Upper Extremity Amputee Rehabilitation and Prosthetics

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Outline

- Epidemiology
- Cause
- Levels
- Evaluation & Management
- Rehabilitation Program
- Prosthetic Systems
- Questions

Epidemiology

- “Prevalence” is determined by the number of people living with amputations and looks at how many people are affected
- “Incidence” refers to the number of new cases, usually per year, per population at risk.

Prevalence

- There are 1.2 to 1.9 million people in the United States living with limb loss, excluding finger tip and toe amputations
- One in every 200 people in the U.S.

Incidence

- Limb Loss Research and Statistics Program, 2008:
  - 185,000 Americans undergo amputation each year.
- Dillingham, 2002:
  - 1,199,111 hospital discharges that involved amputation or congenital limb deficiency from 1988 through 1996
  - 133,235 amputations per year
  - 1996 annual rate of 52 amputations per 100,000 US population.
    - Upper limb amputation incidence rate was 5/100,000
    - Lower limb amputation incidence rate was 47/100,000

Causes

- Trauma
- Congenital
  - deformities - dysmelia
  - shortened limb – phocomelia
  - absence of upper limb – amelia
- Cancer
  - tumors – osteogenic sarcoma, ewing's sarcoma
- Disease related - Dysvascular
  - Emboli from meningococcemia may cause auto-amputation of limbs or digits and can affect all 4 limbs

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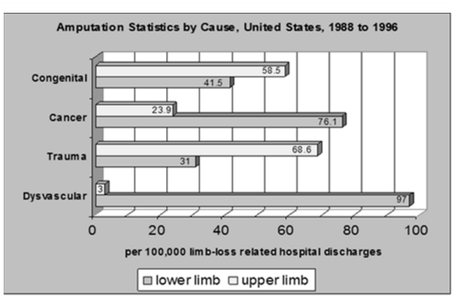
Causes



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Causes- By Age

- Birth-15 years old:
  - Most common: Congenital disorders
- 15 – 45 years old:
  - Most common: Trauma
- 70% of Upper Limb Amputation occurs in individuals younger than 64 years old
- Large number of individuals leading very active lives with upper limb amputation

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Congenital Upper Limb Deficiency

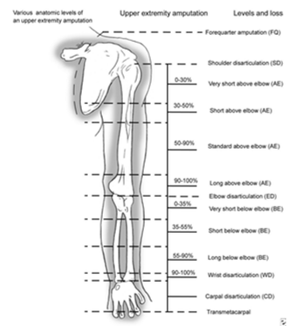
- 4.1 / 10,000 live births
- Most cases have no hereditary implications
- Craniofacial anomalies are associated with limb deficiencies

<u>5 associated conditions</u>:

1. TAR syndrome: thrombocytopenia with absence of radius
2. Fanconi's Syndrome: anemia, leukopenia
3. Holt-Oram Syndrome: congenital heart disease
4. Baller-Gerold Syndrome: craniosynostosis
5. VACTERL: Vertebral defects, Anal atresia, Cardiac defects, Tracheoesophageal fistula, Renal dysplasia, Limb Deficiency

Levels- ISPO Classification

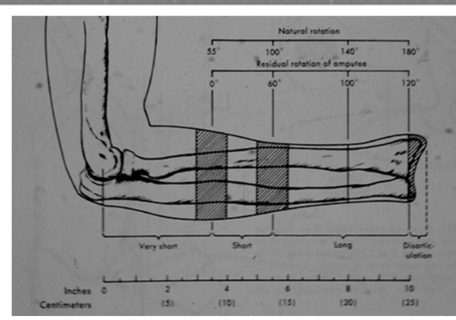
- Digit Amputation
- Partial Hand
- Wrist disarticulation
- Transradial (57%)
- Elbow disarticulation
- Transhumeral (23%)
- Shoulder disarticulation
- Forequarter



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



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

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

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
  - Fit as shoulder disarticulation

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

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

Evaluation of the Patient

Detailed 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
- Pain management

Evaluation of the Patient

Social History:

- Social support system and involvement
- 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, high risk-takers)
- 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
- Check spinal alignment

Evaluation of the Patient

Physical Exam of the involved limb:

- Level of amputation, bone length
- Residual limb circumference
- 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, serratus anterior, latissimus dorsi, supraspinatus, infraspinatus, subscapularis, deltoid)
- Shoulder A/PROM: glenohumeral joint (flexion/extension, abd/adduction, int/ext rotation) scapulo-thoracic rotation and stability
- Cervical spine mobility

Evaluation of the Patient

Physical Exam of the involved limb:

- Strength testing at elbow, wrist
- A/PROM testing at elbow, wrist
- Any remaining segments of hand

Management

Understand differences b/w UE and LE limb loss

- Fewer peers
- Less prosthetic fabrication experience
- Many fewer experienced therapists
- Multiple choices of prosthetic components and operating systems with large variation in cost
- Easier to function with remaining limb

Management

Education – Pre-prosthesis training 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
- Peer support

Management

Pre-prosthesis training program:

- Limb shaping with figure 8 ace wrap/shrinker
- Wound care and healing issues
- Strengthening of residual limb muscles for potential myoelectric control
- Strengthening of proximal muscles for potential body powered control
- ROM exercises at wrist, elbow, shoulder

Management

Education – Prosthesis:

- Discuss fitting/fabricating prosthesis and component selection
- Discuss prosthesis timeline
- Explain cosmetic vs. functional issues
- Inquire about insurance coverage for prosthesis
- Clarify patient concerns or misconceptions about prosthesis

Management

Prosthesis training program:

- Independent with ADLs using adaptive equipment
- Desensitizing techniques for residual limb
- Scar management
- Pain control
- Return locus of control

Management

Long term Management:

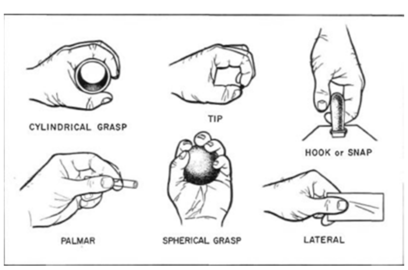
- Lifetime comprehensive management by amputee clinic team
- Skin tolerance issues
- Return to driving
- Return to work/school
- Return to avocational activities and sports

Prosthetic Systems

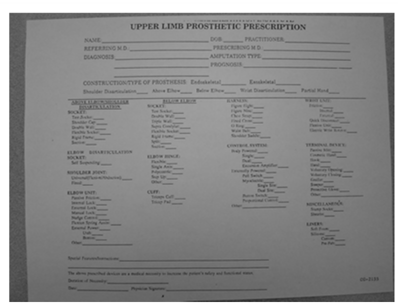
Why are we ordering a prosthesis?

- Prehension
- Movement
- Symmetry
- Balance
- Cosmesis

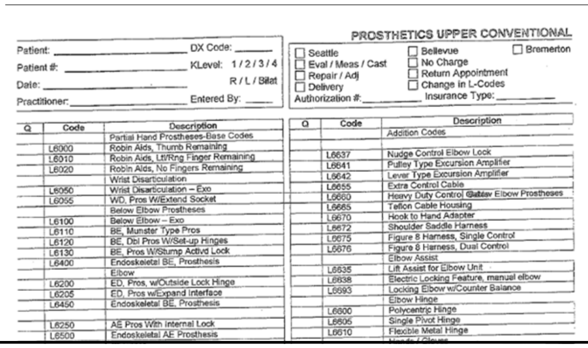
Prehension



Upper Extremity Prosthesis Rx


UPPER LIMB PROSTHETIC PRESCRIPTION

Upper Extremity Prosthetics: Order Form



PROSTHETICS UPPER CONVENTIONAL

Patient: ____________ DX Code: ______
Patient #: ____________ KLevel: 1 / 2 / 3 / 4
Date: ____________ R / L / Bilat
Practitioner: ____________ Entered By: ______

☐ Seattle ☐ Bellevue ☐ Bremerton
☐ Eval / Meas / Cast ☐ No Charge
☐ Repair / Adj ☐ Return Appointment
☐ Delivery ☐ Change in L-Codes
Authorization #: ________ Insurance Type: ________

Q	Code	Description
		Partial Hand Prostheses-Base Codes
	L6000	Robin Aids, Thumb Remaining
	L6010	Robin Aids, Ltl/Rng Finger Remaining
	L6020	Robin Aids, No Fingers Remaining
		Wrist Disarticulation
	L6050	Wrist Disarticulation – Exo
	L6055	WD, Pros W/Extend Socket
		Below Elbow Prostheses
	L6100	Below Elbow – Exo
	L6110	BE, Munster Type Pros
	L6120	BE, Dbl Pros W/Set-up Hinges
	L6130	BE, Pros W/Stump Activd Lock
	L6400	Endoskeletal BE, Prosthesis
		Elbow
	L6200	ED, Pros, w/Outside Lock Hinge
	L6205	ED, Pros w/Expand Interface
	L6450	Endoskeletal BE, Prosthesis
	L6250	AE Pros With Internal Lock
	L6500	Endoskeletal AE Prosthesis

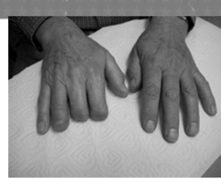
Q	Code	Description
		Addition Codes
	L6637	Nudge Control Elbow Lock
	L6641	Pulley Type Excursion Amplifier
	L6642	Lever Type Excursion Amplifier
	L6655	Extra Control Cable
	L6660	Heavy Duty Control Cable Elbow Prostheses
	L6665	Teflon Cable Housing
	L6670	Hook to Hand Adapter
	L6672	Shoulder Saddle Harness
	L6675	Figure 8 Harness, Single Control
	L6676	Figure 8 Harness, Dual Control
		Elbow Assist
	L6635	Lift Assist for Elbow Unit
	L6638	Electric Locking Feature, manuel elbow
	L6693	Locking Elbow w/Counter Balance
		Elbow Hinge
	L6600	Polycentric Hinge
	L6605	Single Pivot Hinge
	L6610	Flexible Metal Hinge

Control Options

- Passive prosthesis
  - Cosmetic, allows passive positioning of joints or TD
- Body powered prosthesis
  - Uses proximal body movements to position joints/TD
- Myoelectric prosthesis
  - Uses surface electrodes to detect voluntary muscle activity in residual limb to activate joints/TD
- External powered prosthesis
  - Uses switch control to position joints/TD

Passive Prosthesis

- Multiple Digit Amputations



- Custom Silicone Finger Prostheses

Passive Prosthesis

- Transradial Limb Deficiency

- Custom Silicone Hand Prosthesis

Body powered prosthesis

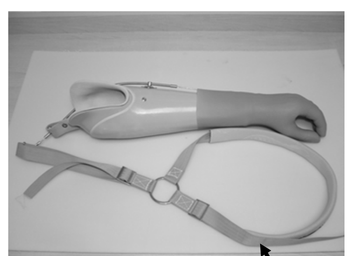
- Advantages
  - Lighter weight
  - Less expensive
  - More durable
  - Better feedback
- Disadvantages
  - Harnessing required
  - Less cosmetic

Suspension Systems

- Figure 8 Harness
- Figure 9 Harness
- Shoulder saddle with chest strap
- Self suspension
  – Northwestern University socket design
  – Muenster socket design

Figure-8 Harness

Figure-9 Harness



Harness (Figure 9)

Shoulder Saddle with chest strap

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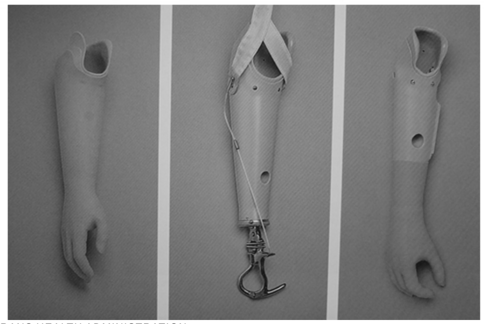
Self Suspension



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Body powered prosthesis

- Transradial Level
  - Body movement to operate TD
    - Forward humeral flexion
    - Bi-scapular abduction (protraction)
- Transhumeral Level
  - Body movement to operate joint/TD via dual cable
    - Shoulder depression/extension/abduction
    - "Down, back and out" to lock/unlock elbow joint

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Body powered prosthesis

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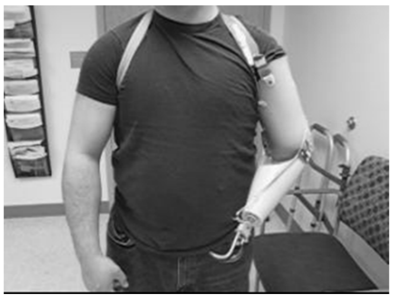
Body powered prosthesis



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Myoelectric prosthesis

- Advantages
  - No harness required
  - Better cosmesis
  - Less muscle strength needed
- Disadvantages
  - More expensive
  - Heavier
  - More maintenance needed

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Myoelectric prosthesis

Common myoelectric sites:

- Transradial level: Intact wrist flexors/extensors
- Transhumeral level: Intact biceps/triceps
- Shoulder disarticulation: Intact pectoralis/latissimus dorsi

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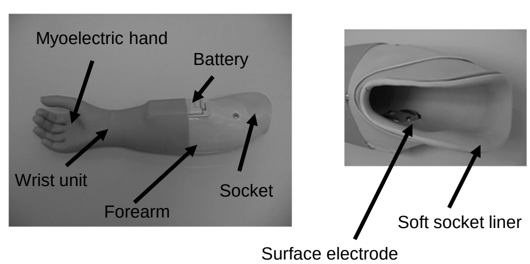
Self Suspension



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Wrist Disarticulation Options

- Control system: passive, cable or myoelectric
- Socket design: soft interface, rigid frame
- Suspension: suction, harness (figure-9)
- Thin wrist unit
- Terminal device: hook, hand, robotic, specialty

Transradial Options

- Control system: passive, cable or myoelectric
- Socket design: single wall or double wall
- Suction suspension: wet/dry fit into hard socket or gel liner
- Harness suspension: Figure 9 (long) or Figure 8 (short)
- Flexible elbow hinge to triceps cuff
- Wrist units: Friction, quick disconnect, flexion
- Terminal device: hook, hand, robotic, specialty

Elbow Disarticulation Options

- Control system: passive, cable, myoelectric or hybrid
- Socket design: single wall
- Suction suspension, self-suspending
- Harness suspension: Figure 8
- External elbow joints
- Forearm shell
- Wrist units: Friction, quick disconnect, flexion
- Terminal device: hook, hand, robotic, specialty

Transhumeral Options

- Control system: passive, cable, myo or hybrid
- Socket design: interface, single/double
- Suction suspension (gel liner or wet fit)
- Harness suspension: Figure 8, shoulder saddle with chest strap
- Mechanical elbow joints (internal locking)
- Electric elbow joints (depending on length)
- Wrist units: Friction, quick disconnect, flexion
- Terminal device: hook, hand, robotic, specialty

Shoulder Disarticulation Options

- May consider shoulder cap for pain control
- Cosmetic vs. functional prosthesis
- Socket designs (passive, cable, myo, hybrid)
- Harness designs (figure-8, cross-chest)
- Shoulder joints: passive, switch
- Elbow joints: mechanical, electric (switch vs. myo)
- Wrist units: Friction, quick disconnect, flexion
- Terminal device: hook, hand, robotic, specialty

Functional Goals- U/L UE Amputee

- Independent in donning and doffing prosthesis
- Independent in activities of daily living
- Can write legibly with remaining hand
- Drives and has returned to work
- Can tie laces with one hand and use a button hook
- Has prepared a meal in the kitchen and has been instructed in use of adaptive equipment
- Wears prosthesis daily and uses for bimanual activities at least 25% of the time

Functional Goals- B/L UE Amputee

- Transradial amputee
  - Achieve independence with ADLs
- Transhumeral amputee
  - 25-50% achieve independence with ADLs
  - Remaining require minimal to moderate assistance
- Shoulder disarticulation
  - Dependent for all ADLs, exceptions include congenital amputees who become independent with foot skills

Usage

- Wright, 1994:
  - 135 major upper limb amputations (above wrist)
  - Usage rate by levels:
    - Wrist disarticulation: 54%
    - Below elbow: 94%
    - Above elbow: 43%
    - Shoulder disarticulation or forequarter: 40%
- Graham, 2006: Upper limb / Ireland
  - 56% used their prosthesis functionally
  - 34% used their prosthesis cosmetically

Usage

- Melendez, 1988:
  - Upper limb amputees who did not use prosthesis attributed their choice to a lack of education and information on prosthetic devices
- Biofeedback therapy
  - Computer based technology enables upper limb amputees to train to use myoelectric prosthetic devices while waiting to be fit for their prosthesis
  - Allows for early muscle strengthening and retraining

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What is this?

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Question

1. Young adult presents with traumatic injury to distal upper extremity and the orthopedic surgeon is deciding between an elbow disarticulation and a transhumeral amputation. In your discussion, you state one benefit of the elbow disarticulation level is:

a. Control of the terminal device will be easier
b. A stronger, more functional elbow joint can be fabricated.
c. A more durable prosthesis can be fabricated.
d. Fitting of the myoelectric prosthesis is easier.
e. Heterotopic ossification of the humerus is avoided.

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Answer

1. Young adult presents with traumatic injury to distal upper extremity and the orthopedic surgeon is deciding between an elbow disarticulation and a transhumeral amputation. In your discussion, you state one benefit of the elbow disarticulation level is:

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Question

2. The primary bodily control motion required for opening the terminal device of a standard transradial prosthesis is:

a. Glenohumeral flexion.
b. Glenohumeral extension.
c. Glenohumeral abduction.
d. Biscapular adduction.
e. Glenohumeral and biscapular adduction.

Answer

2. The primary bodily control motion required for opening the terminal device of a standard transradial prosthesis is:

a. Glenohumeral flexion.
b. Glenohumeral extension.
c. Glenohumeral abduction.
d. Biscapular adduction.
e. Glenohumeral and biscapular adduction.

Question

3. The bodily control motion required to lock or unlock the prosthetic elbow of a standard transhumeral prosthesis is:

a. shoulder depression, glenohumeral flexion and abduction.
b. shoulder depression, glenohumeral extension and abduction.
c. shoulder elevation, glenohumeral flexion and abduction.
d. shoulder elevation, glenohumeral extension and abduction.
e. biscapular abduction, shoulder depression and abduction.

Answer

3. The bodily control motion required to lock or unlock the prosthetic elbow of a standard transhumeral prosthesis is:

a. shoulder depression, glenohumeral flexion and abduction.
b. shoulder depression, glenohumeral extension and abduction.
c. shoulder elevation, glenohumeral flexion and abduction.
d. shoulder elevation, glenohumeral extension and abduction.
e. biscapular abduction, shoulder depression and abduction.

Question

4. In a standard transradial prosthesis, when terminal device operation close to the midline of the body is required, as when buttoning a shirt, body motion necessary to operate the terminal device is:

a. shoulder depression.
b. shoulder elevation.
c. scapular retraction.
d. scapular protraction.
e. glenohumeral abduction.

Answer

4. In a standard transradial prosthesis, when terminal device operation close to the midline of the body is required, as when buttoning a shirt, body motion necessary to operate the terminal device is:

a. shoulder depression.
b. shoulder elevation.
c. scapular retraction
d. scapular protraction.
e. glenohumeral abduction.

Thank you

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TEAMS
TREATMENT TECHNOLOGY
AMPUTATION SYSTEM OF CARE