

Refresh Your Rehabilitation Strategies for Upper Extremity Amputation

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Paradigm

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Presenters and Objectives

Gary Clark, MD



- ▶ Board certified in Physical Medicine and Rehabilitation
- ▶ Specializes in amputation and multiple trauma cases.
- ▶ Professor (and former chair and residency program director) in the Department of Physical Medicine & Rehabilitation at Case Western Reserve University
- ▶ Director of amputee rehabilitation at the MetroHealth Rehabilitation Institute in Cleveland
- ▶ *U.S. News and World Report* has honored Dr. Clark annually since 2011 as one of *America's Top Doctors*.

Jean Kirk, PhD



- ▶ New York state licensed psychologist
- ▶ More than 30 years' experience managing outpatient rehabilitation for people with physical and mental disabilities
- ▶ Director of Disaster Relief Coordination for Project Hope, the FEMA-funded Hurricane Sandy relief program
- ▶ Published and presented on dementia, brain injury rehabilitation, the psychology of rehabilitation and caregiving, and catastrophic injury management

Objectives

- ▶ **Identify major considerations** regarding limb salvage versus “therapeutic” amputation.
- ▶ **Consider importance of expertise** and proximity to a prosthetist for fitting, and a therapist for training, versus value of referral to a Center of Excellence.
- ▶ **Trace decision-making process/criteria** to determine appropriateness and prescription for body-powered, myoelectric, and/or passive prostheses.
- ▶ **Acknowledge the importance** of attention to psychosocial issues.
- ▶ **Appreciate the dynamics** of constantly evolving surgical techniques and advances in prosthetic technology.

Case Study

Meet Albert

Demographics

- ▶ He attended high school, but did not graduate
- ▶ He is a 34-year-old African-American right-hand dominant man who lives in a mid-Atlantic state
- ▶ He was injured mid-2018, referred to Paradigm 4 days later
- ▶ His income was minimal – working a short time in a factory before the accident
- ▶ He smokes
- ▶ He is a social drinker
- ▶ His BMI is in normal range

Psychosocial profile

- ▶ He has received Goodwill services
- ▶ He has housing issues
- ▶ His cell phone is not always activated
- ▶ He has some friends; no significant other
- ▶ He often doesn't understand healthcare system requirements

The Accident and Immediate Medical Care

- ▶ His right hand was caught in a press and amputated at the level of the proximal metacarpals
- ▶ No loss of consciousness; Taken to a Level 1 trauma center
- ▶ Underwent emergency revision surgery, including starfish procedure, with Integra dressing application
- ▶ His hand has no digits with a partial stub of the thumb
- ▶ Discharged 24 hours after surgery
- ▶ The surgeon debrided the residual limb and placed a split thickness skin graft 21 days after the injury



Amputation Surgery

What is Feasible vs What is Advisable

Upper Limb Trauma Surgery

What is feasible versus advisable?

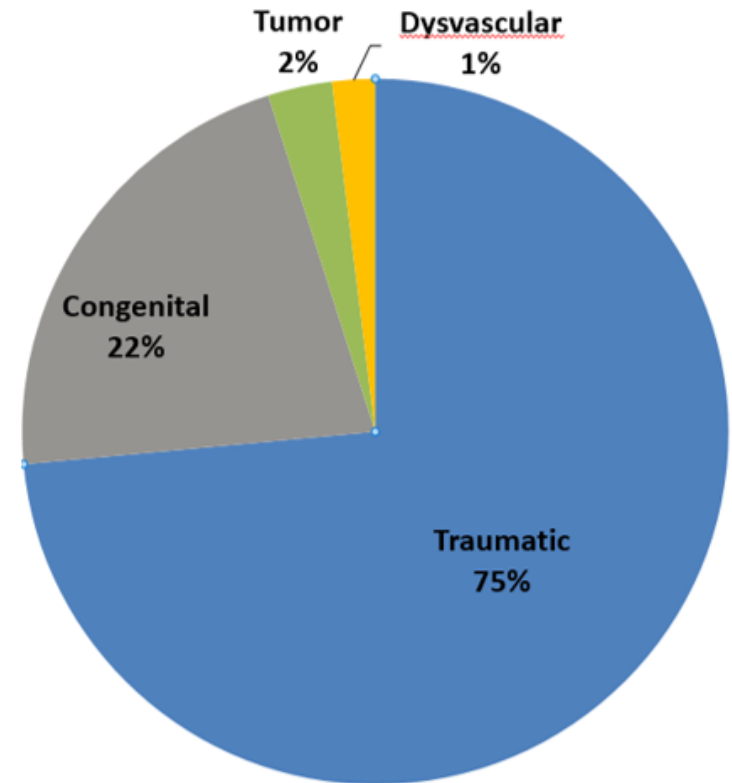
- ▶ **Advances in Limb Salvage and Reconstruction: Often Unclear Outcome & Timeframe**
 - ▶ Significantly better outcomes if Level 1 or 2 Trauma Center
 - ▶ Debridement, skin/muscle flaps, skin/bone grafts
 - ▶ Often multiple surgeons: Trauma, Ortho, Hand, Vascular, Plastics, General
 - ▶ Neurovascular repair – microsurgical techniques
 - ▶ Often multiple surgeries, risk of early/late complications; often significant deformity, pain
 - ▶ Major functional, psychological, marital, vocational impact
 - ▶ Unknown outcomes/timeframes for healing/function
- ▶ **“Therapeutic” Amputation: Usually More Predictable Outcome & Timeframe**
 - ▶ Removal of painful/unstable/infected and/or non-functional body part
 - ▶ Predictable time frame and functional outcome post-amputation

In Perspective

There are tradeoffs between a salvaged hand/arm with limited function/sensation (particularly if prolonged salvage efforts, severe pain, contractures, friable skin), versus a definitive amputation with prompt fitting/training with a state-of-the-art prosthesis.

Upper Limb Amputee Rehabilitation

- ▶ Incidence of UL amputation
 - ▶ 6% of all amputations: 11,000 new UL amputations/year in US
 - ▶ 2/3 of all traumatic amputations involve UL
- ▶ Gender inequity
 - ▶ 72% Male vs. 28% Female
- ▶ Etiology of UL amputation
- ▶ Prevalence of UL amputation
 - ▶ 34% of all amputations: 500,000 in U.S.



Source: Amputee Coalition, 2012 data

Amputation Surgery

What are the goals?

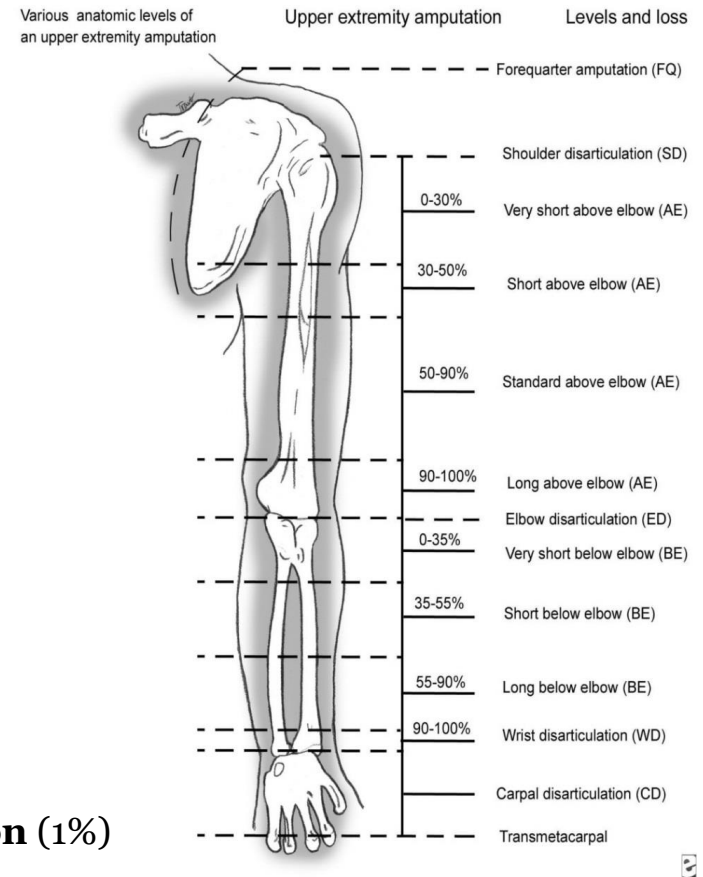
- ▶ Preservation of **functional** length
 - ▷ **Too Short:** Difficulty with prosthesis support/control, skin tolerance, pain
 - ▷ **Too Long:** Limited room for prosthetic components, less soft tissue padding, decreased skin tolerance, pain
- ▶ **Durable** skin/soft tissue coverage
- ▶ Ensure viable circulation/soft tissue for **healing**
- ▶ **Preservation** of useful sensation
- ▶ **Stabilization** of adjacent weight-bearing structures
- ▶ **Prevention** of symptomatic neuromas (TMR)
- ▶ **Controlled** short-term morbidity
- ▶ **Facilitate** early prosthetic fitting/function
- ▶ **Early** patient return to work and play

Amputation Rehabilitation

Upper Limb Amputee Rehabilitation

Levels of amputation

- ▶ **Fingers** – DIP, PIP, MCP joint
 - ▶ **Most common (80%)**
 - ▶ May not need prosthesis for function
- ▶ **Thumb** – IP, MCP joint (10%)
 - ▶ **Thumb most important for function**
- ▶ **Partial hand/wrist disarticulation** (1%)
 - ▶ Functional/Cosmetic limitations
 - ▶ **May be more functional w/o prosthesis**
- ▶ **Transradial** (TRA or Below Elbow) (4%)
- ▶ **Elbow disarticulation** (1%)
- ▶ **Transhumeral** (THA or Above Elbow) (3%)
- ▶ **Shoulder disarticulation/forequarter amputation** (1%)



Source: Amputee Coalition, 2012 data

Amputation Rehabilitation

What are the clinical steps?

- ▶ Amputee clinic team approach
 - ▷ Surgeon vs physiatrist
 - ▷ Occupational/hand therapist
 - ▷ Prosthetist
 - ▷ Rehab psychologist
 - ▷ Patient/family
- ▶ Initial evaluation
 - ▷ Patient/family **education**, clarify **patient goals**
 - ▷ **Engage therapy** for pre-prosthetic program
 - ▷ **Identify prosthetic Rx**, timing
 - ▷ **Continue therapy** for prosthetic training



Amputation Rehabilitation

More clinical steps



- ▶ Frequent follow-up initially (q 4-6 weeks)
 - ▶ Evaluate **fit and function** of prosthesis
 - ▶ Track **functional progress** – update therapy program
 - ▶ **Assess need** for socket modification, alignment change
 - ▶ **Monitor** for complications
- ▶ Periodic long-term follow-up (q 3-6 months)
 - ▶ Socket modifications, replacement gel liners
 - ▶ Prosthetic maintenance/repair/replacement
 - ▶ Vocational needs, driving, etc.

Amputation Rehabilitation

Pre- and post-operative considerations

- ▶ Medical stability and comorbidity
- ▶ Cognitive status
 - ▶ Comprehension, cooperation, motivation => ability to learn [patience/perseverance]
- ▶ Psychological/Emotional status
 - ▶ Anxiety/depression/PTSD => education, counseling, medications
 - ▶ Patient goals
- ▶ Pain management

Amputation Rehabilitation

Pre- and post-operative considerations

- ▶ Musculoskeletal/Neurological status
- ▶ Functional status – premorbid/ current
- ▶ Rehabilitation considerations
- ▶ Psychological/Emotional status
 - ▷ Living setting, family support
 - ▷ Realistic patient/family expectations (functional goals, timeframes)
 - ▷ Proximity to experienced prosthetist/therapist, vs. referral to Center of Excellence
 - ▷ Prosthesis = Tool

Amputation Rehabilitation

Pre-prosthetic training

- ▶ Patient & family education
 - ▷ **Attitude:** therapeutic, function-enhancing
- ▶ Residual limb examination
- ▶ Desensitization
- ▶ Edema control
- ▶ Soft tissue mobility
- ▶ Skin care/Hygiene
- ▶ ROM/Stretching, Positioning => to avoid joint contractures
- ▶ Strengthening
- ▶ Functional Training: **One-handed techniques/Change of dominance as appropriate**

Prosthetics

A Successful Prosthesis

What characteristics make for the best prosthesis?

Characteristics

Comfortable to wear If socket doesn't fit well, nothing else matters.
(Art & Science)

Easy to don and doff

Lightweight

Durable

Cosmetically pleasing/acceptable

Improves function (tool)

Reasonable maintenance

Customization for function

Prescribing a Prosthesis

What must be considered when determining the prosthetic Rx?

Considerations
Amputation level <ul style="list-style-type: none">➤ Digit(s) or partial hand amputation: No prosthesis? Passive (Cosmetic) prosthesis?
Contour/length of the residual limb
Skin/soft tissue mass, mobility, tenderness
Cognitive function
Functional goals
Cosmetic importance
Single vs. multiple prostheses <ul style="list-style-type: none">➤ Body-powered and/or Myoelectric prosthesis;➤ Work vs home/hobby vs. passive 'cosmetic' prosthesis)
Early fitting/training
Expertise of/proximity to experienced prosthetist ('art and science' of fitting)
Expertise of/proximity to experienced Occupational/Hand Therapist <ul style="list-style-type: none">➤ (especially for multi-articulating myoelectric hands)

Prescribing Body-Powered vs Myoelectric Prosthesis

What are the pros and cons to consider when determining prosthetic Rx?

Body-Powered



Myoelectric



Prosthetic Training

What training is involved with a new prosthesis?

Typical Outpatient OT/Hand Therapy

- ▶ Shrinker sock: Shape/shrink residual limb
- ▶ Initially: **Body-powered Prosthesis:** easiest to fit/train, versatile
- ▶ Subsequent: **Myoelectric Prosthesis:** augmented functionality
- ▶ Multiple terminal devices (hook, hand)
- ▶ Prosthetic proper donning technique
- ▶ Progressive wearing tolerance
- ▶ Functional training
- ▶ General strengthening & conditioning
- ▶ Joint conservation strategies (especially shoulders, wrist)
- ▶ Hygiene for residual limb, prosthesis, liners, socks

Post Amputation

Post Amputation

What are the possible complications?

- ▶ Skin
 - ▷ Healing, blisters/ulcer
 - ▷ Rash, folliculitis, cellulitis
- ▶ Pain
 - ▷ Residual limb/Musculoskeletal Pain (70+%)
 - ▷ Painful neuroma (60+%)
 - ▷ Phantom limb pain (60-80%)



Post Amputation

More possible complications.


- ▶ MSK/neurological
 - ▶ Bursitis, bone spurs, heterotopic bone
 - ▶ Overuse syndromes/low back pain
 - ▶ Joint contractures/arthritis/instability
- ▶ Other
 - ▶ Prosthetic fit/alignment issues
 - ▶ Prosthetic component failure
 - ▶ Poor functional outcome
 - ▶ Prosthetic non-user: Rejection



Post Amputation Complications

Psychological issues must be monitored and addressed.

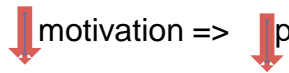
Mourning the Loss

- ▶ Feelings can be overwhelming (anger, sadness, embarrassment)
- ▶ All aspects of life changed (forever)
- ▶ Gradual perspective – takes time
- ▶  Function = > sense of loss

Body Image & Disfigurement

- ▶ Staring at empty place: self, others (**self conscious**)
- ▶ **Low self esteem** (“deformity”, “unattractive”)
- ▶ Hope limb will grow back
- ▶ Prosthesis **function vs cosmesis**
- ▶ **Hide** vs “**flaunt**” prosthesis (**decorate, name**)
- ▶ Inevitable **disappointment with prosthesis**:
“**never as good**” as the limb they lost

Depression

- ▶ **Ubiquitous** – variable timing/severity
- ▶ Vicious cycle:  motivation => progress
- ▶ Recognize & treat
- ▶ Gradual adjustment

Adjustment to Disability

- ▶ “I am still me”
- ▶ Time and perspective “New Normal”
- ▶ Strategies
 - ▶ Education & encouragement
 - ▶ Peer amputees
- ▶ Help others be at ease

Vocational Rehab & Counseling

Factors Contributing to Successful Return To Work

- ▶ Length of premorbid employment
- ▶ Type of premorbid work: “cognitive” activities vs manual labor
- ▶ Pre-morbid job satisfaction, level of education
- ▶ Employer support/flexibility: potential for part time/limited duty work
- ▶ Stable medical status (esp. pain management)
- ▶ Functional independence (with or without prosthesis)
- ▶ “Successful” adaptation to disability, coping mechanisms
- ▶ Functional Capacity Evaluation
 - ▶ IW + employer confidence in ability to RTW
- ▶ Job coaching, training & education (33% Change of Occupation)

Innovations

Amputation Surgical Innovations

What cutting edge procedures are being developed?

- ▶ **Targeted Muscle Re-innervation (TMR)**
 - ▶ Residual nerves implanted into muscle endplates
 - ▶ Muscle acts as a 'biological amplifier' of the motor command
 - ▶ Creates multiple sites for myoelectric signal activity****Reduces neuroma formation**

- ▶ **Starfish Procedure for Partial Hand Amputation**

- ▶ Intrinsic hand muscles myodesed to distal dorsum of residual digits
- ▶ Allows individual digital control of a myoelectric prosthesis

- ▶ **Osseointegration**

- ▶ Percutaneous skeletal attachment of prosthetic implant to residual limb
- ▶ Eliminates need for custom prosthetic socket



AAOS



Jonsson et al, 2011

Prosthetic Innovations

- ▶ Sensory feedback (CWRU/Functional Electrical Stimulation Center)
- ▶ Neuroprostheses (Brain/neural interface for prosthetic control)
- ▶ 3D printing



NIH/Creightn Lab

Summary

Summary – Upper Limb Amputation Rehab Considerations

What are the take-home messages?

- ▶ **Limb salvage vs “therapeutic” amputation**
- ▶ **Expertise/proximity to prosthetist/therapist**
 - ▶ **Socket fit/comfort**, prosthetic alignment
 - ▶ **Appropriate training and practice (tool)**
 - ▶ IW reliability/adherence to Rx recommendations
- ▶ **Prosthetic prescription**
 - ▶ Focus on functional needs/potential
 - ▶ Body-powered, myoelectric, and/or passive
 - ▶ Consider practical issues of battery life, recharging
 - ▶ Factor in appearance, maintenance needs
- ▶ **Importance of Dealing with Psychosocial Issues**

Summary – Upper Limb Amputation Rehab Considerations

More take-home messages.

- ▶ **Evolving Technology – New not always better**
 - ▶ Usually heavier
 - ▶ **Always** costs [a lot] more
 - ▶ Usually requires more training to use
 - ▶ Often more frequent maintenance
 - ▶ ? Durability
 - ▶ Constantly evolving => moving target

Bottom line: The aim should be realistic.

Recommended Strategies in a Challenging Case

Albert's Pre-Prosthetic Program, Initial Prosthesis

- ▶ He was instructed to attend amputation clinic weekly – orthopedic hand surgeon, prosthetists, certified hand therapists, prosthetic company reps
- ▶ Trained in residual limb desensitization - developed a neuroma and used the desensitization techniques – resolved quickly
- ▶ 3½ months after amputation, received a body-powered prosthesis with devices for food preparation
- ▶ Continued functional training with prosthesis with hand therapist



Albert's Prosthetic Challenges

- ▶ The bone of his residual right thumb began to show through the skin
- ▶ Revision surgery completed 7 months after the amputation
- ▶ He was cleared to resume occupational therapy twice a week with use of the body-powered prosthesis
- ▶ ~5 weeks after revision surgery he reported phantom limb pain. His occupational therapist used mirror therapy and desensitization techniques
- ▶ He was determined to be a candidate for a myoelectric prosthesis
- ▶ In February 2019, he traveled out of state for fabrication and fitting of the myoelectric prosthesis
- ▶ Underwent fitting and intensive initial training with the prosthesis for four days – Virgo



Albert's Current Status

- ▶ He is living in a men's shelter
- ▶ He has resumed participating in occupational therapy twice a week
- ▶ Our consultant advised the prosthetic socket would require several adjustments; he has had it less than a month and has had 3 so far
- ▶ He is excited to use the prosthesis to complete his activities of daily living, and he keeps thinking of new uses for it
- ▶ All members of his treatment team (orthopedic surgeon, hand therapist, prosthetist) are pleased with the prosthesis and Albert's ability to control it
- ▶ Paradigm Network Manager continues to provide emotional support and encouragement

Recommended Strategies

- ▶ Ensure treatment by a team of top providers – physician (orthopedist, hand surgeon, physiatrist), prosthetist, hand therapist - - who work closely together.
- ▶ Case manager develops a supportive relationship with the injured worker and maintain close contact to:
 - ▷ Manage his/her recovery and medical services – coordinate care and communication among various providers
 - ▷ Ensure the injured worker understands the treatment and provider recommendations – educate and reinforce, encourage compliance
 - ▷ Be prepared to help injured worker through personal challenges – advocacy, counseling
 - ▷ Help him/her navigate the healthcare system

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