

Prevalence of Peripheral Neuropathy in Pediatric Patients with Type 1 Diabetes Mellitus

Peripheral Neuropathy in Pediatric Patients with Type 1 Diabetes

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ABSTRACT

Objective: The objective of this study was to study the prevalence of peripheral neuropathy in pediatric patients suffering from type 1 diabetes mellitus.

Study Design: A multicenter cross-sectional study.

Place and Duration of Study: This study was conducted at the HITEC-IMS Taxilla, Al -Ihsan Hospital Rawalpindi & Nusrat Hospital Rawalpindi from Jan 2023 to August 2023.

Methods: The study invited parents of paediatrics patients with type 1 diabetes to participate. Participating parents who consented were provided with questionnaires, encompassing neurological examinations and assessments of nerve dysfunction through nerve conduction studies (NCS). The questionnaire also gathered comprehensive information on demographics, family status, education level, chronic illnesses, weight, height, BMI, and access to the healthcare system. NCS procedures were meticulously explained to the participants and conducted using the standard "Allerger's Scorpio Electromyography machine" in a room maintained at an optimal temperature of 72 degrees Fahrenheit. Skin temperature, recorded at 97 degrees Fahrenheit, and ideal lighting conditions were ensured during the examination. The selected nerves for the procedure included median, ulnar, tibial, peroneal, and sural nerves. Reference values for NCS were obtained from a clinician specializing in neuromuscular disorders in infancy, childhood, and adolescence. With parental permission, blood samples were collected to measure blood glucose, HbA1c, Liver Function Tests (LFTs), vitamin B12, lipid profile, thyroid-stimulating hormone (TSH), urea, and creatinine in the children.

Results: The findings from this research indicate that prevalence of peripheral neuropathy in children with type 1 diabetes is 46%. There is a noteworthy association between glycemic control and the prevalence of peripheral neuropathy. The study's overall outcome reveals a 55.2% increase in nerve conduction per unit of HbA1C. The mean age of the study population is 12.8±3.665 years. Notably, the results of nerve conduction studies (NCS) are statistically significant. Furthermore, there are no significant differences observed between the groups concerning lipid profile, vitamin B12 levels, thyroid-stimulating hormone (TSH), urea, and creatinine.

Conclusion: The prevalence of diabetic neuropathy in children is 46%. Major risk factors in this condition are the duration of the disease and uncontrolled glucose level. The use of nerve conduction studies is more reliable than clinical evaluation for the diagnosis of neuropathy. Moreover, neuropathy has a direct relation with elevated levels of glucose. There is no evidence of retinopathy.

Key Words: diabetes, nerve conducting studies, juvenile diabetes, glucose level.

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INTRODUCTION

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Diabetes Mellitus (DM) is a metabolic disease characterized by elevated blood glucose levels¹. It constitutes a significant global health issue. The global estimate indicates that in 2021, approximately 8.4 million people had T1DM worldwide and by 2040, the number of people living with T1DM is projected to reach 17.4¹.

Diabetes is mainly caused by elevated levels of glucose for longer periods. Diabetes may result from either a deficiency in insulin secretion, a reduction in insulin effectiveness, or a combination of both factors². Type 1 diabetes, also known as juvenile diabetes or Insulin-dependent diabetes, typically results from the destruction of beta cells, leading to a deficiency in insulin³. Diabetes, if undiagnosed for a long period can lead to other major problems like cardiovascular

disease, kidney malfunction, retinopathy, neuropathy, and foot amputation⁴.

Neuropathy, a significant complication of diabetes, manifests in both type 1 and type 2 diabetes, impacting 60% of the population in the Western world⁵. Retinopathy and nephritis have also been seen in young populations suffering from type 1 diabetes⁶. 10% of children have complained about peripheral neuropathy with type 1 diabetes which includes the signs and symptoms in the lower limbs⁷.

Along with the peripheral nervous system, diabetes can also affect the autonomic nervous system. Peripheral neuropathy caused by diabetes mellitus is usually referred to as polyneuropathy⁸. The effect of diabetes on the nervous system can be divided into 2 stages which are subclinical and clinical. Subclinical refers to electrophysiological abnormalities in nerve function without evident clinical signs or symptoms of peripheral neuropathy. In contrast, clinical neuropathy implies an abnormal neurological examination that shows evident impairment in peripheral sensory and motor polyneuropathy^{9,10}. Metabolic theory suggests that when the levels of glucose are elevated they damage nerve cells which leads to the accumulation of sorbitol and because of that myoinositol levels drop hence resulting in damage to nerve and myelin¹¹.

The diagnosis of diabetic peripheral neuropathy is based upon symptom profile, neurological examination, quantitative sensory testing, nerve conduction studies (NCS), and quantitative autonomic function testing¹². Neuropathy due to other causes such as Charcot Marie Tooth Disease and Guillain-Barre syndrome should be ruled out while diagnosing diabetic neuropathy¹³.

Different nerve fibers including motor, sensory and autonomic must be assessed thoroughly to confirm the origin of disease. Sensory neuropathy is the most common peripheral neuropathy. There are certain non-neuropathic conditions that resemble peripheral neuropathy that should be ruled out in individuals with a lack of sensory involvement. Autonomic dysfunction can occur with all kinds of neuropathies. Wasting of muscles and fatigue is more common in foot extensor muscles which may lead to foot drop¹⁴.

Electromyography and nerve conduction studies should be done to rule out the clinical diagnosis of peripheral neuropathy. Laboratory assessment includes an initial metabolic profile comprising of blood glucose levels, HbA1C, liver, kidney and thyroid functions. Additionally, medical professionals typically order tests based on a thorough clinical evaluation to help guide diagnosis and treatment¹⁵. Other tests include examination of cerebrospinal fluid, genetic testing, nerve biopsy, peripheral nerve imaging which is done with nerve ultrasound or MRI¹⁶.

METHODS

This cross-sectional multicentre study was conducted in HIT hospital Taxilla, Rawalpindi, Al-Ihsan Hospital

Rawalpindi & Nusrat Hospital Rawalpindi. The duration of study was from January 2023 to August 2023. The study invited parents of paediatrics patients with type 1 diabetes to participate. The objective was to ascertain the prevalence of peripheral neuropathy in this specific demographic region. Participating parents who consented were provided with questionnaires, encompassing neurological examinations and assessments of nerve dysfunction through nerve conduction studies (NCS). The questionnaire also gathered comprehensive information on demographics, family status, education level, chronic illnesses, weight, height, BMI, and access to the healthcare system. NCS procedures were meticulously explained to the participants and conducted using the standard "Alleger's Scorpio Electromyography machine" in a room maintained at an optimal temperature of 72 degrees Fahrenheit. Skin temperature, recorded at 97 degrees Fahrenheit, and ideal lighting conditions were ensured during the examination. The selected nerves for the procedure included median, ulnar, tibial, peroneal, and sural nerves. Reference values for NCS were obtained from a clinician specializing in neuromuscular disorders in infancy, childhood, and adolescence. With parental permission, blood samples were collected to measure blood glucose, HbA1c, Liver Function Tests (LFTs), vitamin B12, lipid profile, thyroid-stimulating hormone (TSH), urea, and creatinine in the children.

Statistical Analysis:

The data was summarized for quantitative analysis based on demographic traits, height, weight, and nerve conducting studies. The mean and standard deviation were calculated for each continuous data parameter to derive average results. Parametric tests, including one-way analysis of variance (ANOVA), student's t-test, and chi-square, were employed to compare the groups. Shapiro-Wilk test is used to assess the normality of data. SPSS Version 23 was used for statistical analysis of data by setting the level of significance to less than 0.05 p value. Mainly the study's focus is to provide the awareness on prevalence of peripheral neuropathy in children and adolescents.

RESULTS

There were 100 participants in the study. 45 patients were males and 55 were females. There were 30 children with age 4 to 7 and 70 with 10-14 years. There were no children with chronic illness other than diabetes. The mean age of the study population is 12.8 ± 3.665 . There was no sign of retinopathy. The prevalence of peripheral neuropathy was 46%. A high amount of prevalence was seen in children of age 4-14. The result of NCS was significant. The prevalence of peripheral neuropathy with glycemic control is significant. The overall result of the study shows that nerve conduction increases by 55.2% as per unit of HbA1C.

Table No. 1: Demographic Characteristics

Demographics		Frequency	Percentage
Gender	Male	45	45%
	Female	55	55%
Age in years	4-7	30	30%
	10-14	70	70%
Chronic disease other than diabetes	yes	0	0%
	no	100	100%

Table No. 2: Mean and SD for age,duration of disease, HbA1C (n=100)

Parameter	Mean	SD
Age in years	12.8	3.665
Duration of disease in years	6.8	2.148
HbA1C	10.9	1.82

Pie Chart

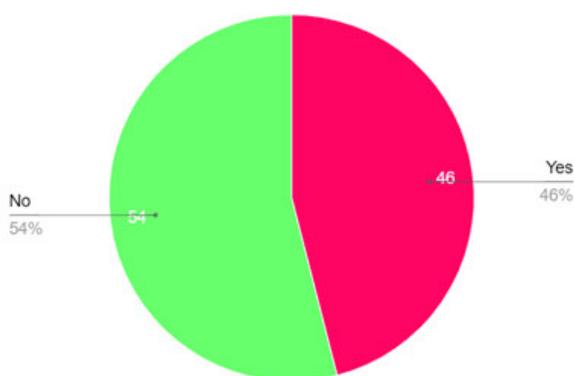


Figure No. 1: Prevalence of peripheral neuropathy

Table No. 3: Comparison of NCS & HbA1C in patients with and without neuropathy

	Mean	SD	P value
NCS			
Normal	5.0	1.442	0.05
Neuropathic	5.8	2.704	
Mean HbA1c level			
No neuropathy	10.6	1.674	<0.001
Neuropathy	11.2	1.799	

Table No. 3: Comparison of glycemic control with prevalence of neuropathy

Neuropathy	Good control (<=8.5)	Fair control (6.6-7.6)	Poor control (>9)
No	1%	76.9%	40%
Yes	0	23.1%	60%

DISCUSSION

The purpose of this study is to know the prevalence of neuropathy in children with Type 1 diabetes mellitus. A total of 100 children were assessed with type 1 diabetes, who had this disease since last five years.

This study shows that type 1 diabetes is more common in females as compared to males. Our study results are comparable with another study conducted in India⁴.

A significant number of children with Type 1 Diabetes Mellitus may have subclinical peripheral neuropathy, meaning nerve dysfunction that is not clinically evident. Poor glycemic control and a longer duration of diabetes are mentioned as risk factors for the development of nerve dysfunction in these children¹⁷.

The Rochester Diabetic Neuropathy Study focused on individuals with Type 1 Diabetes Mellitus (T1DM) who had diabetic neuropathy. The study revealed that among these patients, 54% exhibited polyneuropathy, indicating nerve damage affecting multiple peripheral nerves. Additionally, 22% presented with asymptomatic carpal tunnel syndrome, a condition involving pressure on the median nerve in the wrist, and 11% had symptomatic carpal tunnel syndrome.

Furthermore, 7% of the T1DM patients in the study showed signs of visceral autonomic neuropathy, which affects the nerves regulating internal organs. Lastly, 3% displayed other types of neurological damage, suggesting a diverse range of neuropathic complications in this population¹⁸.

According to our study the mean duration of disease is 6.8±2.148. Comparable results were quoted in a meta-analysis done in Pakistan on adult diabetic patients¹⁹. Toopcizadeh et al ,in their study found that there was no statistically significant difference between age, chronicity of disease and glycemic control between the groups of patients with and without peripheral neuropathy²⁰.

Our study results of the relation between neuropathy and HbA1c are same as in the previous studies which is significantly correlated i-e “p”<0.001^{17,21}. Ziegler et al quoted in his study that neuropathy can be prevented by achieving a good glycemic control in the initial years after developing the disease²². However there are studies which show that there is no correlation between neuropathy and HbA1C^{23,24}. The nerve conduction increases by 55.2% for every unit increase in HbA1C. This can be compared with other studies 5.2%¹⁷, 27.5%¹⁹ and 13.2%³ in regards to peripheral neuropathy.

This study has reviewed the glucose and HbA1c levels in the blood and their effects on peripheral neuropathy. However, its impact on brain and spinal cord in the individuals suffering from peripheral neuropathy is beyond the scope of discussion. There was no evidence of retinopathy on evaluation. The BMI and lipid profile of all the children were normal.

More accurate results can be seen in studies performed for longer duration. We could not assess other factors of neuropathy in diabetes mellitus due to economic constraints.

CONCLUSION

The prevalence of diabetes neuropathy in children with type 1 diabetes is 46%. Major risk factors in this condition are the duration of the disease and uncontrolled glucose level. The use of nerve conduction studies is more reliable than clinical evaluation for the diagnosis of neuropathy. Moreover, neuropathy has a direct relation with an elevated level of glucose. There is no evidence of retinopathy.

Author's Contribution:

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