Prosthesis in Upper Limb Amputation
Upon completion of this lecture student will be able to:

- Identify prosthesis for hand amputation and wrist disarticulation.
- Explain different parts of transradial prosthesis.
- Describe different parts of transhumeral prosthesis.
- Explain prosthesis for elbow disarticulation, shoulder disarticulation, and forequarter amputation.
Upper Limb Amputation Levels

- Trans-Phalangeal Amputation
- DIP
- PIP
- MCP
- Anywhere in Between.
- Trans-Metacarpal Amputation
- Trans-Carpel Amputation
- Wrist Disarticulation
- Trans-Radial Amputation
- Elbow Disarticulation
- Trans-Humeral Amputation
- Shoulder Disarticulation
- ForeQuarter
(Inter-Scapular Disarticulation)
1. Transphalangeal

- No device.
- Cosmetic fingers or portion of a cosmetic glove
2. Transmetacarpal

- Cosmetic glove.
- Mitt-shaped prosthesis.
• **Prosthesis**
  • passive or cosmetic hand.
  • Mechanical hand with Bowden cable operation for hand opening/closing.
  • Myoelectric hand can be fitted.
The types of suspension, cuffs, straps, elbow hinges, socket, wrist units, cable systems and terminal device available for transradial prosthesis are represented schematically.
### Suspension
- Figure of 8.
- Saddle harness.
- Suction.
- Self suspending.

### Cuff and strap
- Flexible.
- Rigid.
- Step up hinges.

### Elbow hinges
- Flexible.
- Rigid.
- Step up hinges.

### Socket
- Standard.
- Munster.
- Socket with step up hinges.

### Cable system
- Bowden’s cable

### Wrist
- **Mechanical:**
  - Supination / pronation.
  - Friction.
  - Quick disconnect.
  - Spring assisted.
  - Flexion
  - Spring assisted.
- **Electrical:**
  - Supination/pronation.
  - Myoelectric.
  - Switch control.

### Terminal device
- **Hook:**
  - Mechanical.
  - Electric.
- **Hand:**
  - Mechanical.
  - Voluntary opening.
  - Voluntary closing.
  - Switch control
  - Electrical.
  - Myoelectric.
  - Switch control
  - Passive.
Suspension

Figure of 8 Suspension

• It consists of a loop around each shoulder.
• These loops are connected at the back and a ‘O' ring may be placed at that place.
• One strap of the loop is connected to control cable
• The loop on the sound side is called axillary loop
Suspension (Cont)

Shoulder Saddle

• It is indicated in person who do heavy manual work.

• It suspends the prosthesis through bowden cable. The suspension cable attaches to 'Y' strap anteriorly and triceps pad posteriorly.
Suspension (Cont)

*Suction Suspension*

- Partial suction and hypobaric suction can be used.

*Self Suspending*

- This suspension can be used in bilateral amputees and for patients with myoelectric arm.
Cuffs and Straps

• They are used to connect the socket with harness through elbow hinges.
• Triceps cuff is attached distally with elbow hinges and proximally with Bowden's cable and to figure of "8" suspension.
Elbow Hinges

They connect the socket to triceps cuff. The different types are:

**Flexible Hinge**
- This permits active pronation and supination.
- It is indicated in long below elbow and in wrist disarticulation.

**Rigid Hinge**
- For short below elbow stump with good flexion, extension at elbow.

**Step Up Hinges**
- Indicated in short stump with restricted range of movement at elbow.
All the sockets are made of two walls:

- Inner wall: corresponds to stump.
- Outer wall: corresponds to contour.
Modified Munster Socket

- Given to short stump with good range of movement at elbow.
- The trim line comes proximal to epicondyle with elbow slightly flexed and the posterior trim line goes above olecranon with elbow extended.
- It is self suspending and no additional suspension is required when properly fabricated.
- Extreme flexion and extension is restricted.
Split Socket with Step Up Hinges

• This is indicated in short stump with limited range of movement at elbow.
• With this arrangement with one degree movement at stump causes 2° movement at outer shell.
Types of wrist units are mechanical and electrical units.

Mechanical units are available pronation with supination and with wrist flexion.

An externally powered switch or myoelectric control also available and not frequently used.
I. Mechanical or Body Powered Hand

- All functional hand uses three jaw chuck principle which involves grip with thumb index and middle fingers.

Voluntary Opening Hook and Hand

- The hooks or fingers are kept closed by springs or rubber bands.
- It is opened by tension placed on control cable.
- Tension is provided by shoulder flexion in transradial amputation and by scapular abduction and chest expansion in above elbow amputations.
- Once the tension is released the hands closes automatically by springs or socket bands.
- This is preferred by most persons.
Mechanical or Body Powered Hand (Cont)

- **Voluntary Closing Hand or Hook**
  - Kept open normally and needs tension to close the hand.
II. Cosmetic or Passive Hand
• Non functional hands constructed of semi rigid or rigid materials with cosmetic glove.

III. Electrical or Externally Powered
• Electrical or externally powered is of:
  - Myoelectric.
  - Switch control
Electrical or Externally Powered

**Myoelectric Arm**

- EMG signals due to muscle contraction in the stump is utilized to operate externally powered prosthesis.
- It can be used to operate terminal device, wrist and elbow units.
- It may be of digital control i.e. on and off or proportional control is stronger signal gives a faster action.
- It consists of:
  - Electrodes.
  - Amplifier.
  - Battery.
  - Motor
Prosthesis in Transhumeral Amputation

Level of Amputation

- Length of limb from acromion to lateral epicondyle on his **sound side** is taken as 100 percent.
- Acromion to bony end on amputated side is calculated in percentage.
  - 0-30% Humeral neck
  - 30-50% Short above elbow
  - 50-90% Standard above elbow
  - 90-100% Long above elbow

- Stump length of 7 cm can be fitted with a prosthesis
### Suspension
- Figure of 8.
- Saddle.
- Chest strap.
- Suction.

### Elbow Unit
- **Body powered.**
  - External with or without spring assisted Flexion.
  - Internal with or without spring assisted Flexion.
  - Internal with rotating turn table.
- **External powered.**
  - Switch control
    - Digital.
    - Proportional.
  - Switch control
    - Digital.
    - Proportional.

### Wrist
- **Mechanical:**
  - Supination / pronation.
  - Friction.
  - Quick disconnect.
  - Spring assisted Flexion
  - Spring assisted.
- **Electrical:**
  - Supination/ pronation.
  - Myoelectric.
  - Switch control.

### Terminal Device
- **Hook:**
  - Mechanical.
  - Electric.
- **Hand:**
  - Mechanical.
  - Voluntary opening.
  - Voluntary closing.
  - Switch control
  - Electrical.
  - Myoelectric.
  - Switch control
  - Passive.

### Socket
- Standard.
- Short stump.

### Forearm Shell

### Cable System
- Dual cable
• **Figure of "8" Suspension** has two loops in each shoulder which meets in upper back where “O" ring is attached. The anterior strap in Amputated side is directly attached to the socket. Posterior strap is attached to control cable.

• **Saddle harness**: It suspends prosthesis though a cable which attaches anteriorly and posteriorly to the socket.

• **Chest strap**: In humeral neck amputation, shoulder disarticulation and in forequarter amputations the chest strap is attached. It is attached to anterior and posterior aspect of socket.
The patient with a transradial amputation demonstrates 2 types of harnessing:

A. The figure-8 harness;
B. The shoulder saddle with chest-strap suspension

C & D: For the patient with a transhumeral amputation
• **Sandard Above Elbow Socket is used**: For short AE (30-50%) and long (50-90%) AE slump. The trim line is 1 cm lateral to acromion.
Elbow Units

Body Powered:

- External with or without spring assisted flexion.
- Internal with or without spring assisted flexion
- Internal with rotating turn table.

External Powered:

- Switch control:
  - Digital.
  - Proportional.
- Myoelectric:
  - Digital.
  - Proportional.
Elbow Units (Cont)

• Internal elbow with rotating turn table allows limited rotation of forearm stimulating internal and external rotation of arm.

• All body powered elbow operated by cable system. It is opened by shoulder depression, shoulder abduction and extension.
Forearm Shell

• Which is equal to the forearm that was present to which wrist unit is attached.

Wrist units

• As discussed in below elbow prosthesis.

Terminal Devices

• As discussed in below elbow prosthesis.
Prosthesis for Elbow Disarticulation

Prosthesis for Elbow Disarticulation

• Elbow disarticulation surgery is not commonly done.
• *Advantages*: It can secure the prosthesis by its bony prominences.
• *Disadvantages*: It prevents rotation movement of forearm.
• If internal elbow unit is used the joint level is 5 cm lower than normal side.

Prosthetic Prescription

• The prosthesis is made of double walled socket with rigid elbow hinges and external/internal elbow unit with forearm shell, wrist unit and terminal device.
Prostheses for Shoulder Disarticulation

• Shoulder disarticulation is usually done in patients with malignant bone tumors or electrocution.

Prosthetic prescription

• The socket extends over a part of scapula and to rib cage anteriorly. Suspension is by means of shoulder strap. Elbow unit is similar to AE prosthesis. Cosmetic or functional terminal device can be provided.
Prostheses for Forequarter Amputation

• The socket covers a large area of rib cage anteriorly and posteriorly to provide stability and suspension by shoulder strap.

• Operating a functional terminal device is difficult at this level of amputation.