THE USE OF LIVELY SPLINTS IN UPPER LIMB PARALYSIS

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A problem in the treatment of upper limb paralysis is to decide between reconstructive surgery and the provision of functional splints. Seddon (1952) stated: "There is no apparatus for the permanent control of the wrist, elbow or shoulder which approaches in usefulness what can be achieved by surgical intervention." Reconstructive surgery, using a combination of tendon transplants and joint stabilisation, has given remarkable results in the restoration of a functional arm (Barr 1949, Seddon 1952). There is, nevertheless, a growing tendency to use lively splints in certain types of paralysis. Capener (1946, 1949) has described a wide range of such splints for hand, wrist and elbow weakness, and there have been many reports in the literature describing new and improved lively splints (Higett 1942, Bunnell 1949, Stewart 1948, Irwin and Eyler 1951, Nangle 1951, Gazeley and Dunham 1952).

There are three main indications for the use of splints in upper limb paralysis. First, to prevent deformity, as for example in the maintenance of the limb in the position of function during the acute stage of poliomyelitis and the splinting of peripheral nerve injuries during the stage of regeneration. Second, to correct deformity—an example of this type is the use of stretch splints for tendon and muscle contracture. Third, to replace and encourage function that is permanently lost, or while recovery is proceeding.

Most of the splints described in the literature are designed primarily to prevent or correct deformity. Insufficient attention has been paid, in our opinion, to the design and development of lively splints to encourage function during the recovery stage or as a permanent replacement for lost muscle power.

This paper attempts to state the indications for their consideration in place of reconstructive surgery. The splints that have been found useful at this Centre are illustrated and described in detail.

ADVANTAGES OF LIVELY SPLINTS

We consider that lively splints offer certain advantages as a permanent or semi-permanent solution rather than surgery. Firstly, they can be made quickly and after a short trial period the patient can return to employment. In over half the cases in this series it was essential for the patient to start training or to return to employment as quickly as possible. Many could not afford the long periods in hospital and rehabilitation units necessitated by a comprehensive reconstructive programme, which may not be completed until many months or years after the original disease or injury. The longer a patient is off work under treatment, the more difficult it is for him to return to normal life and working conditions.

Secondly, lively splints by their nature offer movement, where reconstructive surgery can sometimes offer only stability. An example of this is when there is paralysis of biceps, and flexion of the elbow is required but the pectoralis major is paralysed or too weak to be usefully transplanted. In our opinion a bone block to the elbow is not so efficient functionally as the lively splint described in this paper. Although lively splints may be somewhat unwieldy, some patients prefer the flexibility offered to the fixation produced by bone blocks and arthrodesis.

Thirdly, it is not unknown for reconstructive surgery to turn out rather differently from what was originally intended. Apart from technical factors, the after-treatment and the patient’s full co-operation are equally important for the success of an operation. In one case
a lively splint added to the usefulness of reconstructive surgery. This patient had almost complete paralysis of the right arm. A bone block was performed to give him abduction of the thumb. The provision of an opponens splint enabled him to write more efficiently. It is sometimes difficult for patients to appreciate exactly what the results of reconstruction will be. We have found that a splint made to imitate the results of such an operation and worn for a period of two to three weeks will give the patient and the doctor a fairly exact idea of the likely end result. In two of our patients opponens splints were worn to imitate the action of a transplant, and as a result the patients decided on operation, which was successfully carried out.

Fourthly, the patient himself may be reluctant to accept such a radical measure as reconstruction. Six of the patients with severe paralysis were convinced that they would get further recovery despite the clinical and electrical evidence to the contrary. Many more patients were much happier to accept lively splintage at least for the time being because, as one patient put it, "one can always have one's joint fixed, but once it is done it is done for good."

Finally, the splints are easy to make, require only the simplest materials, and are cheap. The adjustable elbow splint, for example, costs about three shillings and the opponens splint only sixpence to make. There is undoubtedly a place for lively splintage during the recovery period or while nerve regeneration is awaited. The splints offer as near normal function as possible and thus help to lay down correct movement patterns. They can also provide means for the actual rehabilitation of muscle groups. The biceps spring provides resistance against which the weak triceps can work.

**DESCRIPTION OF SPLINTS**

During the last eighteen months splints have been made for twenty-six patients with various types of upper limb paralysis. All the splints have been made in the occupational therapy department with the simplest of materials and at small expense. Some of the splints to be described may be original, but most are modifications of conventional types that we have found to be helpful and sometimes essential in providing efficient function.

The conditions for which splints were provided fall into four groups: 1) disabilities involving elbow alone; 2) disabilities involving elbow, wrist and hand; 3) disabilities involving wrist and hand; 4) disabilities involving hand alone. The causative lesions were: brachial plexus lesions 4; poliomyelitis 8; peripheral nerve injuries—ulnar 4, median 3, radial 5; arthroplasty of elbow 2.

**SPLINTS FOR DISABILITIES INVOLVING THE ELBOW ALONE**

Nine patients had weakness or paralysis confined to the elbow. The splints to be described were also used for patients who had associated wrist or hand weakness, but these will be discussed in a later section.

In two patients, one with arthroplasty of the elbow and one whose olecranon had been excised, the disability was severe weakness of the triceps. In these two patients the splint (Fig. 1) was eventually discarded when the triceps had regained control over the elbow. This splint was also used in two other patients with poliomyelitis who had weakness of both flexion and extension of the elbow. The primary aim was to assist them in function during retraining for their employment, but incidentally it also provided a convenient means of giving resistance to the weak triceps for its rehabilitation.

During treatment it is often necessary to support the arm in a sling. A sling has been devised which provides complete support for the shoulder but avoids putting extra weight on the cervical region (Fig. 2).

When triceps weakness or paralysis is permanent in the presence of normal flexion of the elbow, a different type of splint is required (Fig. 3). This was designed for a patient
with severe paralysis from poliomyelitis. Both legs were completely paralysed and the only useful movements in the arms were flexion of the elbows and a pincer movement of the right

![Elbow splint for weak triceps](image1)

**Fig. 1**

Elbow splint for weak triceps. The strength of the spring is graded according to the strength of the triceps, allowing the elbow to obtain full extension. As the spring requires maximal power to effect full extension, constant use is an efficient form of triceps re-education.

![Shoulder sling](image2)

**Fig. 2**

Shoulder sling. A piece of canvas 7 inches wide and 64 inches long has an envelope piece folded back, the length of which is from the elbow to the tip of the fingers. Into this is inserted a piece of curved aluminium alloy. At the other end are two buckles at either side of the hand piece, into which fit two straps from the shoulder piece. The sling is adjustable and is useful for control of oedema of the hand and forearm.

finger and thumb. The absence of triceps made it impossible for him to manipulate his wheel chair. The splint allowed good extension of the right elbow and enabled him to move his chair unaided.
Two patients with poliomyelitis suffered from complete paralysis of flexion of the elbow and weakness of triceps (grade 3 on Medical Research Council scale). The splint for these patients is similar to the one just described, except that the spring is attached to the anterior aspect of the bars and is in relation to the weight of the forearm and the power of the triceps (Fig. 4). The object of the splint is to bring the elbow into mid-flexion, and it enabled one of the patients confined to a wheel chair to move his chair unaided. The splint also offers resistance to the weak triceps, thereby aiding its rehabilitation.

A patient with a lesion of the brachial plexus involving C.5–6 had paralysis of abduction of the arm and flexion and supination of the elbow. A programme of reconstructive surgery was refused. A splint was made to provide supination and flexion of the elbow. The splint
was worn inside the jacket and the springs outside. It was constructed with the patient's job as telephone operator in mind and allowed him to hold the earpiece in his left hand (Fig. 5).

(A new type of spring that can be worn inside the jacket will be described later.)

A patient with a total brachial plexus palsy underwent extensive reconstructive surgery, including arthrodesis of the shoulder and wrist, bone blocks to the elbow and thumb, and tenodesis of the fingers. Unfortunately the bone block at the elbow was absorbed and the elbow again dropped into full extension. From the point of view of his work it was important that he should have some means of holding his elbow flexed. A splint was made to allow the patient to fix his elbow in any position desired (Fig. 6).
Fig. 7
Adjustable elbow splint with lively wrist extension. The extension consists of two bars with a hinge at the wrist. A transverse padded bar just proximal to the metacarpal heads supports the hand. The strength of the spring is graded according to the strength of the wrist flexors.

Fig. 8
Adaption to splint to prevent shoulder subluxation. The adaption consists of a padded kidney-shaped piece of hide to which is added two straps. These straps fix on to buckles on the upper part of the elbow splint on the medial side, one in front and one behind. A supporting fabric strap passes round the chest from the back of the shoulder piece underneath the opposite arm.
SPLINTS FOR DISABILITIES INVOLVING ELBOW, WRIST AND HAND

Four patients had paralysis of the muscles controlling the elbow, the wrist, and extension of the metacarpophalangeal joints. Flexion of the fingers and intrinsic action of the thumb and fingers were powerful. The splints made for these patients included the elbow and wrist in one piece. The splint provided means of holding the elbow in any desired position and allowing the wrist to be brought into extension (Fig. 7).

Patients with severe paralysis of the shoulder muscles in addition to weakness of the elbow often show partial subluxation of the shoulder. This is not only painful but a serious drawback to function. To combat this a special adaption has been fitted to the elbow (Fig. 8). This successfully prevents subluxation and is virtually no extra weight to the splint. It also provides a counter pull at the elbow against the forearm weight.

DISABILITIES INVOLVING THE WRIST AND HAND

Five patients had paralysis of extensors of the wrist, fingers and thumb. In three cases the paralysis was caused by injury to the radial nerve; all recovered fully. One was due to a gunshot injury of the brachial plexus which showed no recovery. The other was due to a posterior interosseous palsy caused by a blow with a hockey ball. The splint used in these patients is illustrated in Figure 9.
FIG. 11
Opponens splint. A piece of flexible rubber is moulded to enclose the proximal phalanx and to lie across the thenar eminence in the line of action of the opponens muscle; this is attached to a cuff encircling the wrist. A strip of stiff hide approximately \(\frac{1}{2}\) inch wide, attached to the rubber, lies across the metacarpo-phalangeal joint. If full stability is not obtained by this means, a narrow strip of metal is used instead of the hide.

FIG. 12
Thumb stabilising splint. The splint consists of a moulded leather piece on the extensor aspect of the metacarpo-phalangeal joint and the metacarpal, encroaching slightly on the palmar aspect of the thumb and completely encircling the proximal phalanx. A moulded piece of Perspex is fitted over the extensor aspect of the metacarpo-phalangeal joint and the first metacarpal to give stability for writing.
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DISABILITIES INVOLVING THE HAND ALONE

Ulnar nerve lesions—Lively splints have been made for five patients with ulnar nerve lesions. This splint prevents deformity at the metacarpophalangeal joints and allows full function of the hand, which is not permitted by the "knuckleduster" type of splint. This splint is

![Image of a hand wearing a splint](image_url)

**FIG. 13**

Splint to control subluxation of the carpo-metacarpal joint of the thumb. This splint is like that shown in Figure 12, but the moulded piece of Perspex is stitched to the leather piece with a slight upward pressure over the extensor aspect of the carpo-metacarpal joint, encroaching slightly on its palmar aspect.

![Image of a hand wearing a splint with rings](image_url)

**FIG. 14**

Interim splint for paralysed finger flexors. Plastic rings are fitted over each phalanx, the terminal ring covering the nail but leaving the pad of the finger free. Each ring has a tiny horizontal metal bar incorporated on the palmar surface. The thumb is fitted with an opponens splint incorporated into the hand piece, and it has a terminal ring cap only. Nylon is attached to the terminal ring of each digit and passes under each bar and then through fine chain rings in front of the metacarpophalangeal joints and at the first wrist crease, to hook into springs attached five inches proximal to the wrist. Experience has proved that the terminal cap should extend a little farther over than is shown in the photograph.

useful during the stage when recovery of the nerve is awaited, but it can also be used as a permanent splint should recovery not occur. One patient using the splint for a permanent brachial plexus paralysis was able successfully to take a course in paint spraying. The splint is illustrated in Figure 10.

Weakness of the thenar muscles—Splints have been made for six patients with paralysis of opposition—three with median nerve lesions and three with poliomyelitis. The aim of the
The splint is to abduct, rotate and control the thumb at the metacarpo-phalangeal joint (Fig. 11). All six patients using this splint were able to write with the pen correctly gripped and suffered no restriction of thumb movement. In two patients weakness of the thenar muscles required a stabilising splint without the need for rotation. One of these patients had weakness of the flexor pollicis brevis from poliomyelitis and the splint used is illustrated in Figure 12. The other patient suffered from weakness of all the thenar muscles with recurrent subluxation of the carpo-metacarpal joint (Fig. 13).

Paralysis of all finger flexors—A patient with paralysis of all the finger flexors from poliomyelitis was fitted with the splint shown in Figure 14. The splint restored a reasonable grasp.

SUMMARY
1. The indications for the use of lively splints in upper limb paralysis instead of reconstructive surgery are discussed.
2. Examples of lively splints used for the elbow, wrist and hand are described and illustrated.

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REFERENCES