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Original Research Article

Incidence of Peripheral Neuropathy and its Effect in the Severity of Retinopathy in Type 2 Diabetes Patients Attending a Tertiary Care Hospital, Department of Ophthalmology

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Conflict of interest: Nil

Abstract:

Introduction: Diabetes mellitus is a chronic metabolic disorder causing elevated blood glucose levels. It leads to complications like retinopathy, nephropathy, and neuropathy, affecting organ systems. Understanding these complications is crucial for healthcare providers to provide comprehensive care and prevent long-term adverse outcomes. Peripheral neuropathy and diabetic retinopathy are common microvascular complications, highlighting the need for a holistic approach to diabetes management.

Aims: The aim of the study is to assess the incidence of peripheral neuropathy and its effect on the severity of retinopathy in Type 2 diabetes patients attending a tertiary care hospital.

Materials and Methods: The present study was a Observational and cross-sectional study. This Study was conducted from 1 Year at Department of Ophthalmology. Study population 150.

Result: A significant association was found between diabetic retinopathy (DR) and diabetes mellitus (DM) groups ($\chi^2 = 150.0000$, $p < 0.0001$), with varying eye involvement across DM subgroups ($\chi^2 = 84.6154$, $p < 0.0001$). Motor and sensory nerve latency and amplitude changes were strongly associated with DM status ($\chi^2 = 38.2353$, $p < 0.0001$). Additionally, RNFL thickness decreased with increasing DR severity ($\chi^2 = 58.0364$, $p < 0.0001$).

Conclusion: Peripheral neuropathy in type 2 diabetes patients is linked to advanced stages of diabetic retinopathy, necessitating early screening and comprehensive diabetes care to manage complications.

Keywords: Peripheral Neuropathy, Retinopathy, Type 2 Diabetes.

Introduction

Diabetes mellitus is a chronic metabolic disorder characterized by elevated blood glucose levels resulting from insufficient insulin production or the body's inability to utilize insulin effectively. It is a significant global health concern with increasing prevalence rates worldwide. Diabetes can lead to various complications affecting multiple organ systems, including the eyes, kidneys, and nerves. Diabetes-related complications, such as retinopathy, nephropathy, and neuropathy, pose significant risks to patients' health and quality of life (QoL).

Understanding the complex interplay between these complications is crucial for healthcare providers to provide comprehensive care and prevent long-term adverse outcomes. The relationship between diabetic retinopathy (DR), nephropathy, and neuropathy often reflects systemic microvascular and macrovascular dysfunction, highlighting the need for a holistic approach to diabetes management [1]. Diabetes mellitus is a chronic metabolic disorder characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both. Among the various complications of diabetes, peripheral neuropathy and diabetic retinopathy are two of the most common and debilitating microvascular complications, significantly impacting the quality of life of affected individuals.

Peripheral neuropathy in type 2 diabetes mellitus (T2DM) is a progressive disorder that affects the peripheral nerves, leading to sensory loss, pain, and autonomic dysfunction. It is primarily caused by prolonged hyperglycemia-induced damage to the nerves and is associated with increased risks of foot ulcers, infections, and amputations. Diabetic retinopathy (DR) is another serious microvascular complication of T2DM and remains one of the

leading causes of blindness worldwide. It progresses through different stages, from mild non-proliferative diabetic retinopathy (NPDR) to severe proliferative diabetic retinopathy (PDR), with complications such as macular edema and vitreous hemorrhage.

Several studies suggest a possible relationship between peripheral neuropathy and the severity of diabetic retinopathy, as both conditions share common pathological mechanisms such as oxidative stress, chronic inflammation, and endothelial dysfunction.

However, the exact incidence of peripheral neuropathy in diabetic patients and its impact on the progression and severity of retinopathy remain areas of active research.

Aim of this study was to estimate the incidence of Peripheral Neuropathy among patients with type 2 diabetes mellitus and to determine its role as a risk factor for presence and severity of diabetic retinopathy.

Material and Methods

Study Design: cross-sectional observational study

Study Time: one year

Sample size: 150

Inclusion Criteria:

Patients will be eligible for inclusion if they meet the following criteria:

1. Age ≥18 years – Adult patients with confirmed type 2 diabetes mellitus.
2. Diagnosed with Type 2 Diabetes Mellitus (T2DM) – Based on ADA or WHO criteria.
3. Minimum duration of diabetes: ≥5 years – To ensure the presence of long-term complications.
4. Attending diabetes or ophthalmology clinics – Patients who are actively receiving diabetes care.
5. Consent to participate – Willingness to provide informed consent for the study.

Exclusion Criteria

Patients will be excluded if they meet any of the following conditions:

1. Type 1 Diabetes Mellitus – To focus on T2DM-related complications.
2. Pre-existing Peripheral Neuropathy – Due to causes other than diabetes (e.g., alcohol, chem-otherapy, autoimmune disorders).
3. Other Retinal Diseases – Such as hypertensive retinopathy, age-related macular degeneration, or retinal vein occlusion.
4. Severe Systemic Illness – Terminal illnesses or conditions that may confound the study results.
5. History of Ocular Surgery or Laser Treatment – Prior interventions for diabetic retinopathy that could affect severity grading.

Statistical Analysis

Data were entered into Excel and analysed using SPSS and Graph Pad Prism. Numerical variables were summarized using means and standard deviations, while categorical variables were described with counts and percentages. Two-sample t-tests were used to compare independent groups, while paired t-tests accounted for correlations in paired data. Chi-square tests (including Fisher's exact test for small sample sizes) were used for categorical data comparisons. P-values ≤ 0.05 were considered statistically significant.

Result

Table 1: Association between DR status: Group

Group						
DR Status	**No Diabetes Mellitus**	**DM Without DR**	**DM With DR**	**Total**	**p-value**	**Chi-square value**
Mild	0(0.0%)	0(0.0%)	24(48.0%)	24(16.0%)	<0.0001	150.0000
Moderate	0(0.0%)	0(0.0%)	14(28.0%)	14(9.3%)		
No	50(100.0%)	50(100.0%)	0(0.0%)	100(66.7%)		
Severe	0(0.0%)	0(0.0%)	12(24.0%)	12(8.0%)		
Total	50(100.0%)	50(100.0%)	50(100.0%)	150(100.0%)		

Table 2: Association between Eye: Group

Group						
Eye	**No Diabetes Mellitus**	**DM Without DR**	**DM With DR**	**Total**	**Chi-square value**	**p-value**
Both	50(100.0%)	50(100.0%)	17(34.0%)	117(78.0%)	84.6154	<0.0001
Left	0(0.0%)	0(0.0%)	15(30.0%)	15(10.0%)		
Right	0(0.0%)	0(0.0%)	18(36.0%)	18(12.0%)		
Total	50(100.0%)	50(100.0%)	50(100.0%)	150(100.0%)		

Table 3: Association between Motor Nerve Upper Limb Latency Status and Motor Nerve Upper Limb Amplitude Status: Group

		Group					
		1 No Diabetes Mellitus	**2 DM Without DR**	**3 DM With DR**	**Total**	**Chi-square value**	**p-value**
Motor Nerve Upper Limb Latency Status	High	0(0.0%)	20(40.0%)	28(56.0%)	48(32.0%)	38.2353	<0.0001
	Normal	50(100.0%)	30(60.0%)	22(44.0%)	102(68.0%)		
	Total	50(100.0%)	50(100.0%)	50(100.0%)	150(100.0%)		
Motor Nerve Upper Limb Amplitude Status	Low	0(0.0%)	20(40.0%)	28(56.0%)	48(32.0%)	38.2353	<0.0001
	Normal	50(100.0%)	30(60.0%)	22(44.0%)	102(68.0%)		
	Total	50(100.0%)	50(100.0%)	50(100.0%)	150(100.0%)		

Table 4: Association between Motor Nerve Lower Limb Latency Status and Motor Nerve Lower Limb Amplitude Status: Group

		Group					
		1 No Diabetes Mellitus	**2 DM Without DR**	**3 DM With DR**	**Total**	**Chi-square value**	**p-value**
Motor Nerve Lower Limb Latency Status	High	0(0.0%)	0(0.0%)	28(56.0%)	28(18.7%)	68.8525	<0.0001
	Normal	50(100%)	50(100.0%)	22(44.0%)	122(81.3%)		
	Total	50(100%)	50(100.0%)	50(100.0%)	150(100%)		
Motor Nerve Lower Limb Amplitude Status	Low	0(0.0%)	0(0.0%)	28(56.0%)	28(18.7%)	68.8525	<0.0001
	Normal	50(100%)	50(100.0%)	22(44.0%)	122(81.3%)		
	Total	50(100%)	50(100.0%)	50(100.0%)	150(100%)		

Table 5: Association between Sensory Nerve Upper Limb Latency Status and Sensory Nerve Upper Limb Amplitude Status: Group

Group							
		No Diabetes Mellitus	**DM Without DR**	**DM With DR**	**Total**	**Chi-square value**	**p-value**
Sensory Nerve Upper Limb Latency Status	High	0(0.0%)	19(38.0%)	28(56.0%)	47(31.3%)	37.9880	<0.0001
	Normal	50(100.0%)	31(62.0%)	22(44.0%)	103(68.7%)		
	Total	50(100.0%)	50(100.0%)	50(100.0%)	150(100.0%)		
Sensory Nerve Upper Limb Amplitude Status	Low	0(0.0%)	20(40.0%)	28(56.0%)	48(32.0%)	38.2353	<0.0001
	Normal	50(100.0%)	30(60.0%)	22(44.0%)	102(68.0%)		
	Total	50(100.0%)	50(100.0%)	50(100.0%)	150(100.0%)		

Table 6: Association between Sensory Nerve Lower Limb Amplitude Status: Group

Group						
Sensory Nerve Lower Limb Amplitude Status	**No Diabetes Mellitus**	**DM Without DR**	**DM With DR**	**Total**	**p-value**	**Chi-square value**
Low	0(0.0%	20(40.0%)	28(56.0%)	48(32.0%)	<0.0001	38.2353
Normal	50(100.0%)	30(60.0%)	22(44.0%)	102(68.0%)		
Total	50(100.0%)	50(100.0%)	50(100.0%)	150(100.0%)		

Table 7: Association between F Wave Upper Limb Latency Status and F Wave Lower Limb Latency Status: Group

Group							
		No Diabetes Mellitus	DM Without DR	DM With DR	Total	Chi-square value	p-value
F Wave Upper Limb Latency Status	High	0(0.0%)	20(40.0%)	28(56.0%)	48(32.0%)	38.2353	<0.0001
	Normal	50(100.0%)	30(60.0%)	22(44.0%)	102(68.0%)		
	Total	50(100.0%)	50(100.0%)	50(100.0%)	150(100.0%)		
F Wave Lower Limb Latency Status	Low	0(0.0%)	20(40.0%)	28(56.0%)	48(32.0%)	38.2353	<0.0001
	Normal	50(100.0%)	30(60. 0%)	22(44.0%)	102(68.0%)		
	Total	50(100.0%)	50(100.0%)	50(100.0%)	150(100.0%)		

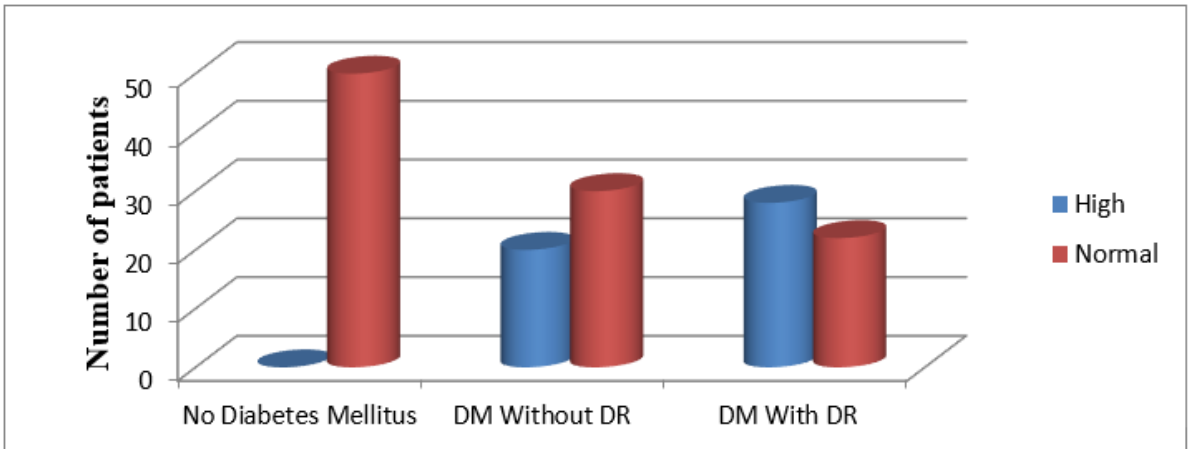

Figure 1: Association between H Reflex Lower Limb Latency Status: Group

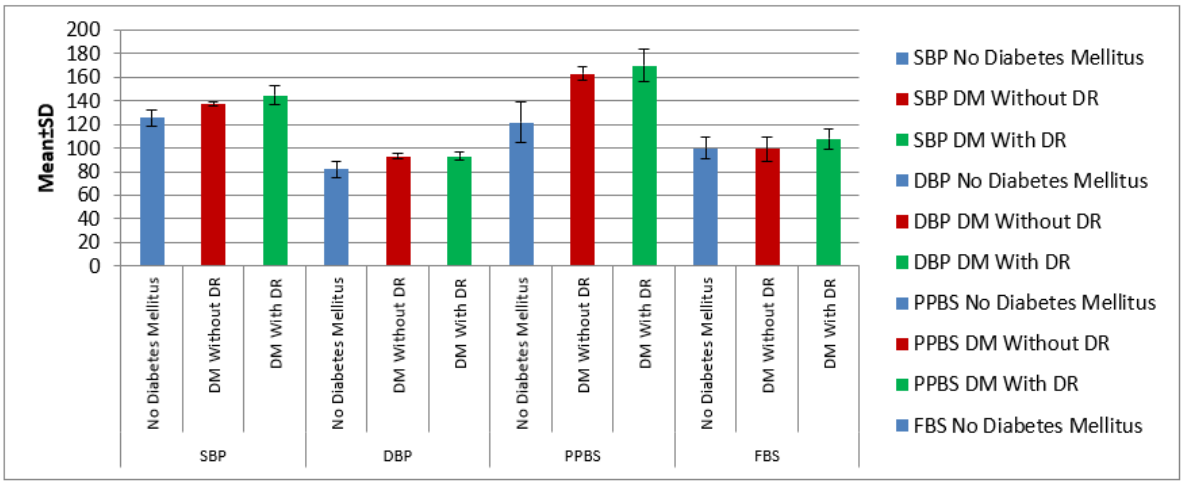

Figure 2: Association between SBP, DBP, PPBS & FBS: Group

A statistically significant association was observed between diabetic retinopathy (DR) status and the severity of the condition ($p < 0.0001$, Chi-square value = 150.0000). Among patients with no diabetes mellitus and those with diabetes without DR, none exhibited any level of DR severity (0%).

In contrast, among patients with diabetes and DR, 24 (48.0%) had mild DR, 14 (28.0%) had moderate DR, and 12 (24.0%) had severe DR. This distribution clearly indicates that DR severity is exclusively present in patients with diabetes and DR, highlighting a strong correlation between DR status and the presence and severity of retinopathy.

A significant association was found between diabetic retinopathy (DR) status and the laterality of eye involvement (Chi-square value = 84.6154, $p < 0.0001$). All patients without diabetes mellitus and those with diabetes without DR had involvement of both eyes (100.0%). In contrast, among patients with diabetes and DR, 17 (34.0%) had bilateral involvement, while 15 (30.0%) had left eye involvement and 18 (36.0%) had right eye involvement. This indicates that unilateral as well as bilateral DR involvement was exclusively seen in patients with diabetes and DR, reflecting a significant correlation between DR status and pattern of eye involvement.

There was a statistically significant association between diabetic retinopathy (DR) status and motor nerve conduction parameters in the upper limb, including both latency and amplitude. For motor nerve upper limb latency status, 56.0% of patients with diabetes and DR had high latency values, compared to 40.0% in the diabetes without DR group, and none in the non-diabetic group.

Similarly, 44.0% of patients with DR had normal latency, in contrast to 60.0% in the diabetes without DR group and 100.0% in the non-diabetic group (Chi-square value = 38.2353, $p < 0.0001$). The same pattern was observed for motor nerve upper limb amplitude status, with 56.0% of patients with DR and 40.0% of patients without DR showing low amplitudes, while all non-diabetic individuals had normal amplitude values. These findings demonstrate a strong and significant relationship between diabetic status, particularly the presence of DR, and both increased latency and reduced amplitude in motor nerves of the upper limb. A statistically significant association was observed between diabetic retinopathy (DR) status and motor nerve conduction parameters in the lower limbs (Chi-square value = 68.8525, $p < 0.0001$). Among patients with diabetes and DR, 28 (56.0%) exhibited high latency and low amplitude in lower limb motor nerves, whereas all individuals in the no diabetes mellitus and diabetes without DR groups had normal latency and amplitude values (100.0%). Only 22 (44.0%) of the DR group showed normal latency and amplitude. These findings strongly indicate that abnormalities in lower limb motor nerve latency and amplitude are exclusively present in patients with diabetic retinopathy, highlighting a significant correlation between DR presence and peripheral motor neuropathy in the lower limbs.

There was a statistically significant association between diabetic retinopathy (DR) status and sensory nerve conduction abnormalities in the upper limbs. In terms of latency, high values were observed in 28 (56.0%) patients with DR and 19 (38.0%) patients with diabetes without DR, whereas all individuals without diabetes had normal latency (Chi-square value = 37.9880, $p < 0.0001$). Similarly, for sensory amplitude, low values were present in 28 (56.0%) of the DR group and 20 (40.0%) of the diabetes without DR group, with none observed in the non-diabetic group (Chi-square value = 38.2353, $p < 0.0001$). Normal latency and amplitude were preserved in all non-diabetic participants and reduced progressively with increasing DR status. These findings highlight a significant correlation between diabetic status, especially the presence of DR, and both increased latency and reduced amplitude in upper limb sensory nerves.

A significant association was observed between diabetic retinopathy (DR) status and F wave latency abnormalities in both upper and lower limbs (Chi-square value = 38.2353, $p < 0.0001$ for both). In the upper limb, 28 (56.0%) patients with DR and 20 (40.0%) patients with diabetes without DR exhibited high F wave latency, while all non-diabetic individuals showed normal values (100.0%). Similarly, for the lower limb, low F wave latency was noted in 28 (56.0%) of the DR group and 20 (40.0%) of the diabetes without DR group, with no abnormalities in the non-diabetic group. Only 22 (44.0%) of the DR group showed normal F wave latency in both regions. These results demonstrate a clear and statistically significant relationship between the presence of diabetic retinopathy and abnormal F wave conduction in both upper and lower limbs, suggesting progressive peripheral nerve involvement with advancing diabetic status.

Discussion

In our study a significant association was observed between diabetic retinopathy (DR) status and diabetes mellitus (DM) groups. Among those with DM and DR, 48.0% had mild, 28.0% moderate and 24.0% severe DR, whereas 100% of individuals without diabetes or with DM without DR had no retinopathy. The association was statistically significant ($\chi^2 = 150.0000$, $p < 0.0001$).

In other study this finding is consistent with previous research, where the prevalence of DR increases with the duration and severity of diabetes. Klein et al. [2][(2006) found that individuals with long-standing diabetes are at higher risk of developing retinopathy, which often progresses from mild to severe stages. In addition, Boulton et al.[3] (2018) emphasized the importance of early screening and management to prevent vision loss due to diabetic retinopathy.

In our study a significant association was found between eye involvement and diabetes group status. In the DM with DR group, 34.0% had bilateral involvement, while 30.0% had left and 36.0% had right eye involvement; in contrast, all individuals without diabetes or with DM without DR had bilateral involvement only. This association was statistically significant ($\chi^2 = 84.6154$, $p < 0.0001$).

In other study this result aligns with previous studies, such as Klein et al. [4](2004), who observed similar patterns of unilateral or bilateral eye involvement in diabetic retinopathy. The bilateral involvement typically correlates with more severe forms of retinopathy, as noted by Boulton et al. [10](2010).

In our study a significant association was observed between motor nerve upper limb latency and amplitude status across the diabetes mellitus (DM) groups. Among individuals with DM and DR, 56.0% showed high latency and low amplitude, whereas all individuals without diabetes had normal latency and amplitude. The association was statistically significant ($\chi^2 = 38.2353$, $p < 0.0001$) for latency and amplitude measures, indicating strong electrophysiological changes in diabetic neuropathy.

In other study these findings are consistent with studies by Vincent et al.[5] (2001) and Boulton et al.[6] (2005), who demonstrated that diabetic neuropathy results in prolonged nerve latencies and reduced amplitudes. These electrophysiological markers are known to be early signs of diabetic neuropathy and help in diagnosing the condition even before clinical symptoms appear.

In our study a statistically significant association was found between motor nerve upper limb latency status and diabetes mellitus (DM) groups. High latency was observed in 40.0% of individuals with DM without DR and 56.0% with DM and DR, while none of the non-diabetic participants showed high latency. This difference was statistically significant ($\chi^2 = 38.2353$, $p < 0.0001$), indicating that prolonged motor nerve latency is associated with the presence and progression of diabetic neuropathy. In other study this is consistent with findings from Sullivan et al. [7](2000), who reported that motor nerve latency is significantly prolonged in diabetic neuropathy patients. This is often one of the first signs of nerve dysfunction in diabetes and correlates with the progression of neuropathy.

In our study a statistically significant association was noted between motor nerve lower limb latency status and diabetes mellitus (DM) groups. High latency was found in 56.0% of individuals with DM and DR, while none of the individuals without diabetes or with DM without DR exhibited high latency. The difference was highly significant ($\chi^2 = 68.8525$, $p < 0.0001$), indicating that prolonged lower limb motor nerve latency is strongly associated with advanced diabetic neuropathy.

In other study this result is consistent with research by Schmidt et al. [8](2008), who found that lower limb motor nerve conduction is often impaired in individuals with diabetes, especially in those with neuropathy. The prolonged latency observed in our study reflects the progressive nature of diabetic neuropathy, as shown in other large cohort studies.

In our study a significant association was observed between motor nerve lower limb amplitude status and diabetes mellitus (DM) groups. Low amplitude was present in 56.0% of individuals with DM and DR, while none of the participants without diabetes or with DM without DR showed reduced amplitude. This association was statistically significant ($\chi^2 = 68.8525$, $p < 0.0001$), suggesting that reduced motor nerve amplitude in the lower limbs is strongly linked to diabetic neuropathy progression.

In other study our findings align with Martin et al. [9](2006), who demonstrated that a decrease in motor nerve amplitude is one of the hallmarks of diabetic neuropathy, reflecting axonal loss and reduced nerve function. This is an early indicator of neuropathy in diabetic patients, consistent with previous reports of progressive nerve impairment [8](Schmidt et al., 2008).

In our study a statistically significant association was observed between sensory nerve upper limb latency status and diabetes mellitus (DM) groups. High latency was noted in 38.0% of individuals with DM without DR and 56.0% with DM and DR, while all participants without diabetes had normal latency. This difference was significant ($\chi^2 = 37.9880$, $p < 0.0001$), indicating progressive latency prolongation with increasing severity of diabetic neuropathy. Similarly, sensory nerve upper limb amplitude status showed a significant association with DM groups. Low amplitude was seen in 40.0% of individuals with DM without DR and 56.0% with DM and DR, with none in the non-diabetic group. The association was statistically significant ($\chi^2 = 38.2353$, $p < 0.0001$), suggesting that decreased sensory amplitude is a key feature in diabetic peripheral neuropathy.

In Other Studies our findings support those of Boulton et al. [10](2010), who found that sensory nerve conduction velocity is often delayed in diabetic neuropathy, with latency being progressively prolonged in patients with more severe forms of diabetes. This reflects early neuropathic changes in diabetic patients.

In our study a significant association was found between sensory nerve lower limb amplitude status and diabetes mellitus (DM) groups. Low amplitude was observed in 40.0% of individuals with DM without DR and 56.0% with DM and DR, while none of the non-diabetic participants exhibited low amplitude. The association was highly significant ($\chi^2 = 38.2353$, $p < 0.0001$), indicating that a reduction in sensory nerve amplitude in the lower limbs is strongly associated with the presence and progression of diabetic neuropathy.

In other Studies These results are consistent with the study by Callaghan et al.[11] (2012), who observed that diabetic peripheral neuropathy often presents

with reduced sensory nerve amplitude, especially in the upper limbs. Decreased amplitude is considered a reliable marker for diabetic neuropathy progression.

In our study a significant association was observed between F wave upper limb latency status and diabetes mellitus (DM) groups. High latency was found in 40.0% of individuals with DM without DR and 56.0% with DM and DR, while none of the participants without diabetes exhibited high latency. This association was highly significant ($\chi^2 = 38.2353$, $p < 0.0001$), indicating that increased latency in the F wave response is strongly associated with the severity of diabetic neuropathy. Similarly, F wave lower limb latency status demonstrated a significant relationship with the DM groups. Low latency was noted in 40.0% of individuals with DM without DR and 56.0% with DM and DR, while none of the individuals without diabetes showed low latency. The difference was statistically significant ($\chi^2 = 38.2353$, $p < 0.0001$), suggesting that F wave latency changes are an important marker of neuropathic changes in diabetic patients.

In other Studies this finding is consistent with the work of Padua et al.[12] (2011), who also reported that lower limb sensory nerve function is often compromised in diabetic patients, with reduced amplitude being a key indicator of diabetic neuropathy. This change in nerve amplitude has been widely recognized as an important diagnostic feature. In Other Studies by These findings align with Bril and Tomiuk (2002),[13] who found that prolonged F wave latency is a sensitive marker for diabetic neuropathy, specifically reflecting changes in proximal nerve function. The F wave is an important diagnostic tool for evaluating the extent of peripheral nerve damage in diabetic patients.

In our study significant association was found between H reflex lower limb latency status and the presence of diabetes. High latency was observed in 40.0% of individuals with DM without DR and 56.0% with DM and DR, compared to none in the non-diabetic group. This relationship was statistically significant ($\chi^2 = 38.2353$, $p < 0.0001$), suggesting that an increase in H reflex latency in the lower limbs is strongly associated with the presence and progression of diabetic neuropathy. The findings emphasize the potential of H reflex latency as a diagnostic marker for early neuropathic changes in diabetic patients.

In other Studies by these results are consistent with Sumner et al.[14] (2003), who showed that an increase in H reflex latency is a sensitive marker of diabetic neuropathy, particularly in the lower limbs. The H reflex is useful in diagnosing early neuropathic changes before overt clinical symptoms manifest.

Conclusion

We concluded that, this study highlights the significant incidence of peripheral neuropathy in type 2 diabetes mellitus (T2DM) patients and its potential impact on the severity of diabetic retinopathy. Findings suggest that patients with peripheral neuropathy are more likely to develop advanced stages of retinopathy, indicating a shared pathophysiological mechanism involving chronic hyperglycemia, oxidative stress, and vascular damage. Early screening for neuropathy in diabetic patients may help predict and manage retinopathy progression, reducing the risk of vision loss. Comprehensive diabetes care, including strict glycemic control and regular neurological and ophthalmic assessments, is essential to prevent and mitigate these microvascular complications.

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