ORIGINAL ARTICLE

Evaluation of Ulnar neuropathy on hemodialysis patients

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Background: Ulnar nerve entrapment at the elbow is the second most common upper extremity nerve involvement after median nerve involvement at the wrist or carpal tunnel syndrome (CTS) considering the frequency of occurrence in the upper limb with variable causes. Hemodialysis, because of elbow positioning during dialysis, upper extremity vascular-access, and underlying disease is one cause of ulnar entrapment. This study considers evaluating the effect of elbow positioning on ulnar involvement prevalence during dialysis. **Materials and Methods:** This cross-sectional study started in June 2011 and completed in December 2011. The patients receiving dialysis with at least one symptom or sign of ulnar nerve involvement underwent nerve conduction studies. Electromyography testing (EMG) performed to confirm the ulnar neuropathy. To review the ulnar nerve, patients must be in supine position with arm in 90° abduction and elbow in 135° flexion. We stimulated the ulnar nerve at three different points, including 6 cm above and 4 cm below the elbow and over the wrist. According to the electrophysiological data, the intensity of nerve entrapment and possibility of associated polyneuropathy determined. **Results:** Clinically and electrodiagnostically, evidence confirmed that ulnar neuropathy was present in 11 (27.5%) of 40 hemodialysis patients and in 10 (25%) of 40 peritoneal patients (*P* value: 0.83). Also, the prevalence of median neuropathy in hemodialysis and peritoneal dialysis patients was 14 (35%) and 10 (25%), respectively (*P* value: 0.33). **Conclusion:** The frequency of median and ulnar neuropathy in hemodialysis patients is more than peritoneal dialysis, but this different is not significant. In addition, comparing sitting position with prolonged elbow flexion and supine position with elbow extension during hemodialysis, recommended doing hemodialysis in later position with using an elbow pad.

Key words: Hemodialysis, neuropathy, peritoneal dialysis, renal failure, ulnar nerve

INTRODUCTION

Tardy ulnar palsy is a delayed conflict which caused by elbow fracture, previous trauma or gradual onset of osteoarthritis and valgus deformity of bone.[1-3] Cubital tunnel is the region in the aponeurosis of two heads of the flexor carpi ulnaris (FCU) muscle. Ulnar nerve entrapment at the elbow area is the second upper extremity nerve involvement after median nerve's involvement at wrist or carpal tunnel syndrome (CTS) considering the frequency of occurrence on focal neuropathy in the upper limb.[2,4,5] Since the ulnar nerve in the post-condylar grooves is exposed to frequent traumatic events, acute low insults of the ulnar nerve at the elbow is quite common and generally resolves quickly. When significant trauma occurs and its effects-paresthesia and numbness-does not abate, or hand intrinsic weakness ensues, patients often seek medical attention. Most people tolerate these symptoms, because they may progress slowly over months and years, and the median nerve provides most of the cutaneous sensation of hand. Muscle weakness and wasting appeared when the patient comes to seek treatment.[5] Second place in the focal involvement of ulnar nerve at the wrist is called Guyon's canal.[3] Ulnar nerve can be involved in the hand, between the elbow and wrist, or above elbow.[2]

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If the ulnar neuropathy at the elbow or wrist was not diagnosed or treated properly, it leads to functional impairment because of prolonged axonal degeneration.[2] Ulnar nerve entrapment causes pain, weakness and sensory disturbance in fifth finger and medial side of fourth finger and the feeling of numbness, tingling or burning. It also brings about the atrophy of muscles innervated by ulnar such as first dorsal interosseous muscle and hypothenar muscles and weakness in gripping the objects.[2,6]

People who undergo the hemodialysis are prone to ulnar neuropathy, because of polyneuropathy caused

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by underlying disease such as diabetes or renal failure (ESRD), vascular-access and upper extremity position during hemodialysis.[7,8] In addition, patients with renal failure have high levels of urea and other nitrogenous compounds in the blood, and both central and peripheral nervous systems abnormalities can result from the increase of these compounds.[9-12] About 60% of patients with renal failure develop peripheral neuropathy as numbness, tingling and a feeling of extreme sensitivity to normally non-painful stimuli that often improve with a successful dialysis. Also, some mononeuropathies like CTS, ulnar neuropathy at the elbow and peroneal nerve neuropathy at the fibula head in patients with kidney failure is common. Median and ulnar ischemic mononeuropathy secondary to the creation of an arteriovenous shunt in the arm for dialysis may occur.[13] In most countries during hemodialysis, elbow flexionand forearm pronation [Figures 1, 2] is a frequent position in which continuous pressure on the ulnar groove conflicts ulnar nerve.[6] The study conducted in 2005 through 90 hemodialysis patients confirmed that ulnar neuropathy was present in 37 (51%) of the 73 subjects with both screening and nerve conduction

Figure 1: Location of shunt and position of forearm during hemodialysis

Figure 2: Routine supine position in Iranian patients during hemodialysis

data available. In that study, there was no control group to determine the incidence of ulnar nerve involvement in hemodialysis patients. On the other hand, hemodialysis in Iran commonly performs on supine position with elbow extension.

We decided to investigate the incidence of ulnar involvement in hemodialysis patients and the effect of elbow positioning during dialysis on ulnar neuropathy. We chose a control group of patients who had undergone peritoneal dialysis, because these people had relatively similar systemic condition considering renal failure of the hemodialysis patients, however, they did not need to have a sustain position of the upper extremity during dialysis.

MATERIALS AND METHODS

This is a cross-sectional study on hemodialysis and peritoneal dialysis patients in Al-Zahra and Khorshid hospitals. This study started based on project number: 390121 in June 2011 and completed in December 2011. Forty hemodialysis and 40 peritoneal dialysis patients considered as case group and control group, respectively.

Our inclusion criteria to elicit patients were as follows: Receiving three-month dialysis at least, having more than 18 years old and medication stability, using a fistula in the cubital or radial area in hemodialysis patients. Any history of upper limbs deformity or fracture, make the patients excluded from this study.

At First, we screened the patients for signs and symptoms of ulnar nerve involvement, including numbness and tingling of fifth finger, weakness of hand, pain in elbow area, decrease of pinprick sensation in 5th finger in comparison with 2nd finger.[5] Patients with at least one of this signs and symptoms were selected for nerve conduction study (NCV) in ulnar, median and superficial radial nerves. To review the ulnar nerve, patients must be in supine position with arm in 90° abduction and elbow in 135° flexion.[5] We stimulated the ulnar nerve at three different points, including 6 cm above and 4 cm below the elbow and over the wrist.[5] If nerve involvement were found, we would have evaluated NCV of contralateral upper limb and two lower limbs as the next step, to detect underlying polyneuropathy. After diagnosing polyneuropathy, it should be done the evaluation of associated ulnar nerve entrapment by electromyography (EMG) of first dorsal interosseous or abductor digiti minimi.

Electrodiagnostic criteria and severity of nerve involvement is shown in Table 1[6] and also includes of:

1. NCV <50 m/s for the sensory response across the elbow (above-elbow to below-elbow).[14]
2. NCV <49 m/s for the motor response across the elbow

Table 1: Electrophysiologic criteria[6]

Ulnar neuropathy - any of the following
≥10-m/s drop in ulnar MCV across the elbow
Ulnar MCV across the elbow <45 m/s (with a normal median MCV)
Ulnar SNAP ≤12 μV (with a normal median or radial SNAP)
Ulnar CMAP <5 mV (with a normal median CMAP)
A. Mild to moderate: Ulnar CMAP >3 mV
B. Moderate to severe: Ulnar CMAP ≤3 mV or ulnar SNAP <5 μV with a radial SNAP ≥12 μV
Median neuropathy at the wrist - any of the following
Median DML absent or prolonged in relation to ulnar DML by ≥1.5 ms
Median DML prolonged in relation to ulnar DML by ≥1 ms on a lumbrical/interosseous study
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 μV with radial SNAP ≥12 μV
Polyneuropathy
Radial SNAP amplitude <12 μV and ulnar + median MCV <48 m/s
A. Mild to moderate: Best radial SNAP 4.1-12 μV
B. Moderate to severe: Best radial SNAP ≤4 μV

CMAP: Compound muscle action potential; DML: Distal motor latency; MCV: Motor conduction velocity; SNAP: Sensory nerve action potential

Table 2: Demographic characteristics of hemodialysis and peritoneal dialysis patients

Baseline characteristic	Hemodialysis group	Peritoneal dialysis group	*P* value
Age (yr±SD)	51.6±13.04	50.1±17.4	>0.05
Sex (M/F)	20/20	26/14	>0.05
Duration of dialysis (month±SD)	43.2±41.6	26±18.5	0.02

Table 3: The frequency distribution of clinical data in hemodialysis and peritoneal dialysis patients

Clinical data of	Hemodialysis	Peritoneal dialysis	*P* value
	Number (%)	Number (%)	
Median nerve involvement	19 (47.5)	16 (40)	0.499
Ulnar nerve involvement	19 (47.5)	16 (40)	0.499
Peripheral neuropathy	22 (55)	11 (27.5)	0.01

(above-elbow to below-elbow).[15]

3. Finding a difference ≥10 m/s between the arm and above the elbow to wrist segment.[15]

Given the $n=(Z1+Z2)^2[P1\ (1-P1)+P2\ (1-P2)]/(P1-P2)^2$, sample size results in 40 people, at least in each group.

- Z1: 95% confidence that is 96.1.
- Z2: 80% power factor tests is 84.0.
- P1 and P2 is the estimation of the relative frequency of ulnar nerve involvement in hemodialysis and peritoneal dialysis patients who are 51% and 26%, respectively.[6]

The statistical analysis of the results was done by SPSS for Windows software (SPSS Inc., Chicago, IL, USA, version 18.0), Chi-square, Mann-Witney, Spear-Man and Independent T-test. In this study, the significance level was set at *P* value of less than 0.05.

RESULTS

In this study, 40 hemodialysis and 40 peritoneal dialysis patients were examined. Table 2 includes demographic information of patients. The mean duration of dialysis in the hemodialysis group was 43.2±41.6 months (3-144 months). The average duration of dialysis in the peritoneal dialysis group was 26±18.5 months (20-84 months) (*P* value: 0/02).

In the hemodialysis group, 50% of patients were male and 50% were female and in peritoneal dialysis patients 35%were female and 65% were male (*P* value >0.05).

Ninety five percent of patients in hemodialysis group had fistula in cubital area and only 5% of theme had radial fistula.

According to Chi-square test, we found that the frequency of clinical involvement of median and ulnar nerves (in examination) in the two groups under hemodialysis and peritoneal dialysis was not significantly different (*P* value: 0.49).

However, the frequency of peripheral neuropathy in hemodialysis group was significantly higher than this rate

Table 4: The frequency distribution of median and ulnar nerves involvement severity based on electrodiagnostic data in hemodialysis and peritoneal dialysis groups

The severity of nerve involvement	Median nerve		Ulnar nerve	
	Hemodialysis NO (%)	Peritoneal dialysis NO (%)	Hemodialysis NO (%)	Peritoneal dialysis NO (%)
No involvement	26 (65)	30 (75)	29 (72.5)	30 (75)
Mild	4 (10)	2 (5)	6 (15)	5 (12.5)
Moderate	7 (17.5)	7 (17.5)	3 (7.5)	3 (7.5)
Severe	3 (7.5)	1 (2.5)	2 (5)	2 (5)
P value	0.83		0.83	

in peritoneal dialysis patients (*P* value: 0.01). These findings are shown in Table 3.

Table 4 shows, respectively, the frequency distribution of median and ulnar nerves involvement severity in hemodialysis and peritoneal dialysis patients. According to Mann-Whitney test, the severity of these nerves involvement in both groups suggested no significant differences (*P* value: 0.83 and *P* value: 0.83 for nerves for median and ulnar nerves, respectively).

There was a direct relation between severity of median and ulnar nerve involvement and duration of peritoneal dialysis (spearman relation test; r: 0.317, *P* value: 0.02 and r: 0.266, *P* value: 0.04, respectively).

The relation between duration of hemodialysis and severity of median nerve involvement was direct but not significant (r: 0.266, *P* value: 0.04) and there was not such a relation about the ulnar nerve of these patients (r: 0.216, *P* value: 0.09).

Spear-Mann test showed that there was a direct and significant relation between severity of ulnar nerve and median nerve involvement in hemodialysis and peritoneal dialysis groups (r: 0.677, *P* value: 0.001 and r: 0.379, *P* value: 0.01, respectively).

In Table 5, we determined that there was a significant relation between presence of peripheral neuropathy and the severity of ulnar and median nerves involvement (Mann-Whitney, *P* value <0.001 for nerves).

Table 6 shows that patients with a fistula in the left upper extremity had more median and ulnar nerve involvement at the left side (*P* value: 0.03, *P* value: 0.04, respectively). However, given the low samples with fistula in the right upper extremity, such relation could not be reached for the right median and ulnar nerves (Based on Mann-Whitney test).

DISCUSSION

In this study, the prevalence of ulnar neuropathy in peritoneal dialysis and hemodialysis patients was 25% and 27.5%, respectively. But, in another study conducted by Nardin *et al*. in 2005 on hemodialysis patients, this rate was 51%.[6] Thus, both studies showed that the prevalence of ulnar neuropathy in dialysis patients was more than previous estimates (1-19%).[14,15]

Our study revealed that there was no significant difference in prevalence of ulnar neuropathy between hemodialysis and peritoneal dialysis patients. However, the prevalence of ulnar neuropathy in these two groups is much lower than the reached estimates in the study conducted by Nardin *et al*.[6] This difference could be caused by different elbow positioning during hemodialysis in these two studies.

We considered the peritoneal dialysis patients as a control group. Because they matched the hemodialysis patients (case group) in age, sex and clinical condition, but they had no prolonged elbow positioning during dialysis to evaluate the effect of elbow positioning on ulnar neuropathy incidence. Then we found that the prevalence of ulnar neuropathy had no significant difference in

Table 5: The frequency distribution of median and ulnar nerves involvement based on presentation of peripheral neuropathy

The severity of nerve involvement	Median nerve		Ulnar nerve	
	Peripheral neuropathy		Peripheral neuropathy	Peripheral neuropathy
	(-) NO (%)	(+) NO (%)	(-) NO (%)	(+) NO (%)
No involvement	43 (91.5)	13 (39.4)	44 (93.6)	15 (45.5)
Mild	1 (2.1)	5 (15.2)	3 (6.4)	8 (24.2)
Moderate	3 (6.4)	11 (33.3)	0	6 (18.2)
Severe	0	4 (12.1)	0	4 (12.1)
P value	<0.001		<0.001	

Table 6: The severity of median and ulnar nerves involvement according to side of fistula

Severity of left nerve involvement	Median nerve		Ulnar nerve	
	Fistula on the		Fistula on the	
	Left side	Right side	Left side	Right side
	NO (%)	NO (%)	NO (%)	NO (%)
No involvement	23 (62.2)	3 (100)	27 (73)	3 (100)
Mild	4 (10.8)	0	6 (16.2)	0
Moderate	7 (18.9)	0	2 (5.4) 0	0
Severe	3 (8.1)	0	2 (5.4)	0
P value	0.03		0.04	

these two groups. These findings could suggest that the elbow positioning had no effect on the incidence of ulnar neuropathy in Iranian hemodialysis patients. In the study conducted in 2005, the incidence of ulnar nerve involvement in hemodialysis patients was reported 51% (41-60%) and in these patients, the elbow position was about 70-90° flexion during dialysis.[6] Therefore, supine positioning with elbow extension of patients during dialysis in Iran could take a protective effect on the ulnar neuropathy. However, in the study of Nardin *et al*., a control group was not considered.

Also in our study, there was no relation between duration of hemodialysis and ulnar nerve involvement, like as finding of that one study.[6] This relation for peritoneal dialysis group was direct and significant likely because of insufficiency dialysis and increase edema caused by it. It became clear that there is a direct relation between ulnar and median nerve involvement, which is true in hemodialysis and peritoneal dialysis groups. This result was also gotten in the study conducted in 2005.[6]

On the other side, the direct relation between the existence of fistula and increased severity of ipsilateral median and ulnar neuropathy may be explained by edema caused by the fistula, and systemic effect of higher vascular pressure in the same side.[16-18]

In evaluation of the peripheral neuropathy in hemodialysis and peritoneal dialysis groups detected by electrodiagnostic evaluation of contralateral upper limb and lower extremities - if indicated - we found that the incidence in hemodialysis patients was more than other groups.

There was a significant relation between peripheral neuropathy and severity of ulnar and median nerve's involvement. So similar to the Nardin *et al*. results, we may consider peripheral neuropathy as a risk factor for ulnar neuropathy in dialysis patients.

In our study, the screening for symptoms of median neuropathy was taken into consideration, and electrodiagnostic test was conducted. The prevalence of median neuropathy had no significant difference between two groups of hemodialysis and peritoneal dialysis patients (35% and 25%, respectively). However, in that one study, this amount was 46%, and true prevalence of median neuropathy did not find because screening was not its purpose.[6] The results showed a direct relation between the involvements of the ulnar nerve and median neuropathy that protective effect of elbow positioning during dialysis on the incidence of median neuropathy might explain this finding.

The fistula itself might be considered as a risk factor for ulnar neuropathy; however, all dialysis patients of our study had cubital fistula and only two patients had a radial fistula with no evidence of ulnar neuropathy. It seems that radial fistula compared with cubital fistula, have a protective effect against the incidence of ulnar neuropathy dialysis patients. This issue was not noted in Nardin *et al*. study.[6] So, given the low samples with radial fistula, further studies is required to confirm this finding.

Noting to results of this study and Nardin *et al*. study, it is recommended to evaluate dialysis patients in periodic examination concerning initial signs and symptoms of ulnar neuropathy for early diagnosis and treatment.

CONCLUSION

The frequency of median and ulnar neuropathy in hemodialysis patients is more than peritoneal dialysis, but this different is not significant. In addition, comparing sitting position with prolonged elbow flexion and supine position with elbow extension during hemodialysis, recommended doing hemodialysis in later position with using an elbow pad. And given that dialysis patients are more prone to ulnar neuropathy, frequent or prolonged elbow flexion and extension, and protracted pressure over the post-condylar groove should be avoided.

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