Evaluation of the Upper Extremity Amputee and Levels of Amputation

Heikki Uustal, MD
JFK-Johnson Rehab Institute
Edison, NJ
Do I really need to see this?
Etiology of Upper Limb Amputation

- Trauma
- Cancer
- Infection
- Burns
- Congenital
Epidemiology - incidence

- Approx. 130,000 amputations per year in US
- 80-100,000 major amputations (>90% are lower limb BK 2/3, AK 1/3)
- Dysvascular disease = 82% (97% lower limb)
- Trauma = 16% (68% are upper limb)
- Cancer = <1% (75% are lower limb)
- Congenital = <1% (60% are upper limb)
- 6-10,000 upper limb amputations per year
Epidemiology-prevalence

- Approx 1.6 million amputee survivors in US (2005)
- Only 32% are diabetic/dysvascular with higher prevalence in males and African Americans
- The majority are trauma related
- Age groups?
Morbidity - traumatic

- Revision surgery in trauma = 14%
- Wound infection rate = 34%
- Risk of heterotopic bone/bone spurs is near 100% in thru bone amputations
Evaluation of the Patient

Injury History:
- Cause of amputation
- Hospital course, time frame
- Repeated surgical procedure
- Skin grafts, muscle flaps
- Nerve injury (brachial plexus, peripheral nerve)
- Other injuries (ortho, spine, brain)
Evaluation of the Patient

Pain History:
- Pain prior to amputation
- Pain related to surgery/procedures
- Phantom sensations
- Phantom pain
- Treatment for each of the above
Evaluation of the Patient

Social History:
- Social support system
- Involvement of support system
- Work history
- Contact/Discussions with employer
- Patient concerns about family, friends, employer
- Financial issues
- Education level
Evaluation of the Patient

Psychological History:
- Prior psychological issues (depression, previous disabilities)
- Current feelings about amputation
- Future concerns about function
- Body image issues
- Concepts about prosthesis
- Previous experience with prosthesis
Evaluation of the Patient

Avocational Activities History:
- Family Responsibilities
- Sports / Fitness
- Intimacy / Sex
- Driving
- Outdoor activities (swimming)
- Hobbies
Evaluation of the Patient

Physical Exam:
- Single limb vs. Multiple limb involvement
- Dominant vs. Non-Dominant limb loss
- Single limb loss – Examine remaining limb first in detail proximal and distal (makes exam of involved limb easier for doctor and patient)
- Check spinal alignment
Evaluation of the Patient

Physical Exam of the involved limb:
- Level of amputation, bone length
- Skin and soft tissue integrity
- Skin grafting or scarring
- Adherent skin
- Tenderness to palpation
- Sensation throughout
Evaluation of the Patient

Physical exam of the involved limb:

- Shoulder girdle muscles: (trapezius, rhomboids, pectoralis, latissimus, supraspinatus, infraspinatus, subscapularis, deltoid)
- Shoulder A/PROM: glenohumeral joint (FL, Ext, Abd, Add, IR, ER), scapulo-thoracic rotation and stability
- Cervical spine mobility
Evaluation of the Patient

Physical exam of the involved limb:
- Elbow motor (Fl, Ext)
- Elbow A/PROM (Fl, Ext)
- Wrist motor/ROM (Flex, Ext, Pron, Sup)
- Any remaining segments of hand
Introduce the P&O Team Concept

- Patient
- Physiatrist
- Prosthetist
- Physical Therapist
- Occupational Therapist
- Social Service
- Psychologist
- Vocational Counselor
- Case Manager
Review the Rehab Issues and Plans

Education – Pre-prosthetics Program:

- Need for early therapy to mobilize joints and maintain strength
- Regain independence in self-care and mobility
- Residual limb shaping and shrinking
- Pain control
- Psychological issues
- Buddy system with other patients
Review the Rehab Issues and Plans

Education – Prosthesis:

- Explain about fitting/fabricating prosthesis and component selection
- Explain cosmetic vs. functional issues
- Inquire about insurance coverage for prosthesis
- Clarify patient concerns or misconceptions about prosthesis
Review the Rehab Issues and Plans

Long term Management:
- Lifetime comprehensive management by P&O Team
- Skin tolerance issues
- Return to driving
- Return to work/school
- Return to avocational activities and sports
Levels of Amputation

- Forequarter
- Shoulder disarticulation
- Humeral neck
- Short above elbow
- Long above elbow
- Elbow disarticulation
- Very short below elbow
- Short below elbow
- Long below elbow
- Wrist disarticulation
- Transcarpal
- Transmetacarpal
- Transphalangeal
Functional Impact of Finger Amputation

- Thumb → Opposition
- Index and Middle → Fine motor
- Fourth and Fifth → Power Grip
Finger Pinch and Gross Grasp
Single Digit Amputation
Multiple Finger Amputations
Multiple Finger Amputation
Functional Hook Grasp
Multiple Digit Burns
Multiple Digit Amputation
Functional Tip pinch
Functional Gross Grasp
PIP driver
MCP driver
Point Design
ratcheting fingers

- Release button & auto spring back
- MCP center of rotation
- Ratcheting positioning mechanism
- Steel construction 100 lb load carrying capacity
- Polished or brushed finishes
- Anatomical flexion
Multiple Finger Amputation
Levels of Thumb Amputation
Partial Thumb Amputation
Deepen First Web Space
Functional Gross Grasp
Finger Tip Pinch for Fine Motor Skills
Partial Thumb Prosthesis
Full Thumb Prosthesis
Thumb Prosthesis
Trans-metacarpal Amputation
Myo-electric partial hand
Trans-metacarpal Amputation
Trans-metacarpal Amputation
Electrocution Injury
Partial Hand Prosthesis
Mitt Amputation with Burns
Mitt Amputation Prosthesis

(1) Dorsal extension of the residual limb for opening the hand.
Hand Amputation and Re-implantation
Functional Hand?
Wrist Disarticulation Amputation

- Advantages: Maximum Pronation/Supination
  Maximum leverage for lift/push
- Disadvantages: Bulky distal end
  Poor prosthetic cosmesis
  Need 3-4 cm for wrist unit
Degrees of Pronation

Natural rotation

Residual rotation of amputee

Very short  Short  Long  Disarticulation

Inches

Centimeters

0  2  4  6  8  10
(5)  (10)  (15)  (20)  (25)
Wrist Disartic Prosthetic Options (cosmetic, cable, myo)
Wrist Disarticulation Amp
Wrist Disartic Prosthesis
Body-powered Socket Fitting
Figure-9 Harness with Control Cable to Terminal Device
Wrist Disartic Myo-electric Self-suspending Socket
Wrist Dis-artic Prostheses
Trans-radial Amputation

- Long = 55-90 % of radius intact
  Ideal length for function and cosmesis
  Maintains most of pron/sup and leverage
- Short = 35-55 % of radius intact
  Still very functional and fittable
- Very short = 0-35 % of radius
  Difficult socket fit and limited function
Trans-radial Prosthetic Options (cosmetic, cable, myo)
Long Trans-radial Amputee
Long Trans-radial Amputation
Long Trans-radial Cable Prosthesis
Figure-8 Harness
Short Trans-Radial Amp
Cable-Powered Trans-radial Prosthesis
Very Short Trans-radial Amputee
Krukenburg Reconstruction
Elbow Disarticulation Amputation

- Advantages: Maximum leverage for lift/push
  Humeral condyles assist with suspension

- Disadvantages: Bulky distal end
  Poor prosthetic cosmesis
  Must use external elbow joints
  Need 4-5 cm for electric elbow
Elbow Disarticulation
Elbow Disartic Cable-powered Prosthesis
Elbow Disartic Prosthesis with Harness
Elbow Disartic Myo-electric Prosthesis with test socket
Smart idea?
Elbow Disarticulation Amp
Elbow Disarticulation Cable Prosthesis with external elbow joints
Figure-8 Harness Plus Suspension Straps and External Locking Elbow Joint
Hybrid Elbow Disartic Prosthesis with cable to elbow and myo-hand
Elbow Disartic Prosthesis
Bi-valve Socket
Elbow Disartic with Brachial Plexus Injury
Trans-humeral Amputation

- **Long** = 50-90 % of humerus intact
  Ideal length for function and cosmesis
- **Short** = 30-50 % of humerus intact
  Limited leverage for lift/push
  Socket design now limits shoulder motion
- **Very short** = Humeral neck = 0-30 % intact
  Fitted as shoulder disarticulation
Trans-humeral Prosthetic Options
(cosmetic, cable, myo, hybrid)
Trans-humeral Socket Design
Figure-8 Harness on Trans-humeral Prosthesis
Long Trans-humeral Amputee
Long Trans-humeral Amputee
Trans-humeral Prosthesis
Trans-humeral Prosthesis with Hybrid Control (cable elbow)
Short Trans-Humeral Amp
Hybrid Trans-humeral Prosthesis
Saddle Harness for Short Trans-humeral Prosthesis

Fig. 3-43. A saddle harness suspension system. The components are a: saddle suspension; b: posterior "V" strap; c: anterior "V" strap; d: anterior elastic suspensory strap; e: elbow locking cable and adjustable strap; f: dual control Bowden cable; g: dual control cable strap (adjustable); and h: chest strap (adjustable).
Humeral Neck Amputation
Humeral Neck Cable Prosthesis
Humeral Neck Prosthesis with Cross-chest Strap Suspension

Fig. 3-46. Illustration of humeral neck amputation prosthesis using chest expansion to operate the elbow lock. Note the socket extending over the shoulder. The components are:
a: dual walled socket; b: elbow locking cable and housing; c: chest expansion elbow locking control strap (adjustable); d: elastic suspensory strap (adjustable); e: anterior suspensory strap (adjustable); f: posterior suspensory strap (adjustable); g: chest strap (adjustable); h: dual control cable and housing; and i: dual control cable strap (adjustable).
Shoulder Disarticulation Amputation

- Difficult socket design
- Difficult to achieve functional prehension
- Heavy prosthesis may not be tolerated
- Patient may choose to be independent without prosthesis if other hand intact
Shoulder Disartic Prosthetic Options
Shoulder Disartic
Shoulder Disartic Prosthesis
Myo-electric
Shoulder Disarticul Amputation
Shoulder Disartic Prosthesis
Myo-electric
Forequarter Amputation

- Loss of entire limb and scapula
- Most commonly caused by tumor resection
- Lightweight cosmetic prosthesis is the most practical device
Bilateral Upper Limb Amputation

- Fit the longer residual limb with a prosthetic device for functional prehension (pinch and gross grasp)
- Fit the remaining limb as an assist for longer limb
- Use any and all available assistive devices to achieve independence in self-care and ADL’s
Bilateral Elbow Disartic Prostheses
Complex Cases

- Multiple limb amputation
- Other confounding medical issues
- Timing of multiple limb prosthetic fitting
- If delay in fitting, preserve myo-electric sites with muscle isometric or FES
Thank You