ABOVE ELBOW CHAPTER

Introduction

Functional Levels of Amputation

Biomechanical studies of the above elbow amputee have led to the establishment of amputee classification based on remaining body functions.

In the past it has been the practice to classify upper extremity amputations according to the percentage of remaining stump length. This system of classification is no longer adequate to establish the optimal level of prosthetic restoration.

There are three basic functional classifications of above elbow (AE) amputations:

I. Where primary control of the prosthesis is by the humerus: (elbow disarticulations or remaining humeral condyles);
II. Where primary control of the prosthesis is by the humerus assisted by the shoulder girdle: (amputations above the humeral condyle flares);
III. Where primary control of the prosthesis is by the shoulder girdle assisted by a short humerus: (amputations from the deltoid insertion to the axillary level).

Discussion

One function of the normal human arm is to place the hand in an efficient position for the performance of an act. For prosthetic replacement to be functionally satisfactory, the amputee must be able to direct the prosthetic arm to achieve the same goal, referred to as "pre-positioning".

Below elbow amputees usually retain full range of motion of the shoulder girdle and remaining arm, and therefore, experience little difficulty in pre-positioning the prosthesis.

In order to accomplish the complex' function of pre-positioning the prosthesis, the above elbow amputee: 1) must employ directional control of the prosthesis through a combination of stump and shoulder girdle movements, and, 2) must operate the cable control system whenever elbow motion is required to pre-position the terminal device.

The design and fitting goal of the above elbow prosthesis is that it should be secure and stable on the stump, allowing the full range of motion available.

I. Primary control of the prosthesis by the humerus:

Stumps classified as elbow disarticulations or with the condylar flares remaining have a sufficient lever (see Biomechanics Chapter) so that motion at the glenohumeral joint is the primary directional control motion of the prosthesis. An additional factor of importance is the oval shape of the distal stump bone which enables the prosthetist to contour the socket into a "screwdriver"-like shape; thus, providing the amputee active rotational control and stability of the prosthesis.

The proximal portion of the socket is shaped to stabilize against the shoulder but never inhibit rotational motions at the glenohumeral joint.

When the socket is designed and fabricated with these functional characteristics incorporated, the amputee has ample excursion available to operate the prosthetic elbow and terminal device.

II. Primary control of the prosthesis is by the humerus assisted by the shoulder girdle:

Rotational control and stability of the above elbow prosthesis by the stump are lost when the amputation is above the condyles of the humerus. This loss severely handicaps prosthetic function at this level.

To provide rotational control and stability, the socket is secured to the shoulder girdle by capping the acromion and forming a skirt or wing posteriorly over the scapula in combination with the harness.

In the absence of the humeral condyles, active rotational control and stability now stemming from the shoulder girdle only are limited by the available motion that can be translated through the socket into prosthetic function. The prosthetic control motions of flexion, abduction and extension occurring at the glenohumeral joint will be limited to the ability of the stump to secure a purchase in the socket (see Biomechanics Chapter). Generally, the longer humeral stumps have a marked advantage over shorter stumps, particularly those where excessive subcutaneous tissue is present. Prosthetic motion may be limited to as little as 20°-30° from the arm hanging position. Control motions should be measured (see Prosthetic Information, Page_____) to aid in the type of socket design and harnessing system required to achieve maximum function in this group.

III. Primary control of the prosthesis is by the shoulder girdle assisted by a short humerus:

Prosthesis operation is dependent on bilateral shoulder girdle motions in amputations of the arm above the deltoid insertion to the axillary level. Pre-positioning of the prosthesis, a unilateral operation of the prosthetic side is limited in this classification. The obtainable ranges of motion the amputee will be able to move the prosthesis through, are limited to the range of motions of the shoulder girdle. Assisted by a short humerus the performance will be considerably less than the two previous classifications. Operation of the control cable assembly to flex the prosthetic elbow and operate the terminal device is a bilateral shoulder function in this functional level. The total excursion available even with gross body motions is little more than four inches. Four and three-quarters inches of cable excursion is required to flex the prosthetic elbow and operate the standard terminal device. Therefore, prosthetic function is marginal. The terminal device is little more than a portable holding vice.

It is in this group that external power assist is mandatory to achieve nominal function. The following chapter demonstrates that passable results can be achieved in the ideal case when proper techniques are applied. In the marginal Type III classification, acceptable prosthetic function is doubtful

Side A

Upper Extremity Prosthetic Information

General Information

Date _____

Name of Patient _____ Site of Amputation _____ R L _____

Address _____ Phone _____

Date of Amputation _____ Cause of Amputation _____

Height _____ Weight _____ Sex _____ Skin Color _____

Condition of Stump

Skin _____

Muscles _____

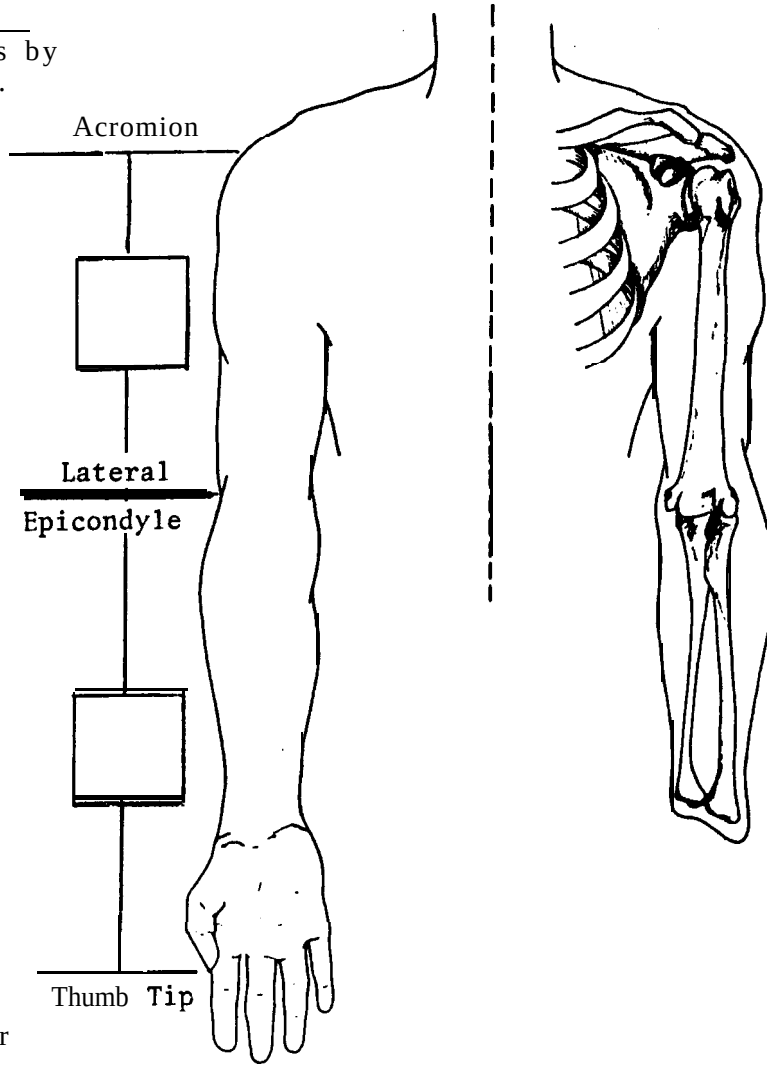
Nerves _____

Bones _____

Special Considerations _____

Indicate Location of stump details by use of letter code given at right. Explain Details.

A Abrasion
B Boil or Skin infection
BS Bone Spur
BU Bursa
D Discoloration
E Edema
M Muscle Bunching
P Pressure Point
R Redundant. Tissue
S Scar
Z Pain



RX FOR PROSTHESIS

Terminal Device:
Hook Type _____ Length _____
Hand Type _____ Length _____
Cosmetic Glove Style _____
Color Guide Number _____

Elbow Unit:
Prosthetic Elbow _____
Outside Joint With Locks _____
Other _____

Description of Harness

Plastic Pigment Color

Shoulder Disarticulation Shoulder Joint Type _____

Cable _____

Hardware _____

Above Elbow Forearm Shell Length

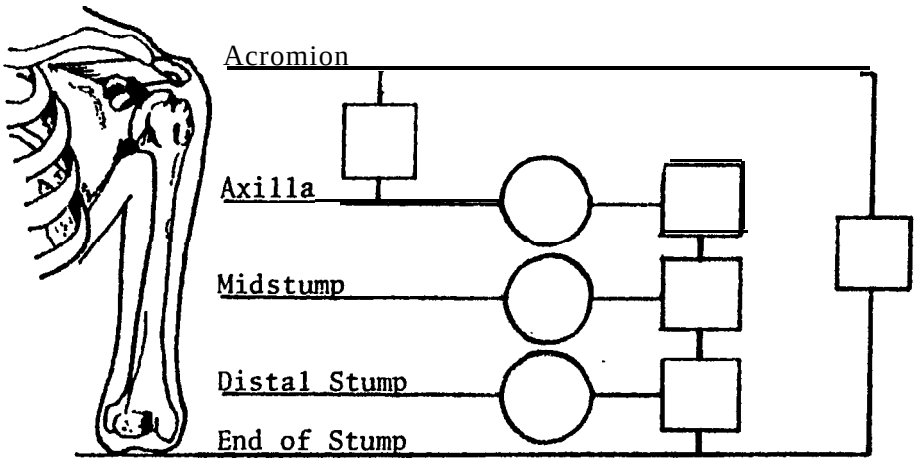
SIDE C

Above Elbow And Shoulder Disarticulation
Prosthetic Measurements

Name _____ R_____ L_____

Length

Circumference



Control Motions For Excursion:	Normal Range	Average Excursion	Amputated Excursion
enohumeral forward flexion	0° - 30° 3	inches	_____ in.
ilateral scapular abduction	0° - 20°	2 inches	_____ in.
scapular abduction	0° - 20°	4 inches	_____ in.
oulder depression	0° - 10°	1 ½ inches	_____ in.
oulder elevation	0° - 40°	3 ½ inches	_____ in.

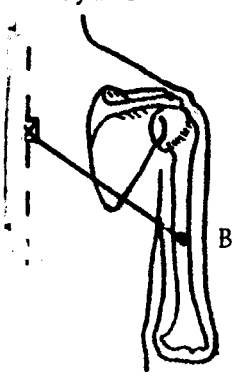
trol Motions For Rotation:

Glenohumeral: condyles remaining	0° - 110°	45°	_____ °
(measured against some resistance) Shoulder: abduction & adduction	0° - 30°	25°	_____ °
(measured in relation to socket rotations)			

A = Anchor point three inches below 7th cervical vertebrae

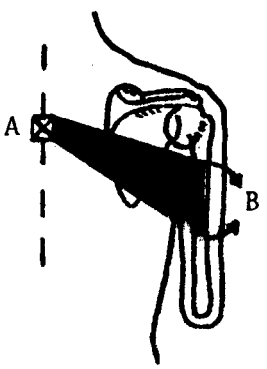
B = 50% of stump length

Elbow disarticulation or condyles remaining "

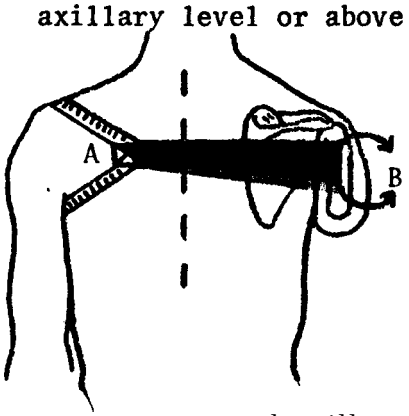


ce tape from "A" to "B" and note distance; x glenohumeral joint to 30°. Measure ursion and record.

Above condyles to deltoid insertion

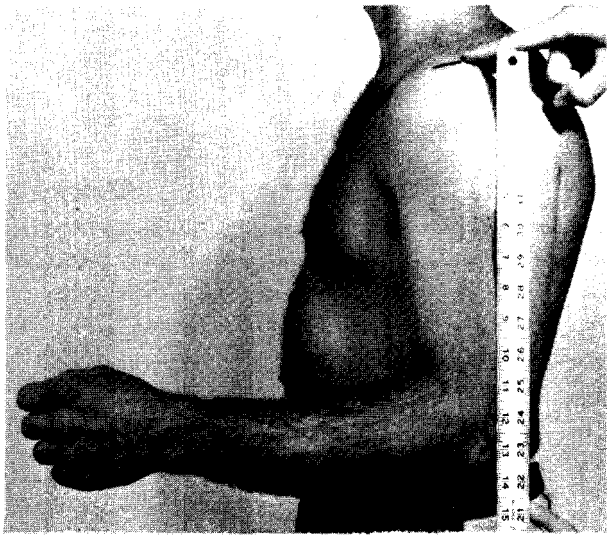


Deltoid insertion to axillary level or above

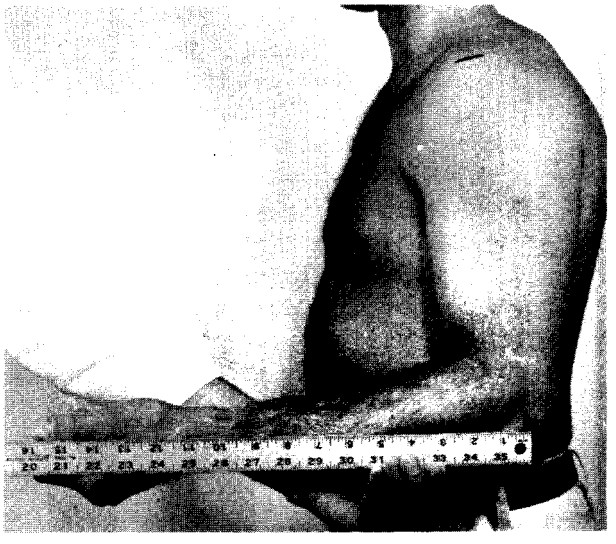


Make a loop on non-amputated axilla and measure unilateral and bilateral scapular abduction.

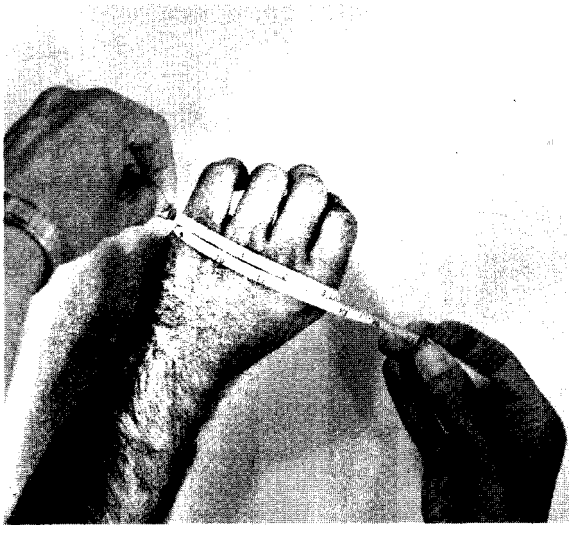
6. Make a mark on the lateral superior edge of the ‘acromion. The posterior margin is the most accessible point. Mark the lateral epicondyle when the elbow is flexed 90 degrees. Measure the distance with a straight edged ruler. Record the measurement in the appropriate box on the Prosthetic Information Form.



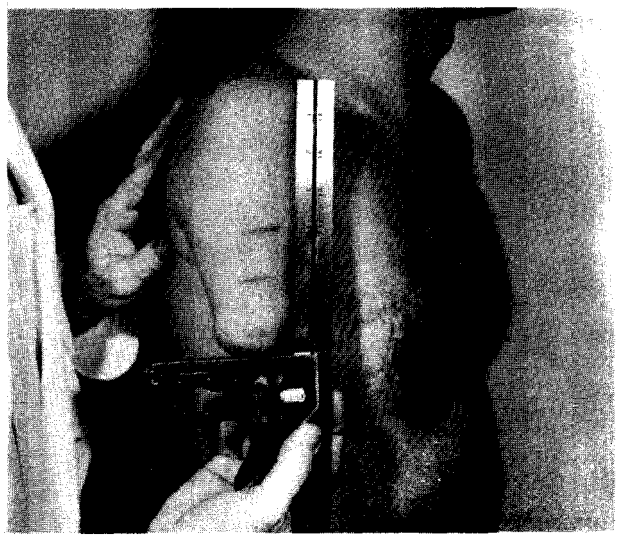
7. Measure the distance from the lateral epicondyle to the thumb tip. 1) the hand is supinated, the wrist in the neutral position; 2) the thumb in a lateral grasp position to the index finger. Record in appropriate box.



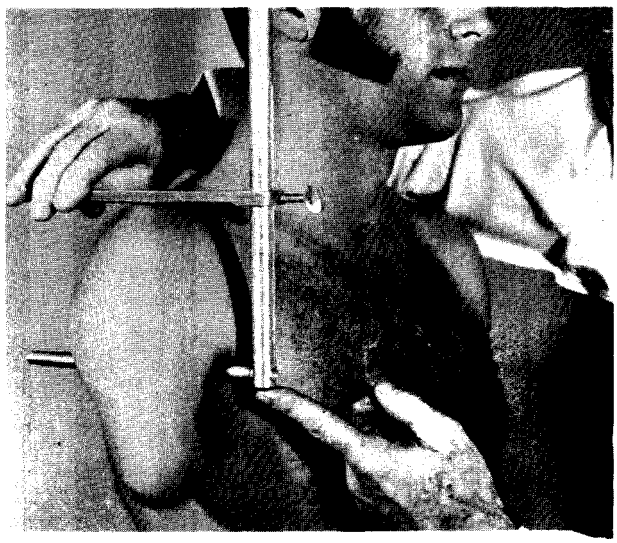
7a. Measure the cosmetic glove size.



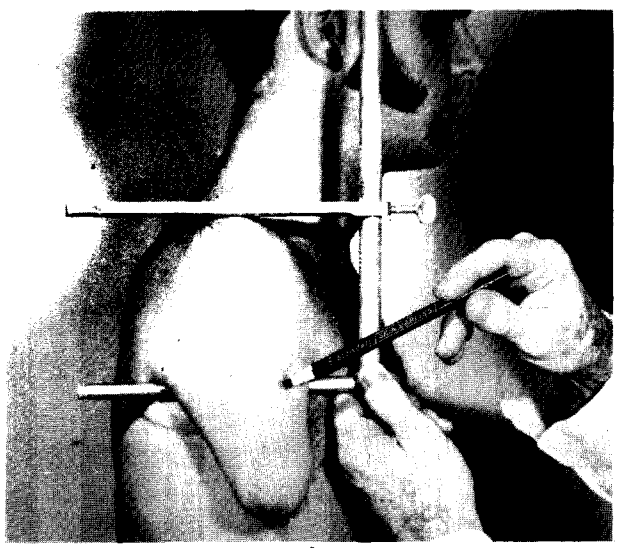
8. Mark the outer edge of the acromion and (a) measure the distance from the mark to the end of the stump; (b) measure the length of the humerus when it is less than the end of stump measurement. Subcutaneous tissue distal to the humerus is easily distorted and when present will indicate that care must be taken during the wrap cast procedures. When applying the casting sock and wrapping of the plaster do not distort, elongate or shorten the stump tissues excessively or it will adversely affect the socket fit.



9. Measure the distance from the acromion to the axilla. A special device is shown (see Materials Chapter). Apply gentle pressure against the pectoralis major and latissimus dorsi tendons and have the amputee contract those muscles. If necessary, adjust the device for comfort. Record the distance on the Prosthetic Information Form.

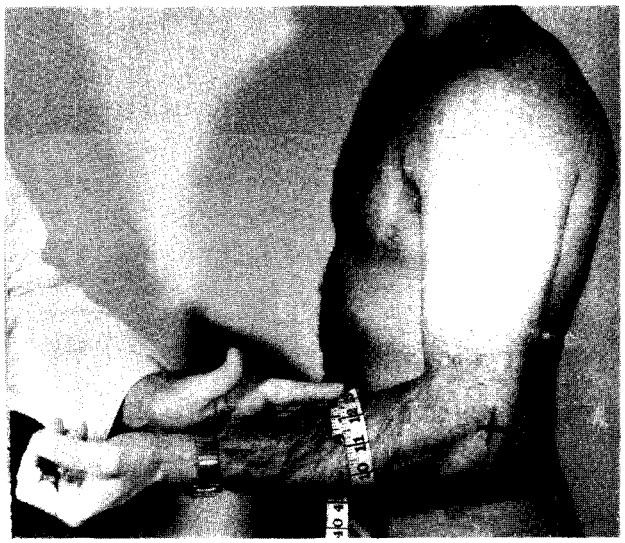


10. Mark the stump on the lateral side at the level of the axilla.



11. Measure the girth of the stump at the axilla level, mid-stump, and the first reliable measurement from the distal end and record in the proper circle on the drawing of the Prosthetic Information Form. Record the level of each of the girth measurements from the end of the stump in the proper box on the drawing.

12. When a cosmetic glove or restoration is planned, make any measurements that will be helpful in shaping or contouring the prosthetic arm. Consult manufacturer? catalog for any special information needed for central fabrication.



13. When the range of motion is less than 50% of normal, complete the tests on the Prosthetic Information Form, Side C.

WRAP CAST

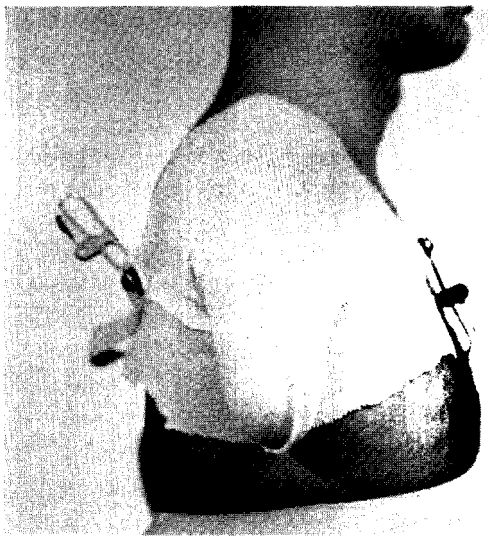
Information obtained from the Prosthetic Information Form will designate the type of wrap and area to be covered so that the appropriate socket design can be fabricated from the plaster model.

a) E.D.: The E.D. wrap covers the acromion so that an identification mark can be transferred to the model to use during fabrication.

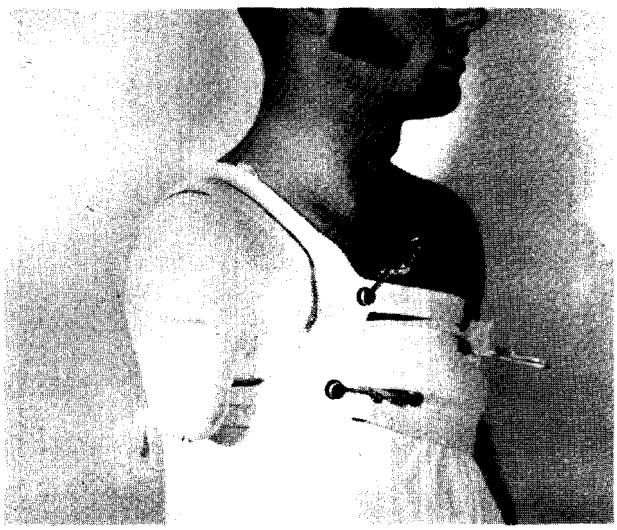
b) Condyles absent: When the condyles are absent the wrap covers an area of the shoulder large enough to form the skirting to stabilize the prosthesis.

c) Above deltoid insertion: When the amputation is above the deltoid insertion, a major part of control motion stems from the shoulder so the wrap cast should include the scapula, one-half the distance to the neck line and a skirting under the axilla to include three ribs.

1. Apply the stockinette or tubegauze and secure it to the patient with webbing and clamps.

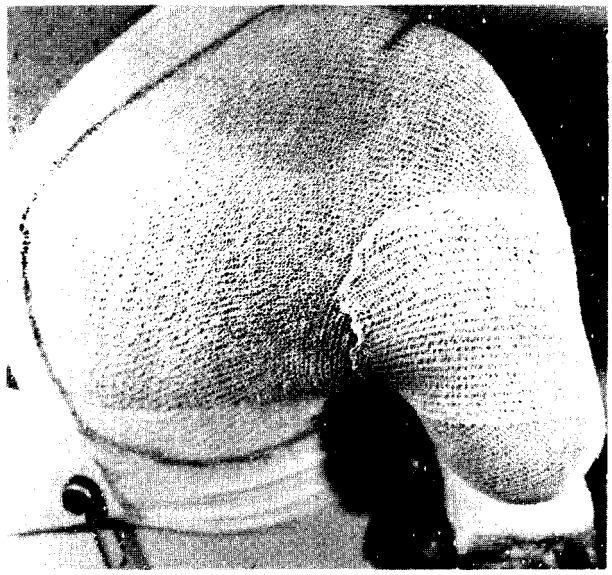


2. Outline the area to be wrapped (see Introduction) according to the functional classification. When marking the outline allow for ample coverage over the scapular wing and medial to the delto-pectoral groove.

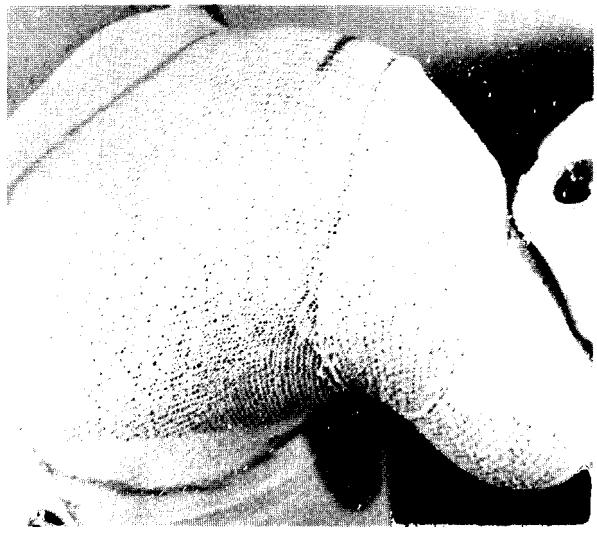


3. Posterior view: Tubegauze is being used in the illustration.

4. Positioning of the stump will facilitate the wrapping procedure. Have the subject abduct and hold the humerus at a 20°-30° angle from the body. The natural tendancy of the short AE stump to flex should be avoided. Caution the subject to maintain the neutral 0° position without flexion or extension.



5. Begin the wrap on the stump. Using spiral obliques cover the distal end so that the tissues are suspended without distortion. Avoid pulling the elastic plaster to the maximum stretch point as the edges will ruffle and cause unwanted distortions of the inner surface of the wrap. (Reg plaster)



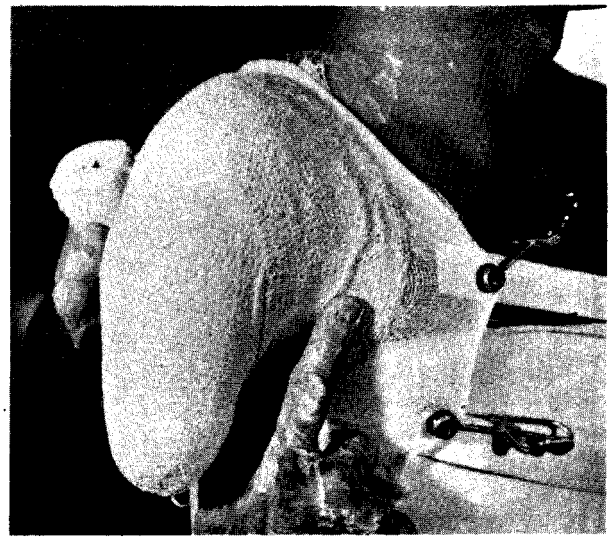
6. Continue the wrap over the shoulder.

7. When applying plaster through the axilla lay the plaster so that it will be on the rib cage and the medial aspect of the stump.

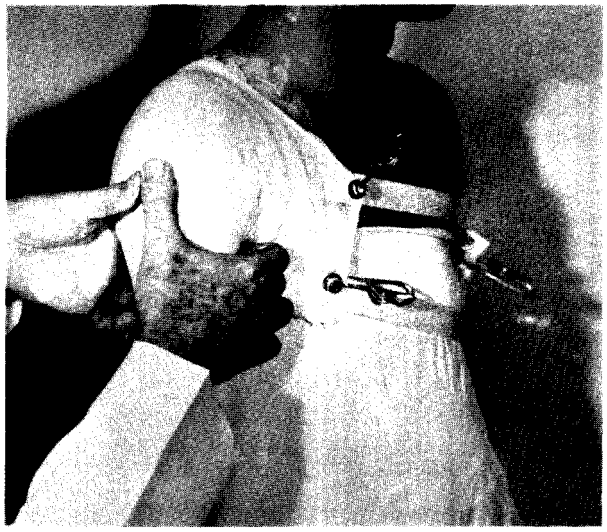
8. Continue to wrap making figure-of-8's or reverses until there is sufficient coverage and strength, usually 4-5 layers.

All Levels of Above Elbow

9. The wrap includes the delto-pectoral groove and extends on to the pectoral muscle so that the tendon will form a channel in the cast.



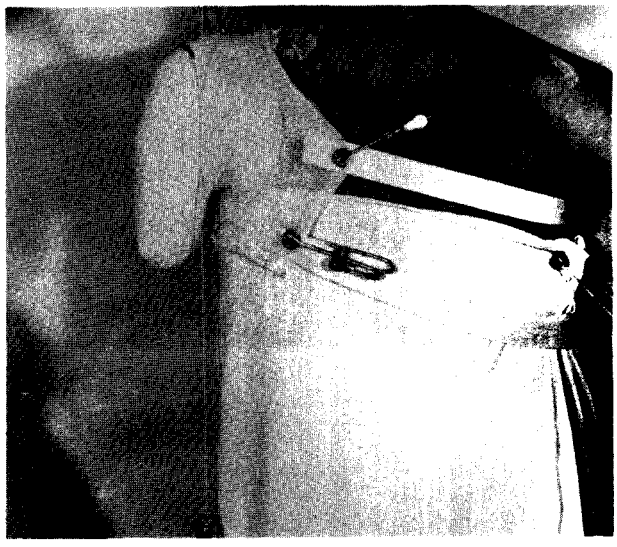
10. When the wrap is completed, position the stump to the side using the fingers, or a small dowel when the fingers are too large. Mold and shape the plaster into the axilla making sure there is close fit over the pectoral and latissimus tendon areas being careful not to abduct the humerus during this procedure.



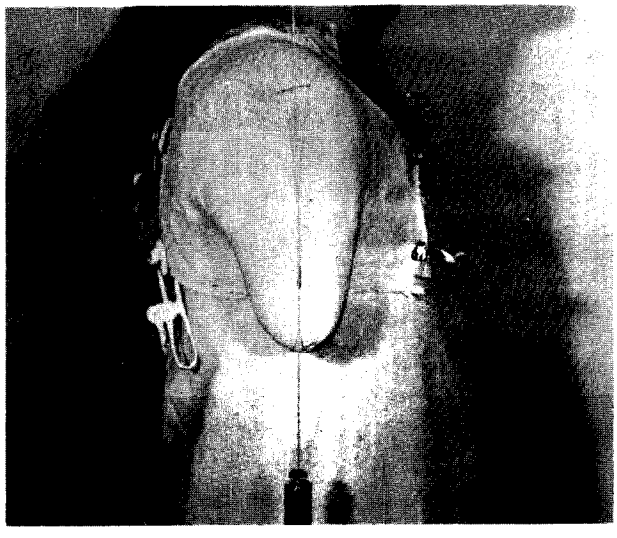
10a. A small dowel will prevent excessive abduction when placed in the axilla to shape the axillary brim.

11. Mold the scapular skirting making sure that the patient? shoulder is erect and in a normal position.

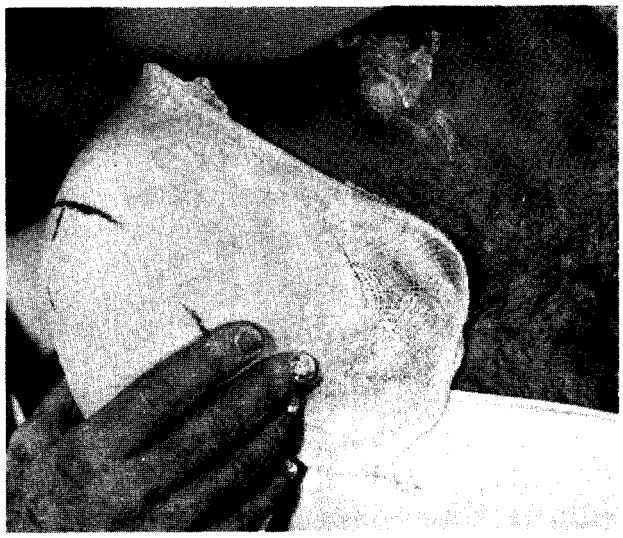
12. The correct position of abduction is shown.



13. It is important that the stump be in the correct position (without flexion or extension) when the plaster sets.



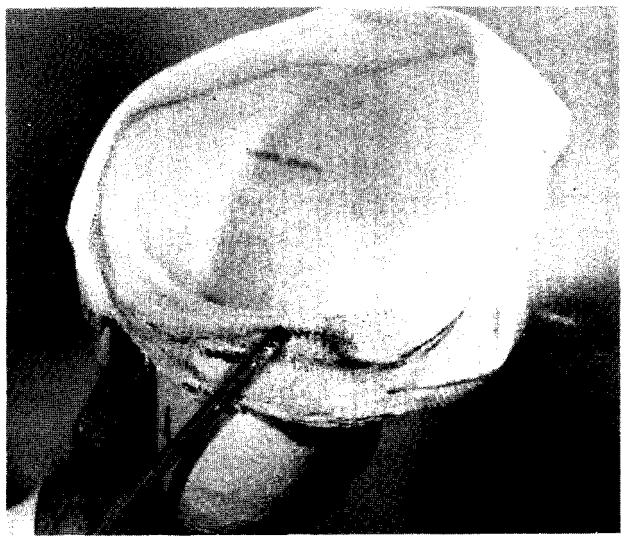
14. Remove the wrap cast carefully so as not to deform the skirting areas.



15. Inspect the inner areas of the wrap cast for the following:

    1. The axillary brim is flat and thin.

    2. The distance from the acromion to the brim corresponds to the measured distance.



The Wax Check Socket (Patient should remain until after breakout mold is made.)

List of Materials:

cotton stockinette (about 3 inches wide)
scissors
string
molten wax
knife
wood burning tool
talcum powder
heat gun
plumb bob
plaster bandage
parting agent for wax check socket

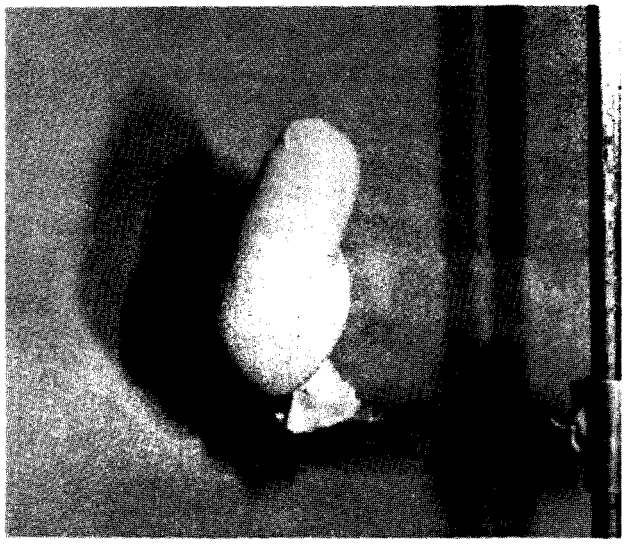
How to Fit the Wax Check Socket

Fitting of the wax check socket to an upper extremity amputee is similar to the initial fitting of a lower extremity socket.

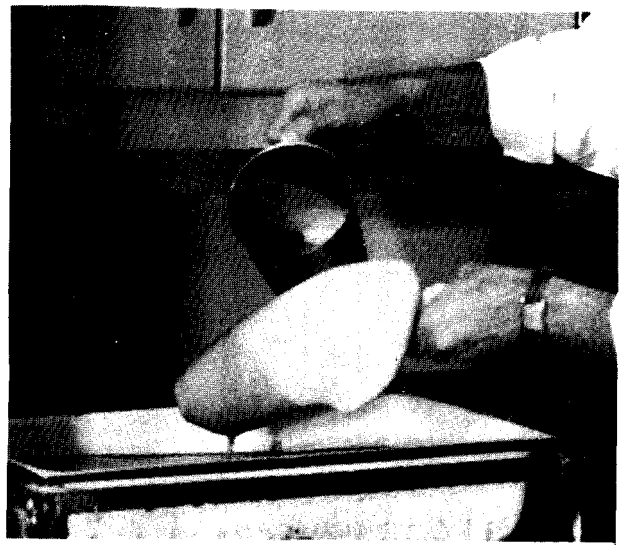
The initial fitting of the wax check socket involves an evaluation of the fit as to comfort, a satisfactory stump-socket volume relationship, and general fit, taking into consideration critical dimensions of length related to elongation or shortening of the distal stump soft tissues and total contact.

The second, or dynamic phase follows. In the lower extremity the socket is constructed of materials to support the stress and loads put upon it when walking during dynamic alignment. In the upper extremity the socket can be made of a lighter and simple to fabricate type material. This makes it possible to accomplish check socket fitting as a part of the prosthetic information session.

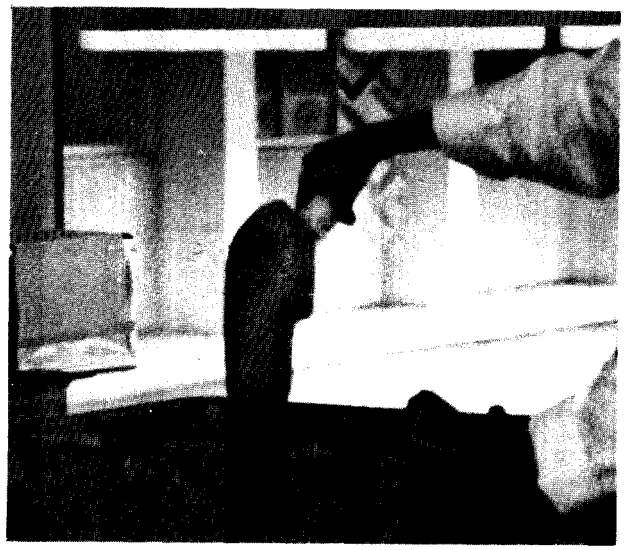
1. Put six layers of about 3-inch wide cotton stockinette over the model.



2. After tying off the stockinette, impregnate it thoroughly with molten wax.



3. Dunk the model in cool water to harden the wax. (Do not get any water into the container of hot wax or vice versa; a violent reaction results.) Before the wax hardens completely, form the wax well over the model with your hands to eliminate bridging of contours.



4. Cut the wax check socket to the approximate desired proximal trim and pull off the model, heating it slightly if necessary. Save the model in case another wax check socket must be made.

5. Apply powder to the wax check socket to allow it to slide on the stump. When the stump is soft and flabby a pull sock can be used.

6. Make a hole at the distal end when using a pull sock. Gently pull the sock out the hole to apply the socket to the stump.

First, check the length of the socket. With the stump at the end, the proximal edge of the socket should not gap over the shoulder and the socket should fit snugly in the axilla area.

7. Holding the socket firmly, instruct the amputee to move his stump in different directions within the socket to determine if the socket is loose on the stump.

8. When the socket is too large, cut openings in the suspected loose areas and reapply the socket.

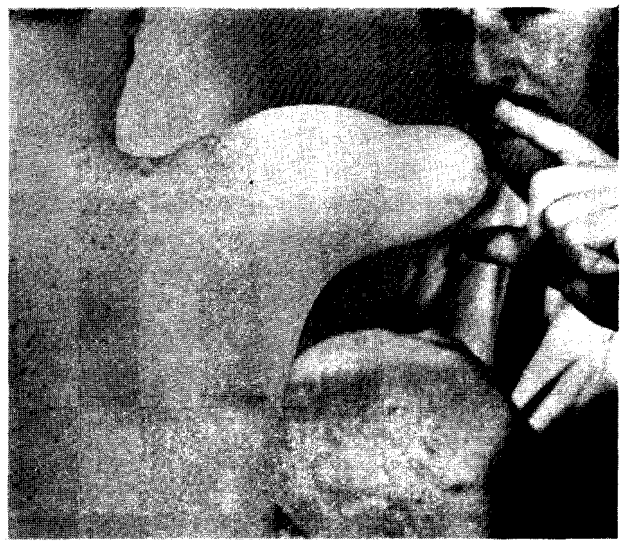
9. Note the gapping over the shoulder and through the openings. This type of problem may be caused by the presence of stump edema when the wrap cast was made. Re-measure the stump and modifv the model to the correct dimensions. Fabricate a new wax check socket.

When the socket fits the stump, proceed to the dynamic tests. These tests are designed to achieve the correct proximal trim for the skirting based on the functional motions of the amputee.

Review and compare the range of motion tests on the Prosthetic Information Form with the range of motion achieved in the wax check socket. The range of motion tests, to be realistic, should remain within those parameters recorded.

Abduct ion

10. Instruct the amputee to abduct his stump without gross or exaggerated shoulder girdle elevation. Observe the position; usually this will approximate 90°.



11. Apply the check socket. Holding it securely to the humeral stump and shoulder have the amputee repeat the above step. When there is excessive proximal skirting it will impinge on the shoulder preventing abduction

12. Mark the impingement area and trim off the excess material.

13. Reapply the check socket and have the amputee abduct his stump to 90° observing the area between the spine of the scapula and the clavicle. Mark a trim line following the shoulder contour.

Forward Flexion Test

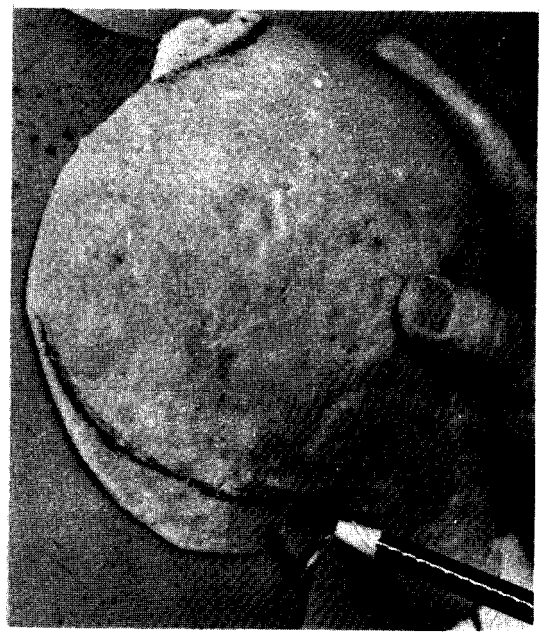
Trim the skirting of the check socket to permit flexion and extension. There are two areas of the shoulder girdle that are important to observe during this procedure.

1. On the anterior, impingement on the clavicle by the skirting during the flexion act and,
2. The posterior, skirting wing over the scapula which will inhibit forward flexion by impinging on the tissues and rib cage as shown in the illustration.

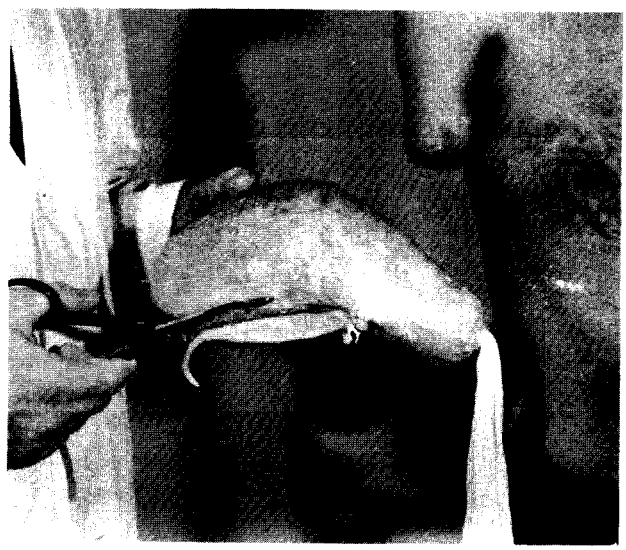
When the humeral condyles are absent active rotational control and stabilization of the prosthesis is obtained mainly from the posterior wing of the skirting. The skirting acts as a lever as it slides along the body contours rotating the prosthesis internally with shoulder girdle abduction. At the same time the skirting is stabilizing against any external rotational forces.

14. Hold the socket snugly against the shoulder. At the same time slowly attempt to move it from 0-45° in forward f lexion. Observe the lower edges of the anterior wing and whether it impinges on the soft tissues preventing flexion.

15. When the flexion is limited because of impingement scribe a line with the radius at the shoulder joint.



16. Trim to the line; smooth the edges.



17. Repeat this procedure of removing small amounts of material until a smoother sliding motion occurs when the amputee actively moves the socket through the desired degrees of motion.

18. The longer stumps may be able to flex to 90° or more thus the skirting will be less. With the Level III classification, however, 45°-60° is ample as shown in the illustration.

Anterior

19. The delto-pectoral groove is the border line of humeral motions in relation to the body. In the long E.D. the socket edge is trimmed lateral to this point to permit internal rotation of the socket.

20. In Classifications II and III, however, the socket is in the pectoral groove and with a reverse flare crosses onto the chest near the pectoral tendon with a small skirting for stabilization of the prosthesis.

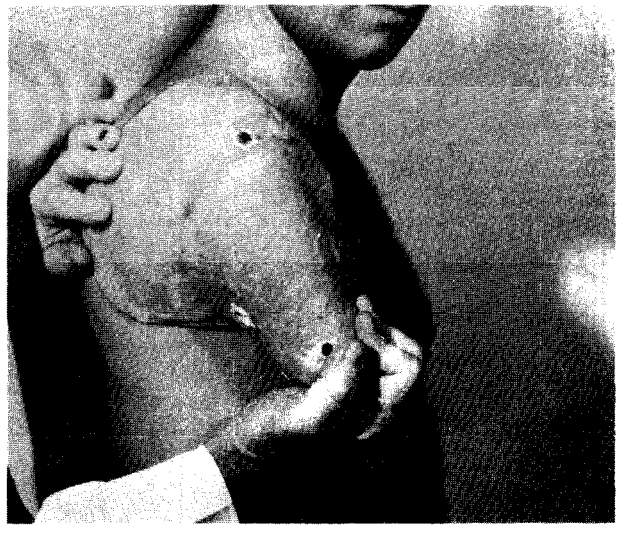
21. Mark the trim line 1/2" to 3/4" medial to the delto-pectoral groove and trim off the excess material.

22. Instruct the amputee to slowly bring the stump into a position of flexion and abduction observing the area along the clavicle. Trim away or relieve the material that impinges on the clavicle.

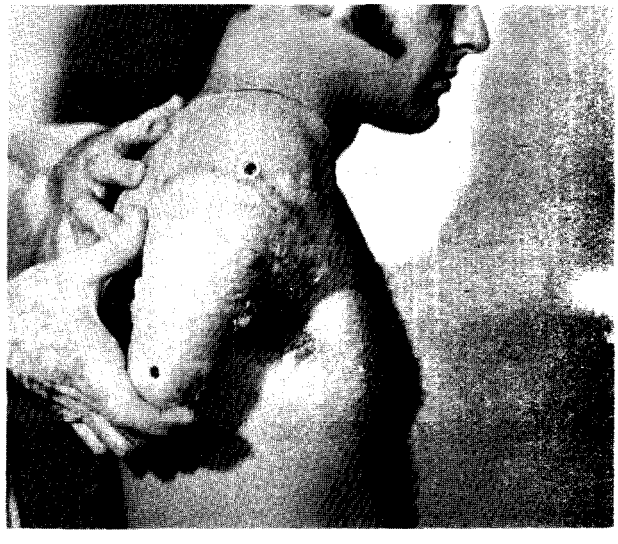
23. The shape is correct when the amputee can move the socket through the desired degrees of flexion and abduction without impingement on the clavicle.

The final tests motion against resistance are given after the brim design is completed.

24. Stabilize the socket and have the amputee try to forward flex. This test should reveal any discomfort at the anterior/distal end of the stump bone.

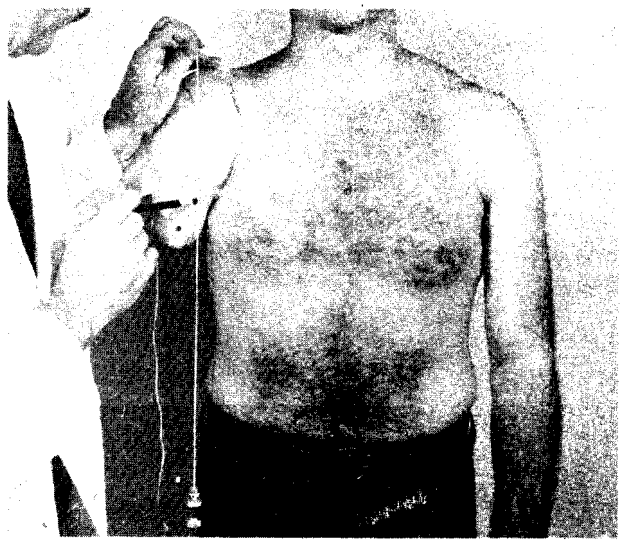


25. Repeat this test for extension and abduction. If there is discomfort in the socket correct the shape by heating, enlarging and reshaping the area.

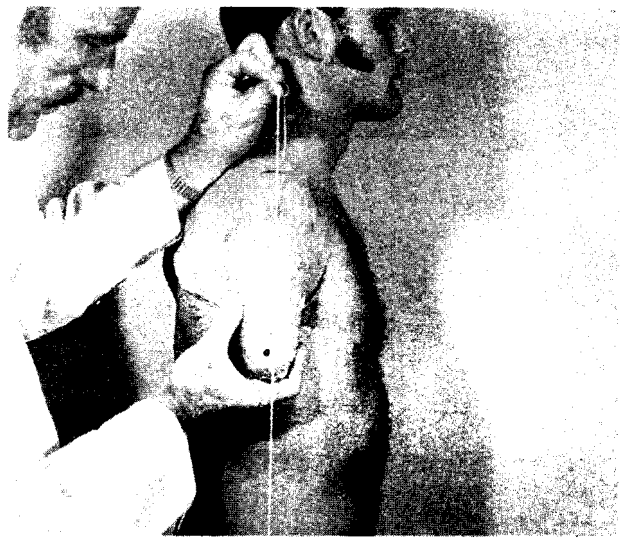


26. Mark the check socket alignment lines. Locate and mark the location of the outer acromion on the check socket.

27. Viewed from the anterior with the patient standing erect drop a plumb line from the mark over the acromion. Identify this line on the anterior socket.



28. Viewed directly from the lateral repeat this plumb line procedure. Hold the socket so that the plumb line will follow along the humerus (unless there is a flexion contracture) and at the mid line of the socket. Identify this line.



29. Place B.B.'s or punch identification holes through the socket at two places on each line about 3 inches apart.

Harnessing: Long Above Elbow - Figure Eight

List of Materials:
dacron tape (1 inch wide)
elastic webbing (1 inch wide - 8 inches long)
plastic axilla tubing (polyethylene)
four bar buckles (1 inch)
safety buckles (1 inch)
dacron tape (1/2 inch wide)
velcro (hook and pile)
four harness clamps
pop rivets or self tapping screws
speedy rivets
swaging tool or soldering materials
masking tape

Prepare the harness by sewing an 8 inch piece of elastic webbing to a piece of dacron webbing approximately 52 inches long.

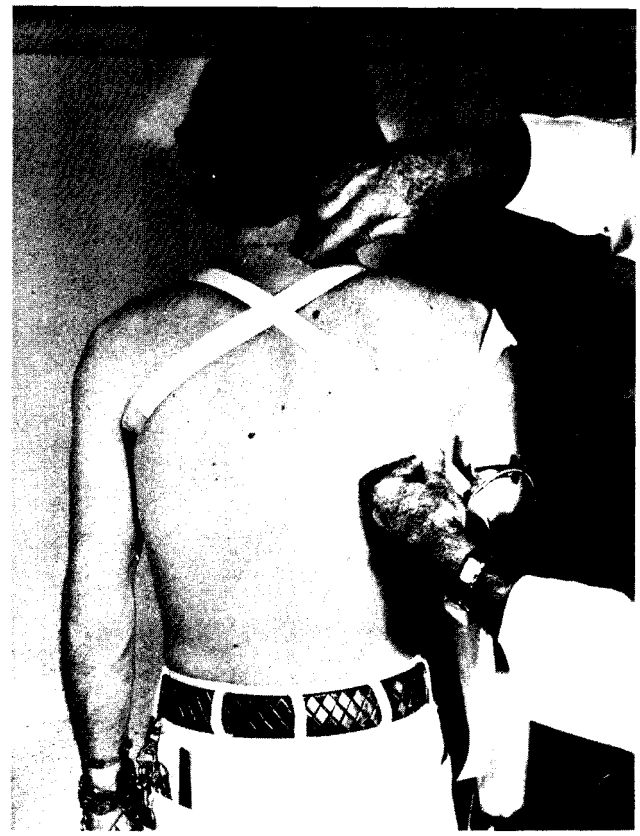
Apply the prosthesis using whatever stump sock thickness, if any, is to be used. Flexing the elbow 90° and locking it will enable the patient to assist in holding the prosthesis.

1. Temporarily, attach the elastic suspension strap to the socket with masking tape. Position the suspension strap so that the elastic will extend from one inch above the pectoralis major tendon in the delto-pectoral groove to the center of the distal one half of the humeral section.

2. Position the axillary covering (polyethylene tubing) on the harness strap to extend through the opposite axilla. Maintain tension enough to suspend the prosthesis.

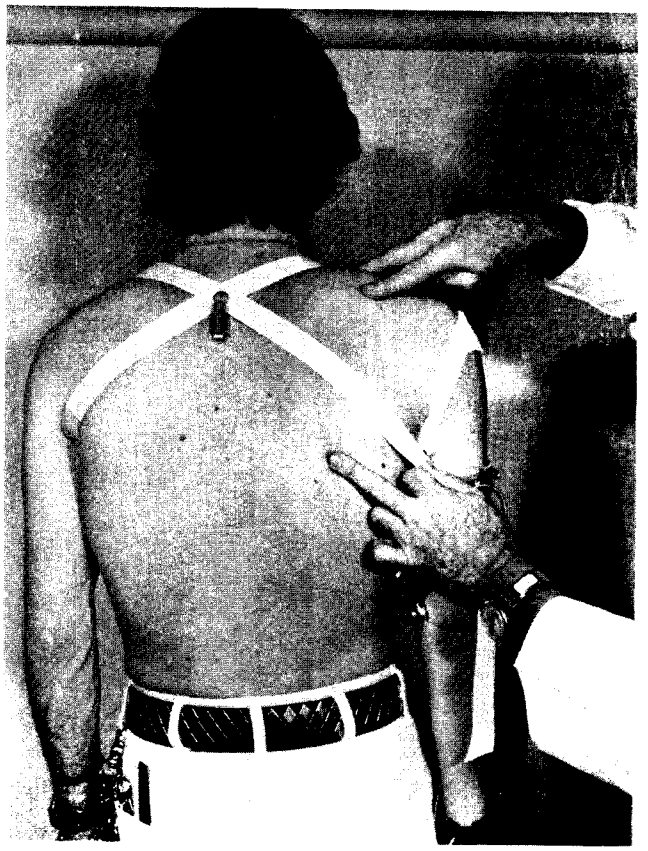
3. Form the axillary loop by laying the harness strap upward through the delto-pectoral groove and back over the sound shoulder.

4. Position the webbing below the seventh cervical vertebrae to form the loop.

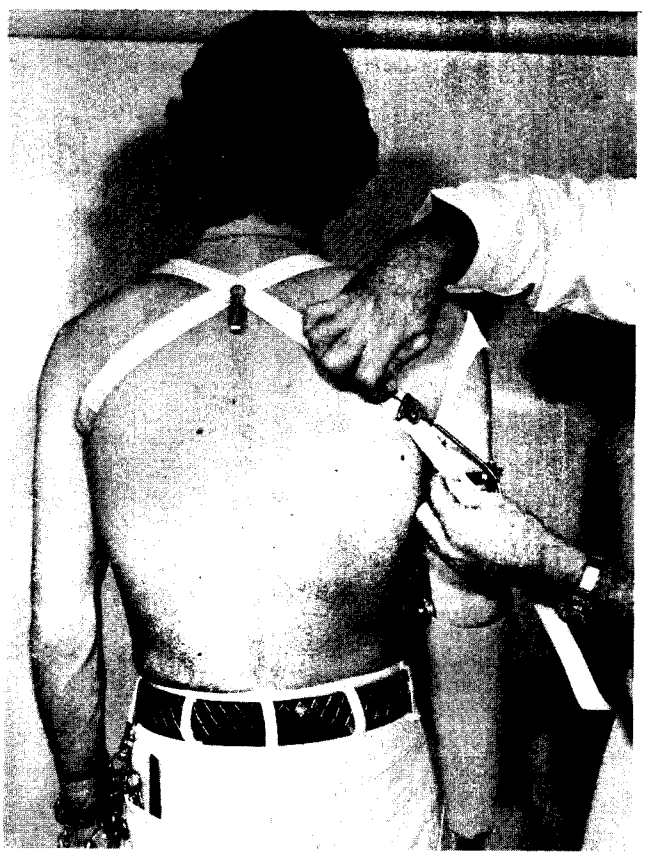


5. Maintaining tension, the harness strap pointing towards the control system, place a clamp to the cross one inch toward the sound arm from the spinal column. Moving the cross and clamp toward the sound side tends to lower the control strap. Conversely, placing them towards the prosthesis will raise the control strap.

6. The control strap now extending from the cross is positioned on the lower one-fourth of the wing of the scapula. This will also be in approximately a straight line to the center of the humeral length.



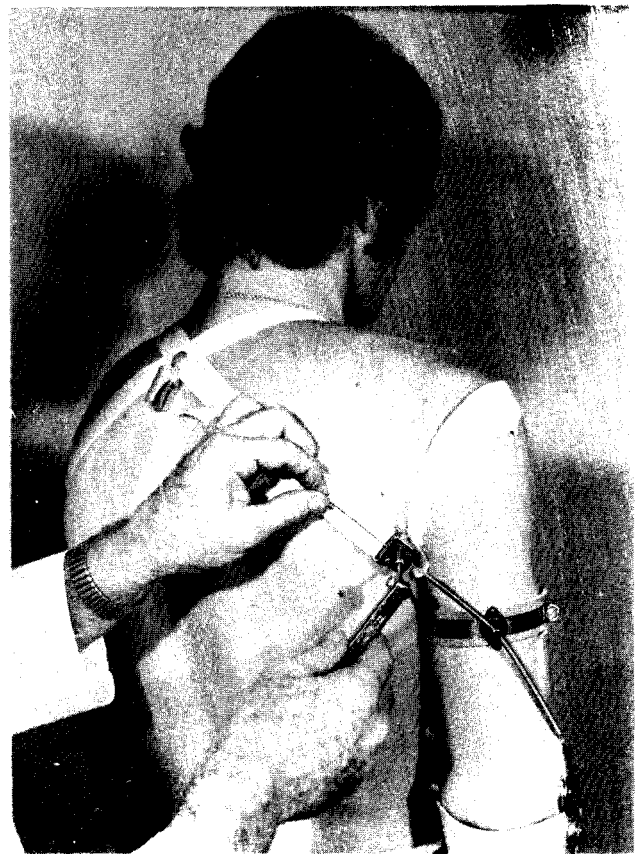
7. Position the (adjustable) hanger so that there will be minimal control cable lying on the skin. In this illustration, the cable and housing are too long.



8. Remove the hanger from the cable. Fasten it to the harness control strap in the correct position just above the socket brim. Measure and mark the housing to be removed.

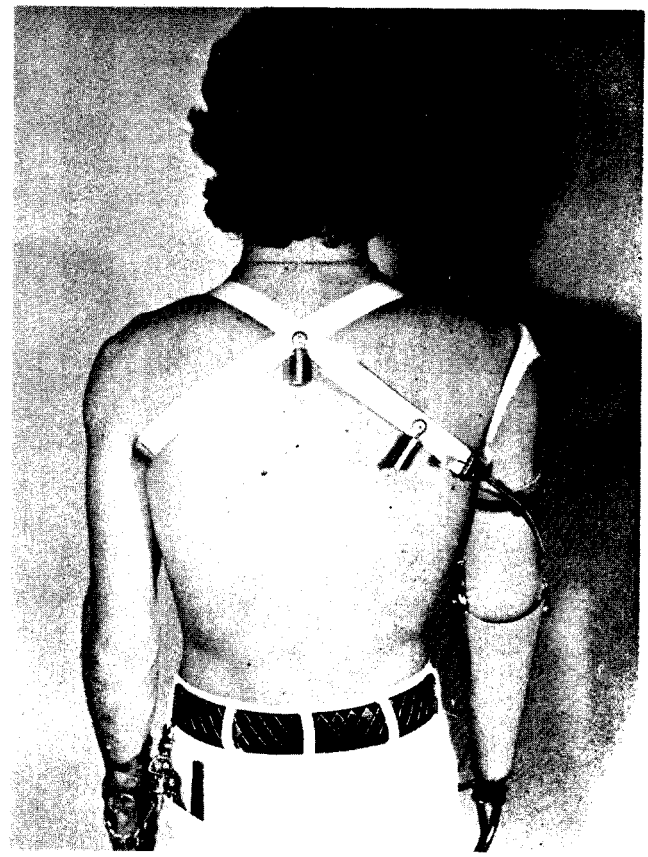
9. Pull the cable out of the housing and cut the housing so that it will not be able to contact the flesh.

10. Run the cable through the housing and again attach it to the adjustable hanger. Pull on the cable to remove all of the slack before tightening the clamp. The control strap and cable should now follow a smoothly curving line from the cross of the harness to the elbow flexion attachment. In the illustration, note the angle of the housing at the humeral retainer.



11. Adjust the position of the retainer to remove the angle of the housing. When making this adjustment, avoid moving the retainer too far towards the lateral aspect of the arm as it will cause the prosthesis to externally rotate. The reverse will occur if it is moved too far medial. When a sharp angle cannot be removed by adjusting the retianer, try a different position at the harness cross clamp.

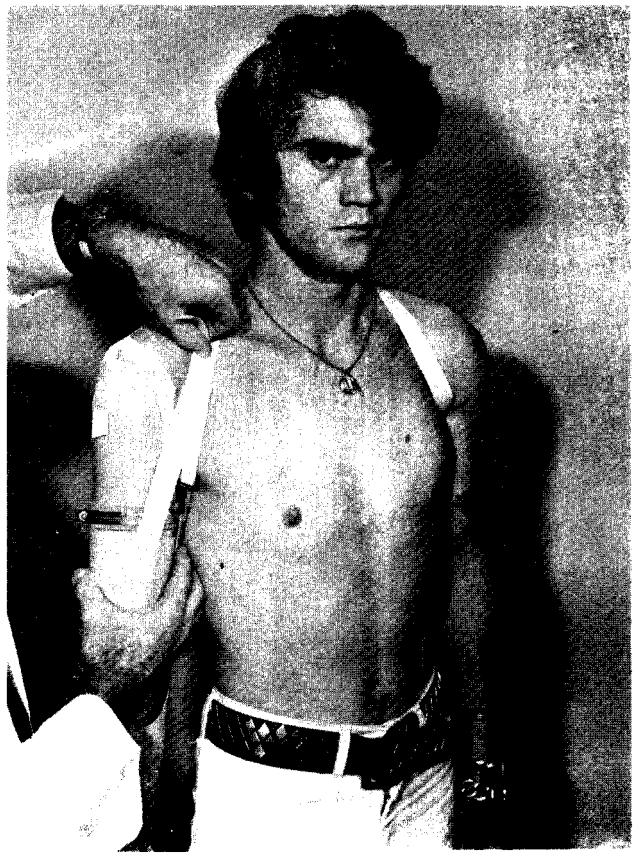
12. As illustrated, the harness will lay smoothly on the body when designed to the anatomical references previously described.



13. Apply a lateral suspension strap when the socket does not have good retention on the condyles or in cases of very heavy duty. Place the strap so that it has a smooth transition from the harness and extending laterally over the acromion. Attach it to the socket at the rotation center, usually a point just lateral to the head of the humerus. Have the subject flex and extend his shoulder joint to locate this point on the socket.

14. Mark the location to rivet the billet. The buckle should be on the socket and not the skin. Temporarily attach the lateral suspension strap with masking tape.

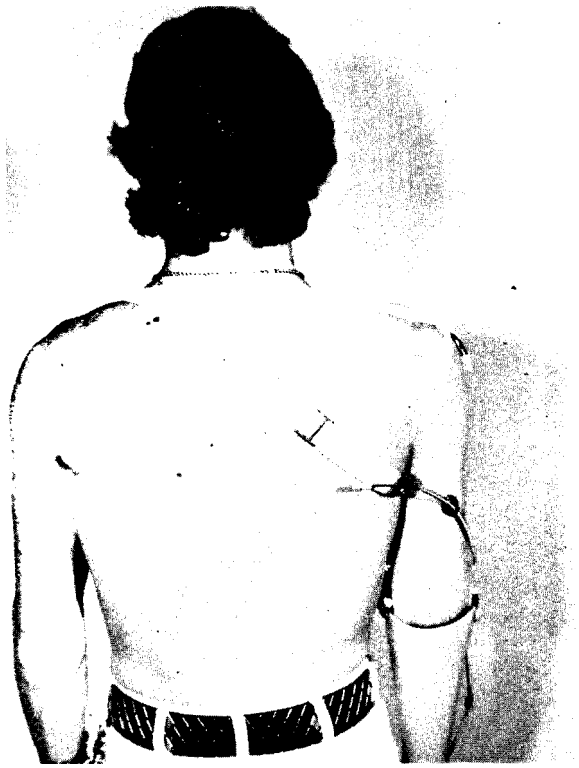
15. Attach and position the elbow locking control strap. The 1/2 inch hanger is attached to the operating cable so that it will not be on the skin. Locate the webbing attachment point just below the clavicle. Hold the strap taut and at a fixed point, extending the arm passively backwards until the lock clicks. This should occur with approximately 15° of motion. Adjust the tension and location until satisfactory function is achieved.



16. Clamp the elbow lock control strap to harness at the point located and have the amputee operate it to see if its location is satisfactory. Sometimes moving it only 1/2 inch up or down will improve the function.

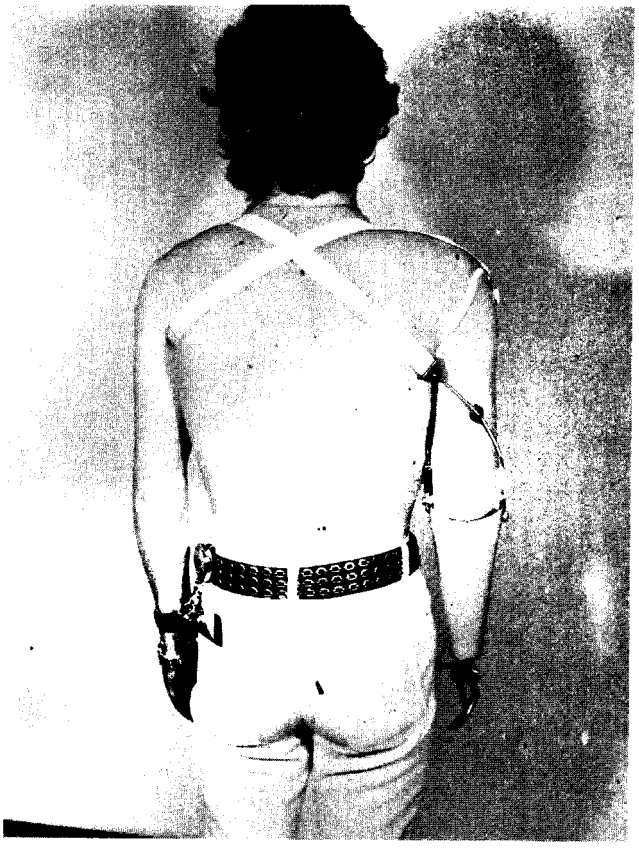
17. Scribe lines to indicate the angle of the webbing at the cross. Mark the positions of the buckles or other fastenings. Carefully remove the harness and stitch the harness together.

18. Apply the harness once again and adjust the location and tension of the buckles. The harness should be comfortably taut.



19. Have the amputee operate the controls to determine if additional adjustments are needed. If this is the amputee's first prosthesis, teach him the control motions by following the instructions in the chapter on Controls Training.

20. Small adjustments are usually needed to improve the function. In the illustration, the addition of a housing retainer on elbow operation cable improved that operation.

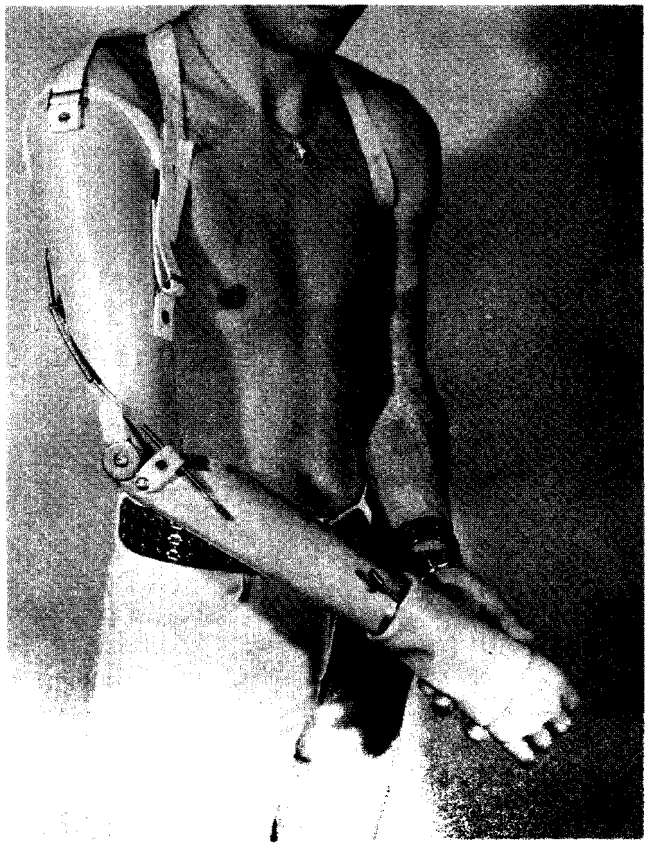


21. Swage or solder the cable control hanger when the final adjustment has been made.

22. Finally have the amputee practice the control motions. Observe all the systems to see if the function is correct.

23. The completed prosthesis can now be evaluated. Note the hook to cable adapter.

24. In the illustration, the control system is altered for interchangeability between hand and hook.



25. All accessories should be located to facilitate one handed operation. For hand and glove installation, see chapter on Cosmesis.

Controls Training

Above Elbow Prosthesis with Dual Control

Introduction

Aside from prepositioning there are four basic operations that the amputee must learn before he will be able to successfully use his prosthesis.

They are:

1. terminal device operations
2. mechanical elbow flexion
3. elbow lock operation
4. a combination of elbow flexion and elbow lock operations

Terminal Device Operation:

When using a voluntary opening device, a pull on the cable control will open it. The rate of speed and amount of opening (width of grasp) can be voluntarily controlled by the amputee. The closure, however, is dependent upon the force of a spring or rubber band.

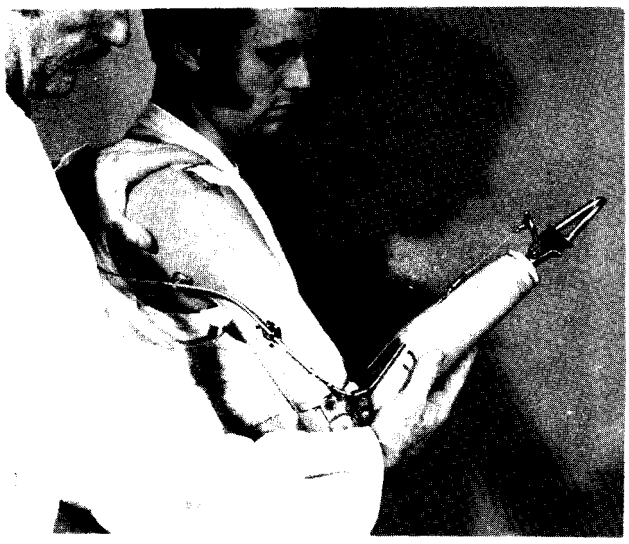
Voluntary closing:

The cable control pull closes the device while the spring opens it. Prehension force is more selective.

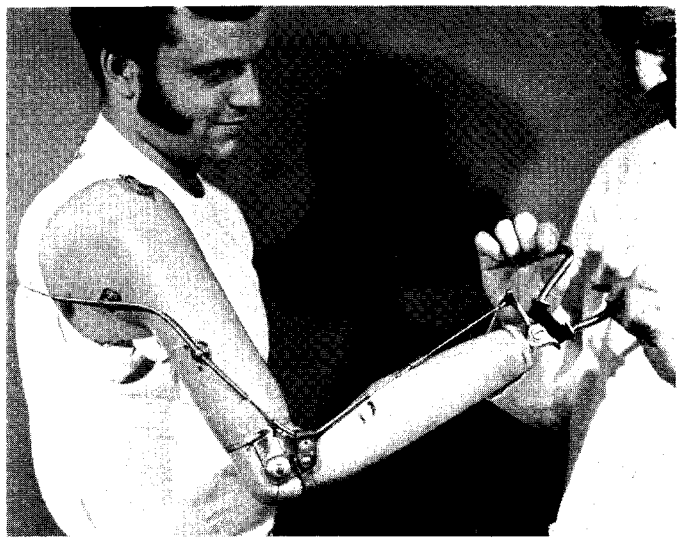
1. Trainer flexes the prosthetic elbow to 90^{o} and manually locks elbow.

2. Open the terminal device and demonstrate the resulting slack in the cable.

3. Passively forward flex the arm and demonstrate that there no longer is slack in the cable. This will occur at aproximately 30^{o}.

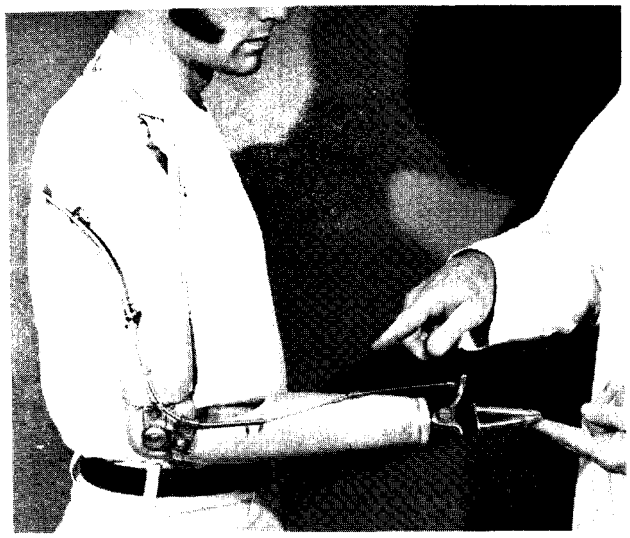


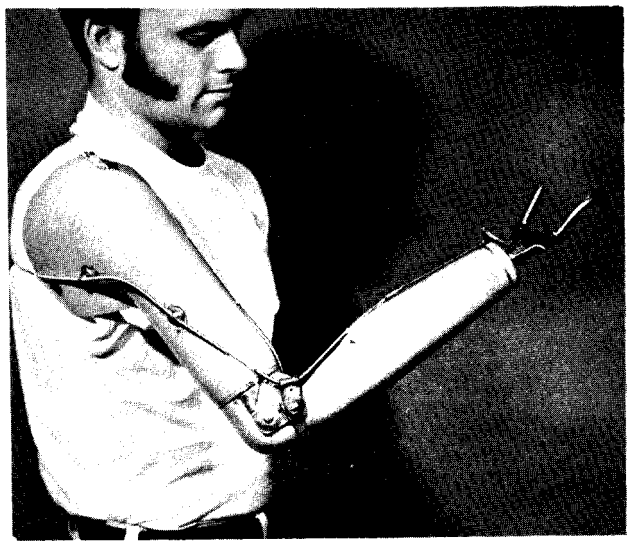
4. Still holding the previous position, open the terminal device by hand. Have the amputee observe that the cable is again slack.



5. Direct the amputee to continue the flexion an additional amount. The terminal device will then remain open.

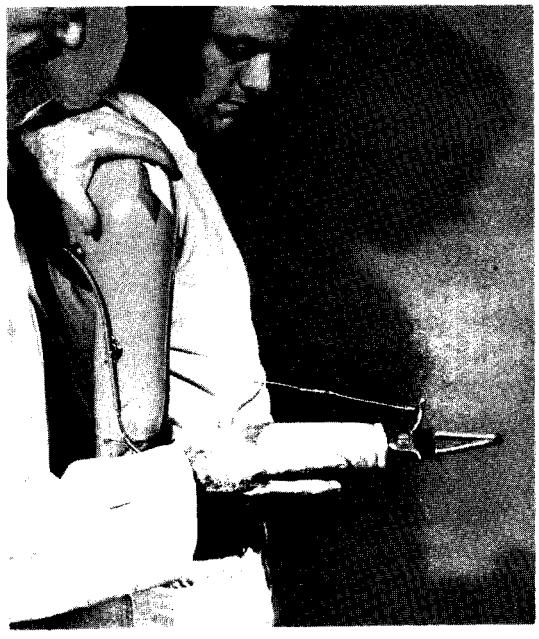
6. Direct the amputee to bring the prosthesis back to his side. The terminal device will then close.





7. He repeats opening and closing the terminal device until the control is smooth.

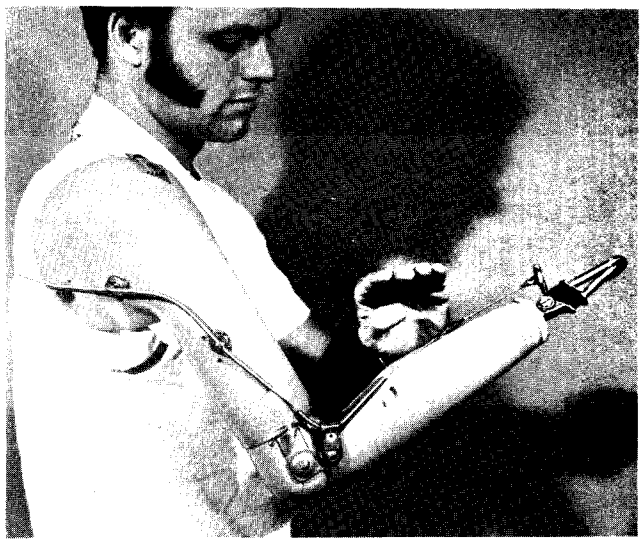
Forearm Positioning by Active Prosthetic Elbow Flexion and Extension.



8. With the elbow unlocked, the trainer brings the prosthetic forearm from the arm hanging position to 90^{0} of elbow flexion. Have the amputee observe the slack in the cable.

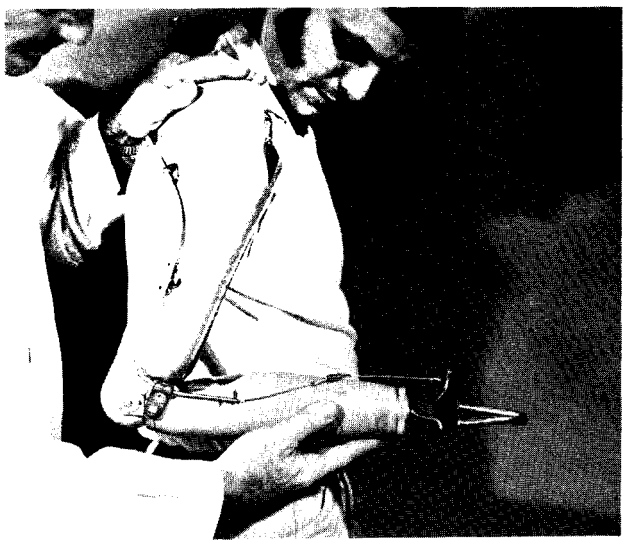
9. The trainer, maintaining the forearm at 90° of elbow flexion instructs the amputee to flex forward until the cable slack is taken up. Repeat this until the amputee understands the motion. Then have him hold the position independently.

10. Trainer instructs amputee to shield face with sound hand and assits amputee in flexion and extension of humerus and points out resulting flexion and extension of elbow. Amputee flexes and extends humerus slowly and independently and practices until he is able to control position of the prosthetic forearm.

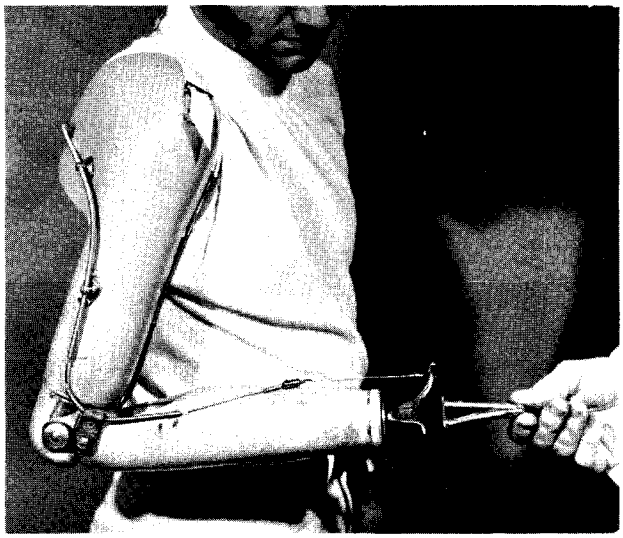


Elbow Lock Operation

11. Begin with prosthetic elbow unlocked. Stabilize the shoulder with one hand. With the prosthetic elbow flexed 90° and the forearm held in the other hand, force the humeral section into extension until elbow lock "click" is heard. Trainer slowly flexes shoulder toward the neutral position until second "click" is heard. The elbow is now locked. The sequence is repeated to unlock the elbow. Have the amputee assist you in performing the motions listening for the full sequence of four "clicks".



12. Support the forearm by holding onto the hook only. Amputee locks and unlocks elbow until operation is smooth.



13. Trainer flexes elbow to 90° and abducts humerus to 60°. Trainer points out that the dual control cable slack is taken up and that tension on this cable maintains the position of the forearm. Amputee independently flexes 90° and abducts humerus to 60° and locks and unlocks elbow.

14. Amputee attempts to lessen degree of humeral abduction and locks and unlocks elbow while forearm section is in various degrees of elbow flexion.

    Trainer drills amputee in combined: terminal device operation; forearm positioning, and elbow lock operation until their functioning is reliable.