisest!

1) Biologic Healing Level
   - the lowest level the skin will heal

2) Functional Level
   - the amputation level the patient will function best with
     -- previous level of ambulation
     -- intelligence
     -- cognitive status
     -- motivation
     -- cardio-pulmonary capacity
     -- spasticity or contractures
     -- rehabilitation goals
Classification of Amputations

4) Congenital Amputation (~ 5%)
- Revision of lower extremity deformity to improve the weight bearing capacity and durability
- Usually don’t revise upper extremity deformities – even rudimentary digits can have useful function
Goals of Prosthetic Rehabilitation

- Restoration of functional mobility
- Maintain/increase ROM
- Attempt return to independent lifestyle
- Pain management
- Wound management
- Psychosocial counselling and support
Levels of Amputation in the Lower Extremity

- Partial Foot
- Symes (ankle disarticulation)
- Transtibial
- Through knee (knee disarticulation)
- Transfemoral
- Hip Disarticulation
Physical Assessment
Assessment

Assess
- Wound/incision line
- Sensation
- Adhesions
- Contractures
- Strength
- Balance
- Endurance
Post operative Edema

Goal:
- reduce swelling
- shape residual limb
Stump Shrinkers

- Elastoband wrap (figure 8)
- Tubi-grip
- Compression Stocking measure to fit T/T or T/F
Bandaging
Transtibial Amputation
Biomechanics of Socket Fit
Biomechanics of Socket Fit
Exposed Bone
Bevel Tibia
Transtibial Foot Selection

Consider

- Activity level, weight of amputee, weight of foot, action at heel strike and toe-off, function demands (terrain, lifestyle, etc.)
Transtibial Feet Categories

- **SACH** – simple, low activity/function, rigid
- **Single Axis** – Rapid foot flat, increases knee stability
- **Multi-Axis** – Adapts to uneven terrain, good for walking outdoors, may reduce impact on skin
- **Elastic Keel/Dynamic** – Smooth rollover, comfort, responsive, may not propel
- **Energy Storing** – Carbon keel, stores energy in early stance, gives back at toe off, good for higher activity levels
SACH

- Solid Ankle, Cushioned Heel
- Impact absorbed at heel strike, simulated PF
- Simple, low activity/function, rigid
Single Axis

- Foot plantar flexes at heel strike, to foot flat
- Move line of action of GRF anteriorly
- Increased knee stability, important for TF
- Heavier, rigid rollover
Multi Axis

- Adapts to uneven terrain, good for walking outdoors, may reduce impact on skin
- Rubber or Urethane may serve as material being deformed
Elastic Keel/Dynamic

- Smooth rollover, improved comfort, responsive
- May not propel
- Increased cost
Energy Storing

- Carbon Keel
- Stores energy in early stance, gives back at toe off
- Good for higher activity levels
- Significantly higher cost
Suspension (T/T)

- Fork Strap and waist belt
- Cuff Suspension
- Supracondylar (PTS)
- Sleeve (Neoprene, Silicone), (2S)
- Liner and Pin (3S)
- One way valve and Sleeve (suction)
- Harmony (elevated vacuum)
Fork Strap and Waist belt
Fork Strap and Waist belt
Supracondylar (PTS)

Medial wedge is created over adductor tubercle
Self suspends
Increase height of brim, improving ML knee stability
Cuff Suspension (T/T)
What are Interface Liners?

- Interface – a surface forming a common boundary of two bodies, spaces, or phases; to connect by means of an interface
- Liner – one that lines or is used to line or back something
What are Interface Liners?

- Interface liners relating to prosthetics, refers to a lining that is placed on the residual limb which will act as a boundary between the skin and the hard weight bearing socket.
- Many different types of liners:
  - Polyurethane
  - Silicone
  - Gel
  - Elastic Polymers
General Description

- Liners act as excellent forms of protection vs friction, they distribute dynamic pressure due to the flow characteristics of the liner, and they may act as a form of suspension

- 4 goals:
  - ↓ average and peak pressures on the limb
  - ↓ rate of skin breakdown
  - ↑ weight bearing capabilities
  - Improves comfort and suspension
Liner and Pin (3S)

- Liner has pin attachment
- Different pin types exist
Liner and Pin (3S)

- Locking Liner Suspension Techniques
  - Locking Pin systems
    - a serrated pin engages a gear in locking mechanism
    - a smooth pin engages a clutch mechanism
  - Pin systems can take up significant space
  - problems with elongation of liner
  - simple and can be effective
Urethane liners

- available from some manufacturers in standard sizes and can be custom fabricated by TEC Interface Systems
- cannot currently be manufactured in-house
- University of Minnesota study showed that urethane behaves more like human tissue than silicone or mineral oil gel when stressed
- Excellent results with very delicate skin
- Can be used with Vacuum Assisted fittings (Harmony)
- Cast mods are very different from any other socket type
Custom Urethane Liner
Harmony (elevated vacuum)

- **ROTATING** - The new rotational feature allows wearers to move more naturally — whether they are walking, running errands or golfing.

- **INCREASED RELIABILITY** - Offered through a double filtration system, shorter tubing and fewer in-line connections.

- **IMPROVED VOLUME CONTROL** - The Harmony System’s elevated vacuum pulls oxygenated fluids into the residual limb during swing phase and pushes fluids out during weight bearing. The result is less than 1% volume loss during the course of the day.*
Harmony (elevated vacuum)

- **Linkage** - Not only does the elevated vacuum between the socket and the liner control volume, it helps the prosthesis become one with the user.

- **Improved Volume Control** controlling volume fluctuations can improve fit for many amputees helping reduce pressure points on the limb.

- **Proprioception** - Elevated vacuum leads to heightened proprioception, the awareness a user has of her or his leg in space. This leads to increased balance, stability and control over the prosthesis.
Case Study
Mr. R. F.
Harmony (elevated vacuum)
Harmony (elevated vacuum)

- Uses TEC urethane liner, harmony pump and urethane sleeve
- Patient has donned urethane liner and is now donning socket
Harmony (elevated vacuum)
Harmony (elevated vacuum)

- Seal is created between liner, leg and sleeve
- Suspends prosthesis with up to 25mmHg
- Accurate “Total Surface Weight Bearing” fit is critical
Transfemoral Amputation
Suspension (T/F)

- Silesian Bandage & Billet
- Liner and Pin
- Seal-In Liner
- Suction
- TES Belt
- Hip Joint and Pelvic Band
Suspension (T/F)

Billet attachment
- Anteromed 1/3
- At level of IT

Silesian attachment
- Posteroprox to GT
Seal-In Liner

- Used with Icelock Expulsion Valve
- Good for all impact levels
- Available for both TT/TF patient
Prosthetic Knee Categories

- Locked
- Safety (stance control)
- Polycentric
- Single Axis, Friction
- Fluid Controlled (pneumatic or hydraulic)
- Microprocessor
- Hybrid (ie. 4 bar with hydraulic)
Manual Locking Knee

**PROS**
- Safety

**CONS**
- Gait Deviations
Safety Knee
(Weight-activated Stance Control)

PROS
- Inexpensive
- Foot clears in swing

CONS
- Possibility of falling if user is distracted
- Brake wears over time
- Gait deviations
- Single cadence
Polycentric Knee (aka: 4 bar)

- **PROS**
  - Stability
  - Sitting cosmesis for long residual limb
  - Improved swing clearance

- **CONS**
  - Weight
  - Cost
  - Must be a hybrid for variable cadence
  - Some 4 bar designs have up to 15 degrees of stance flexion built in for loading response
Fluid Controlled
Pneumatic or Hydraulic

PROS
- Variable Cadence
- Stance and Swing control
- More ‘normalized’ gait
- Good for higher activity levels

CONS
- Weight
- Cost
- Maintenance
Microprocessor Controlled Knee

- **PROS**
  - Variable Cadence
  - Stumble recovery
  - Stability in Stance
  - Ability to walk down stairs/ramps step over step
  - Second mode
  - Improved confidence

- **CONS**
  - Cost
C Leg Case Study
Symes Amputation
Symes

- Symes Amputations have many unique Advantages
  - Heel pad retention
  - Bulbous distal configuration
    - Self suspension
  - Length advantageous
    - Longer lever arm
  - Increased ability to perceive distal pp & increased SA of Pros/residual limb contact, therefore:
    - >proprioception
    - >prosthetic control
Symes
Tom Whittaker climbing with prosthesis on South Col of Mt. Everest, 1989.
Thank you!!
RESIDUAL LIMB
SKIN CONDITIONS
Keloid Scarring
Ulceration
Delayed Wound Healing
Choking of Residual Limb
Contact Dermatitis
Distal Bursa with Chronic Infection