Original Research Article

Assessment of electrophysiological findings by nerve conduction study in the chronic kidney disease patients

Chaudhari Abdul Hameed Abdul Shikur[1], Ashish Baban Kundalwal[2*]

[1]associate Professor, [2]Resident, Department of Medicine, MIMSR Medical College, Latur, Maharashtra, INDIA.
Email: laturcritical@gmail.com

Abstract

Background: Peripheral polyneuropathy is most common CKD related complication with prevalence of more than 60%. Neuropathy in CKD is distal, symmetrical, mixed sensory motor polyneuropathy affecting lower limbs greater than upper limbs. The prevalence of peripheral neuropathy is directly proportional to duration and severity of CKD. **Amis and objective:** To assess electrophysiological findings by nerve conduction study in the chronic kidney disease patients **Materials and Method:** In the present study all the patients visiting to tertiary health care centre of CKD patients (according to KDIGO guidelines) and willing to give informed consent were included as Cases. During the study period total 90 cases of which 60 patients who were receiving conservative management without HD included in pre HD group and 30 patients who were on HD included in HD group. **Results:** Out of 60 pre HD patients, 33 (55%) showed peripheral neuropathy. Out of 30 HD patients, 24 (80%) showed peripheral neuropathy. Out of total 90 patients, 57 (63.33%) showed peripheral neuropathy. The difference in pre HD and HD was statistically significant ($p<0.05$). Majority of the patients suffering from neuropathy were belonging to the age group of 45-54years (35.09%) followed by 35-44years (19.30%). Majority of the patients were male (68.42%). Majority of the patients (40.35%) diagnosed with neuropathy were suffering from CKD for more than 5 years. Pure sensory type of PN found in 6 (18.18%) patients in pre HD group, 4 (16.67%) patients in HD group. Total 10 (17.54%) patients showed pure sensory type of PN. Pure motor type of PN was not present in any patient. Sensory-motor type of PN found in 27 (81.82%) patients in pre HD group, 20 (83.33%) patients in HD group. Total 47 (82.46%) patients showed sensory- motor type of PN. **Conclusion:** Thus we conclude that Peripheral neuropathy is very common in CKD, more common in dialysis patients as compared to predialysis patients. It's frequency and severity increases as the duration of disease and stage of CKD increases and Sensory motor type of neuropathy is more common than pure sensory type of neuropathy. Distal symmetrical sensory motor neuropathy is common type of neuropathy, which is more in lower limbs than upper limbs. Pure axonal sensory motor and mixed (axonal + demyelinating) sensory motor neuropathy are common patterns of PN in CKD.

Key Words: chronic kidney disease.

***Address for Correspondence:**
Dr. Ashish Baban Kundalwal, Resident, Department of Medicine, MIMSR Medical College, Latur, Maharashtra, INDIA.
Email: laturcritical@gmail.com

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INTRODUCTION

Chronic kidney disease (CKD) encompasses a spectrum of different pathophysiological processes associated with abnormal kidney function and progressive decline in glomerular filtration rate (GFR).[1] CKD has become a major cause of morbidity and mortality. In the 2015 Global Burden of Disease Study, kidney disease was the 12th most common cause of death and CKD ranked as the 17th leading cause of morbidity worldwide. [2]CKD is of diverse etiology like diabetic nephropathy, hypertensive nephrosclerosis, glomerulonephritis, chronic interstitial nephritis, obstructive uropathy, renovascular, genetically mediated. In western countries, diabetes and hypertension

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account for over 2/3rd of the cases of CKD.[3] Diabetes and hypertension are also gaining status of potential epidemic in India.[4,5] These two diseases account for 40–60% cases of CKD in India.[6]Peripheral polyneuropathy is most common CKD related complication with prevalence of more than 60%.[7] Neuropathy in CKD is distal, symmetrical, mixed sensory motor polyneuropathy affecting lower limbs greater than upper limbs. The prevalence of peripheral neuropathy is directly proportional to duration and severity of CKD.[8] Peripheral neuropathy becomes evident after the patient reaches stage 4 CKD, but electrophysiological evidences occurs earlier. Initially sensory nerves are involved more than motor. If dialysis is not instituted soon after onset of sensory abnormalities, motor involvement follows including muscle weakness. Evidence of peripheral neuropathy without another cause (e.g. diabetes mellitus) is an indication of renal replacement therapy.[1] Electrophysiological testings for peripheral nerves can be done by nerve conduction study (NCS) and by electromyography (EMG).[9] Electrodiagnostic studies help in peripheral neuropathy by confirming the site of lesion, assessment of fiber type involvement (motor, large sensory, small fiber: sensory and autonomic), distribution of nerve involvement (distal symmetric, polyradiculoneuropathy, multiple mononeuropathies or mononeuropathy multiplex, upper/lower extremity predominant), identifying the underlying pathophysiologic process (axon loss, demyelination, mixed, channelopathy), determining the severity of fiber involvement (mild, moderate, severe), monitoring recovery or treatment effect.[10]In EMG motor unit lesions of both nerves and muscles can be detected, but in NCS only lesions of nerves can be detected of both motor and sensory nerves. NCS is an important means of evaluating the functional integrity of peripheral nerves and has implications regarding clinical course and prognosis. NCS when supplemented with meticulous neurological assessment can provide invaluable input. Therefore the present study was conducted for evaluation of peripheral neuropathy, clinically and electrophysiologically by NCS in CKD patients.

AMIS AND OBJECTIVE

To assess electrophysiological findings by nerve conduction study in the chronic kidney disease patients

MATERIALS AND METHOD

The present cross sectional, descriptive study was undertaken to study clinical and electrophysiological findings by nerve conduction study of peripheral neuropathy in CKD patients in the department of medicine of tertiary care institute. The study was conducted in October 2016 to October 2018.All the patients visiting to our tertiary health care centre in OPD, wards, HD centre, during the time frame of study and fulfilling the following study criteria of CKD were included in the study.

Inclusion Criteria:

- All the diagnosed CKD patients (according to KDIGO guidelines) and willing to give informed consent were included as Cases.
- Serum creatinine more than 2 mg %.
- eGFR < 45 ml/min/1.73m2 (stage G3b, G4, G5 of CKD) which is calculated by MDRD (Modification of Diet in Renal Disease) formula.
- Abnormalities on renal imaging (e.g. Ultrasound abdomen — kidney size < 9 cm with loss of corticomedullary differentiation.)

Exclusion Criteria:

- Patients with preexisting peripheral neuropathy before the diagnosis of CKD or with other recognizable risk factors for peripheral neuropathy were excluded from the study (e.g. Diabetes mellitus, Alcoholism, Drug induced peripheral neuropathy, Hansen's disease)
- Patients with collagen vascular disorders, amyloidosis, or any primary neurologic disorder.
- Patients on peritoneal dialysis and kidney transplant recipients.
- Patients on immunosuppressants and steroids.

Thus during the study period total 90 cases of which 60 patients who were receiving conservative management without HD included in pre HD group and 30 patients who were on HD included in HD group. Pre HD group 60 patients had not received any cycle of HD previously. Patients on HD group were receiving 1 to 2 cycles of HD per week for 3 to 5 hours per session, since they were diagnosed as CKD. All patients were receiving multivitamins tablets, antihypertensive and lipid lowering medications. The study was approved by the Ethical Committee of the institute**.** For all the patients in the study a proforma was given after a written informed consent. The proforma was filled by interviewing the patient. The proforma (given in the annexure IV) which includes socio-demographic details like name, age, sex, address, occupation, detailed history of symptoms, ongoing treatment, general physical and neurological examination, biochemical investigations including blood urea, serum creatinine and serum electrolytes were measured in all the patients as per the standard methods used in the department of biochemistry, radiological investigations and nerve conduction study.All patients were requested to give a detailed description of the character and localization of sensory symptoms, time of onset, its progression. Symptoms for peripheral

neuropathy like numbness, pins and needle sensation, defective appreciation of pain and weakness, thinning of muscles were noted. Each patient was subjected to a detailed physical examination which included testing of sensitivity to touch, pin prick, temperature, vibration, joint position sense, bulk and tone of muscles, strength of muscles (grading of weakness was done as per Medical Research Council Scale) and deep tendon reflexes. The results were entered in a standard proforma. All 90 cases were subjected to the standard protocols of nerve conduction studies (NCS) using NCS machine: Octopus 2 CH – NCS / EMG / EP. The room temperature was kept at 25-28°C. The filters were set at 2-5 kHz for the motor studies and at 20-2kHz for the sensory studies. The sweep speed was set at 5ms/division for the motor studies and at 2 ms/division for the sensory studies. A stimulus duration of 50 ¼s to 1000 ¼s and a current of 0–100 mA are required for an effective nerve stimulation. The supramaximal stimuli were delivered in order to get adequate responses.[11]For HD group, 2 days after HD cycle, clinical, neurological examinations were done and blood investigations were performed following which NCS was done. NCS procedure was done for both motor conductions and sensory conductions. For motor conductions median nerve, ulnar nerve, common peroneal nerve and posterior tibial nerve were assessed, in which distal latency, conduction velocity, amplitude and F wave were studied. For sensory conductions median nerve, ulnar nerve and sural nerve were assessed in which distal latency, conduction velocity and amplitude were studied. A standardized technique was used to obtain and to record the action potentials for the motor and sensory studies.[12]

RESULTS

Table 1: Comparison of peripheral neuropathy in pre HD and HD group

Peripheral Neuropathy	Pre HD pts.	No. of pts. on HD	Total
Pts. with Peripheral Neuropathy	33 (55%)	24 (80%)	57 (63.33%)
Pts. without Peripheral Neuropathy	27 (45%)	06 (20%)	33 (37.77%)
No. of pts. examined (n = 90)	60	30	90

X^2= 5.38, df=2, p=0.02 (significant)

In our study there were total 90 CKD patients, of whom 60 patients were not on HD and 30 were on HD. Out of 60 pre HD patients, 33 (55%) showed peripheral neuropathy. Out of 30 HD patients, 24 (80%) showed peripheral neuropathy. Out of total 90 patients, 57 (63.33%) showed peripheral neuropathy. The difference in pre HD and HD was statistically significant ($p<0.05$).

Table 2: Comparison in patients with peripheral neuropathy with reference to age group

		Pre HD	HD	Total	Total %
Age group	15-24	2	1	3	5.26
	25-34	6	3	9	15.79
	35-44	7	4	11	19.30
	45-54	11	9	20	35.09
	55-64	4	4	8	14.04
	65-74	3	3	6	10.53
Sex	Male	21	18	39	68.42
	Female	12	6	18	31.58
Duration of illness	<1 year	4	2	6	10.53
	1-3 year	10	2	12	21.05
	3-5 year	9	7	16	28.07
	>5 year	10	13	23	40.35
	Total	33	24	57	100.00

It was observed that majority of the patients suffering from neuropathy were belonging to the age group of 45-54years (35.09%) followed by 35-44years (19.30%). Majority of the patients were male (68.42%) with male: female ratio of 2.17:1. Majority of the patients (40.35%) diagnosed with neuropathy were suffering from CKD for more than 5 years.

Table 3: No of patients affected with reference to type of peripheral neuropathy

Type of neuropathy	Pre HD (n=60)	HD (n=30)	Total (n=90)
Pure sensory	6 (18.18%)	4 (16.67%)	10 (17.54%)
Pure motor	0 (0%)	0 (0%)	0 (0%)
Sensory-motor	27 (81.82%)	20 (83.33%)	47 (82.46%)
Total	33 (100%)	24 (100%)	57 (100%)

Pure sensory type of PN found in 6 (18.18%) patients in pre HD group, 4 (16.67%) patients in HD group. Total 10 (17.54%) patients showed pure sensory type of PN. Pure motor type of PN was not present in any patient. Sensory-motor type of PN found in 27 (81.82%) patients in pre HD group, 20 (83.33%) patients in HD group. Total 47 (82.46%) patients showed sensory- motor type of PN. In this study sensory-motor type of PN was the predominant type (82.46%) found in study followed by pure sensory type of PN (17.54%).

Table 4: Pattern of peripheral neuropathy in pre HD and HD patients

Pattern of peripheral neuropathy	Pre HD (n=60)	HD (n=30)	Total (n=90)
Pure axonal sensory motor	15 (25%)	11(36.66%)	26 (28.88%)
Mixed sensory motor (axonal+demyelinating)	12 (20%)	9(30%)	21 (23.33%)

Pure axonal sensory motor pattern of PN found in 15 (25%) patients in pre HD group, 11 (36.66%) patients in HD group. Total 26 (28.88%) patients showed pure axonal sensory motor PN. Mixed (axonal + demyelinating) sensory motor pattern of PN found in 12 (20%) patients in pre HD group, 9 (30%) patients in HD group. Total 21 (23.33%) patients showed mixed sensory motor PN. In this study pure axonal sensory motor neuropathy (28.88%) was most common pattern followed by mixed (axonal + demyelinating) sensory motor (23.33%).

Table 5: Frequency of nerve conduction abnormalities in CKD patients

Nerve Conduction Parameters		Pre HD (n=60)	HD (n=30)	Total Pts. (n=90)
Median Nerve	Reduced CMAP	18 (30%)	15 (50%)	33 (36.66%)
	Reduced MCV	17 (28.33%)	11 (36.66%)	28 (31.11%)
	Prolonged mdL	10 (16.66%)	6 (20%)	16 (17.77%)
	F wave: Prolonged / Absent	30 (50%)	18 (60%)	48 (53.33%)
Ulnar Nerve	Reduced CMAP	16 (26.66%)	12 (40%)	28 (31.11%)
	Reduced MCV	15 (25%)	11 (36.66%)	26 (28.88%)
	Prolonged mdL	9 (15%)	9 (30%)	18 (20%)
	F wave: Prolonged / Absent	24 (40%)	19 (63.3%)	43 (47.77%)
Common Peroneal Nerve	Reduced CMAP	20 (33.33%)	19 (63.33%)	39 (43.33%)
	Reduced MCV	20 (33.33%)	18 (60%)	38 (42.22%)
	Prolonged mdL	15 (25%)	9 (30%)	24 (26.66%)
	F wave: Prolonged / Absent	22 (36.66%)	17 (56.66%)	39 (43.33%)
Posterior Tibial Nerve	Reduced CMAP	19 (31.66%)	17 (56.66%)	36 (40%)
	Reduced MCV	18 (30%)	16 (53.33%)	34 (37.77%)
	Prolonged mdL	15 (25%)	10 (33.33%)	25 (27.77%)
	F wave: Prolonged / Absent	28 (46.66%)	15 (50%)	43 (47.77%)
Median Nerve (sensory)	Reduced SNAP	28 (46.66%)	17 (56.66%)	45 (50%)
	Reduced SCV	26 (43.33%)	17 (56.66%)	43 (47.77%)
	Prolonged mdL	15 (25%)	12 (40%)	27 (30%)
Ulnar Nerve (sensory)	Reduced SNAP	30 (50%)	20 (66.66%)	50 (55.55%)
	Reduced SCV	28 (46.66%)	19 (63.33%)	47 (52.22%)
	Prolonged mdL	18 (30%)	15 (50%)	33 (36.66%)
Sural Nerve (sensory)	Reduced SNAP	31 (51.66%)	23 (76.66%)	54 (60%)
	Reduced SCV	32 (53.33%)	20 (66.66%)	52 (57.77%)
	Prolonged mdL	27 (45%)	18 (60%)	45 (50%)

In the preset study each nerve was tested to examine amplitude (amp), conduction velocity (CV) and distal latency (dL) and F wave. The frequency of abnormality of each parameter for individual nerve is shown in table no.5. Most common affected nerves were sural nerve, ulnar sensory nerve, median nerve followed by common peroneal and posterior tibial nerve. The total F wave abnormality in individual nerve as, for median nerve 48 (53.33%), for ulnar nerve 43 (47.77%), for common peroneal nerve 39 (43.33%), for posterior tibial nerve 43 (47.77%).

Table 6: Comparison of nerve conduction parameters in pre HD and HD pts

		Group	N	Mean	SD	T	P	Inference
	Median nerve Amp (mV)	Predialysis	60	6.53	1.72		0.020	
		Dialysis	30	5.66	1.47	2.367	(<0.05)	Significant
	Median nerve CV (m/s)	Predialysis	60	49.44	7.91		0.263	
		Dialysis	30	47.38	8.78	1.126	(>0.05)	Not Significant
	Median nerve dL (ms)	Predialysis	60	4.08	0.82		0.710	
		Dialysis	30	4.16	1.09	-0.373	(>0.05)	Not Significant
	Ulnar Nerve Amp (mV)	Predialysis	60	6.55	1.76		0.180	
		Dialysis	30	6.05	1.45	1.351	(>0.05)	Not Significant
	Ulnar Nerve CV (m/s)	Predialysis	60	49.36	7.84		0.287	
		Dialysis	30	47.47	8.01	1.072	(>0.05)	Not Significant
	Ulnar Nerve dL (ms)	Predialysis	60	2.86	0.73		0.109	
		Dialysis	30	3.12	0.76	-1.619	(>0.05)	Not Significant
	Common Peroneal Nerve Amp (mV)	Predialysis	60	4.71	1.60		0.140	
		Dialysis	30	4.17	1.73	1.490	(>0.05)	Not Significant
	Common Peroneal Nerve CV (m/s)	Predialysis	60	43.32	7.97		0.012	
		Dialysis	30	38.60	8.84	2.554	(<0.05)	Significant
MOTOR	Common Peroneal Nerve dL (ms)	Predialysis	60	4.11	1.04		0.157	
		Dialysis	30	4.46	1.20	-1.428	(>0.05)	Not Significant
	Posterior Tibial Nerve Amp (mV)	Predialysis	60	5.77	1.93		0.083	
		Dialysis	30	4.98	2.13	1.751	(>0.05)	Not Significant
	Posterior Tibial Nerve CV (m/s)	Predialysis	60	41.01	7.44		0.045	
		Dialysis	30	37.41	8.78	2.031	(<0.05)	Significant
	Posterior Tibial Nerve dL (ms)	Predialysis	60	4.16	0.92		0.049	
		Dialysis	30	4.68	1.52	-2.001	(<0.05)	Significant
	Median nerve Amp (µV)	Predialysis	60	10.51	3.39		0.283	
		Dialysis	30	9.68	3.53	1.081	(>0.05)	Not Significant
	Median nerve CV (m/s)	Predialysis	59	45.96	8.86		0.400	
		Dialysis	30	44.23	9.75	0.846	(>0.05)	Not Significant
	Median nerve dL (ms)	Predialysis	60	3.45	0.98		0.106	
		Dialysis	30	3.81	0.95	-1.632	(>0.05)	Not Significant
	Ulnar Nerve Amp (µV)	Predialysis	60	10.32	3.64		0.136	
		Dialysis	30	9.13	3.33	1.504	(>0.05)	Not Significant
	Ulnar Nerve CV (m/s)	Predialysis	60	46.49	9.15		0.132	
		Dialysis	30	43.35	9.43	1.521	(>0.05)	Not Significant
	Ulnar Nerve dL (ms)	Predialysis	60	2.56	1.17		0.107	
		Dialysis	30	2.97	1.05	-1.629	(>0.05)	Not Significant
SENSORY	Sural Nerve Amp (µV)	Predialysis	60	10.00	3.59		0.089	
		Dialysis	30	8.64	3.50	1.718	(>0.05)	Not Significant
	Sural Nerve CV (m/s)	Predialysis	60	41.79	10.67		0.413	
		Dialysis	30	39.84	10.59	0.822	(>0.05)	Not Significant
	Sural Nerve dL (ms)	Predialysis	60	2.89	1.31		0.011	
		Dialysis	30	3.73	1.70	-2.613	(<0.05)	Significant

The mean and standard deviation values for these parameters in pre HD and HD group are mentioned in the table no. 6. The difference between the pre HD and HD groups were statistically significant for the median nerve amplitude, common peroneal nerve CV, posterior tibial nerve CV, posterior tibial nerve distal latency and sural nerve distal latency ($p < 0.05$).

DISCUSSION

CKD is becoming epidemic in developed and developing countries.[13] CKD is a complex comorbid condition with multiple complications. Neurological complications occur in all levels of the nervous system. Peripheral neuropathy is most common neurological complication, resulting in significant morbidity and impairs patient's quality of life. The present study was undertaken to study clinical and electrophysiological findings of peripheral neuropathy in CKD patients and to correlate the electrophysiological findings by nerve conduction study with reference to the severity and duration of the chronic kidney disease. The findings were correlated with previous studies and results were compared.In our study, there were 60 patients in pre HD group of which 33 (55%) showed PN. Out of 30 HD patients, 24 (80%) showed PN. Out of total 90 patients, 57 (63.33%) showed PN. The difference in pre HD and HD was statistically significant ($p<0.05$). Sultan LI *et al*[14] study showed prevalence of PN in pre HD group was 60% and in HD group was 65%. The overall prevalence was 62.5%. There was no significant difference in two groups. Deniz *et al*[15] study had 68.5% PN in CKD patients who are on HD. Jasti DB *et al*[16] study showed out of 200 patients 178 (89%) had PN. Alagesan *et al*[17] study showed incidence of PN in CKD patients not on HD was 64.9%. Janda K *et al*[18] study showed out of 68 CKD patients on HD 59 (86.8%) had PN. Aggarwal HK *et al*[19] showed PN in 70% of the pre HD patients. These studies showed prevalence of PN in CKD varies from 60 to 90% and HD group was more predominantly involved than pre HD group, similar results were found in our study.It was observed that majority of the patients suffering from neuropathy were belonging to the age group of 45-54years (35.09%) followed by 35-44years (19.30%). Alagesan *et al*[17] study showed maximum PN in 35-44 age group (27.8%). Sultan LI *et al*[14] study showed maximum PN in > 50 years age group followed by 35-49 age group and 20-34 age group (44.44%). In our study maximum percentage of PN were found in 45-54 age group, which were almost similar to Alagesan *et al*[17] and Sultan *et al*[14] study results.In the present study, Majority of the patients were male (68.42%) with male: female ratio of 2.17:1. Alagesan *et al*[17] and Sultan LI *et al*[14] also observed male predominance in their studies. Majority of the patients (40.35%) diagnosed with neuropathy were suffering from CKD for more than 5 years followed was 3-5years of illness (28.07%). This shows that PN increases as the duration of disease increases. Alagesan *et al*[17] study showed 19.8% PN in <3 years of disease detection and 45.1% of patients had PN after > 3 years of disease detection. The incidence of PN was significantly correlated with duration of CKD ($P<0.001$). Sultan LI *et al*[14] study showed high significant difference in PN between the kidney disease duration < 5 years (15.39), 5-10 years (77.77%) and >10 years (100%). Pure sensory type of PN found in 6 (18.18%) patients in pre HD group, 4 (16.67%) patients in HD group. Total 10 (17.54%) patients showed pure sensory type of PN. Pure motor type of PN was not present in any patient. Sensory-motor type of PN found in 27 (81.82%) patients in pre HD group, 20 (83.33%) patients in HD group. Total 47 (82.46%) patients showed sensory- motor type of PN. In this study sensory-motor type of PN was the predominant type (82.46%) found in study followed by pure sensory type of PN (17.54%). Alagesan *et al*[17] study had 111 CKD patients out of which 72 showed PN. In which sensory motor neuropathy was in 38 patients (34.23%), sensory neuropathy was in 18 (16.21%) pts. and motor neuropathy was in 16 (20.51%) pts. Deniz *et al*[15] study had sensory motor neuropathy (76%) most common followed by pure sensory neuropathy (20%) and pure motor neuropathy (4%). Sensory-motor type of PN remained predominant not only in our study but also in that carried out by Alagesan *et al*[17] and Deniz *et al*[15]. Pure motor neuropathy was absent in our study while it accounted for 4% in the study by Deniz *et al*[15] and 20.51% in Alagesan *et al*[17]. In all the studies, sensory-motor was the predominant type of PN followed by sensory type, similar results were found in our study.In our study, in total 90 patients, pure axonal sensory motor pattern of neuropathy was present in 26 (28.88%) patients which was most common pattern followed by mixed sensory motor present in 21 (23.33%) (Table no. 10). Jasti DB *et al*[16] found pure axonal sensory motor neuropathy in 33% and mixed sensory motor neuropathy in 30% patients of predialysis group. In hemodialysis group, 42% patients had mixed sensory motor neuropathy and 18% patients had pure axonal sensory motor neuropathy. Sultan LI *et al*[14] study showed pattern of uremic neuropathy was axonopathic affecting the sensory fibers more than the motor fibers, distal more than proximal portions of peripheral nerves. As shown by these studies axonal sensory-motor is common type followed by mixed sensory-motor neuropathy, similar results were found in our study.NCS parameters were used for comparison the amp (amplitude), CV (conduction velocity) and dL (distal latency) were expressed in mean ± SD in each group.

Table 7: Comparison of NCS parameters in Pre HD group with other studies

NCS parameters		Present stydy Pre HD Pts.(n=60)	Jasti DB *et al*[16]	Sultan LI *et al*[14]	Aggarwal HK *et al*[19]
Median nerve	Amplitude(millivolts)	6.53 ± 1.72	6.9 ± 2.7	12.7 ± 5.5	NA
	CV (meters/sec)	49.44 ± 7.91	51.4 ± 4.7	55.6 ± 6.8	51.34 ± 6.07
	dL (milliseconds)	4.08 ± 0.82	3.8 ± 0.8	3.1 ± 0.6	NA
Ulnar nerve	Amplitude(millivolts)	6.55 ± 1.76	6.8 ± 2.2	13.8 ± 3.5	NA
	CV (meters/sec)	49.36 ± 7.84	52.3 ± 5.4	57.7 ± 6.5	53.04 ± 5.91
	dL (milliseconds)	2.86 ± 0.73	2.9 ± 2.1	2.6 ± 0.5	NA
Common Peroneal nerve	Amplitude(millivolts)	4.71 ± 1.60	2.8 ± 2.4	3.8 ± 2.5	NA
	CV (meters/sec)	43.32 ± 7.97	38.7 ± 14.5	43.5 ± 4.2	44.72 ± 6.14
	dL (milliseconds)	4.10 ± 1.04	3.5 ± 1.4	5.4 ± 1.3	NA
Posterior Tibial nerve	Amplitude(millivolts)	5.76 ± 1.93	5.9 ± 4.5	12.4 ± 5.0	NA
	CV (meters/sec)	41.0 ± 7.44	39.2 ± 12.9	42.9 ± 5.4	44.20 ± 5.17
	dL (milliseconds)	4.16 ± 0.92	3.7 ± 1.4	5.1 ± 1.0	NA
Median nerve (sensory)	Amplitude(microvolts)	10.51 ± 3.39	11.4 ± 9.1	NA	NA
	CV (meters/sec)	45.96 ± 8.86	43.7 ± 13.3	NA	NA
	dL (milliseconds)	3.45 ± 0.98	2.7 ± 0.9	NA	NA
Ulnar Nerve (sensory)	Amplitude(microvolts)	10.32 ± 3.64	7.8 ± 7.4	54.0±16.32	NA
	CV (meters/sec)	46.49 ± 9.15	39.2 ± 19.7	54.5 ± 5.4	NA
	dL (milliseconds)	2.56 ± 1.17	1.9 ± 0.9	2.9 ± 0.3	NA
Sural nerve (sensory)	Amplitude(microvolts)	10.0 ± 3.59	5.4 ± 6.9	9.8 ± 3.8	NA
	CV (meters/sec)	41.79 ± 10.67	29.4 ± 24.5	39.9 ± 5.4	NA
	dL (milliseconds)	2.89 ± 1.31	1.6 ± 1.4	3.9 ± 0.8	NA

The present study NCS results of pre HD group were compared with Jasti DB *et al*[16], Sultan LI *et al*[14], Aggarwal HK *et al*[19] studies and most of the parameters were showing similar results as shown in table given.

Table 8: Comparison of NCS parameters in HD group with other studies

NCS parameters		Present study HD Pts. (n=30)	Jasti DB *et al*[16]	Sultan LI *et al*[14]	Deniz *et al*[15]
Median nerve	Amplitude(millivolts)	5.66 ± 1.47	6.7 ± 2.5	9.6 ± 3.3	7.0 ± 3.2
	CV (meters/sec)	47.38 ± 8.78	49.6 ± 5.2	51.1 ± 3.9	54.2 ± 4.5
	dL (milliseconds)	4.16 ± 1.09	3.7 ± 0.6	4.2 ± 1.1	3.9 ± 0.6
Ulnar nerve	Amplitude(millivolts)	6.05 ± 1.45	6.3 ± 2.2	13.8 ± 3.4	8.3 ± 2.2
	CV (meters/sec)	47.47 ± 8.01	49.7 ± 6.7	56.9 ± 6.1	57.0 ± 4.9
	dL (milliseconds)	3.12 ± 0.76	2.7 ± 0.5	2.7 ± 0.5	NA
Common Peroneal nerve	Amplitude(millivolts)	4.17 ± 1.73	2.2 ± 1.9	3.6 ± 2.5	3.2 ± 2.0
	CV (meters/sec)	38.6 ± 8.84	36.9 ± 12.9	43.6 ± 4.9	40.8 ± 7.2
	dL (milliseconds)	4.46 ± 1.20	3.7 ± 1.2	5.4 ± 1.0	NA
Posterior Tibial nerve	Amplitude(millivolts)	4.98 ± 2.13	4.9 ± 3.8	11.3 ± 6.0	5.7 ± 2.5
	CV (meters/sec)	37.41 ± 8.78	37.4 ± 11.7	42.6 ± 4.4	37.3 ± 4.2
	dL (milliseconds)	4.68 ± 1.52	3.9 ± 1.3	5.3 ± 1.2	NA
Median nerve (sensory)	Amplitude(microvolts)	9.68 ± 3.53	11.9 ± 10.0	NA	NA
	CV (meters/sec)	44.23 ± 9.75	44.4 ± 11.2	NA	52.1 ± 5.5
	dL (milliseconds)	3.81 ± 0.95	2.8 ± 0.7	NA	NA
Ulnar Nerve (sensory)	Amplitude(microvolts)	9.13 ± 3.33	7.6 ± 6.9	51.78 ± 18.0	NA
	CV (meters/sec)	43.35 ± 9.43	43.1 ± 14.2	54.65 ± 5.42	52.6 ± 4.8
	dL (milliseconds)	2.97 ± 1.05	2.2 ± 0.7	2.9 ± 0.30	NA
Sural nerve (sensory)	Amplitude(microvolts)	8.64 ± 3.50	4.1 ± 4.7	10.67 ± 4.64	NA
	CV (meters/sec)	39.84 ± 10.59	32.9 ± 21.8	40.1 ± 5.92	32.5 ± 18.7
	dL (milliseconds)	3.73 ± 1.70	2.1 ± 1.4	3.93 ± 0.6	NA

In present study NCS results of HD group were compared with Jasti DB *et al*[16], Sultan LI *et al*[14], Deniz *et al*[15] studies and most of the parameters were showing similar results as shown in table given.

CONCLUSION

Thus we conclude that Peripheral neuropathy is very common in CKD, more common in dialysis patients as compared to predialysis patients. It's frequency and severity increases as the duration of disease and stage of CKD increases and Sensory motor type of neuropathy is more common than pure sensory type of neuropathy. Distal symmetrical sensory motor neuropathy is common type of neuropathy, which is more in lower limbs than upper limbs. Pure axonal sensory motor and mixed (axonal + demyelinating) sensory motor neuropathy are common patterns of PN in CKD.

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