THE SURGICAL TREATMENT OF EQUINOVARUS DEFORMITY IN ADULTS WITH SPASTICITY

B. A. ROPER, A. WILLIAMS, J. B. KING

From The London Hospital, London

Adults with deformities of the lower limb due to spasticity may be considerably improved by operation, but thorough pre-operative assessment as an inpatient is essential in order to pinpoint the disability. The commonest deformity is equinovarus which often responds to simple operative procedures. The results of seventy-seven operative procedures in fifty patients are recorded. Correction once achieved is stable and the deformity does not recur.

Patients with hemiplegia secondary to cerebrovascular accidents or to head injury frequently have an equinovarus deformity in the affected limb. This is due to imbalance between flexors and extensors. The deformity produces a disability varying from dragging of the toe, through instability of the ankle from weight-bearing on the head of the fifth metatarsal alone, to being chairbound because of the inability to put the foot to the ground.

A skilled physiotherapist can train some patients to overcome their disability. Others, in whom the spasticity is relatively mild, can control it with the help of orthoses. But there remain some patients in whom the spasticity is so severe that the deformity cannot be so controlled and still others who, if their spasticity were reduced, could dispense with appliances altogether. It is these last two groups for whom operation may be valuable.

MATERIALS AND METHODS
Between 1970 and 1975 sixty patients with lower limb spasticity were admitted to hospital so that their suitability for operative treatment could be assessed. A group twice as large were seen as outpatients but were considered unsuitable for inpatient review for one of the following reasons: adequate function and adaption to disability; good control by appliances; poor proprioception; poor ability to communicate and understand; or poor motivation.

Clinical examination
Pattern of motor activity. Flexor patterns of reflex activity were usually predominant, although mixed flexor and extensor patterns did occur. We found large individual variations in spasticity at different times in the same patient, usually associated with his mental state; apprehension, for example, exaggerated spasticity. For this reason the assessments were repeated at intervals over several days. Often an apparent arm and leg pattern became leg only as the patient became used to his surroundings. It was in this group with reflex patterns of motor activity that the biggest reduction in spasticity in the upper limb after operations on the lower limb was observed.

Range of movement. The active and passive range of movement of all joints of the spastic limbs were measured with the patient standing, sitting, lying and walking.

Muscle strength. Initially this was assessed using the Medical Research Council scale, but the results varied so much in the same patient at different times that the method was abandoned. Instead, an overall estimate was made as to whether muscle activity was under voluntary control and strong enough to be useful, under voluntary control but too weak for useful action, reflex and useful, or reflex but useless.

Sensation and proprioception. Conventional methods were used for this assessment.

Comprehension and communication. Standard psychological techniques were used.

Gait analysis
This was undertaken in several different ways and, even more important, on a number of separate occasions for each patient. The methods used were:

Conventional visual assessment. While the patient used his normal aids (sticks, calipers, etc.) his gait was recorded in detail.

Assessment without aids. This was often very revealing. Sometimes it showed the effectiveness of an apparently minor aid, without which the patient became quite severely disabled. The removal of spring-loaded appliances often improved function, since springs potentiated spasticity.

Assessment with additional aids. The addition of a static aid such as a plaster or polypropylene below-knee brace sometimes had a dramatic effect.
The biggest problem has been to find a way of reporting the gait and spasticity in such a way that changes can be recorded. We have used and are still using a combination of videotape, ciné film, pressure-sensitive foot printing and photographs. We accept that all methods of assessment remain crude and subjective.

**Nerve blocking**

This is a simple technique in which a local anaesthetic is infiltrated around the nerve supplying the spastic muscle group. Such blocks have been performed on the median, ulnar, popliteal, lateral popliteal, obturator and femoral nerves. Their purposes are, first, to eliminate spasticity temporarily in one group of muscles, so as to allow assessment of function in another. This has been most commonly done in the median and ulnar nerves in order to assess wrist and finger extension. It is also useful to block the popliteal nerve between the two heads of gastrocnemius in order to evaluate dorsiflexion of the foot. The second purpose is to distinguish between spasticity and contracture. Despite physical methods of therapy designed to relax spasm, it often remains impossible to be sure whether a deformity is due to spasticity or to contracture until the spastic group is eliminated by nerve blocking. Thirdly, they are to evaluate the functional results likely after operation; and lastly, to estimate the factors responsible for pathological function. In certain situations spasticity in two muscle groups together may produce a disabling deformity, not associated with the normal activity of either group alone. Nerve blocks may be used to delineate which group is producing the deformity. For example, medial rotation of the lower limb may be seen in spasticity of the knee extensors and adductors. Blocking one or the other reveals which is responsible for the deformity (usually the adductors).

**OPERATIVE TREATMENT**

After thorough inpatient assessment it was considered that fifty patients would be helped by operation. Seventy-seven procedures were carried out on these fifty patients.

In four patients obturator neurectomy was performed, in six, adductor tenotomy, in five hamstring release and in four patients an electric stimulator (called a Neuromuscular Assist Device) was inserted capable of giving a pulsed signal to a particular nerve to initiate motor action at the appropriate part of the normal cycle of activity. These patients form part of an on-going series and will be reported elsewhere.

Fifty-eight procedures were directed to the correction of equinovarus deformity: thirteen for toe flexor release; eight for tibialis posterior release; fourteen for elongation of tendo calcaneus; and twenty-three for elongation of tendo calcaneus and transfer of the split tibialis anterior tendon. Whenever one of the first two was performed it was combined with one of the last two.

Equinovarus deformity of the foot in the swing and stance phase results from the combined influence of contracture or spasticity (or both) in two muscle groups: the first group is the gastrocnemius and soleus; the second is the toe flexors and the tibialis anterior and posterior muscles. Tibialis anterior is usually overactive and unopposed in the reflex flexor pattern of the swing phase and continues its influence in the extensor pattern of the stance phase by holding the foot in unbalanced inversion. Clearing the foot in the swing phase depends on and influences the activity of the whole leg and is not achieved simply by increased dorsiflexion of the foot. When a balanced position for foot strike is achieved, the abnormal extensor pattern is diminished and there is better control of the hip and knee.

**Surgical procedures**

_Toe flexor release._ Toe flexor spasticity as a significant contributor to disability was only occasionally found at the original examination. More often it revealed itself after some other procedure had reduced spasticity in the ankle and hindfoot.

Simple elongation by division of the flexor tendons, or a flexor-to-extensor (Girdlestone) transfer was performed. Recurrence after simple division was common and, in those patients in whom the deformity can be passively corrected, we now prefer the tendon transfer. **Tibialis posterior division.** This was performed in those patients in whom, during the swing phase of gait, the hindfoot was dragged into more varus than would have been expected from activity of tibialis anterior alone. **Elongation of the tendo calcaneus.** This was performed either by formal Z-plasty, or, more usually, by a triple-cut percutaneous tenotomy.

The procedure was used on its own in patients whose attempts at dorsiflexion lifted the foot in neutral position when the knee was flexed, even if the foot dorsiflexed into varus when the knee was extended. These patients were treated in a below-knee walking cast for three weeks, and then by a polypropylene below-knee brace during the process of re-education of the gait pattern. At three months these aids were discarded.

**Split tibialis anterior tendon transfer.** The insertion of tibialis anterior into the medial cuneiform is identified and the lateral half elevated from the bone. The split in the tendon is developed proximally to just above the extensor retinaculum, where a second skin incision is made. The split portion of the tendon is withdrawn, then threaded subcutaneously to the intermediate cuneiform opposite the cleft between the third and fourth toes; there it is threaded through a bony tunnel and sutured back to itself as tightly as possible (Mooney and Goodman 1969). The operation is always combined with elongation of the tendo calcaneus. A below-knee walking cast is worn for six weeks and a polypropylene below-knee brace is used day and night for a further three months.

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In a certain number of patients with severe spasticity uncontrollable by an appliance and with disturbed proprioception, tibialis anterior transfer and tendo calcaneus elongation were performed and an infinitely adjustable fixed below-knee brace was worn permanently; this combination was used if reflex dorsiflexion (initiated by flexing the hip and knee) could not be instituted after operation, or where there was gross instability of the knee.

Whatever the procedure the patients remained in bed for only two days after the operation; they were then got up taking full weight in a plaster cast. Rehabilitation continued throughout.

RESULTS
Because of the difficulties of analysing and recording gait, we have assessed our results by a simple method which provides an objective guide to function: namely, to what extent does the patient need splints or walking aids. The ages of the patients range from eighteen to seventy-two with an average age of forty-three years.

Two patients previously chairbound have become mobile with walking aids, six patients have been able to give up their walking aids, and twelve patients have been able to give up all forms of bracing and aids altogether. Ten of the fifteen with conventional appliances have been able to discard them: two patients were able to exchange them for cosmetically acceptable simple polypropylene splints. The two patients originally in polypropylene splints no longer required them.

The one flexion deformity of the knee was completely corrected and five of seven patients with loss of voluntary knee flexion regained it. All five cases of hyperextension were corrected.

Thirty-three patients had a fixed plantarflexion deformity of the ankle ranging from 30 to 60 degrees with the knee extended, and from 10 to 50 degrees with the knee flexed. After operation there was no fixed plantarflexion and an average range of active dorsiflexion of 10 degrees.

There was no mortality or major complication, despite the fact that most patients had one or all of the following medical conditions: hypertension, diabetes, ischaemic heart disease and respiratory problems.

In none of the patients followed up has there been a recurrence of deformity.

OTHER OBSERVATIONS
Within the assessment group of patients there were twice as many left-sided as right-sided hemiplegics with severe equinovarus deformity, despite near parity in the total number of right and left hemiplegias. This discrepancy was not caused by more severe spasticity in left hemiplegia but was apparently due to less effective proprioception than on the right. The left-sided hemiplegics took much longer than the right to re-learn their walking patterns after operation, but the end-result in both groups was the same.

All patients noticed subjective relaxation of the spasticity in the upper limb with improved function of the hand in some cases. This was difficult to measure objectively, but in some cases a previously flexed adducted upper limb would now hang by the side during walking, something which, despite intensive physiotherapy, had been impossible before operation.

DISCUSSION
With muscle imbalance resulting from cerebral palsy, spinal injuries, head injuries, and cerebrovascular accidents, physiotherapy remains the mainstay of treatment. We must accept, however, that in many cases the end-result of even the best physiotherapy is unsatisfactory: a large proportion of the patients require walking aids and bracing to achieve even minimal independence.

We have shown that in some of these unsatisfactory patients operation may produce considerable improvement in independence from previously required aids.

We emphasise that the operations described are not applicable to all patients. Many patients originally referred to us were rejected because severe intellectual impairment would have made co-operation in rehabilitation impossible. Others were rejected because of problems of communication or of sensation. Even after this process of elimination, it was found, after inpatient assessment, that a further 17 per cent were unsuitable for operation for reasons previously mentioned.

We believe that a period of inpatient assessment is essential before embarking upon surgical treatment. This should include evaluation using all the methods described above, and no operation should be undertaken unless a specific disability has been pinpointed. The surgeon must know whether he is dealing with contracture or spasticity, and be sure that muscles are capable of functioning if the opposing spastic group is weakened.

Operations should be directed to correcting the specific disability by the simplest means possible. The patient must be aware of what is expected of him in his subsequent rehabilitation, and be capable of using any improvement in function.

We feel that the most disabling problem in this group of patients was equinovarus deformity of the foot; in most cases simple tendon-lengthening procedures associated with one simple tendon transfer resulted in significant improvement.

REFERENCE