Vol 45 (2) June , 2021

Print: ISSN 0304 4904
Online: ISSN 2305-820X

PAKISTAN PEDIATRIC JOURNAL

A JOURNAL OF PAKISTAN PEDIATRIC ASSOCIATION

Indexed in EMBASE/Excerpta Medica, Index Medicus WHO
IMEMR & Global Health/CAB Abstracts and UDL-EDGE Products and Services

www.pakpedsjournal.org.pk

http://www.pakmedinet.com/PPJ

ORIGINAL ARTICLE

Effects of Wrapping Technique on Upper Extremity in Children with Spastic Cerebral Palsy

SHAFAQ TEHSEEN AWAN, MIRZA OBAID BAIG

Pak Pediatr J 2021; **45(2):** 192-99

Correspondence to:

Mirza Obaid Baig,
Faculty of Rehabiliation & Allied Health Sciences, Riphah International University, Islamabad, Pakistan

E-mail: obaid.baig@riphah.edu.pk

Received 23rd June 2020;
Accepted for publication
2nd November 2020

ABSTRACT

Objective: The aim of the study was to determine the effects of wrapping on range of motion, tone and manual ability in spastic upper limb of cerebral palsy (CP) child.

Study Design: Randomized controlled trial.

Place and Duration of Study: The study was conducted at National Institute of Rehabilitation Medicine from January to June 2019.

Material and Methods: The sample size of 40 subjects which were selected through convenient purposive sampling. Study had two groups, 20 subjects in each. Outcome measures include range of motion (ROM), tone and manual ability which were assessed using goniometer, modified ashworth scale and manual ability classification system scale on zero, 2nd, 3rd and 5th week of intervention.

Results: There were statically significant results showing improvement in ROM and tone. Experiment group showed more improvement than control. Little improvement was observed in manual ability.

Conclusion: Wrapping is effective technique in improving range of motion and tone. It gives additional effects when applied in combination of other treatment techniques.

Key Words: *Cerebral palsy, Wrapping technique, Tone*

INTRODUCTION

Cerebral palsy (CP) is broad term encompassing group of non-progressive motor impairments resulting from brain lesion in early life.[1] It has been defined as non-progressive brain lesion resulting in tone and movement abnormalities in children. Half side body paralysis or hemiplegia is the commonest presentation of CP. There could be some prenatal causes including genetic factors, infections, or vascular lesions. Meningitis, head trauma, epilepsy and cerebrovascular accident could be among post natal causes of CP. Hemiplegia could result in variable degree of sensory-motor deficits, perceptual and functional limitations and disturbed balance.[2] CP is further classified as spastic, dyskinetic, hypotonic and mixed with spastic type most prevalent one. Spastic CP is further categorized as diplegia, hemiplegia or monoplegia.[3] Tone abnormalities, contractures and mal-positioning are the common features of cerebral palsy involving upper extremity.[4] As a result, hemiplegic CP have tendency for unilateral, irregular patterns and limited range of motion. Severity of these abnormalities depend on extent of brain lesion.[5]

Most common CP disorders are spasticity (hypertonicity) and muscle synergy which reflects as complex movements. Combined activity of various muscle groups of upper limb results in development of muscle synergy which is

abnormal movement pattern.[6] Spasticity mostly found in flexor muscle of upper limb which further explains limited passive range of motion (PROM) for supination and elbow extension.[7] Spastic posture of upper limb include shoulder adduction and internal rotation, elbow flexion, forearm pronation and wrist flexion.[8] Muscle length has major role in muscle tension generation. Spasticity results in decreased muscle length which in turn results in decrease muscle force generation causing activity limitation.[9] Prolong increased tone has major role in limiting range of motion and muscle growth resulting mal-alignment.[10] Spasticity management improves body alignment which further improves function.[11]

In spastic CP initial treatment is being focused on tone management as excess tone limits normal function, range of motion ultimately results in activity limitation.

There are multiple options available for the management of CP child including, surgical interventions and conservative treatment including physical therapy and occupational therapy, exercises, medications whether oral or IV, casting, splinting, wrapping, botulinum toxin injections, intrathecal baclofen, and rhizotomy. There must be combination of these to ensure better and early development of CP child.[12]

Wrapping is one of techniques used to treat spasticity which involves bandage of upper limb in anti-synergy posture for days to week using elastic bandage. Literature suggests wrapping of upper limb at the end range of ROM limitation for shoulder flexion, external rotation, abduction, and elbow and wrist extension. It is been suggested to use 4-inch elastic bandage and wrapping in "figure 8" pattern to avoid any hindrance in circulation. Wrapping is used to be continuous for at least 3 hours per day for up to 2-4 weeks. Wrapping is used to be done from wrist to axilla and was secured with paper tape at ends.[13,14]

MATERIAL AND METHODS

It was a Randomized Control Trial (RCT) being conducted in National Institute of Rehabilitation Medicine (NIRM), Islamabad. Sample size of the study was 40 which were selected through convenient purposive sampling. Randomization was done using lottery method dividing sample into two groups, experiment and control. In experiment group wrapping was applied along with conventional physical therapy whereas, controls received only conventional therapy. Five week treatment session was given to both groups. Assessment was done at four times, at baseline, after 2nd week, after 3rd week and after 5th week. Outcome measures include ROM, tone and manual ability which were assessed using goniometer, Modified Ashworth Scale (MAS) and Manual ability classification system (MACS) scale. Inclusion criteria of study were as follow: Spastic hemiplegic cerebral palsy, upper limb mild to moderate spasticity grade 1-3 on MAS, age limit between 4-10 years, level 2-4 handling ability on MACS scale, ability to understand commands and both genders. Two weeks of wrapping treatment along with conventional therapy was given to experiment group and two weeks of conventional therapy (stretching and PROM) was given to control group, followed by one week conventional therapy. Another two weeks treatment of wrapping was given to experiment group on alternative days assessment was done at baseline, after two weeks, at the start of 4th week and at the end of 5th week. Assessment was done using passive and active range of motion of shoulder flexion-abduction-external rotation, elbow extension and extension of wrist will be assessed using goniometer. Tone of shoulder flexors-adductors-external rotators, elbow flexors and wrist flexors was assessed using Modified Ashworth Scale. Handling ability was assessed using Manual ability classification system (MACS). After collection of data the Shapiro-Wilk test was used to check normality of data. According to those values parametric and non-parametric tests were applied including independent test, one-way repeated measure ANOVA, Mann Whitney U test, Friedman test and Wilcoxon Sign Ranks test. Demographic data was analyzed using descriptive statistics. Data was analyzed using SPSS version 21. No ethical concerns were involved in study. Ethical permission was granted by institutional research ethical committee.

RESULTS

Demographic data is given in table 1, including mean age, gender, affected body side, dominant hand and socio-economic status of subjects in both groups. In experiment group, mean age was

7.6 years, with 12 male and 8 female subjects. Mean age in control group was 6.6 years with half male and half female subjects. 12 (60%) subjects in experiment group have right affected side, whereas in control it was 14 subjects (70%) of right sided CP. Experiment group had 14 (70%) right hand dominant, 2 (10%) left hander, whereas 4 subjects were not sure about their hand dominancy. Controls had 13 (65%) right, 4 (20%) left and 3 (15%) non side distribution of hand dominancy.

TABLE1: Demographic data

Group	Mean Age(Y)	Gender		Affected Body Side		Dominant Hand			Socio-Economic Status		
		Male (%)	Female (%)	Right (%)	Left (%)	Right (%)	Left (%)	N/A (%)	Good (%)	Average (%)	Poor (%)
Experiment (n=20)	7.6	12 (60)	8 (40)	12 (60)	8 (40)	14 (70)	2 (10)	4 (20)	2 (10)	11 (55)	7 (35)
Control (n=20)	6.6	10 (50)	10 (50)	14 (70)	6 (30)	13 (65)	4 (20)	3 (15)	4 (20)	8 (40)	8 (40)

N/A: Not applicable; not identified.

Mean values of passive and active ROM of different joints of upper limb showed change in range of motion over time at 4 different time intervals in both experiment and control group. There was a trend towards improvement in both groups at all 4 measures with more improvement in range of motion observed in experiment group. There was about 32 degrees improvement in shoulder flexion from baseline (110) to measure 4 (142), whereas 16.45 degrees improvement observed in control group's PROM. Same trend was observed in AROM of shoulder flexion in experiment (98-127 degrees) and control (103-121 degrees) group. 34 degrees improvement in passive shoulder abduction and 24° in active shoulder abduction in experiment group, 18 degrees improvement in both passive and active shoulder abduction was recorded in control group. Both passive (41-61 degrees) and active (36-56 degrees) shoulder external rotation had 20.65 degrees ROM improvement in experiment group. Control group had almost 14 degrees (47-61 degrees) improvement in PROM and 16 degrees (40-56 degrees) in AROM in shoulder external rotation. In passive wrist extension experiment group had 18.65 degrees (43-61 degrees) and controls had 15 degrees (49-64 degrees) improvement, whereas there was gain of 22 degrees in experiment group and 17 degrees in control's AROM. Most of range of motion improvement was observed from measure 3 to measure 4 showing most effective time zone for improvement.

Table 2 and 3 summarize results of One-Way repeated measure ANOVA, whereas table 4 and 5 are summary tables of Friedman test which is non-parametric alternate to One-Way repeated measure ANOVA which is parametric test. All tables of repeated measures show significant within and between subjects' results for both groups rejecting null hypothesis that there is no difference within subjects and between treatments (measures) at different measures. The results of each ANOVA were as follow: passive shoulder Flx ($df = 3$, $F = 483$, $p = 0.001$ for experiment and $df = 3$, $F = 214.529$, $p = 0.001$ for control), passive shoulder external rotation (ER) ($df = 3$, $f = 386.03$, $p = 0.001$ for experiment and $df = 3$, $F = 279.986$, $p = 0.001$ for control), passive wrist extension ($df = 3$, $F = 231.159$, $p = 0.001$ for experiment and $df = 3$, $F = 273.617$, $p = 0.001$ for control), active shoulder flexion ($df = 1.065$, $F = 25.977$, $p = 0.001$ for experiment and $df = 3$, $F= 235.356$, $p = 0.001$ for control), active shoulder ER ($df = 3$, $F= 400.341$, $p = .001$ for experiment and $df = 3$, $F= 113.233$, $p = .001$ for control), active wrist extension ($df = 3$, $F = 250.734$, $p = 0.001$ for experiment and $df = 3$, $F= 450.561$, $p = 0.001$ for control). This showed that there was significant difference in PROM and AROM observed at 4 time interval for all given movement proving treatment effective.

Table 4 shows Friedman test for passive shoulder abduction ($df = 3$, $p = .001$ for experiment and $df = 3$, $p= .001$ for control) indicating significant

difference in passive shoulder abduction at 4 instances.

Friedman test values for active shoulder abduction which were as follow: for experiment group df = 3, p = .000, for control group df = 3, p= .001, rejecting null hypothesis that there is no difference in ROM at 4 measurements. Ranks of Friedman test shows values progression. Smallest values ranked 1 and 2, 3 so on for increasing values.

TABLE 2: One-Way Repeated Measure ANOVA for PROM

	Source	SS	Df	MS	F	Sig.
Shoulder flexion	Within Subjects	10356	3	3452	483	.001
Experiment Group	Between Subjects	125626	1	125626	3280	.001
	Error	407.4	57	7.148		
	Within Subjects	2711.724	3	903.908	214.529	.001
Control Group	Between Subjects	1086972	1	1086972	3841.567	.001
	Error	227.526	54	4.213		
Shoulder external rotation	**Source**	**SS**	**df**	**MS**	**F**	**Sig.**
	Within Subjects	4480.2	3	1493.4	386.03	.001
Experiment Group	Between Subjects	199101	1	199101	1069.456	.001
	Error	220.512	57	3.869		
	Within Subjects	1800.263	3	600.088	279.986	.001
Control Group	Between Subjects	222697.3	1	222697.3	2211.390	.001
	Error	115.737	54	2.143		
Wrist extension	**Source**	**SS**	**Df**	**MS**	**F**	**Sig.**
Experiment Group	Within Subjects	3671.938	3	1223.979	231.159	.001
	Between Subjects	212283	1	212283	1805.259	.001
	Error	301.812	57	5.295		
	Within Subjects	2253.737	3	751.246	273.617	.001
Control Group	Between Subjects	243515.8	1	243515.8	2533.460	.001
	Error	148.263	54	2.746		

TABLE 3: One-way repeated measure ANOVA for AROM

	Source	SS	Df	MS	F	Sig.
Shoulder flexion	Within Subjects	10687.450	1.065	10036.483	25.977	.001
Experiment Group	Between Subjects	937012	1	937012	1242.769	.001
	Error	7817.050	57	137.141		
	Within Subjects	2601.303	3	867.101	235.356	.001
Control Group	Between Subjects	961650.01	1	961650.01	2517.871	.001
	Error	198.947	54	3.684		
Shoulder external rotation	**Source**	SS	Df	MS	F	Sig.
	Within Subjects	4268.900	3	1422.967	400.341	.001
Experiment Group	Between Subjects	161140.200	1	161640.200	873.408	.001
	Error	202.600	57	3.554		
	Within Subjects	1964.684	3	654.895	113.233	.001
Control Group	Between Subjects	166196.3	1	166196.3	1568.928	.001
	Error	312.316	54	5.784		
Wrist extension	**Source**	SS	Df	MS	F	Sig.
Experiment Group	Within Subjects	3551.850	3	1183.950	250.734	.001
	Between Subjects	178038.450	1	178038.450	1644.857	.001
	Error	269.150	57	4.722		
	Within Subjects	2717.197	3	905.732	450.561	.001
Control Group	Between Subjects	199004.224	1	199004.224	1248.534	.001
	Error	108.553	54	2.010		

TABLE 4: Friedman test for shoulder abduction

Shoulder Abduction (PROM)	Measurement	Mean rank	Test statistics		
Experiment Group	Measure 1	1.00	Chi-Square	Df	Sig.
	Measure 2	2.00			
	Measure 3	3.00	60.00	3	0.001
	Measure 4	4.00			

Control group	Measure 1	1.00			
	Measure 2	2.03	56.714	3	0.001
	Measure 3	2.97			
	Measure 4	4.00			
Shoulder Abduction (AROM) Experiment Group	**Measurement**	**Mean Rank**	**Test Statistics**		
	Measure 1	1.01	Chi-Square	Df	Sig.
	Measure 2	2.00			
	Measure 3	3.01	60.10	3	0.001
	Measure 4	4.00			
Control group	Measure 1	1.03	56.714	3	0.001

Table 5 describes summary of Friedman test for tone upper limb muscle groups. Values showed are mean with test ranks with significance value among measurements. Values are ranked from maximum to minimum because tone was given in descending order i.e., 3 for more tone and towards 1 is decreasing tone. Results of given table are as follow: shoulder flexors (df = 3, p = 0.001), shoulder adductors (df = 3, p = .001), shoulder internal rotators (df = 3, p = 0.001), elbow flexors (df = 3, p = 0.001), and wrist flexors (df = 3, p = 0.001).this shows that there was significant difference in tone at 4 measurement indicating treatment as effective one.

Difference between manual ability at 4 measurements among both group was recorded in table 5 with p = 0.001 and p = 0.019 for experiment and control group respectively.

TABLE 5: Friedman test for tone and manual ability

Tone	**Groups**	**N**	**Mean (ranks)**				**Test statistics**		
			Measure 1	**Measure 2**	**Measure 3**	**Measure 4**	**Chi-square**	**Df**	**Sig.**
Shoulder flexors	E Group	20	2.8 (3.65)	2.375 (2.80)	2 (2)	1.8 (1.55)	43.352	3	0.001
	C Group	20	2.842 (3.05)	2.789 (2.95)	2.526 (2.42)	2.105 (1.58)	31.340	3	0.001
Shoulder adductors	E Group	20	2.65 (3.63)	2.2 (2.88)	1.85 (2.18)	1.4 (1.33)	45.671	3	0.001
	C Group	20	2.737 (3.24)	2.474 (2.71)	2.184 (2.08)	2.105 (1.97)	25.636	3	0.001
Shoulder internal rotators	E Group	20	2.75 (3.78)	2 (2.83)	1.63 (2.20)	1.05 (1.20)	49.281	3	0.001
	C Group	20	2.789 (3.32)	2.474 (2.71)	2.368 (2.55)	1.789 (1.42)	35.348	3	0.001
Elbow flexors	E Group	20	2.421 (3.63)	2 (2.95)	1.526 (92.0)	1.16 (1.39)	43.717	3	0.001
	C Group	20	2.421 (3.26)	2.105 (2.68)	1.895 (2.29)	1.684 (1.76)	26.876	3	0.001
Measurement	Groups	N	Mean (Ranks)	Test statistics	1.3 (2.03)	1 (1.45)	44.960	3	0.001
Manual ability	C Group	20	**Measure 1**	**Measure 2**	**Measure 3**	**Measure 4**	**Chi-Square**	**Df**	**Sig.**
	E Group	20	3.65 (2.93)	3.65 (2.93)	3.55 (2.73)	2.90 (1.43)	40.021	3	0.001
	C Group	20	3.63 (2.63)	3.63 (2.63)	3.58 (2.53)	3.42 (2.21)	9.923	3	0.019

E: Experimental; C: Control

DISCUSSION

The aim of the study was to determine the effects of wrapping technique on spastic upper limb in CP child. Statically significant results were found indicating that wrapping could be an effective

technique in improvement of ROM and tone in spastic extremity. Improvement was observed in both study group but more improvement in degree of PROM and AROM and tone was found in experiment group having wrapping as study intervention along with conventional therapy. These findings are supported by the study by Maryam Madizadeh et all about wrapping technique. They also have stated this technique as effective one in reducing tone and improving ROM with significant results in intervention group than control group. Significant difference was stated for between group T test.[14] Khaled et al also suggested wrapping as an effective tone inhibiting technique either applied alone or in combination.[2] They found significant results in their study. It was 26 degrees mean gain in PROM and 22° in AROM in experiment group whereas 15 and 17 degrees recorded in control group's PROM and AROM respectively. In experiment group, passive shoulder abduction range improvement was highest among others being 34 degrees followed by passive shoulder flexion and external rotation. AROM improvement was observed in following descending order: shoulder flexion > shoulder abduction > shoulder external rotation. These study finding of ROM improvement were consistent with findings of Donna J. Twist , who showed average 30 degrees improvement in arm muscle groups stating wrapping as effective treatment technique.[15] More subjects showed tone as 3 (mean 2.54) on MAS with decreased to 1(mean 1.43) for most of them in experiment group. Experiment group's shoulder adductors and internal rotators showed maximum tone changes. These findings agree with Maryam Madizadeh et all concluding maximum tone reduction in shoulder internal rotators and abductors.[14] There was very little change being observed in manual ability on MACS scale which were observed in both groups. Literature suggests very little improvement in manual ability without specific training as brain has wide area in hand controlling. So it requires much work done for its improvement.[15] There was no association between demographic factors and improvement in either ROM or tone, although literature suggest that with less age, there is more chance of neural improvement.[14] Although the physiologic mechanism of wrapping is not clear there might be some possible reasons behind therapeutic effects of wrapping which could be as follow: Firstly, heat generation by wrapping. There was production of local heat in area of wrapping. This heat improves local blood circulation and causes underlying physiological changes leading to localized muscle relaxation and ROM and tone improvement. This heat production improves muscle activity and stimulation resulting in improved muscle work. Warmth induces reduction in continuous neural stimulation via C fibers. Secondly, it might be maintained sensory stimulation for hours limiting continuous neural activity, acting as tone inhibiting sensory technique. It is also suggested that maintained cutaneous stimulation using wrapping causes high threshold C fibers adaption. These two factors result in tone reduction through activation of autonomic nervous system.[13,16] Third one could be positioning of limb. Anti-spasticity positioning, keeping limb in positioning opposite to developed pattern provides prolong stretch to shortened muscles, for hours on consecutive days could be another factors imposing tone and ROM changes. Comparing time factor with improvement, it had been showed that more improvement for all outcome measures was observed during measure 3 (after 3rd week of treatment) to measure 4 (after final week or treatment, 5th week). It could be due to "the continuity" of the treatment which was applied for five consecutive weeks, 6 days a week. Keeping arm in anti-synergy posture daily for 3 hours could be helpful in breaking the fixed pattern. This suggests that increased treatment session with wrapping is more effective than usual number of wrapping sessions used till now. Wrapping is type of passive strain applied to desired position at the end of available movement range. This provide prolong and sustained stretch to the spastic muscles for hours, maintained at end of maximum stretch range.[17] Another study by Sheng Li et al explains that there is imbalance between corticospinal tract and reticulospinal tract (RST) presenting as extensor weakness and flexor spasticity due to hyper-excitable RST.[18] This could be manage using reciprocally inhibiting or limiting flexor hyper-excitable state. Long duration stretch for stretched muscles has potential to limit hyper-excitable stretch reflex, therefore, it can be explained that wrapping in anti-spasticity pattern can have potential impact on neurophysiological and morphological

components of hyper-excitable muscles.[19] Another study suggest that continuous afferent stimulation can have modulator effect on spinal stretch reflex hence positive effect in spasticity reduction,[20] this can be correlated with effects being achieved with wrapping technique.

CONCLUSION

Wrapping technique, applied over five week time period is an effective technique in improving tone and range of motion in children with spastic CP. There was less improvement observed in manual ability with this technique. Hence it could be helpful in clinical settings used as spasticity limiting technique. Limitations of the study were small sample size, optimal usage of necessary tools specially related to bandage pressure measurement. More rigorous, well controlled studies need to be conducted in future to determine further effects of wrapping in other regions especially in lower extremity. Clinical studies estimating exact physiological impacts of wrapping are necessary. Future studies need to focused on its local and as well as central effects indicating its effectiveness. Long term follow up cases must be included in future to observe retention of improvement long time after treatment.

Grant support: No grant and financial assistance.

Conflict of interest: None.

Authors' affiliation

Shafaq Tehseen Awan, Mirza Obaid Baig,
Faculty of Rehabiliation & Allied Health Sciences,
Riphah International University, Islamabad, Pakistan

REFERENCES

1. Autti-Rämö I, Suoranta J, Anttila H, Malmivaara A, Mäkelä M. Effectiveness of upper and lower limb casting and orthoses in children with cerebral palsy: an overview of review articles. American journal of physical medicine & rehabilitation. 2006;85(1):89-103.
2. Olama KA, El-Kafy EA, El-Meniawy GH. Lower Limb Spasticity Control in Response to Cryotherapy and Wrapping Technique in Hemiplegic Children. Bull Fac Ph Th Cairo Univ. 2008;13(1).
3. Majnemer A, Shikako-Thomas K, Shevell M, Poulin C, Lach L, Law M, et al. The relationship between manual ability and ambulation in adolescents with cerebral palsy. Physical & occupational therapy in pediatrics. 2013;33(2):243-52.
4. Lannin NA, Novak I, Cusick A. A systematic review of upper extremity casting for children and adults with central nervous system motor disorders. Clinical Rehabilitation. 2007;21(11):963-76.
5. Klotz M, Kost L, Braatz F, Ewerbeck V, Heitzmann D, Gantz S, et al. Motion capture of the upper extremity during activities of daily living in patients with spastic hemiplegic cerebral palsy. Gait & posture. 2013;38(1):148-52.
6. Kim JY, Chung JS, Jang GU, Park S, Park JW. The effects of non-elastic taping on muscle tone in stroke patients: a pilot study. Journal of physical therapy science. 2015;27(12):3901-5.
7. Klingels K, Demeyere I, Jaspers E, De Cock P, Molenaers G, Boyd R, et al. Upper limb impairments and their impact on activity measures in children with unilateral cerebral palsy. European Journal of Paediatric Neurology. 2012;16(5):475-84.
8. Kheder A, Nair KPS. Spasticity: pathophysiology, evaluation and management. Practical neurology. 2012;12(5):289-98.
9. Kumar C, Palshikar R, Choubey V. Effect of Manipulating Object Shape, Size and Weight Combined with Hand-Arm Bimanual Intensive Training (HABIT) in Improving Upper Extremity Function in Children with Hemiplegic Cerebral Palsy-A Randomized Controlled Trial. J Nov Physiother. 2017;7(338):2.
10. Deon LL, Gaebler-Spira D. Assessment and treatment of movement disorders in children with cerebral palsy. Orthopedic Clinics. 2010;41(4):507-17.
11. To M, Chow W. Orthopaedic Management in Children with Cerebral Palsy. BrainChild. 2014.
12. DeLuca PA. The musculoskeletal management of children with cerebral palsy. Pediatric Clinics. 1996;43(5):1135-50.
13. Kim SJ, Koh I. The effects of music on pain perception of stroke patients during upper extremity joint exercises. Journal of Music Therapy. 2005;42(1):81-92.
14. Sarvestani MB, Mehdizadeh M, Mehdizadeh F, Shabdini S. Effect of Wrapping Technique on Range of Motion and Muscle Tone of Upper Extremity in Children with Spastic Cerebral Palsy: A Pilot Study. Journal of Clinical Physiotherapy Research. 2018;1(1):9-12.

15. Twist DJ. Effects of a wrapping technique on passive range of motion in a spastic upper extremity. Physical therapy. 1985;65(3):299-304.

16. Yilmaz A, Beyleroglu M, Hazar M, Kirimoglu H, Sentürk U. Flexibility and Game Actions' Effects on Lower Extremity Joint Range of Motion in Cerebral Palsied Children (Spastic Type). Studies on Ethno-Medicine. 2017;11(2):174-9.

17. de Mello Sposito MM. Surgeries and physical interventions in the treatment of cerebral palsy spasticity. Acta Fisiátrica. 2010;17(2):84-91.

18. Li S, Francisco GE. New insights into the pathophysiology of post-stroke spasticity. Frontiers in human neuroscience. 2015;9:192.

19. Miczak K, Padova J. Muscle Overactivity in the Upper Motor Neuron Syndrome: Assessment and Problem Solving for Complex Cases: the Role of Physical and Occupational Therapy. Physical medicine and rehabilitation clinics of North America. 2018.

20. Estes SP, Iddings JA, Field-Fote EC. Priming neural circuits to modulate spinal reflex excitability. Frontiers in neurology. 2017;8:17.