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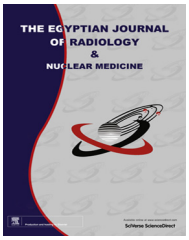

ORIGINAL ARTICLE

Evaluation of median nerve in children with type1 diabetes using ultrasonographic imaging and electrophysiology

Rania Refaat [a,*], Abeer Maghawry Abdelhameed [a], Nancy Samir Elbarbary [b], Rana Ahmed El-Hilaly [c]

[a] *Department of Radiodiagnosis, Ain Shams University, Cairo, Egypt*
[b] *Department of Pediatrics, Pediatric Endocrinology and Diabetes Unit, Ain Shams University, Cairo, Egypt*
[c] *Department of Physical Medicine, Rheumatology and Rehabilitation, Ain Shams University, Cairo, Egypt*

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KEYWORDS

Ultrasonography (US);
Nerve conduction study (NCS);
Children type1 diabetes (T1DM);
Cross-sectional area (CSA) of median nerve

Abstract *Background:* Diabetic peripheral neuropathy (DPN) is a worldwide costly complication of diabetes.
Objective: To evaluate the relationship between the sonographically measured cross-sectional area (CSA) of the median nerve and nerve conduction study (NCS) in children with type1 diabetes (T1DM) complaining of DPN.
Material and methods: Forty children with T1DM and 20 age-matched healthy subjects were enrolled in this study. The diabetic children were divided into 2 groups (without and with DPN). All participants underwent NCS and sonographic measurement of CSA for the median nerve in the carpal tunnel.
Results: The CSA of the median nerve in children with DPN was higher than that in the control subjects yet with no significant difference with that of children without DPN. The increased median nerve CSA in the carpal tunnel was considerably correlated with the median nerve motor latency and duration of diabetes, nevertheless, with no correlation with median nerve motor conduction velocity (MNCV).
Conclusion: Sonographic measurement of CSA of the median nerve in the carpal tunnel serves as a good discriminator for diabetic children from healthy individuals. Moreover, it has significant positive correlation with duration of disease and the nerve motor latency.

* Corresponding author. Tel.: +2 01005285089.
E-mail address: raniarefaat_1977@hotmail.com (R. Refaat).
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1. Introduction

The World Health Organization estimates that more than 220 million people worldwide have diabetes mellitus (DM) (1). Furthermore, International Diabetes Federation states 78,000 children develop T1DM every year (2).

Diabetic neuropathy is recognized as the most common clinical picture of nervous system disorders caused by DM (3) and is considered the most common type of neuropathies. It affects patients with both type1 and type2 diabetes, but it progresses more rapidly and its manifestations are more severe in T1DM (4). Earlier observations and population-based cohort studies have shown that 66% of patients who have T1DM develop some form of neuropathy (5).

For the evaluation of peripheral neuropathy (PN), physicians traditionally relied primarily on information gained from an accurate clinical history, a thorough physical examination and electrodiagnostic testing with NCS (6,7). However, such diagnostic tests and studies do not provide spatial information regarding the nerve and the surrounding structures (8). Ultrasonography (US) provides a rapid, cheap and non invasive method for the examination of the soft tissue structures of the wrist as it easily detects the median nerve which is located deep to the retinaculum (9).

A sophisticated search revealed a limited knowledge of diabetic peripheral neuropathy (DPN) in children and a largely variable reported prevalence of PN in different studies of pediatric patients with T1DM. Moreover, these children are more prone to complications because of the early onset of diabetes and accordingly, to assure them of a better life style through early detection and proper management of the complications of the PN.

Thus, our hypothesis is to demonstrate the relationship between the sonographically measured CSA of the median nerve in children with T1DM complaining of DPN and the results of NCS.

2. Materials and methods

We conducted the study on 40 eligible consecutive patients with type1 diabetes [10 males, 30 females (mean age 15.2 ± 2.9 years; range: 7–18 years)] recruited from the regular attendants of the Pediatric Diabetes Clinic, Children's Hospital between June 2011 and January 2012. These patients were included in the order that they showed up in the diabetes clinic.

To be eligible for the study patients had to satisfy the following criteria: (1) children with T1DM, who are able to perform all neurological examinations and tests and (2) having diabetes for more than five years. We divided the diabetic children into 2 groups; children with and without diabetic peripheral neuropathy (DPN). DPN was diagnosed on the basis of sensory symptoms in the form of bilateral tingling and numbness which started a few months ago. Complete history taking was performed including age, diabetes duration, complications and insulin regimen for the 40 diabetic patients.

Full clinical neurological examination was done to confirm peripheral neuropathy if present. We adopted the simple rapid bedside neuropathy disability score (NDS) as a screening tool for DPN (10). The NDS was derived from the examination of vibration perception (by means of a 128-Hz tuning fork), pinprick and temperature perceptions in the great toe and the presence or absence of ankle reflexes. The sensory modalities were scored as either present (0) or reduced or absent (1) for each leg. This means that "reduced" was scored as (1) indicating involvement of the nerve. Ankle reflexes were scored as normal (0), present with reinforcement (1) or absent (2) for each leg. The total maximal abnormal score was 10. A score above 2 was defined as clinical DPN (11).

Exclusion of neuropathies other than DPN was considered. This includes the following: patients with other significant chronic diseases (renal, liver and thyroid diseases) and other systemic diseases that affect the central nervous system. In addition, history of familial neuropathy, other neurological diseases, alcohol consumption, medications and exposure to toxins (known to cause neuropathy), patients with mental retardation or psychiatric diseases were excluded. Anthropometric measures; weight in kg, height in cm and body mass index (BMI); were calculated as weight in kilograms divided by square of height in meters, which were measured and recorded.

Other microvascular complications were screened including diabetic retinopathy (DR) that was diagnosed by doing complete ocular examination and indirect ophthalmoscopy. Further urinary albumin excretion was measured by the immuno-turbidimetric method for the detection of diabetic nephropathy. The kit used was from SERA-PAK (Bayer Corporation, Bendict Ave., Tarrytown, NY, USA). The result was expressed as albumin to creatinine ratio (ACR) in urine to avoid diurnal variation in albumin excretion. Urinary creatinine was estimated on Synchron C×7 (Beckman Instruments Inc., Brea., CA, USA). Venous blood samples were obtained in the morning from all patients after an overnight fast. A 2 ml blood sample was drawn from peripheral veins under complete aseptic conditions. The tube was placed on EDTA for the direct assay of HbA_1c. The average of HbA_1c measurements was determined and calculated for each patient (four determinations per year) with an average length of three months between each HbA1c measurement.

For comparison, we enrolled 20 age-matched healthy subjects (12 males and 8 females) with no obvious medical disorder and not receiving any medication who served as a control group. This group included children recruited from the same region as the case subjects; most were classmates or acquaintances of the case subjects. They were age–BMI – matched healthy individuals with a mean age of 13.9 ± 3.3 years; range: 7–17 years. We studied a total of 120 upper limbs in all 60 subjects who underwent median NCS and sonographic measurement of the median nerve CSA about 5 cm proximal to the wrist (in the carpal tunnel). These investigations were done concurrently in the same day.

The study protocol was approved by the Committee of Ethics and the parents of all study participants; the patients and the control subjects gave their written informed consent.

2.1. Sonographic measurement of the median nerve cross-sectional area (CSA)

Sonographic examination was performed unbiased to patient's history and NCS results using a Philips HD11 Revision 1.0.9 imaging system with an L12-3 linear array probe and a B mode real time apparatus. The examiners had a board-certified license and more than 10 years of experience. Patients were seated in a chair with arms extended, hands resting in a