Review Last Lecture
Prosthesis

• A **prosthesis** is a replacement of a body part
• A **prosthetist** is a health care professional who designs, fabricates, & fits prostheses
• **Prostheses include**: dentures, wigs, plastic heart valves, etc
• **PT/PTAs are primarily concerned with limb prostheses & the treatment of patients with UE & LE amputation**
The concept of replacing a missing limb is very old.

- The PT & PTA should be familiar with the characteristics and maintenance of lower-limb prostheses
Foot-ankle assembly

Socket & Suspension component

Shank

Pylon

Foot-ankle assembly
PARTIAL FOOT PROSTHESSES

• **Purpose**: to restore foot function in ambulation and simulate the shape of the missing foot segment

• A patient who has lost one or more toes may just pad the toe box of the shoe to improve appearance
PARTIAL FOOT PROSTHESSES

• **Transmetatarsal amputation**: A socket for the remainder of the foot is affixed to a rigid plate that extends the full length of the inner sole of the shoe. Plate has a cosmetic toe filler. May have a rocker bar on the bottom to assist with late stance.
BELOW KNEE PROSTHESSES

• The patient retains the anatomical knee

• From a prosthetic viewpoint, the Syme’s amputation is similar (amputation just distal to the malleoli with all foot bones removed)

• While the Syme’s amputation limb is longer than the BKA, prostheses for both include:
  – A foot-ankle assembly & socket
  – While the BKA also has a shank & suspension component
Purpose is to:
- restore the general contour of the pt’s foot
- absorb shock at heel strike
- plantarflex in early stance
- and simulate push-off.

Foot-Ankles come in both nonarticulated and articulated
FOOT-ANKLE ASSEMBLY

• **Nonarticulated feet:**
  – most often prescribed in the USA
  – Appears as one piece (no ankle joint)
  – Compared to articulated feet, these are lighter, more durable & more attractive

• **Examples:**
  – solid ankle cushion heel (SACH);
  – stationary attachment flexible endoskeleton (SAFE)
Foot-Ankle Assembly

• **SACH foot**
  – Solid ankle cushioned heel
  – Standard foot for BK prosthesis
  – Cushioned heel (foam/rubber)
  – Wooden keel
  – Bolt
Foot-Ankle Assembly

- **SAFE foot**
  - Stationary attachment flexible endoskeleton
  - A version of the SACH foot
  - A rigid ankle block attached to the posterior keel at 45° mimics ST jt
  - Permits tri-planar mvmt
  - Heavier, more expensive, less durable than SACH
ANKLE-FOOT ASSEMBLY

- **Articulated feet:**
  - manufactured with separate foot and lower shank sections
  - joined by a metal bolt or cable.

- **Examples:**
  - Single-axis feet
  - Multiple-axis feet
Single-axis foot: permits motion only in the sagittal plane about the fixed bolt.

- 2 bumpers limit & control PF & DF
- simpler to control
- Provides stability in stance
**ANKLE-FOOT ASSEMBLY**

**Multiple-axis foot:** moves slightly in all planes to permit maximum contact with the walking surface

- heavier and less durable
SHANK

- Purpose is to restore leg length and shape, and transmit body weight from the socket to the foot
- Two types:
  - Exoskeletal
  - Endoskeletal
Shank

- **Exoskeletal** (crustacean): support consists of a rigid material (usually wood), covered with a thin layer of tinted plastic (to match skin color) distally
  - very durable and impervious to liquids and most abrasives (if it has a plastic finish)
SHANK

- **Endoskeletal**: support consists of a rigid pipe (pylon) covered with a resilient material to simulate the contour and color of the contralateral limb
  - more life-like
  - pylon has a mechanism that permits small adjustments for angulation (for ease of walking)
SOCKET

• This is the receptacle for the amputated limb made of custom-molded plastic

• **Reliefs**: concavities within a socket to decrease loading on pressure-sensitive areas
  – fibular head, tibial crest, tibial condyles, & anterodistal tibia

• **Build-ups**: convexities within a socket to increase loading over pressure-tolerant tissues
  – patellar tendon, gastroc belly, tibial and fibular shafts
Socket Alignment on the Shaft

• **Slight Flexion**
  – Prevents genu recurvatum
  – Resists tendency of residual limb to slide down the socket
  – Facilitates contraction of quadriceps muscle

• **Slight Lateral Tilt**
  – Reduces load on fibular head
Socket Liners

• The transtibial socket generally includes a foam liner
  – Cushions limb
  – Facilitates alteration of socket size

• Unlined Sockets
  – Patient still wears a sock, so there is a soft interface
  – Sometimes has a pad in the bottom
  – Good choice for a limb that is stable in size
BK SUSPENSION

- During swing (or any other NWB activity), the prosthesis requires some form of suspension
- Types:
  - Cuff
  - Rubber sleeve
  - Thigh corset
  - Supracondylar brim
BK SUSPENSION

- **Cuff variants:**
  - supracondylar cuff: leather strap encircles the thigh immediately above the femoral condyles
  - fork-strap: fork-shaped elastic strap extends from the anterior portion of the BK shank to a waist belt
BK SUSPENSION

- **Rubber Sleeve Suspension**: tubular component that covers the proximal socket and the distal thigh
  - provides excellent suspension
  - requires 2 strong hands to don
BK Suspension

- **Thigh Corset Suspension:**
  - For pts with very sensitive skin on residual limb
  - Metal hinges attach to the med/lat aspects of socket & to a leather corset that may reach up to the ischial tuberosities
  - Heavy
  - Difficult to don
BK Suspension

• **Supracondylar Brim Suspension**
  – The medial & lateral walls extend above the femoral condyles
  – A medial wedge helps to keep it in place
  – Increases med/lat stability
  – expensive
AK PROSTHESSES

- Consists of: A) foot-ankle assembly
  B) shank
  C) knee unit
  D) socket
  E) suspension device

- Foot-ankle assembly and shank are same as those that are used with BK prostheses
AK Prostheses

A. Foot:
   - The SACH is the most commonly used for AK

B. Shank:
   - Either exoskeletal or endoskeletal may be used
• Commercial units are described according to 4 features:
  – 1. Axis
  – 2. Friction mechanism
  – 3. Extension aid
  – 4. Mechanical stabilizer
C. KNEE UNITS – 1. Axis system

– The thigh piece can be connected to the shank by either...

– a **single-axis hinge**: permits flexion and extension at a point correlating to the anatomic axis of the knee

  • most common
  • OR...
C. KNEE UNITS – 1. Axis System

- **Polycentric linkage**: mechanism that permits the momentary axis of knee flexion to change through the arc of motion
  - increases knee stability
C. KNEE UNITS – 2. Friction Mechanisms

- **Friction mechanism:**
  - Changes the knee swing by modifying the speed of knee motion during the various parts of swing phase
  - Adjusts knee swing according to cadence
C. KNEE UNITS – 2. Friction Mechanism

- **Constant friction**: mechanism that applies uniform resistance throughout the swing phase
- **Variable friction**: greater friction is applied at early and late swing
C. KNEE UNITS – 2. Friction Mechanisms

- **Medium**: the medium through which the resistance is applied influences performance. Several types:
  - **sliding friction**: consists of solid structures that resist motion by moving up against each other
    - Most common medium
C. KNEE UNITS – 2. Friction Mechanism

- **Fluid friction**: consists of a cylinder (hydraulic is oil-filled, pneumatic is air-filled) in which a piston connected to the knee hinge moves up and down. These units automatically compensate for changes in walking speed.
C. KNEE UNITS

• **Microprocessor**
  – Computer chip provides a more fluid response to changes of cadence
  – Most advanced
  – Expensive
C. KNEE UNITS – 3. Extension Aids

- **Extension aid**: mechanism designed to assist prosthetic knee extension during the latter part of swing phase. May consist of
  - elastic webbing placed *externally* across the knee
  - elastic strap or coiled spring *within* the unit
C. KNEE UNIT – 4. STABILIZERS

• Most units do not have a special device to increase stability

• the patient controls the knee action through hip motions (in addition to the alignment of the knee in relation to other components of the prosthesis).

• Those available are…
C. KNEE UNIT – 4. STABILIZERS

- **manual lock**: prevents knee flexion
- **friction brake**: resists knee flexion during early stance, commonly through a spring-loaded wedge
D. SOCKETS

- Several types designed to emphasize loading on pressure tolerant tissues
  - Ischial tuberosity
  - Gluteal musculature
  - Sides of the thigh
  - Distal end of residual limb (to a lesser degree)

- Care must be taken to avoid pressure over the pressure intolerant tissues
  - pubic symphysis
  - perineum
D. SOCKETS:

- **Quadrilateral socket:**
  - posterior shelf for the ischial tuberosity and glut
  - medial brim same height as posterior shelf
  - anterior wall higher to apply a posterior force
  - lateral wall same as anterior for medlat. stab
D. SOCKETS:

- **Ischial containment**: covers the ischial tuberosity and is relatively narrow in width
  - weight bearing occurs through the sides and bottom of the amputation limb
D. SOCKETS: Alignment & Fit

• Fit and alignment: the socket should fit snugly to resist chafing and maximize control.

• Slight socket flexion desirable for:
  – facilitating contraction of the hip extensors
  – reduce lumbar lordosis
  – permit zone to extend thigh for equal steps
E. SUSPENSION

• Three means of suspension:
  a) total suction
  b) partial suction
  c) no suction
E. SUSPENSION

- **Suction**:  
  - Socket is held on by atmospheric pressure (pressure is greater on the outside than on the inside)  
  - Air release valve located at the bottom of the socket  
  - Requires snug fit
E. SUSPENSION

- **Total suction**: maximum control of the prosthesis without any auxiliary suspension
  - socket must fit very snugly
  - if patient experiences changes in volume of the amputated limb, suction is lost
E. SUSPENSION

- **Partial suction**: socket is slightly loose; patient wears a sock and an auxiliary suspension aid that encircles the pelvis
  - **Silesian bandage**: fabric
  - **hip joint and pelvic band**: rigid plastic or metal
- **makes prosthesis heavier**
E. SUSPENSION

- **No suction**: socket has a distal hole, but no valve (pressure is same inside and outside the socket)
  - Patient wears one or two socks and requires a pelvic band
  - Easier to don but hinders control
SOCKS AND SHEATHS

• All prosthetic wearers (except total suction or those using a sheath) wear socks
• Socks come in various thicknesses (ply) and materials
SOCKS AND SHEATHS

- **Cotton**: 2-, 3-, and 5- ply
  - absorbs perspiration and least allergenic
- **Wool**: 3-, 5-, and 6- ply
  - provides good cushioning
- **Orlon/Lycra**: 2-, and 3- ply
  - provides considerable resilience, poor absorption of perspiration
SOCKS AND SHEATHS

• **Sheaths**: Nylon sheaths create a smooth surface over the skin
  – decreases the risk of chafing
  – perspiration passes through the weave to be absorbed by the outer sock
SOCKS AND SHEATHS

- Silicone, urethane, and synthetic sheaths:
  - excellent shock absorption and abrasion resistance
  - can aid in suspending the socket on the limb
  - more expensive
SOCKS & SHEATHS

• **FIT:**
  – Should fit smoothly without wrinkling or undue stretching
  – Should be long enough to terminate above the most proximal part of the socket or thigh corset

• **Limb Shrinkage**
  – As limb shrinks, add more socks
  – When the patient requires 15-ply of socks to achieve a snug fit, the socket should be altered or replaced by a prosthetist
Looking Ahead

• Orthotics
Questions??