Correlation between Soleus Muscle Spasticity and Ankle Range of Motion in Children With Spastic Cerebral Palsy

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ABSTRACT

Introduction: Spasticity is one of the main characteristics that define children with spastic cerebral palsy which is specified by hyper-tonia and hyper-reflexia of the muscle. Spastic cerebral palsy children, which clearly accompanied by an increase in soleus muscle activity , shows a limited joints range of motions especially to their ankles dorsiflexion range, affecting functional abilities and standing abilities. **Objective:** To determine a correlation between soleus muscle activity and ankle range of motion in spastic cerebral palsy children. **Participants and methods:** the study was carried out onforty eight ankles and soleus muscles of spastic cerebral palsy children selected from the outpatient clinic of the Faculty of physical therapy Cairo University , the children was level II according to Gross Motor Function Classification Systemand their developmental age ranged from 9 to 12 month according to Peabody developmental motor scale , Hoffman reflex to Muscle response (H/M)ratio was used to asses spasticity of soleus muscle ;Ankle dorsiflexion range of motion (ROM)was measured using digital goniometer. **Results:** the study indicates that H/M Ratio concerning soleus muscle spasticity has a negative moderate correlation ($r = -0.5306$; $p < 0.05$) to ankle dorsiflexionROM. **Conclusion and recommendation:** Soleus muscle spasticity in spastic cerebral palsy children is correlated to the ankle dorsiflexion ROM in those children, where the higher the spasticity is the more decrease in the dorsiflexion range, so its highly recommended in physical therapy treatment program to link the goal of increasing the ankle range of action to controlling and inhibiting the soleus muscle spasticity.

Keywords: *Spasticity, Cerebral Palsy, Soleus, Ankle,*, children.

Introduction

Cerebral palsy (CP) children are at particular risk due to some impairment such as weakness, spasticity, lack of muscle co-ordination, and poor postural control, which make independent mobility difficult and may limit physical activity.(1)

Spasticity is a movement disorder characterized by abnormally excessive motor unit activity which is associated with increased muscle tone.[2]It is considered an important neural contributor to muscle hyper-tonia in children with CP[3]which impair function.[4]

The most common muscles affected by spasticity are soleus,gastrocnemius, hamstrings, rectus femoris, adductors and psoas major [5],where spasticity of the calf muscles is thought to be related to the reduced ankle range in children with cerebral palsy.[6]

Many of the lower limb muscles are affected by an increase of passive stiffness as a result of spasticity, [7]but the most common muscle is soleus muscle.

Soleus and calf muscles in general are the main plantar flexorsof the ankle joint.[8]It is noticed that in most of children with spasticity there is a change in the pattern of standing and the active range of ankle joint dorsiflexion action.[9]

The aim of the study is to determine a correlation between soleus muscle spasticity and ankle range of motion in spastic cerebral palsy children.

Subjects, Instrumentations and Methods

Subjects:

Forty eight ankles and soleus muscles of children with spastic cerebral palsy from both sexes participated in this study. Subjects were selected from the outpatient clinic of the Faculty of Physical Therapy Cairo University.All subjects were selectedto be at levelIIon the Gross Motor Function Classification System, the developmental age ranges from 9 to 12 month, and degree of spasticity ranged from 1 to 1+ according to the Modified Ashworth scale (Bohannon and Smith, 1987).The subjects were

excluded if they hadany fixed contracture in the calf muscleand surgical intervention (tenotomy operation) in the lower limbs.

Instrumentations

- Electroneuromyography and Neurosoft© software were used to asses Hoffman reflex to muscle response (H/M) ratio.
- Digital Goniometer (baseline 12-1027 Absolute Axis 360 Degree Digital goniometer©) was used for assessing ankle dorsiflexion range of motion. Digital goniometer demonstrates good reliability for repeated measurement of ankle Dorsi/plantar flexion.

Study design is a cross sectional study.

Procedures

*H/M Ratio testing application steps:*The childrenwere assessed in a prone position, where the ankle was well supported and the foot was outside the plinth. Surface plate electrodes were used. Stimulation site is over the tibial nerve in the knee, the position of recording active electrode was over the soleus muscle and the reference electrode over the Achilles tendon.The amplification changed to 0.2 mV/div., the stimulation intensity was taken down to 0 and then increased gradually until the H-wave appears. The stimulation was repeated on this level to demonstrate the stability in latency and appearance of the H-reflex. The stimulation intensity increased until the H-reflex disappears, replaced by F-waves and a maximal motor amplitude. The H/M ratio is calculated by the Neurosoft © software.

Digital Goniometer testing application steps:

The child was asked to sit on a chair with ankle, knee and hip 90 degree flexed. The Fulcrum was placed on the Lateral Mallulas to measure ankle dorsi flexion range of motion (ROM). The joint Actionwas active dorsiflexion of the ankle joint.Then the measured angle was recorded.

Statistical analysis

Statistical Package for the Social Sciences (SPSS)program version (22) was used for analysis of data.

Pearson's correlation coefficient was used to determine the correlation between the soleus muscle spasticity and the degree of available ankle dorsiflexion ROM. The initial alpha level of the correlation analysis was 0.05.

RESULTS

This study revealed that there is a moderate negative correlation between the H/M Ratio which represent the spasticity of the soleus muscle and the ankle ROM towards dorsiflexion , which means the higher the soleus H/M ratio is , the lower available dorsiflexion ankle range of motion .

Correlation between H/M Ratio and Ankle ROM: As presented at table (1) and illustrated at figure (1), the correlations between H/M Ratio and Ankle Range of Motion were studied through the Person correlation coefficient, it revealed there is a moderate negative correlation between the H/M Ratio of soleus muscle and Ankle range of motion (ROM) (r= -0.531, p= 0.000127).

Table (1): Correlation between H/M ratio and ankle dorsiflexion range of motion

	Ankle dorsiflexion range of motion ***(n=48)***	
H/M Ratio	r= -0.531*	p=0.000127

* Correlation is significant at the 0.05 level

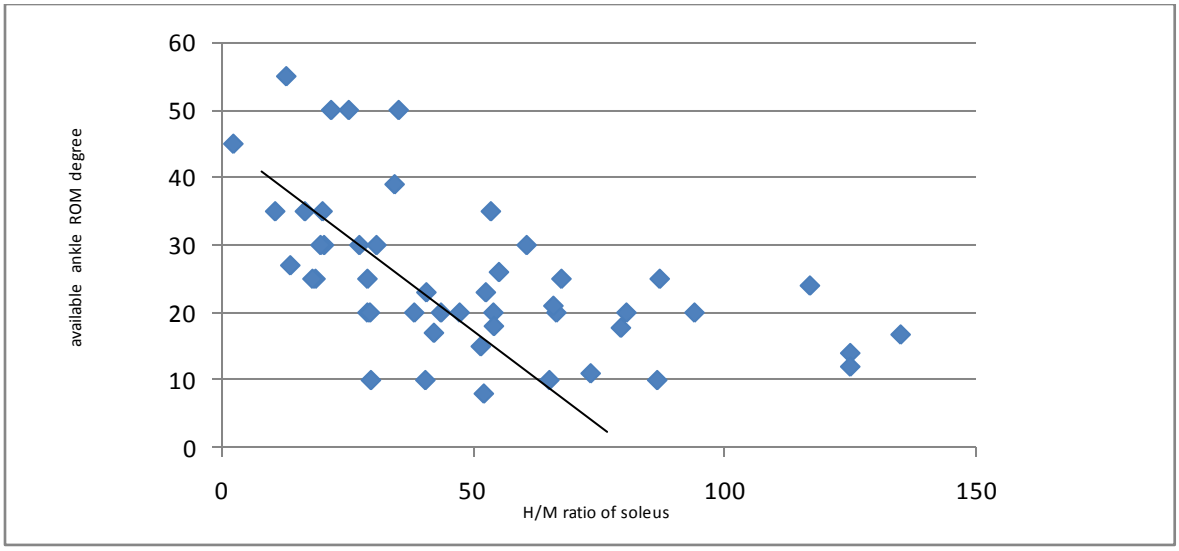

Figure (1). Scatter plot for thecorrelation between H/M ratio and available ankle ROM

DISCUSION

This study revealed that the children with spastic cerebral palsy of level II of Gross Motor Function Classification System (GMFCS) have a negative moderate correlation between their soleus H/M ratio - which indicates the spasticity - and their Ankle ROM in the dorsiflexion direction, where the higher the H/M ratio,the lower dorsiflexion range of motion of the ankle.

Analysis of 2796 examination in 355 children at Sweden, it was found that their a decrease in the dorsiflexion ankle range due to spasticity especially in the first eighteen years of life of spastic cerebral palsy children[10], this agree with the current study , which confirm the correlation between soleus spasticity and ankle ROM.

The results of this study agree with**Ballaz, Plamondon and Lemay**[11]who found that the Ankle dorsiflexion ROM is highly affected by the increase in muscular spasticityand decreasing the joint range.

During childhood of patients with CP, the loss in passive dorsiflexion is progressive [12], wherespasticity of the gastrosoleus muscle is thought to

be related to the reduced dorsiflexion of the ankle in children with cerebral palsy.[10]

Engsberg, Ross and Park's[13]study shows an increase in the ankle dorsiflexion range of motion in ankles in spastic subjects that lower limb spasticity is decreased, in compare to subjects no spasticity was decreased.That meant that there is relation between the spasticity and ankle range as the current study shows.

The higher the spasticity of calf muscles, the weaker were the dorsiflexors, the lower ankle dorsiflexion range was available [14]that is confirm the current study results.

CONCLUSION

Spasticity is a common associated problem affecting the spastic cerebral palsy children especially soleus muscle, where the increase in its tone (Hyper-tonia) is found to be correlated to the decreased ankle dorsiflexion range of motion.

The higher the spasticity of soleus muscle, the lower degree of available active ankle dorsiflexion range of motion is allowed.

The findings may have implications both for clinical management and for research studies on spasticity modulation and increasing ankle function in children with spastic cerebral palsy.

Conflict of interest

We confirm that there are no conflicts of interestassociated with this publication and there has beenno financial support for this work that could haveinfluenced its outcome.

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