ADAPTIVE PROSTHETICS
Deficits and devices of upper & lower limb amputees

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TOPICS COVERED

- Major amputation levels and prosthetic overview
- Adaptive Prosthetics – definitions and history
- Lower Limb overview
- Upper Limb -
  - Amputation deficits
  - Upper Limb prosthetic overview
  - Activity specific/adaptive prosthetics
  - Indications/Contraindications
  - The therapist-prosthetist team

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MY BACKGROUND

- AZ Native
- Studied Biomedical Engineering at ASU
- Practiced in Phoenix for 8 years
- Faculty at Baylor College of Medicine
- Returned to AZ to make a difference

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MAJOR AMPUTATION LEVELS – Lower Limb

- Lower Limb Amputations
  - Partial foot
  - Ankle disarticulation
  - Transtibial
  - Knee disarticulation
  - Transfemoral
  - Hip disarticulation
MAJOR AMPUTATION LEVELS – Upper Limb

- Upper Limb Amputations
  - Digital amputation
  - Partial Hand
  - Wrist disarticulation
  - Transradial
  - Elbow Disarticulation
  - Transhumeral
  - Shoulder Disarticulation
  - Inter-scapulothoracic
PROSTHETIC OVERVIEW

- Terminology:
  - Prosthesis (noun) – Any device that replaces a missing part of the body.
  - Prosthetic (adjective) – Describing anything that deals with a prosthesis.
  - Socket - The part of the device that encapsulates and interacts with the residual limb.
  - Foot – It’s a foot...
  - Terminal Device – The part of an upper limb prosthesis that interacts with the environment (hook, hand, etc...).
  - Suspension – The method of holding the prosthesis on to the body.
ADAPTIVE PROSTHETICS

- Adaptive Prostheses – “Any component or group of components that enable the amputee to engage in (adapt to) a specific Physical activity”

- A lot of overlap

Adaptive prosthesis were among the first type of prostheses

201 BC - Marcus Sergius was a Greek general who had an iron hand made to support his shield.
1509 AD - A hand made representing armor for Goetz von Berlichingen. The fingers could be locked shut to hold a weapon
HISTORY ADAPTIVE PROSTHETICS - 3

- Late 19th Century - The civil war left many amputees to fend for themselves and create novel "home brew" devices. The prosthesis shown here was made out of a gun stock.
Post WWII - Much was done to get veteran amputees back to their specialized work.
LOWER LIMB ADAPTIVE PROSTHETICS - OVERVIEW

- Socket
- Suspension
- Knee
- Alignable components
- Ankle
- Foot
LOWER LIMB ADAPTIVE PROSTHETICS – GOALS & BENEFITS

- Activity specific
- Mostly recreational
- The major goal is increase in performance
LOWER LIMB ADAPTIVE PROSTHETICS - EXAMPLES

- **Knees**
  - Focus on shock absorption, rather than stance and swing phases of gait

- **Feet**
  - Running
  - Swimming
  - Skiing
  - Etc...

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360oandp.com

Hedef prosthetics

Freedom Innovations
UPPER LIMB PROSTHETICS

Alternative Limb Project
UPPER LIMB ADAPTIVE PROSTHETICS – Amputation Statistics by site

- Difference in Goals, in numbers, and in cause of amputation

UPPER LIMB ADAPTIVE PROSTHETICS – Amputation Statistics by cause

UPPER LIMB ADAPTIVE PROSTHETICS – AMPUTATION DEFICITS – Partial Hand

**functional Deficiencies**
- Precision finger manipulation
- Padded distal end

**Remaining functions**
- Fine palmer positioning (Wrist movement, pronation/supination)
- Elbow and shoulder movement
- Possible fine digital opposition remaining
- Suspension in cubital fold
- Bilateral Oppositional force
- Sensation

**Percent impaired**
- Thumb: 38% UE, 23% WP
- Full partial hand: 90% UE, 54% WP
UPPER LIMB ADAPTIVE PROSTHETICS – AMPUTATION DEFICITS - Transradial

Deficiencies
- Large surface area for load bearing
- Pronation/supination?
- Fine palmer positioning
- Precision finger manipulation
- Padded distal end

Remaining functions
- Elbow and shoulder movement
- Suspension in cubital fold
- Bilateral oppositional force
- Sensation

Percent impaired
- TR deficiency: 95%UE, 57%WP
UPPER LIMB ADAPTIVE PROSTHETICS – AMPUTATION DEFICITS - Transhumeral

Deficiencies
- Bilateral opposition
- Humeral Rotation
- Elbow flexion
- Large surface area for load bearing
- Pronation/supination?
- Fine palmer positioning
- Precision finger manipulation
- padded distal end
- Usable sensation

Remaining functions
- Shoulder movement
- Axilla Oppositional force

Percent impaired
- Elbow deficiency: 95%UE, 57%WP
UPPER LIMB ADAPTIVE PROSTHETICS – PROSTHETIC OVERVIEW - BASICS

- Socket
- Suspension
- Elbow
- Wrist
  - Pronation, Supination, Flexion, quick change
- TD
  - Hook
  - Hand
  - Activity Specific

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Main types of Prostheses
- Passive
- Active
- Activity Specific
UPPER LIMB ADAPTIVE PROSTHETICS – PROSTHETIC OVERVIEW - Passive

- Psychosocial function
- Basic Opposition
- Protection
- Very Costly
UPPER LIMB ADAPTIVE PROSTHETICS –
PROSTHETIC OVERVIEW - ACTIVE

- Controlled articulations at the elbow
  - Flexion & Extension
  - Passive humeral rotation
- Controlled articulations at the wrist
  - Supination & Pronation
- Control of the Terminal Device
  - Open and Close
UPPER LIMB ADAPTIVE PROSTHETICS – PROSTHETIC OVERVIEW – BODY POWERED

- Controlled by shoulder and arm movements
  - Glenohumeral flexion
  - Scapular abduction
- Feedback available
- Greater precision and speed
- Less adaptable

O&P Library
UPPER LIMB ADAPTIVE PROSTHETICS – PROSTHETIC OVERVIEW – EXTERNAL POWERED

- Controlled by:
  - Myoelectric signals (EMG)
  - Force pads
  - Potentiometers
- Less compensatory movements
- No harnessing
- Less effort
- More adaptive
UPPER LIMB ADAPTIVE PROSTHETICS – Overall Goals

- Improve function/Ease of use
- Reduce onset of overuse symptoms
UPPER LIMB ADAPTIVE PROSTHETICS – Ease of Use

- Many tasks require complex manipulation or movement, but not a variety of manipulations.
- Specialization
UPPER LIMB ADAPTIVE PROSTHETICS – Overuse symptoms

- Overuse in Contralateral Side
  - Approximately 50% of patients with a unilateral amputation will experience overuse syndrome\(^2\)
- Overuse in residual limb

UPPER LIMB ADAPTIVE PROSTHETICS – Examples - Employment
UPPER LIMB ADAPTIVE PROSTHETICS – How to implement

Cuff

Wrist Orthosis

Custom Socket
UPPER LIMB ADAPTIVE PROSTHETICS – So many options
UPPER LIMB ADAPTIVE PROSTHETICS – Examples – House ADL’s (Kitchen)

- Eating
- Food Preparation
UPPER LIMB ADAPTIVE PROSTHETICS – Examples – House ADL’s (Outdoors)
UPPER LIMB ADAPTIVE PROSTHETICS – Examples – House ADL’s (Out and About)
UPPER LIMB ADAPTIVE PROSTHETICS – Examples - Recreations
UPPER LIMP ADAPTIVE PROSTHETICS – Changing devices

- Can be difficult for bilateral patients
- Quick change stands are available
UPPER LIMB ADAPTIVE PROSTHETICS – Other considerations

- More than just the terminal device you use.
- Socket alignment, materials, and flexibility are also critical.
UPPER LIMB ADAPTIVE PROSTHETICS – Limitations

- Task specific
- No sensation
- Learning curve
UPPER LIMB ADAPTIVE PROSTHETICS – Indications/Contraindications

- “The most expensive prosthesis is the one in the closet.”
- Aspects to look at
  - Gaps in function
  - Overuse possibilities
  - Motivation
WHO WOULD BENEFIT FROM A PROSTHETIC CONSULTATION?

- Any individual with limb loss

“Education is more empowering than any device.”
THERAPISTS & PROSTHETISTS

- A team that is...
  - **Exciting**
  - **Necessary**
  - **Beneficial to all parties**
  - **Overlooked**
QUESTIONS?

Thank you for your time!

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