Effect of Instrument Assisted Soft Tissue Mobilization on Hamstring Flexibility in Children with Diplegic Cerebral Palsy

Dina E. Mostafa*, Khaled A. Olama, Maya G. Aly
Department of Physical Therapy for Pediatrics, Faculty of Physical Therapy Cairo University, Egypt
***Corresponding author:** Dina E. Mostafa, **Mobile:** (+20) 01092829714, **E-Mail:** deenam44@gmail.com

ABSTRACT

Background: Generally, muscles of children with cerebral palsy (CP) lack flexibility. Muscle flexibility is a basic element for muscle action and an important milestone in the rehabilitation program for children with CP. Instrument assisted soft tissue mobilization (IASTM) is indicated for tissue extensibility dysfunction. **Objective**: To investigate the short-term effect of IASTM on hamstring flexibility of children with diplegic CP. **Patients and Methods:** This study included thirty children diagnosed as diplegic CP with mild to moderate spasticity, their ages ranged from 4 to 8 years of both genders (13 girls and 17 boys). They were assigned into two equal groups; control group received conventional physical therapy program and study group received same program of controls in addition to IASTM application on hamstrings of both sides. All participated children received session two times weekly for two successive weeks. The Knee extension angle test was used to assess hamstring flexibility before and after treatment (immediate effect after the first session and post 2 weeks). **Results**: There was a significant difference in hamstring flexibility after treatment sessions of both groups compared with pretreatment. The study group was significantly improved in comparison to the control group. **Conclusion:** Adding IASTM to the physical therapy program was found to improve hamstring flexibility in children with diplegic CP after application of four sessions.

Keywords: Cerebral palsy, Children, Hamstring, Instrument assisted soft tissue mobilization, Muscle flexibility.

INTRODUCTION

Cerebral palsy (CP) is a group of permanent disorders in children [(1)], it is caused by a non-progressive brain malformation that arose in the developing fetus or infant [(2)]. Spastic diplegia is the most common type of CP [(3)], children with diplegic CP exhibit muscle weakness, poor muscle coordination, unsteadiness on their feet, and poor postural control [(4, 5)]. Most of them have normal cognitive function and a reasonable chance of being able to walk independently [(6)]. The semitendinosus, semimembranosus, and biceps femoris muscles are the three separate muscles that make up the hamstring muscle complex. Most of them cross the femoroacetabular and tibiofemoral joints as it extends from the pelvis posteriorly along the length of the femur. As an exception to this rule, the short head of the biceps femoris arises from the lateral lip of the femoral linea aspera, which is located distal to the femoroacetabular joint. Flexibility of the hamstring muscles is essential for maintaining an efficient and functioning gait [(7)].

A child with CP may experience muscle shortening that both impairs and facilitates some functions [(8)]. Hip, knee, and ankle involvements are present in the vast majority of diplegic CP children. Despite this greater level of engagement, the majority of diplegic CP youngsters can walk on their own [(9)]. They must therefore be able to move normally, without limping, in order to engage in daily activities at home and in the community. This idea encompasses activities like standing, bending, walking, and climbing and significantly enhances the child's quality of life in terms of their health [(10)].

Instrument assisted soft tissue mobilization (IASTM) is a current treatment approach for myofascial restriction that makes use of specifically designed tools to mobilize soft tissue that has developed myofascial adhesion in order to lessen discomfort and increase range of motion and function. The use of an instrument is supposed to give therapists a mechanical advantage by allowing for more focused treatment and deeper penetration [(11)]. The IASTM treatment is believed to promote connective tissue remodeling by encouraging the removal of superfluous fibrosis. It also promotes collagen repair and regeneration as a result of fibroblast recruitment [(12)].

The fast rhythm of modern life needs more options to merge the children with CP in their communities such as schools and gardens. Treatment options provided to improve muscles flexibility and functions of children must not be limited to invasive methods like Botox injection which are also financially expensive. The IASTM is a non-invasive method that depends on an easy-held, cheap, and light-weighted tool.

The aim of this study was to investigate the short-term effect of IASTM on hamstring muscle flexibility in children with diplegic CP.

PATIENTS AND METHODS

Study Design and Setting:

Prospective experimental pre-post study design was used.

Ethical Considerations:

The ethical committee at Faculty of Physical Therapy, Cairo University approved the protocol of this research (No: P.T.REC/012/003399). Parent of each child signed an informed consent form before

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participation in this study after comprehensive explanation of the aim and procedures of the study. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Subjects:

Sample was selected from out-patient pediatric clinic of Faculty of Physical Therapy, Cairo University at the period from August 2021 to December 2021. Sixty two children were screened before inclusion to assess their eligibility. Thirty two of them were excluded as twenty children didn't meet the inclusion criteria and other twelve parents did not stick to their appointments for sessions. Thirty diplegic children represented the sample of this study.

Inclusion criteria: children diagnosed with spastic diplegic CP with mild to moderate spasticity according to modified Ashworth scale (grade 1, 1+), and ages were ranging from 4 to 8 year.

Exclusion criteria: children with infectious diseases, skin infection, seizures and any lower limb soft tissue injury; children with history of surgical interference in the lower limb or recent Botox injection, and child who missed any of the four successive treatment sessions were excluded.

Included children were assigned to one of two groups of equal number, 15 for each group. **Control Group:** children received conventional physical therapy program. **Study Group:** children received the same conventional program of controls in addition to IASTM application for hamstring muscles of both sides.

Methods:

Procedure for evaluation

Assessment for hamstring muscle flexibility

All children in both groups were assessed three times; pretreatment and post the first session, then post the 4th session after 2 weeks of treatment. The Knee extension angle (KEA) test [13] was used to assess hamstring muscle flexibility of both lower limbs. The child was positioned in supine with both legs extended and relaxed. The therapist raised the child's hip of the tested leg to 90 degree and maintained it while passively extended the tested knee until either the therapist felt slight resistance in the hamstring musculature. The knee angle was then measured with a universal goniometer [14].

Procedures for treatment:

The intervention period of both groups was two consecutive weeks, two sessions per week; duration of the total session was about 60 minutes.

Control group: received conventional physical therapy program [15] included different exercises using tools as mat, wedges, rolls, balance board for facilitation of milestones, stretching exercises, balance and gait training. Exercises were selected according to the needs of each child.

Study group: treated by the same physical therapy program of the controls in addition to the application of IASTM [16] using Graston tool in multidirectional stroking at 30-60º angle for 5 minutes on each hamstring muscle.

Statistical analysis

The collected data were coded, processed and analyzed using the SPSS (Statistical Package for the Social Sciences) version 22 for Windows® (IBM SPSS Inc, Chicago, IL, USA). Descriptive statistics and unpaired t-test were conducted for comparison of the mean age, weight and height and KEA data between groups. Quantitative data were expressed as mean ± SD (Standard deviation). Chi squared test was conducted for comparison of spasticity distribution between groups. ANOVA with repeated measure was conducted for comparison between pretreatment, after first session and post treatment (after 4 sessions) in each group, and if the difference was significant then, Bonferroni test was used as a post-hoc test for multiple comparison. P-value < 0.05 was considered significant.

RESULTS

I-General Characteristics

-Age, weight and height:

The mean ± SD values of age, weight and height for the control group were 5.66 ± 1.34 years, 22.33 ± 5.44 kg and 105.2 ± 8.98 cm respectively and that of the study group were 5.8 ± 1.26 years, 23.6 ± 6 kg and 107.66 ± 8.82 cm respectively ($p > 0.05$). There was no significant difference between the two groups in the mean age, weight and height.

- Spasticity grades distribution:

The control group revealed 7 (47%) children with mild spasticity and 8 (53%) children with moderate spasticity. The study group revealed 9 (60%) children with mild spasticity and 6 (40%) children with moderate spasticity. There was no significant difference between groups in spasticity grades distribution ($p = 0.47$).

II-Comparison between groups pre-treatment:

-Pre-treatment mean values of KEA of both groups (control and study) showed no significant difference for the right KEA ($p = 0.61$) and the same regarding the left KEA ($p = 0.31$).

III-Results of the Control Group

-Comparison between pretreatment, after first session and post treatment (after 4 sessions) mean values of right KEA of control group: There was a significant difference in right KEA between the three-time intervals as illustrated in table (1).

Table (1): Comparison between pre-treatment, after first session and post treatment mean values of right KEA of control group

Control Group Right KEA (degrees) (N=15) $\bar{X}$ ±SD			F- value	p- value	Significance
Pre treatment	**After first session**	**Post treatment**			
29.8 ± 5.33	25.73 ± 4.36	27.46 ± 5.38	35.64	0.0001	**S**
Multiple comparison (Bonferroni test)					
	MD	**% of change**	**p- value**	**Significance**	
Pretreatment Vs after first session	4.07	13.66	0.0001	**S**	
Pretreatment Vs post treatment	2.34	7.85	0.0001	**S**	
After first session Vs post treatment	-1.73	6.72	0.02	**S**	

$\bar{X}$ ±SD: Mean±Standard deviation, S: Significant, MD: Mean difference.

-Comparison between pretreatment, after first session and post treatment (after 4 sessions) mean values of left KEA of control group: There was a significant difference in left KEA between the three-time intervals as illustrated in table (2).

Table (2): Comparison between pretreatment, after first session and post treatment mean values of left KEA of control group

Control Group Left KEA (degrees) (N=15) $\bar{X}$ ±SD			F- value	p- value	Significance
Pre treatment	**After first session**	**Post treatment**			
30.13 ± 5.39	26 ± 4.71	27.53 ± 4.54	17.57	0.0001	**S**
Multiple comparison (Bonferroni test)					
	MD	**% of change**	**p- value**	**Significance**	
Pretreatment Vs after first session	4.13	13.71	0.001	**S**	
Pretreatment Vs post treatment	2.6	8.63	0.01	**S**	
After first session Vs post treatment	-1.53	5.88	0.001	**S**	

$\bar{x}$ ±SD: Mean±Standard deviation, S: Significant, MD: Mean difference.

IV-Results of the Study Group

-Comparison between pretreatment, after first session and post treatment mean values of right KEA of study group: There was a significant difference in right KEA between the three-time intervals as illustrated in table (3).

Table (3): Comparison between pretreatment, after first session and post treatment mean values of right KEA of study group

Study Group Right KEA (degrees) (N=15) $\bar{X}$ ±SD			F- value	p- value	Significance
Pre treatment	**After first session**	**Post treatment**			
28.86 ± 4.79	24.86 ± 4.26	23.46 ± 3.96	51.75	0.0001	**S**
Multiple comparison (Bonferroni test)					
	MD	**% of change**	**p- value**	**Significance**	
Pretreatment Vs after first session	4	13.86	0.0001	**S**	
Pretreatment Vs post treatment	5.4	18.71	0.0001	**S**	
After first session Vs post treatment	1.4	5.63	0.03	**S**	

$\bar{x}$ ±SD: Mean±Standard deviation, S: Significant, MD: Mean difference.

-Comparison between pretreatment, after first session and post treatment mean values of left KEA of study group: There was a significant difference in left KEA between the three-time intervals as illustrated in table (4).

Table (4): Comparison between pretreatment, after first session and post treatment mean values of left KEA of study group

Study Group Left KEA (degrees) (N=15) $\bar{X}$ ±SD			F- value	p- value	Significance
Pre treatment	**After first session**	**Post treatment**			
28.33 ± 4.15	24.93 ± 4.25	22.8 ± 3.51	74.87	0.0001	**S**
Multiple comparison (Bonferroni test)					
	MD	**% of change**	**p- value**	**Significance**	
Pretreatment Vs after first session	3.4	12	0.0001	S	
Pretreatment Vs post treatment	5.53	19.52	0.0001	S	
After first session Vs post treatment	2.13	8.54	0.002	S	

$\bar{X}$ ±SD: Mean±Standard deviation, S: Significant, MD: Mean difference.

V-Comparison between control and study groups after first session.
-Mean values of KEA after first session of both groups (control and study):

Table (5) showed that there was no significant difference in the right KEA (p = 0.58) or the left KEA (p = 0.52) between the control and study groups after the first session.

Table (5): Comparison of mean values of KEA after first session between control and study group

KEA (degrees) after first session	Control group (N=15) $\bar{X}$ ±SD	Study group (N=15) $\bar{X}$ ±SD	t- value	p-value	Significance
Right knee	25.73 ± 4.36	24.86 ± 4.26	0.55	0.58	**NS**
Left knee	26 ± 4.71	24.93 ± 4.25	0.65	0.52	**NS**

$\bar{X}$ ±SD: Mean±Standard deviation, NS: Non-significant.

VI-Comparison between control and study groups post treatment (after 4 sessions).
- Post treatment mean values of KEA of both groups:

Table (6) showed that there was a significant difference in the right (p=0.002) and left (p=0.003) KEA of the study group compared with that of the control group post treatment, in favor to the study group.

Table (6): Comparison of post treatment mean values of KEA between control and study group

KEA (degrees) Post treatment	Control group (N=15) $\bar{X}$ ±SD	Study group (N=15) $\bar{X}$ ±SD	t- value	p-value	Significance
Right knee	27.46 ± 5.38	23.46 ± 3.96	2.31	0.002	**S**
Left knee	27.53 ± 4.54	22.8 ± 3.51	3.19	0.003	**S**

$\bar{X}$ ±SD: Mean±Standard deviation, S: Significant.

DISCUSSION

The present study was conducted to investigate the short-term effect of IASTM on hamstring muscle flexibility in children with diplegic CP. Hamstring flexibility was measured by KEA test, it was considered as the gold standard reliable measure for hamstring muscle flexibility with intratester reliability of 0.99 [(13)]. The application of IASTM was found to improve hamstring flexibility after four sessions. Graston Technique that was used to treat children in this study is a form of IASTM that utilizes metal tools to localize and treat soft tissue restrictions. Its utilization has been reported to produce a mobilizing effect to soft tissues, and stimulate connective tissue remodeling [(15)].

Several theories explained the underlying mechanism of remote IASTM effects. One theory explaining non-local reactions of IASTM is based on neurophysiological basis and consists of cortical adaptation central pain-modulatory processes. One could argue that using IASTM results in systemic reactions like lowered stretch tolerance [(15,17)]. According to reports, using myofascial techniques can result in both local and overall body relaxation as well as a reduction in myofascial tone, which may help to explain the results of the current study. The mechanical force transmission through connective tissue can also be used to explain the results of the current investigation [(18)].

Pischinger and Heine [(19)] stated that manual soft tissue mobilization (STM) does not need availability of any specific instrument for treatment application; however, it can cause increased joint stress in therapist’s hand. A detected 91% absenteeism was attributed to pain in therapist’s hands due to manual STM. On the contrary, the IASTM provides a mechanical advantage for the therapists as it allows specific treatment, deeper penetration and decreases stress on therapist's hands [(11)].

Similar to this study results, previous research by **Pathania and Muragod** [(20)] compared the effects of IASTM, static stretching and foam rolling for hamstring tightness. All therapy interventions, according to their findings, significantly improved hip flexibility, although IASTM outperformed foam rolling when groups were compared. Similar to how foam rolling and IASTM both dramatically increased knee and hip range of motion in soccer players, the IASTM effect was twice as strong as foam rolling's [(21)].

A systematic review in 2016 by **Cheatham *et al.*** [(22)] indicated insignificant results that challenged the efficacy of IASTM as a treatment for common musculoskeletal pathology. The addition of IASTM application to the conventional physical therapy program used in this study was found to have better benefits than that the conventional therapy alone, this did not reach to statistical difference after the first session, but significant difference was detected in hamstring flexibility improvement after four sessions. IASTM tool is of value can added the easiness and time-consuming factors to the rehabilitation program. Graston is a simple and practical technique.

Limited literatures have evaluated the effect of IASTM applications on specific body region in children with CP. The present research assessed the short-term effect of the IASTM application on hamstring muscles flexibility over 2 weeks of treatment. Some factors may limit the generalization of this study findings; the small sample size, non-randomization and the varied child pain tolerance levels. It is recommended for future researches to investigate the effect of IASTM with larger well-designed studies and longer follow-up. The use of more objective measures also can strengthen its findings.

CONCLUSION

Short-term improvement in hamstring flexibility can be gained by adding IASTM to the physical therapy program of children with diplegic CP. Significant changes could be detected after 4 sessions of IASTM application within and between groups.

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