15. Strengthening of hand movements

15.1 Introduction
The final stage in restoring the normal function of the arm consists of strengthening the movement of the hand and establishing precision movements of the hand.

To regain precision movements, the hand must be kept free from the typical spasm pattern (see fig. a, page 5) through correct positioning.

The shoulder and elbow movement must be restored first (see section 6); the muscles of the affected arm must be strengthened by active exercises (see sections 8.1 and 11.2).

The person must be taught to support, hold and move her arm in space in different positions, releasing the hand for functional movements as described below.

- Hold a rolled towel (a stick or a rope) in front of the person
- the person is taught to grasp and release the towel and/or
- to move the hands up on the towel, grasping one hand on the top of the other

  • the arm must be kept straightened with the shoulder forward (anti-spasm pattern)

You can encourage hand movement by asking the person to think of the specific movement taking place in the joint concerned. Remember to give the movement commands slowly and clearly (e.g. “Think about your elbow..... Look at it.....help me to bend your elbow....”). If the commands do not gain the required response, you should then demonstrate the exercise.

It is best to start with a simple sequence of movement or a series of actions. Encourage the person to practise constant repetitions of the exercise. The movement can be reinforced by approximation with manual pressure (from the heel of the hand through a straightened elbow to an outward rotated shoulder -see sections 9.3 to 9.7)

Give the person different objects and modelling materials to hold (e.g. plasticine, wax for moulding, modelling clay, lumps of foam rubber, plastic foam, small balls of various sizes etc.) This will allow different weights, shapes and textures to be experienced. It can encourage the person to practise different grips. Remember to insist on the exercise of both hands.
15.2 Activities to establish precision hand movement

When using the hand, the **elbow should be supported** on a table (see Figs.44/45) until the muscle tone has been restored. The following movements should be practised by the patient:
- making a fist
- elbow bending/straightening
- wrist bending backward/forward
- wrist rotations
- hands pressed together, with thumb and fingers open and apart (unaffected hand assisting the movement of the affected one)
- finger-tips pressed together
- sliding, palms placed over a tin
- finger-tips grips
- precision movements, including small grips (e.g. when building a tower with small blocks of wood) and a pinch grip (e.g. using a pen)

15.3 Wrist bending backward

The person sits, the hands are pressed together, with thumbs and fingers spread. The elbows are supported on a table.
- Wrist bending backward is practised. First as a passive movement with the assistance of the unaffected hand (see fig. 48) and then as a graduated active/resisted movement working against the unaffected hand

Ask the person you are training to stand. When he is standing (as shown in fig. 41.1) ensure that weight bearing is over a correctly positioned hand, with the shoulder in external rotation. The elbow and wrist are extended.
- Ask the person to roll out a piece of modelling material, pressing down on the palm. The fingers are kept straightened when pushing away and relaxed when pulling back.

With the person standing, the affected hand is placed palm down on a table, thumb and fingers straightened and open
- The person lifts the hand off by bending backward the wrist. The heel of the hand is left in contact with the table.

15.4 Wrist bending forward
• The hands are positioned with thumb and fingers open. Wrist bending forward is then practised using the unaffected hand to give graduated resistance to the affected one.

• The hand is placed palm down on a table. Wrist bending forward is practised by lifting the palm and leaving the fingers in contact with the table.

15.5 Weight -bearing on the finger-tips

• The person stands in front of a table. The thumb and finger-tips are pressed down firmly: Practice supporting the body and increasing the amount of weight over controlled finger-tips

15.6 Close and spread the fingers

• Grip a little ball firmly, then release, opening the hand to straighten the fingers

15.7 Thumb Opposition

• Use thumb bending to touch the finger-tips

• Pinch and pull out small pieces from a lump (i.e. thick foam rubber) held in the unaffected hand, using thumb and first finger, thumb and second finger, and so on

• Roll a very small piece of modelling material between thumb and first finger
15.8 Sequence of activities

Precision movements of the hand can be established when controlled shoulder and elbow movements have been re-established and the hand is free from the “flexor spasm”. The following illustrations summarise some of the training activities (suggested in this Guide) that can facilitate this task. The examples are related particularly to the upper limb.

**activities:**

- **gravity approximation** reinforced by manual pressure
- **manual pressure** is given with **counter-pressure**

  All activities are taking place in the different positions (side-lying, sitting, standing, etc.) through a correctly positioned base (**recovery pattern**)

  The **handgrip** is used to inhibit the spasm pattern in flexion (an open thumb, with pressure on the heel of the hand, helps to release fingers)

**aims:**

- to reduce flexor spasticity in the arm
- to obtain an arm elevation without pain
- to enable the person to keep the shoulder in the different positions with the elbow straightened

**Note on handgrip:**

- distal (hand) and proximal arm control
- inhibiting handgrips are used during approximation (elbow control is needed in the early stages; the aim is to achieve the ability to hold the arm straightened without elbow support)
weight-bearing on the affected limbs

- the arm is moved not only in regard to the body, but the person is taught to use the arm as a fixed point for trunk movements (body movements in regard to the arm)

**cross facilitation:** the person works with the unaffected side of the body, across the mid-line, to the affected side to initiate bilateral activity and vice versa

In sitting position, feet flat on the floor
- he lifts the buttocks straightening the arms

- weight-bearing on the affected arm held in different positions, maintaining the elbow straightened, shoulder forward
place and hold a limb in space (a, b, c, d):

a) the arm is maintained by the trainer into the recovery pattern:
thumb and fingers open, wrist bent backward and elbow straightened,
arm turned outward with shoulder forward

b) a brisk tapping may be used on the elbow to keep it straight

c) the person holds the arm into the recovery pattern with your assistance

d) wrist bent backward position may be added as an additional inhibiting influence

final stage:
• the person holds (and move) the upper limb in space in any position, into recovery pattern and without your assistance

practice
• active movements of wrist and fingers
• precision movements of the hand (different grips)

16. Some common problems to avoid
16.1 Hand spasm

After a stroke special care must be given to prevent the development of the typical spasm pattern in the affected hand (see fig. 92). Correct positioning of the person is needed from the early days to avoid this.

CORRECT  WRONG

If severe spasticity and muscular retractions in the hand are prevented the person will have more potential to regain controlled movements of the hand and fingers.

A good functional hand position is one where the wrist is bent backward, the fingers are partially bent and the thumb is opened. It can be facilitated by good positioning, range of motion activities, active movements and the use of simple devices. The simple devices described below can help to promote a functional hand position.

- **Hand roll**
  A hand roll (made by rolling a cloth, a towel or other soft material) can be placed in the hand of the person who is developing severe spasticity.

   Fig. 92.1

   ![Figure 92.1](image)

- **Palmar positioning splint**
The splint covers the anterior aspect of the hand and the anterior and distal side of the fingers and thumb. The splint does not cover the palm area because pressure on this area may increase spasticity. The hand is in the functional position, with the wrist bent backward, fingers partially bent and thumb open.

**Fig. 92.2**

this splint can be made of sheet aluminium, PVC plastic or thermoplastic material if available

- **Soft fingers divider**

Another simple device can be made using soft foam rubber. This soft fingers divider will promote better bending backward of the wrist and fingers. The divider keeps the fingers widely apart, it reduces also the flexor spasticity of the whole arm and it prevents the development of swelling in the hand. If the person finds this device comfortable she can wear it at night to help in keeping the fingers apart.

**Fig. 92.3**

Keeping the **hands clasped with the fingers interlaced** has the same effect in reducing flexor spasticity in the arm.

**16.2 Subluxation of the shoulder and painful shoulder**
The shoulder joint is dependent on the support of muscles and ligaments to maintain articulation of the head of the humerus with the cavity of the scapula.

Without adequate stabilising support, because of mechanical position, or due to a flaccid hanging arm, subluxation may follow.

In many people, the partial dislocation (subluxation) of the shoulder joint becomes a problem in sitting, standing and walking. This is particularly so if the muscles (the deltoid and supraspinatus) that support the arm are flaccid and the arm is hanging down because of the lack of support. However, even in a flaccid arm there is some degree of spasticity in the wrist and fingers, and in the muscles around the scapula.

The main causes of shoulder joint subluxation can be summarised as follows:

- the muscles that should support the arm are flaccid and weak
- the weight of the arm and gravity pull the arm downward
- the muscles around the scapula are retracted because of spasticity: This prevents the scapula turning outward and upwards when the arm is raised up and it increases the depression of the shoulder joint

The Painful shoulder
The “painful shoulder” that is often suffered by a person who has had a stroke is not linked to the problem of shoulder subluxation. The pain is associated with strained muscles and ligaments caused by incorrect positioning and bad lifting (for example, see fig. 10 or fig. 12) combined with the following:

- an immobile scapula
- an altered plane of the joint between the scapula and the humerus
- muscle weakness and lax ligaments
- pinching of the rotator cuff and impinging of bony surfaces between scapula and humerus

the cavity in the scapula in which the head of the humerus is placed remains rotated downward when the arm is passively raised up

the joint capsule and the supraspinatus muscle are pinched against the acromion (see fig. 93.2)

this mechanical problem is exacerbated if the arm is held turned inward and the scapula is drawn backward

**How to prevent the onset of a painful shoulder**

The individual needs to be correctly handled in the early days after a stroke, especially during the flaccid stage. This must include the maintenance of a free scapula (see chapter 3, “Range of motion activities”). Trainers, nurses, family members and the person herself must be taught how to maintain the correct positioning of the shoulder. Everyone must be fully aware that the person’s future upper extremity function, range of motion and comfort all depend on it.

In addition to correct positioning it is important to strengthen the flaccid muscles (the deltoid and supraspinatus muscles) that provide support to the shoulder.

**The following actions are recommended:-**

- Weight-bearing through a correctly positioned shoulder will reinforce the mechanical stability of the joint.

- The shoulder must be raised up with the shoulder joint turned outward.

- Rolling exercises must always be carried out by the person with hands clasped, both arms reaching forward, shoulder forward and turned outward.

- Sitting at a table with both arms supported and hands clasped, the person should try to reach forward as far as possible across the table.

**Shoulder support aids**

In the early stages of treatment, a temporary shoulder support may be needed to prevent strong and prolonged stretching of the muscles and ligaments that support the
arm. This device consists of a roll of soft material (i.e. cotton, wool, foam rubber) with a diameter of about 10 cm. It is placed under the affected armpit. It may be needed especially when the person is standing.

**Fig. 93.4**
A correct device that may be used to avoid the depression of the affected shoulder

![front view](image1.png) ![posterior view](image2.png)

**Important: a sling should NOT be used**
**Fig. 93.5**

- it is wrong to think that a sling keeps the arm upwards preventing the subluxation;
- in this position the elbow is bent, the arm is kept towards the body and turned inward, hand palm down (the typical spasm pattern in flexion);
- the spasticity of the arm is reinforced not reduced thus increasing the risk of subluxation. Furthermore, the bent position increases the swelling of the hand

However, if the arm remains flaccid and it hangs down when the person is sitting or standing (the person’s hand is swelling) the shoulder support may not be enough. In that case a **wider sling** may be used, keeping the elbow and the whole hand in it.

**Fig. 93.6**
16.3 Leg spasticity

An effective gait will be difficult to achieve if the person develops severe spasticity in the affected leg some weeks after the onset of the stroke. Due to spasticity, it will be difficult for the person to bend her hip and knee when walking. He will walk with an awkward gait, making a great effort to swing the affected leg forward (see fig. 60). This major effort will increase unwanted muscle tone in the affected arm. An important rule in stroke treatment is that lower limb activity should not activate upper limb activity.

The person will also bear weight on the forepart of her foot and not through the heel, and this will further reinforce spasticity in the leg. The foot hangs down and is turned inward. This foot position may begin due to the initial floppy weakness, but it will become stiff from contractures if preventive measures are not taken.

How to prevent extensor leg spasticity

The following activities should be adopted to reduce the spasm pattern. They are given in sequential order:-
• careful positioning at all times
• passive movements in “recovery pattern”
• assisted- active movement
• placing and holding a limb in space and active movement
• weight bearing over a correctly positioned base (preventing the knee drift with the hip turned outward)

Devices to reduce the spasm pattern

When standing and walking many persons bear weight on the forepart of the foot. The toes of some of them are so bent that standing and walking are painful. Foam rubber pads placed between widely spread toes can be used to break down the spasm pattern. The opening of toes reduces the spasticity of the whole foot.

Fig. 94.1
Toes can be kept widely apart using foam rubber or cotton pads