Prevalence of Ulnar Neuropathy in Patients Receiving Hemodialysis

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Background: Ulnar neuropathy can cause pain, weakness, and sensory changes in the hand and can result in functional impairment. Patients with end-stage renal disease receiving hemodialysis may be predisposed to ulnar neuropathy by factors such as arm positioning during hemodialysis, underlying polyneuropathy, and upper extremity vascular access.

Objective: To determine the prevalence of clinically evident ulnar neuropathy in a cohort of 102 patients with end-stage renal disease receiving hemodialysis.

Design: All eligible patients in a single dialysis unit were screened for symptoms and signs of ulnar neuropathy. Those with at least 1 symptom or sign underwent nerve conduction studies to confirm the presence of ulnar neuropathy.

Results: Clinically evident, electrophysiologically confirmed ulnar neuropathy was present in 37 (51%) of the 73 subjects with both screening and nerve conduction study data available. The true prevalence of ulnar neuropathy in this cohort was estimated between 41% and 60%.

Conclusions: There is a high prevalence of ulnar neuropathy in patients with end-stage renal disease receiving hemodialysis, which has not been previously recognized. The high prevalence of ulnar neuropathy in this population suggests that preventative efforts are indicated to prevent this functionally limiting complication.


Ulnar Neuropathy Causes weakness and sensory changes in the hand and pain in the elbow and distal arm. Untreated ulnar neuropathy can lead to an ulnar “claw hand” with functional impairment. The ulnar nerve is prone to injury at the elbow, where it is subject to mechanical stretch and compression owing to its location in the ulnar groove. Risk factors for ulnar neuropathy include repetitive flexion of the elbow and sustained external pressure on the ulnar groove. Individuals with polyneuropathy appear more likely to develop secondary compressive mononeuropathies.1

Patients with end-stage renal disease (ESRD) receiving hemodialysis may be at increased risk for ulnar neuropathy. They often have underlying polyneuropathy from uremia2 3 or diabetes.4 Patients receiving hemodialysis spend many hours sitting in a dialysis chair with the forearm typically pronated so that the cubital tunnel is in contact with the flat surface of the arm rest; this may lead to compression of the ulnar nerve (Figure 1). Many patients receive hemodialysis through an arteriovenous fistula or a synthetic graft in the arm. The hemodynamic effects of vascular access or the repeated inflation of a blood pressure cuff during hemodialysis may lead to ischemia of peripheral nerves, increasing their vulnerability to compression.4 7 Lastly, tumoral calcinosis,8 amyloid deposition,9 10 and expanded extracellular fluid volume11 may also affect peripheral nerves in this population.

Estimates of the prevalence or incidence of ulnar neuropathy in the hemodialysis population range from 1% to 19%, with the higher figures including asymptomatic subjects.11 12 Based on our expe-
Table 1. Electrophysiologic Criteria

<table>
<thead>
<tr>
<th>Ulnar Neuropathy—Any of the Following:</th>
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<tr>
<td>1. ≥10-m/s drop in ulnar MCV across the elbow</td>
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<tr>
<td>2. Ulnar MCV across the elbow &lt;45 m/s (with a normal median MCV)</td>
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<tr>
<td>3. Ulnar SNAP ≤12 uV (with a normal median or radial SNAP)</td>
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<tr>
<td>4. Ulnar CMAP &lt;5 mV (with a normal median CMAP)</td>
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<tr>
<td>A. Mild to moderate: ulnar CMAP ≥3 mV</td>
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<tr>
<td>B. Moderate to severe: ulnar CMAP ≤3 mV or ulnar SNAP &lt;5 uV with a radial SNAP ≥12 uV</td>
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Median Neuropathy at the Wrist—Any of the Following:

1. Median DML absent or prolonged in relation to ulnar DML by ≥1.5 ms
2. Median DML prolonged in relation to ulnar DML by ≥1 ms on a lumbral/interosseous study
3. Median SNAP absent (if no polyneuropathy) or prolonged in relation to ulnar SNAP by ≥1 ms
   A. Mild to moderate: median CMAP ≥2.5 mV
   B. Moderate to severe: median CMAP <2.5 mV or median SNAP <5 uV with radial SNAP ≥12 uV

Polyneuropathy:
Radial SNAP amplitude <12 uV and ulnar + median MCV <48 m/s
   A. Mild to moderate: best radial SNAP 4.1-12 uV
   B. Moderate to severe: best radial SNAP ≤4 uV

Abbreviations: CMAP, compound muscle action potential; DML, distal motor latency; MCV, motor conduction velocity; SNAP, sensory nerve action potential.

Table 1. Electrophysiologic Criteria

<table>
<thead>
<tr>
<th>Method</th>
<th>Criteria</th>
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<tr>
<td>Antidromic sensory NCS</td>
<td>Ulnar SNAP ≤12 uV</td>
</tr>
<tr>
<td>Median DML</td>
<td>≥1.5 ms</td>
</tr>
<tr>
<td>Median SNAP</td>
<td>≥1 ms</td>
</tr>
<tr>
<td>Ulnar SNAP</td>
<td>≥5 uV</td>
</tr>
</tbody>
</table>

Figure 2. Study flow diagram. NCS indicates nerve conduction study.

ELECTROPHYSIOLOGIC STUDIES

Board-certified electromyographers performed all NCSs using a Synergy electromyograph (Oxford Instruments, New York, NY). We studied only subjects’ arms with symptoms or signs. We performed the following studies: antidromic sensory NCS of the ulnar nerve (recording digit V), the median nerve (recording digit II), and the superficial radial nerve (recording at the snuff box); and motor NCS of the median nerve (recording abductor pollicis brevis) and the ulnar nerve (recording abductor digiti minimi), performed with the elbow in 70° to 90° of flexion. The electromyographer performed a second lumbral-first palmar intersosseous comparative study if needed to clarify the presence of a median or ulnar nerve lesion at the wrist. Table 1 summarizes the electrophysiologic criteria used to define ulnar neuropathy, median neuropathy, and polyneuropathy. The criteria we used were stricter than the standard diagnostic criteria used in the BIDMC Electromyography Laboratory to minimize false-positive diagnoses.

STATISTICAL ANALYSIS

Comparisons of demographic variables between subjects with and without ulnar neuropathy were made using unpaired t tests. Analysis of the relationship between ulnar neuropathy and subject risk factors used the χ² test of significance. All analyses were performed using StatView statistical software (SAS Institute, Cary, NC).

RESULTS

SUBJECTS

During the study period, 102 patients received hemodialysis at Gambro Healthcare. Figure 2 illustrates the flow through the study of these individuals. Twelve patients did not meet inclusion criteria. We screened the remaining 90 subjects for symptoms or signs of ulnar neuropathy. Table 2 summarizes the clinical characteristics of this cohort.

ELECTROPHYSIOLOGIC FINDINGS

Of the 90 subjects, 62 (69%) had at least 1 symptom or sign suggestive of ulnar neuropathy in 1 or both arms and were thus eligible for NCSs. Complete NCS data were available for 45 (72%) of these 62 subjects. The NCS results confirmed the suspected ulnar neuropathy in 37
(82%) of these 45 subjects and in 52 (72%) of the 72 subjects’ arms studied. Twenty-two subjects had unilateral and 15 had bilateral ulnar neuropathy.

**Table 3** summarizes the electrophysiologic findings in the 52 arms diagnosed as having ulnar neuropathy. Twenty-three met more than 1 criterion for ulnar neuropathy. In the remaining 29, a single criterion was met, most often criterion 1 (focal slowing of motor conduction velocity [MCV] across the elbow). In 25 of these 29 arms, additional abnormalities involving the ulnar nerve were present, which did not meet established criteria; this was most often owing to the coexistent presence of polyneuropathy. In 19 of these 25 arms, the ulnar sensory amplitude was low, but criterion 3 was not met because the median and radial sensory amplitudes were also abnormal. In 3 additional arms, ulnar MCV across the elbow was abnormally slow, but criterion 2 was not met because the median MCV was slow as well. This left 4 arms in which there was no second, confirmatory abnormality for ulnar neuropathy; 1 had only slowing of MCV across the elbow compared with 7 (54%) of the moderate to severe ulnar neuropathies.

Of the 45 subjects who underwent NCSs, 24 (53%) had evidence for a median neuropathy at the wrist (6 [25%] of which were severe); 19 (42%) had concomitant ulnar and median neuropathies; 20 (44%) had evidence for polyneuropathy affecting the upper extremities, which was mild to moderate in 16 subjects and severe in 4; and 17 (45%) of the subjects with an ulnar neuropathy also had polyneuropathy. One patient had an ischemic monomelic neuropathy.

**CLINICAL FINDINGS**

Of subjects with an electrophysiologically confirmed ulnar neuropathy, 26 (71%) had signs of ulnar neuropathy and 23 (62%) had symptoms. **Figure 3** illustrates the distribution of symptoms and signs in arms with ulnar neuropathy. Objective weakness of finger spreaders was the most common symptom or sign and was present in a higher proportion of arms with moderate to severe ulnar neuropathy (12 [92%]) than with mild to moderate ulnar neuropathy (29 [74%]).

In 8 of the 43 subjects with symptoms or signs of ulnar neuropathy for whom electrophysiologic data were available, NCSs did not confirm ulnar neuropathy. Of
electrophysiologically confirmed ulnar neuropathy. Significantly longer than those with ulnar neuropathy. Subjects without ulnar neuropathy were receiving dialysis significantly longer than those with ulnar neuropathy except for the duration of dialysis. Sub-group variables between patients with and without ulnar neuropathy were similar. However, subjects with diabetes were more likely to have a long duration of dialysis. There were no statistically significant differences in demographic variables between patients with and without ulnar neuropathy. Of the cases with electrophysiologic confirmation of ulnar neuropathy and then that all did). All 17 subjects did not have an electrophysiologically confirmed ulnar neuropathy in this cohort. We estimate, however, that the true prevalence of clinically evident ulnar neuropathy in this population lies between 41% and 60%. Male sex and diabetes were no more likely to have an ulnar neuropathy than diabetics were diabetic; this combination was more likely in diabetic than in nondiabetic subjects ($\chi^2$, $P = .007$).

There was no significant association between any current or prior vascular access in the affected arm and an ulnar neuropathy ($\chi^2$, $P = .88$). When grafts and fistulas were examined separately in the 146 arms screened for ulnar neuropathy, there was a significant association between an ulnar neuropathy and an ipsilateral functioning graft ($\chi^2$, $P = .03$) but not an ipsilateral functioning fistula ($\chi^2$, $P = .85$).

Our results confirm that there is a high prevalence of ulnar neuropathy in patients with ESRD and receiving hemodialysis. Thirty-seven subjects (51%) met both clinical and electrophysiologic criteria for ulnar neuropathy, with the true prevalence of clinically evident ulnar neuropathy in this cohort estimated between 41% and 60%.

Our decision to diagnose ulnar neuropathy based on a single ulnar NCS abnormality raises the possibility of overdiagnosis. However, we believe that the false-positive rate was low for the following reasons: (1) most arms (15/29) diagnosed as having ulnar neuropathy by a single criterion showed slowing of ulnar MCV across the elbow (ie, criterion 1 or 2; this is an accepted diagnostic criterion with specificity reported at $\approx 95\%$) and (2) all but 3 of the 14 arms which met only criterion 3 (ie, low ulnar sensory or motor amplitudes) had a second, internally consistent abnormality in the ulnar nerve that did not meet criteria, usually owing to the presence of coexistent polyneuropathy.

This study suggests that the prevalence of ulnar neuropathy in patients receiving hemodialysis is higher than previously recognized. Prior studies of prevalence were retrospective reviews of only cases that came to medical attention or reports of ulnar neuropathies found incidentally in studies of carpal tunnel syndrome. To our knowledge, this is the first study to screen an entire cohort of patients specifically for ulnar neuropathy.

The factors responsible for the high incidence of ulnar neuropathy in this population are unknown. Male sex and high or low body mass index, which are risk factors in other populations, were not risk factors. In contrast to prior findings, diabetes was not an independent risk factor, but it was clearly associated with more severe ulnar neuropathies. Amyloidosis, tumoral calcinosis, and edema could have played a role in individual subjects; we did not assess for these potential risk factors.

The correlation between an ulnar neuropathy and an ipsilateral graft, as opposed to an ipsilateral fistula or central venous access, suggests that nerve ischemia may be a contributing factor. The hemodynamics of grafts differs from that of fistulas because blood flow through a graft is more likely to ultimately decline. In addition, grafts are usually reserved for subjects whose native blood vessels are inadequate for a fistula or who have failed fistula placement, in whom the potential for nerve ischemia may be higher.

The localization of most ulnar nerve lesions to the elbow supports the hypothesis that external compression...
A similar observation has been made in patients with diabetes; many (42%) had numbness or tingling and only 11 (29%) had pain.

This cohort, none of the subjects were aware that they had receiving hemodialysis often presents without sensory symptoms or signs of ulnar neuropathy, but the presence and/or severity of polyneuropathy may be a risk factor for ulnar neuropathy in this population as well.

A median neuropathy was present in 33 (46%) of arms studied. Because signs and symptoms of median neuropathy were not screening criteria for electrophysiologic testing, this does not represent the true prevalence of median neuropathy in this population. Nonetheless, the many concomitant ulnar and median neuropathies (19 subjects [42%]) supports an underlying vulnerability of the peripheral nerves in this population to compression. This finding confirms that of Delmez et al,11 who found both ulnar and median nerve involvement in 31% of patients receiving chronic hemodialysis.

Despite the high prevalence of ulnar neuropathy in this cohort, none of the subjects were aware that they had a mononeuropathy. Ulnar neuropathy in patients receiving hemodialysis often presents without sensory symptoms; only 19 (52%) of the subjects with ulnar neuropathy had numbness or tingling and only 11 (29%) had pain. A similar observation has been made in patients with diabetes.18 Patients who are receiving hemodialysis should be screened for symptoms or signs of ulnar neuropathy and referred for electrophysiologic testing because the treatment for ulnar neuropathy differs from that of carpal tunnel syndrome, polyneuropathy, or ischemia.

The high prevalence of ulnar neuropathy in this population suggests that preventative efforts are justified. Patients and staff in hemodialysis units should be taught the location of the ulnar nerve and instructed to avoid arm positions that can cause nerve compression (e.g., elbow resting on a hard surface with the forearm pronated, or prolonged elbow flexion >30°). Although many dialysis chairs have padded arms, additional protection, such as a block of “memory foam,” could be added. In patients with symptoms or signs of ulnar neuropathy, an elbow pad should be worn which restricts flexion and pads the nerve. For moderate to severe ulnar neuropathies that do not respond to conservative measures, surgery should be considered. Although there is little controlled data guiding the choice of procedure, in this population in whom external compression is a likely contributing cause, anterior transposition of the nerve makes theoretical sense.

Previous studies documenting a high incidence of postoperative compressive ulnar neuropathy have led to preventative measures in operating rooms designed to prevent ulnar nerve compression. Although these changes have not eliminated postoperative ulnar neuropathy, there is some evidence that they have reduced its incidence.14 The improved survival of hemodialysis patients and the shortage of kidney transplants for the growing ESRD population has increased the length of time spent receiving hemodialysis, making the recognition and prevention of functionally limiting complications such as ulnar neuropathy increasingly important. Greater awareness of the high prevalence of ulnar neuropathy in patients receiving hemodialysis should lead to changes in dialysis delivery and more vigilant screening for this complication. These measures should reduce the incidence of ulnar neuropathy in this population.

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REFERENCES