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ORIGINAL ARTICLE

A Comparative Analysis of Diabetic Neuropathy Examination Scoring and Nerve Conduction Velocity in Individuals Affected by Diabetic Neuropathy

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ABSTRACT:
Background:Diabetes Mellitus (DM) is a global metabolic disorder that impacts people worldwide. It gives rise to Neuropathy, leading to notable morbidity characterized by symptoms such as Paraesthesia, hyperesthesia, gait disturbance, distal weakness, insensitive extremities, and a heightened susceptibility to foot ulcers, potentially resulting in amputations. The pain associated with diabetic neuropathy significantly affects the overall quality of life. Early diagnosis and management of diabetic neuropathy through tools like Diabetic Neuropathy Examination Scoring (DNE Scoring) and Electrophysiological studies (NCV study) are instrumental in reducing the morbidity associated with DM.**Methods**:Over the course of one year, 104 patients within the age range of 40 to 90 years were comprehensively examined. The assessment involved a thorough review of medical histories, detailed clinical examinations using DNE scoring, and Neuroconduction Velocity (NCV) studies.**Results and conclusion:**The combined utilization of NCV testing and DNE Scoring proves instrumental in early diagnosis, effective management, and slowing down the progression of diabetic neuropathy by achieving better control. The optimal diagnosis of Diabetic Sensorimotor Polyneuropathy (DSPN) is established through a comprehensive evaluation of both clinically observed symptoms and corresponding electrophysiological alterations. The synergy between Diabetic Neuropathic Examination (DNE scoring) and its alignment with NCV findings enhances the early detection capabilities for diabetic neuropathy.
Keywords:DNEscoring, NCVstudy,Diabetesmellitus

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INTRODUCTION

Diabetes mellitus, a pervasive metabolic disorder, unfolds its impact over time in both type 1 and type 2 DM, ushering in intricate changes across multiple organ systems and giving rise to complications such as Neuropathy, Nephropathy, and Retinopathy. Neuropathy, a complex manifestation of diabetic complications, assumes various forms including Polyneuropathy, Mononeuropathy, and Autonomic Neuropathy.Within this spectrum, Diabetic Sensorimotor Polyneuropathy (DSPN) emerges as the most common, displaying initial symptoms of numbness, tingling, and a pricking sensation localized predominantly in the toes and feet[1]. This sensory disturbance progresses in a distinctive stocking-glove distribution, advancing from the lower extremities to the hands. As the condition evolves, individuals may experience gait disturbances, distal weakness, and a dichotomy of either painful or insensate extremities, heightening the susceptibility to debilitating foot ulcers.Autonomic manifestations further contribute to the complexity of neuropathic involvement, presenting as impotence, nocturnal diarrhea, voiding difficulties, abnormal sweating, and orthostatic hypotension. In the clinical examination, a discernible pattern of distal sensory loss to pain, temperature, touch, and vibration is observed. Ankle reflexes consistently exhibit a reduction or absence, and any motor weakness detected tends to be mild, primarily affecting the toe flexors and extensors.This multifaceted presentation underscores the intricate nature of diabetic neuropathy, emphasizing the need for comprehensive understanding and management to address its diverse clinical facets.The Diabetic Neuropathy Examination Score (DNE Score) stands as a refined iteration of Dyck's Neuropathy Disability Score, employing a comprehensive neurological examination that includes meticulous scoring. Concurrently, Nerve Conduction Velocity testing (NCV) has risen to prominence as an indispensable electrophysiologic (EP) measurement, assuming a pivotal role in the evaluation of individuals grappling with diabetic neuropathy.

Diverging from the limitations of clinical examinations, electro-diagnostic tests, notably NCV, offer a distinct advantage by furnishing a more exhaustive and quantitative analysis of neuropathic conditions[2]. This methodology proves invaluable in capturing nuances and subtleties that may go unnoticed in standard clinical assessments. Furthermore, the appeal of these electro-diagnostic tests lies in their minimally invasive nature,

contributing to patient comfort and acceptance.The surge in popularity of NCV and analogous studies is rooted in their capacity to deliver a more precise and consistent evaluation compared to alternative non-invasive nerve tests. The diminished variability in results enhances the reliability of these electro-diagnostic tools, positioning them as indispensable assets in the clinical toolkit for diagnosing and understanding the complexities of diabetic neuropathy. Their ability to offer a detailed and reliable assessment underscores their significance in enhancing diagnostic accuracy and guiding effective management strategies for individuals with diabetic neuropathic conditions.In asymptomatic patients, the presence of nerve conduction abnormalities may manifest despite a clinical examination appearing either normal or abnormal. This discrepancy highlights the insidious nature of diabetic neuropathy, where physiological changes may precede overt clinical symptoms. Nerve conduction studies reveal a notable decrease in both sensory and motor amplitudes, reflecting the progressive degeneration and loss of nerve fibers over time. Notably, sensory nerve conduction tends to be more severely impaired than motor nerve conduction.Researchers from the American Diabetic Association have observed that diabetic neuropathy leads to a reduction in both nerve conduction and amplitude, pointing towards underlying processes of demyelination and axonal degeneration. Electrophysiological studies have further elucidated the interplay between nerve conduction studies, disability scores, and quantitative autonomic testing, revealing a robust correlation among these parameters.This correlation underscores the significance of integrating both clinical and electrophysiological findings for an ideal diagnosis of Diabetic Peripheral Neuropathy (DPN)[3]. The comprehensive approach, considering compatible clinical signs and corresponding electrophysiological changes, provides a more nuanced understanding of the condition. Emphasizing the multifaceted nature of diabetic neuropathy, this integrated diagnostic strategy facilitates a more accurate assessment, enabling healthcare professionals to tailor interventions and management strategies to individual patient needs.

MATERIALS AND METHODS

This is a prospective observational study conducted on both outpatient (OPD) and inpatient (IPD) individuals seeking medical attention for diabetes-related concerns and reporting symptoms indicative of diabetic neuropathy. The study enrolled patients who met the criteria and subjected them to a comprehensive assessment, including a detailed medical history, clinical examination, and electrophysiological studies.A total of 104 patients diagnosed with type 2 diabetes mellitus participated in the study. The evaluation encompassed an in-depth history and physical examination, with a specific focus on employing the Diabetic Neuropathy Examination (DNE) scoring system. Additionally, a battery of investigations, including complete blood count (CBC), erythrocyte sedimentation rate (ESR), mean corpuscular volume (MCV), fasting blood sugar (FBS), postprandial blood sugar (PP), glycated hemoglobin (HbA1C), urine analysis, serum creatinine, and Nerve Conduction Velocity (NCV) studies, were conducted.Inclusion criteria for the study comprised diabetic patients with a clinical diagnosis of Diabetic Sensory-Motor Polyneuropathy, ensuring a targeted focus on individuals manifesting this specific neuropathic condition. Conversely, exclusion criteria aimed at mitigating confounding factors by excluding patients with sensorimotor neuropathy arising from alternative causes such as drug-induced effects, hypothyroidism, alcoholism, and other non-diabetic etiologies.This structured methodology aligns with the research objective of comprehensively investigating diabetic neuropathy within the defined patient population while systematically excluding potential confounding factors, contributing to the scientific rigor of the study.The Diabetic Neuropathy Examination (DNE) scoring system serves as a comprehensive tool for assessing diabetic neuropathy, encompassing muscle strength, tendon reflex, and various sensations. The maximum score is 16, with a score exceeding 3 considered abnormal, indicative of diabetic neuropathy. The testing protocol involves evaluating specific aspects, including muscle strength in the Quadriceps femoris and Tibialis Anterior, ankle reflex, sensitivity to pinpricks in the index finger and big toe, sensitivity to touch, vibration perception, and sensitivity to joint position. Testing is conducted on the right leg and foot, or on the left if the right leg is amputated.Scoring ranges from 0 to 2, with 0 denoting normal function, 1 indicating a mild to moderate deficit, and 2 representing severe disturbance or absence of the measured parameters. A total score exceeding 3 leads to a diagnosis of diabetic neuropathy, with further classification into Mild Grade I (4 to 8), Moderate Grade II (9 to 12), and Severe Grade III (13 to 16).Nerve Conduction Velocity (NCV) testing is employed as a diagnostic measure to assess the electrical conduction abilities of both motor and sensory nerves. This involves the application of a low-intensity electric shock, which is not painful, to stimulate the nerves. Sensory testing is conducted on the sural nerve behind the lateral malleolus, with action potentials recorded at a standardized distance of 14 cm. Motor testing includes assessments of Motor Nerve Conduction Velocity (MNCV) and distal latency for tibial and peroneal nerves. All neurophysiological tests adhere to a standardized setup with specified distances. The impulses generated by the electric current are displayed on a computer screen, and the data are recorded. The tests are conducted under stable hemodynamic conditions, with patients maintaining normal body temperature and the testing environment

set at 32°C. This meticulous approach ensures the reliability and accuracy of the neurophysiological assessments for diagnosing diabetic neuropathy[4].In the comprehensive evaluation of diabetic neuropathy, a detailed scoring system is meticulously applied to various electrophysiological parameters, enhancing our understanding of the condition's intricacies. Distal latency, a measure of the time required for a nerve signal to traverse from a stimulus site to a recording site, is deemed normal within a 6 ms range. Grading is nuanced, hinging on the percentage increase from this normal baseline, introducing a systematic approach to discern abnormalities. Simultaneously, Sural Nerve Conduction Velocity (SNCV) and Motor Nerve Conduction Velocity (MNCV) evaluations consider normal values up to 41 m/sec. Scoring, in this instance, is contingent upon the degree of decrease in NCV from the established normal parameters.

Further refining the evaluation, Sural Sensory Nerve Action Potential (SNAP) scoring takes into account the percentage decrease from the normal value. Individuals demonstrating normal NCV, SNAP, and distal latency receive a score of 0, acknowledging their absence of deviation from established electrophysiological norms. These individual scores collectively contribute to an overarching grading system in the Electrophysiological (EP) assessment.This cumulative scoring structure ensures a nuanced classification of diabetic neuropathy severity. Grade I, encompassing scores ranging from 0 to 4, signifies a mild degree of involvement. Grade II, comprising scores from 5 to 8, denotes a moderate level of neuropathic impact. Finally, Grade III, characterized by scores from 9 to 12, signifies a severe degree of involvement. This meticulous scoring methodology serves as a valuable tool, offering a sophisticated and comprehensive understanding of diabetic neuropathy's impact on various electrophysiological parameters.

RESULTS

Within the framework of the conducted study, a clear demographic profile emerged, revealing a significant male predominance, constituting 78% of the study participants. The age distribution underscored a concentration of cases within the 50-60 year age bracket, encompassing 36.5% of the total study population. The mean age of the participants was calculated to be 64.5 years, reflecting a mature cohort under investigation.A noteworthy aspect of the study pertained to the duration of diabetes among the participants, with 48% of the population having lived with diabetes for a duration spanning 5 to 10 years. The mean duration before the onset of neuropathic symptoms was found to be 7.8 years, highlighting the chronic nature of diabetic neuropathy and the extended period preceding symptomatic manifestation.Symptomatology assessment revealed a diverse range of experiences among the study population. Topping the list was the sensation of tingling, reported by the highest number of patients (68 individuals), constituting a significant 65.38% of the total study cohort. Following closely, numbness was reported by 54 patients (52%), underlining its prevalence as a prominent symptom. Hyperesthesia, characterized by heightened sensitivity, was observed in 38 cases (36%), while foot ulcers and weakness were reported in 14 cases (13%) and 36 cases (34%), respectively. This intricate breakdown of symptom prevalence not only paints a detailed picture of the diverse clinical manifestations of diabetic neuropathy but also lays the groundwork for targeted interventions and further explorations into the intricacies of this prevalent and impactful complication of diabetes.The neurological evaluation in this study, utilizing the Diabetic Neuropathy Examination (DNE) scoring system, meticulously assessed various signs to gauge the presence and severity of neuropathy. Scores were stratified into 0, 1, and 2, with 0 denoting the absence of the neurological sign and 1 and 2 indicating increasing degrees of neuropathy severity. Specifically, observations related to quadriceps signs revealed that the majority of participants showed an absence (Score 0), while a smaller proportion exhibited scores of 1 or 2. Similarly, T-Anterior signs demonstrated varied severity levels, with a notable representation of Score 1. Ankle reflex assessments indicated diverse responses, with a substantial number of participants scoring 2. The examination of pinprick sensations on the big toe and index finger uncovered a range of scores, reflecting the prevalence and intensity of neuropathic symptoms. Furthermore, assessments related to touch, vibration, and joint position exhibited nuanced patterns, delineating the distribution and severity of neurological impairments. This detailed breakdown underscores the heterogeneity of neuropathic manifestations within the study population, providing a valuable framework for understanding the multifaceted nature of diabetic neuropathy in clinical contexts.

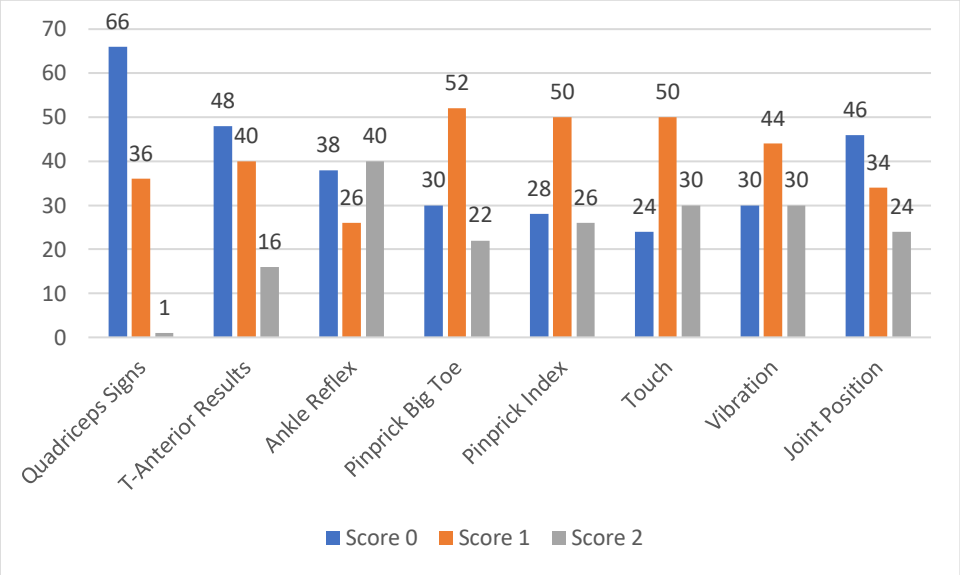
Table 1: Neurologic Signs in Study patients with Diabetic Neuropathy (DNE Scoring)

Neurologic Signs	Score 0	Score 1	Score 2
Quadriceps Signs	66	36	1
T-Anterior Results	48	40	16
Ankle Reflex	38	26	40
Pinprick Big Toe	30	52	22
Pinprick Index	28	50	26
Touch	24	50	30

Vibration	30	44	30
Joint Position	46	34	24

This table summarizes the neurologic signs observed and graded based on the DNE score, where the scoring system is divided into 0, 1, and 2, representing the absence of the sign and presence of neuropathy, respectively. The table provides the number of participants for each score category in various neurologic signs.

Fig 1: Neurologic Signs in Study patients with Diabetic Neuropathy (DNE Scoring)



The study revealed a correlation coefficient of 0.61 between the Diabetic Neuropathy Examination (DNE) Score and Nerve Conduction Velocity (NCV) Score, indicating a robust and positive linear relationship. The associated p-value of <0.001 suggests that this correlation is statistically significant. This finding underscores the interconnectedness between the DNE and NCV scores, emphasizing their concordance in evaluating diabetic neuropathy.To further characterize the severity of diabetic neuropathy, the study employed a grading system. According to the Diabetic Neuropathy Examination, 58 respondents were categorized in the first grade, 42 in the second grade, and 4 respondents were classified in the third grade. Meanwhile, NCV grading placed 50 participants in Grade I, 44 in Grade II, and 10 in Grade III. The Chi-square value comparing DNE and NCV grades yielded a p-value greater than 0.05, indicating a non-significant relationship (NS). This suggests that the grading systems based on DNE and NCV do not significantly differ, further supporting the coherence between these two assessment methods in characterizing the severity of diabetic neuropathy in the studied population.

DISCUSSION

Diabetic neuropathy, a consequential complication of uncontrolled or chronic diabetes mellitus, manifests as the impairment of nerve function. Prolonged exposure to uncontrolled diabetes can inflict damage upon the nerves, particularly affecting those in the hands and feet. Through the analysis of collected data, a notable correlation emerged between elevated blood sugar levels and a prolonged duration of diabetes with the occurrence of diabetic neuropathy[5]. This association underscores the intricate relationship between glycemic control and nerve health.It is well-established that nerve sensitivity to various somatic sensations increases, particularly in the early stages of diabetic neuropathy, a phenomenon accentuated in insulin-dependent patients. The study's findings further highlight the susceptibility of individuals within the age range of 50-60 years to diabetic neuropathy, positioning this demographic as the most adversely affected. Past research has indicated that maintaining blood sugar levels close to normal significantly reduces the risk of developing nerve damage in diabetic patients.The current study, encompassing 104 individuals diagnosed with diabetic sensory-motor polyneuropathy, employed the Diabetic Neuropathy Examination (DNE) scoring system for assessment. With a notable male dominance of 78 participants compared to 26 females, individuals within the age group of 50-60 years constituted the largest proportion at 36.5%. The mean age of the study population was calculated to be 64.5 years, providing valuable insights into the demographic characteristics of those affected by diabetic neuropathy in the investigated cohort.The manifestation of tingling, prevalent in 65.38% of individuals with diabetic neuropathy, underscores the sensory complexities associated with this condition. Numbness, experienced by 52% of participants, represents another prominent sensory disturbance. Additionally, participants reported sensations of hyperesthesia (36%), foot ulcers (13%), and weakness

(34%), collectively forming a spectrum of symptoms reflective of the multifaceted nature of diabetic neuropathy.

Detailed examination through the Diabetic Neuropathy Examination (DNE) scoring system elucidated specific neurological impairments, with ankle reflex dysfunction being the most frequently observed, impacting 66 respondents. Concurrently, pinprick sensation abnormalities over the toes added further insights into the sensory manifestations associated with diabetic neuropathy.Nerve Conduction Velocity (NCV) findings unveiled the sural nerve as the most frequently affected, followed by the tibial and peroneal nerves. The robust correlation coefficient of 0.61 between DNE Score and NCV Score signifies a strong linear relationship, highlighting the congruence between clinical assessments and electrophysiological studies in evaluating sensorimotor polyneuropathy. The associated p-value of <0.001 reinforces the statistical significance of this correlation, emphasizing its reliability as a diagnostic tool.

In agreement with Asad et al[6]. (2009), the study's findings accentuate the valuable association between nerve conduction studies (NCS) and clinical scores in detecting diabetic peripheral neuropathy. Notably, both modalities were found to be beneficial, and the study suggests that electrophysiological parameters can be indicative of the severity of nerve neuropathy. Furthermore, the study aligns with Feki and Lefaucheur's findings, reinforcing the correlation between the neuropathy disability score and the index of polyneuropathy. This collective body of evidence underscores the comprehensive diagnostic utility of combining clinical and electrophysiological assessments for a thorough understanding of diabetic neuropathy.The findings reported by Pfeifer et al. in 2012 significantly contribute to the understanding of diabetic neuropathy. Their assertion that the electrophysiological (EP) study reveals a robust correlation among nerve conduction studies, disability scores, and quantitative autonomic testing emphasizes the interconnected nature of these diagnostic measures.The correlation between nerve conduction studies and disability scores implies that the functional impairment of nerves, as assessed through electrophysiological techniques, aligns closely with the clinical manifestations observed in patients. This linkage underscores the relevance of electrophysiological assessments in capturing the physiological changes associated with diabetic neuropathy.Additionally, the incorporation of quantitative autonomic testing into the correlation further expands the scope of understanding diabetic neuropathy. Autonomic dysfunction is a common manifestation in diabetic neuropathy, affecting various bodily functions such as blood pressure regulation, heart rate, and gastrointestinal motility. The inclusion of quantitative autonomic testing provides a comprehensive assessment of the autonomic nervous system's involvement, offering valuable insights into the broader impact of diabetic neuropathy on physiological functions beyond the peripheral nerves.By recognizing the strong correlation among these diagnostic modalities, Pfeifer et al.'s[7] findings contribute to the establishment of a more holistic and integrated approach to assessing diabetic neuropathy. This comprehensive understanding is crucial for accurate diagnosis, effective management, and a nuanced appreciation of the impact of diabetic neuropathy on both peripheral nerves and autonomic functions.

CONCLUSION

Diabetic Neuropathy stands out as the most prevalent complication associated with prolonged diabetes, its incidence closely linked to the duration of diabetes and suboptimal glycemic control. Timely identification of neuropathy proves essential, and a cost-effective approach involves a detailed clinical examination, such as the Diabetic Neuropathic Examination (DNE) scoring. This method, characterized by its accessibility and affordability, serves as a valuable tool for early diagnosis.Electrophysiological studies, particularly Nerve Conduction Velocity (NCV) studies, play a pivotal role in initiating and maintaining effective control over diabetic neuropathy, thereby impeding its progression and enhancing overall quality of life. While these studies are highly beneficial, their limited availability and costliness pose challenges, particularly in resource-poor settings.In light of these constraints, the study underscores the significance of employing DNE scoring in all patients with diabetes, especially those exhibiting complaints related to diabetic neuropathy. The study's positive correlation ($r=0.61$, $p<0.001$) between NCV studies and DNE scoring further validates the efficacy of clinical examination in conjunction with glycemic control assessments.The study's findings advocate for a pragmatic approach in resource-limited settings, where the absence of electrophysiological studies necessitates relying on a combination of clinical scores and monitoring glycemic control for diagnosing and grading neuropathy. Early identification of diabetic neuropathy, coupled with stringent glycemic control, emerges as a crucial strategy to mitigate the associated morbidity. This comprehensive approach not only addresses the challenges posed by limited resources but also emphasizes the paramount importance of timely intervention for effective management of diabetic neuropathy.

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