Med. J. Cairo Univ., Vol. 89, No. 7, December: 2821-2825, 2021
www.medicaljournalofcairouniversity.net

Relations between Knee Joint Range of Motion and Growth Motor Function Measure in Children with Hemiplegic Cerebral Palsy

MOSTAFA M. MOSTAFA, M.Sc.*; KHALED A. MAMDOUH, Ph.D.*;
SHAIMAA A. ABDALGELEEL, M.D.** and RADWA S. ABDULRAHMAN, Ph.D.*

The Departments of Physical Therapy for Pediatrics, Faculty of Physical Therapy and Biostatistics & Epidemiology**, National Cancer Institute, Cairo University*

Abstract

Background: Knee contracture is a frequent problem in cerebral palsy (CP) child due to spasticity.

Aim of Study: To determine the effect of therapeutic ultrasound in addition to passive stretching on knee joint range of motion (ROM) in children with HCP (hemiplegic CP).

Material and Methods: Sixty HCP children, were suffering from knee joint flexion deformity due to hamstrings muscle tightness and their ages ranged from 4 and 6 years old. They were divided into two equal groups.Control group received traditional treatment in addition to stretching while study group received the same program in addition to therapeutic ultrasound 3 times per week for 3 months. Patients in both groups were assessed by Absolute + AxisTM Digital Goniometer and Growth Motor Function Measure (GMFM-88&66) before treatment and after 12 weeks.

Results: There is a strong positive significant correlation between ROM and GMFM post treatment in study group (r=0.95, p=0.0001) when compared with the control group (r=0.85, p=0.0001).

Conclusion: There was a signficant improvement in knee ROM and gross motor functions infavour the study group.

Key Words: *Stretching – Ultrasound – Contracture – Cerebral palsy.*

Introduction

CEREBRAL palsy is a disorder that has an effect on thousands of children born yearly. It is a neurologic disease caused by a malformation of the brain or a lesion in the developing brain [1].

It is a static disease of the central nervous system (CNS), presents since birth that includes motor function impairment [2]. A HCP is characterized by unilateral neurological manifestations, due to congenital or soon acquired damage to the immature CNS [3]. Hemiplegia (affecting one side of the body) represents 22.6-40% of all CP cases [4].

In stroke-induced hemiplegia, physical changes in muscles occur, these alterations have a direct impact on visco-elastic properties and tissue extensibility. Children with CP show impaired muscle tone and alterations in muscle flexibility, which may lead to poor function [5].

Stretching is a traditional maneuver used for management of spastic CP children and is considered to be an important technique used to control and manage the associated contractures [6]. Stretching is helpful in restoring the affected range of motion, especially when the contracture is the limiting cause. The duration and the intensity seem to be the main factors when performing stretching. [7]. Therapeutic ultrasound (US) is a wide spread and a commonly used physical modality in clinical rehabilitation. It has a different number of clinical uses, including the management of musculoskeletal impairments such as muscle injury, tightness, pain, and, contractures [8].

The aim of this study was to determine the effect of therapeutic ultrasound in addition to passive stretching on knee joint ROM in children with HCP and to detect the relationship between knee joint ROM and gross motor function in these children.

Material and Methods

Subjects:

Sixty HCP children of both sexes participated in the study. According to the following criteria:

Correspondence to: Dr. Mostafa M. Mostafa, The Department of Physical Therapy for Pediatrics, Faculty of Physical Therapy, Cairo University

Inclusive criteria:

1- Sixty HCP children, were suffering from knee joint flexion deformity due to hamstring muscles tightness.
2- Ages ranged between 4 and 6 years.
3- Level I and II motor function, Growth Motor Function Classification System (GMFC) expanded and revised **[9]**.
4- Grade (1-2) of spasticity (modified Ashworth scale) **[10]**.

Exclusive criteria:

1- Other causes of knee flexion deformities.
2- Previous history of orthopedic surgery in knee joint.
3- Visual or auditory problems.
4- Seizures.
5- Sensory or perceptual deficits.

The participants were assigned into two equal groups (30 children in each group).

Approvals from Ethical Committee of Faculty of Physical Therapy, Cairo University and consent forms were obtained from children's parents before the study. All parents informed about the nature and the effect of the measurement and treatment devices. They instructed to report any side effects during the management.

For subject selection:

- GMFCS expanded and revised version.
- Modified Ashworth scale.

For evaluation:

- Growth Motor Function Measure (GMFM88&66).
- Absolute + AxisTM Digital Goniometer:

Fabrication Enterprises, Inc. White Plains, New York 10602 USA.

For treatment:

- Therapeutic ultrasound unit: (Gymna Uniphy N.V, PULSON 200). Pasweg 6A, 3740 Bilzen, Belgium.

Measuring procedures:

1- *Knee range of motion:*

Measurements of the extension angle of the knee joint were done before and after 12 successive weeks from starting treatment program for each child in both groups. Each trial was repeated three times, after which the mean was recorded.

The digital goniometer axis was placed on the knee axis and its base arm was placed along the line drawn on the thigh and scale arm was placed along the line drawn on the leg (angle measured was scale arm relative to base arm).

2- *Gross motor function:*

The GMFM is a standardized and validated tool used to measure gross motor function changes over time in CP children.

Scoring system:

0 = Can not initiate.
1 = Initiates.
2 = Partially completes.
3 = Completes.
9 (or leave blank) = Not tested (NT).

The score that given was based on the best performance out of the 3 trials. Any item that was omitted or that the child was unable or unwilling to attempt was indicated as NT. If a child refused to attempt an item that I think they can do, I returned to the item at the end of the test. Verbal encouragement or demonstration was permitted. Spontaneous performance of any item was acceptable. Toys and incentives were used as motivators.

Treatment procedures:

All patients received passive stretching and neuro-developmental technique for a period of 12 successive weeks. The sessions were conducted at 3 times per week for all patients.

Stretching of the hamstrings was performed in 3 sets. Each stretch was held for 30 seconds at the end of the range; and then the leg was slowly lowered).

The study group received therapeutic ultrasound and the previously described program for the same period of treatment, according to the following procedures:

Target tissues: Hamstring muscle.
Frequency: (3 MHz).
Pulse ratio: Pulsed mode (1:1).
Intensity: (1 watt/cm^2).
Duration: (10-15 minutes).

Results

Statistical analysis:

(SPSS version 26) was used to analyse results. Kolmogorov-Smirnov single-sample test used to test the normality of the data. Numerical data were summarized as means and standard deviations (SD)

or medians and ranges as appropriate. Medians were used mainly for skewness and not normally distributed data. Comparison between two groups for numerical variables was done using student *t*-test, while comparison between pre and after treatment was done using paired *t*-test. *p*-value was adjusted due to multiple comparisons. Percentage change was compared using the Mann-Whitney test as it was not normally distributed. Pearson Correlation was used to correlate continuous data A ($p \leq 0.05$) was considered significant.

Relationship between ROM and GMFM:

The correlations between ROM and GMFM post treatment was strong positive significant correlation in control group (r=0.85, p<0.001) and study group (r=0.95, p<0.001).

Correlations.

	Post ROM	Post GMFM
Post ROM Pearson Correlation		.951**
Sig. (2-tailed)		<0.001
N		60

Highly significant positive correlation between post ROM and post GMFM (r=0.951, p-value <0.001).

For study group:

Correlations.

	Post ROM	Post GMFM
Post ROM Pearson Correlation		.951**
Sig. (2-tailed)		0.000
N	30	30

**. Correlation is significant at the 0.01 level (2-tailed).

For control group:

Correlations.

	Post ROM	Post GMFM
Post ROM Pearson Correlation		.851**
Sig. (2-tailed)		0.000
N	30	30

**. Correlation is significant at the 0.01 level (2-tailed).

Discussion

Contracture is defined as lack of passive ROM assessed by measuring maximum passive joint excursion [11-14]. Spasticity can lead to contracture Farmer and James, [15] and both spasticity and contracture can limit activity [16].

The purpose of this study was to investigate the effect of therapeutic ultrasound in addition to passive stretching on knee joint ROM in HCP.

Sixty children with HCP participated in our study. Subjects were subdivided into two groups, thirty in each group. The first group was the control group who received passive stretching and neuro-developmental technique; and the second group was the study group who received therapeutic ultrasound, passive stretching and neuro-developmental technique.

Data obtained from both groups pre and post treatment regarding Knee ROM and (GMFM) were statistically analyzed and compared. The mean ± SD knee ROM pre treatment of the control group was 108.26±4.57 degrees and that of the study group was 109.63±4.71 degrees. There was no significant difference in knee ROM between the control and study groups pre treatment (p=0.25).

While The mean ± SD GMFM pre treatment of the control group was 49.4±3.33% and that of the study group was 50.93±4.21%. There was no significant difference in GMFM between the control and study groups pre treatment (p=0.12). The mean ± SD knee ROM post treatment of the control group was 116.6±4.07 degrees and that of the study group was 124.5±3.92 degrees. There was a significant increase in knee ROM of the study group compared with that of control group post treatment (p=0.0001). While The mean ± SD GMFM post treatment of the control group was 55.63 ±3% and that of the study group was 62.13±3.26%. There was a significant increase in GMFM of the study group compared with that of control group post treatment (p=0.0001).

The correlation between ROM and GMFM post treatment in both study and control groups was strong positive significant correlation (r=0.95, p=0.0001) and (r=0.85, p=0.0001) respectively.

The improvement in the study group may be attributed to the therapeutic effect of ultrasound. Frequncy of Therapeutic ultrasound ranged from 0.75 to 3MHz, most of US units set at a frequency of 1 or 3MHz. A frequency of 3MHz is may penetrate up to l-2cm depth [7]. Pulsed ultrasound showed a great significance effect in treatment of joint contracture especially after a prolonged period of immobilization as it can expand the space between the bundles of collagen fiber and so enhance muscle fibers extensibility and thereby enhance the limitation of ROM [18].

US may inhibit the spasticity by making modifications of viscoelasticity in the muscle. US also decreases the resistance against the passive elongation by stretching reflex inhibition **[19]**.

Conclusion:

The results of our present study demonstrated that a 12 week of hamstring stretching and ultrasound treatment has a significant improvement in knee ROM and gross motor functions when compared with passive stretching alone in HCP.

There is a strong positive significant correlation between ROM and GMFM post treatment in study group (r=0.95, p=0.0001) when compared with the control group (r=0.85, p=0.0001).

Acknowledgments:

I want to thank the staff of physical therapy department for Pediatrics for their support. I am really thankful to all participated children and their parents for serious cooperation.

Conflicts of Interest:

No conflicts founded in our study.

References

1- Cerebral Palsy.org: About cerebral palsy. Retrieved from http://www.cerebralpalsy.org/about-cerebral-palsy, 2018.

2- BAXTER P.: The definition and classification of cerebral palsy. Dev. Med. Child Neurol., 49: 1-44, 2007.

3- PANTELIADIS C.P., HAGEL C., KARCH D. and KARL HEINEMANN: Cerebral palsy: A lifelong challenge asks for early intervention. Open Neurol. J., 9: 45-52, 2015.

4- RICE J., RUSSO R., HALBERT J., VAN ESSEN P. and HAAN E.: Motor function in 5-year-old children with cerebral palsy in the South Australian population. Dev. Med. Child Neurol., Jul. 51 (7): 551-556, 2009.

5- De BRUIN M., SMEULDERS M.J., KREULEN M., et al.: Intramuscular connective tissue differences in spastic and control muscle: A mechanical and histological study. PLoS One, 9: e101038, 2014.

6- NIHCE (National Institute for Health and Clinical Excellence): Spasticity in children and young people with non-progressive brain disorders: Management of spasticity and co-existing motor disorders and their early musculoskeletal complications. CG145. (London, UK), 2012.

7- MORIYAMA H., TOBIMATSU Y., OZAWA J., KITO N. and TANAKA R.: Amount of torque and duration of stretching affects correction of knee contracture in a rat model of spinal cord injury. Clin. Orthop. Relat. Res., 471: 3626-3636, 2013.

8- KNIGHT L.K. and DRAPER D.O.: Therapeutic Modalities. The Art and Science, 2nd ed. Therapeutic ultrasound. Philadelphia: Lippincott Williams and Wilkins, pp: 252-282, 2013.

9- REID S.M., CARLIN J.B. and REDDIHOUGH D.S.: Using the Gross Motor Function Classification System to describe patterns of motor severity in cerebral palsy. Developmental Medicine and Child Neurology, Nov. 1; 53 (11): 1007, 2011.

10- TIROSH O. and RUTZ E.: Quantifying the velocity-dependant muscle response during gait of children with cerebral palsy. Journal of Electromyography and Kinesiology, 48: 76-83, 2019.

11- HARVEY L., De JONG I., GOEHL G., MARWEDEL S.: Twelve weeks of nightly stretch does not reduce thumb webspace contractures in people with a neurological condition: A randomised controlled trial. Australian Journal of Physiotherapy, 52: 251-258, 2006.

12- HORSLEY S.A., HERBERT R.D. and ADA L.: Four weeks of daily stretch has little or no effect on wrist contracture after stroke: A randomised controlled trial. Australian Journal of Physiotherapy, 53: 239-245, 2007.

13- FOLPP H., DEALL S., HARVEY L.A. and GWINN T.: Can apparent changes in muscle extensibility with regular stretch be explained by changes in tolerance to stretch? Australian Journal of Physiotherapy, 52: 45-50, 2006.

14- REFSHAUGE K., RAYMOND J., MICHOLSON G. and VAN DEN DOLDER P.A.: Night splinting does not increase ankle range of motion in people with Charcot-Marie-Tooth Disease: A randomised, cross-over trial. Australian Journal of Physiotherapy, 52: 193-199, 2006.

15- FARMER S.E. and JAMES M.: Contractures in orthopaedic and neurological conditions: A review of causes and treatment. Disability & Rehabilitation, 23: 549-558, 2001.

16- BOYD R.N. and ADA L.: Physiotherapy management of spasticity. In, Barnes M.P., Johnson G.R. (Eds) Upper Motor Neurone Syndrome and Spasticity: Clinical Management and Neurophysiology. Cambridge: Cambridge University Press, pp. 79-98, 2008.

17- GANN N.: Ultrasound: current concepts. Clin. Manage, 11: 64-9, 1991.

18- WATANABE M., KOJIMA S. and HOSO M.: Effect of low-intensity pulsed ultrasound therapy on a rat knee joint contracture model. Journal of Physical Therapy Science, 29 (9): 1567-1572, 2017.

19- STRAUB S.J., JOHNS L.D. and HOWARD S.M.: Variability in effective radiating area at 1 MHz affects ultrasound treatment intensity. Physical Therapy, 88 (1): 50-57, 2008.

تأثير الموجات فوق الصوتية العلاجية بالإضافة إلى الاطالة السلبية على مدى حركة مفصل الركبة فى الأطفال المصابين بالفالج الشقى

\الخلفية: تيبس مفصل الركبة فى حالات الفالج الشقى من المشاكل الشائعة بسبب التشنج العضلى لديهم وذلك يؤثر على المدى الحركى لمفصل الركبة.

طرق \البحث: شارك فى الدراسة ستون طفلاً مصابون بالفالج الشقى ويعانون من تيبس فى مفصل الركبة، تتراوح أعمارهم بين أربع إلى ست سنوات. تم تقسيمهم إلى مجموعتين متساويتين، تلقت المجموعة الحاكمة تقنيات التطور العصبى بالإضافة إلى تمارين الإطالة السلبية للعضلة الخلفية وقد تلقت مجموعة الدراسة تقنيات التطور العصبى وتمارين الإطالة السلبية للعضلة الخلفية بالإضافة إلى الموجات فوق الصوتية العلاجية على العضلة الخلفية ثلاث مرات أسبوعياً لمدة ثلاثة شهور. وقد تم تقييم جميع الحالات فى المجموعتين بواسطة مقياس الزوايا الرقمى المطلق ومقياس الوظيفة الحركية الإجمالية قبل العلاج وبعد اثنى عشر أسبوعياً.

\النتائج: كشفت النتائج عن وجود فروق ذات دلالة إحصائية لصالح مجموعة الدراسة وكذلك وجود ترابط قوى بين التحسن فى المدى الحركى للمفصل ومقياس الوظيفة الحركية الإجمالية فى مجموعة الدراسة بالمقارنة بالمجموعة الحاكمة.

\الخلاصة: وجود تحسن معتبر فى المدى الحركى لمفصل الركبة ومقياس الوظيفة الحركية الإجمالية لصالح مجموعة الدراسة.