Original Article

Assessment of nerve conduction studies in insulin-dependent diabetes in children and adolescents at the tertiary care center in eastern Nepal

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Abstract

Background: Young adults suffering from Type 1 Diabetes mellitus may have diabetic peripheral neuropathy without any signs and symptoms, as one of the complications. Nerve conduction study is routinely used for evaluation of neuromuscular function. This study aimed to conduct a nerve conduction study in insulin-dependent type 1 diabetes mellitus in children and adolescents. **Methods:** It was a cross-sectional, descriptive study conducted on 16 diagnosed cases of diabetes mellitus in children aged between 5–15 years and 16 healthy controls. Children were selected based on inclusion criteria from Pediatric and adolescent diabetic clinics who came for follow-up. A motor nerve conduction study of the median, tibial, and common peroneal nerves was recorded, and a sensory nerve conduction study of the median and sural nerves was recorded. **Results:** The percentage of females was 46.4% and males were 53.6%. The age of diabetic children was (mean ± SD) 9.75 ± 3.53 and healthy control was 10.75 ± 3.14. A comparison of sensory nerve conduction parameters between type one diabetes in children and healthy control; onset latency of the sural nerve was prolonged on the bilateral side in diabetes children. Similarly, the SNAP amplitude of the median and sural nerves was decreased in diabetes children. **Conclusions:** In type 1 diabetes in children, peripheral nerves get affected even in asymptomatic patients in children. More disease duration and uncontrolled glucose levels will lead to the involvement of nerves getting affected. Proper follow-up is needed for better management.

Keywords: Children and adolescents, peripheral neuropathy, type 1 diabetes mellitus

Introduction

Diabetes mellitus is a metabolic disorder that affects all age groups. In 2021, the International Diabetes Federation (IDF) published that the demographic population of children and adolescents aged 0–19 years is 563552.2, and an estimated 184,000 children and adolescents under the age of 20 are living with type 1 diabetes mellitus.[1] Diabetes mellitus is characterized by hyperglycemia, resulting from defects in insulin secretion, insulin action, or both. In type 1 diabetes mellitus, the destruction of beta cells is usually by an autoimmune process, resulting in loss of insulin production.[2] Risk factors of diabetes include family history, age at diagnosis, disease duration, education, lifestyle changes, and medical interventions.[3] Diabetic peripheral neuropathy is one of the complications in diabetes mellitus and it may be present in young patients with no clinical signs and symptoms. Many children suffer from subclinical neuropathy which is not diagnosed unless a sensitive test or examinations are performed. Nerve conduction study is routinely used for

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evaluation of neuromuscular function. It is one of the most sensitive and specific methods to detect diabetic peripheral neuropathy.[4] It helps assess the type of neuropathy (axonal and demyelinating type), and the degree of peripheral nerve abnormalities. Distal symmetric polyneuropathy is the most common form of diabetic neuropathy.[5] It may be classified as small fiber, neuropathy, large fiber neuropathy, or mixed neuropathy (large and small fiber involved). Prolongation of latency and decreased conduction velocity leads to demyelination neuropathy whereas a decrease in CMAP amplitude or SNAP amplitude leads to axonal neuropathy.

In contrast to adults, children, and adolescents often show minimal signs or symptoms of neuropathy early on in their disease; therefore, clinical examination is less sensitive and specific than nerve conduction studies (NCSs), which serves as the gold standard test in the detection of subclinical neuropathy.[6-10] Several studies have been done on type one diabetes to see the prevalence and clinical presentation of diabetes in children in Nepal.[11,12] However, no studies have been done so far to see the neuropathy status using NCS in children suffering from diabetes in Nepal. As NCS is sensitive to clinical findings to assess peripheral neuropathy, we want to conduct a nerve conduction study in insulin-dependent type 1 diabetes mellitus in children and adolescents which will help in screening the status of neuropathy as well as early management of diabetes in children.

It was a cross-sectional, descriptive study conducted on 16 diagnosed cases of diabetes mellitus in children aged between 5–15 years and 16 healthy controls. Children were selected based on inclusion criteria from Pediatric and adolescent diabetic clinics who came for follow-up. The study was conducted in the Department of Basic and Clinical Physiology, from July 2021 to June 2022 at BPKIHS, Dharan. Ethical approval was taken from the Institutional Review Committee and written informed assent and consent were obtained from all participants and their guardians. All the diagnosed children with diabetes mellitus were included in the study.

The inclusion criteria of the study were children diagnosed with type 1 diabetes mellitus, both male and female, with HbA1C of more than 6.5%. Children clinically diagnosed with systemic illnesses like chronic kidney disease, anemia, thyroid disorder, nephrotic syndrome, smokers, alcoholics, or children under any medication likely to affect NCS were excluded from the study. Detailed information regarding the study/procedure was explained to the participants and their guardians. Proper history and anthropometric variables were taken using standard proforma. Glycated hemoglobin (HbA1c) values were noted from the lab report of the patient and control. A nerve conduction study (NCS) was performed bilaterally in motor (median, tibial, common peroneal) and sensory (median and sural) nerves of the upper and lower limbs in all subjects using standardized proforma. NCS were recorded in upper limbs in the sitting position whereas that of lower limbs in the supine position at 23–25° C maintaining room temperature.

Motor nerve conduction study of the median, tibial, and common peroneal nerves was recorded using Digital Nihon Kohden (NM_420S, H636, Japan) by belly tendon montage. Nerve conduction parameters recorded; were distal latency, CMAP (compound motor action potential) amplitude, and nerve conduction velocity (NCV).

A sensory nerve conduction study of the median and sural nerves was recorded. The orthodromic method (median nerve) and antidromic method (sural nerve) used ring electrodes. Nerve conduction parameters recorded; were onset latency, SNAP (sensory nerve action potential) amplitude, and nerve conduction velocity.

The study considers 95% CI and 80% power to estimate the sample size. According to the literature review, the mean and SD were found to be 55.16 ± 6.8 and 49.7 ± 8.6 respectively. Now using two mean formulas for sample size calculation $n = 16$.[13] The statistical analysis was done using the SPSS 11.5 version. Anthropometric and nerve conduction parameters were normally distributed. Therefore, an independent *t*-test was used to compare the data between the groups. The P value < 0.05 was considered statistically significant.

Result

The NCS was performed on 16 type one diabetic children. The percentage of females was 46.4% and males were 53.6%. The age of diabetic children was (mean ± SD) 9.75 ± 3.53 and healthy control was 10.75 ± 3.14. The baseline characteristics of diabetic patients were height, weight, Body mass index (BMI), and HbA1C (Plasma glycated hemoglobin). The height, weight, BMI, and HbA1C of diabetic children were 132.25 ± 18.04 (height), 64.89 ± 9.047 (weight), 16.5 ± 3.3 (BMI), and 8.11 ± 2.25 (HbA1C). The median duration of diabetes in children was 1.75 [1–2.88] years [Table 1].

A comparison of sensory nerve conduction parameters between type one diabetes in children and healthy control; onset latency of the sural nerve was prolonged on the bilateral side in diabetes children. Similarly, the SNAP amplitude of the median and sural nerves was decreased in diabetes children [Table 2]. Whereas the nerve conduction velocity of the median and sural nerves was comparable within the group.

A comparison of motor nerve conduction parameters between type one diabetes in children and healthy control; distal latency of bilateral median, right tibial, and right common peroneal nerve was prolonged whereas CMAP amplitude of right tibial and common peroneal nerve was decreased in diabetes children. Similarly, the proximal amplitude of the bilateral tibial and right common peroneal nerve was decreased. Along with that, we found a decrease in nerve conduction velocity in bilateral median nerves in diabetes children [Table 3].

Table 1: Comparison of baseline characteristics between type one diabetes children and healthy control

Baseline characteristics	Type one diabetes *n*=16 (Mean±SD)	Healthy Control *n*=16 (Mean±SD)	*P*
Age	9.75±3.53	10.75±3.14	0.444
Height (cm)	132.25±18.04	142.08±0.160	0.147
Weight (kg)	30.06±12.829	40.36±14.39	0.057
BMI (kg/m^2)	16.5±3.3	19.219±4.01	0.060
HbA1C (%)	8.11±2.25	5.38±0.19	0.000

Table 2: Comparison of Sensory nerve conduction parameters between type one diabetes children and healthy control

NCS parameters	Type one diabetes *n*=16 (Mean±SD)	Healthy Control *n*=16 (Mean±SD)	*P*
RMAMP (mv)	21.96±5.50	31.39±16.15	0.038
LTMAMP (mv)	21.34±4.85	31.03±13.60	0.014
RSONLAT (ms)	2.30±0.38	1.99±0.22	0.020
RSAMP (mv)	25.80±11	34.38±9.09	0.037
LTSONLAT (ms)	2.31±0.48	1.97±0.27	0.034

RMAMP: Right median SNAP amplitude, LTMAMP: Left median SNAP amplitude, RSONLAT: Right sural onset latency, RSAMP: right sural SNAP amplitude, and LTSONLAT: Left sural onset latency

Table 3: Comparison of Motor nerve conduction parameters between type one diabetes children and healthy control

NCS parameters	Type one diabetes *n*=16 (Mean±SD)	Healthy Control *n*=16 (Mean±SD)	*P*
RMDL	2.68±0.48	2.24±0.36	0.014
RMNCV	49.56±6.63	56.06±8.46	0.031
LMDL	2.63±0.54	2.22±0.20	0.020
LMNCV	49.73±5.17	55.38±7.96	0.031
RTDL	2.93±0.50	2.56±0.35	0.036
RTDAMP	11.22±2.84	16.03±3.96	0.001
RTPAMP	9.09±2.87	12.63±3.66	0.008
LTPAMP	9.22±2.88	13.29±4.69	0.009
RCPDL	3.38±0.98	2.55±0.37	0.011
RTCPDAMP	3.40±1.34	4.96±1.45	0.007
RTCPPAMP	3.32±1.21	4.71±1.09	0.004

RMDL: Right median distal latency, RMNCV: Right median nerve conduction velocity, LMDL: Left median distal latency, LMNCV: left median nerve conduction velocity, RTDL: Right tibial distal latency, RTDAMP: Right tibial distal amplitude, RTPAMP: Right tibial proximal amplitude, LTPAMP: Left tibial proximal amplitude, RTCPDL: Right common peroneal distal latency, RTCPDAMP: Right common peroneal distal amplitude, and RTCPPAMP: Right common peroneal proximal amplitude

Discussion

Peripheral nerves get involved even in asymptomatic cases of type 1 diabetes in children and are often under-recognized and under-screened. Due to a lack of awareness of diabetic neuropathy in children and proper management in time, patients remain undiagnosed and receive delayed treatment. If a nerve conduction test can be used as a screening test to assess neuropathy in type one diabetes in children then neuropathy can be detected early and treatment can be planned. We studied NCS in 16 type 1 diabetic children and 16 healthy children. On comparison of demographic characteristics between type 1 diabetic children and healthy children, age, height, weight, and BMI were insignificant, whereas HbA1C was significant. Similar studies were found by Polat *et al.*,[14] who studied vitamin D and nerve conduction studies in pediatric type 1 diabetes mellitus.

On comparison of sensory nerve conduction parameters between type one diabetes patients and healthy control SNAP amplitude of bilateral median and right sural nerve were significantly decreased in type one diabetic children, whereas onset latency of bilateral sural nerve was prolonged in diabetic children. Similar findings were seen by Karsidag *et al.*[15] They found significant differences between groups in terms of latency with the sural nerve and latency and nerve conduction velocity with the median nerve. Several studies also suggested that hyperglycemia leads to the formation of advanced glycation end products which affect the structure of myelin and lead to axonal degeneration. Poor glycemic control has an impact on nerve conduction velocity and amplitude. This was shown in research done by Duck *et al.* and other various researchers.[16,17]

In a comparison of motor nerve conduction parameters between type one diabetes children and healthy control, latency and nerve conduction velocity were significant in the upper limb between the groups; whereas latency and CMAP amplitude were significant in the lower limb between the groups. These findings are similar to the study done by Karsidag *et al.*[15] They found significant differences in latency, CMAP amplitude, and nerve conduction velocity in the upper limb between the groups with similar findings. Whereas, significant differences were found with nerve conduction velocity between the patient and control group in the lower limb. We did not find any significant difference with nerve conduction velocity in the lower limb, it may be in our population latency and amplitude are more pronounced than nerve conduction velocity leading to mixed (axonal and demyelinating) types of neuropathies.

Conclusion

In type 1 diabetes, both motor and sensory nerves of the upper and lower limbs are involved in terms of latency, amplitude, and nerve conduction velocity. Nerve conduction studies can be used as screening tests in children with type 1 diabetes. In summary, in type 1 diabetes in children, peripheral nerves get affected even in asymptomatic patients in children. More disease duration and uncontrolled glucose levels will lead to the involvement of nerves getting affected. If proper care and monitoring of blood glucose is done then the progression of neuropathy can be halted.

Limitation

We had to exclude a lot of diabetic children due to their comorbidities. The result shown here is based on a small sample size, to emphasize it bitterly, it would be better to do it in a large sample size.

Author Contributions

SG contributed to conducting the research, designing, creating, and writing the manuscript, JA, NL, and DT helped in data

collection and helped in manuscript writing, and PS and RK helped in reviewing the manuscript.

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Conflicts of interest

There are no conflicts of interest.

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