# Some Characteristics of Peripheral Neuropathy in Newly Diagnosed Type 2 Diabetes Patients

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## SUMMARY

**Objectives:** To describe the clinical and electrophysiological characteristics of peripheral nerve damage in newly diagnosed type 2 diabetes patients.

**Subjects and methods:** A cross-sectional descriptive study was conducted on 101 people with newly diagnosed type 2 diabetes patients at the Department of Endocrinology - Diabetes and Neurology Center of Bach Mai Hospital.

**Results:** The average age of the patients is 58.04 ± 12.66 years; males account for 60.4%, while females account for 39.6% (p = 0.038). The majority of patients have HbA1C levels ≥ 7%, accounting for 86.1%. The average HbA1C level is 11.6%. There is a correlation between age and abnormalities in electromyography of the median nerve, ulnar nerve, sural nerve, peroneal nerve and tibial nerve. There is a correlation between HbA1C levels and abnormalities in electromyography of the superficial peroneal nerve, median nerve, ulnar nerve, and peroneal nerve (p < 0.05).

**Conclusion:** Nerve conduction studies can reveal early changes in peripheral nerve damage in patients with newly diagnosed diabetes.

**Keywords:** Diabetes, Electromyography.

## I. INTRODUCTION

Diabetes mellitus is a metabolic disorder characterized by chronic hyperglycemia due to defects in insulin secretion, insulin action, or both. It is one of the leading causes of cardiovascular disease, blindness, kidney failure, and limb amputations.[1] The disease has many dangerous chronic complications, among which diabetic neuropathy is the most common chronic complication, presenting with diverse clinical manifestations: sensory disturbances, muscle weakness, muscle atrophy, foot ulcers, amputations, etc. Up to 50%

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of diabetic peripheral neuropathy cases may be asymptomatic.[1] Electrophysiological testing is the most advantageous method for examining and detecting nerve damage in general, and particularly in diabetic patients. This method allows for the early detection of damage, pinpointing the exact location of the injury to diagnose, monitor treatment, and predict peripheral neuropathy with high sensitivity. Detecting neuropathy in both symptomatic and asymptomatic groups of type 2 diabetic patients in the early stages of the disease is key to providing an opportunity to optimize multi-factorial treatment and limit disease progression. The application of electrophysiological diagnostics in early-stage type 2 diabetes remains relatively challenging for clinical practitioners. Arising from this practical need, we conducted this study with the objective of investigating the electrophysiological characteristics of peripheral neuropathy in newly diagnosed type 2 diabetic patients.

## II. SUBJECTS AND METHODS OF RESEARCH

### 2.1. Research Subjects

Selection Criteria: Patients newly diagnosed with type 2 diabetes according to the 2021 standards of the American Diabetes Association (ADA).[2]

Exclusion Criteria: Patients unable to undergo electromyography (EMG) due to various reasons (e.g., non-cooperation, presence of lesions in the EMG recording area: ulcers, amputations, casts, etc.). Newly diagnosed with diabetes but also have other diseases causing peripheral neuropathy complications, pregnant women.

### 2.2. Sampling Method

Convenient sampling while ensuring adherence to selection and exclusion criteria.

### 2.3. Research Time and Location:

- Research Location: The Endocrinology - Diabetes Department and the Neurology Center of Bach Mai Hospital

- Research time from November 2021 to July 2022.

### 2.4. Research Method

Cross-sectional descriptive study.

### 2.5. Statistical Methods and Data Processing

All collected data were entered and processed using SPSS 20.0 software.

## III. RESEARCH RESULTS

### 3.1. General Characteristics of the Study Subjects

#### *3.1.1. Age and Gender Correlation*

***Table 1**. The distribution of age groups between male and female patients in the study population*

| Gender / Age Groups | Male | | Female | | Total |
|---|---|---|---|---|---|
| | Number of Patients (n) | Percentage Ratio (%) | Number of Patients (n) | Percentage Ratio (%) | |
| Under 40 Years Old | 5 | 5% | 5 | 5% | 10 (10%) |
| Aged 40 to 49 | 10 | 9,9% | 7 | 6% | 17 (16,8%) |
| Aged 50 to 59 | 19 | 18,9% | 8 | 7,9% | 27 (26,7%) |
| 60 Years and Older | 27 | 26,7% | 20 | 19,8% | 47 (46,5%) |

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***Comments:*** In the total of 101 study patients, male patients were 61, accounting for 60.4% of the total, with a male-to-female ratio of 1.53, p = 0.038. The average age of the study group was 58.04 ± 12.66, ranging from 30 to 82 years old. Among them, the group of patients over 60 years old accounted for the highest proportion at 46.5%, while the group of patients under 40 years old accounted for the lowest proportion at 10%.

### *3.1.2. Characteristics of HbA1C in the study group*

***Table 2****. The HbA1c ratio in the study group.*

| HbA1C levels | Number of Patients (n) | Percentage Ratio (%) |
|---|---|---|
| HbA1c < 7% | 14 | 13,9 |
| HbA1c ≥ 7% | 87 | 86,1 |

***Comments:*** The group with HbA1c < 7% accounts for 13.9%. The group with HbA1c ≥ 7% accounts for 86.1%, indicating that the majority of patients had pre-existing diabetes. The average HbA1c of the study group is 11.6%.

## 3.2. Correlation between nerve conduction indices and selected factors

***Table 3****. Average motor conduction values of study subjects by age*

| Indices \ Age groups | | Under 40 Years Old (n=10) | | Aged 40 to 49 (n=17) | | Aged 50 to 59 (n=27) | | 60 Years and Older (n=47) | | P |
|---|---|---|---|---|---|---|---|---|---|---|
| | | $\bar{X} \pm SD$ | Median (IQR) | $\bar{X} \pm SD$ | Median (IQR) | $\bar{X} \pm SD$ | Median (IQR) | $\bar{X} \pm SD$ | Median (IQR) | |
| Latency (ms) | Median nerve | 3,95 ± 0,34 | 3,95 (3,76-4,3) | 4,02 ± 0,34 | 4 (3,75-4,3) | 3,8 ± 0,37 | 3,8 (3,6-4,1) | 4,11 ± 0,38 | 4,1 (3,8-4,4) | **<0,05**** |
| | Ulnar nerve | 2,99 ± 0,31 | 3 (2,75- 3,2) | 2,91 ± 0,15 | 2,9 (2,8-3) | 3,07 ± 0,81 | 2,9 (2,9-3,1) | 2,98 ± 0,26 | 3 (2,8-3,1) | >0,05* |
| | Tibial nerve | 4,5 ± 1,23 | 4,3 (3,58 -5,3) | 3,91 ± 1 | 4 (3,05 – 4,2) | 4,12 ± 0,91 | 4 (3,5 -4,5) | 4,23 ± 1,22 | 3,9 (3,5-4,5) | >0,05* |
| | Peroneal nerve | 4,08 ± 0,49 | 4,1 (3,78 -4,5) | 4,26 ± 1 | 4,1 (3,7 -4,45) | 3,97 ± 0,32 | 4 (3,7 -4,2) | 5,32 ± 1,82 | 4,3 (4-7,2) | **<0,05*** |

| Indices \ Age groups | | Under 40 Years Old (n=10) | | Aged 40 to 49 (n=17) | | Aged 50 to 59 (n=27) | | 60 Years and Older (n=47) | | P |
|---|---|---|---|---|---|---|---|---|---|---|
| | | $\bar{X} \pm SD$ | Median (IQR) | $\bar{X} \pm SD$ | Median (IQR) | $\bar{X} \pm SD$ | Median (IQR) | $\bar{X} \pm SD$ | Median (IQR) | |
| Response amplitude (mV) | Median nerve | 9,93 ± 1,65 | 9,6 (8,56-11,48) | 10,02 ± 1,41 | 9,7 (8,9 -11,4) | 10,69 ± 2,18 | 10,1 (9,5– 12,3) | 9,69 ± 2,52 | 9,7 (8,8-11,6) | >0,05* |
| | Ulnar nerve | 9,36 ± 1,72 | 9,35 (8,88 -10,7) | 10,14 ± 1,54 | 9,8 (8,95 -11,4) | 9,69 ± 2,4 | 9,5 (8,6 -11,7) | 9,78 ± 2,03 | 9,2 (8,8-11,4) | >0,05* |
| | Tibial nerve | 9,33 ± 2,7 | 9,6 (7,6 -11,63) | 8,1 ± 2,93 | 8,8 (5,85 -9,6) | 8,63 ± 2,47 | 9 (8,7 – 9,7) | 8,57 ± 3,05 | 9 (5,8-11) | >0,05* |
| | Peroneal nerve | 2,76 ± 0,43 | 2,8 (2,6 -3,05) | 2,77 ± 0,38 | 2,9 (2,7 -3) | 3,3 ± 0,29 | 2,9 (2,8 -3,2) | 2,59 ± 0,64 | 2,9 (1,9-3,1) | >0,05* |
| Conduction velocity (m/s) | Median nerve | 53,83 ± 0,65 | 54 (53,48–54,05) | 53,63 ± 2 | 53,7 (52,95-55) | 53,57 ± 1,03 | 53 (52,8 – 54) | 51,92 ± 1,92 | 52,4 (51,5-53) | **<0,05*** |
| | Ulnar nerve | 53,17 ± 1 | 53,05 (52,68 – 54) | 52,91 ± 1,68 | 53 (52,8 -53,9) | 53,07 ± 2,4 | 53 (52,4-54) | 53,41 ± 1,86 | 53 (52,6-54,2) | >0,05* |
| | Tibial nerve | 51,68 ± 2,64 | 52,85 (48,75-53,38) | 51,43 ± 3,53 | 52,7 (50,2-53,2) | 51,37 ± 2,48 | 52,6 (48-53) | 46,88 ± 6,59 | 48 (40-53) | **<0,05*** |
| | Peroneal nerve | 50,03 ± 3,6 | 51,5 (47 – 52,57) | 49,91 ± 5 | 52,6 (46-53,2) | 50 ± 4,62 | 52,4 (47-53) | 47,21 ± 6,5 | 51,8 (40-52,9) | >0,05* |

*Median, IQR (Interquartile Range Q1-Q3); * Test performed using Kruskal-Wallis test;*
*** Test performed using ANOVA test*

***Comments:***

There is no statistically significant difference in latency, response amplitude, or motor conduction velocity of the median nerve, ulnar nerve, and tibial nerve among the age groups (p>0.05).

There is a statistically significant difference in motor latency of the median nerve and peroneal nerve nerve; and in motor conduction velocity of the median nerve and tibial nerve among the age groups (p<0.05).



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***Table 4.*** *The average sensory conduction values of the study subjects by age*

| Indices \ Age groups | | Under 40 Years Old (n=10) | | Aged 40 to 49 (n=17) | | Aged 50 to 59 (n=27) | | 60 Years and Older (n=47) | | P |
|---|---|---|---|---|---|---|---|---|---|---|
| | | $\bar{X} \pm SD$ | Median(IQR) | $\bar{X} \pm SD$ | Median(IQR) | $\bar{X} \pm SD$ | Median(IQR) | $\bar{X} \pm SD$ | Median(IQR) | |
| Latency (ms) | Median nerve | 2,98 ± 0,18 | 3 (2,89-3,13) | 2,88 ± 0,43 | 2,9 (2,7-3,05) | 2,68 ± 0,51 | 2,83 (2,6-3) | 3,2 ± 0,8 | 3 (2,79-3,8) | **<0,05**** |
| | Ulnar nerve | 2,88 ± 0,24 | 2,8 (2,68-3,13) | 2,88 ± 0,2 | 2,9 (2,7-3,05) | 2,89 ± 0,2 | 2,9 (2,79-3,1) | 2,94 ± 0,26 | 2,9 (2,8-3,1) | >0,05* |
| | Superficial peroneal nerve | 2,84 ± 0,24 | 2,85 (2,6-2,98) | 3,02 ± 0,41 | 2,9 (2,8-3,1) | 3 ± 0,54 | 2,9 (2,8-3,1) | 3,74 ± 1,07 | 3,2 (2,8-4,9) | >0,05* |
| | Sural nerve | 3 ± 1,26 | 2,8 (2,4-3,2) | 3,17 ± 1 | 2,9 (2,65-3) | 3,01 ± 0,6 | 2,9(2,8-3,2) | 3,62 ± 1,21 | 3,1 (2,82-4,97) | **<0,05*** |
| Response amplitude (mV) | Median nerve | 19,14 ± 0,61 | 19,17 (18,54-19,41) | 19,31 ± 0,78 | 19,4 (18,58-19,88) | 18,81 ± 1,07 | 19,04 (17,5-19,4) | 19,24 ± 1,28 | 19,4(18,58-20,3) | >0,05* |
| | Ulnar nerve | 19,14 ± 0,61 | 19,17 (18,5-19,41) | 19,31 ± 0,78 | 19,4 (18,58-19,88) | 18,81 ± 1,07 | 19,04 (17,5-19,4) | 19,24 ± 1,28 | 19,4 (18,58-20,3) | >0,05* |
| | Superficial peroneal nerve | 10,15 ± 4,67 | 9,6 (7,2-11,7) | 12,24 ± 6,12 | 12 (5,38-19,35) | 13,35 ± 5,64 | 11,7 (9,5-19,04) | 11,61 ± 4,93 | 11,2 (8,9-17,4) | >0,05* |
| | Sural nerve | 18,94 ± 3,67 | 19,95 (19,12-20,63) | 14,82 ± 5,06 | 17,5 (9,4-18,82) | 14,03 ± 4,94 | 13,4 (10-19,4) | 10,04 ± 5,53 | 8,7 (5,32-15,8) | **<0,05*** |
| Conduction velocity (m/s) | Median nerve | 56,66 ± 2,61 | 57,92 (53,75-58,54) | 54,8 ± 2,62 | 54 (52,65-57,6) | 54,05 ± 2,06 | 53,7 (52,9-54,6) | 52,19 ± 2,63 | 52,9 (49,3-53,4) | **<0,05*** |
| | Ulnar nerve | 52,7 ± 3,13 | 52,9 (51,08-54,15) | 54,53 ± 2,63 | 54 (52,45-56,5) | 54,89 ± 2,62 | 53,7 (52,8-58) | 54,76 ± 2,82 | 53,7 (53-58) | >0,05* |
| | Superficial peroneal nerve | 52,23 ± 2,39 | 52,95 (51,45-53,4) | 51,44 ± 5,48 | 52,8 (49,55-53,7) | 51,52 ± 4,73 | 52,8 (48-54) | 44,57 ± 7,85 | 40 (37,5-52,7) | **<0,05*** |
| | Sural nerve | 53,11 + 5,9 | 53,6 (51,63-58,12) | 54,72 + 4,62 | 54,6 (53,1-58) | 53,05 + 3,27 | 52,8 (51,8-54,6) | 48,22 + 6,98 | 52,6 (40-53,2) | **<0,05*** |

*Median, IQR (Interquartile Range Q1-Q3); * Test performed using Kruskal-Wallis test; ** Test performed using ANOVA test*

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***Comments:***

There is a difference in latency of the median nerve and sural nerve, response amplitude of the sural nerve, and sensory conduction velocity of the median nerve, superficial peroneal nerve, and sural nerve among the age groups (p<0.05).

The latency of the nerves is directly proportional to age, the response amplitude decreases with age, and the conduction velocity is inversely proportional to the age of the study group.

***Table 5**. The relationship between nerve electrophysiological indices and HbA1c in the study subjects (n=101)*

| Indices | | Nerves | OR | 95% confidence interval | P |
|---|---|---|---|---|---|
| Motor | Latency (ms) | Median nerve | **1,176** | **1,07 -1,28** | **0,01** |
| | | Ulnar nerve | 1,048 | 1,00 - 1,09 | 0,126 |
| | | Tibial nerve | 2,08 | 0,24 - 17,38 | 0,459 |
| | | Peroneal nerve | **2,930** | **0,35 - 24,04** | **0,001** |
| Motor | Response amplitude (μV) | Median nerve | 1,061 | 1,00 - 1,11 | 0,923 |
| | | Ulnar nerve | 0,177 | 0,35 - 0,89 | 0,292 |
| | | Tibial nerve | 0,479 | 0,13 - 1,75 | 0,022 |
| | | Peroneal nerve | 1,261 | 1,13 - 1,40 | 0,056 |
| | Conduction velocity (m/s) | Median nerve | **1,074** | **1,01 -1,14** | **0,01** |
| | | Ulnar nerve | 0,464 | 0,05 - 4,81 | 0,047 |
| | | Tibial nerve | 1,192 | 1,08 - 1,30 | 0,105 |
| | | Peroneal nerve | 2,93 | 0,36 - 24,04 | 0,873 |
| Sensory | Latency (ms) | Median nerve | 1,243 | 1,12 - 1,38 | 0,149 |
| | | Ulnar nerve | 0,96 | 0,19 - 4,83 | 0,807 |
| | | Superficial peroneal nerve | **1,022** | **0,98 - 1,43** | **0,038** |
| | | Sural nerve | 1,28 | 0,79 - 1,73 | 0,083 |
| | Response amplitude (μV) | Median nerve | 1,5 | 0,18 - 12,85 | 0,853 |
| | | Ulnar nerve | 1,024 | 0,99 - 1,06 | 0,701 |
| | | Superficial peroneal nerve | **1,21** | **0,68 - 1,86** | **0,015** |
| | | Sural nerve | 1,02 | 0,56 - 1,34 | 0,909 |

| Indices | | Nerves | OR | 95% confidence interval | P |
|---|---|---|---|---|---|
| Sensory | Conduction velocity (m/s) | Median nerve | 1,192 | 1,08 - 1,30 | 0,309 |
| | | Ulnar nerve | 1,048 | 1,01- 1,09 | 0,972 |
| | | Superficial peroneal nerve | **1,04** | **0,89 - 1,34** | **0,024** |
| | | Sural nerve | 1,27 | 1,13 - 1,38 | 0,208 |

** OR*

***Comments:*** There is a correlation between HbA1c and motor latency of the median nerve, peroneal nerve and superficial peroneal nerve; sensory response amplitude of the superficial peroneal nerve; motor conduction velocity of the median nerve and superficial peroneal nerve (OR > 1, p < 0.05).

## IV. DISCUSSION

The average age of the patients participating in the study, 58.04 ± 12.66, is similar to that of studies by Nhat Tran Thi in 2010[3] and Van Cao Thi in 2016[4], which the average age ranged from 55 to 60 years. The average age in our study is higher compared to previous studies, but it aligns with the trend of recent years. The increasing average age of diabetic patients indicates an increase in life expectancy, as well as an improvement in knowledge and awareness among patients, and a better healthcare system.

In our study, we collected HbA1C data from 101 diabetic patients. The average HbA1c level was 11.6%. The majority, 86.1%, belonged to the group with HbA1c ≥ 7%. Our research findings are similar to those of HK Gill and colleagues when conducting a study on newly diagnosed type 2 diabetic patients.[5]

It can be observed that age influences various electrophysiological indices. Our research findings are also consistent with the study results of Stetson D. and colleagues (1992) and other authors when investigating the impact of age, gender, and factors affecting peripheral nerve conduction measurements: Age-related decreases in nerve conduction velocity and sensory amplitude have been noted, along with a reduction in the number of nerve fibers, decreased fiber diameter, and changes in nerve membranes. The average sensory conduction velocity decreases by 1.3 m/s over 10 years, and motor conduction velocity decreases by 0.8 m/s.[6]

A simple rule is that a 1% decrease in HbA1c can improve conduction velocity by approximately 1.3 m/s. HbA1c concentration reflects the average blood glucose level over 3 months.[7] The progression of nerve cell damage in diabetic patients will be faster if blood sugar control is poor. Nerve conduction parameters and HbA1c levels in diabetic patients are highly valuable for disease prognosis.

## V. CONCLUSION

The average age of the patients is 58.04 ± 12.66 years; males account for 60.4%, while females account for 39.6% (p = 0.038). The majority of patients have HbA1c levels ≥ 7%, accounting for

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86.1%. The average HbA1c level is 11.6%.

There is a correlation between age and abnormalities in electromyography of the median nerve, ulnar nerve, sural nerve, peroneal nerve and tibial nerve.

There is a correlation between HbA1C levels and abnormalities in electromyography of the superficial peroneal nerve, median nerve, ulnar nerve, and peroneal nerve ($p < 0.05$).

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