International Journal of PharmTech Research
CODEN (USA): IJPRIF, ISSN: 0974-4304, ISSN(Online): 2455-9563
Vol.9, No.12, pp 198-203, 2016

Effect of spasticity on muscle thickness of hip adductors

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Abstract : Background: Spasticity is a widespread problem in cerebral palsy (CP) as it affects function and can lead to musculoskeletal complications. muscle thickness is defined as the perpendicular distance between the deep and superficial aponeurosis. The purpose of this study was to study the effect of spasticity on muscle thickness of hip adductors in spastic children.

Subjects and Methods: Thirty five (20 spastic diaplegic and 15 normal) children from both sexes with age ranged from 2 to 5 years and the spastic children were able to stand holding on, participated in this study. Muscle architecture parameters (pennation angle and muscle thickness) were measured by ultrasonography, spasticity was measured by MAS.

Results: There was a significant difference in muscle thickness of left hip adductors between both groups, more in the normal group ($p< 0.05$), while there was no significant correlation between spasticity and muscle thickness of both right adductors ($p= 0.529$) and left adductors ($p= 0.613$).

Conclusion: Spasticity has an effect on decreasing the muscle thickness in spastic muscles of spastic children.

Key words: spasticity, muscle thickness, diplegic children.

Introduction

Spasticity is one of the upper motor neuron syndrome (UMNS) that interferes with basic motor tasks that is required to accomplish activities of daily living. The definition of spasticity was put forth by Lance (1980): “spasticity is a motor disorder characterized by a velocity dependent increase in the tonic stretch reflexes (muscle tone) with exaggerated tendon jerks, resulting from hyper-excitability of the stretch reflexes, as one component of the upper motor neuron syndrome”[1]. Spasticity refers to increased tone, or tension, in a muscle. Normally, muscles must have enough tone to maintain posture or movement against the force of gravity while at the same time provides flexibility and speed of movement[2]. Spasticity may result from either diffuse or localized pathology of the cerebral cortex, brain stem, or spinal cord. Possible causes of these injuries include cerebral palsy, traumatic brain injury, stroke, multiple sclerosis, spinal cord trauma, or disease and anoxic insults[3]. Several tools such as the ashworth scale (AS) and the modified ashworth scale (MAS) have been used in clinical trials to measure spasticity, these scales measure a wide set of neural and musculoskeletal factors of non velocity dependent hypertonia in addition to spasticity it self[4]**.** Skeletal muscle tissue is a contractile material that has the capacity to adapt its internal architecture to applied stresses. The structure of the muscle is strongly correlated to its activity, therefore, its characterization can help in the understanding of the different mechanisms involved in muscle injury, aging and neuromuscular disorders[5]**.** One of the primary determinants of muscle function is its architecture. Muscle architecture refers to the internal arrangement of muscle fibers within a muscle relative to the axis of force generation[6]. Different imaging modalities have been used to measure muscle architecture such as US and CT. Ultrasound (US) was the first imaging technique that was used to measure directly the muscle size in living human subjects[7]**.** Measurements of muscle architecture include quantification of muscle thickness, angle of fascicles (bundles of muscle fibers), fascicle length and physiological and anatomical cross-sectional areas (ACSA)[8]**.** Muscle thickness is defined as the distance between the superficial aponeurosis and the deep aponeurosis in the middle of the ultrasound image at a 90-degree angle from the deep aponeurosis[6]. Researchers have continued to use US as a non-ionizing imaging modality, particularly for obtaining morphometric data on large, superficial muscle groups such as the gastrocnemius and quadriceps muscles[9]**.** The US quantification of muscle architecture allows for the description of the effect of neuromuscular disorders or to document treatment outcomes[6]**.**

Subjects and Methods

This study was approved by ethics review committee of the Faculty of Physical Therapy, Cairo University during 2015 and parents signed a consent form authorizing the child’s participation. Thirty five (20 spastic diplegic and 15 normal) children participated in this study.

Thirty five children from both sexes were divided into 2 groups spastic group (20 children) and normal group (15 children), they were initially assessed to determine Inclusion and exclusion criteria. They ranged in age from two to five years of both sexes. Diplegic children were able to stand holding on according to the GMFM 88[10]. Their degree of spasticity was ranged from 1 to 2 according to the Modified Ashworth Scale[11]. The children were able to follow instructions given to them during the testing procedure. The Exclusion criteria included patients with knee joint deformity, patients who take antiepileptic drugs or peak action is at the time of assessment of spasticity and patients without spasticity or with flexor spasticity in the lower limb.

Tools and Instrumentation:

A- For subjects selection

1. Modified Ashworth Scale to differentiate between normal tone and spasticity and to assess the degree of spasticity[11].
2. GMFM 88 to determine the level of function[10].

B- For assessment

Ultrasonography device type (GE LOGIQ P6) with frequency 7.5 MHz, was used to measure the muscle thickness of hip adductors[7].

Procedures:

At the start of the study, the personal data of the child were collected from parents, including the child name, age, address. A brief explanation of the study was done for the parents and how this study can help their children.

Evaluation of spasticity

Each child in the spastic group was assessed for the degree of spasticity by using the modified ashworth scale using the following instructions:

- Place the patient in a supine position.
- Place the knee joint in extension position and move to a maximal knee flexion over one second (count one thousand one).
- Then put a score for the child based on the classification of MAS.

Evaluation of functional ability

By using the GMFM – 88 to measure the abilities of these children in the standing domain (standing holding on).

At first, the child was positioned in standing holding a stand bar with one or both hands according to his abilities and the researcher followed the tasks of the standing domain in GMFM- 88. After ending, the researcher divided the number of achieved tasks by the whole number of tasks of the standing domain then multiplied by 100 to obtain the percentage of achieved tasks then recorded and saved to an excel sheet.

Measurement of muscle thickness

By using ultrasonography to measure the muscle thickness of the hip adductors of both sides from a supine lying position with hip in mid position.

At first, the child was positioned in supine or sitting with extended knee. A longitudinal section was taken by the radiologist for the hip adductors for right and left sides while the researcher was seated beside the patient to support the lower limb as needed. After capturing the images by ultrasonography, the images were entered in the " AutoCAD" programme which was used to measure the muscle thickness which was measured by drawing a vertical line between the superficial aponeurosis and the deep aponeurosis or bone. Measurements were taken three times in each image and the mean of the three times of measurement was calculated, recorded and saved to an excel sheet.

Statistical analysis

Results are expressed as mean ± standard deviation or number (%). According to test of normality, comparison between variables in the two groups was performed using either unpaired t test or Mann Whitney test whenever it was appropriate. Correlation between variables was performed using Spearman Rank correlation coefficient test. Statistical Package for Social Sciences (SPSS) computer program (version 19 windows) was used for data analysis. P value ≤ 0.05 was considered significant.

Results

There was no statistical significant difference between value of age in normal group (3.33 ± 0.96) and diplegic group (2.95 ± 0.84) with Z value = -1.192 and p value = 0.233 as shown in table (1).

Muscle thickness of both right and left adductors in the two studied groups

A- Right adductors

There was no statistical significant difference between the mean value of muscle thickness of right adductors in normal group (2.56 ± 1.04) and its corresponding thickness of diplegic group (2.20 ± 0.75) with t value= 1.205 and p value= 0.237 as shown in table (3).

B- Left adductors

There was a significant increase in the mean value of muscle thickness of left adductors in normal group (2.81 ± 0.78) and decrease in its corresponding thickness of diplegic group (2.27 ± 0.67) with t value= 2.183 and p value= 0.036 as shown in table (3) and illustrated in figure (1).

For correlation, there was no statistical significant correlation between spasticity Ashworth and muscle thickness of both right adductors (r= -0.150; p= 0.529) and left adductors (r= -0.121; p= 0.613) as shown in table (4).

Table (1) : Comparison between age values of the two studied groups.

	Normal (n= 15)	**Diplegic (n= 20)**	**Z value**	**P value**
Mean ± SD	3.33 ± 0.96	2.95 ± 0.84	-1.192	0.233 (NS)

Data are expressed as mean ± SD, Z value= Mann Whitney test, NS= p> 0.05= not significant.

Table(2) : Distribution of spasticity Ashworth in diplegic group.

	Number	Percent
1	9	45.0
1* (1.5)	6	30.0
2	5	25.0

Table(3) : Comparison between mean values of muscle thickness of both right and left adduction in the two studied groups.

	Normal (n= 15) Mean ± SD	Diaplegic (n= 20) Mean ± SD	t value	P value
Right adduction	2.56 ± 1.04	2.20 ± 0.75	1.205	0.237 (NS)
Left adduction	2.81 ± 0.78	2.27 ± 0.67	2.183	0.036 (S)

S= p< 0.05= significant

Table(4) : Correlation between spasticity Ashworth and muscle thickness of both right and left rectus and adduction in diplegic group.

	Spasticity Ashworth	
	Spearman's rank Correlation	*P value*
Rt. adduction	-0.150	0.529 (NS)
Lt. adduction	-0.121	0.613 (NS)

NS= p> 0.05= not significant.

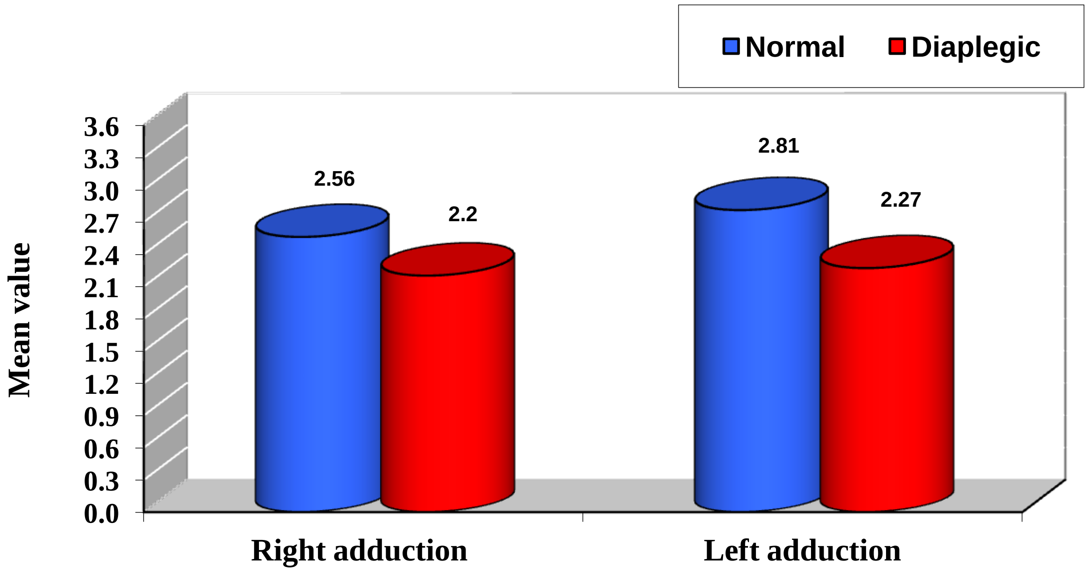

Fig (1). Comparison between mean values of muscle thickness of both right and left adduction in the two studied groups.

Discussion:

The results of this study clarified that there was a significant difference in muscle thickness of left adductors between both groups, more in the normal group. Also, there was no statistical significant correlation between spasticity Ashworth and muscle thickness of both right and left adductors. The MAS is a commonly used evaluation system for spasticity, with classification by resistance throughout the course of passive movement; however, there are doubts whether it is a true measure of spasticity, because it does not reflect velocity-dependent characteristics of spasticity. In fact, it has been suggested that the MAS rating reflects muscle hypertonia rather than excitability of alpha motor neurons[12]**.** The MAS were commonly thought of satisfactory reliability and validity in preliminary evaluation of abnormal muscle tone in clinical practice, which there are lots of advantages such as convenient, simple and easy to master in short period. There are good interrater and intrarater reliability with MAS to assess typical spasticity and normal muscle tone, because there was significant difference between them[11]**.** Ultrasonography is another useful device for muscle imaging and has been used to measure the deep fascicle angle and length in individuals with CP[13]. Muscle thickness measurement using B-mode ultrasound has been used in several studies in normal children[14]. It is a reliable method in normal children for the quadriceps femoris[14]**,** and in young adults for muscles of the upper arm, forearm, abdomen, back, thigh, and calf[15]. Ultrasonography has been used to measure changes in muscle thickness, muscle fiber pennation angle during static and dynamic contractions[16]. MAP has a better sensitivity in evaluating muscle tone between spastic patients and non-spastic patients, and degrees of spasticity have a clear corresponding exponential relationship to MAP. Combining MAS and MAP can assess muscle tone more objectively and accurately because subtle changes can be observed by testing values of architecture parameters that compensating for the shortcomings of MAS in reliability and validity. Thus it is helpful for guiding clinical antispastic practice[11].

The results of the current study comes in agreement with[17] who found that the affected side of stroke patients showed reduced muscle thickness and fascicle length compared to the unaffected side. Also[18] found that muscle thickness at the resting ankle position was reduced in the paretic compared to the non-paretic legs by up to 18% and 20% respectively, indicating a loss of both in-series and in-parallel sarcomeres in the affected muscles. Also[19] claimed that MTQ showed no significant correlation with MAS ratings either in knee extensors or in flexors. On the other hand[11] found that the muscle architecture parameters (pennation angle and muscle thickness) were higher in the spastic group more than the non spastic.Also[20] found that higher levels of knee extensor muscle spasticity are associated with greater quadriceps muscle volume in children with spastic diplegic CP. The decrease of muscle thickness in left adductors (in the non dominant side in most of people) may be due to the weakness caused by spasticity and also the weakness caused by non dominance, but this may conflict with [21] who found that there was no relation between spasticity and strength either within the same muscle group or at opposing muscle groups at the knee and ankle joints in persons with CP.

Conclusion

Based on the results of the current study, it may be concluded that spasticity may affect the muscle thickness of the spastic hip adductor muscles, inspite of the non significant correlation found between spasticity and muscle thickness of these muscles.

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