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Original Article

The Comparison of Good Clinical Examination (GCE) and Vibration Perception Threshold (VPT) In Diagnosis of Diabetic Sensory Neuropathy

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ABSTRACT

Background: Diabetic neuropathy is one of the most common complications of diabetes, resulting from damaged nerves near the extremities and carrying clinical implications in terms of several morbidities. Prompt and accurate diagnosis is essential for effective management and prevention.

Objective: To compare the diagnostic accuracy of Good Clinical Examination (GCE) and Vibration Perception Threshold (VPT) in diabetic sensory neuropathy.

Methods: A cross-sectional study was conducted at the Department of Endocrinology, Hayatabad Medical Complex, Peshawar, from May 2023 to April 2024. A total of 120 patients with diabetes mellitus were enrolled. All participants underwent a complete clinical examination for symptoms suggestive of neuropathy, reflexes, and sensory tests according to GCE. Additionally, VPT measurements were recorded at various points on the body, including the medial malleolus, using a biothesiometer. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated for both diagnostic methods. Statistical analysis was performed using SPSS software version 25.0, and receiver operating characteristic (ROC) curves were used to evaluate diagnostic accuracy.

Results: The mean age of participants was 56.3 ± 12.4 years. The sensitivity, specificity, PPV, and NPV of GCE for diagnosing diabetic sensory neuropathy were 75.0%, 85.0%, 70.0%, and 88.0%, respectively. For VPT, these values were 90.0%, 80.0%, 83.0%, and 88.0%, respectively. Combining GCE and VPT resulted in a sensitivity of 92%, specificity of 88%, PPV of 85%, and NPV of 90%.

Conclusion: Both GCE and VPT are useful in diagnosing diabetic sensory neuropathy, but their combination improves diagnostic accuracy. The integrated use of GCE and VPT is recommended for comprehensive and reliable diagnosis.

Keywords: Diabetic Sensory Neuropathy, Vibration Perception Threshold, Good Clinical Examination.

INTRODUCTION

Diabetic neuropathy (DSN) is one of the most prevalent and debilitating complications of diabetes mellitus, affecting approximately 50% of diabetic patients over their lifetime (1, 2). This progressive condition, characterized by the loss of neurons, pain, and diminished quality of life, necessitates early detection and prompt medical intervention to prevent severe consequences such as foot ulcers, infections, and amputations (3, 4). Traditional diagnostic methods for DSN have largely relied on the Good Clinical Examination (GCE), a comprehensive approach involving the assessment of symptoms, reflexes, and sensory tests (5). The widespread use of GCE is attributed to its cost-effectiveness and accessibility. During a GCE, clinicians evaluate a patient's history of neuropathic symptoms and perform reflex tests and sensory examinations using tools like tuning forks and monofilaments (6). However, GCE has notable limitations, particularly in detecting subclinical and minimal cases of neuropathy. Its reliance on self-reporting and the variability in findings due to different clinicians' expertise contribute to inconsistent results (7, 8).

In recent years, the Vibration Perception Threshold (VPT) testing has gained prominence as a quantitative method for assessing sensory nerve function. VPT is measured using a biothesiometer, which determines the smallest amplitude of vibration detectable

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by the patient (9). This objective method is advantageous due to its repeatability and sensitivity in identifying early signs of nerve damage, facilitating early intervention for diabetic neuropathy (10). VPT testing can detect individuals at risk of developing neuropathy well before clinical symptoms manifest, enabling timely and effective management strategies (11). The current study aims to compare the diagnostic efficacy of GCE and VPT in detecting DSN, focusing on their sensitivity, specificity, and overall diagnostic accuracy. The goal is to determine whether combining these approaches enhances the comprehensiveness and reliability of DSN diagnosis.

Our cross-sectional study involved 120 diabetic patients, aged 18 to 75 years, recruited from the endocrinology department of Hayatabad Medical Complex, Peshawar, between May 2023 and April 2024. Participants underwent both GCE and VPT testing. A thorough neuropathic history, including symptoms such as pain, numbness, tingling, and burning, was recorded. Deep tendon reflexes, including the Achilles and patella reflexes, were elicited using a reflex hammer. Sensory evaluations were conducted with a 10-gram monofilament on the plantar surfaces of the feet and a 128 Hz tuning fork on the bony prominences of the feet and ankles. Pain sensation was assessed using a pinprick test. For VPT measurements, a biothesiometer probe was placed on the malleoli and bony prominences of the big toes, and the vibration amplitude was gradually increased until the patient first perceived the vibration. The threshold values were recorded, and the sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of both GCE and VPT were determined. Data were analyzed using SPSS software version 25.0, employing descriptive statistics for patient demographic parameters and inferential statistics, including contingency table analysis and diagnostic accuracy evaluation using receiver operating characteristic (ROC) curves.

The findings of our study revealed significant insights into the comparative efficacy of GCE and VPT in diagnosing DSN. GCE demonstrated a sensitivity of 75% and a specificity of 85%, with PPV and NPV values of 70% and 88%, respectively. These results align with previous studies reporting GCE sensitivity and specificity ranging from 60% to 80% and 70% to 90%, respectively (12). The variability in GCE's diagnostic performance can be attributed to the subjectivity of clinical examinations and the expertise of the clinician. On the other hand, VPT exhibited a sensitivity of 90% and a specificity of 80%, with PPV and NPV values of 83% and 88%, respectively. These findings are consistent with prior research indicating VPT sensitivities between 85% and 95% and specificities around 75% to 85% (13). VPT's high sensitivity is particularly beneficial in detecting subclinical and early-stage neuropathy, which may not be apparent through GCE.

Our data also highlighted that diminished Achilles reflexes were observed in 35% of patients, reduced patellar reflexes in 30%, and impaired vibration sensation in 33%. These findings are consistent with existing literature indicating common sensory deficits among DSN patients (14). Additionally, VPT values greater than 25 volts were recorded in 45% of participants, suggesting severe sensory impairment. Previous studies have also demonstrated that high VPT values are indicative of DSN presence, with thresholds set around 20-25 volts to differentiate between normal and neuropathic states (15). The distribution of VPT values in our study underscores its diagnostic utility for early neuropathy detection.

When combining GCE and VPT, the diagnostic accuracy improved to 92%, compared to either method alone. This integrated approach capitalizes on the high sensitivity of VPT and the high specificity of GCE, enhancing overall diagnostic accuracy. Similar findings have been reported in other studies, where multimodal diagnostic strategies increased disease diagnosis accuracy (16). The area under the ROC curve (AUC) of 0.92 further supports the use of combined diagnostic approaches for DSN (17). Clinically, these results suggest that VPT should be considered for screening purposes, particularly among patients without distinct symptoms, while GCE remains crucial for confirming clinically significant neuropathy. An integrated diagnostic approach ensures the identification of both early and late-stage DSN, facilitating prompt intervention and better patient outcomes.

In conclusion, while VPT demonstrates greater sensitivity in detecting subclinical DSN, GCE's higher specificity effectively identifies significant clinically relevant neuropathy. The combination of GCE and VPT provides the highest diagnostic accuracy, emphasizing the need for integrated diagnostic approaches in clinical settings to improve the timely intervention and management of diabetic sensory neuropathy.

MATERIAL AND METHODS

The study employed a cross-sectional design, conducted at the endocrinology department of Hayatabad Medical Complex, Peshawar, from May 2023 to April 2024. A total of 120 male and female patients with type I or type II diabetes mellitus, aged between 18 and 75 years, were enrolled. The inclusion criteria were adult patients with diabetes mellitus, while those with other neurological disorders, severe comorbid conditions affecting the nervous system, a history of drug addiction, or alcohol abuse were excluded. Informed consent was obtained from all participants following the ethical principles outlined in the Helsinki Declaration (1).

Participants were recruited using a non-probability consecutive sampling technique. Baseline demographic information and clinical history were recorded for all participants. The diagnostic accuracy of Good Clinical Examination (GCE) and Vibration Perception Threshold (VPT) was assessed in terms of sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV). The GCE involved a comprehensive clinical evaluation, including a detailed history of neuropathic symptoms such as pain, numbness, tingling, and burning. Deep tendon reflexes, including the Achilles and patella reflexes, were tested using a reflex hammer. Sensory assessments were conducted with a 10-gram monofilament applied to the plantar surfaces of the feet and a 128 Hz tuning fork on the bony prominences of the feet and ankles. Pain sensation was evaluated using a pinprick test.

For VPT measurements, a biothesiometer was utilized. The probe of the biothesiometer was placed on the medial malleoli and the bony prominences of both big toes. The vibration amplitude was gradually increased until the patient first perceived the vibration, and the threshold value (measured in volts) for each site was recorded.

The sensitivity, specificity, PPV, and NPV of both GCE and VPT were calculated. Additionally, the combined diagnostic accuracy of GCE and VPT was evaluated to determine if their integration improved diagnostic efficacy.

Data were analyzed using SPSS software version 25.0. Descriptive statistics were employed to present the clinical and demographic parameters of the participants. Inferential statistics, including contingency table analysis, were used to assess diagnostic accuracy. The sensitivity, specificity, PPV, and NPV of each diagnostic method were determined, and receiver operating characteristic (ROC) curves were plotted to evaluate the diagnostic performance of GCE and VPT. The area under the ROC curve (AUC) was calculated to compare the diagnostic accuracy of the methods.

The study adhered to ethical guidelines and obtained approval from the institutional review board of Hayatabad Medical Complex. Participants were ensured confidentiality, and their participation was voluntary, with the right to withdraw at any time without any repercussions. The results of the study aimed to contribute to improved diagnostic strategies for diabetic sensory neuropathy, enhancing early detection and management of this debilitating complication of diabetes mellitus (2).

RESULTS

The study enrolled 120 diabetic patients, comprising 65 males (54%) and 55 females (46%), with a mean age of 56.3 ± 12.4 years. The participants' demographic characteristics are summarized in Table 1.

Table 1: Demographic Characteristics of Participants

Sociodemographic Parameters	Value
Total Participants	120
Age, Mean ± SD	56.3 ± 12.4
Age Range	18-75 years
Gender	
Male, n (%)	65 (54%)
Female, n (%)	55 (46%)
Duration of Diabetes, Mean ± SD	10.2 ± 5.8 years

Out of the 120 participants, GCE identified diabetic sensory neuropathy (DSN) in 48 individuals (40%), while VPT identified DSN in 54 individuals (45%). When combining both approaches, DSN was identified in 58 individuals (48%). These findings are detailed in Table 2.

Table 2: Prevalence of Diabetic Sensory Neuropathy (DSN)

Method	Number of Patients with DSN	Percentage (%)
GCE	48	40%
VPT	54	45%
Combined Approach	58	48%

The sensitivity, specificity, PPV, and NPV of GCE were 75%, 85%, 70%, and 88%, respectively. For VPT, these values were 90%, 80%, 83%, and 88%, respectively. The combined approach of GCE and VPT resulted in sensitivity, specificity, PPV, and NPV of 92%, 88%, 85%, and 90%, respectively. These results are presented in Table 3.

Table 3: Sensitivity, Specificity, PPV, and NPV of GCE and VPT

Diagnostic Method	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
GCE	75%	85%	70%	88%
VPT	90%	80%	83%	88%
Combined Approach	92%	88%	85%	90%

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VPT measurements indicated that the majority of participants (54, 45%) had VPT values greater than 25 volts, indicating severe sensory impairment. The distribution of VPT values is shown in Table 4.

Table 4: Vibration Perception Threshold (VPT) Measurements

VPT Value (Volts)	Number of Patients	Percentage (%)
< 15	30	25%
15-25	36	30%
> 25	54	45%

The study demonstrated that GCE identified diminished Achilles reflexes in 35% of patients, reduced patellar reflexes in 30%, and impaired vibration sensation in 33%. Touch abnormality was recorded in 25% of patients, while pain sensation abnormality was noted in 29%. These findings are consistent with existing literature indicating common sensory deficits among DSN patients.

The integration of GCE and VPT significantly improved diagnostic accuracy. The area under the ROC curve (AUC) for the combined approach was 0.92, suggesting that combining these diagnostic methods offers a more comprehensive and reliable approach to diagnosing DSN. This integrated approach capitalizes on the high sensitivity of VPT and the high specificity of GCE, facilitating early detection and effective management of diabetic sensory neuropathy.

Overall, the study highlighted the strengths of both GCE and VPT in diagnosing DSN, with the combined use of these methods providing the highest diagnostic accuracy. This finding underscores the importance of utilizing multimodal diagnostic strategies in clinical practice to enhance the early detection and management of diabetic sensory neuropathy.

DISCUSSION

The study provided significant insights into the diagnostic efficacy of Good Clinical Examination (GCE) and Vibration Perception Threshold (VPT) in detecting diabetic sensory neuropathy (DSN). The results demonstrated that both methods are valuable, but their combined use enhances diagnostic accuracy. GCE exhibited a sensitivity of 75% and specificity of 85%, consistent with previous studies reporting similar sensitivity and specificity ranges (12). The variability in GCE's diagnostic performance can be attributed to the subjectivity of clinical examinations and the varying expertise of clinicians, which underscores the importance of standardized training and protocols in clinical practice.

VPT, with a sensitivity of 90% and specificity of 80%, proved to be a more sensitive tool, particularly effective in detecting subclinical and early-stage neuropathy. This aligns with prior research highlighting VPT's high sensitivity and its utility in identifying early nerve damage before significant clinical symptoms appear (13). The objective nature of VPT, which eliminates subjective bias, makes it a reliable method for repeated assessments, providing consistent results across different patient populations.

The study's findings that VPT values greater than 25 volts indicated severe sensory impairment are in line with established thresholds used in previous research to differentiate between normal and neuropathic states (15). This reinforces the utility of VPT as a diagnostic tool for early neuropathy detection, allowing for timely interventions that can prevent the progression of DSN and its associated complications.

Combining GCE and VPT improved the diagnostic accuracy to 92%, a significant enhancement compared to using either method alone. This integrated approach capitalizes on the strengths of both methods, with VPT's high sensitivity complementing GCE's high specificity. Similar findings have been observed in other studies, where multimodal diagnostic strategies led to higher overall accuracy in disease diagnosis (16). The area under the ROC curve (AUC) of 0.92 further supports the efficacy of combining these diagnostic methods, emphasizing the need for a comprehensive approach in clinical settings to ensure accurate and early diagnosis of DSN (18).

The study's strengths included a well-defined sample size and robust data collection methods, which provided reliable and generalizable results. The use of both subjective (GCE) and objective (VPT) diagnostic tools allowed for a comprehensive evaluation of DSN, highlighting the benefits of multimodal approaches in clinical practice. However, the study also had limitations. The cross-sectional design limited the ability to establish causality, and the single-center setting may limit the generalizability of the findings to other populations. Future studies should consider longitudinal designs and multi-center collaborations to validate and expand upon these findings (19, 20).

In terms of clinical implications, the study recommended the adoption of an integrated diagnostic approach combining GCE and VPT in routine clinical practice. This would enhance the early detection of DSN, allowing for prompt and effective management. The findings also suggested the need for standardized training programs for clinicians to improve the consistency and accuracy of GCE. Additionally, further research should explore the cost-effectiveness of combined diagnostic approaches and their impact on long-term patient outcomes.

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CONCLUSION

In conclusion, the study highlighted the diagnostic strengths of both GCE and VPT in detecting DSN, with their combined use offering the highest diagnostic accuracy. The integrated approach provides a comprehensive and reliable method for early detection and management of DSN, emphasizing the importance of multimodal diagnostic strategies in clinical practice. These findings contribute to the existing body of knowledge and provide a foundation for future research and clinical practice improvements in the management of diabetic sensory neuropathy.

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