Observations on Severe Ulnar Neuropathy in Diabetes

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ABSTRACT

We describe the clinical and neurophysiologic findings in a group of diabetic patients with a severe ulnar neuropathy. All patients attending a large inner-city diabetes center were prospectively screening for hand wasting and weakness due to ulnar nerve disease. Twenty diabetic patients fulfilling the clinical criteria underwent nerve conduction studies and electromyography. All but one patient with a motor ulnar neuropathy had systemic complications, mostly severe: ten were amputees, four had had a renal transplant, and two were blind. The onset of hand weakness was sudden in five. All patients had a classical "ulnar hand" (bilateral in five) but forearm muscles were little affected. Sensory loss was prominent in only one-half. Nerve conduction studies showed markedly reduced ulnar motor responses (mean, 1.2 mV versus 7.4 mV in controls) and ulnar/median motor ratios. Motor conduction was disproportionately slowed across the elbows, with or without conduction block, in only eight of 34 affected ulnar nerves. Five of these patients had a habit of leaning on their elbows and/or a Tinel's sign. Median sensory action potentials (SAPs) were recordable in 12 patients but ulnar SAPs were absent in 30 of 34 affected nerves. Electromyography revealed advanced denervation of ulnar supplied hand muscles. We conclude that motor ulnar neuropathy is not uncommon in patients with diabetes of long standing, especially in those with severe systemic complications. Nerve entrapment at the elbows occurs in some, but in many the lesion is axonal, and damage may occur through ischemia. (Journal of Diabetes and Its Complications 12;3:128–132, 1998.)

INTRODUCTION

It is well known that mononeuropathies can occur in diabetic patients, sometimes in the absence of a clinically significant background polyneuropathy. There are descriptions of diabetic cranial, median, ulnar, femoral, peroneal, and truncal nerve lesions. Some occur as a result of external pressure or entrapment, such as the median nerve at the wrist or the common peroneal nerve at the neck of the fibula. Though the ulnar nerve is often mentioned as potentially vulnerable, there are surprisingly few detailed descriptions of ulnar neuropathy in diabetic patients. The prevailing view is that it occurs as a result of compression in the cubital tunnel. Marked slowing of motor conduction in the elbow segment has been observed in 15 diabetic patients with symptoms of an ulnar nerve lesion.[1] Seen from another perspective, 17% of 46 patients who had a surgical decompression for ulnar neuropathy suffered from diabetes.[2]

While sensory disturbance in the little and ring fingers from ulnar nerve compression at the elbow is probably quite common in diabetic patients, we were interested in studying those with more substantial dis-

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ability, i.e., patients with predominantly *motor* ulnar neuropathies. This report deals with the clinical and electrophysiologic findings in 20 such patients and highlights the fact that entrapment may not be the main mechanism of damage in more disabling forms of ulnar diabetic neuropathy.

METHODS

Patients. Diabetic patients attending the Manchester Diabetes Centre were screened for small muscle wasting in one or both hands. Those in whom such wasting was identified were referred for examination by a neurologist who, in turn, selected patients with an ulnar neuropathy. The criteria for this diagnosis were: (1) moderate/severe wasting and weakness of interossei and abductor digit minimi, (2) sparing of the thenar muscle mass, and (3) absence of any other pathology likely to cause muscle wasting. Patients were excluded if they had symptoms of cervical spondylotic radiculopathy, namely pain and/or paresthesia radiating down the affected limb, if there were features of a thoracic outlet syndrome, or if they suffered from any other disease liable to cause a neuropathy.

Twenty patients fulfilling the above criteria were identified over an 18-month period. They underwent detailed clinical and neurophysiologic assessment.

Clinical Evaluation. The neurological symptom score (NSS)[3] was obtained by means of a standardized questionnaire. Complaints of weakness at various sites, sensory disturbance and autonomic dysfunction were recorded as either present or absent and the number of symptoms present constituted the score (maximum total, 17). In addition, a neurological disability score (NDS) was calculated by assessing limb weakness, reflexes, and sensation on both sides and scoring the severity of the deficit from 0 (absent) to 4 (very severe).[3] The NSS and NDS were used as measures of the severity of the patient's background diabetic polyneuropathy. After a detailed neurological examination, the palmar and dorsal aspect of the hands were photographed.

Nerve Conduction Studies. Nerve conduction studies were performed with standard techniques, using a Medelec MS6 electrodiagnostic system (Medelec, Old Woking, UK). Surface recording and stimulating electrodes were employed throughout. Motor conduction studies were undertaken on the median, ulnar, common peroneal, and tibial nerves and sensory action potentials (SAPs) were obtained from the median, ulnar, and sural nerves (both upper limbs and right lower extremity). Limb surface temperature was maintained above 32°C. Upper limb SAPs were recorded orthodromically, sural SAPs antidromically. For the ulnar nerve, motor responses were recorded at the hypothenar eminence and conduction velocity was measured across the elbow as well as in the forearm segment, with the forearm flexed at 120°.

The electrophysiological data were compared with those from 60 healthy controls, aged 37–73 years. Parametric statistics were used for most comparisons and the limits of normality were defined as mean ± 2.5 SD. For some ratios that were non-normally distributed nonparametric statistics were employed.

Electromyography. Concentric needle electromyography was carried out in the following muscles in the affected limbs: first dorsal interosseous, abductor digiti minimi, abductor pollicis brevis, and flexor carpi ulnaris or flexor digitorum profundus. Selected lower limb muscles were also sampled.

RESULTS

Clinical Assessment. Results are shown in **Table 1**. The patients comprised 16 men and 4 women. Their ages ranged from 39 to 77 years (mean, 60.3). Seven had type I (insulin-dependent) and 13 type II (non–insulin-dependent) diabetes. The mean duration of diabetes was 22.3 years (range, 4–38 years). Seven of the type II patients had been taking insulin for 2–10 years prior to their assessment for the purpose of this study. Control of the diabetes was variable: mean glycosylated hemoglobin values for the previous 4 years ranged from 5.3% to 12.7% (normal range for nondiabetic subjects, 5%–7%). None of the patients drank alcohol to excess, and none was on potentially neurotoxic medication.

All but one patient had long-term complications of diabetes. The serum creatinine was mildly elevated (less than 150 μmol/L) in eight, moderately elevated (150–400 μmol/L) in nine, and markedly elevated in three (pre-dialysis, 518, 824, and 1000 μmol/L, respectively). One patient was on continuous ambulatory peritoneal dialysis, and four others had received a renal transplant. All but two patients had retinopathy requiring laser therapy and two were registered blind. Most (15 of 20) had symptoms of intermittent claudication or other manifestations of peripheral vascular disease. One-half of the patients had had amputations of toes or one or both legs. Seven had symptomatic heart disease. Four patients had mild/moderate intermittent neck pain with radiological changes of early cervical spondylosis and one had had a cervical laminectomy 5 years earlier. None of them had symptoms suggestive of ongoing cervical nerve root disease.

Neurological symptom scores were low (median, 5; range, 3–8). They were compared to those of 12 control subjects attending hospital for non-neurological conditions (mean age, 56.5 years; range, 39–78 years). The control scores were 0–2, reflecting non-motor complaints, such as postural fainting, numbness, and impotence. The median neurological disability score (cor-

TABLE 1. CLINICAL AND ELECTROPHYSIOLOGIC DATA IN OUR 20 PATIENTS WITH A SEVERE ULNAR NEUROPATHY

Patient Number	Age (years)	Type of Diabetes	Duration of Diabetes (years)	Duration of Symptoms (years)	CMAP (mV)		MCV Forearm (m/sec)		MCV Elbow (m/sec)	
					R	L	R	L	R	L
1	70	II	20	4	0	—	—	—	—	—
2	59	I	35	2	2.0	1.6	50	47	63	49
3	39	I	23	1	0.4	0.6	46	42	40	32
4	58	II	16	8/2	0	—	—	—	—	—
5	68	II	20	3	1.4	1.0	46	51	49	33
6	65	II	17	7	0.2	0.1	25	—	37	—
7	49	I	35	15	0.8	0.7	26	34	30	32
8	52	II	27	9	—	2.6	—	44	—	42
9	56	I	28	3	0.2	0.2	31	33	28	30
10	50	I	26	5	0.2	0.4	24	38	32	39
11	71	II	17	⅓	—	0.2	—	42	—	13
12	77	II	27	2	1.2	—	31	—	35	—
13	59	I	29	2	2.4	3.2	50	58	39	32
14	62	II	30	2	1.6	1.5	41	44	24	32
15	65	II	8	1	0.7	0	37	—	30	—
16	71	II	6	½	2.8	4.2	59	55	43	37
17	69	II	18	2	1.7	1.6	47	51	40	37
18	56	I	38	6	0.8	0.9	24	47	40	39
19	54	II	23	7	—	1.5	—	38	—	30
20	75	II	4	2	2.9	2.0	53	51	45	57

Age and duration are given in years. The first five patients presented acutely. All electrophysiologic data are for affected ulnar nerves.

rected for amputees) was 54 (range, 20–80) in the patients and 0 in the controls (range, 0–4). All patients had absent ankle jerks and distal sensory impairment to at least two modalities in the lower limbs.

Muscle thinning, weakness, or clumsiness in one or both hands had been noticeably present for between 4 months and 15 years (median, 2.5 years). Three patients denied any functional loss in the affected hand, despite obvious wasting. The onset of motor symptoms was insidious in 15 patients and acute in five (four bilateral and one unilateral). Seven patients admitted to leaning on their elbows frequently. One-half of the patients complained of numbness in the hands, often with paresthesia on waking, though not necessarily restricted to the little and ring fingers.

The examination findings were characteristic of a predominantly motor ulnar neuropathy, affecting one hand in six patients (three dominant, three nondominant) and both sides in the remaining 14 patients (often asymmetric). Severe wasting and weakness were observed in dorsal and palmar interossei and in adductor digiti minimi in all, with obvious clawing of the little and ring fingers in about one-half. The thenar muscles were either completely spared or marginally flattened but normal in strength. Flexor carpi ulnaris and/or flexor digitorum profundus III/IV were clinically weak in only a quarter of cases. Dupuytren's contracture was present in seven. One or more upper limb tendon reflexes were depressed in most patients, but they were absent in just one (both triceps jerks). Sensation was distinctly impaired in an ulnar nerve distribution in nine patients and more diffusely in the hand in a further four. Tinel's sign at the elbows was present in six patients.

Nerve Conduction Studies. The amplitude of the compound muscle action potential (CMAP) in 34 affected ulnar nerves (distal stimulation) was 1.2 ± 1.0 mV (mean ± 1 SD) compared to 7.4 ± 1.3 mV in controls. The ulnar CMAP was unrecordable in three patients and it fell below the minimum normal (mean − 2.5 SD) in all but one of the remaining patients. Because even in the absence of a focal ulnar neuropathy some reduction in the ulnar CMAP would be expected due to background diabetic polyneuropathy, we compared the median and ulnar CMAP amplitudes for each affected limb. The median ratio for median versus ulnar CMAP in the patients was 4.7 (range, 0.8–87), as opposed to 1.1 (range, 0.5–2.0) in controls ($p < 0.001$). Distal motor latencies were longer in the ulnar than the median nerve in six cases but always modestly so (difference range, 0.2–1.7 ms).

The mean (SD) motor conduction velocity in the median nerves of the diabetic patients was 43.8 m/sec (5.5). Three had a carpal tunnel syndrome. The mean MCV in the forearm segment of affected ulnar nerves

was 42.1 m/sec (10.1). Motor conduction velocity was disproportionately slowed across the elbow (i.e., by more than 27% of the forearm value, the maximum normal) in eight affected nerves. Motor conduction block in the elbow segment was suspected (a drop in amplitude of more than 30% in the absence of temporal dispersion) in three of these nerves and in three others. In all, eight patients had at least one of these two neurophysiologic pointers to ulnar nerve entrapment at the elbow. Five of them admitted to a habit of leaning on the elbows and/or they had Tinel's sign over the ulnar nerve at the elbow. All but one had type II diabetes. The ulnar nerve lesion developed acutely in two of these patients. In other respects their patient profile was the same as for those who did not have electrophysiologic evidence of a focal lesion at the elbow.

A median nerve sensory action potential was recordable, at least on one side, in 13 patients (amplitude range, 0.5–7 μV). By contrast, digital ulnar SAPs could be obtained in only two of 34 affected nerves.

Electromyography (EMG) revealed advanced denervation (fibrillation and marked reduction in the number of recordable motor units) in interossei and/or hypothenar muscles in 17 patients and less severe denervation at these sites in two. By contrast, EMG was normal or only mildly deranged in abductor pollicis brevis, flexor carpi ulnaris, and flexor digitorum profundus.

Turning to the lower limbs, common peroneal and/or tibial motor action potentials could be recorded in 4/15 patients. They were diminished in two (10–500 μV) and normal in two (both with unilateral ulnar nerve lesions). In all cases where the common peroneal motor conduction velocity could be measured, it was reduced (29–32 m/sec). Sural sensory action potentials were absent in all but one patient.

DISCUSSION

The 20 patients in this study all had clear-cut motor signs of an ulnar nerve lesion: selective and profound wasting and weakness of the interossei and hypothenar muscles was the hallmark. We took care to exclude patients with thenar involvement or symptoms and signs of cervical nerve root or brachial plexus disease. Sensory disturbance in the ring and little fingers was not a required criterion and, in fact, was present in only one-half of the patients. This was somewhat surprising, but, from the neurophysiologic findings, there can be no doubt that sensory fibers were also affected. Several of the patients were uncomplaining as regards their hands. This contrasts with patients suffering from diabetic retinopathy, in whom sensory symptoms predominate, with few patients complaining of muscle weakness.[4] It is noteworthy that a recent study of muscle power in longstanding type I diabetic patients demonstrated significant weakness in the lower limb, but not upper limb, muscle strength.[5]

Community based studies suggest that the prevalence of ulnar neuropathy in diabetic patients may be of the order of 2%.[6] Our figure of 1% (20 patients from about 2000 attending a diabetes center) is lower despite the selected population we screened, presumably because we did not include patients with principally sensory involvement. In any case, it is clear that the problem is not rare and that the ulnar nerve should be high on the list of limb mononeuropathies in diabetes.[7] While this may seem obvious to those involved in the diagnosis and management of diabetes, it has not been carefully documented in the literature. Small muscle wasting in the hands is easy to observe and should alert the observer to the possibility that a diabetic patient has other major long-term complications. Moreover, as the majority of patients in the current series had type II diabetes, which often presents with long-term complications, the presence of unexplained muscle wasting should suggest the possible diagnosis of diabetes.

It is worth highlighting some aspects of the patient profile in our cases. The male:female ratio was 4:1. Male predominance has previously been noted in diabetic ulnar nerve lesions,[1] by contrast with the much commoner occurrence of the carpal tunnel syndrome in female diabetic patients. Dominance, age, and type of diabetes were not relevant. All patients had signs of a distal symmetrical sensorimotor polyneuropathy in the lower limbs. Their high neurological disability scores[6] and very abnormal lower limb nerve conduction studies indicate that the background polyneuropathy was usually severe.

One of the most striking findings in our patients was the high incidence of diabetic complications, including not just retinopathy and renal failure but vascular disease. This is in keeping with previous reports.[1] Angina was common and no fewer than ten patients had had an amputation of a toe, foot, or leg for gangrene. It is also worth pointing out that the onset of hand symptoms was acute in one-quarter of the patients. These observations raise the possibility that ischemia is at the root of the ulnar nerve lesion in some of our patients.

Nerve conduction studies (NCS) showed absent or very reduced motor and sensory responses from the affected ulnar nerves, reflecting loss of axons. There was no comparable reduction in the response from the ipsilateral median nerves. The EMG finding of selective denervation in interossei and/or hypothenar muscles also indicates a severe axonal ulnar neuropathy. This can be interpreted in one of two ways: either the lesion was primarily compressive but so severe that axon loss ensued, or it was axonal from the onset (i.e., probably ischemic). Much hinges on the electrophysiologic localization of the lesion by either EMG or NCS.

The fact that flexor carpi ulnaris (FCU) and flexor

digitorum profundus (FDP) muscles were weak in just five patients and denervated (as judged by EMG) in only three might be taken to indicate that in the remainder the lesion was distal to the elbow. Alternatively, it could be that the axons innervating the hand muscles are more vulnerable to compression because they tend to be located medially in the ulnar nerve at the elbow.[8] Moreover, the motor branch to FCU sometimes leaves the ulnar nerve proximally to the medial epicondyle. In any event, ulnar neuropathies at the elbow frequently spare the forearm muscles.[9] In one series of surgically proven cubital tunnel syndrome, only five of 36 patients showed signs of clinical involvement of FCU.[2]

As regards nerve conduction studies, we took care to perform them with the arm always in the same position, namely flexed at 120° at the elbows.[10] We were able to demonstrate focal entrapment in only one-third of the affected nerves (slowing of motor conduction and/or motor conduction block across the elbow segment). Because NCS are not invariably abnormal in patients with the cubital tunnel syndrome,[11] it could be argued that in our patients the lesion may have been at the elbow even though we failed to prove that this was so. Having said that, the proportion of false negative motor conduction studies at the elbow in nondiabetic patients with a cubital tunnel syndrome is 10%–20%,[12] a far lower figure than the proportion of patients in our study without signs of entrapment at the elbow.

The balance of the neurophysiologic evidence in our cases suggests that there is a subgroup of patients with longstanding diabetes and major complications who have motor manifestations of a severe ulnar neuropathy, in whom the lesion is more than a simple compressive event at the elbow. Ischemia is a possible explanation in such cases, especially in unilateral lesions of acute onset. Ischemic mononeuropathies in cranial and peripheral nerves have been described before in association with diabetes mellitus.[13] Interestingly, in such cases the motor deficit often outweighs the sensory involvement, as in our patients. In instances where the ulnar nerve lesion is bilateral and concurrent it may be that both mechanisms are operating, namely, compression acting on nerves verging on ischemia. Indeed, it is possible that the elbow is a *locus minore resistentia* for both entrapment and vascular damage to the ulnar nerve due to repeated subclinical trauma and fibrosis.

These considerations guided our approach to treatment. We feared that ulnar nerves whose circulation was already compromised were vulnerable to further damage if subjected to surgical exploration, with little chance of recovery of function. Two of the patients whose NCS suggested entrapment of the ulnar nerve at the elbow underwent operative treatment. One had a simple decompression and the other an anterior transposition of the nerve, but neither improved. Surgery may, of course, still be the preferred treatment option in patients with a milder, predominantly sensory ulnar neuropathy, especially if the evolution is gradual and the lesion is picked up in its early stages.

In conclusion, it appears that severe motor ulnar neuropathy is not uncommon in male patients with diabetes and multiple complications, in whom the etiology may well be ischemic rather than simple compression. Surgical decompression may exacerbate rather than alleviate the condition in such cases.

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