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Original Article

Sensation Assessment With Two-Point Discrimination And Graphesthesia In Diabetic Patients

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ABSTRACT

Background: Diabetes mellitus is a polyneuropathic disorder in which there is a gradual deprivation of nerve function in patients with diabetes mellitus. Two-point discrimination is a measurable testing procedure used for the assessment of nerve function and is generally used in patient-contact experience to evaluate tactile acuity in diabetic patients. Graphesthesia is the capability to perceive symbols that are traced on the skin of the participant. **Objective:** To assess the sensation with two-point discrimination and graphesthesia in diabetic patients. **Methods:** This cross-sectional study was conducted from August to November 2022. In this study, 385 diabetic patients aged ranged from 35 to 75 years were included, after fulfilling the inclusion criteria using non-probability convenient sampling. Data was collected from Aamir Hospital and Dr. Ejaz Ali Physiotherapy Services Gujrat. The capability to discriminate the two-point was evaluated in millimeters by using a Vernier caliper. The data was analyzed using SPSS version 24 and for descriptive analysis, mean and standard deviation were calculated for quantitative variables whereas frequency and percentages were used for qualitative variables. The chi-square and non-parametric tests were applied to find the association between variables. **Results:** The results had been obtained from 385 diabetic patients of which 62.6% were females and 37.4% were males. In a two-point discrimination assessment on both hands, 243(63.1%) participants show the normal frequency (<6mm), 123(31.9%) show fair (6-10mm) and 19(4.94%) showed poor frequency (11-15mm). Graphesthesia assessment was conducted using a list of 10 letters and numbers on both forearms. The correct response on the right forearm is 7.03±2.29 & on the left side is 6.63±2.18. Women scored less than men ($p<0.001$). **Conclusion:** The study concludes that females with diabetes have more poor two-point discrimination and graphesthesia sensation as compared to males. The study also concluded that age is associated with sensation. As the old patients have more sensory disturbance as compared to younger ones.

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INTRODUCTION

Diabetes mellitus is a group of metabolic diseases specified through a high blood sugar level over an enlarged interval of time. Signs and symptoms include polyuria, polydipsia and polyphagia. If diabetes is left untreated, it may cause many problems.[1] Despite having few complaints, patients with diabetic neuropathy physically indicate mild to moderate sensation loss. These symptoms are commonly seen on feet before they are seen on the hands and arms.[2] Diabetes mellitus is associated with reduced life expectancy, significant morbidity and reduced quality of life.[3]

It is hard to evaluate polyneuropathy in people with early-stage diabetes because thin fibers are the first to be compromised. To determine the association among neuropathic pain, physical examination and two-point discrimination (TPD) based on the outcomes of electrophysiological screening, the study's purpose was to determine TPD levels and conduct this screening in individuals who had early-stage diabetes.[4] The TDP is the ability to influence that adjacent objects touching the skin are precisely two marked points, not one. It is usually evaluated with sharp points at some point in a neurological assessment.[5]

Poor diabetic control increases the danger of neuropathy with subsequent neuropathic pains.[6] To use a TPD task, a person's ability to distinguish between soft touch signals applied simultaneously to the body is evaluated. Following a surgical procedure or damage to a peripheral nerve, TPD was used to properly assess sensory impairments and touch restoration. A tactile acuity size, like TPD, was initially intended to be exclusively based on changes in the frequency of peripheral nerve innervation in the area being examined after nerve damage.[7] A tuning fork, static and dynamic TPD, mono-filaments, and other harmless and easily available screening tools can be used to identify sensibility loss caused by diabetic sensorimotor polyneuropathy (DSP).[8] Huge variability was observed in all tests, which suggests clinicians have to be careful when decoding changes in tactile acuity in individual sufferers.[9] The TPD test evaluates the smallest distance at which a man or woman can distinguish between two stimuli presented simultaneously with the same intensity. It is frequently used as a reliable tool to assess somesthetic perception since it is a tactile discriminating technique that presents accurate information on the region. Depending on which body part is assessed, a different space size is used within the TPD test.[10]

It's intended to measure tactile acuity and discrimination and has been defined as a simple and dependable method for comparing sensitivity.[11] Fingertips have more sensations than other regions of the hand & women have more two-point discrimination values than men.[12] The two-point assessment was completed utilizing a basic hand-operated instrument, specifically a sketching compass with a flat or strong point. This simple instrument's distance between its two solid tips changed into a continuously adjustable millimeter measurement. By putting the two device recommendations to use at the measuring point, the two-point evaluation was completed.

The contact time increases to about 1.5 seconds.[13] TPD thresholds imply the smallest distance between points of sliding mechanical caliper, which could still be perceived as wonderful points. [14] Graphesthesia is the ability to recognize the writing on the skin in easy phrases through the feeling of touch.[15] A useful tool to assess how people interpret physical sensation is graphesthesia. Individuals can develop various views that are either self-focused or other-focused to recognize confusing tactile symbols, such as

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the letters b, d, p and q. To research the physical point of view, the head-centered view, which entails mentally turning the head toward the direction of the stimulating area, is particularly intriguing because it also mentally alters the body posture.[16] Examining graphesthesia is one way to look into how complex spatial data is processed. A typical neurological assessment of a patient's capacity to execute higher cortical interpretation of minor changes in the direction and position of mobile tactile sensory information is the ability to detect numbers "drawn" by tactile pressure applied to the skin. This research examines graphesthesia and two-point discrimination tests during harmless sensory stimuli with painful non-contact thermal heating on the arm and abdomen to fully appreciate the exteroceptive abilities of the nociceptive mechanism.[17]

No influence on the threshold is exerted by way of repeated size.[18] Diabetes and peripheral neuropathy are conditions that cause nerve damage. It causes numbness, loss of feeling and occasional discomfort in your hands, legs or feet. It is the most frequent side effect of diabetes. To determine the early sensory loss in diabetes mellitus patients and to assess the degree of nerve damage, the purpose of the study was to evaluate the results of the two-point discrimination test and graphesthesia. Although thin fibers are the first to be impaired in the early stages of diabetes, polyneuropathy is difficult to diagnose. At an early stage of the condition, TPD and graphesthesia are more effective ways. A simple, useful and inexpensive method of assessing patients with diabetes in its early stages is the TPD and graphesthesia.

METHODS

This cross-sectional study was conducted from August to November 2022. This study consists of 385 diabetic patients and was conducted in Aamir Hospital Gujrat and Dr. Ejaz Ali Physiotherapy Services Gujrat through non-probability convenient sampling. Sample size has been calculated by the given formula:

$$n=\frac{Z^2 1\text{-}a/2P(1-P)}{d^2}$$

where Z1-a/2 = is the standard normal variant at 95% confidence interval=1.96, P = expected proportion in population=0.5, d = marginal error effect size =0.05 and n = 385 Data were collected from those who meet the inclusion and exclusion criteria. Participants of 35 to 75 years of age and with disease onset of more than 3 years were selected according to the inclusion criteria. Gestational diabetes and the presence of other multiple diseases e.g., stroke, transient ischemic attacks, multiple sclerosis, metabolic disease, cancer and radiculopathies were excluded according to the exclusion criteria. Consent was taken from all the patients in written form. After getting permission, demographic data was obtained.
The individuals were informed about the whole study procedure and the purpose of the study was also explained.

The patients were in a comfortable position either sitting on a chair or lying on a couch. In all patients, TPD values were assessed at room temperature using the index finger of both hands or by the same examiner using the Vernier caliper device in and out of patients' clinics and hospitals. The patient's eyes should be closed, depending on the patient's capacity and/or willingness to express his or her true feelings. The test may be conducted by the therapist using a caliper or simply a modified paperclip. In the testing area, the therapist may touch the patient randomly with one or two points.

The patient's two-point threshold is defined as the minimum distance between two points that still causes them to perceive two different

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stimuli. It is possible to compare performance on the two extremities to look for differences. The test respondent expressed verbally whether he or she felt the touch as a single point or as multiple points.[4] The value of the TPD threshold increase with aging.[19] The participant's forearms were marked with a number by the therapist using their index fingers as part of the tactile graphesthesia exam. The individual was asked to vocally declare whether the written letters or numbers were for them. The person is required to describe the drawn letters or numbers precisely. The technique was repeated three to five times, or until the therapist could decide if the patient's sensibility was intact or impaired.[17] Combinations of letters were also used to increase task difficulty.[20]

Data were entered and analyzed through statistical software, Statistical Package for Social Sciences (SPSS) version 24, IBM Corp. Released 2016. For descriptive analysis, mean and standard deviation were calculated for quantitative variables whereas frequency and percentages were used for qualitative variables. Bar charts and pie charts representations were done for the qualitative data. The chi-square and non-parametric tests were applied to find the association between variables. All results were calculated at a 95% confidence interval and the p-value ≤0.05 were considered a significant value.

RESULTS

The mean age of participants was 54.03±10.84 and the meantime of disease onset of participants was 7.9±4.36. The highest percentage is 32.99% in the 46 to 55 years age group. The lowest percentage is 14.03% in the 66 to 75 years age group and the moderate percentage is 28.83% (56-65 years) and 24.16% (35-45 years). Of the gender distribution of 385 participants in 241(62.6%) were females and 144(37.4%) were males (Table I). In the two-point discrimination assessment on both right and left hands in 385 participants in which 63.12% have normal (<6mm) sensations, 31.95% have fair (6-10mm) and 4.94% had poor (11-15mm) sensations on both right and left hands. The chi-square value was 195.82 (Table II). In the graphesthesia assessment; all data were calculated by using SPSS. The total number of repetitions in graphesthesia was ten. The mean and standard deviation for graphesthesia are given in the table and have been calculated by using SPSS. According to this, the mean number of correct responses through the right hand was 7.04±2.29, and the mean number of errors through the right hand was 2.69±2.29.

The table also showed that the mean number of correct responses through the left hand was 6.63±2.18, and the mean number of errors through the left hand was 3.37±2.18 (Table III). The frequency of two-point discrimination on the right and left hand in 385 participants in which 243 participants showed normal (<6mm) sensations, 123 showed fair (6-10mm) sensations and 19 showed poor (11-15mm) sensations with p-value≤0.001.

Table I: Demographic characteristics of participants

Demographics		
Variables		**Mean±SD**
Age (years)		54.03 ± 10.84
Time of Disease onset (years)		7.89 ± 4.36
Gender Distribution %	**Female**	241 (62.60)
	Male	144 (37.40)
Total		385 (100)

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Table II: Two-point Discrimination Assessment

Two-point Discrimination				
Sensation	**n**	**%**	**Chi-square**	**p-value**
Normal (<6mm)	243	63.1	195.82	<0.001*
Fair(6-10mm)	123	31.9		
Poor(11-15mm)	19	4.9		
Total	385	100		

"*" indicates the statistically significant difference

Table III: Mean and Standard deviation of Graphesthesia (Total repetitions =10)

Statistics	
Graphesthesia	**Mean± S.D**
Through the right-hand number of correct response	7.04 ± 2.29
Through the right-hand number of errors	2.96 ± 2.29
Through the left-hand number of correct response	6.63 ± 2.18
Through a left-hand number of errors	3.37 ± 2.18

Therefore, there was an association between two-point discrimination of both the left and right hands.

DISCUSSION

This study was conducted to assess the sensations with two-point discrimination and graphesthesia in diabetic patients. It was performed in Aamir Hospital and Dr. Ejaz Ali Physiotherapy Services Gujrat with a sample size of 385 diabetic patients. The current study concluded that age is a highly significant factor ($p<0.001$) and the age group (35 to 75 years) is more prone to develop sensation loss. There is one previous study conducted by Priscilia G. Franco et al. to recognize vigor level and two-point discrimination analysis of young and elder participants. They manifest that the elder individuals confirmed poor sensitivity in two-point discrimination when compared to the young members ($p< 0.01$).[21] In our study, 62.6% were women and 37.4% were men. Our study supports the consequence of the TPD approach between different populations with diabetes. They proved that the standard TPD assessment is 2.49±.754 (Men:2.57±0.73 & Women:2.40±0.77). Two-point discrimination results between several variables showed a remarkably wide range. Men were less sensitive than women. TPD value rises with a person's age.[22] There is a distinction in the response of the skin according to body area and gender; consequently, prevention is needed to avoid triggering fatigue for the duration of the workout.[23]

This study showed the two-point discrimination assessment on hand in 385 participants in which 243 participants showed normal (<6mm) sensations, 123 participants showed fair (6-10mm) and 19 participants showed poor (11-15mm) sensations. Our study supports the results of a study conducted by Shriprabha Thube and his colleagues to perceive the evaluation of two-point discrimination on arms in older people. They proved that two-point discrimination trial following different segments of hand.

The research assumed that fingertips have more sensations than other regions of the hand & women have more two-point discrimination values than men.[12] In our study the alphabet and some digits drawn on the forearm are recognized with the assorted degree of validity when supervised according to our procedure. Females are associated with higher scores.

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Our study supports the result of a study conducted by Muayqil T.A. et al. who stated that a total of 126 male and female participants were added. In the results, men's score was less than women's ($p<0.001$) linked with the presentation. More correct results were perceived in numerical symbols ($p<0.001$). Alphabetic numbers with unique styles were easier to identify.[24] One more study supports our study results conducted by Daniel S. Harvie and their colleagues concluding that the two-point discrimination illustrated magnificent re-inspection accuracy, comprehensive and confined tests illustrated good results and graphesthesia demonstrated fair reliability. There was no consequential association amid measures. Only graphesthesia failed in receptivity to alter the training. Two-point discrimination was the most accurate test for sensation assessment.[25] Data was collected from multiple centers. The researcher uses more than one tool to evaluate the sensations. Further research is required for a better understanding of the topic.

CONCLUSION

The study concluded that females with diabetes have more poor two-point discrimination and graphesthesia sensation as compared to males. The study also concluded that age is associated with sensation. As the old patients have more sensory disturbance as compared to young patients.

DECLARATIONS

Consent to participate: Written consent had been taken from patients. All methods were performed following the relevant guidelines and regulations.

Availability of data and materials: Data will be available on request. The corresponding author will submit all dataset files.

Competing interests: None

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