Innovations

Upper Limb Sensory Alterations in Adults with Type II Diabetes Mellitus

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Abstract

Background: *Sensory abnormalities are connected with Diabetes associate dneuropathy & the evaluation of sensation is usually carried out on foot to avoid ulcers. Even while sensory changes in the upper limb are possible, they are not usually documented.* ***Aim:*** *To determine the two-point discrimination (2PD) values & further sensory alterations in the upper limb of patients with type II diabetes.* ***Methodology:*** *Thirty volunteers (aged 45–60) with type 2 diabetes who had the condition for more than five years were selected using a non-random sampling technique. Thirty individuals, matched for age and gender, who were not on a diabetes diagnosis made up the control group.* ***Statistical analysis:****2 sample T Test reveals that there is a significant difference between Non diabetics and Diabetic. p values less than.05 were considered significant.* ***Result:*** *Among 60 participants there are almost equal number of males and females in two groups. The comparison between the two groups revealed that the diabetic group demonstrated significantly higher values compared to the non-diabetic group.* ***Conclusions:*** *The diabetes patients changed sensations during the whole testing process suggested that underlying neuropathy alterations might be present. The two-point discrimination test can be used to detect upper limb neuropathy in people with type II diabetes; nerve conduction velocity testing can then be used to confirm the diagnosis further. It is important to perform a sensory evaluation in the upper limb to rule out neuropathy, particularly in individuals who have had diabetes for longer than five years.*

Keywords: *Diabetes Mellitus, Two-point discrimination (2PD),Diabetic Neuropathy, DHI (Duruöz Hand Index)*

Introduction: One of the most prevalent metabolic syndromes in almost every nation on earth is diabetes mellitus. The prevalence of diabetes in our nation is rising daily as a result of changing lifestyles that result in less physical exercise and obesity.[1]A high blood sugar level over a longer period of time is the hallmark

of a set of metabolic illnesses known as diabetes mellitus. Polyuria, polydipsia, and polyphagia are some of the indications and symptoms. Diabetes can result in a variety of issues if it is not managed. Peripheral neuropathy is one of the related consequences of diabetes that may present as the initial clinical manifestation of the condition. Patients with diabetic neuropathy physically show modest to severe loss of sensation, even though they rarely complain.

Before they manifest on the hands and arms, these symptoms are frequently observed on the feet. Significant morbidity, a lower quality of life, and a shorter life expectancy are all linked to diabetes mellitus.[2]

Diabetes affects over 135 million people globally, and by 2025, that figure is predicted to rise to almost 300 million.[3] It is linked to a shortened life expectancy, substantial morbidity, and a lower quality of life. Ninety to ninety-five percent of diabetes cases are type 2, which is age-related, peaking between the ages of 60 and 69.[4,5]Owing to its steady course, type 2 diabetes often takes 4–7 years on average to diagnose.Up to 50%–60% of individuals with inadequate glycaemic control may develop diabetic neuropathy, one of the most prevalent long-term consequences of diabetes.[6]

Two-point discrimination (2PD) is the ability to distinguish between two points that are applied to the skin at the same time. The smallest distance between two stimuli applied to the skin simultaneously and with equal pressure is the measure of two point discrimination. Weber initially defined two-point discrimination in 1853. There are two components to the nervous system: the central nervous system and the peripheral nervous system. Peripheral nerves transfer motor information from the central nervous system to the organ and sensory information from the distal organ to the CNS.Somatosensory senses include pressure, touch, light touch, pain, temperature, and proprioception.

Somatosensory senses include pain, temperature, proprioception, pressure, tactile, and light touch. These feelings are very important for awareness, for starting and controlling movements, and for understanding one's surroundings. The assessment of these senses provides insight into the functionality of the PNS and CNS. Valid and trustworthy two-point discrimination (2PD) results are possible when the proper process and instrument are used. The simplest and most widely used test is two-point discrimination, which is used to assess peripheral nerve damage and the recovery of sensation following a nerve injury.

The two-point discrimination (2PD) test gauges an individual's ability to distinguish between two stimuli that are given simultaneously and with equal intensity. It is frequently used as a trustworthy tool to assess somesthetic perception because of its tactile discriminating technique and accurate

presentation of the region. Depending on the part of the body is being assessed, the two-point discrimination (2PD) test employs different spacing sizes.

The goal of the study is to measure two-point discrimination (2PD) levels in people with type two diabetes. The two-point discrimination (2PD) is the capacity to ensure that two defined locations, not just one, are precisely where adjacent objects touch the skin. In a neurological assessment, it is typically assessed using sharp points at some point. Neuropathy and the ensuing neuropathic pain are more likely to occur in those with poorly controlled diabetes.This study is necessary because it aims to explore the sensory impairments associated with type II diabetes, particularly the loss of the ability to distinguish touch. Diabetic neuropathy, a common complication of poorly controlled diabetes, can lead to significant sensory deficits, including reduced touch perception, which can increase the risk of injury and complications. By measuring two-point discrimination (2PD) levels, the study seeks to better understand how diabetes affects tactile sensitivity, helping to identify early signs of neuropathy. This knowledge can inform more effective interventions and treatments, potentially improving the quality of life and preventing further nerve damage in individuals with diabetes. Additionally, the study could contribute to the development of strategies for restoring sensory function following nerve injury or surgical procedures.

Methodology

A total of thirty volunteers, aged between 45 and 65 years, diagnosed with type II diabetes for over five years, were included in the study. All participants in this group were undergoing treatment with 1000 mg of metformin hydrochloride, administered twice daily. These individuals were selected using a non-random sampling technique. Additionally, a control group was formed, comprising thirty individuals matched to the diabetic group in terms of age and gender, but without any history of a diabetes diagnosis. The research was carried out at the Physiotherapy and Wellness Clinic in Jaipur over a four-month period, from January 2024 to April 2024.

The following conditions were excluded: congenital abnormalities of the wrist and hand; autonomic neuropathy; peripheral vascular disease symptoms; upper limb traumatic nerve injury; skin infections; and neuromusculoskeletal disorders of the hand.

The control group comprised 30 participants who were matched based on gender and age and did not have a diabetes diagnosis. The two point discrimination was checked using an Aesthesiometer device with a millimeter marking. The subject's eyes were covered, but their hands were properly supported on the examination table. Because they are crucial for active and

tactile item scanning, the tips of the index and little fingers of both the left and right hands were evaluated.

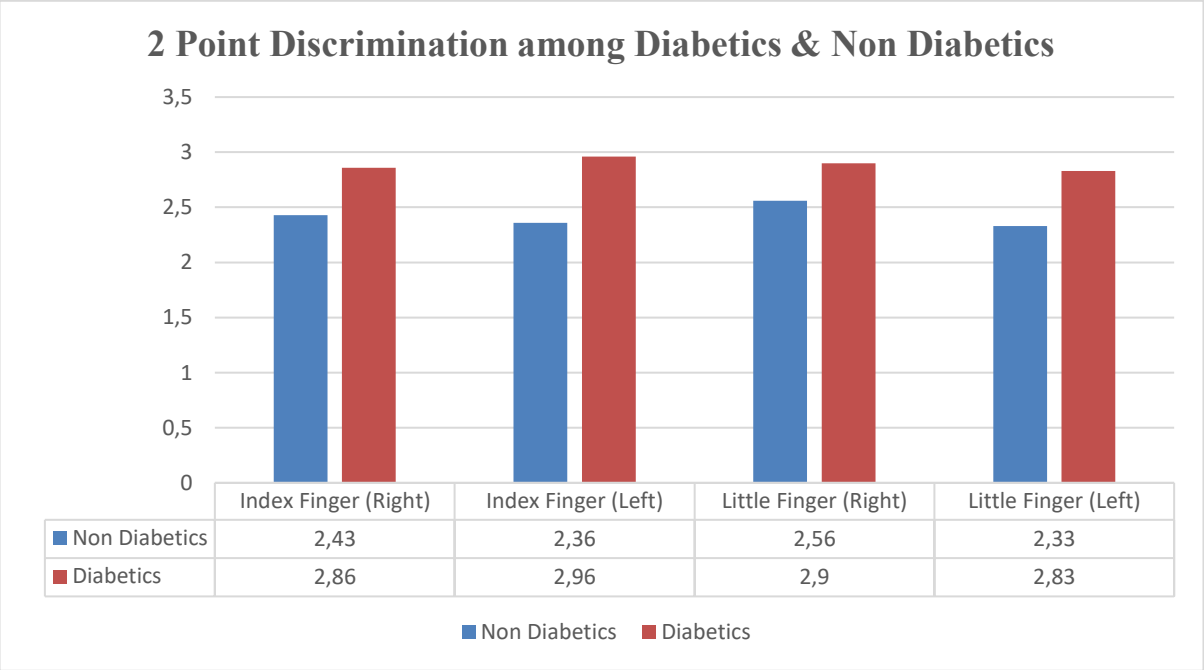
To reliably assess hand dysfunction in diabetic patients, a self-report questionnaire known as the DHI (Dutuöz's Hand Index) is a helpful tool. This scale measures functional impairment. The DHI was utilized to assess the general functional level of both groups with respect to their everyday life abilities.

Results

Among 60almost equal numbers of men and women are participating (50% in each group) in two groups. Mean of two-point discrimination (2PD) values for non-diabetics for 30 participants is 2.43±.49553 at right index finger tip. Mean of two-point discrimination (2PD) values for diabetics for 30 participants is 2.86±.61824 at right index finger tip. The mean value of two-point discrimination (2PD) for diabetics is found to be higher than non-diabetics at right index finger tip. Mean of two-point discrimination (2PD) values for non-diabetics for 30 participants is 2.36±.65743 at left index finger tip. Mean of two-point discrimination (2PD) values for diabetics for 30 participants is 2.96±.60461 at Left index finger tip. The mean value of two-point discrimination (2PD) for diabetics is found to be higher than non-diabetics at both right & left index finger tips. In the similar waymean of two-point discrimination (2PD) values for non-diabetics for 30 participants is 2.56±.55876 at right little finger tip. The mean value of two-point discrimination (2PD) for diabetics is found to be higher than non-diabetics. Mean of two-point discrimination (2PD) values for non-diabetics for 30 participants is 2.33±0.47140 at Left little finger tip. Mean of two-point discrimination (2PD) values for diabetics for 30 participants is 2.83±0.68718 at Left little finger tip. The mean value of two-point discrimination (2PD) values for diabetics for 30 participants is 2.90±.65064 at both right& left little finger tip. 2 sample T Test reveals that there is a significant difference between Non diabetics and Diabetics. All statistical tests were performed using the SPSS Version.

Part tested	**Group**	**Mean**	**Standard deviation**	**P value**
Index Finger (Right)	NonDiabetics	2.43	0.49553	0.004
	Diabetics	2.86	0.61824	
Index Finger (Left)	Non Diabetics	2.36	0.65743	0.001
	Diabetics	2.96	0.60461	
Little Finger (Right)	Non Diabetics	2.56	0.55876	0.034
	Diabetics	2.90	0.65064	
Little Finger (Left)	Non Diabetics	2.33	0.47140	0.002
	Diabetics	2.83	0.68718	

Fig. 1 Mean values of 2 point discrimination among Diabetics and Non Diabetics



Discussion

The findings of this study underscore the importance of accurately assessing sensory deficits in individuals with type II diabetes, particularly with regard to upper limb (UL) neuropathy. Although much of the existing research has focused on lower limb neuropathy, the hands are essential for many daily tasks, and any sensory impairment in the upper limbs can significantly impact an individual's quality of life. This study aimed to fill the gap in research by focusing on the sensory function of the hands in diabetic patients, using two-point discrimination (2PD) as a key measure.Sensory tests such as temperature, vibration, point localization, and two-point discrimination have long been employed to assess the sensory loss associated with diabetic neuropathy, most often in the lower limbs. While these modalities are effective for identifying sensory deficits, the focus has traditionally been on the feet due to the higher prevalence and more severe nature of lower limb neuropathy in diabetic patients. As mentioned, the lower limbs are more affected because the nerves there, especially the smaller, unmyelinated-fibers (such as C fibers), are more vulnerable to damage from the metabolic disturbances caused by diabetes. This study focuses on upper limb (UL) neuropathy, which has historically been less studied. The relative sparing of the upper limbs in comparison to the lower limbs in diabetic neuropathy has led to fewer investigations in this area. However, emerging evidence suggests that the upper limbs are not immune to neuropathy, and sensory changes in the hands can be early indicators of neuropathy. As the study indicates, the diabetic group exhibited significantly reduced two-point

discrimination (2PD) scores, suggesting that nerve involvement in the hands can be an early sign of neuropathy, even when the lower limbs show no clear signs.The study further explores the role of myelinated A-beta fibers in sensory perception. These fibers are primarily responsible for pressure sensation, and their involvement in neuropathy could explain the sensory deficits observed in diabetic patients. A-beta fibers are large, myelinatedfibers that typically transmit touch and pressure signals with high accuracy. In diabetes, prolonged hyperglycemia and metabolic changes can damage these fibers, resulting in reduced tactile sensitivity, which may explain the diminished ability to perceive two-point discrimination in the diabetic group. The fact that these fibers are involved suggests that the sensory deficits observed may be related to more than just small, unmyelinatedfibers, pointing to a more widespread impact on nerve function.The current study supports the continued use of two-point discrimination (2PD) as a reliable tool for assessing sensory loss in diabetic patients. The significant difference in 2PD values between the diabetic and non-diabetic groups reinforces the diagnostic utility of this method. 2PD measures an individual's ability to distinguish between two points of touch applied to the skin. In cases of neuropathy, the ability to differentiate between two points becomes impaired, and 2PD can serve as an early indicator of sensory changes, often before the patient notices other symptoms.This finding is crucial for early detection and intervention. Given that neuropathy can lead to further complications, such as foot ulcers, falls, and loss of manual dexterity, identifying sensory deficits in the hands through 2PD may help prevent these adverse outcomes. Furthermore, it emphasizes the need for more widespread screening for neuropathy, not just in the feet but also in the hands, especially in individuals with type 2 diabetes who have had the condition for several years.

The identification of sensory deficits in the upper limbs can help in the early detection of neuropathy, which, in turn, can guide interventions aimed at preventing or delaying further nerve damage. Management strategies such as glycemic control, pharmacological treatments, and physical therapy might be tailored to prevent progression of neuropathy. Early recognition of sensory loss can also help healthcare providers recommend specific lifestyle changes to minimize the risk of injury, such as foot and hand care education, the use of specialized equipment to improve dexterity, and adjustments in daily activities to reduce the strain on affected areas.This study's findings highlight the critical need for regular sensory testing in diabetic patients, particularly for early detection of neuropathy in the upper limbs. Although lower limb neuropathy has received much attention, the hands are also at risk, and sensory impairment in the upper limbs may signal the onset of neuropathy. Two-point discrimination is a simple, effective tool for identifying such deficits, and its application should be expanded in clinical settings. The involvement of large myelinated nerve fibers, such as A-beta fibers, suggests that neuropathy in diabetes can affect sensory

pathways responsible for fine touch and pressure, further complicating the management of this condition.[7] Future research should continue to explore the full scope of upper limb neuropathy in diabetes and refine screening techniques to ensure early and effective intervention.

Limitations

The study's sample size was relatively small, consisting of only 30 diabetic and 30 non-diabetic participants, which could limit the generalizability of the findings to the broader diabetic population. A larger sample size would provide more robust data, increasing the statistical power and ensuring more reliable and valid conclusions. Additionally, the study relied solely on the two-point discrimination (2PD) test to assess neuropathy, which, while useful for detecting certain sensory impairments, may not fully capture the entire spectrum of sensory and motor deficits associated with diabetic neuropathy. Incorporating other sensory tests, such as vibration, perception, pinprick sensation, or nerve conduction velocity measurements, would offer a more comprehensive assessment of neuropathy in diabetic patients, providing a clearer picture of the extent of sensory and motor dysfunction.Despite these limitations, the study highlights the importance of early sensory testing in diabetic patients and provides a foundation for future research into neuropathy assessment.

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