ISCHAEMIC AND POST-ISCHAEMIC PARAESTHESIAE IN MOTOR NEURONE DISEASE

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In a recent study of ischaemic and post-ischaemic paraesthesiae in the upper limb (Poole, 1956a) it was noted that the responses in subjects with advanced motor neurone disease differed from those in normal subjects. This observation seemed relevant to the study both of motor neurone disease itself, and of factors which determine the production of paraesthesiae in normal and other diseased states, *e.g.*, polyneuritis (Poole, 1956b). This report is to amplify the original observations and to draw attention to a simple clinical investigation from which useful information may accrue. For a general description of ischaemic and post-ischaemic paraesthesiae reference may be made to previous studies in this field (Lewis, Pickering, and Rothschild, 1931; Zotterman, 1933; Kugelberg, 1944; Weddell and Sinclair, 1947; Merrington and Nathan, 1949). The abbreviations employed here are I.P. for ischaemic paraesthesiae and P.I.P. for the pricking and tingling elements of post-ischaemic paraesthesiae.

Method and Material

Paraesthesiae were produced in the upper limb by circulatory occlusion with a sphygmomanometer cuff applied above the elbow. The tests were performed and assessed as detailed in a previous report (Poole, 1956a). The duration of occlusion varied from nine to 21 minutes, 10 minutes being adopted as a standard minimum except in the cases first studied. In some instances the post-ischaemic muscle twitching induced in the intrinsic hand muscles was also assessed, as described previously (Poole, 1956a).

Six patients with motor neurone disease were examined, four on one occasion each and two on several occasions over some months. Three cases were very advanced with gross wasting and weakness of limb muscles; the remainder were less severely affected and retained some useful limb movement. To contrast with these results tests were performed on patients with other conditions causing severe wasting: in three cases convalescent from acute anterior poliomyelitis (without residual respiratory difficulties) and in two cases of muscular dystrophy. Such subjects were not precisely similar to those with motor neurone disease in age and wasting.

Tests were also performed in one case each of syringomyelia, Charcot-Marie-Tooth disease, disseminated sclerosis, and carcinomatous neuropathy, all with severe wasting; but since these had (with the exception of the carcinomatous neuropathy) distinct sensory deficits these results were not strictly comparable with other cases and have only been noted.

Muscle power and wasting were assessed clinically. The results for the upper arm, forearm, and hand groups have been expressed crudely in the Table using the M.R.C. grading for muscle power (0, no contraction; 1, flicker or trace of contraction; 2, active movement with gravity eliminated; 3, active movement against gravity; 4, active movement against gravity and resistance; 5, normal power). Flexor and extensor groups have not been detailed separately because there were no gross differences.

Results

Data concerning the age, duration of symptoms, muscle power, and ischaemic test results are given for each subject in the Table. The results for one limb only are listed since, with one partial exception, symmetrical responses were obtained in the five cases of motor neurone disease tested bilaterally. In all, 36 tests were performed, but since these showed consistent results no more than two have been given for any limb.

It is apparent that all subjects with motor neurone disease lacked ischaemic paraesthesiae. The youngest (Case 1) perceived faint sensations on the opposite limb in some tests, especially the earlier ones, but these were more feeble and uncertain than in comparable normal subjects. Post-ischaemic pricking and tingling were lacking after occlusions of at least 10 minutes' duration in the three most severe longstanding cases (Nos. 1, 3, 4), and with more prolonged occlusions only feeble responses were provoked. In the other three cases (Nos. 3, 5, 6) distinct P.I.P. were perceived after 10 or 11-minute tests, but in one (Case 6) were referred to only two fingers.

In contrast all the subjects with anterior poliomyelitis or muscular dystrophy experienced prominent I.P. and P.I.P. with occlusions of 10 minutes

TABLE

ISCHAEMIC AND POST-ISCHAEMIC PARAESTHESIAE IN UPPER LIMBS OF SUBJECTS WITH MOTOR NEURONE DISEASE, ANTERIOR POLIOMYELITIS (CONVALESCENT), OR MUSCULAR DYSTROPHY

No.	Age (yr.)	Duration of Symptoms (yr.)	Muscle Power (M.R.C. Grading)			Duration of Occlusion (min.)	Ischaemic Paraesthesiae	Post-ischaemic Paraesthesiae	
			Upper arm	Forearm	Hand		Intensity	Intensity	Duration (min.)
<i>Motor Neurone Disease</i>									
1	25	3.7	1	2	1	10	0	0	0
2	50	3.8	1	2	1	18	0	+	3.1
		0.9	1	3	2	20	0	0	0
3	51	1.9	1	3	2	11	0	0	0
		0.5	4	4	3	10	0	++	3.2
4	55	2	2	3	3	10	0	0	0
5	54	0.7	4	4	4	11	0	++	3
6	68	0.5	3	4	3	10	0	+	1.6
<i>Anterior Poliomyelitis</i>									
7	20	0.8	3	4	5	10	++	+++	5.8
8	30	0.5	3	4	3	10	++	++	3.5
9	33	0.8	2	4	4	9	+++	+++	4.5
<i>Muscular Dystrophy</i>									
10	39	—	4	4	3	10	++	++	5.7
11	48	—	3	4	4	10	++	++	6.1

or less. Subjects with syringomyelia, Charcot-Marie-Tooth disease, disseminated sclerosis, or carcinomatous neuropathy, however, lacked I.P. and P.I.P. in such tests, though the subject with Charcot-Marie-Tooth disease had atypical I.P. on one side.

In comparing these results and contrasting them with those elicited from normal subjects both age and duration of ischaemia must be borne in mind, since paraesthesiae responses decrease with ageing (Poole, 1956a) and the duration of ischaemia determines the ensuing post-ischaemic pricking and tingling. In 93 normal subjects examined by a standard 10-minute test in a previous study (Poole, 1956a), no subject under 35 lacked clear I.P., but over the age of 60 years 58% lacked post-ischaemic paraesthesiae. The uniform absence of I.P. in the above cases of motor neurone disease forms a significant contrast with this ($P < 0.01$). In the same study P.I.P. were lacking in only 4.3% of the subjects, all over 64 years in age. The motor neurone disease results again form a significant contrast ($P < 0.01$). It is noteworthy that even in the three cases perceiving P.I.P. after 10- or 11-minute occlusions their duration fell towards the lower limits found in normals. These results can broadly be compared with other paraesthesiae studies (Gilliat and Wilson, 1953; Sinclair and Hinshaw, 1951; Marshall, Poole, and Reynard, 1954; Kugelberg, 1944) and a similar contrast found.

Observations on post-ischaemic muscle twitching in the intrinsic hand muscles were made in five subjects with motor neurone disease and in no instance was visible twitching clearly provoked, despite occlusions of 15 to 20 minutes' duration in three cases. In contrast, in four of the subjects with poliomyelitis or dystrophy muscle twitching

was evident after 10 minutes' occlusions. The differences in age and in degree of muscle atrophy made interpretation difficult, but the motor neurone disease responses also formed a contrast with experiences in normal subjects (Poole, 1956a; Kugelberg, 1944), and this result was in keeping with other studies (Poole, 1956a and b) where post-ischaemic muscle twitching was lacking when paraesthesiae were absent.

Discussion

These results suggest that motor neurone disease is associated with a reduction in the iterative responses provoked by ischaemia. As in ageing and polyneuritis (Poole, 1956a and b) both I.P. and P.I.P. are affected (and possibly post-ischaemic muscle twitching), but I.P. are more frequently totally lacking than "10-minute" post-ischaemic pricking and tingling. Further observations, including comparable serial tests from the earliest stage of the disease, are desirable to confirm this change and to investigate its clinical value. Parallel electrophysiological studies of fibre characteristics and responses to ischaemia would be relevant.

Depression of paraesthesiae responses must be due either to impairment of the mechanisms activating nerve fibres during and following ischaemia, or to functional changes in sensory innervation, assuming of course the competency of the witness. Since factors determining paraesthesiae normally are ill understood, many aspects have to be considered. General factors such as nutritional deficiency or respiratory embarrassment do not provide a satisfactory explanation in view of the dietary intake and clinical state of the patients. Local mechanical factors at the compression site influencing the deformation of the nerve trunks

have been claimed of importance in the production of ischaemic paraesthesiae (Weddell and Sinclair, 1947). The normality of the responses in the poliomyelitis and dystrophy cases indicates that an alteration in local mechanical factors is unimportant; and moreover such an explanation would not account for the depressed post-ischaemic pricking and tingling. Lowered temperature of nerve trunks relatively exposed by wasting might provide a simple explanation, though the effects of cooling on paraesthesiae are complex (Poole, 1956a). Care was taken to ensure that the limbs were warm before examination, and tests performed in Case 1 when warm and cold showed if anything more definite responses in the cold. The responses in subjects without motor neurone disease did not favour a "cooling" explanation. Moreover, detailed study of the ischaemic degradation of vibration perception in Case 1 did not reveal the delay which might be expected at reduced temperatures.

Structural changes in muscle and nerve following motor neurone degeneration might disturb the mechanisms which are possibly responsible for activating nerve fibres in the production of paraesthesiae. Thus changes in the liberation and spread of products from ischaemic muscle (*e.g.*, K ions) might be relevant, as also changes in the neural content and fibrosis of nerve trunks. Merrington and Nathan (1949) suggested that the discharges responsible for P.I.P. were dependent on some property of a large nerve as such. The normality of the responses in the poliomyelitis and dystrophy cases does not favour any such simple structural explanation, though these cases were not as severely affected as those with motor neurone disease. Anatomical studies (Sunderland and Bedbrook, 1949) indicate that even if all the motor fibres degenerated in the ulnar nerve the calibre change

could scarcely be extreme. Finally the possibility of a change in the sensory innervation itself should not be overlooked. The similarity between the present results and those in polyneuritis and ageing merits consideration in any satisfying explanation.

Summary

Ischaemic and post-ischaemic paraesthesiae responses have been studied in the upper limbs of six subjects with motor neurone disease, and five subjects with muscle wasting from anterior poliomyelitis or muscular dystrophy.

In subjects with motor neurone disease the paraesthesiae responses were less than in subjects either normal or with wasting from poliomyelitis or dystrophy.

The origin and significance of these differences remains obscure; possible sources of explanation are noted.

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