Research Article

Correlation Study between Development of Diabetic Peripheral Neuropathy, Level of Glycosylated Hemoglobin and Duration of Diabetic Mellitus

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ABSTRACT

Background: Diabetic neuropathy is one of the most common microvascular complications associated with diabetes mellitus. Diabetic peripheral neuropathy (DPN) has been linked to hyperglycaemia and long duration of uncontrolled type 2 diabetes mellitus (T2DM) as measured by glycosylated haemoglobin (HbA1c). To our knowledge the estimated duration between diagnosis and developing DPN and the level of HbA1c have not yet been investigated in Sudanese patients with type 2 DM. Therefore, this study aims to investigate the relationship between the duration of diabetes and HbA1c with nerve conduction velocity (NCV) in patients with type 2 DM.

Objective: This study aims to investigate the correlation between the development of DPN, levels of HbA1c, and the duration of diabetes mellitus.

Methods: A cross-sectional study was conducted involving 250 diabetic patients diagnosed with DM for at least 4 year. Patients underwent clinical assessments for DPN, including sensory and motor tests, and HbA1c levels were measured. Data were analyzed using Pearson correlation coefficients to assess relationships between DPN severity, HbA1c levels, and diabetes duration.

Results: The study found a significant positive correlation between the duration of DM and the severity of DPN ($r = 0.836$, $p < 0.001$). Additionally, higher HbA1c levels were strongly associated with increased DPN severity ($r = 0.836$, $p < 0.05$). Patients with HbA1c levels above 7% had a significantly higher incidence of DPN compared to those with lower levels ($p < 0.01$).

Conclusion: The findings indicate that both prolonged duration of diabetes and poor glycemic control, as reflected by elevated HbA1c levels, are significant risk factors for the development of diabetic peripheral neuropathy. These results underscore the importance of effective glycemic management and regular monitoring of diabetes duration to mitigate the risk of DPN in diabetic patients.

Keywords: Complications, DPN, hyperglycaemia, nerve conduction velocity.

INTRODUCTION

Diabetes mellitus (DM) is a long-term hyperglycemic condition linked to insulin resistance and the metabolic syndrome. Prolonged diabetes mellitus damages numerous organs, resulting in serious consequences such as retinopathy, nephropathy, and neuropathy. A high concentration of plasma glycosylated hemoglobin (HbA1c) is the most significant risk factor for predicting complications from diabetes mellitus. HbA1c is often used as an indicator of average glycemic control during the preceding two to three months and denotes poor diabetic management. Retaining a HbA1c level below 6.5% is essential for reducing the risk of complications related to diabetes.[1]

There is strong evidence to suggest that generalized varieties can be further divided into at least two major groupings. The most frequent variant of DPN is believed to be the typical DPN, which is a chronic, symmetrical, length-dependent sensorimotor polyneuropathy. It arises in the context of chronic hyperglycemia, related metabolic disorders (including elevated polyol flux, build-up of advanced glycation end products, oxidative stress, and changes in lipid levels among other metabolic disorders), and cardiovascular risk factors.[2]

About 1.91% of all diabetes people globally have diabetic neuropathy. Patients with diabetic neuropathy may have axonal loss, which accounts for the majority of symptoms, or demyelinating illness with or without polyneuropathy symptoms. Preventive measures that can be employed to prevent DPN or other delayed consequences include blood glucose control, cholesterol and blood pressure index improvement, abstinence from tobacco use, and excessive alcohol consumption. Complications from diabetic neuropathy are a growing source of worry since they are thought to be a major contributor to impairment from foot ulceration and amputation, gait abnormalities, and accidents from falls. These issues significantly impair patients' quality of life and raise the price of diabetes-related healthcare.[3]

DPN is relevant to the onset and progression of sarcopenia, and numerous studies have documented its connection to muscle weakness. DPN is characterized by metabolic and microvascular abnormalities that harm the intraneural capillaries supplying the peripheral nerves, resulting in sensory loss, discomfort, and weakening of the muscles.

DPN can cause diabetic people to lose muscle mass more quickly than they would if they only had diabetes.[4]

The aim of this study was to explore the relationship between the duration, glycaemic control and Correlation between development of diabetic peripheral neuropathy, level of glycosylated hemoglobin and duration of diabetic mellitus

METHODS AND MATERIALS

Study design- case control study

Setting- Diabetic patients admitted in department of medicine, Govt. General hospital Thiruvananthapuram

Study population- 250 diabetic patients admitted in Govt. General Hospital, Department of Medicine during period of 2011-2014

Sample Size- 250 diabetic patients admitted in Department of Medicine during period of 2011-2014

Inclusion Criteria

I. Patient having diabetes mellitus with HbA1c more than 8….as case

II. Patient having diabetes mellitus with HbA1c less than 8….as control

Exclusion Criteria

a) Patient with thyroid disorder

b) Patient with vitamin b12 deficiency

c) Alcoholic neuropathy

Observation And Result

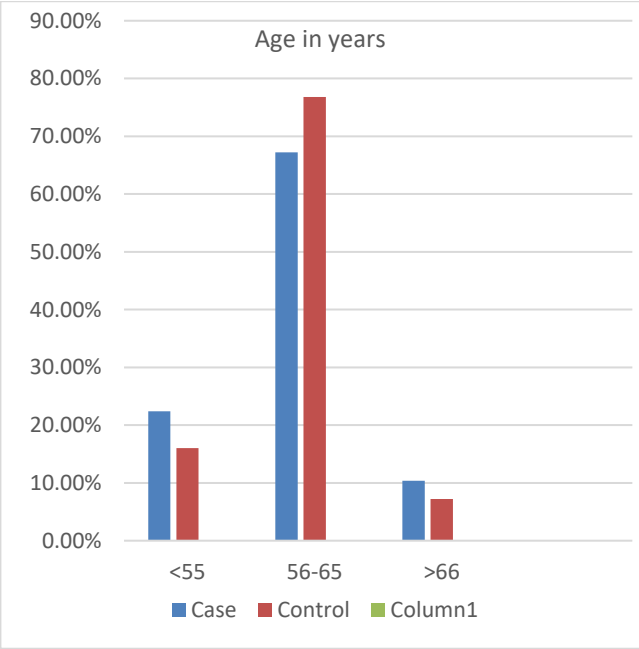

Figure 1: Age wise distribution

There was no much difference between age groups of cases and controls. Most of the patient were between age group 56-65.

Table 1: Age wise distribution

Age	Category				Total	
	Case		Control			
	N	%	N	%	N	%
<55	28	22.4	20	16.0	48	19.2
56-65	84	67.2	96	76.8	180	72.0
>66	13	10.4	91	7.2	22	8.8
Total	125	100	125	100	250	100

$\chi 2 = 2.861$ df= 2 p=0.239

38.4% of the cases have diabetic peripheral neuropathy whereas only 14.6% of the controls have diabetic peripheral Neuropathy studied against biothesiometer testing. The observed difference is statistically significant ($p<0.05$). Patients with $HBA_1C<8$.

95% confidence limit=2.002-6.860

Table 2: Biothesiometry (Diabetic Peripheral Neuropathy from mild to severe)

Biothesiometry	Category				Total	
	Case		Control			
	N	%	N	%	N	%
No Neuropathy	77	61.6	107	85.6	184	73.6
Mild	22	17.6	12	9.6	34	13.6
Moderate	17	13.6	5	4.0	22	8.8
Severe	9	7.2	1	8	10	4.0
Total	125	100	125	100	250	100

Development of diabetic peripheral neuropathy has been seen in significant proportion in cases, compared that with controls.

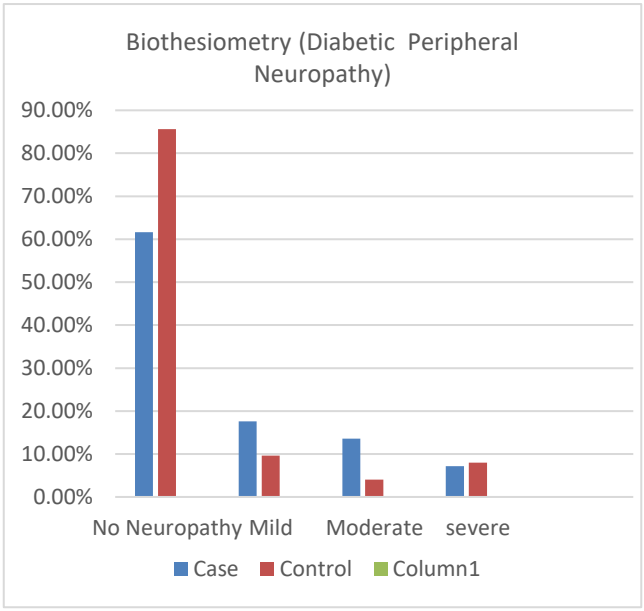

Figure 2: Biothesiometry (Diabetic Peripheral Neuropathy mild to severe)

Using biothesiometer study testing,it is found that cases have 3.706 more times chance of development of DPN compared with control Odd ration = 3.706. There is statistically significant difference in development of DNP when both groups were compared[p<0.001]

OR= 3.706

95% CL=2.002-6.860

Table 3: Biothesiometry (Diabetic Peripheral Neuropathy Present or Absent)

Biothesiometry (DPN)	Category				Total	
	Case		Control			
	N	%	N	%	N	%
Present	48	38.4	18	14.6	66	26.4
Absent	77	61.6	107	85.6	184	73.6
Total	125	100	125	100	250	100

χ2 =18.528 df=1 p<0.0001 OR=3.706

95% CL=2.002-6.860

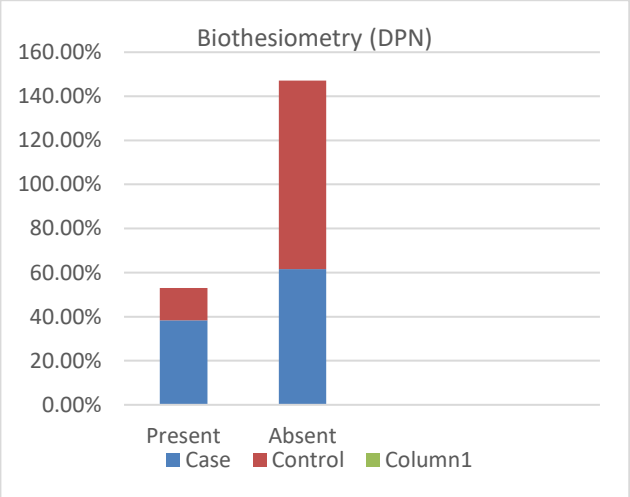

Figure 3: Biothesiometry (Diabetic Peripheral Neuropathy Present or Absent)

40.8% of the cases have diabetic Peripheral Neuropathy whereas only 16% of the controls have diabetic peripheral neuropathy studied against Nerve Conduction Velocity. The observed difference is statistically significant (p<0.05). Patients with HBA1C>8 have 3.618 time more chance to develop neuropathy than the patients with HBA1C <8

Table 4: By using (Nerve conduction velocity whether present or Absent)

Nerve conduction velocity (neuropathy)	Category				Total	
	Case		Control			
	N	%	N	%	N	%
Present	51	71.8	74	41.3	125	50
Absent	20	28.2	105	58.7	125	50
Total	71	100	179	100	250	100

χ2 =18.904 df=1 p<0.0001 OR=3.618

95% CL=1.993-6.570

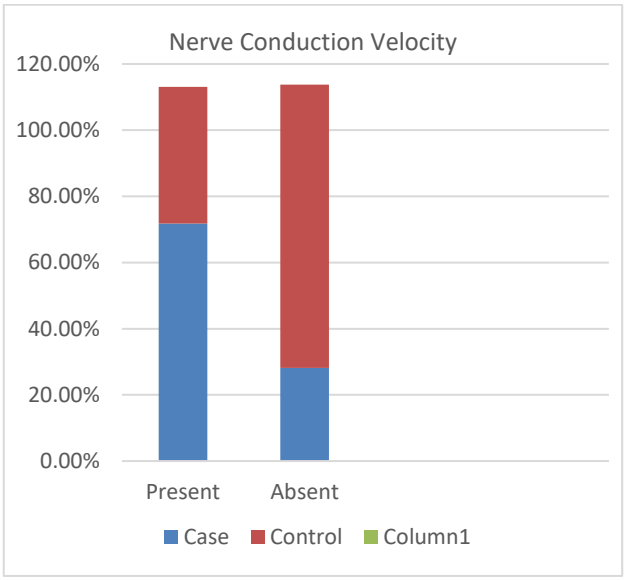

Figure 4: By using (Nerve conduction velocity whether present or Absent)

Statistically significant difference in two groups was observed when compared against duration of diabetes and development of DPN [P<0.001], Showing DPN more in cases with longer duration of Diabetes.

Table 5: Duration of DM in year

Duration of DM in year	Category				Total	
	Case		Control			
	N	%	N	%	N	%
<5	4	3.2	109	87.2	184	45.2
6-10	85	68.0	8	6.4	34	37.2
>10	36	28.8	8	6.4	22	17.6
Total	125	100	125	100	250	100

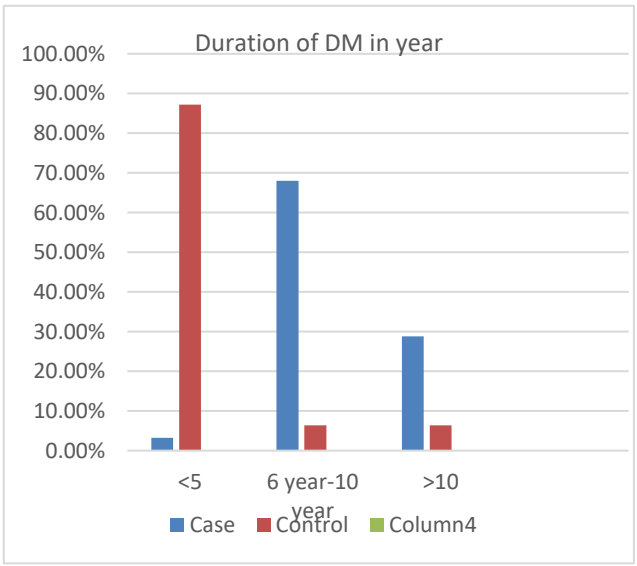

Figure 5: Duration of DM in year

χ2=179.137 df=2 p<0.0001

As duration of diabetic mellitus increases, development of DNP increases, more amongst the cases than compared with cases.

Table 6: Development of DNP in male and female

Gender	Category				Total	
	Case		Control			
	N	%	N	%	N	%
Male	66	52.8	63	50.4	129	51.6
Female	59	47.2	62	49.6	121	48.4
Total	125	100	125	100	250	100

χ2=0.144 df=3 p=0.704

There was no much gender difference both in cases and controls p value not statically significant p>0.05.

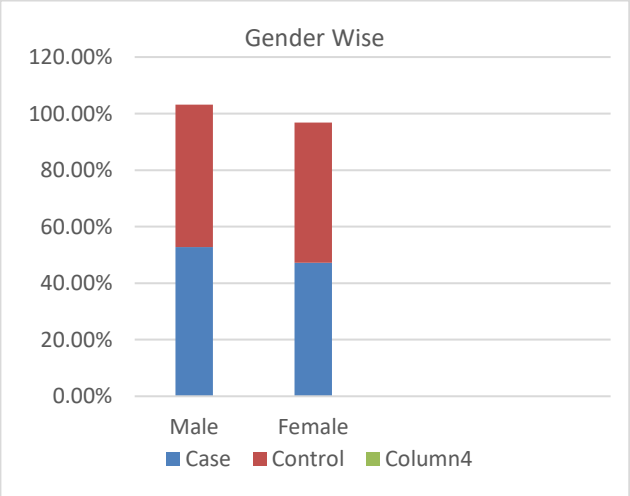

Figure 6: Development of DNP in male and female

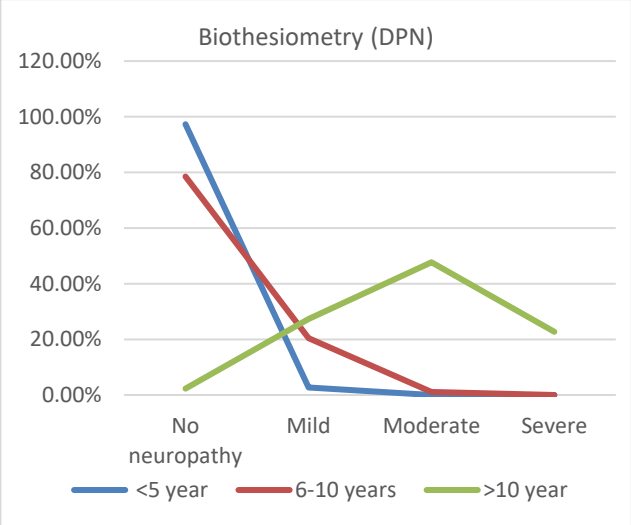

Figure 7: Duration of DM year From Mild To severe By using biothesiometry

Biothesiometer threshold increases with duration of diabetes mellitus [r=0.836, p<0.05]

Table 7: Duration of DM year From Mild To severe By using biothesiometry

Biothesiometry	Duration of DM year						Total	
	<5		6-10		>10			
	N	%	N	%	N	%	N	%
No Neuropathy	110	97.3	73	78.5	1	2.3	184	73.6
Mild	3	2.7	19	20.4	12	27.3	34	13.6
Moderate	0	0	1	1.11	21	47.7	22	8.8
Severe	0	0	0	0	10	22.7	10	4.0
Total	113	100	93	100	44	100	250	100

DISCUSSION

Diabetes mellitus (DM) frequently results in diabetic peripheral neuropathy (DPN), a condition that has a major negative influence on patients' quality of life. To effectively manage and prevent diabetes, it is essential to comprehend the relationship between the development of DPN, glycosylated haemoglobin (HbA1c) levels, and the length of diabetes.

Age and HbA1c level were found to be independent risk factors for polyneuropathy comorbidity in DM patients in the current study.

Numerous studies have demonstrated that higher HbA1c levels are associated with an increased risk of DPN. For instance, a study by Tesfaye et al. found that patients with HbA1c levels above 8% had a significantly higher prevalence of neuropathy compared to those with lower levels [5]. This relationship is believed to arise from prolonged hyperglycaemia, which leads to metabolic and vascular changes that contribute to nerve damage [6].

According to the current study Male and female percent with DNP 51.6% and 48.4%. In a study done by manal mohammed hashem et.al during a one and half year duration was carried out on 150 patients (80 males and 70 females) with DPN, during their attendance to the neurology outpatient clinic.[7]

In the present study, age and HbA1c level were independent risk factors for comorbidity of polyneuropathy in DM patients.

In Previous study by dipika bansal et.at., depending on VPT scores, the distribution of mild, moderate, and severe neuropathies was found to be 8.1% (95% CI 6.7–10.2), 14.5% (95% CI 12.6–16.4) and 6.6% (95% CI 4.4–8.2), respectively.[8]

In our study the odds of developing neuropathy in patients who had diabetes for >52 years duration was 3.706 (95% CI 2.002-6.860, $P < 0.001$) compared with duration <5 years was observed. In a study done by dipika bansal et.al. The odds of developing neuropathy in patients who had diabetes for >15 years duration was 8.03 (95% CI 5.96–10.8, $P < 0.001$) compared with duration <5 years was observed.[8]

There is a complicated association between the duration of diabetes and HbA1c levels. Tight glycaemic management is necessary, but prolonged exposure to elevated glucose levels also plays a major role in the development of neuropathic pain. Regardless of their current HbA1c levels, patients who endure extended periods of poor glycemic control are more likely to develop DPN. Thus, limiting neuropathic consequences requires a dual strategy that addresses both glucose control and the length of diabetes.[9]

CONCLUSION

Our study at the General Hospital Thiruvananthapuram demonstrated a significant correlation between elevated HbA1c levels and the prevalence of diabetic peripheral neuropathy (DPN) among diabetic patients. The findings indicate that patients with HbA1c levels greater than 8% exhibit a markedly higher incidence of DPN—38.6% when assessed using the Biothesiometer and 40.2% when evaluated with nerve conduction velocity (NCV) testing—compared to those with HbA1c levels below 8%, who showed DPN rates of 14.8% and 16%, respectively.

The calculated odds ratios further underscore this relationship, revealing that patients with HbA1c levels above 8% are approximately 3.706 times (Biothesiometer) and 3.618 times (NCV) more likely to develop neuropathy than their counterparts with lower HbA1c levels. Additionally, our analysis highlighted that DPN prevalence increases with the duration of diabetes, reinforcing the importance of effective glycemic control over time.

Importantly, no gender differences were observed in the incidence of DPN, suggesting that both male and female diabetic patients are equally susceptible to this complication. Our findings also indicate that as diabetes duration lengthens, NCV values decline and vibration perception thresholds rise, further supporting the relationship between prolonged hyperglycemia, increased HbA1c, and the development of DPN.

In summary, our study reinforces the critical need for regular monitoring of HbA1c levels and early intervention strategies in diabetic patients to prevent or mitigate the progression of diabetic peripheral neuropathy, particularly in those with longer durations of diabetes.

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