"Prevention is better than cure" is a maxim with particular application to Volkmann's contracture. But in spite of the advances which have been made in preventive measures in recent years—particularly since traumatic arterial spasm has become generally recognised as an important causative factor—one still meets the occasional case of fully developed contracture of the flexor muscles in the forearm and is faced with the problem of treating this most disabling condition.

**Criticism of present methods**—In most of the methods at present advocated the deformity is corrected by increasing the absolute or relative length of the contracted muscles, and little attention is given to the problem of restoring adequate voluntary power to the long flexor tendons of the fingers. Such methods, whether they consist of long and tedious stretching by special splints, of tendon-lengthening or muscle-slide operations, or of one of the forms of bone shortening, merely succeed in replacing what is virtually an overnight tenodesis by one of more suitable length. But, except in mild cases, a tenodesis it remains, because the massive necrosis of muscle fibres precludes the restoration of any useful range of active contraction in the affected muscles. Most patients, including those seen by the author, **appear** to regain some power of flexion in the fingers, but careful exclusion of trick movements by fixing the wrist and metacarpo-phalangeal joints may demonstrate that the movement is only apparent and not due to active contraction of the long flexor muscles. Although the finger flexion obtained by the trick movement may be useful, its range of movement is necessarily limited. Bunnell (1948) and others have suggested arthrodesis of the wrist in order to make the dorsiflexor tendons available for transplantation, but this eliminates the trick movement and none of the muscles made available has a range of movement sufficient to restore full movement to the fingers.

**Suggested method**—If the movement of active dorsiflexion of the wrist be restored and retained while one of the wrist dorsiflexors is used to reactivate the long flexor tendons of the fingers, the range of movement due to the transplant will be supplemented by an additional range contributed by the trick movement of dorsiflexion of the wrist, and the summation of the two effects might be expected to give an adequate total range. Phalen and Miller (1947) in America, treating cases of paralysis of the long flexors due either to nerve injury or to direct injury of the muscles, have transplanted extensor carpi radialis longus into the tendons of flexor profundus, and it seems that this type of transplant might be eminently suitable for many cases of established Volkmann's contracture.

**Selection of cases**—The most suitable type of case for this operation would be one in which: 1) there is moderate or severe contracture of the long flexor muscles; 2) there is little or no real voluntary power in the finger flexors after sufficient time for recovery; 3) the joints are mobile; 4) any coincident nerve lesion has recovered and the intrinsic muscles of the hand are active. Good voluntary power in all the dorsiflexors of the wrist is, of course, essential.

**Technique of operation**

*Division of contracted wrist flexors*—Flexor carpi radialis, palmaris longus and flexor carpi ulnaris are completely divided in order to allow dorsiflexion of the wrist. This can be carried out at a preliminary stage by subcutaneous tenotomy if desired, but care must be taken not to damage the median or ulnar nerves.
Division of all contracted finger flexors — The tendons of flexor digitorum sublimis are resected within the limits of the operation field and the tendons of flexor digitorum profundus are divided high enough above the wrist to avoid retraction of the distal stumps into the carpal tunnel when the fingers are extended. The tendon of flexor pollicis longus is also divided to allow extension of the thumb.

Transplantation of extensor carpi radialis longus into the distal stumps of the profundus tendons — The tendon of extensor carpi radialis longus is divided at its insertion, but a rather extensive exposure may be required in order to free the tendon from interconnecting bands between it and the short radial extensor of the wrist. The muscle with its tendon is rerouted in as straight a line as possible from its origin to the front of the wrist; here, proximal to the carpal tunnel, it is buttonholed through the four tendons of flexor digitorum profundus and fixed in the usual way. Correct tension is necessary to ensure that full advantage may be taken of wrist movement.

Very little post-operative re-education is needed because extensor carpi radialis longus is a synergist of the long flexors and naturally contracts simultaneously with extensor carpi radialis brevis when this is used to dorsiflex the wrist.
Treatment of Established Volkmann's Contracture by Tendon Transplantation

There was no voluntary power in the long flexor muscles.

Case 2—Figure 4, after operation, showing range of finger movement and ability to pinch between index and thumb.

Case reports

The rarity of the condition nowadays must be the excuse for publishing a method tried on so few as two cases. Among the records for the past twelve years at three of the large hospitals in Glasgow, only three cases of established Volkmann's contracture have been discovered, including these two. In the remaining case the carpus was excised some years ago with a disappointing result.

Case 1—Boy, aged seven years, with bilateral congenital radio-ulnar synostosis. An attempt to correct the deformity on the left side by a rotation osteotomy had caused a typical Volkmann's ischaemic contracture accompanied by ischaemic lesions of both median and ulnar nerves.

Clinical features—There was moderate contracture of all the long flexors of the fingers and thumb and also of the wrist flexors. Only a flicker of voluntary power remained in flexor sublimis and none at all in flexor profundus and flexor pollicis longus, but the patient was able to move the digits through a limited range by moving the wrist (Fig. 1). The ischaemic nerve lesions had almost completely recovered. Treatment was by the operation described. Result—The tendon transplant is rather tight in this case, so that the fingers cannot be fully extended (Fig. 2).

Case 2—Boy, aged six years. Sustained a supracondylar fracture of the left humerus, and later a typical Volkmann's contracture with ischaemic lesions of both median and ulnar nerves.

Clinical features—Nine months after the injury there was a severe contracture of all the long flexors.
of the fingers and thumb, and of the wrist flexors, but the pronators had escaped (Fig. 3). The nerve lesions had completely recovered. Treatment was by operation as described. Result—There is a full range of flexion of the fingers and an excellent grip (Fig. 4).

DISCUSSION

The advantages claimed for this method of treatment over those hitherto advocated are: 1) immediate correction of the severe deformity; 2) the maintenance of wrist movement and of the trick flexion movement; 3) the restoration of voluntary power to the long flexor tendons of the fingers; 4) the restoration of a good range of finger movement and of reasonably good function to the hand.

One obvious criticism of the method is that dorsiflexion of the wrist and consequently the trick movement are weakened by the loss of extensor carpi radialis longus, but it is felt that the gain in the range of finger movement more than outweighs the loss of power. The inclusion of flexor pollicis longus in the transplant was not deemed advisable, nor is it considered that lack of voluntary power in this tendon constitutes a material disability provided there is good active opposition of the thumb (Figs. 2 and 4). Certainly there does not, in these particular cases, appear to be any justification for doing an arthrodesis of the wrist in order to provide a muscle to actuate flexor pollicis longus, as such a procedure would considerably restrict the present range of finger movement.

SUMMARY

A method of treatment of Volkmann’s ischaemic contracture is described which retains wrist movement and restores reasonably good function to the hand in suitable cases.

REFERENCES
