The flexor carpi radialis H-reflex in lesions of the sixth and seventh cervical nerve roots

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SUMMARY In 143 normal subjects latencies of H-reflexes of the flexor carpi radialis muscle were well correlated with arm lengths. In 32 patients with injury to cervical roots C5 to C8 it was shown that latencies were only abnormal in lesions of roots C6 or C7. It is suggested that in most instances root C6 or C7 and, probably both roots in some cases are involved in the reflex pathway. Repeat electrophysiological examinations after surgery provided valuable data about the various types of nerve root recovery.

Although the H-reflex of the flexor carpi radialis muscle is easily obtainable its diagnostic value has so far been scantily evaluated.¹⁻³ The cervical nerve root involved in this reflex is unclear.

In a previous study on changes in the flexor carpi radialis H-reflex in radiation-induced brachial plexus lesions, parameters have been determined for latency and conduction velocity.³ In this report normal latencies of the H-reflex were correlated with arm lengths. In addition, H-reflexes in patients with compression of a single cervical root shown by myelography were studied in order to gain information regarding H-reflex changes in such lesions and to evaluate the nerve root involved in the reflex pathway.

Methods and materials

Flexor carpi radialis EMG and H-reflexes in both arms were performed by needle electrodes in both controls and patients. The method used to investigate the flexor carpi radialis H-reflex has been described previously.³ The median nerve in the cubital fossa was stimulated using a bipolar surface electrode with the cathode proximal. The stimulus frequency was one per five seconds, and the pulse duration 0.5 ms. The voltage was increased until a maximal H-reflex amplitude was obtained. After that supramaximal shocks were delivered to produce the maximal direct muscle (M) response. The H-reflex latency (H-RL) was measured at the beginning of the maximal H-reflex and the interlatency time (ILT) calculated by subtracting the max-

imal M from the maximal H-reflex latency. A right-left difference in H-RL of 0.85 ms or more and in ILT of 0.9 ms or more are considered abnormal. The size of the H-reflex amplitudes are also taken into consideration. A reduction to less than one third of the comparable amplitude on the opposite side is considered pathological.

The control group consisted of 143 subjects, 77 females and 66 males, between ages 20 and 86 years (mean 47.7 years). Fifty four were without history or signs of neurological disease. Eighty nine control subjects had pain in the lower back accompanied by radiation down one leg, but were otherwise healthy. Myelography in these controls was normal in 23 and showed a lumbar disc herniation at L4-L5 or L5-S1 in the remaining 66.

The patient group consisted of 32 patients, 17 females and 15 males, between ages 27 and 85 years (mean, 50.7 years). Myelography was performed in all these patients and showed a single nerve root compression limited to the fifth, sixth, seventh, or eighth cervical root on the side of the symptoms (roots C5, C6, C7 and C8). CT of the cervical spine was performed in five patients. About half of the patients had neck pain and 26 had arm pain which was poorly localised. Paraesthesia occurred in thumb and index finger in eight and in digit 2 alone in three of 11 patients with root C6 compression. In root C7 compression paraesthesia was present in digits 2 and 3 in five patients, in digits 1, 2 and 3 in two patients, in digit 3 alone in two patients, in all fingers in one patient, and in none of the fingers in four patients. In four patients with root C8 compression paraesthesia occurred in digits 3 to 5. Compression of root C5 caused paraesthesia in the lateral side of the upper arm in only one of the three patients. The biceps reflex alone was diminished in three patients; two with root C6 and one with root C7 compression. Biceps and triceps reflexes were diminished in four patients with root C7 lesion. The triceps reflex alone was diminished in five instances of involvement of root C7. Weakness was evident in 15 of the 32 patients; deltoid muscle in two patients with root C5,

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biceps and brachioradialis muscles in four patients with root C6, triceps muscle and wrist extensors in seven patients with root C7, and the intrinsic hand muscles in two patients with root C8 involvement.

Compression of the nerve roots was caused by protrusion of a cervical disc in 29 patients, a spondylotic spur in one patient, metastasis from breast cancer to one side of the seventh cervical and first thoracic vertebrae in one patient, and a unilateral epidural metastatic mass from breast cancer extending from the seventh cervical to the fourth thoracic vertebra in one patient. The latter three patients and one of the former 29 patients had a C8 root compression. Of the remaining 28 patients three had a root C5, 11 had a root C6, and 14 had a root C7 compression. Twenty four patients with disabling pain underwent surgical treatment which confirmed the positive findings at myelography. The duration of the complaints before the electrophysiological study ranged from 24 days to 2 years (mean, 63 days). Repeat EMG examinations were performed after operation in 11 patients with C6 or C7 compression during a follow-up period which ranged from 0.5 month to 6 months.

Age and arm length of each subject were recorded. Arm length was measured from the top of digit 3 to C6 spine with the arm pronated and abducted to a right angle.

Results

Controls

In all controls H-reflexes could be elicited in both arms. The mean H-RL was $17.07 \text{ ms} \pm 1.77 \text{ SD}$ and the mean ILT $14.47 \text{ ms} \pm 1.77 \text{ SD}$.

Multiple regression equations using H-RL or ILT as a variable dependent on arm length (cm) and age (years) were calculated;⁴ $\text{H-RL (ms)} = -0.95 + 0.1920 \text{ arm length} + 0.0232 \text{ age} \pm 0.74 \text{ SD}$ and $\text{ILT (ms)} = -3.33 + 0.1894 \text{ arm length} + 0.0235 \text{ age} \pm 0.79 \text{ SD}$ respectively. The analyses showed highly significant (Student's two tailed *t* test: $p < 0.001$) relationships between H-RL or ILT and both arm length and age. A single regression equation was calculated for H-RL and ILT as a function of arm length; $\text{H-RL (ms)} = 0.29 + 0.1905 \text{ arm length} \pm 0.84 \text{ SD}$ and $\text{ILT (ms)} = -2.08 + 0.1878 \text{ arm length} \pm 0.89 \text{ SD}$. These relationships were highly significant ($p < 0.001$). Upper crossing of the $+3 \text{ SD}$ level is considered abnormal (figures 1a and 1b). The SD differences between H-RL and ILT in the four formulae were small (0.1) and the SDs for H-RL slightly narrower (0.05) than for ILT.

Patients

In the seven patients with lesions of roots C5 and C8 the H-reflex could be elicited in both arms. All H-RLs, ILTs and their R/L differences fell among the control values.

In the 25 patients with root C6 or C7 compression (table 1) H-reflexes were absent on the affected side in 11 and present in 14 patients. Delayed H-RLs and ILTs were seen in six of the latter patients and of whom five had an abnormal and one (no 24) a normal

Fig 1 (a) relationship of arm length of control subjects to the H-reflex latency (H-RL), and (b) to the inter-latency time (ILT) of the flexor carpi radialis H-reflex.

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Table 1 Representation of the values of H-reflex Latencies (H-RLs) and Inter Latency Times (ILTs) found in the 25 patients with cervical disc herniation with injury to root C6 or C7

Patient no, sex, age (yr)	Unaffected arm			Affected arm		
	Arm length (cm)	H-RL (ms)	ILT (ms)	Arm (side)	H-RL (ms)	ILT (ms)
Root C6						
1, F, 32	84	16	13.5	R	—	—
2, M, 34	92	18.5	16	R	22†	19.5†
3, F, 42	84	16.5	14	L	16.5* (low)	14
4, M, 45	85	16.5	13.5	R	16	13.5
5, M, 48	83	19†	16.5†	L	—	—
6, F, 57	86	16.5	13.0	R	16 (low)	13.5
7, M, 59	91	18.5	15.5	R	18.5*	16
8, F, 63	76	15	12	R	18.5†	16†
9, F, 63	83	16.5	14	L	16.5* (low)	14.5
10, F, 64	77	16	13.5	R	—	—
11, F, 86	80	15.5	13	L	—*	—
Root C7						
12, M, 31	92	22.5†	20.5†	R	—*	—
13, M, 32	89	17	14.5	L	—	—
14, F, 34	82	15.5	13	R	—	—
15, F, 39	79	15.5	13	L	19†	17.5†
16, M, 39	83	16.5	14	L	20†	17.5†
17, M, 41	87	17	14.5	L	—*	—
18, F, 42	81	16	13.5	L	16* (low)	13.5
19, M, 46	85	17	14	R	19.5†	17†
20, F, 51	76	15	12.5	R	—	—
21, M, 53	86	16.5	13.5	R	—*	—
22, M, 57	86	16	13.5	R	16	13
23, M, 70	86	16.5	14	R	—	—
24, F, 71	78	18.5†	16†	R	18*†	15.5†
25, F, 76	83	17.5	15	R	18	15

† = delayed, * = EMG, denervation, F = female, M = Male, R = Right, L = Left.

mal difference between the latencies in the right and left arm. The abnormal R/L differences ranged from 2.5 to 3.5 ms (mean, 3.2 ms) for H-RL and from 3 to 4.5 ms (mean, 3.6 ms) for ILT. Three patients had prolonged latencies in the clinically unaffected side and CT scans revealed the disc protrusion extending medially. In the affected arm two of them had absent reflexes and one a prolonged reflex resulting in a normal R/L difference. In four patients latencies on the affected side were normal but the reflex amplitudes were up to 70% lower than those on the unaffected side. Normal H-reflex configurations and latency times were seen in four patients;

two with root C6 and two with root C7 involvement.

Flexor carpi radialis EMGs (table 1) revealed denervation potentials in eight patients with injury to root C6 or C7; one had normal latencies, two had low H-reflex amplitudes with normal latencies, four had absent reflexes and one had prolonged latencies.

After surgery a repeat study was performed in 11 patients in whom more than one examination was carried out on ten (table 2). Absent reflexes reappeared (fig 2) in four patients and remained absent in one patient after surgery. Delayed reflexes normalised after operation in two patients. Reflexes with markedly decreased amplitudes and normal

Table 2 Repeated H-reflex and EMG examinations in 11 patients with root C6 or C7 lesion

Patient no (see table 1)	H-reflex latency (ms)	Affected arm	
	Preoperative	Postoperative (intervals in months)	
1	—	— (0.5)	16 (2)
13	—	— (0.5)	17.5 (3.5)
2	22†	20 (0.5)	18 (3)
5	—	— (0.5) 22† (2)	17 (6)
17	—*	—* (0.5)	17 (large) (5)
24	18*†	16.5* (0.5)	15 (large) (6)
18	16* (low)	16* (low) (0.5)	16 (low) (6)
9	16.5 (low)	17 (low) (0.5)	16.5 (5.5)
22	16	—* (0.5)	16 (5)
20	—	—* (0.5)	—* (6)
25	18	18 (0.5)	—

† = delayed, * = EMG, denervation.
Low = markedly decreased reflex amplitude.
Large = markedly increased reflex amplitude.

Fig 2 (a) example of an absent H-reflex response before operation in a patient (no 5) with a lesion of nerve root C6. Three responses are superimposed. (b) the reflex occurred with a prolonged latency (22 ms) two months after operation.

latencies showed after operation a clearly increased amplitude in one and no change in the other patient. Two patients showed normal reflexes before operation. In one of them the reflex disappeared after operation but returned to normal after 5 months. In the other the reflex remained normal. The interpretations of these results are discussed below.

Discussion

Age and length of the arm abducted to 90° may be used to predict H-RL and ILT, because both contri-

bute significantly to this prediction. However, the small SD differences in the formulae made the age influence of little importance and arm length alone sufficient for practical uses (figs 1a and b).

Although measurement of ILT is physiologically more accurate than H-RL,⁵ both revealed the same amount of abnormalities. This could be due to the less precise ILT estimation, probably, reflected by the SD of the formula to predict latency from arm length being slightly smaller (0.05) for H-RL than for ILT.

Comparison of the absolute values of the latencies in both arms was sufficient to discover abnormalities in most of our patients. However, one patient with a normal R/L difference had a similar delay in latency in both arms ms, and two patients with an absent reflex on the symptomatic side showed a prolonged reflex in the arm without symptoms. CT scans showed the disc herniation extending medially and compressing the nerve root on the asymptomatic side to a lesser extent than the root ipsilateral to the arm with pain.

In lesions of nerve roots C5 and C8 neither abnormalities were seen in H-reflexes nor in EMGs of flexor carpi radialis muscles signifying that nerve roots C5 and C8 are not involved in the pathway for the flexor carpi radialis H-reflex. In contrast, injury to roots C6 or C7 changed flexor carpi radialis H-reflexes in 21 of the 25 patients with disc herniation between the fifth and sixth or the sixth and seventh cervical vertebrae. Absence or delay of the reflex indicate, that in some individual reflex impulses are conducted mainly, if not all, along root C6 and in others along root C7. This may also be true for a clearly decreased H-reflex amplitude which is, probably, due to axonal loss and seen in four patients, but it may also be possible that the reflex utilises both nerve roots. If this is the case, in damage to one of the roots reflex impulses running through the other root only produce the reflex response which may then be reduced in amplitude.

The electrophysiological studies were repeated after surgery in 11 patients (table 2), providing valuable data about the various types of recovery of the nerve root injuries.⁶ In two patients a preoperative absent reflex and in one patient a preoperatively delayed reflex became normal within 2 to 3.5 months after surgery. This suggests that a delay or loss of the reflex was due to local demyelination which might be expected to improve relatively rapidly after decompression. In one patient the preoperative absent reflex reoccurred after 2 months with a prolonged latency (fig 2), which became normal by the sixth month after operation, suggesting that loss of myelin was probably more extensive than in the former three patients. Two

patients showed denervation before operation and 5 to 6 months after surgery increased amplitudes of markedly prolonged duration compared with the normal side, suggesting that collateral reinnervation had occurred. Two patients showed preoperatively reflexes with markedly decreased amplitudes. In one of them the amplitude remained abnormally low even six months after operation and in the other the amplitude became equal to the one on the unaffected side within 5.5 months after surgery. This may indicate that degeneration of some of the axons was more severe in the former and early improvement of conduction of blocked axons had occurred in the latter patient. Two patient showed denervation and an absent reflex after surgery. The reflex reappeared within 5 months in one and remained absent for up to 6 months in the other. Destruction of the axons was more severe in the latter and operation unsuccessful in relieving pain. In one patient flexor carpi radialis EMGs and H-reflex remained normal after decompression of root C7. This might be explained by the fact that in this patient the reflex utilises the undamaged nerve root C6.

In conclusion, the present study has shown that measurements of latencies of the flexor carpi radialis H-reflexes and comparison with the normogram

presented in fig 1a proved helpful in detection of pathology of the sixth or seventh cervical nerve root.

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