ID Design Press, Skopje, Republic of Macedonia
Open Access Macedonian Journal of Medical Sciences. 2019 Mar 15; 7(5):767-770.
https://doi.org/10.3889/oamjms.2019.169
eISSN: 1857-9655
Clinical Science

Neurological Alterations in Type 1 Diabetes Mellitus Among Adolescents

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Citation: Almenabbawy K, Helal SI, Elzaree FA, Galal EM, Fathy A, Azmy A. Neurological Alterations in Type 1 Diabetes Mellitus Among Adolescents. Open Access Maced J Med Sci. 2019 Mar 15; 7(5):767-770. https://doi.org/10.3889/oamjms.2019.169

Keywords: DM type 1; Motor power; Neurological affection; Adolescents

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Received: 07-Jan-2019; **Revised:** 21-Feb-2019; **Accepted:** 22-Feb-2019; **Online first:** 14-Mar-2019

Funding: The study was a part of a project supported financially by the National Research Centre Egypt (Grant no. 11010146)

Competing Interests: The authors have declared that no competing interests exist

Abstract

BACKGROUND: Diabetes mellitus (DM) is a group of chronic disorders of metabolism characterised by high blood glucose levels. There is an increased prevalence of Type 1 DM in children and adolescents with its adverse complications especially microvascular ones (retinopathy, nephropathy and neuropathy) that might cause multiple organ damage.

AIM: To study the relation between DM and neurological affection.

METHODS: Fifty-nine children with type I DM, divided randomly into 2 groups, aged 8-18 years old of both sexes were enrolled in this cross-sectional study. All children were subjected to full history taking, physical, neurological and systemic examination.

RESULTS: There was an affection of motor power in both upper limbs as well as lower limbs. Also, we found that there was an affection of the superficial peripheral sensation affecting both upper and lower limbs.

CONCLUSION: Neurological assessment of children with diabetes mellitus type I should be a routine to early discover these manifestations which can have a deteriorating effect on the child's health.

Introduction

Diabetes mellitus (DM), is known to be a disorder of metabolism characterized by elevated blood sugar concentrations for a long time, which leads to a great number of nutritional, neurological, audiological and cognitive impairment symptoms that can be a direct consequence of metabolic disease or its management, or they could be secondary symptoms [1]. Diabetes is caused by either insufficient pancreatic production of insulin or the improper responsiveness of body cells to its insulin. Few studies have examined the effect of DM on hearing and cognitive functions in children [2]. There are some debates concerning the affected function in spite of known neuro-cognitive problems seen in DM, their rising about disease occurrence and their underlying progression. Learning the whole effect of T1DM on the brain especially glycemic control, is crucial [3], particularly in childhood and adolescence, which are critical periods of brain matter and cognitive skills development [4], [5]. This is the hardest time for T1DM adjustment because of its complicated therapeutic self-care rules, particularly during that age [6]. Researches have shown that dominance over one's surroundings, an essential constituent of resiliency, is correlated with life satisfaction, life quality and better daily performance particularly in school [7]. Better glycemic control is associated with resiliency and better life quality, that are both related to improved school performance in children with T1DM [8].

Material and Methods

Fifty-nine already diagnosed and under insulin treatment cases, their age ranged from 8-18 years were recruited from the Child Health Clinic, neurology clinic and paediatric neurology clinic medical research and Paediatric Neurology Clinic in Centre of Medical Excellence at National Research centre “MRCE”. Our inclusion criteria include children known to have type 1 diabetes mellitus, from both sexes. Those with chronic medical conditions known to affect a child`s health, blood sugar, patients with a history of known chronic neurological disorders and those with a history of any other chronic endocrinal disorders were excluded. We started collecting data and filling the sheets prepared for the study from parents and caregivers, by detailed history taking, disease duration, frequency and dose of insulin injection “Medication History”, detailed nutritional history [9].

Thorough clinical examination, anthropometric measurements were obtained using the standardised equipment, following the recommendations of the International Biological Program. Systemic examination including cardiac examination, chest, and abdominal examination were performed for detection of any clinical and nutritional problems — complete neurological assessment including examination of cranial nerves, motor power, sensation and mental status. Written informed consent was taken from parents of all participants before enrollment in the study and after full explanation of their role in the study. The consent was approved by The Ethical Committee of The National Research Center under the registration number 16358.

Results

The male to female ratio (frequency table) is shown in Table 1.

Table 1: Shows male to female ratio (Frequency table)

	GENDER		Total
	Male	Female	
Count	21	38	59
% within cases	35.59%	64.41%	100%

Gender distribution according to controlled and uncontrolled case is shown in Table 2.

Table 2: Shows gender distribution according to controlled and uncontrolled cases (Frequency table)

	GENDER		Total
	Male	Female	
Count	21	38	59
Controlled cases	16	17	33
Non-controlled cases	5	21	26

In our study we enrolled 59 cases with T1DM of them 21 were males (35.59% of all patients), 16 cases were controlled, and 5 cases were uncontrolled and 38 female patients (64.41%) of the 17 cases were controlled and 21 cases were uncontrolled, as shown in Table 1, 2, with a male/female ratio is 1:1.8.

Table 3: Mean value ± SD of height, weight, BMI of 59 cases

Vari-ables	Male cases (21 cases)			Female Cases (38 cases)		
	Height (cm)	Weight (Kg)	BMI (Kgm^{-2})	Height (cm)	Weight (Kg)	BMI (Kgm^{-2})
Range	145.3-159.7	44.1-57.9	17.35-27.37	135.1149.5	38.150.9	16.95-22.37
Mean ± SD	151.6 ± 4.02	46.7 ± 3.07	21.08 ± 3.67	148.6 ± 3.92	43.2 ± 4.03	20.3 ± 3.9

In our study regarding the anthropometric measurements, we found that the mean height, weight, and BMI among male cases are (151.6 cm, 46.7 Kg, 21.08 Kg/m^2) respectively, while in females all these measurements are (148.6 cm 43.2 Kg, 20.3 $Kg/m^{2)}$ respectively, Table 3, which means that anthropometric measurements were affected among diabetic cases.

Table 4: Distribution of motor power affection in Upper limbs in group I (Males) and group II (Females)

Crosstab						
			Motor UL affection			Total
			Normal	Grade I	Grade II	Grade III	
Group	I	Male	13	4	2	2	21
		% within Male Group	62%	19 %	9.5%	9.5%	100.0%
	II	Female	22	7	4	5	38
		% within Female Group	57.9%	18.4%	10.5%	13.2%	100.0%

In our results, regarding the distribution of affection of motor power in both upper limbs, we found that 62% of male patients had no affection of motor power, while 38% had variable stages of motor affection (19% had grade II affection, 9.5% had grade III, and 9.5% had grade IV motor power affection), compared to females we found that 57.9% of female patients had no affection of motor power, while 42.1% showed variable stages of motor affection (18.4% had grade II affection, 10.5% had grade III, and 13.2% had grade IV motor power affection) (Table 4).

Table 5: Distribution of motor power affection in lower limbs in group I (Males) and group II (Females)

Crosstab							
			Motor LL after therapy				Total
			Normal	Grade I	Grade II	Grade III	
Group	I	Male	10	6	4	1	21
		% within Male Group	47.62%	28.58%	19%	4.8%	100.0%
	II	Female	19	11	3	5	38
		% within Female Group	50%	28.9%	7.9%	13.2%	100.0%

Regarding the distribution of the affection of motor power in both lower limbs, we found that 47.62% of male patients had no affection for their motor power in lower limbs, while 52.38% showed different stages of motor affection (28.58% had grade II affection, 19% had grade III, and 4.8% had grade IV motor power affection), while in comparison with females we found that 50% of female cases had no affection for their motor power, while 50% showed different stages of motor affection (28.9% had grade II

affection, 7.9% had grade III, and 13.2% had grade IV motor power affection), Table 5.

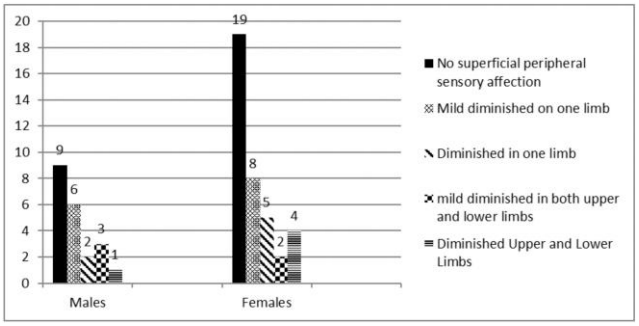

Figure 1: Distribution of superficial sensation at baseline in group I (Males) and group II (Females)

Regarding the distribution of the superficial peripheral sensory affection, we found that 47.4% of all cases had normal superficial peripheral sensation. While 52.6% showed different staged of Superficial peripheral sensory affection (23.7% had mild diminished superficial sensation in one limb, 11.9% had Superficial peripheral sensory affection on one limb, 8.5% shows mild diminished affection of both upper and lower limbs, and also 8.5% shows diminished superficial peripheral sensation in both upper and lower limbs) for both sexes (Figure 1).

Table 7: Distribution of deep sensation affection at baseline in group I (Males) and group II (Females)

	Deep sensation		Total
	Not affected	Affected	
Male	17	4	21
Female	32	6	38
Percentage	83.05%	16.95%	100%

Regarding the deep sensory affection, we found that 83.08% of all cases had normal deep sensation, while 16.95% showed some deep sensory affection for both sexes Table 7.

Discussion

It is almost presumed that there is trivial or no sex prejudice among either Type I (insulin-dependent) or Type II (non-insulin-dependent) DM. Type I diabetes is the unique major organ-specific autoimmune disease to demonstrate sex equality. The whole sex ratio is nearly similar in patients diagnosed < 15 years old. Communities with the maximal occurrence usually show male prejudice; while communities with minimal risk, mostly of non-European origin, particularly show female dominance. On the contrary, male dominance is a constantly seen in European origin people aged 15-40 years, with approximately 3:2 male: female ratio [10].

Bulletin of the WHO, 2013, [11] stated that the average incidence of diabetes mellitus did not markedly influenced by sex and was shown to be low or high in females than in males when analysed by African subregion. Growth measures are essential signs of child health and affected by elements like glycemic control in diabetic youth. A study done in India showed that growth was negatively affected by children with DM when compared with healthy ones. Children diagnosed earlier, need maximum concern to improve growth [12].

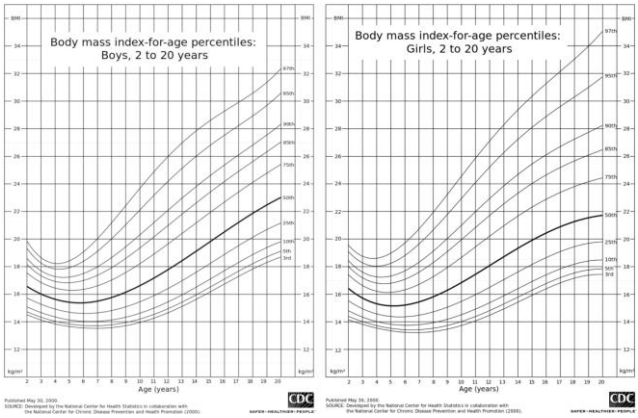

Figure 7: BMI for age percentiles for boys 2 to 20 years of age (Left). BMI for age percentiles for girls 2 to 20 years of age (Right)

Using the growth charts, BMI was used differently in youth; instead of its comparison against constant thresholds for underweight and overweight, the BMI is compared against percentile for children similar in sex and age Figure 7 [13]. A BMI that is < 5th percentile is referred to underweight & > 95th percentile is referred obese. Children with a BMI between the 85th and 95th percentile is referred to be overweight [14]. New researches in UK have shown that girls between 12 and 16 of age have bigger BMI than boys similar in age by nearly 1.0 kg/m^2 [15], while Vaman et al., 2013, [12] stated that children having T1DM were shorter for their age-matched controls and children that were on intensive insulin therapy were less influenced than those in the traditional regimen in spite of non-significant difference. They were less in weight than normal peers. Toddlers who were diagnosed before 3 years old were the shortest, whereas the tallest were those diagnosed after 14 years old [12].

Both motor power and cardiorespiratory performance can be affected by adolescents having T1DM. There is a unique relationship between metabolic control and cardiorespiratory performance confirming how essential lifestyle changes in the management and caring of diabetes in childhood are. Routine follow up of the motor, and cardiorespiratory fitness by the Euro fit battery tests could be of great help to determine the child's need of specific exercises which help in better physical fitness and glycemic control of youth with type 1 diabetes. So, more researches are needed to demonstrate the

processes by which diabetes causes decreased fitness and to study the influence of lifestyle modification on improving cardiovascular performance [16].

Peripheral neuropathy is common morbidity of DM that affects patients in adulthood, but early manifestations can occur in childhood and adolescence. Therefore, it is claimed that yearly investigations for the prompt discovery of nervous system dysfunction, has to be ordered for all youths with T1DM and children with diabetes of more than 3 years duration [17]. Screening should include simple non-invasive tests and patients diagnosed with subclinical neuropathy must be motivated to reach near-normoglycemia by scheduled insulin regimen, as perfect glycemic control is the successful way to avoid or postpone diabetic neuropathy besides other diabetes sequelae. Nowadays medications are capable of decreasing symptoms but unable to prevent the development of diabetic neuropathy [17].

In conclusion, T1DM children are at risk of having neurological morbidities which affect their lifestyle; so, adjustment of insulin therapy is considered of maximum importance in adjusting blood glucose level and preventing neurological complications.

Acknowledgements

The authors thank all the candidates who participated in the study and their parents.

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