

## Detection of Subclinical Peripheral Neuropathy by High-Resolution Ultrasonography of Median and Ulnar Nerves: A Cross-Sectional Study Done On Diabetic And Hypertensive Patients and its Comparison with Normal

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### Abstract

**Introduction:** In the modern era, diabetes as well as hypertension, separately or combined, especially with obesity, are found to be associated with an increased incidence of peripheral neuropathy. Early detection of peripheral neuropathy by Ultrasonography is of paramount importance to aid in early treatment by physicians and get maximal benefits to prevent morbidity caused by it.

**Aims and Objectives:** Our study aims to use ultrasonography as the first modality for evaluation of changes in peripheral nerves ( Ulnar and median) for early diagnosis of peripheral neuropathy in these conditions and early intervention by physicians to prevent the severe neuropathic changes in peripheral nerves resulting in co-morbid conditions.

**Method And Materials:** In this study, we have focussed on median and ulnar nerves of diabetic and hypertensive patients alone or in combination. We included 150 diabetic cases, 125 hypertensive cases, 125 cases with coexisting diabetes and hypertension & 100 normal as control. The cross-sectional areas of median and ulnar nerves were studied with ultrasonography and changes were detected in the nerves of these groups of patients. Study were done at BMIMS, Pawapuri, Nalanda.

**Results:** There was a higher cross-sectional area (CSA) in both median and ulnar nerves in all the above groups of patients as compared to normal. Hypertensive and diabetic group (coexisting) patients had higher CSA than the hypertensive or diabetic group alone.

**Conclusion:** On comparing the CSA with those in the normal group, we concluded that the prediction of neuropathies can be made at an early stage by high-resolution ultrasonography (HRU), and hence appropriate measures can be taken at a suitable early stage to alleviate their symptomatic problems.

**Keywords:** HRU- high-resolution ultrasonography, MRI- Magnetic resonance imaging, DPN- diabetic peripheral neuropathy, CSA- cross-sectional area, DM- diabetes mellitus, HTN – hypertension.

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## Introduction

The two imaging techniques—HRU and magnetic resonance imaging (MRI) can identify the abnormal nerves, and their exact anatomical locations, and can ascertain the cause and site of pathology. [1,2]

Both these methods provide excellent soft tissue details. HRU is however beneficial over MRI as it includes better soft tissue resolution and higher attenuation. This study was done to assess the role of HRU in diagnosing peripheral neuropathy. [3,4]

HRU can scan and continuously observe in real time the morphological changes in tissues. With HRU, we can scan an affected nerve along its expected course quickly and efficiently, can easily make comparisons with the contralateral normal side, and can be done on patients who are MRI incompatible. Hence the causative factor can be easily identified. [5,6]

Both HRU and MRI provide information that is supplementary to clinical findings, history, and electrodiagnostic studies. From electro diagnostic studies, we get only the functional information of the nerves; but the anatomical information is given by HRU & MRI. [7,8]

Diabetic neuropathy has emerged as the most common cause of peripheral neuropathy in developed countries owing to the rise in the rate of obesity and the prevalence of type 2 diabetes. [9]

Uncontrolled high blood sugar damages nerves and interferes with their sensory functions. It also weakens the wall of capillaries that supply nerves with oxygen and nutrients.

Hypertension is a co-morbidity that at late stages of neuropathy adds to the diabetic effect upon sensory slowing. Hypertension causes myelin thinning, contributes to Schwann cell expression of matrix metalloproteinase, and induces atherosclerosis. Hypertension contributes to the initiation or worsening of diabetic peripheral neuropathy (DPN). [10]

In patients with DPN, HRU shows an increase in CSA of affected peripheral nerves.

The present HRU study aims to explore the effects of diabetes and hypertension on median and ulnar nerves alone or in combination.

### Aims and Objectives

This work aims to evaluate the role of HRU in the diagnosis of diabetic and hypertensive neuropathy in the median and ulnar nerves alone or in combination and to compare the same with normal.

In this way, early prediction of neuropathy can be made, and early treatment can be initiated so that a good prognosis and good quality of life for patients with peripheral neuropathies can be insured.

### Method and Materials

A total of 500 patients coming to OPD at BMIMS and Hospital Pawapuri, Nalanda during the period from October 2021 to may 2022 were included in this study. Patients were distributed into the following groups :

Diabetes group (DM) → 150 patients.

Hypertension group (HTN) → 125 patients.

Both hypertension and diabetes coexisting (DM +HTN) → 125 patients.

Healthy normal controls → 100 patients.

The age group selected was → 40 to 55 years.

Sex → male: 265 in number. Female: 235 in number.

Patients' groups were matched regarding the duration of the clinical condition. After taking informed consent from all, random blood glucose level was taken in all cases.

A random blood sugar level of 140 mg/dl or below was taken to be normal, 140—199 mg/dl was prediabetes and 200 mg/dl or above was diabetes. We selected diabetes

patients having blood sugar 200mg\dl or above.

The blood pressure of all patients was measured after making them rest for 30 mins. Blood pressure below 140/90 mmHg was taken to be normal and above it was considered to be hypertensive.

We have focussed here on median and ulnar nerves getting affected by mentioned conditions above alone or in combination, by using HRU.

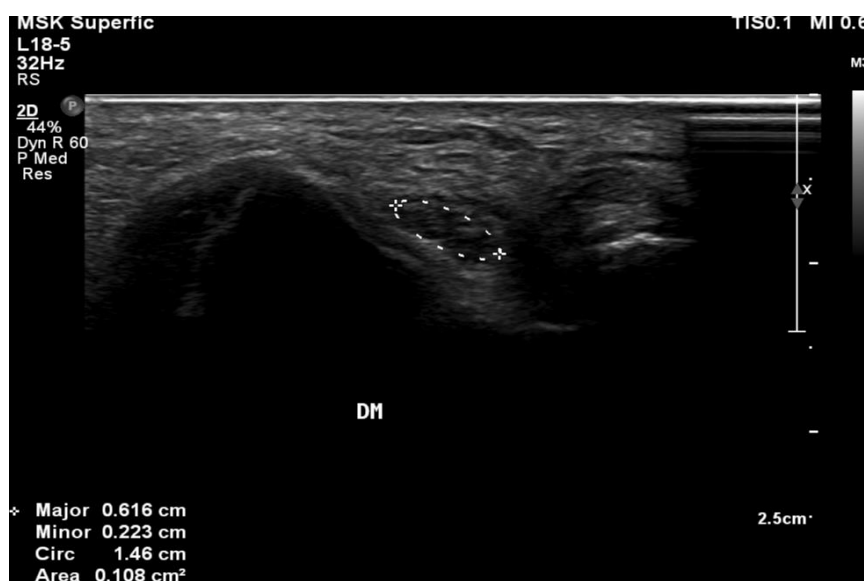
With HRU, we measured the cross-sectional area of nerves.

In an HRU image normal nerves on the transverse axis show nerve bundles (lower echo) surrounded by (higher echo) nerve bundle membrane and the outer membrane to form a honeycomb structure.

HRU displays the changes in image echo. We determined the median nerve CSA at the level of carpal tunnel and the ulnar nerve CSA in between the olecranon process and medial epicondyle.



**Figure 1: High-frequency ultrasonography showing the cross-sectional area of the median nerve at the wrist.**



**Figure 2: High-frequency ultrasonography showing the cross-sectional area of the ulnar nerve at the elbow behind the medial epicondyle.**

## Results

We had done the present study on 150 diabetes patients in (the DM group), 125 hypertensive patients (the HTN group), 125 patients having both diabetes and

hypertension (the HTN+DM group), and 100 healthy normal people (control). Age and sex distribution were matched in all 4 groups and disease duration was matched in the 3 patient groups.

**Table 1: Age, Sex, and duration of disease distribution :**

DISEASE	AGE Mean age in. Yrs+/-sd.	SEX (M/F).	DURATION Mean duration in Yrs+/-sd
HTN	45.9+/-8.7	80/70.	8.1+/-10.7
DM.	49.8+/-4.5.	65/60.	10.5+/- 6
HTN+DM	48.66+/-13.3.	80/70.	13.5+/- 4.3
CONTROL	47.6+/- 10.9.	50/50.	00

The table shows the comparison between the different groups concerning age, sex, and duration of disease. Age is comparable in all groups except in the HTN group which caters to a slightly younger generation. As regards sex, males dominate over females. Disease duration is highest in the HTN+DM group.

**Table 2 : The cross-sectional area of both median and ulnar nerves was measured in patients in cm<sup>2</sup> as such :**

NERVES	DM	HTN	HTN+DM	CONTROL
Ulnar nerve.	0.076.	0.081.	0.089.	0.066
Median nerve.	0.085.	0.092.	0.100.	0.080

In this table, we can see that patients in the HTN+DM group had higher Ulnar or Median nerves CSA values as compared to the HTN or DM group of patients. All three groups of patients had higher CSA values than the control group.

Analysis of Variance of Peripheral Nerves among all groups ( DM, HTN, HTN+DM, CONTROL):

Our study analysis of the variance of Median Nerve shows that patients in the HTN+DM group had higher CSA values than the HTN group or DM group of patients. In all the above group's Median nerve CSA had a higher value than a control group of patients.

Our study analysis of variance of Ulnar Nerve shows that patients in the HTN+DM

group had higher CSA values than the HTN group or DM group of patients. In all the above group's ulnar nerve CSA had a higher value than a control group of patients.

## Discussion :

Clinical and experimental studies done before have suggested that hypertension is an independent risk factor for diabetic peripheral neuropathy (DPN) in patients with T1DM and T2DM. [11]

Some studies show an association between hypertension and the development of DPN in T1DM & T2DM patients. [12,13]

Our present study shows the effect of coexisting HTN & DM on peripheral nerves namely the median and ulnar by HRU. It also shows the effect of HTN

alone and DM alone on median and ulnar nerves. We found higher CSA in patient groups in both median and ulnar nerves compared to controls. When DM and HTN coexisted, the CSA in both nerves was significantly higher when compared to either HTN or DM group. HTN group had slightly higher CSA than the DM group.

From the present study finding, we can foresee the effect of HTN and DM in the development of DPN. [14]

Previous studies have established the value of median nerve assessment in the diagnosis of peripheral neuropathy. The study of Su et al also recognizes the same by assessing the median nerve at the pisiform level by HRU and identifying subclinical peripheral neuropathy. [15]

DM is a significant risk factor for carpal tunnel syndrome and leads to median nerve enlargement. When the median nerve is compressed in the carpal tunnel, there is a swelling in this nerve and the degree of nerve swelling is mainly determined by factors related to compression rather than systemic effects caused by DM. [16]

A study done by Riazi S et al and another study done by Ishibashi F, Taniguchi M, et al state that in diabetic patients, the CSA, hypoechoic area, and maximum thickness of median nerve are closely related to the degree of neuropathy ( $p < 0.0001$ ). The degree of this correlation is significantly higher than in control subjects ( $p < 0.05$ ) [17]

Singh et al have stated that only the average CSA of the ulnar nerve conformed to this rule. [18]

The increase in CSA of nerves in diabetic patients is attributed to increased water content and is consistent with Huang's finding.

Controversies exist. Attah et al noted in their studies that a significant increase in median nerve CSA occurred in carpal tunnel in diabetic cases and the presence of

DPN resulted in a further increase in median nerve CSA. However, they noted that there is no association between median nerve CSA and glycaemic control or disease duration. Contrary to this, Solomon Tesfaye et al have concluded in their studies that apart from blood glucose control, no other treatment retards the progression of DPN.

Joshua A Gregory et al conducted trials on rats and suggested that hypertension may contribute to the etiology of DPN, while another study by Georgios Ponirakis et al, shows that hypertension has no effect on neuropathy in subjects without diabetes.

A study done by Gregory et al is in support of our work that HTN when superimposed on DM caused significant swelling in CSA. A study by De Visser et al confirms this.

Our study indicates that increased CSA in the median and ulnar nerves in diabetic and hypertensive patients precedes the development of clinical peripheral neuropathy.

HRU has unique diagnostic advantages in early and subclinical neuropathy so that early control of predisposing factors in high-risk cases can be done.

Our study identifies nervous affection in hypertensive patients without diabetes too. This needs more exploration to identify the possible risk factors and get favorable outcomes in long run.

### Conclusion :

Early diagnosis and early treatment of patients with neuropathies can improve the quality of life of patients and can improve the co-morbid conditions of the patients.

High-resolution ultrasonography has a definitive role in the early diagnosis of peripheral neuropathy.

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