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Research Article

# ELECTROPHYSIOLOGICAL ASSESSMENT OF NERVE CONDUCTION IN DIABETES MELLITUS AND HYPERTENSION PATIENTS OF TERTIARY CARE HOSPITAL OF CENTRAL INDIA

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**ABSTRACT**

**Objectives:** Nerve conduction studies (NCS) are electrophysiological tools used to assess the whole perseverance of the cranial and peripheral nervous systems; consequently, NCS seems to be diagnostically advantageous in the documentation and categorization of disorders concerning nerve roots, peripheral nerves, muscle, and neuromuscular junction, and are often complemented by needle electromyography. Hence, the current research was aimed to evaluate the electrophysiological nerve conduction among cases through diabetes and hypertension (HTN).

**Methods:** This prospective study was achieved with the cases attending the Department of Physiology, NSCB Medical College, after obtaining ethical clearance from the institution and the consent forms from all the patients, we have enrolled 165 patients on total, which grouped into three groups: Group Diabetes Mellitus [DM] = 55, Group HTN (Hypertension) = 55, and Group DM+ HTN (Diabetes with HTN) = 55. Patients willing to enroll for the study of either sex, of aged between 30 and 79 years with clinical and laboratory evidence of disorder, were included in the study.

**Results:** The mean duration for DM patients was 7.00±6.99 and for DM+HTN patients was 8.0±5.66 which was observed as statistically significant ($p<0.0001$). The observed fluctuations in the temperature as well as blood sugar showed statistically significant among the groups ($p<0.0001$). The variables, namely, median nerve, ulnar nerve, peroneal nerve, tibial nerve, and sural nerve sensory showed statistically significant among the groups ($p<0.0001$).

**Conclusion:** The hypertensive cases with diabetes have provocatively abnormal NCV parameters when compared with hypertensive cases without diabetes and cases with diabetes alone.

**Keywords:** Diabetes mellitus, Nerve conduction velocity, Hypertension, Sensory nerves, Neurological investigation, Duration of diabetes.

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## INTRODUCTION

Diabetes mellitus (DM) is perhaps one of the primogenital human diseases. It has been first mentioned in an ancient Egyptian manuscript around 3000 years ago [1]. DM is evidenced to be a universal public well-being problematic, as its pre-dominance is projected to increase by 200 million by 2040 [2]. In cases with DM, chronic hyperglycemia in coincidence with additional metabolic abnormalities can harmnumerous organ systems, prominent to the progress of disabling and life-threatening health problems, the most conspicuous of which are microvascular (retinopathy, nephropathy, and neuropathy) and macrovascular (retinopathy, nephropathy, and neuropathy) difficulties that rise the threat of cardiovascular disease by 2–3 fold [2]. Hypertension (HTN) remains a leading cause of global morbidity and mortality, fuelled by a large number of patients with uncontrolled BP although the obtainability of various pharmacological decisions. In current years, there has been a swift development of device-based therapies suggested as novel non-pharmacological methodologies for managing HTN, that is, resistance to drug therapy [3]. DM is more pre-dominant in India with approximately 4.3% [4] than it is in the West with a prevalence of 2% [5]. Asian Indians are disproportionately susceptible to insulin resistance and cardiovascular mortality. The prevalence of DM in India is unknown, but 19.1% of Type II diabetic patients in the South Indian research reported peripheral neuropathy [6].

Autonomic diabetic neuropathy causes quiet myocardial infarction and shortens the life span, ensuing in the death of 25–50% of cases within 5–10 years [7]. According to experts, the most imperative analytic measures for diabetic neuropathy are conflicts in nerve conduction velocity (NCV), an augmented threshold of sensory nerves, and abnormal autonomic system function tests. Conducting electro-diagnostic tests is one of the analytical procedures for diabetic neuropathy (NCV determination). According to a study by Dyck (1991), NCV measurement is not only the most sensitive test for the diagnosis of diabetic neuropathy but it also possesses certain characteristics, such as repeatability. In addition, it is a specific test for neurological disorders. The demerits are that it does not offer direct evidence on neuropathy signs [8]. Diabetes-related nerve damage is divided into 2 categories: Myelin and axonal damage. The NCV primarily reflects myelin variations, whereas the action potential amplitude reflects axonal variations and the condition of nerve fibers. Action potential amplitude is an estimation of the number of neural fibers triggered by electrical stimulation, and its diminution indicates axonal injury. Rendering to research directed by specialists in this field, the NCV is further adjustable than the action potential amplitude and is further affected by interventions [9]. According to research conducted by specialists in this field, the NCV is more mutable than the action potential amplitude and is more exaggerated by interventions [9].

There is a correlation between the prevalence of diabetic neuropathy and cardiovascular diseases, such as HTN. Despite the prevalence of this clinical association, the contribution of each isolated entity to the development of neuropathy is still poorly understood. In light of the foregoing, the current research intended to evaluate the electrophysiological nerve conduction among cases with diabetes and HTN.

## METHODS

The present, observational, hospital-based, and prospective study was performed with the patients attending OPD/IPD in the Department of Physiology, Netaji Subhash Chandra Bose Medical College, Jabalpur, and

willing to enroll for the study were included in the study. After obtaining ethical clearance and consent forms, we have enrolled 165 patients on total, which further subdivided into three groups (Group DM=55, Group HTN=55) and Group DM+ HTN (Diabetes with HTN)=55. Patients willing to enroll for the study of either sex, of aged between 30 and 79 years with clinical and laboratory evidence of disorder, were included as per exclusion or inclusion criteria. Inclusion criteria for the study include patients diagnosed with diabetic/hypertensive or with both, of any age or gender, and patients giving informed consent for the study. Exclusion criteria include a history of major cardiac, cerebral/peripheral vascular diseases, congestive heart failure/ having life life-threatening/unstable medical condition, liver cirrhosis, or malignancies. Assured forms of neuropathy (other than diabetic or hypertensive neuropathy) which occur more frequently in those with diabetes/hypertensive than in the general populace (comprising chronic inflammatory demyelinating polyneuropathy, neuropathy due to Vitamin B12 insufficiency, hypothyroidism, autoimmune syndrome, paraproteinemia, and uremia); latest history of acquaintance to a neurotoxic and/or heavy metals; family history of hereditary peripheral neuropathy; misuse of illegal pills or alcoholism; and patients not giving informed consent.

In these patients, the subjective neuropathy symptoms, the neurological investigation, and the electrophysiological results will be assessed. The subjective symptoms encompassed muscle weakness in the limbs, unsteady walking, numbness, pain, burning feet, and other types of sensory impairment (touch, pain, and temperature). All patients will experience clinical neurological investigation containing the conventional examinations of light touch, pinprick, vibration, joint position and pain sensations, motor functions, and tendon reflexes.

For all patients, the standard nerve conduction extents will be carried on peroneal, tibial motor, and sural sensory nerves in together lower extremities, and median, ulnar motor, and sensory nerves in together upper extremities. Skin temperature of the arm and lower leg is standardized and sustained between 32 and 36°C. The electrophysiological tests will be implemented by the same examiner as per standard procedure.

**Statistical analysis**

Statistical analysis will be completed by the SPSS software (SPSS Inc., Chicago, IL, USA) for the Windows program. The continuous variables will be assessed by mean value when obligatory. The dichotomous variables will be presented in percentage and will be investigated using the Chi-square or Fisher's exact investigation. Analysis and ANOVA for comparing means in three categories followed by Bonferroni *post hoc* investigation for the comparison of the individual group will be carried out. For comparison of the means between the two categories, investigation by Student's t-test and Mann–Whitney U test with 95% confidence interim will be used. Correlations among the electrophysiological data and the clinical variables of the patients (age, duration of the disease, and glycated hemoglobin) will be analyzed with non-parametric techniques (Spearman's rank correlation coefficient). *P*<0.001 will be considered significant.

## RESULTS

The current observation revealed, a maximum number of 19 patients in the DM group which were from the age group of 50–59 years (Table 1). Similarly, maximum number of 19 patients in HTN and DM+HTN groups were from the age group of 50–59 years.

The gender distribution (Table 2) among cases revealed to be male as 32 over females 23 in DM group, similarly 34 males over 21 females in the HTN group and males 36 over females 19 in DM+HTN group.

The mean duration for DM patients was 7.00±6.99 and for DM+HTN patients was 8.0±5.66 which was observed as statistically significant (p<0.0001).

The fine touch was found to be the maximum patients of DM group as 19 cases with normal test results, followed by the maximum patients of HTN group as 55 cases with normal test results and finally, the maximum patients of DM+HTN group as 18 cases with normal test results (Table 3).

The maximum patients of DM group as 40 cases with normal test results, followed by the maximum patients of HTN group as 55 cases with normal test results and finally, the maximum patients of DM+HTN group as 34 cases with normal test results (Table 4). The

**Table 1: Distribution of age among patients**

| Age (years) | DM (n=55) | HTN (n=55) | DM+HTN (n=55) | p-value |
|---|---|---|---|---|
| | n (%) | n (%) | n (%) | |
| 30–39 | 5 (9.09) | 4 (7.27) | 7 (12.73) | p=0.0657 |
| 40–49 | 13 (23.64) | 10 (18.18) | 2 (3.64) | |
| 50–59 | 19 (34.55) | 19 (934.55) | 19 (34.55) | |
| 60–69 | 16 (29.09) | 16 (29.09) | 25 (45.45) | |
| 70–79 | 2 (3.64) | 6 (10.91) | 2 (3.64) | |
| Total | 55 (100.00) | 55 (100.00) | 55 (100.00) | |

**Table 2: Gender distribution among patients**

| Variables | DM (n=55) | HTN (n=55) | DM+HTN (n=55) | p-value |
|---|---|---|---|---|
| | n (%) | n (%) | n (%) | |
| Female | 23 (41.82) | 21 (38.18) | 19 (34.55) | p=0.7348 |
| Male | 32 (58.18) | 34 (61.82) | 36 (65.45) | |
| Duration of diabetes (mean±standard deviation) | 7.00±6.99 | - | 8.0±5.66 | p<0.0001* |

*Denotes significant (p-value<0.05)

**Table 3: Fine touch characteristics among the groups**

| Fine touch | DM (n=55) | HTN (n=55) | DM+HTN (n=55) | p-value |
|---|---|---|---|---|
| | n (%) | n (%) | n (%) | |
| Absent In 4 Limbs | 10 (18.18) | 0 (0.00) | 9 (16.36) | p<0.0001* |
| Absent In Ll | 10 (18.18) | 0 (0.00) | 12 (21.82) | |
| Altered In Ll | 1 (1.82) | 0 (0.00) | 0 (0.00) | |
| Reduced In 4 Limbs | 4 (7.27) | 0 (0.00) | 2 (3.64) | |
| Reduced In Ll | 11 (20.00) | 0 (0.00 ) | 14 (25.45) | |
| Normal | 19 (34.55) | 55 (100.00) | 18 (32.73) | |
| Total | 55 (100.00) | 55 (100.00) | 55 (100.00) | |

*Denotes significant (p-value<0.05)

**Table 4: Presentation of the observed temperature fluctuations**

| Temperature | DM (n=55) | HTN (n=55) | DM+HTN (n=55) | p-value |
|---|---|---|---|---|
| | n (%) | n (%) | n (%) | |
| Absent In LL | 4 (7.27) | 0 (0.00) | 13 (23.64) | p<0.0001* |
| Altered In LL | 0 (0.00) | 0 (0.00) | 0 (0.00) | |
| Reduced in all 4 limbs | 2 (3.64) | 0 (0.00) | 0 (0.00) | |
| Reduced In LL | 9 (16.36) | 0 (0.00) | 8 (14.54) | |
| Normal | 40 (72.73) | 55 (100.00) | 34 (61.82) | |
| Total | 55 (100.00) | 55 (100.00) | 55 (100.00) | |

*Denotes significant (p-value<0.05)

observed fluctuations in the temperature were observed as statistically significant among (p<0.0001) the groups.

The observed fluctuations in the pressure are tabulated in Table 5 with statistically significant differences among them with the value of p=0.0011. Maximum patients of the DM group with 78.18% of normal test results, followed by maximum patients of the HTN group with 100% of normal test results and finally, maximum patients of DM+HTN group with 70.91% of have normal test results.

The observed vibrations (Table 6), showed statistically significant differences among them with p<0.0001. Maximum patients of the DM group with 34.55% reported the absence of vibrations in all four limbs, followed by maximum patients of the HTN group with 100% of normal test results and finally, maximum patients of the DM+HTN group with 29.09% reported of the absence of vibrations in all four limbs and absence in lower limb each.

The observed proprioception with a statistically significant of p=0.0024 as the maximum patients of DM group 72.73% reported with normal test results, followed by the maximum patients of HTN group 100% having normal test results and finally, the maximum patients of the DM+HTN group 63.64% also reported to have normal test results. The two-point discrimination among the groups is observed as statistically significant with p<0.0001. Maximum patients of DM group (21 [38.28%]) reported increased discrimination in lower limb, followed by maximum patients of HTN group (55 [100%]) having normal test results and finally, maximum patients of DM+HTN group (23 [41.82%]) also reported to have increased discrimination in lower limbs.

The NCV (Fig. 1) among the groups was observed as statistically significant with p<0.0001. Maximum patients of DM group (16[29.09%]) reported with normal test results, followed by maximum patients of HTN group (55 [100%]) having normal test results and finally, maximum patients of DM+HTN group (29 [52.73%]) reported to have sensory motor axonal demyelinating polyneuropathy.

The blood sugar (Fig. 2) testing parameters among the groups are observed as statistically significant with p<0.0001. Maximum mean FBS was reported in DM+HTN (179.73±63.35), followed by DM (171.09±63.35). Similarly, the maximum mean PPBS was reported in DM+HTN (283.53±76.46), followed by DM (277.40±77.23). Further, maximum mean RBS was reported in DM+HTN (275.03±112.17), followed by DM (265.07±97.34), and maximum mean HbA1c was reported in DM+HTN (9.54±1.75), followed by DM (8.22±1.40).

The motor median nerve was observed as statistically significant with p<0.0001 among the groups. For the right limb maximum latency was observed for DM (3.57±0.49), maximum amplitude was observed for DM (12.76±5.09) and maximum velocity was observed for HTN (62.73±0.61). However, for the left limb, maximum latency was observed for DM+HTN (3.32±0.47), maximum amplitude was observed for HTN (15.22±2.32), and maximum velocity was observed for HTN (62.72±0.64).

The sensory median nerve (Fig. 3) was observed as statistically significant with p<0.0001 among the groups. For the right limb, maximum latency was observed for DM (2.99±0.64), maximum amplitude was observed for HTN (53.86±3.72), and maximum velocity was also observed for HTN (53.05±6.41). However, for the left limb, maximum latency (2.50±0.31), maximum amplitude (37.37±5.77), and maximum velocity (57.08±1.45) was observed for HTN.

The findings of the F-wave median (Fig. 4) nerve were observed as statistically significant differences among the groups. For the right limb, maximum F min was observed for HTN (26.47±3.35), maximum F mean was observed for HTN 32.55±3.13), and F max was also observed for HTN (39.25±2.86). However, for the left limb, F min (28.43±2.37) was observed for DM, F mean (34.48±1.81) was also observed for DM, and F max (40.61±1.45) was observed for DM+HTN.

The observed findings of the motor ulnar nerve were found to be statistically significant differences among the groups (p<0.0001). For the right limb, maximum latency was observed for DM+HTN (2.66±0.96), maximum amplitude was observed for HTN (15.36±1.00), and maximum velocity was also observed for HTN (61.68±2.95). However, for the left

**Table 5: Pressure characteristics among the patients**

| Pressure | DM (n=55) | HTN (n=55) | DM+HTN (n=55) | p-value |
|---|---|---|---|---|
| | n (%) | n (%) | n (%) | |
| Absent In LL | 2 (3.64) | 0 (0.00) | 4 (7.27) | p=0.0011* |
| Reduced In LL | 10 (18.18) | 0 (0.00) | 12 (21.82) | |
| Normal | 43 (78.18) | 55 (100.00) | 39 (70.91) | |
| Total | 55 (100.00) | 55 (100.00) | 55 (100.00) | |

*Denotes significant (p-value<0.05)

**Table 6: Vibration characteristics among the groups**

| Vibration | DM (n=55) | HTN (n=55) | DM+HTN (n=55) | p-value |
|---|---|---|---|---|
| | n (%) | n (%) | n (%) | |
| Absent In all four Limbs | 19 (34.55) | 0 (0.00) | 16 (29.09) | p<0.0001* |
| Absent in LL | 15 (27.27) | 0 (0.00) | 16 (29.09) | |
| Altered In four Limbs | 6 (10.91 ) | 0 (0.00) | 7 (12.73) | |
| Altered In LL | 5 (9.09 ) | 0 (0.00) | 9 (16.36 ) | |
| Normal | 10 (18.18) | 55 (100.00) | 7 (12.73) | |
| Total | 55 (100.00) | 55 (100.00) | 55 (100.00) | |

*Denotes significant (p-value<0.05)

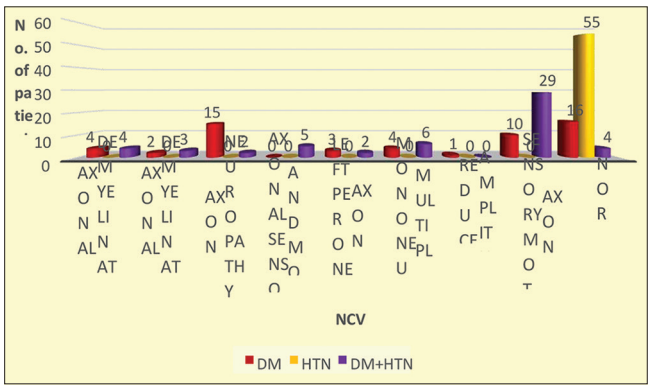


**Fig. 1: NCV among the groups**

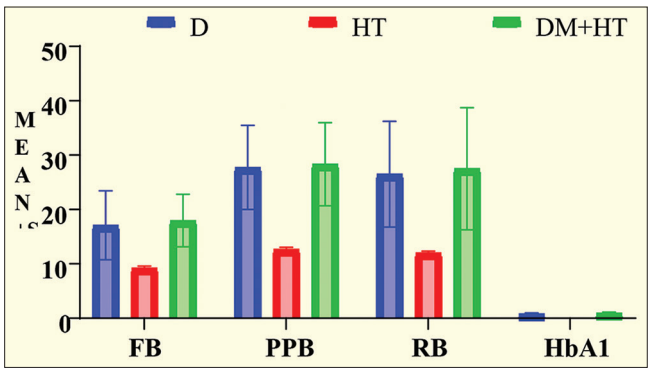


**Fig. 2: Blood sugar levels among the groups**

limb, maximum latency was observed for DM (2.53±0.32), maximum amplitude was observed for HTN (14.95±1.18), and maximum velocity was also observed for HTN (61.47±3.63).

Table represents the observed findings of the sensory ulnar nerve, having statistically significant differences among all. For the right limb, maximum latency was observed for HTN (2.47±0.04), maximum amplitude was observed for HTN (37.15±5.78), and maximum velocity was observed for DM (47.07±8.95). However, for the left limb, maximum latency was observed for DM (2.57±0.47), maximum amplitude was observed for DM+HTN (25.98±6.57), and maximum velocity was also observed for HTN only (59.17±4.53).

F-wave ulnar nerve exhibited statistically significant differences among all the groups. For the right limb, maximum F min (29.00±2.34), F mean (35.16±2.39), and F max (41.28±2.91) were observed for HTN, respectively. However, for the left limb, F min (28.57±2.28) and F mean (36.81±4.48) were observed for DM, and F max (40.64±2.83) was observed for DM+HTN.

The motor peroneal nerve (Fig. 5) showed statistically significant differences among the groups (p<0.0001). For the right limb, maximum latency was observed for DM+HTN (3.95±1.79), maximum amplitude (6.85±2.26) and velocity (48.00±2.22) were observed for HTN. However, for the left limb, maximum latency was observed for DM + HTN (4.47±1.80), maximum amplitude (7.69±1.04) and velocity (47.89±1.60) were observed for HTN only.

The findings of the F-wave peroneal nerve exhibited the statistical insignificancy among the right and showed significant effect among the left side (p<0.0001). For the right limb, maximum F min (41.52±2.37), F mean (51.12±2.37), and F max (58.00±2.25) were observed for HTN correspondingly. Likewise, for the left limb, F min (42.29±2.55), F mean (51.86±2.55), and F max (57.74±2.86) were observed for HTN.

The motor peroneal nerve having statistically significant differences among the groups (p<0.0001) was observed before right limb, maximum latency DM (4.27±0.97), maximum amplitude (21.61±3.80), and velocity (51.15±2.30) were observed for HTN. However, for the left limb, maximum latency was observed for DM + HTN (4.33±2.18), maximum amplitude (24.41±1.07), and velocity (47.37±2.41) were observed.

The F-wave tibial nerve (Fig. 6), showed statistically significant differences among the right. For the right limb, maximum F min (54.68±10.60), F mean (63.72±9.51), and F max (72.80±8.97) were observed for HTN correspondingly. Likewise, for the left limb, F min (49.89±20.55), F mean (58.28±21.95), and F max (66.67±23.79) were observed for HTN.

## DISCUSSION

In this study, the maximum number of 19 (34.55%) patients in the DM group was aged 50–59 years. Correspondingly, maximum number of cases was observed as 19 (34.55%) each in HTN and DM+HTN groups were from the age groups among 50–59 years [10]. The gender distribution among patients male 32 (58.18%) dominance was observed over females 23 (41.82%) in the DM group, also 34 (61.82%) males over 21 (38.18%) females in the HTN group, and males 36 (65.45%) over females 19(34.55%) in DM+HTN group. According to the study reported by Tehrani also documented that age, duration of diabetes, and male gender can suggestively raise the threat of uncharacteristic NCV [11].

The mean duration for DM patients was 7.00±6.99 and for DM+HTN patients was 8.0±5.66. However, a statistically significant difference among them was observed. Harris *et al*. documented that people with Type 2 diabetes were independently interrelated with the duration of diabetes, HTN, hyperglycemia, and glycosuria. There was a 60% greater chance of emerging indications in persons with HTN [12]. Maximum

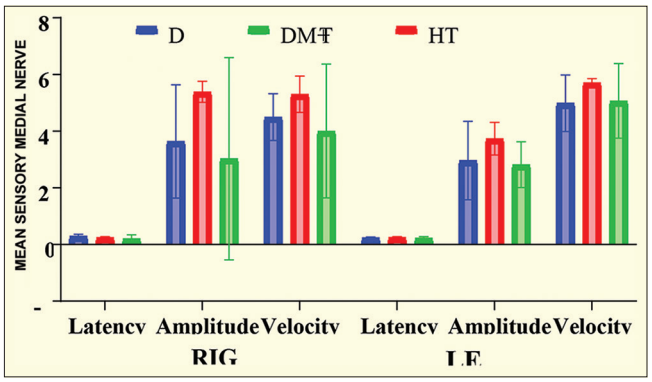


**Fig. 3: Sensory median nerve among the groups**

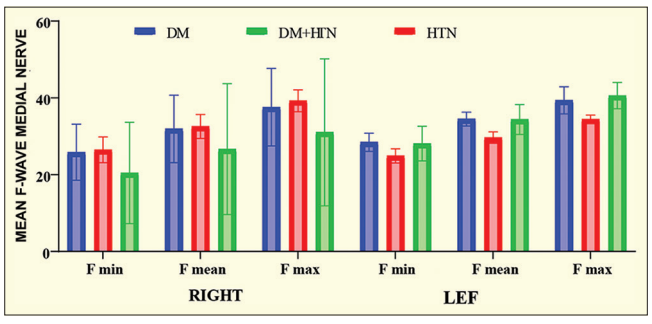


**Fig. 4: F-wave median nerve among the groups**

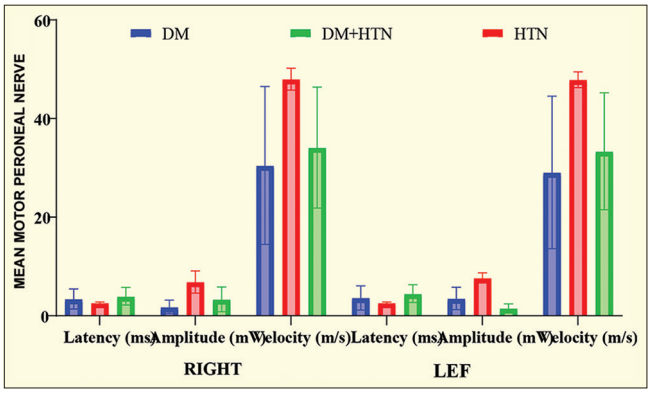


**Fig. 5: Motor peroneal nerve among the groups**

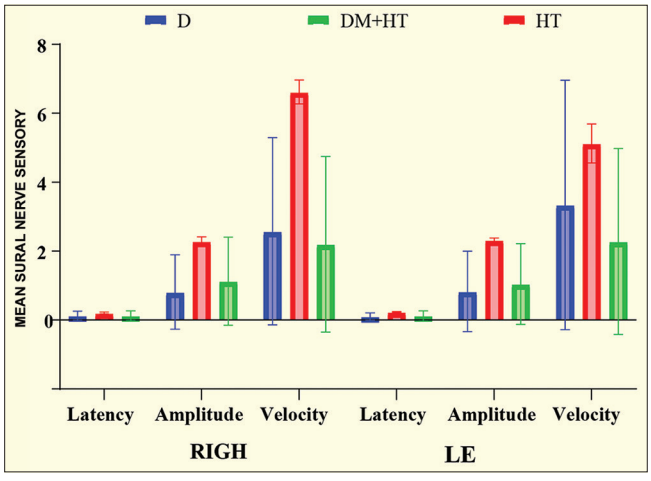


**Fig. 6: Sural nerve sensory among the groups**

patients of the DM group 34.55% showed normal test results, followed by maximum patients of the HTN group 100% for normal test results. Finally, the maximum of patients DM+HTN group (18 [32.73%]) also has normal test results. The similar prevalence of at least one bilateral sensory deficit rose from 26% for 65–74-year-old to 54% for those 85 and older [13] groups.

Maximum patients of the DM group (40 [72.73%]) have normal test results, followed by maximum patients of the HTN group (55 [100%]) having normal test results. Finally, maximum patients of the DM+HTN group (34 [61.82%]) also have normal test results. A study also reported that the agreement between the patient grouping results and the variance in skin temperature suggests that small fiber neuropathy contributes to the early onset of microcirculatory disruption. All of the patients who were at risk exhibited a lack of sympathetic cutaneous response in both feet. In the diabetic foot, the decreased sudomotor activity and concurrent disruption in the thermoregulatory system should be an early marker of sympathetic damage [14].

Maximum patients of DM group (43 [78.18%]) have normal test results, followed by maximum patients of HTN group (55 [100%]) having normal test results, and finally, maximum patients of DM+HTN group (39 [70.91%]) also have normal test results. A research of cross-sectional study in 2007 found that there is a strong correlation between HTN and the development of SMPN (sensorimotor peripheral neuropathy) in patients with relatively recent Type 2 diabetes. Pulse pressure, a measure of arterial stiffness, is independently and negatively associated with nerve function, meaning that as pulse pressure increases, nerve function decreases [15].

The maximum patients of DM group reported the absence of vibrations in all four limbs, followed by the maximum patients of HTN group (55 [100%]) having normal test results, and finally, the maximum patients of the DM+HTN group (16 [29.09%]) reported absence of vibrations in all four limbs and absence in lower limb each. A research documented whether Type 1 diabetes patients' HTN affects their risk of developing DPN (T1DM). They found HTN in 20 of 78 healthy controls and 40 of 70 T1DM patients. Their research showed a connection between T1DM's decreased nerve conduction and HTN. In T1D patients, HTN was linked to aberrant nerve conduction characteristics, a raised vibration threshold, and decreased corneal nerve fiber density and length. In people without diabetes, HTN did not affect neuropathy [16]. It is comparable with the present study.

According to the recent documentation of the related study also revealed that significant time effect and time×group interaction of proprioception in all four directions ($p<0.05$), the conduction velocity of peroneal nerve revealed a significant time effect ($p=0.007$) and time×group interaction ($p=0.022$). An interaction effect was found to be significant for median gastrocnemius and multifidus while standing with eyes open and closed ($p\leq0.004$). Only multifidus showed a significant group ($p=0.002$) and interaction effect ($p=0.003$) during walking [17].

The present study represents the observed 2-point discrimination with statistically significant differences among them ($p<0.0001$). Agreeing with Sheng *et al*., 100 women underwent baseline 2PD testing; C.T.S. was identified by questionnaire in 11% at baseline before A.I. initiation. The prevalence of C.T.S. at any time in the 1st year was 26%. A significant increase in the worst 2-PD score was observed from baseline to 3 months (3.7–3.9 mm, respectively, $p=0.03$) when adjusted for age, prior chemotherapy, randomized treatment assignment, and diabetes. There were no significant differences in treatment discontinuation due to C.T.S. between the arms [18].

For the plasma blood glucose, patient awareness was low, and the prevalence of CKD was high. Uncontrolled blood pressure, fasting blood sugar >150 mg/dL, long duration of HTN, non-users of A.C.E.I.s, and lack of knowledge about CKD were predictors of chronic kidney disease and these observations were comparable with our study [19].

The present study table represents the observed findings of the median motor nerve, having statistically significant differences among all ($p<0.0001$*). For the right limb, maximum latency was observed for DM (3.57±0.49), maximum amplitude was observed for DM (12.76±5.09), and maximum velocity was observed for HTN (62.73±0.61). However, for the left limb, maximum latency was observed for DM+HTN (3.32±0.47), maximum amplitude was observed for HTN (15.22±2.32), and maximum velocity was observed for HTN (62.72±0.64). A research documented that sensory nerve abnormality was more apparent than motor nerve abnormality in pre-diabetic subjects. Changes in the amplitude of abnormal motor nerves were observed later in the course of the disease, that is, in asymptomatic diabetics as opposed to pre-diabetics These reported observations coincide with our observed findings of the median motor nerve ($p<0.0001$), which is statistically significant differences among the groups [20].

The median sensory nerve showed statistically significant differences among the groups. For the right limb, maximum latency was observed for DM (2.99±0.64), maximum amplitude was observed for HTN (53.86±3.72), and maximum velocity was also observed for HTN (53.05±6.41). However, for the left limb, maximum latency (2.50±0.31), maximum amplitude (37.37±5.77), and maximum velocity (57.08±1.45) were observed for HTN. According to Hussain *et al*. 2016 [21], the correlation of the serum levels of TGF-1 with the motor and sensory nerve conduction velocities in patients with Type 2 DM discovered that a high level of TGF-1 in the serum of T2DM patients with neuropathy suggests a possible role in the development of neuropathy [21].

As per the documentation on the F wave median nerve, more than 40% of the patients had A waves in at least one of the nerves investigated. The presence of A waves is almost always a sign of either a localized nerve lesion or polyneuropathy. Although the presence of A waves does not enable nerve pathology to be quantified, it indicates the presence of nerve pathology. It provides additional information about peripheral nerve function in diabetic patients [22].

They exhibited statistical significant difference among the groups with $p<0.0001$. For the right limb, maximum latency was observed for DM+HTN (2.66±0.96), maximum amplitude was observed for HTN (15.36±1.00), and maximum velocity was also observed for HTN (61.68±2.95). However, for the left limb, maximum latency was observed for DM (2.53±0.32), maximum amplitude was observed for HTN (14.95±1.18), and maximum velocity was also observed for HTN (61.47±3.63). A study done on motor ulnar nerve suggests that the male gender, motor neuropathy, and mononeuropathies, especially ulnar neuropathy, are associated with the development of D.F. among our patients with D.F. Patients with DM have a pre-disposition to developing chronic inflammatory demyelinating polyneuropathy, which may also facilitate the formation of diabetic foot [18]. The ulnar sensory nerves showed statistical significant differences among all. For the right limb, maximum latency was observed for HTN (2.47±0.04), maximum amplitude was observed for HTN (37.15±5.78), and maximum velocity was observed for DM (47.07±8.95). However, for the left limb, maximum latency was observed for DM (2.57±0.47), maximum amplitude was observed for DM+HTN (25.98±6.57), and maximum velocity was also observed for HTN only (59.17±4.53). This is supported by the already documented report as the sensory response amplitude of the median plantar nerve was significantly lower in patients with impaired glucose tolerance and insulin resistance [23].

F-wave ulnar nerve also showed statistically significant among the groups $p<0.0001$ and this observation was comparable with the similar observation of the *Z* scores of the peroneal minimal F-wave latency exceeded those of peroneal MCV, sural S.C.V., and sural SNAP. F-wave persistence did not differ significantly from the reference values. In conclusion, minimal F-wave latency is the most sensitive

measure for detecting nerve pathology and should be considered in electrophysiological studies of diabetic patients [22].

The motor peroneal nerve showed statistically significant among the groups $p<0.0001$ in contrast to healthy controls, another study also found that non-diabetic hypertensive patients had higher peroneal nerve perception threshold values, confirming the significance of vascular factors in the development of DPN [24].

The motor tibial nerve and F-wave tibial nerve showed the statistically significant of $p<0.0001$. Similarly, the cross-sectional area and maximum thickness of the tibial nerve bundles are larger in patients with diabetic peripheral neuropathy than in healthy subjects or diabetic patients with no signs of neuropathy [25].

The present study signifies the observed findings of the sural nerve sensory, to be statistically significant differences among the groups with $p=0.0002$ and $p<0.0001$. A similar observation was documented with another study of nerve action potential (NAP) amplitudes of sural and superficial peroneal nerves were within normal ranges in all patients. Still, in the patient group, mean value was significantly lower than in the controls. Among clinically defined 30 DSN patients, median plantar NAP amplitude was abnormal in 18 (60%) and dorsal sural nerve amplitude was abnormal in 13 (40%) of the patients bilaterally [26].

## CONCLUSION

Our observation concluded that the hypertensive cases with diabetes have suggestively abnormal NCV parameters when compared with hypertensive patients without diabetes and patients with diabetes alone. The novel results require additional investigation to recognize the probable threat influences and the possible consequence in the long-term. These variations are associated with the scientific manifestations and are exacerbated when the two circumstances coexist. However, to enhance the accuracy of the present findings and bypass the confounders, we recommend a resilient, multicentric study with a high descriptive sample size. In addition, periodic surveys should be done for any change or update in the pattern of results.

### Limitations

A major limitation of our study includes a single observational approach with a lack of randomization and case–control analysis. Outcomes were partial to a particular tertiary care center that may not be widespread for all surroundings. Hence, it cannot be assimilated into a higher populace.

## RECOMMENDATIONS

The present study reveals that hypertensive patients with diabetes have significantly abnormal NCV parameters when compared with hypertensive patients without diabetes and patients with diabetes alone. A larger study assessing similar issues and bypassing the confounders may recommend a multicentric study with a comparatively higher sample size. Further, longitudinal studies should be conducted assessing similar concerns of comparing the nerve conduction assessment in DM and HTN patients.

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Nil.

## CONFLICTS OF INTEREST

Nil.

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