*IOSR Journal of Pharmacy and Biological Sciences (IOSR-JPBS)*
*e-ISSN:2278-3008, p-ISSN:2319-7676. Volume 13, Issue 1 Ver. IV (Jan. – Feb. 2018), PP 42-48*
*www.iosrjournals.org*

# Electrophysiological Assessment of nerve fibers dysfunction in chronic kidney disease patients

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***Abstract:*** *This prospective study was performed to assess peripheral nerves involvement in Chronic Kidney Disease Patients using electrophysiological tests (NCS and EMG).*
*Two groups of subjects included in this study: adult patients of chronic kidney disease (CKD) not on dialysis yet and Patients on hemodialysis and control subjects .*
*This study was conducted at the unit of neurophysiology in Al-yarmouk Teaching Hospital, Baghdad.*
*Eighty patients included in this study had chronic kidney disease. They consist of two groups :*
*A- Forty (40) patients with chronic kidney disease on customary follow-up of a clinic of kidney and dialysis not on dialysis with determinedly high serum creatinine larger than 2.5 mg/dL of either sex (22 males and 18 females), the ages of patients were ranging from (35 to 72 years) of a mean of (55.35 ± 9.05) years.*
*B-Forty (40) patients with chronic kidney disease on regular hemodialysis of either sex (21 males and 19 females), their ages ranging between (43 to 70 years) with a mean (56.98 ±7.40) years. The results showed data were processing separately between males and females with mean accompanying with standard deviation for sensory and motor of median, ulnar sural, common peroneal and tibial nerves.Conclusion: The serum creatinine level have strong correlation with NCS parameters in CKD pre dialysis patients (when increase level of s.cr decrease the NCS parameters) and sensory NCS is more useful and helpful than the motor NCS in the diagnosis of early peripheral neuropathy in CKD pre dialysis.*

***Keywords:*** *CKD, creatinine, Lower limbs, Nerves Conduction study, Upper limbs.*

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Date of Submission: 20-01-2018 Date of acceptance: 09-02-2018

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## I.Introduction

The Chronic Kidney Disease (CKD) is a purposeful identification portrayed by an irretrievable and step by step advancing decrease in glomerular filtration rate (GFR). Furthermore, it is intricate by a rising incapability to preserve common stages of protein metabolism products (such as urea, creatinine, standard blood pressure, hematocrit, sodium, water, calcium phosphate homeostasis, potassium and acid base balance).

A further frequent involvement is the Peripheral neuropathy of chronic kidney disease. Nevertheless, patients who suffer CKD are further exposed to increase peripheral polyneuropathy. Neurological impediments that is subsidiary to the uremic status, participate fundamentally to the sickness and death to patients who suffer renal failure. The occurrence of peripheral neuropathy stays extreme in advanced renal dysfunction

Electrophysiological study (nerve conduction study NCS) is useful adjunct test to the medical history and clinical examination in the diagnosis of such complication, early detection and differentiation from an axonal type of peripheral neuropathy. The aims of this study are designed to:

(1) Evaluate the function of electrophysiological study (NCS ) in diagnosing the neuropathy for patients who suffer CKD.

(2) Decide and rule out the most necessary parameters of NCS and EMG, to be performed as preliminary test in the diagnosis of small fiber neuropathy.

(3)Correlation between the severity of the peripheral neuropathy and the level of serum creatinine.

## II.Subjects and methods

Two groups of subjects included in this study: adult patients of chronic kidney disease not on dialysis yet and Patients on hemodialysis.

This study was conducted at the unit of neurophysiology in Al-yarmouk Teaching Hospital, in a period from June/2016 to September /2017.

**The patients:**

Eighty patients included in this study had chronic kidney disease. They consist of two groups :

A- Forty (40) patients with chronic kidney disease on customary follow-up of a clinic of kidney and dialysis not on dialysis with determinedly high serum creatinine larger than 2.5 mg/dL of either sex (22 males and 18

females), the ages of patients were ranging from (35 to 72 years) of a mean of (55.35 ± 9.05) years. The age of the males ranged between (35-70 years) with a mean (51.73 ±9.321) years and females group ranged between (48-72 years) with a mean of age (59.78± 6.549) years. The duration of CKD is ranged between (2 - 10) years, with mean (8.72 ± 3.65) years.

B- Forty (40) patients with chronic kidney disease on regular hemodialysis of either sex (21 males and 19 females), their ages ranging between (43 to 70 years) with a mean (56.98 ±7.40) years. The age of the males group ranged between (43 - 70 years) with a mean (56.71 ± 8.032) years. While females group ranged between (44-67 years) with an age mean of (57.26 ± 6.862) years. In addition the duration of CKD is ranged between (7-25) years with mean (13.87 ± 5.41) years. All of 122 subjects (patients and control) that were included in this study had been told about the aim behind this study as well as the techniques that will be followed in this study and they had accepted these terms.

**Exclusion criteria:**

Patients with other causes of peripheral polyneuropathy excluded from this study like: diabetes mellitus, autoimmune disease " SLE " , connective tissue disease " vasculitis " , cancer, inherited peripheral neuropathy , chronic alcoholism. Patients with vitamin B12 deficiency, hypothyroidism, pre-existing peripheral neuropathy, malignancy were also excluded, in addition to patients on drugs famous of causing peripheral neuropathy.

In this study the following electrophysiological tests were considered:

(1) "Sensory nerve conduction of right, left median, right, left ulnar and right sural nerves".

(2) "Motor nerve conduction and F-wave studies of right, left median; right ulnar"; right, left fibular (common peroneal) and right tibial nerves.

The room temperature was monitored between (25C°- 28 C°) during the test procedures and skin temperature between (36C° to 37C°) with a mean of 36.7C° was measured by using a skin thermometer.

Instrumentation:

The EMG machine:

Cadwell Sierra Wave, Version 11.0.116 EMG system was used for recording and "analysis of sensory, motor nerve conduction parameters and" muscle activities. This system includes four channels preamplifiers. Stimulus intensity can be manually adjusted (1-99 mA), and the elicited reactions can be demonstrated on the screen, the matter that enables the four channels to be displayed at the equivalent time. A thermal printer connected with a device to get stable recording of the exhibited signals are used to obtain the printed results. The device includes an audio amplifier, the audio amplification throughout needle examination assists in the identification of muscle impending by their sounds characteristics. Throughout the study of nerve conduction, the associated auditory monitor assist to confine the site of the nerves stimulation.

The electrodes:

A-Grounding electrode

B- Stimulating Electrodes.

C- Recording electrodes:

1- Surface electrodes.

2- Needle electrodes.

Each subject was submitted to medical history and electrophysiological tests (NCS) of the two limbs i.e. the upper and the lower.

These tests include:

1- Sensory nerve conducting study (SNCS) for Median, Ulnerand Sural nerves, in which, distal sensory latency, "sensory nerve action potential (SNAP) amplitude and sensory nerve conduction velocity (SNCV)" are performed.

2- Motor nerve conducting study (MNCS) for Median, Ulnar, Fibular (Common peroneal), and tibial nerves , which includes measurement of "distal motor latency (DML), compound muscle action potential (CMAP) amplitude, Motor nerve conduction velocity (MNCV).

The Statistical Package for the Social Sciences, (SPSS version 25 for windows, SPSS Inc., Chicago, Illinois) and computerized Program and Microsoft Excel program were utilized for all data manipulation and analyses.

Categorical variables were presented as frequency and percentage, Chi-square was used to test the significance of association between categorical variables.

The level of statistical significance was defined as P value <0.05, which was obtained by comparing the calculated t-value to the tabulated t-value at 95% confidence interval.

## III. Results

**Table (1)** Comparison of sensory parameters between males and females in the CKD post dialysis group.

| Parameter | CKD post dialysis | | |
|---|---|---|---|
| | **Male (mean±SD)** | **Female (mean±SD)** | **P- value** |
| **median nerve** | | | |
| Distal latency(msec.) | **4.64 ± 0.398** | **4.73 ± 0.433** | **0.4981** |
| SNAP amplitude (µV) | **18.55 ± 5.14** | **20.34 ± 4.05** | **0.2471** |
| SNCV (m/sec.) | **38.31 ± 2.55** | **39.76 ± 2.29** | **0.0689** |
| **ulnar nerve** | | | |
| Distal latency(msec.) | **3.90 ± 0.461** | **3.91 ± 0.486** | **0.9472** |
| SNAP amplitude (µV) | **13.51 ± 4.16** | **15.70 ± 5.72** | **0.1694** |
| SNCV (m/sec.) | **36.46 ± 5.30** | **36.32 ± 4.90** | **0.9320** |
| **sural nerve** | | | |
| Distal latency(msec.) | **5.06 ± 0.274** | **4.95 ± 0.371** | **0.2878** |
| SNAP amplitude (µV) | **10.53 ± 3.14** | **9.80 ± 3.62** | **0.4988** |
| SNCV (m/sec.) | **29.81 ± 3.37** | **31.72 ± 4.59** | **0.1376** |

**Table (2)** Comparison of sensory parameters between males and females in the CKD pre dialysis group.

| Parameter | CKD pre dialysis | | |
|---|---|---|---|
| | **Male (mean±SD)** | **Female (mean±SD)** | **P- value** |
| **median nerve** | | | |
| Distal latency(msec.) | 4.92 ± 0.648 | 4.90 ± 0.296 | 0.9025 |
| SNAP amplitude (µV) | 13.81 ± 5.37 | 15.25 ± 5.94 | 0.4256 |
| SNCV (m/sec.) | 38.85 ± 3.53 | 38.61 ± 1.71 | 0.7894 |
| **ulnar nerve** | | | |
| Distal latency(msec.) | 4.47 ± 0.725 | 3.98± 0.871 | 0.0598 |
| SNAP amplitude (µV) | 11.004 ± 2.70 | 10.72 ± 2.084 | 0.7138 |
| SNCV (m/sec.) | 38.03 ± 4.93 | 36.78 ± 1.58 | 0.2976 |
| **sural nerve** | | | |
| Distal latency(msec.) | 5.40 ± 3.60 | 5.22 ± 0.524 | 0.8304 |
| SNAP amplitude (µV) | 7.12 ± 3.41 | 8.10 ± 2.98 | 0.3415 |
| SNCV (m/sec.) | 28.84 ± 9.13 | 30.67 ± 8.41 | 0.5151 |

**Table (3):**Comparison of sensory NCS parameters of the upper and lower limbs among the two studied groups.

| **Parameter** | **CKD pre dialysis** | **CKD on dialysis** | **P- value** |
|---|---|---|---|
| | **(mean ±SD)** | **(mean ±SD)** | |
| **Median nerve** | | | |
| Distal latency(msec.) | 4.91 ± 0.514 | 4.69 ± 0.41 | 0.0785 |
| SNAP amplitude (µV) | 14.53 ± 5.99 | 19.45 ±5.19 | =0.0001 |
| SNCV (m/sec.) | 38.73 ± 2.82 | 39.03 ±2.42 | 0.611 |
| **Ulnar nerve** | | | |
| Distal latency(msec.) | 4.22 ± 0.798 | 3.90 ± 0.46 | 0.0323 |
| SNAP amplitude (µV) | 10.87 ± 2.41 | 14.60 ± 6.75 | <0.0001 |
| SNCV (m/sec.) | 37.40 ± 4.43 | 36.39 ±5.05 | 0.3446 |
| **Sural nerve** | | | |
| Distal latency(msec.) | 5.31 ± 2.70 | 5.01 ± 0.35 | 0.711 |
| SNAP amplitude (µV) | 7.61 ± 3.51 | 10.18 ±3.35 | 0.0296 |
| SNCV (m/sec.) | 29.75 ± 9.35 | 30.76 ± 4.24 | 0.5356 |

**Table (4):** Comparison of motor NCS parameters of the upper and lower limbs among the two studied groups.

| Parameter | CKD pre dialysis (mean ±SD) | CKD on dialysis (mean ±SD) | P- value |
|---|---|---|---|
| **Median nerve** | | | |
| Distal latency(msec.) | 3.64 ± 0.68 | 3.37 ± 0.66 | 0.0754 |
| Distal amplitude. (µV) | 9.24 ± 1.71 | 7.92 ± 2.33 | 0.4082 |
| MNCV (m/sec.) | 44.61 ± 5.84 | 44.11 ± 9.20 | 0.7724 |
| **Ulnar nerve** | | | |
| Distal latency(msec.) | 3.08 ± 0.41 | 3.32 ± 0.44 | 0.0136 |
| Distal amplitude. (µV) | 9.45 ± 1.16 | 10.10 ± 0.76 | 0.0034 |
| MNCV (m/sec.) | 44.95 ± 7.19 | 46.58 ± 7.40 | 0.3208 |
| **Common peroneal nerve** | | | |
| Distal latency(msec.) | 5.48 ± 0.56 | 5.24 ± 0.99 | 0.1859 |
| Distal amplitude. (µV) | 3.77 ± 0.90 | 3.44 ± 0.95 | 0.1148 |
| MNCV (m/sec.) | 38.66 ± 4.05 | 40.14 ±9.21 | 0.3551 |
| **Tibial nerve** | | | |
| Distal latency(msec.) | 5.47 ± 0.71 | 5.44 ± 0.53 | 0.8310 |
| Distal amplitude. (µV) | 4.79 ± 0.87 | 4.87 ± 0.91 | 0.2514 |
| MNCV (m/sec.) | 37.01 ± 3.93 | 37.04 ± 3.43 | 0.9711 |

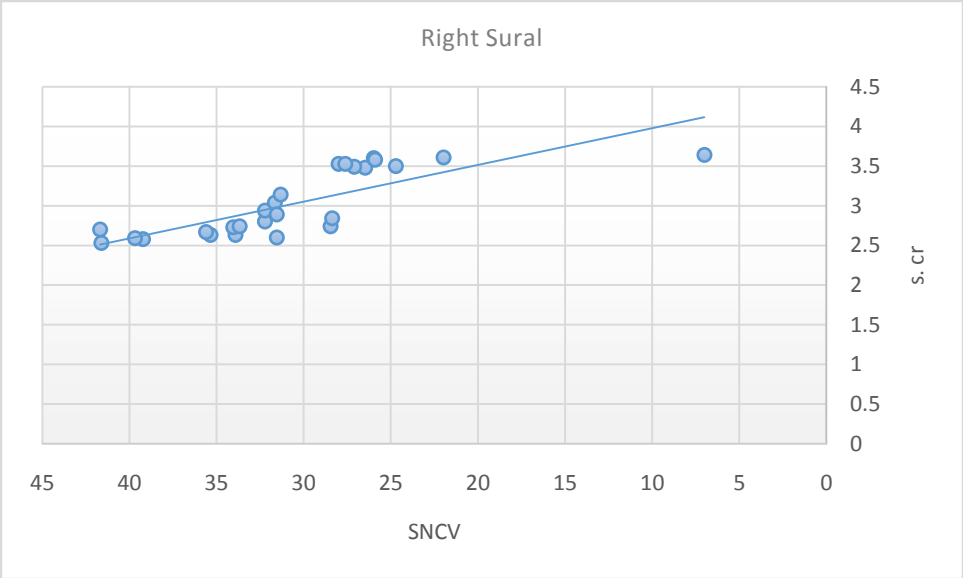


**Figure (1):** Correlation between Serum Creatinine (S.Cr) and of sensory nerve conductive velocity (SNCV) of right sural sensory nerves in CKD pre dialysis patients.

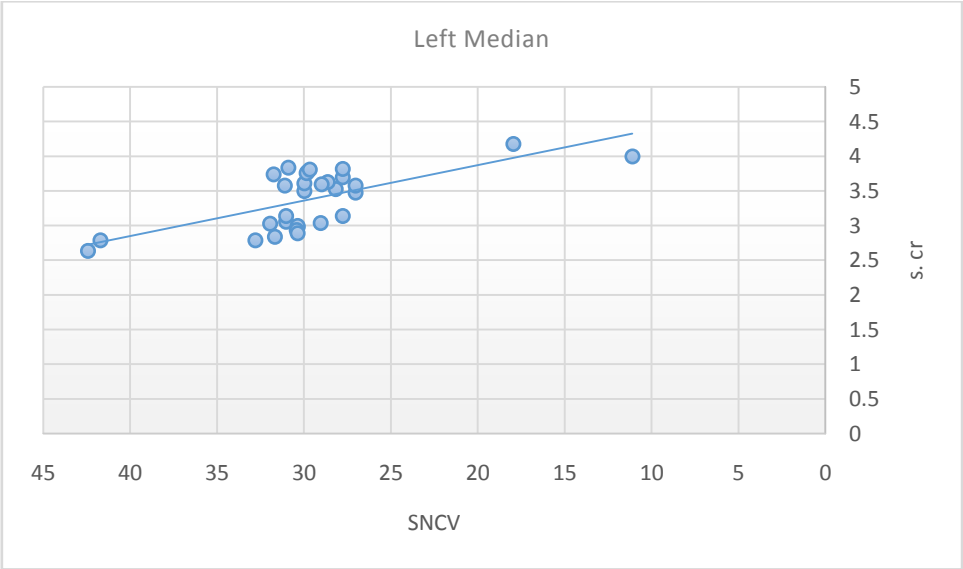


**Figure (2):** Correlation between Serum Creatinine (S.Cr) and sensory nerve conductive velocity (SNCV) of left median sensory nerves in CKD pre dialysis patients.

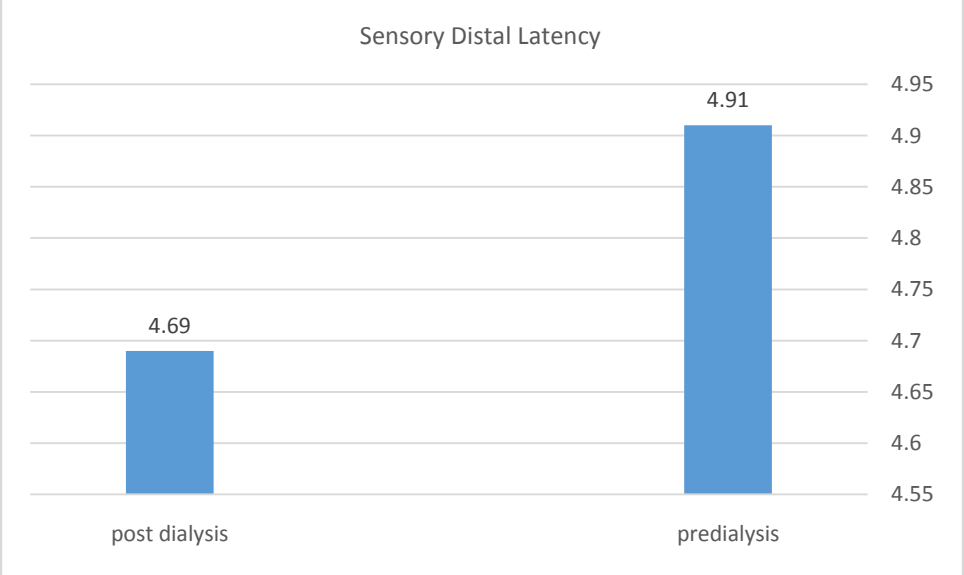


**Figure (3):** Mean of distal motor latency of median sensory nerve.

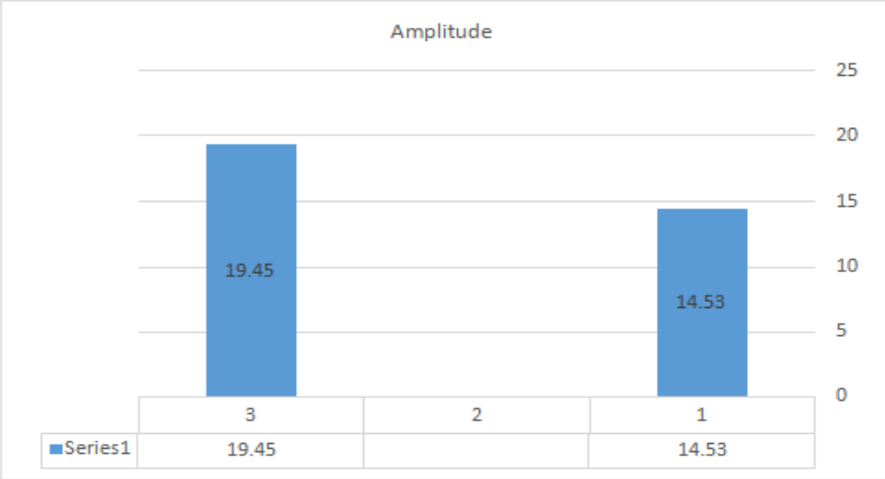


**Figure (4):** Mean of SNAP amplitude of median sensory nerve.

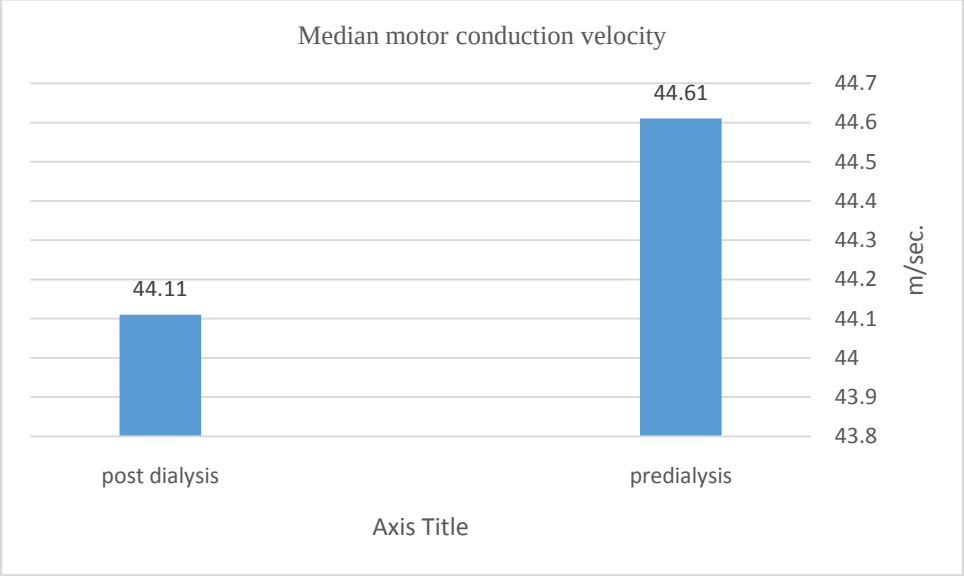


**Figure (5):** Mean of conduction velocity of median motor nerve.

## IV. Discussion

The present study compares the demographic and characteristic data of patients with CKD pre-dialysis and CKD post-dialysis table (1and 2). The non-significant differences in age and gender among the studied groups could be explained on the basis that there are no age and gender effect [1].

Sensory nerve conduction study (SNCS) are more sensitive than motor studies in detecting mild abnormalities and are often abnormal when motor studies are normal [2].

Although the parameters of SNAP of CKD pre-dialysis differ from CKD post-dialysis non significantly (table 3 and 4), in the right ulnar sensory nerve the differences are significant specifically distal sensory latency and SNAP amplitude in right and left median ,right ulnar and right sural nerves . These findings could be explained by the prolongation of distal sensory latency and decrease SNAP amplitude in CKD pre-dialysis patients more than that of CKD post-dialysis. However, these finding are similar to that of Fuglsang-Frederiksen and Kirsten, 2011[3].

In figures (1 and 2) that there are statistically positive correlation ($r > 0$) between Serum Creatinine (S.Cr) and sensory nerve conductive velocity (SNCV). These findings involve all nerves such as right sural and left median nerves as an examples of lower and upper limbs respectively.

Moreover, these correlations are statistically significant in patients with CKD pre dialysis of both upper and lower limbs ($P<0.05$).The nerve conduction velocities of all the tested nerves (median, ulnar, sural) decreased with increase in serum creatinine levels. When NCVs of all the nerves were plotted against serum creatinine values and analyzed using the Pearson correlation, it showed a significant correlation ($p < 0.05$), suggesting that peripheral neuropathy worsened with rise in serum creatinine levels in pre-dialysis patients harmony with Laaksonen et al.,2002[4] and Hari et al.,2013[5].

there are significant differences between CKD pre dialysis and CKD post- dialysis in the distal CMAP amplitude of the right ulnar nerve, distal motor latency (DML) of left median and right ulnar nerves and MNCV (m/sec.) of left median nerve whereas, the differences are statistically non-significant in other parameters .The observations in our study likewise the findings of studies conducted earlier in this regard Krishnan et al., 2005[6] Studied the excitability properties of lower limb motor nerves (common peroneal nerve) in 14 patients with end-stage renal disease treated with hemodialysis**.**

## V. Conclusion

1. The serum creatinine level have strong correlation with NCS parameters in CKD pre dialysis patients (when increase level of s.cr decrease the NCS parameters).
2. Majority of patients with CKD have both axonal and demyelinating neuropathy when compared to the lower percentage with only demyelinating neuropathy.
3. Sensory NCS is more useful and helpful than the motor NCS in the diagnosis of early peripheral neuropathy in CKD pre dialysis.

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FarisKadhim Khadir "Electrophysiological Assessment of nerve fibers dysfunction in chronic kidney disease patients." IOSR Journal of Pharmacy and Biological Sciences (IOSR-JPBS) 13.1 (2018): pp 42-48.