

The H-reflex of the flexor carpi radialis muscle; a study in controls and radiation-induced brachial plexus lesions

BW ONGERBOER DE VISSER, RJ SCHIMSHEIMER, AAM HART

From the Department of Clinical Neurophysiology, St. Lucas Hospital and the Clinical Division of the Netherlands Cancer Institute, Amsterdam, The Netherlands

SUMMARY H-reflexes of the flexor carpi radialis muscle were studied in 52 controls and 25 cancer patients with radiation-induced brachial plexopathy. It was found that H-reflex conduction velocity (H-RCV) decreased with increasing age. This was not true for H-reflex latency (H-RL) and inter-latency times. There were no H-RCV and latency differences between age-matched male and female subjects. In the affected arm the reflex was absent in nine patients and delayed in 16 patients in whom H-RCV was decreased in 13 patients. Three patients showed large H-RL differences which were also notable features in median nerve disease in the region of the brachial plexus.

H-reflexes of the flexor carpi radialis muscle have been well documented,^{1,2} but their clinical significance has not been studied in detail. In this report, we have determined parameters in control subjects and in addition studied reflex changes in cancer patients with brachial plexus lesions induced by radiation therapy.

Material and methods

The electrophysiological examinations were performed in an air conditioned room with the temperatures controlled between 23°C and 25°C. Surface temperatures of the upper arms ranged from 32°C to 34°C. EMG and H-reflexes of the flexor carpi radialis muscle in the right and left arm were performed by coaxial electrodes in both the controls and the patients. To elicit the flexor carpi radialis H-reflex the median nerve in the cubital fossa was stimulated with bipolar surface electrodes. The elbow joint was positioned at 30°C flexion. Square wave shocks of 0.5 ms duration were delivered at a rate one per 5 seconds. The stimulus voltage was gradually increased until a maximal H-reflex was obtained. After that a supramaximal stimulus was delivered to obtain the maximal direct muscle response (M). Subsequent H-reflexes were recorded below

each other on a microfilm reader-printer. The H-reflex latency (H-RL) was measured from the displayed stimulus artefact to the start of the maximal evoked potential. In addition, the inter-latency time (ILT) was determined by subtracting the latency of the maximal M from the maximal evoked H-reflex. The H-reflex conduction velocity (H-RCV) was estimated utilizing the following equation:

$$\text{H-RCV (in m/s)} = \frac{(\text{Distance in mm from stimulus point to C6 spine}) \times 2}{((\text{H-RL} - \text{M latency in ms}) - 1)}$$

The monosynaptic delay has been estimated to be about 1 ms.³ The approximate length of the median nerve from the stimulus point at the elbow to C6 spine was obtained as the sum of the distance from (1) the elbow to the medial end of the deltoid muscle, and (2) the latter point to the C6 spine.

In 52 control subjects, 28 female and 24 males, between 20 and 85 years (mean, 50.8 years) H-RL, ILT and H-RCV were established. Relations with sex and ages were determined using analysis of covariance. In addition intra-individual differences between H-RL, ILT and H-RCV on the right and left arm in females were compared with those found in males. For statistic analysis the Student *t* and the paired *t* tests were used.

Twenty five patients, 21 females and 4 males, between 19 and 74 years (mean, 47 years) were selected from September, 1980 to June, 1983. Twenty one women suffered from breast carcinoma. Two men had Hodgkin lymphoma and two had lung carcinoma. All had received radiation therapy 8 months to 4 years prior to the electrophysiological examinations. In seven patients the radiation fields included the medial part of the clavicular space and in 18

Address for reprint requests: Dr Ongerboer de Visser, Department of Clinical Neurophysiology, St. Lucas Hospital, Jan Tooropstraat 164, 1061 AE Amsterdam, The Netherlands

Received 19 January 1984 and in revised form 29 March 1984.
Accepted 1 April 1984

Table H-reflex conduction velocity (H-RCV), H-reflex latency (H-RL) and inter-latency time (ILT) with the right/left (R/L) differences of the flexor carpi radialis muscle in 52 control subjects with the values considered to be abnormal, and the findings on the affected side in 16 patients.

	Mean	Normal SD	Range	Abnormal (2 × SD)	Mean	Patients SD	Range
H-RCV, m/s	73.7	7.2	75 ± 13	<59.3	76.4	9.1	61 ± 21.5
R/L difference	0.38	2.4		≥4.8*	12.9	8.0	
H-RL, ms	16.8	1.1	17.5 ± 2.5	>19	19.1	1.9	18.5 ± 4.5
R/L difference	0.002	0.42		≥0.85*	2.9	1.7	
ILT, ms	13.8	1.2	14.25 ± 2.75	>16.2	16.5	1.9	16.5 ± 4.5
R/L difference	0.11	0.44		≥0.9*	2.8	1.8	

*absolute value

patients the whole supraclavicular area with the axilla. In the latter patients radiation induced scarring and fibrosis caused modest to severe shoulder contractures. Lymphoedema in the affected limb was mild in 14 and absent in 11 patients. Eight patients had no pain and some pain existed in the others. Paresthesias combined with sensory signs were limited to the median nerve distribution in nine and overlapped the ulnar and median distribution in 15 patients. Four patients did not show any motor abnormality, 13 had proximal weakness of the arm and eight had mild weakness or atrophy of hand muscles. None of the patients had physical findings indicative of polyneuropathy. On the affected limb the biceps reflex was absent in seven, lowered in 12 and normal in six patients. In all patients radiographs and CT with bone windows of the cervical and upper thoracic spine did not show destructive bone lesions. Chest radiographs showed radiation fibrosis in the apex of the lung ipsilateral to the affected brachial plexus in 12 patients. CT of the brachial plexus from C4 to T3 revealed diffuse loss of normal soft tissue, probably due to fibrosis, in 17 patients. In eight patients CT was normal. Needle biopsy directed to the CT abnormalities revealed fibrosis in 12 patients. Myelograms were performed in seven patients and were normal.

Results

Controls

In both arms H-reflexes could be elicited in all controls. The absolute values and the right/left difference of the H-RCV, H-RL and ILT with the values considered to be abnormal are presented in the table. No significant difference was found between H-RCV/ (p = 0.25), H-RL (p = 0.74) and ILT (p = 0.086) on the two sides. Therefore the right and left sides were considered together. The mean H-RCV was 73.7 m/s ± 7.2 SD, the mean H-RL 16.8 ms ± 1.1 SD, and the mean ILT 13.8 ms ± 1.2 SD. A right/left difference of the H-RCV of 4.8 ms or more, of the H-RL of 0.85 ms or more and of the ILT of 0.9 ms or more was considered pathological.

There were no relationships between age and H-RL (p = 0.1) or ILT (p = 0.39). No sex-relationship was found. In contrast H-RCV

decreased significantly (p < 10⁻⁴) with increasing age (H-RCV = 88.3 (±2.0) - 0.29 (±0.039) × age ± 5.1). There are no indications that age relationship depends of sex (p = 0.34). Flexor carpi radialis EMGs were normal in all controls.

Patients

In the unaffected arm H-reflexes could be elicited in all patients. The mean H-RCV was 82.8 m/s ± 4.6 SD, the mean H-RL 16.3 ms ± 1.2 SD, and the mean ILT 13.8 ms ± 1.2 SD. These values are similar to those of the controls (p = 0.89, p = 0.23 and p = 0.31, respectively).

In the affected arms H-reflexes were absent (fig 1A) in nine and present with delayed latencies (fig 1B) in 16 patients. The table represents the absolute values of these 16 reflexes and the right/left differences of H-RCVs, H-RLs and ILTs. They were significantly longer (p < 10⁻⁴) than those found in the controls. In the affected arm H-RCV fell into the normal range in 12, H-RL in nine and ILT in eight patients. However, with respect to right/left differences H-RCV was normal in three patients, H-RL normal in one patient and ILT normal in none of the patients. The relationships between age and H-RCV in both the affected and unaffected arm were not different from those determined in the controls (p = 0.84 and p = 0.89, respectively).

EMGs of flexor carpi radialis were normal in all of the unaffected arms and in 12 of the affected ones in which the H-reflex was absent in four and delayed in eight. EMGs showed denervation in 13 patients in whom the H-reflex was absent in five and delayed in eight.

Interesting observations were made in two patients where part of the M-responses were succeeded by three late responses (fig 2A), and in one patient where M-responses were followed by late responses of which latencies differed markedly from each other (fig 2B). All these late responses could be obtained with stimulation strengths that were

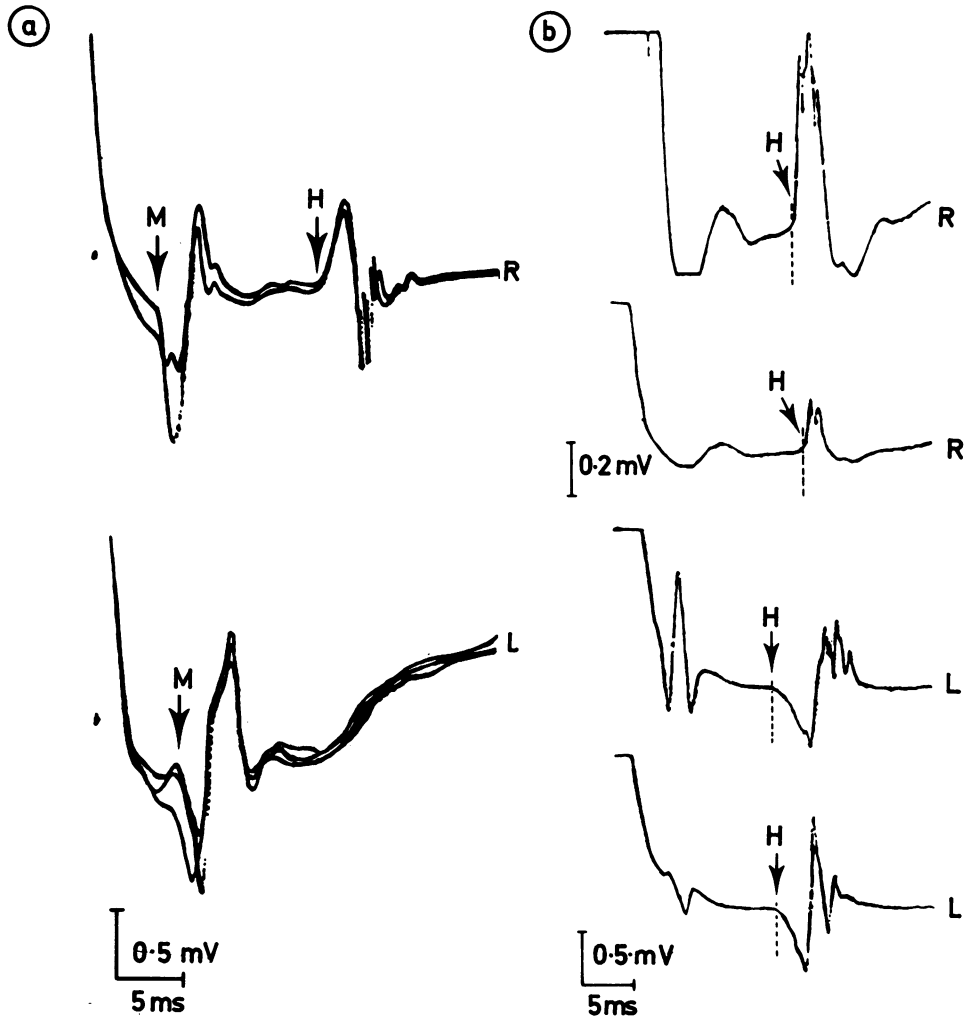


Fig 1 (A) Example of an absent H-reflex response on the left in a patient with a left sided plexopathy. The H-reflex on the right is normal (R = right and L = left arm in this and subsequent figures). (B) Example of a delayed (3 ms) H-reflex on the right in a patient with a right sided plexopathy. The H-reflex on the left is normal.

below the threshold for obtaining maximal M-responses. Only the H-reflex with the shortest latency time was used for the study. In the three patients flexor carpi radialis EMGs were normal.

Discussion

Radiation-induced brachial plexus lesions are commonly seen in patients with malignant diseases.⁴ The few related EMG reports in this complication describe delayed nerve conduction velocities,

decreased amplitudes of sensory nerve potentials, denervation potentials and myokymic discharges.⁵⁻⁷ In our 25 patients denervation potentials in flexor carpi radialis muscles occurred in 13 patients. Overlying scarring and fibroid induration prevented electroneurography of proximal nerve segments. In contrast, eliciting flexor carpi radialis H-reflexes provides a useful method for demonstrating a proximal median nerve lesion. On the side of the plexopathy no H-reflex occurred in nine patients. In 16 the reflex was present with a prolonged latency; H-RL

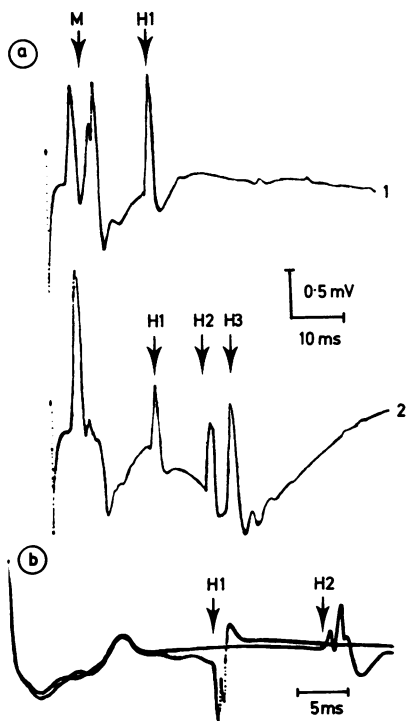


Fig 2 (A) Example of H-reflexes (H1) of which part are followed by two late responses (H2 and H3) with markedly different latencies and considered to be H-reflexes. (B) Example of two H-reflexes (H1 and H2) with markedly different latencies being in H2 13 ms longer than in H1. H1 also shows a delayed latency time of 23 ms.

in 15 and ILT in 16 patients. In 13 patients the H-RCV was delayed. This difference lies partly in the range of normal of right/left difference being larger for H-RCV than for latency times. Although the cervical root along which the flexor carpi radialis H-reflex pass is not known, the C6 spine was taken for measuring the nerve segment because it is suggested that the flexor carpi radialis muscle is innervated by the C6 and C7 roots.⁸ Measuring the length of the proximal segment of the median nerve with the arm pronated and abducted to 90°C, which may be more precise than our method was impossible in most of our patients because of shoulder contracture due to radiation-induced fibrosis. This experience led to our method of estimating the H-RCV. Despite these factors we found, as with the F-wave⁹ or conventional nerve conduction velocity,¹⁰ a decline of H-RCV with advancing age. This suggests that our measuring method was satisfactory. Otherwise, estimating the H-RL or probably more precise calculating the ILT seems sufficient in asymmetrical

nerve lesions. In symmetrical injury, however, conversion of H-RL to conduction velocity may be of greater importance.

The high incidence of H-reflex abnormality in our study is certainly explained by selection of our patients. All had brachial plexopathies with sensory signs in the median nerve distribution and most of them had an abnormal biceps reflex. Mild motor signs were present in 21 patients which involved the upper plexus (C5 – C6) in 13, and C6 and C7 roots in eight patients. The large difference between H-RLs found in three patients having normal EMGs of flexor carpi radialis muscles suggests a predominant lesion of afferent fibres in these patients. The finding may be important for interpreting abnormal cervical cord potentials when somatosensory evoked potentials are used for demonstrating lesions of the brachial plexus.

In conclusion the present study has shown that recording of the H-reflex in the flexor carpi radialis muscle affords a useful tool in demonstrating a proximal lesion of the median nerve in the plexus region as a complication of radiation therapy.

References

- Deschuytere J, Rosselle N, De Keyser C. Monosynaptic reflexes in the superficial forearm flexors in man and their clinical significance. *J Neurol, Neurosurg Psychiatry* 1976;**39**:555–65.
- Jabre JF. Surface recording of the H-reflex of the flexor carpi radialis. *Muscle Nerve* 1981;**4**:435–8.
- Magladery JW, Porter WE, Parle AM, Teasdall HD. Electrophysiological studies of nerve and reflex activity in normal man. IV. The two neuron reflex activity and identification of certain action potentials from spinal roots and cord. *Bull Johns Hopkins Hosp* 1951;**88**:499–519.
- Kori SH, Foley KM, Posner JB. Brachial plexus lesions in patients with cancer: 100 cases. *Neurology (NY)* 1981;**31**:45–50.
- Contamin F, Mignon B, Ecoffet M, Ollat H, Jouneau P. Les atteintes plexiques post-radiothérapiques. *Sem Hôp Paris* 1978;**54**:1225–9.
- Albers JW, Allen AA, Bastrow JA, Daube JR. Limb myokymia. *Muscle Nerve* 1981;**4**:494–504.
- Streib EW, Sun SF, Leibrock L. Brachial plexopathy in patients with breast cancer: unusual electromyographic findings in two patients. *Eur Neurol* 1982;**21**:256–63.
- Goodgold J. In: Goodgold J, ed *Anatomical Correlates of Clinical Electromyography*. Baltimore: Williams and Wilkins, 1975;36.
- Ongerboer de Visser BW, van der Sande JJ, Kemp B. Ulnar F-wave conduction velocity in epidural metastatic root lesions. *Ann Neurol* 1982;**11**:142–6.
- Ludin HP. In: Ludin HP ed. *Praktische Elektromyographie*. Stuttgart: F Enke Verlag 1976.