Comprehensive Upper Extremity Prosthetic Rehabilitation

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Learning Objectives

• To understand the demographics, causes and challenges that are unique to upper limb loss.
• To describe the levels of upper limb loss and related terminology.
• To list and describe the 6 different prosthetic options available for persons with upper limb amputation, be able to describe a contemporary socket design and advancements in materials using rolled silicone.
• To identify the various members of the collaborative upper limb rehabilitation team.
• To discuss the treatment approaches for the 4 phases of prosthetic rehabilitation.
Comprehensive UE Prosthetic Rehabilitation

- Upper Limb Specialists
- Occupational Therapy
- Counseling
- Case Management
- Insurance Assistance
- Expedited Fitting
- Research & Development

The Profession of Prosthetics

Prosthetists impact rehabilitation with expertise in complex patient presentations combined with a vast knowledge base of information such as:

- emergence/application of complex materials
- componentry applications
- control systems configuration/adjustment
- unique fitting and suspension techniques

The Profession of Prosthetics

- Allied Health Profession
  - Physical Therapist
  - Occupational Therapist
  - Physician Assistant
  - Clinical Nutritionist
- Master’s Level Education
- National Certification (CP)
- State Licensure (CP/L)
- American Academy of Orthotists & Prosthetists
- Upper Limb Prosthetic Society
Limb Amputation and Deficiency

- Data from the Healthcare Cost and Utilization Project, Nationwide Inpatient Sample

18,496 per year.


Limb Amputation and Deficiency

- Upper Limb – 1,606 /year

- Lower Limb – 63,956 /year

40:1 Ratio

Causes of Amputation

<table>
<thead>
<tr>
<th>Cause of Amputation</th>
<th>Lower Extremity</th>
<th>Upper Extremity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Congenital</td>
<td>41.5%</td>
<td>58.5%</td>
</tr>
<tr>
<td>Tumor</td>
<td>76.1%</td>
<td>23.9%</td>
</tr>
<tr>
<td>Trauma</td>
<td>32.4%</td>
<td>68.6%</td>
</tr>
<tr>
<td>Disease (PVD)</td>
<td>95%</td>
<td>5%</td>
</tr>
</tbody>
</table>

*Per 100,000 Limb-loss hospital discharges from 1988-1996

**In the United States, there are approximately 1.8 million people living with limb loss. It is estimated that one out of every 200 people in the U.S. has had an amputation.


Causes of Amputation

Limb Loss Levels

- Shoulder Disarticulation
- Elbow Disarticulation
- Wrist Disarticulation
- Interscapular-thoracic
- Transhumeral
- Transradial
- Partial Hand
Glossary

Socket – the interface that contacts and contains the residual limb; the newest sockets are rolled or injected silicone for sensitive or scarred residual limbs.

T.R.A.C. Socket Design

1. Antecubital region
2. Olecranon region
3. Epicondylar region
4. Distal radial region
5. Wrist extensor and flexor musculature

TransRadial Anatomically Contoured Socket

Custom Silicone Socket

HTV silicone socket improves fit and comfort of prosthesis through entire ROM.
Glossary

**Frame** – rigid outer structure supporting the socket

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**Harness** – transmits energy from specific body motions to move a prosthetic component; also a type of suspension

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**Component** – the fingers, hand, wrist or elbow of a prosthesis
Glossary

Terminal device – component at the distal portion of prosthesis, i.e. hook, hand, etc.

Glossary

Suspension – the means of holding the prosthesis on the user

3 Types:
- Harness
- Self-suspending
- Suction suspension

Glossary

Diagnostic – first prosthesis a patient is fit with, intended to be temporary
Glossary
Definitive/final – prosthesis that is intended to be used until replacement is needed

The Challenge
• Traumatic nature of most cases
• Need for comprehensive care
• Limited patient population

Primary Prosthetic Goals
• Function
• Comfort
• Protection
• Suspension
• Cosmesis
• Ease of use
Prosthetic Options
1. No prosthesis

Pros
• No expense or maintenance
• Sensory feedback
• Intuitive

Cons
• Lack of prehension
• Limited ability to do bimanual tasks
• Cosmetic concerns
• Increased risk of over injuries due to compensatory body movements

Prosthetic Options
2. Cosmetic/Passive

Pros
• Lightweight
• Low maintenance
• Can provide some function
• Natural appearance
• Protection of residual limb
• Psychological benefit

Cons
• Lack of active prehension
• Limited ability to do bimanual tasks
• Skin tone changes difficult to duplicate

Prosthetic Options
3. Body-powered

Pros
• Durable
• Grasp ability
• Initial cost can be low
• Maintenance is less expensive

Cons
• Limited range of function
• Limited grip force
• More mechanical appearance
• Harness can cause overuse of remaining joints
Prosthetic Options
4. Electrically Powered

**Pros**
- Increased functional envelope
- Potential for significantly increased grip strength
- More natural, intuitive control of prosthesis
- Can be cosmetically appealing

**Cons**
- Heavier in weight
- Increased cost
- Should be worn with caution in wet, dusty, or dirty environments

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Prosthetic Options
5. Hybrid

**Pros**
- A combination of options
- Electric AND body-powered
- Usually seen in above elbow applications
- Body-powered Electric

**Cons**
- Need to master two types of controls
- May have increased cost compared to other designs
- Should be worn with caution in wet, dusty, or dirty environments

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Prosthetic Options
5. Hybrid

**Pros**
- Lighter weight and less expensive than a fully electric system
- May be possible to have increased grip strength
- May be possible to have a reduced harness

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Prosthetic Options
6. Activity Specific
Usually limited to specific activities and provides function for a specific use.

Pros
• Lighter weight and less expensive than a fully electric system
• May be possible to have increased grip strength
• May be possible to have a reduced harness

Cons
• Need to master two types of controls
• May have increased cost compared to other designs
• Should be worn with caution in wet, dusty, or dirty environments

Expedited Fitting Procedure
Day 1 – Casting / Therapy
   Pre-Prosthetic Training
Day 2 – Test Socket /Therapy
   Electrode Placement
Day 3 – Diagnostic Prosthesis
   Functional Training /
   Programming
Day 4 – Diagnostic Prosthesis

Comprehensive Upper Extremity Prosthetic Rehabilitation:
Therapy
OT Intervention

“The goal of OT intervention for patients with limb loss is returning them to their potential for maximum performance of daily occupations that lead them to a meaningful and satisfying life. OT provides the patient the necessary skills and tools to reintegrate back into the military unit or to civilian life physically, psychologically, and socially.”

Smurr et al. 
Occupational Therapy for the Poly-Trauma Casualty with Limb Loss

Phases of Prosthetic Rehabilitation

- **Phase I**: Initial Management and Protective Healing
- **Phase II**: Pre-Prosthetic Training
- **Phase III**: Intermediate Prosthetic Training
- **Phase IV**: Advanced Prosthetic Training

Phase I: Initial Management and Protective Healing
Wound care, limb shaping, desensitization, pain management

Phase I: Initial Management and Protective Healing
Strength and Activity Tolerance

Phase I: Initial Management and Protective Healing
Basic ADLs, adaptive techniques and equipment
Phase I: Initial Management and Protective Healing

Psychological Support
- Post traumatic stress disorder
- Depression
- The grief cycle:
  - shock and denial
  - anger
  - bargaining
  - acceptance
- Fear of community reintegration
- Substance abuse

Phase II: Pre-prosthetic Training

- Education and Expectations
- Strength, ROM and endurance
- Desensitization and pain management

Phase II: Pre-prosthetic Training
ADLs, special adaptations and home modifications
Phase II: Pre-prosthetic Training
Proper posture, body mechanics and prevention of overuse syndromes

Phase II: Pre-prosthetic Training
Musculoskeletal Changes

- shift of the trunk
- elevation of the shoulder
- scoliosis with bowing
- torsion of the trunk


Phase II: Pre-prosthetic Training
Myoelectric site testing and training
Phase III: Intermediate Prosthetic Training
Donning/doffing, components operation, prosthetic care

Phase III: Intermediate Prosthetic Training
Controls training

Phase III: Intermediate Prosthetic Training
ADL training
Phase III: Intermediate Prosthetic Training
  Prepositioning

Phase IV: Advanced Prosthetic Training
  Job Site Assessment

Phase IV: Advanced Prosthetic Training
  Home Assessment
Phase IV: Advanced Prosthetic Training
Community Re-integration

Phase IV: Advanced Prosthetic Training
Instrumental Activities of Daily Living

Phase IV: Advanced Prosthetic Training
Driver Evaluation and Training
Recreational Activities

Phase IV: Advanced Prosthetic Training

Conclusion

• Upper limb prosthetic rehabilitation is very specialized and individualized.

• Collaboration with other team members is essential in order to provide holistic client-centered care.

• Success for upper limb amputation patients is possible!

Thank You!

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