

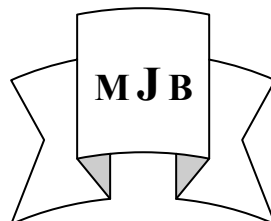
Physiological Study of Chronic Renal Failure According to Peripheral Neuropathy

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Abstract

Background: Chronic renal failure (CRF) is a pathological syndrome developed due to a progressive destruction of renal structures by chronic nephropathies. It is characterized by gradually increasing renal functions impairment. peripheral neuropathy is one of the most common neurological complications of CRF , the mechanism of production of neuropathy is that accumulation of slowly dialyzable middle molecules (500- 2000 Daltons) which may include methylguanidine, parathyroid hormones, $\beta 2$ microglobulin and myoinositol, can be correlated with the degree of neurotoxicity.

Objective: This study aims to estimate the variations in the peripheral nerve via electrophysiological changes in patients suffering from CRF on continuous hemodialysis with uremic peripheral neuropathy and without uremic peripheral neuropathy since the changes in these parameters are important in detecting, quantifying, identifying some possible risk factors and assessing patient's response to treatment.

Method: The study lasted from November/2010 to April /2011 in Marjan Teaching Hospital.. The study was carried out on 100 persons (70 patients and 30 healthy persons as a control group) . The patients and controls were classified into four age groups. Also the patients suffering from CRF on continuous hemodialysis classified into patients with uremic peripheral neuropathy and without uremic peripheral neuropathy .

The patients and controls enrolled in the study had undergone full assessment that included:- electrophysiological assessment for the following nerves (median ,ulnar ,peroneal ,tibial and sural nerve) that involved the sensory and motor nerve conduction studies.

Results: Regarding electrophysiological changes patients had shown significant increase in latency for sensory and motor nerves and significant decrease in amplitude and conduction velocity for sensory and motor nerves in patients with peripheral neuropathy than that of the controls and patients without peripheral neuropathy .

Conclusion: The results of this study supports the hypothesis that CRF is a critical disease that results in a multi-systemic disorders The incidence of uremic peripheral neuropathy present to be very high in this study . Therefore, a good attention should be directed to study this problem and seriously creates the suitable solutions.

الخلاصة

الفشل الكلوي المزمن (chronic renal failure) هو متلازمة مرضية تحدث نتيجة تلف تقدمي في التركيب الكلوي بواسطة مسببات مرضية كلوية تعمل على إعاقة الوظائف الكلوية بصورة تدريجية. اعتلال الأعصاب المحيطية يعتبر من المضاعفات العصبية الأكثر شيوعاً للفشل الكلوي المزمن، أن آلية حصول الاعتلال العصبي هي بسبب تراكم الجزيئات المتوسطة (التي لها كتلة جزيئية تتراوح بين ٥٠٠ - ٢٠٠٠ دالتون) مثل الميثيل جوانيندين وهرمونات الغدة جار الدرقية وبيتا ٢ ميكروجلوبولين والميوانوزيتول يمكن ان تربط بدرجة التلف العصبي .

ان الهدف من الدراسة الحالية هو لتقدير مدى التغيرات الكهروفسيولوجية للأعصاب المحيطية للمرضى المصابين بالفشل الكلوي المزمن الخاضعين للديليزة الدموية (hemodialysis) من المصابين وغير المصابين باعتلال الأعصاب المحيطية وذلك لأهمية هذه المعايير في تشخيص، تحديد، معرفة بعض عوامل خطوره ألاممكنه و تقدير مدى استجابة المريض للعلاج.

استمرت فترة الدراسة من تشرين الثاني ٢٠١٠ حتى نيسان ٢٠١١. في مستشفى مرجان التعليمي، الدراسة شملت على ١٠٠ شخصاً (٧٠ مريض و ٣٠ شخص سليم كمجموعة سيطرة). تم تقسيم كلاً من المرضى و الأصحاء إلى أربعة مجاميع عمرية. كذلك تم تقسيم المرضى إلى مرضى مصابين بالفشل الكلوي المزمن الخاضعين للديليزة الدموية مصابين باعتلال الأعصاب (CRF patients on HD with peripheral neuropathy) وغير مصابين باعتلال الأعصاب (CRF patients without peripheral neuropathy) من مرضى الفشل الكلوي.

أخضع المرضى ومجموعة السيطرة المشمولين بالدراسة الى تقييم شامل حيث تضمن: التقييم الفسلجي الكهربائي لكل من الأعصاب التالية (الوسطى، الزندي، الشظي، القصبي والعصب السماني) و دراسة التوصيل العصبي الحسي والحركي لها . أظهرت نتائج الدراسة فيما يخص التغيرات الكهروفسلجية أن هنالك زيادة معنوية ملحوظة في مستوى الكمون الحركي والحسي (motor & sensory latency) بين المرضى المصابين باعتلال الأعصاب المحيطية وكل من مجموعة السيطرة والمرضى غير المصابين باعتلال الأعصاب المحيطية، في حين ظهر أن هنالك انخفاض معنوي ملحوظ في مستوى سرعة التوصيل للأعصاب الحركية والحسية (conduction velocity) والسعة الحركية والحسية (Amplitude) بين المرضى المصابين باعتلال الأعصاب المحيطية وكل من مجموعة السيطرة والمرضى غير المصابين باعتلال الأعصاب المحيطية . أن نتائج الدراسة الحالية تعزز الفرضية المعروفة بأن الفشل الكلوي المزمن هو مرض خطير يسبب تأثيراً كبيراً على عدة أجهزة في الجسم . إن نسبة اعتلال الأعصاب المحيطية في هذه الدراسة كان عالياً جداً لذلك فأن مثل هذه النسب تستدعي اهتماماً كبيراً لدراسة مختلف مشاكل المرضى وإيجاد الحلول المناسبة لها.

Introduction

Renal failure is a condition in which the kidneys fail to remove and concentrate metabolic end products from the blood, regulate the fluid, electrolytes, and pH balance of the extracellular fluids. The underlying cause may be renal disease, systemic disease, and/or urologic defects of non renal origin [1]. Renal failure can occur as an acute or a chronic disorder [2,3]. The manifestations of renal failure are determined largely by the extent of renal function that is present, coexisting disease conditions, and the type of renal replacement therapy that the person is receiving. The progression of chronic renal failure usually occurs in four stages: diminished renal reserve, renal insufficiency, renal failure, and End-stage renal disease (ESRD) [4]. Renal insufficiency represents a reduction in the glomerular filtration rate GFR to approximately 20% - 50% of normal; renal failure, a reduction to less than 20% - 25% of normal; and ESRD, a decrease in GFR to less than 5% of normal [5]. End-stage renal disease almost affects every body system. It

causes an accumulation of nitrogenous wastes (i.e., azotemia), alters sodium and water excretion, alters regulation of body levels of electrolytes (potassium, phosphate, calcium, and magnesium). It also causes skeletal disorders (bones and muscles), anemia, alterations in cardiovascular functions, neurologic disturbances, gastrointestinal dysfunction, and discomforting skin changes (like pruritis) [6].

One of the risky neurological complication in chronic renal failure is Uremic neuropathy which is a distal sensorimotor polyneuropathy caused by uremic toxins. It is considered a dying-back neuropathy, or central-peripheral axonopathy, associated with secondary demyelination [7].

The Aim of Study

1- This study aimed to evaluate patients with CRF condition prognosis of the disease and prediction of its complications (like nerve involvement) in order to prevent and treat these disorders.

2-Assessment of patients with uremic polyneuropathy that include Electrophysiological assessment, by

doing nerve conduction study (motor, sensory and F-wave latency) thus we will know the degree of nerve damage and we will try to prevent farther damage of the nerve by doing the hemodialysis (HD) for the patient about twice weekly to get rid of the waste products that may cause this nerve damage such as urea.

Materials and Methods

The study lasted from first of November/2010 to thirty of April /2011 in Marjan Teaching Hospital. Seventy patients (40 males and 30 females) were included in the study. The patients were consist of four age groups and divided as follows: first group (31 to 40 years),second group (41 to 50 years), third group (51 to 60 years),fourth group (61 to 70 years). Also the patients were subdivided into two groups as follows: patients suffering from chronic renal failure (CRF) with uremic peripheral neuropathy (UPN).The second group patients suffering from CRF without uremic peripheral neuropathy (UPN) .The patients were admitted to the artificial kidney unite at Marjan Teaching Hospital. They were suffering from chronic renal failure (CRF) and they were clinically assessed by a specialist doctor.

The control subjects consist of (30) person (18 male and 12 female). They were subdivided into four age groups of apparently healthy subjects, clinically also assessed by a specialist doctor. Their ages ranged as follows: first group (31 to 40 years), second group (41 to 50 years), third group (51 to 60 years), fourth group (61-70 years).

The electrophysiological test was done in the electrophysiological department in Marjan teaching hospital. All subjects (patients and control) had at least four motor nerves tested (median, ulnar, tibial and

peroneal), and three sensory nerves (median, ulnar and sural nerves). Limb temperatures were maintained above 33C° in the legs and 34C° in the arms, and the skin was prepared when necessary using abrasive skin cleanser and isopropyl alcohol. The nerve conduction studies were performed using a Micromed machine (Japan). Maximal responses were obtained using electrical stimuli. Distal latency, conduction velocity and waveform amplitude, duration and shape were measured and recorded for each nerve at each stimulus site [8].

1.Procedure of nerve conduction study:-

Patches called surface electrodes, similar to those used for ECG, were placed on the skin over nerves at various locations. Each patch gives off a very mild electrical impulse, which stimulates the nerve.

The nerve's resulting electrical activity was recorded by the other electrodes. The distance between electrodes and the time it takes for electrical impulses to travel between electrodes were used to determine the speed of the nerve signals [9].

A. Sensory nerve conduction studies:

Sensory nerve conduction study (NCS) were performed by electrical stimulation of a peripheral nerve and recording from a purely-sensory portion of the nerve, such as on a finger.The recording electrode is the more proximal of the two. Like the motor studies , sensory latencies are on the scale of milliseconds . Sensory amplitudes are much smaller than the motor amplitudes, usually in the microvolt (μ V) range. The sensory nerve conduction velocity (NCV) was calculated based upon the latency and the distance between the stimulating and recording electrode [10].

The sites of the electrodes for sensory nerve conduction studies for the tested nerves were as the follows:

A.1. Median Nerve:

Recording electrodes placement: The recording electrodes were placed over the median nerve at the index finger.

Stimulating electrodes placement: Stimulation was applied with electrode at the plantar aspect of forearm near the wrist joint between the tendons of palmaris longus and flexor carpi radialis [11].

A.2. Ulnar Nerve:

Recording electrodes placement: The recording electrodes were placed over the ulnar nerve around the fifth finger.

Stimulating electrodes placement: Stimulation was applied with surface electrodes at the wrist, just radial to the flexor carpi ulnaris. [12].

A.3. Sural Nerve:

Recording electrodes placement: The recording electrodes were placed posterior and below the lateral malleolus of the fibula .

Stimulating electrodes placement : Stimulation was applied with surface electrodes lateral to the mid-line of the calf 12cm proximal to the recording electrode.[8].

B. Motor Nerve Conduction Studies:

Motor NCS were performed by electrical stimulation of a peripheral nerve and recording from a muscle supplied by this nerve. The time it takes for the electrical impulse to travel from the stimulation to the recording site was measured. This value

called the latency and measured in milliseconds (ms). The size of the response - called the amplitude – was also measured. Motor amplitudes were measured in millivolts (mV). By stimulating in two or more different locations along the same nerve, the NCV across different segments can be determined.

Calculations were performed using the distance between the different stimulating electrodes and the difference in latencies [12] .

The sites of the electrodes for motor nerve conduction studies of the tested nerves were as follows:

B.1. Median nerve :

Recording electrodes placement: The active electrode was placed halfway between the mid point of the distal wrist crease and the first metacarpophalangeal joint (over the prominence of abductor pollicis brevis muscle), while the reference electrode was placed slightly distal to the first metacarpophalangeal.

Stimulating electrodes placement: Stimulation was performed at two sites.

1. At wrist joint : 8 cm proximal to the active electrode, just between palmaris longus and flexor carpi radialis tendons.

2. At elbow joint : in the median aspect of the antecubital fossa, just lateral to the brachial artery.[11].

B.2. Ulnar nerve :

Recording electrodes placement : The active electrode was placed over the belly of the abductor digiti minimi muscle, While the reference electrode was placed over the proximal phalanx of the fifth finger .

Stimulating electrode placement : stimulation was performed at two sites:

1- At wrist joint: At 8 cm proximal to the active electrode ,just lateral or medial to the flexor carpi radialis muscle at the wrist .

2- At elbow joint : Approximately 3-4 cm distal to the medial epicondyle. [10]

B.3. Common Peroneal Nerve:

Recording electrodes placement: Both the active and the reference electrodes were placed over the belly of extensor digitorum brevis muscle in the foot. (the active electrode placed proximally toward the body while the reference electrode was placed distally).

Stimulating electrodes placement:

Stimulation was performed at two sites

1. At the ankle joint : 8 cm proximal to the active electrode, proximal to the lateral malleolus.
2. At the knee joint : just below the head of fibula (capitulum fibulae). [12].

B.4. Posterior tibial nerve:-**Recording electrodes placement :**

Both the active and the reference electrodes were placed in front of the medial malleolus at the convexity of the foot . (the active electrode placed proximally toward the body while the reference electrode was placed distally).

Stimulating electrodes placement :

Stimulation was performed at two sites

- 1- At ankle joint : behind the medial malleolus.
- 2- At knee joint : in the popliteal fossa. [12].

C. F-wave study :

Uses stimulation of a motor nerve and recording of action potentials from a muscle supplied by the nerve. This is not a reflex, per se, in that the nerve potential travels from the site of the stimulating electrode in the limb to the spinal cord and back to the limb in the same nerve that was stimulated. The F-wave study evaluates conduction velocity of nerves between the limb and spine, whereas the motor and sensory nerve conduction studies evaluate conduction in the limb itself [11].

Statistical analysis

All values were expressed as means $\pm$ standard deviation (SD). The data were analyzed by using computerized SPSS program. Student's

t-test was used to examine the differences between different groups and within groups.

Comparison between and within patient groups were performed by using unpaired t-test and ANOVA test. A p value < 0.05 is considered to be statistically significant [13].

Results

The results of electrophysiological test of studied group were as following:-

1. Results of motor nerve conduction study of median nerve :

The results of motor nerve conduction study of median nerve for patients with CRF who were presented with PN were categorized as : distal motor latency (DML) in millisecond, amplitude which mean compound muscle action potential (CMAP) in millivolt and conduction velocity (CV) in meter/second which show the following results respectively, 4.6 ± 0.7 ms, 9 ± 2 mv and 41 ± 4 m/s for males and 5 ± 1 ms, 6 ± 1 mv and 43 ± 3 m/s for females, while for CRF patients without PN were as follows: 3.4 ± 0.2 ms, 14 ± 2 mv and 51 ± 1 m/s for males and 3.1 ± 0.3 ms, 16 ± 2 mv and 55 ± 2 m/s for females. While, for normal healthy controls the results were: 3.5 ± 0.3 ms, 16 ± 3 mv and 52 ± 2 m/s for males and 3 ± 0.7 ms, 15 ± 2 mv and 57 ± 1 m/s for females.

There were statistically significant differences regarding motor latency, amplitude and conduction velocity of CRF male and female patients with PN compared with the male and female control and CRF patients without PN at $p < 0.05$, These results shown in Table (1).

Table 1 Results of electrophysiological parameters of median nerve (motor part) between both (control, patients with CRF on hemodialysis without PN) and patients with CRF on hemodialysis with PN according to sex difference

The electrophysiological test	Control group =30		CRF patients on Hemodialysis without PN=18		CRF patients on Hemodialysis with PN=52	
	Male	Female	Male	Female	Male	Female
Distal motor latency (ms)	3.5±0.3	3±0.7	3.4±0.2	3.1±0.3	4.6±0.7*	5±1 *
Compound muscle action potential (mv)	16±3	15±2	14±2	16±2	9±2 *	6±1 *
Conduction velocity(m/s)	52±2	57±1	51±1	55±2	41±4*	43±3 *

Values are mean ±SD

* : P<0.05 relative to control group and CRF patients without PN.

2 .Results of sensory nerve conduction study of median nerve: -

The results of sensory nerve conduction study for patients with CRF who were presented with PN were as follows: Distal sensory latency (DSL) and amplitude or sensory nerve action potential (SNAP) which show the following results respectively, 3.8±0.8 ms and 45±14 μ v for males and 4±0.6 ms and 38±18 μ v for females, while for CRF patients without PN were as follows: 2.1±0.7 ms and 144±7 μ v for

males and 2.6±0.2 ms and 126±22 μ v for females. For normal healthy controls the results were show: 2.2±0.3ms and 98 ±21 μ v for males and 2±0.5 ms and 100±19 μ v for females. There were statistically significant differences regarding sensory latency and amplitude of CRF male and female patients with PN compared with the male and female control and CRF patients without PN at p<0.05, These results shown in Table (2).

Table 2 The electrophysiological parameters of median nerve (sensory part) between both (control ,patients with CRF on hemodialysis without PN) and patients with CRF on hemodialysis with PN according to sex difference

The electrophysiological test	Control group=30		CRF patients on Hemodialysis without PN=18		CRF patients on Hemodialysis with PN=52	
	Male	Female	Male	Female	Male	Female
Distal sensory latency (ms)	2.2±0.3	2±0.5	2.1±0.7	2.6±0.2	3.8±0.8 *	4±0.6 *
Sensory nerve action potential(μ v)	98 ±2 1	100±19	144±7	126±22	45±14*	38±18*

Values are mean ±SD

* : P<0.05 relative to control group and CRF patients without PN.

3. Motor nerve conduction study of ulnar nerve :-

The results of motor nerve conduction study of ulnar nerve for

patients with CRF who were presented with PN were as follows: distal motor latency (DML) in millisecond, amplitude (CMAP) in millivolt and

conduction velocity (CV) in meter /second which show the following results respectively, 3.3 ± 0.8 ms, 6 ± 2 mv and 42 ± 4 m/s for males and 3.5 ± 0.4 ms, 5 ± 1 mv and 39 ± 3 m/s for females, while for CRF patients without UNP were as follows: 2.4 ± 0.1 ms, 13 ± 1 mv and 58 ± 6 m/s for males and 2.1 ± 0.3 ms, 12 ± 3 mv and 54 ± 4 m/s for females. For normal healthy controls the results were as follows:

2.5 ± 0.2 ms, 14 ± 2 mv and 56 ± 5 m/s for males and 2.3 ± 0.5 ms, 13 ± 2 mv and 57 ± 1 m/s for females.

There were statistically significant differences regarding motor latency, amplitude and conduction velocity of CRF male and female patients with PN compared with the male and female control and CRF patients without PN at $p < 0.05$, These results shown in Table (3).

Table 3 The electrophysiological parameters of ulnar nerve (motor part) between both (control ,patients with CRF on hemodialysis without PN) and patients with CRF on hemodialysis with PN according to sex difference.

The electrophysiological test	Control group=30		CRF patients on Hemodialysis without PN=18		CRF patients on Hemodialysis with PN=52	
	Male	Female	Male	Female	Male	Female
Distal motor latency (ms)	2.5 ± 0.2	2.3 ± 0.5	2.4 ± 0.1	2.1 ± 0.3	$3.3 \pm 0.8^*$	$3.5 \pm 0.4^*$
Compound muscle action potential (mv)	14 ± 2	13 ± 2	13 ± 1	12 ± 3	$6 \pm 2^*$	$5 \pm 1^*$
Conduction velocity(m/s)	56 ± 5	57 ± 1	58 ± 6	54 ± 4	$42 \pm 4^*$	$39 \pm 3^*$

Values are mean $\pm$ SD

* : $P < 0.05$ relative to control group and CRF patients without PN.

4. Results of sensory nerve conduction study of ulnar nerve: -

The results of sensory nerve conduction study for patients with CRF who were presented with PN were as follows: distal sensory latency (DSL) and amplitude (SNAP) which show the following results respectively, 3.1 ± 0.3 ms and 74 ± 6 μ v for males and 3 ± 0.2 ms and 72 ± 8 μ v for females, for CRF patients without PN were as follows: 2.1 ± 0.4 ms and 104 ± 10 μ v for males and 1.9 ± 0.2 ms

and 113 ± 9 μ v for females. Whereas, for normal healthy controls the results were as follows: 2.1 ± 0.1 ms and 118 ± 17 μ v for males and 2 ± 0.2 ms and 106 ± 13 μ v for females .

There were statistically significant differences regarding sensory latency and amplitude of CRF male and female patients with PN in comparison with the male and female control and CRF patients without PN at $p < 0.05$, As it shown in Table (4).

Table 4 The electrophysiological parameters of ulnar nerve (sensory part) between both (control ,patients with CRF on hemodialysis without PN) and patients with CRF on hemodialysis with PN according to sex difference

The electrophysiological test	Control group=30		CRF patients on Hemodialysis without PN=18		CRF patients on Hemodialysis with PN=52	
	Male	Female	Male	Female	Male	Female
Distal sensory latency (ms)	2.1±0.1	2±0.2	2.1±0.4	1.9±0.2	3.1±0.3 *	3±0.2 *
Sensory nerve action potential(μv)	118±17	106±13	104±10	113±9	74±6*	72±8*

Values are mean ±SD

* : P<0.05 relative to control group and CRF patients without PN

5. Motor nerve conduction study of Common peroneal nerve: -

Common peroneal nerve is a motor nerve and so it was assessed by motor nerve conduction study. The results of motor nerve conduction study of Common peroneal nerve for patients with CRF who were presented with PN were as follows: motor latency (DML) in millisecond, amplitude (CMAP) in millivolt and conduction velocity (CV) in meter/second which respectively are: 4.8±0.6 ms, 21±3 mv and 30±2 m/s for males and 4.5±0.4 ms, 24±6 mv and 32±5 m/s for females, while for CRF patients without PN were as

follows: 3±0.1ms, 38±2 mv and 49±2 m/s for males and 3.6±0.3 ms, 40±4 mv and 45±6 m/s for females. For normal healthy controls

the results were as follows: 3±0.2 ms, 42±32 mv and 46±3 m/s for males and 3.2±0.4 ms, 36±20 mv and 50±1 m/s for females

There were statistically significant differences regarding motor latency, amplitude and conduction velocity of CRF male and female patients with PN relative to the male and female control and CRF patients without PN at p<0.05, These results shown in Table (5).

Table 5 The electrophysiological parameters of common peroneal nerve between both (control ,patients with CRF on hemodialysis without PN) and patients with CRF on hemodialysis with PN according to sex difference.

The electrophysiological test	Control group=30		CRF patients on Hemodialysis without PN=18		CRF patients on Hemodialysis with PN=52	
	Male	Female	Male	Female	Male	Female
Distal motor latency (ms)	3±0.2	3.2±0.4	3±0.1	3.6±0.3	4.8±0.6*	4.5±0.4*
Compound muscle action potential (mv)	42±32	36±20	38±2	40±4	21±3 *	24±6 *
Conduction velocity(m/s)	46±3	50±1	49±2	45±6	30±2*	32±5 *

Values are mean ±SD

* : P<0.05 relative to control group and CRF patients without PN.

6. Motor nerve conduction study of Posterior tibial nerve: -

Posterior tibial nerve is a motor nerve and so it was assessed by motor nerve conduction study. The results of motor nerve conduction study for patients with CRF who were presented with PN were as follows: motor latency (DML) in millisecond, amplitude (CMAP) in millivolt and conduction velocity (CV) in meter/second which respectively are, 5.5 ± 0.7 ms, 14 ± 8 mv and 30 ± 3 m/s for males and 5 ± 1 ms, 16 ± 7 mv and 32 ± 4 m/s for females, while for CRF patients without PN were as follows

3.8 ± 0.5 ms, 34 ± 8 mv and 44 ± 3 m/s for males and 3.7 ± 0.4 ms, 36 ± 5 mv and 46 ± 2 m/s for females. For normal healthy controls the results were as follows: 3.6 ± 0.4 ms, 33 ± 6 mv and 45 ± 1 m/s for males and 2.9 ± 0.2 ms, 38 ± 3 mv and 48 ± 1 m/s for females.

There were statistically significant differences regarding motor latency, amplitude and conduction velocity of CRF male and female patients with PN in comparison with the male and female control and CRF patients without PN at $p < 0.05$, These results are shown in Table (6).

Table 6 The electrophysiological parameters of posterior tibial nerve between both (control ,patients with CRF on hemodialysis without PN) and patients with CRF on hemodialysis with PN according to sex difference

The electrophysiological test	Control group=30		CRF patients on Hemodialysis without PN=18		CRF patients on Hemodialysis with PN=52	
	Male	Female	Male	Female	Male	Female
Distal motor latency (ms)	3.6 ± 0.4	2.9 ± 0.2	3.8 ± 0.5	3.7 ± 0.4	$5.5 \pm 0.7^*$	$5 \pm 1^*$
Compound muscle action potential (mv)	33 ± 6	38 ± 3	34 ± 8	36 ± 5	$14 \pm 8^*$	$16 \pm 7^*$
Conduction velocity(m/s)	45 ± 1	48 ± 1	44 ± 3	46 ± 2	$30 \pm 3^*$	$32 \pm 4^*$

Values are mean $\pm$ SD

* : $P < 0.05$ relative to control group and CRF patients without PN.

7. Sensory nerve conduction study of Sural nerve: -

Sural nerve is a sensory nerve and so it was assessed by sensory nerve conduction study. The results of sensory nerve conduction study of Sural nerve for patients with CRF who were presented with PN were as follows: Distal sensory latency (DSL) in millisecond and amplitude (SNAP) in microvolt which show the following results respectively, 3 ± 0.4 and 17 ± 5 for males and 3.2 ± 0.3 ms and 12 ± 8 μ v for females, while for CRF patients

without PN were as follows : 1.9 ± 0.2 ms and 30 ± 2 μ v for males and 2 ± 0.1 ms and 38 ± 4 μ v for females. For normal healthy controls the results were as follows: 2.1 ± 0.1 ms and 39 ± 7 μ v for males and 2 ± 0.2 ms and 42 ± 5 μ v for females .There were statistically significant differences regarding sensory latency and amplitude of CRF male and female patients with PN relative to the male and female control and CRF patients without PN at $p < 0.05$, These results shown in (Table 7).

Table 7 The electrophysiological parameters of sural nerve between both (control ,patients with CRF on hemodialysis without PN) and patients with CRF on hemodialysis with PN according to sex difference

The electrophysiological test	Control group=30		CRF patients on Hemodialysis without PN=18		CRF patients on Hemodialysis with PN=52	
	Male	Female	Male	Female	Male	Female
Distal sensory latency (ms)	2.1±0.1	2±0.2	1.9±0.2	2±0.1	3±0.4 *	3.2±0.3*
Sensory nerve action potential(μv)	39± 7	42±5	30±2	38±4	17±5*	12±8*

Values are mean ±SD

* : P<0.05 relative to control group and CRF patients without PN.

8. Resultes of F-wave latency : -

Late response or F-wave latency assessed by motor nerve conduction study. The results of F-wave latency in millisecond of (median ,ulnar ,tibial and peroneal nerves) for patients with CRF who were presented with PN which respectively are: 30 ± 4 ms, 29 ±5 ms, 57±4.8 ms and 56.7±3 ms for males and 29.5±3.2 ms, 28.8±3.7 ms , 55.3±5.1 ms and 54 ± 5 ms for females, while for CRF patients without PN were as follows : 26.7± 2 ms, 27.5± 1 ms, 48±1 ms and 47.7±2 ms for males and 24± 1.5 ms, 26.5 ±1

ms, 47.2± 3 ms and 46 ± 2 ms for females. For normal healthy controls the results were as follows: 25± 1.9 ms , 27 ±1.8 ms, 47 ± 3ms and 46 ± 2 ms for males and 23± 1 ms , 26 ± 2 ms, 45.3± 4 ms and 44.6±3 ms for females. There were statistically significant differences regarding F-wave latency for median ,ulnar ,tibial and peroneal nerves of CRF male and female patients with PN relative to the male and female control and CRF patients without PN at p<0.05, These results shown in Table (8).

Table 8 late response parameters (F-wave latency) between both (control ,patients with CRF on hemodialysis without PN) and patients with CRF on hemodialysis with PN according to sex difference

The electrophysiological test F-wave latency	Control group=30		CRF patients on Hemodialysis without PN=18		CRF patients on Hemodialysis with PN=52	
	Male	Female	Male	Female	Male	Female
Median nerve	25± 1.9	23± 1	26.7± 2	24± 1.5	30 ± 4*	29.5±3.2*
Ulnar nerve	27 ±1.8	26 ± 2	27.5± 1	26.5 ±1	29 ±5*	28.8±3.7 *
Tibial nerve	47 ± 3	45.3± 4	48±1	47.2± 3	57±4.8*	55.3±5.1 *
Peroneal nerve	46.8± 4	44.6±3	47.7±2	46 ± 2	56.7±3*	54 ± 5 *

Values are mean ±SD

* : P<0.05 relative to control group and CRF patients without PN.

Discussion

Research found that the results of nerve conduction study of all nerves (motor nerves that includes:- median, ulnar, common peroneal, posterior

tibial and the sensory nerves that includes the median ,ulnar and sural nerves), were shown a significant difference for all nerve conduction motor and sensory parameters of CRF

patients with uremic peripheral neuropathy (UPN) in comparison to (control group and patients without UPN) as prolonged DML, low CMAP amplitude and decrease in CV of the motor nerves .While ,sensory nerves show low SNAP and decrease CV .These results were concurrent with findings of other studies done by [14-17]. Peripheral nerve neuropathy can be classified roughly into two pathological types: (1) one mainly due to axonal degeneration, and (2) one mainly due to demyelination [12]. The pathological state of uremic neuropathy is a multiple neuropathy due to axonal degeneration of the sensory and motor nerves starting from the lower extremities with secondary development of demyelination (mixed axonal and demyelinating neuropathy) [17].

Demyelinating neuropathy causes much prolongation in distal latency and decrease in conduction velocity (>30-40% reduction) with little effect on amplitude. Axonal degeneration injuries affects primarily the axon and characterized by dying back degeneration of distal portions of axon causes much reduction in amplitude with little reduction in conduction velocity (<20-30% reduction) [11].

Also our study show significant prolongation of F-wave latency for CRF patients with UPN in comparison to (control group and patients without UPN). This finding is consistent with the findings of studies done by [14,17]. This may be attributed to the segmental demyelination which was secondary to a primary axonal degeneration [11].

Other investigators reported that CRF may be associated with a variety of neuropathies, including an acute axonal neuropathy, a progressive axonal neuropathy, a progressive axonal neuropathy with secondary segmental demyelination and a

predominately demyelinating neuropathy [18].

The current study confirmed principally a progressive axonal neuropathy with secondary segmental demyelination nature of UPN, although most of the abnormal parameters gave us an impression of distal involvement, however evidences of proximal affection were also present. The most obvious was the reported widespread prevalent abnormalities in the late responses. F-wave abnormalities were found to be commoner than conventional motor study abnormalities for all the motor nerve examined [17].

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