

AN INVESTIGATION INTO
PARALYSIS PATTERNS IN THE FOREARM
AND HAND IN LEPROSY

RUTH E. THOMAS, S.R.N., M.C.S.P.

It is well known that in neural leprosy the hands frequently develop some degree of paralysis, often resulting in the deformity known as claw-hand. The purpose of this investigation was to see if by the use of physiotherapy or surgery this paralysis could be prevented or overcome, and so it became important to know how the paralysis usually progressed, and whether recovery could take place.

Paralysis in leprosy appears to be haphazard in some respects. It may be completely asymmetrical, and it may show periods of rapid progress and of complete arrest, which seem to bear no relation to the activity of the disease. But in one important respect the paralysis appears to conform to a certain pattern—it affects only certain nerves, and these nerves only at certain anatomical levels. The muscles of the forearm and hand may be considered in the following pattern:—

Muscles supplied by the ulnar nerve.

Muscles below the wrist supplied by the median nerve.

Muscles in the forearm supplied by the median nerve.

Muscles supplied by the posterior interosseous nerve.

It is well-known that there is a swelling of the ulnar nerve above the elbow in many cases of leprosy, and that swellings occur in other nerves as well. Mr. P. W. Brand has investigated these swellings at a series of autopsies and at operations, and has been able to show that the swellings in the nerves of the limbs occur in regular anatomical positions and that they are closely associated with the paralysis in the limbs. In the ulnar nerve the swelling begins at the olecranon groove and extends up the arm for 3 inches or more; in the median nerve the swelling begins at the wrist and extends for about 3 inches up the nerve. In the leg similar swellings are found in the lateral popliteal nerve proximal to the neck of the fibula and also in the tibial nerve proximal to the ankle. Swelling in the radial nerve is not so well defined.

Clinically it has been observed that muscles supplied by branches of the ulnar and median nerves given off below the specified swellings atrophy, and become paralyzed. It seemed, therefore, that the muscles commonly affected in neural involvement of leprosy were those supplied by the ulnar nerve, and the intrinsic muscles in the hand supplied by the median nerve. The flexor muscles in the forearm supplied by the median nerve, and the

extensor muscles in the forearm supplied by the posterior interosseous nerve did not usually appear to be affected.

To verify this clinical observation it was decided to test the following muscles electrically:—

- | | |
|--|--|
| <p>(a) Ulnar nerve:—
 Flexor carpi ulnaris
 1st—4th dorsal interossei
 3rd and 4th lumbricals
 Abductor minimi digiti
 Opponens minimi digiti</p> | <p>(b) Median nerve:—
 Flexor carpi radialis
 Palmaris longus
 Flexor sublimis digitorum
 Flexor longus pollicis
 1st and 2nd lumbricals
 Abductor pollicis brevis
 Opponens pollicis</p> |
| <p>(c) Posterior Interosseous Nerve:—
 Abductor pollicis longus
 Extensor indices
 Extensor carpi ulnaris.</p> | |

In twenty patients—some very early cases, some with a fair degree of paralysis, and some with gross paralysis of all the muscles of the forearm and hand—the muscles of the upper arm (deltoid, triceps, and biceps brachialis) were tested. In every case all these muscles were normal, and these muscles were therefore not included in the detailed survey.

Some muscles it has not been possible to test, as they lie too deep to be affected by electrical stimulation through the skin, e.g. flexor profundus digitorum and palmar interossei. The three extensor muscles selected were chosen because Dr. Brand thought they might be useful for tendon transplantation operations and wanted to know whether or not they usually remain normal. In a few cases a test of all the extensor muscles of the forearm was required, and these occasional tests showed that all these muscles usually gave about the same type of response. That is, if one was normal generally all were normal; and if in an advanced case one muscle showed signs of denervation all the muscles usually showed a similar degree of denervation. Posterior interosseous paralysis is rare in leprosy, and no early cases have come our way, so there has been no opportunity to discover in what order the extensor muscles of the forearm become denervated.

In the course of this investigation it has been possible to find out which of the muscles selected generally remain normal and which ones usually deteriorate, and of the muscles which showed deterioration it has been possible to discover whether the denervation is slight, rather marked, or very gross.

For the purpose of electrical diagnosis of muscle denervation a Ritchie-Sneath stimulator was used. This machine has been designed to provide the forms of current required—faradic and galvanic currents—for electro-diagnosis of nerve and muscle lesions. If any suitable tissue, either nerve or muscle, is stimulated by

electrical impulses of known duration and voltage, it will be found that the voltage required for a minimum muscle response increases as the impulse duration is decreased.

These pulse volts are registered on a galvanometer, and are plotted on a graph against the various pulse lengths, and are joined to form a curve. The resultant strength duration curve is found to give a useful measure of the excitability of the tissue being tested. In this way it can be ascertained whether or not a certain muscle is normal, and if it is abnormal it is possible to tell whether the denervation is slight or gross.

When a muscle responds to galvanism only it means that there is "complete reaction of denervation," and when this is shown, one of two things may follow:

(a) "Partial Reaction of Denervation" may take place, when the muscle may gradually improve until it responds to faradism, and perhaps recover completely;

OR

(b) The muscle may continue to regress until "absolute reaction of degeneration" has taken place, when there will be no response of the muscle to either galvanism or faradism, and then we have only exceptionally seen recovery in the muscle. But in some hands where the intrinsic muscles have shown absolute reaction of degeneration when being tested through the skin, yet at open operation there has been a definite response when these same muscles were stimulated directly. In two cases, after a period of no reaction to galvanic stimulation, improvement has been observed in some of these muscles, and this improvement has gradually increased till (at the time of writing) there is partial reaction of denervation. In one case the flexors sublimis digitorum and longus pollicis of one hand have improved to a marked degree, but so far the other muscles give little or no response to electrical stimulation.

Every time a test was done on a patient, it was completed at one sitting because of the possibility of changes in muscle power over a period of time. Fifty patients with leprosy were tested. These patients were selected from a larger group who were attending a hand clinic, and therefore they do not represent anything like a cross-section of all patients suffering from leprosy because, of course, a large number of leprosy patients do not have any paralysis at all, and another large number have minimal paralysis which does not bother them and they therefore will not attend a hand clinic. These figures therefore represent patients with a significant or severe degree of paralysis. Furthermore, some further selection has been made so as deliberately to include in this series a few patients who had exceptionally severe paralysis and a few who

had typical mild paralysis. No selection has been exercised, however, in choosing patients with regard to the type of distribution of the paralysis. Initial tests gave the following results:—

<i>Muscle</i>	<i>Normal</i>	<i>Weaker than Normal</i>	<i>Gross Denervation</i>
(a) Ulnar Nerve			
Flexor carpi ulnaris	33%	26%	41%
Dorsal interossei:—1st	40%	3%	57%
2nd	37%	4%	59%
3rd	34%	3%	63%
4th	32%	5%	63%
Lumbricals ... 3rd	31%	5%	64%
4th	30%	6%	64%
Opponens minimi digiti	27%	5%	68%
Abductor minimi digiti	23%	8%	69%
(b) Median Nerve			
(1) In the hand:			
Abductor pollicis brevis	41%	5%	54%
Opponens pollicis	63%	1%	36%
Lumbricals ... 1st	44%	5%	51%
2nd	44%	6%	50%
(2) In the forearm:			
Flexor longus pollicis	70%	27%	3%
Flexor sublimis digitorum	76%	21%	3%
Palmaris longus	92%	5% (absent)	3%
Flexor carpi radialis	97%	—	3%
(c) Posterior Interosseous Nerve			
Abductor pollicis longus	79%	16%	5%
Extensor indices	81%	14%	5%
Extensor carpi ulnaris	79%	16%	5%

This table shows in a very striking fashion the uniformity of the paralysis in the upper limb, all the muscles supplied by one main peripheral nerve being paralyzed with about equal frequency, while muscles supplied by another main peripheral nerve, or by the same main nerve at a different anatomical level are either not paralyzed at all or are paralyzed more slightly or only in a more advanced stage of the disease.

It appears then that the muscles usually affected are those supplied by the ulnar nerve; and the intrinsic muscles in the hand supplied by the median nerve. The forearm muscles supplied by the median nerve usually escape paralysis, but in the one or two cases seen, where there is denervation in these muscles supplied by the median nerve there may also be denervation in the muscles supplied by the posterior interosseous nerve.

FOLLOW-UP ASSESSMENTS :

The aim in doing these tests was to find out if early cases of neural involvement in leprosy always continued to show gradual denervation of the muscle, or if improvement sometimes occurred. A certain number of early cases were selected and they were tested at intervals of 6-8 weeks. In this series the process of muscle degeneration was found to be more common than that of muscle

regeneration. From these tests it has been observed that of the muscles supplied by the ulnar nerve in the hand, abductor minimi digiti appears to be the first to commence denervation, but it also seems to be the last to show absolute reaction of degeneration. Similarly, of the muscles supplied by the median nerve in the hand, abductor pollicis brevis appears to be the first to commence denervation, but seems to be the last to show absolute reaction of degeneration. But this limited number of follow-up tests is not sufficient on which to base any definite conclusions.

In following up our cases at frequent intervals we have observed that in leprosy the normal course of paralysis is not a steady downward trend. There may be a period of improvement and then one of regression, or there may be a period of regression and then one of improvement followed again by another period of regression, or there may be a period of regression followed by one of improvement, etc. Often there are long periods when the paralysis is completely stationary. For example, in one patient who had had tendon transplantation operations to the four fingers and thumb of his right hand, for over a year this was a good functioning hand. Then for three weeks the patient complained of nerve pains in the forearm, but movements of the wrist and fingers were not hampered in any way. The patient woke up one morning to find that he was unable to use the extensor muscles of the forearm. Electrical tests showed that all these muscles were completely paralysed.

It is important to find out the cause of these improvements and regressions. Part of the work at the Vellore clinic will be to continue to observe these improvements and regressions, and to try and find out the factors initiating them.

SUMMARY.

The paralysis pattern in the forearm and hand demonstrated in 50 cases of leprosy with neural involvement shows a certain uniformity, in that the muscles supplied by one nerve are usually all paralysed at the same time and to about the same degree:

Muscles supplied by the ulnar nerve in the forearm and hand	All paralysed early.
Muscles below the wrist supplied by the median nerve	Also early paralysis.
Muscles in the forearm supplied by the median nerve	Paralysed rarely or slightly.
Muscles in the forearm supplied by the posterior interosseous nerve	Paralysed rarely or slightly, but an occasional total complete paralysis has been observed.

The progress of paralysis is often not continuous, but may show periods of improvement and regression. The causes of the latter demand further study.