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EFFECT OF COMPLEMENTARY THERAPY ON HIP ABDUCTION IN CHILDREN WITH CEREBRAL PALSY

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ABSTRACT **Background:** Mechanical Horse Riding Simulator (MHRS) is one of the complementary therapy used in the rehabilitation of children with cerebral palsy which produces rhythmical and repetitive movements. It is working under the principles of hippotherapy and considered an alternative method for hippotherapy. Purpose: This study aimed to find out the effectiveness of a mechanical horse riding simulator on hip abduction range of motion in children with spastic diplegia and evaluate the magnitude of improvement at different periods (2 weeks, 4 weeks, and 6 weeks). **Methods:** This study included 30 children with spastic diplegia and was divided into two groups, the experimental and the control group. The experimental group received 15 minutes of complementary therapy with MHRS, 3 days/ week for 6 weeks along with regular physiotherapy, while the control group received 15 minutes of conventional trunk control exercise along with the regular physiotherapy session. Hip abduction passive range of motion (PROM) was measured with the Goniometer. Pre and post-intervention scores were recorded and analyzed with appropriate statistical tools. **Results:** The baseline characteristics were similar in both groups before the intervention with the p-value ($p>0.01$). The observed mean value of hip abduction PROM has been improved in both groups over 6 weeks and the experimental group shows significantly better improvement ($p<0.01$) than the control group in all the weeks. **Conclusion:** The study results confirmed that gradual improvement of hip abduction passive range of motion (both sides) was observed in both groups. Children exposed to MHRS show better improvement than the children in the control group. It was concluded that the MHRS is an effective complementary therapy improving hip abduction passive range of motion (both sides) in children with spastic diplegia and the provision of MHRS in longer duration provides more benefits than the shorter duration.

KEYWORDS : Mechanical horse riding simulator, Spastic diplegia, hip abduction range of motion, adductor spasticity.

1. BACKGROUND

Cerebral palsy is one of the developmental disorders which is characterized by disorder of movement and posture due to the lesion in the immature brain.[1] Recent literature reported that the prevalence of CP estimated as 1.5 to more than 4 per 1000 live births.[2-7] In India the prevalence of CP is similar to global estimation as 4.37 per 1000.[8] This study focused on the spastic type of CP which is characterized by abnormal muscle tone and movement which leads to abnormal posture. More than 70 % of CP children observed with excessive muscle tone and restricted movements. It was also observed that asymmetric and hyperactive adductor muscle activity leads to reduced hip range of motion, uneven bone growth, degenerative changes in bones which leads to subluxation and dislocation.[9,10] The pathophysiology of hip displacement in CP is a combination of hip flexor, adductor muscle spasticity, abductor muscle weakness, and delayed weight bearing, resulting femoral deformities and progressive acetabular dysplasia.[11] In order to avoid secondary Orthopedic complications, hip abduction range of motion should be maintained in children with spastic diplegia. Martinsson and Himmelmann, (2011) et al declared that passive hip abduction of less than 35 degree and flexion contracture more than 20 degree increases the chance of hip instability and interfere with positioning and dressing.[12] There is poor awareness among the health care professionals about the importance of hip abduction range of motion. Physical therapy for spastic diplegic children with adductor spasticity should be focused to improve children's highest functional ability and minimize the effects of adductor hyperactivity.

Mechanical horse riding simulator (MHRS) is one of the complementary therapies used in the rehabilitation of CP. It is working under the principles of hippotherapy and imitates the movement of a real horse.[13] It generates three dimensional movements that is forward backward right and left up and down.[14,15] Literatures have been proved that HRS is effective in reducing spasticity and improving range of motion and postural control.[16-20] HRS was developed to overcome the primary constraints of hippotherapy which could be used in the indoor setting to make hippotherapy more accessible and adaptable to the children.[21] Peeraya et al justified that astride sitting posture on a moving saddle of HRS offers prolonged stretching of lower limb muscles especially in adductors, in which higher muscle tension is observed in children with CP.[18] The purpose of the study was to find out the therapeutic effects of MHRS improving hip abduction range of motion in children with spastic diplegia. This study attempts to explore the therapeutic effects of complementary therapy (HRS) in the improvement of hip abduction range of motion in cerebral palsy children with spastic diplegia. There is a need for innovative, entertainment-based therapy that enables the children's full participation, efforts and enthusiasm. There are many conventional interventions are used by physiotherapists to improve range of motion in hip. Very few research evidence supports the use of this technology (MHRS) with the standard protocols in the rehabilitation of CP. So this study was executed to find out the therapeutic benefits of MHRS in improving hip abduction range of motion children with spastic diplegia.

2. METHODS

This study was carried out in the Department of Physical Medicine & Rehabilitation (PM&R), Rajah Muthiah Medical College & Hospital, Annamalai University. The study protocol was approved by the Institution Human Ethics Committee (IHEC), Rajah Muthiah Medical College, Annamalai University. This study enrolled 30 clinically diagnosed spastic diplegic cerebral palsy children from the division of PM&R based on the inclusion and exclusion criteria. **Inclusion criteria** are age between 2 - 6 yrs, both gender, motor function level up to 3 as per GMFCS, adductor tone up to 2 as per Modified Ashworths Scale and able to sit upright with support. Children exposed to recent neurological and orthopaedic surgery, uncontrolled seizures, unable to tolerate the oscillatory movements were excluded from the study. OSIM U-Gallop (OS-950 Gallop 2) is a mechanical horse riding simulator (MHRS) used in this study, which is an indoor exercise equipment provides oscillatory movements in anterior, posterior and lateral to simulate the horse riding experience. This study includes 30 children with spastic diplegia and divided into two groups, the experimental and the control group each consists of 15 children. The experimental group received 15 minutes complementary therapy with MHRS, 3 days/ week for 6 weeks along with the regular physiotherapy while the control group received 15 minutes of conventional trunk control exercise along with the regular physiotherapy session. The regular physiotherapy session (range of motion exercise, stretching and strengthening exercise) was given for 30 minutes which was common to both groups. Adductor muscle tone and hip abduction passive range of motion (PROM) were measured with Modified Ashworth scale and Goniometer at baseline, 2 weeks, 4 weeks and 6 weeks. Pre and post intervention scores were recorded and analysed with appropriate statistical tools.

3. RESULTS

Statistical analysis was done by SPSS version 18 with the level of significance set at 0.05. The basic characteristics (age, sex, height weight and motor function level) of the study population were analysed. Chi-square test was applied to examine the homogeneity between the groups which shows that the both groups are similar at baseline before treatment. Student's t- test has been applied to find out the difference that exists in the baseline study variable, range of motion

also confirms the homogeneity between the groups. The magnitude of improvement at different duration was compared between the groups using One-way ANOVA repeated measures. The comparison of right side range of motion (RROM) and left side range of motion (LROM) at four assessments in the experimental group was given in table 1 and table 2,which shows the mean and standard deviation of right side hip abduction range of motion in the experimental group at baseline, 2 weeks, 4 weeks and 6 weeks. The comparison of right side and left side range of motion (RROM&LROM) at four assessments in the control group was given in table 3 &4 which shows after 2 weeks of treatment there is no improvement in the range of motion in both sides. The observed mean values remain the same. After 4 weeks there is a significant difference observed in the range of motion in the control group which is confirmed by the p-value (0.01). It was also observed that at the end of 6 weeks there is no significant difference within the group. The significant p-value indicates that there is a significant variation between the four assessments. The comparison of right side range of motion (RROM) and left side range of motion (LROM) between the experimental group and the control group was given in table 5 and table 6. The ANOVA repeated measures test has been applied to compare the experimental group and control group on 4 assessments. A significant p-value of "assessment" indicates that the RROM and LROM values differs for the four assessments.

After 6 weeks it was observed that the number of children with grade 1 was found to be more (58%) in the experimental group than the control group (23%). It was also observed that 29% of children were at grade 2 of adductor tone in the control group and only 6% of children were in the experimental group which denotes that at the end of 6 weeks more children have been improved their adductor tone in the experimental group than the control group. Overall, it was concluded that there is a high improvement of adductor tone reduction in the experimental group compared to the control group.

Table 1 Comparison of right side range of motion (RROM) at four assessments in the experimental group

Experimental group (N=15)	ANOVA repeated				Repeated contrast test		
	Mean	SD	F value	p-value	Comparison	F value	p-value
RROM baseline	25.33	6.93	39.69	0.001	Baseline vs 2 weeks	42.25	0.001
RROM 2 weeks	29.67	6.93			2 weeks vs 4 weeks	16.20	0.001
RROM 4 weeks	34	5.73			4 weeks vs 6 weeks	21.00	0.001
RROM 6 weeks	38	6.21					

Table 2 Comparison of left side range of motion (LROM) at four assessments in the experimental group

Experimental group (N=36)	ANOVA repeated				Repeated contrast test		
	Mean	SD	F Value	p-value	Comparison	F value	p-value
LROM baseline	23.67	5.49	51.54	0.001	Baseline vs 2 weeks	52.50	0.001
LROM 2 weeks	28.67	5.81	-	-	2 weeks vs 4 weeks	13.44	0.003
LROM 4 weeks	33.00	6.76	-	-	4 weeks vs 6weeks	27.51	0.001
LROM 6 weeks	37.33	6.23	-	-	-	-	-

Table 3 Comparison of right side range of motion (RROM) at four assessments in the control group

Control group (N=35)	ANOVA repeated				Repeated contrast test		
	Mean	SD	F value	p-value	Comparison	F value	p-value
RROM baseline	23.33	8.99	62.25	0.001	Baseline vs 2 weeks	-	-
RROM 2 weeks	23.33	8.99	-	-	2 weeks vs 4 weeks	56.0	0.001
RROM 4 weeks	27.33	9.23	-	-	4 weeks vs 6 weeks	3.50	0.082
RROM 6 weeks	28.33	8.16	-	-	-	-	-

Table 4 Comparison of left side range of motion (LROM) at four assessments in the control group

Control group	ANOVA repeated				Repeated contrast test		
	Mean	SD	F value	p-value	Comparison	F value	p value
LROM 0	21.67	8.99	10.97	0.001	Baseline vs 2 weeks	-	-
LROM 1	21.67	8.16	-	-	2 weeks vs 4 weeks	10.00	0.007
LROM 2	25	8.16	-	-	4 weeks vs 6 weeks	3.50	0.082
LROM 3	26	8.28	-	-	-	-	-

Table 5 Comparison of right side range of motion (RROM) between the experimental group and the control group

Source	F value	p value	Repeated Contrast test value		
			Comparison	F value	p value
Between subjects	5.15	0.031	-	-	-
Within subjects	73.60	0.001	Baseline vs 2	42.25	0.001
			2 weeks vs 4 weeks	48.07	0.001
			4 weeks vs 6 weeks	23.86	0.001

Table 6 Comparisons of left side range of motion (LROM) between the experimental group and the control group

Source	F value	p value	Repeated Contrast test value		
			Comparison	F value	p value
Between subjects	7.59	0.010	-	-	-
Within subjects	17.50	0.001	Baseline vs 2 weeks	17.50	0.001
			2 weeks vs 4 weeks	23.43	0.001
			4weeks vs 6 weeks	29.37	0.001

4. DISCUSSION

The purpose of the study was to find out the effectiveness of MHRS improving hip abduction range of motion in children with spastic CP. In the present study passive hip abduction range of motion (RROM & LROM) was evaluated in children in the experimental and control group at baseline, 2 weeks, 4 weeks and 6 weeks. The pre and post comparison values show that both groups improved their range of motion after 6 weeks but the experimental group shows better improvement than the control group. The observed mean value of range of motion in hip abduction has been improved over the period of time from baseline to 2 weeks, 2 weeks to 4 weeks and 4 weeks to 6 weeks. This result indicates hip abduction range of motion gradually improved from baseline to 6 weeks in both groups. Even though both groups were improved, the observed improvement in the experimental group was better in the experimental group than the control group in all the weeks, which is confirmed by statistical significance. Spasticity is one of the important factor contribute shortening and stiffness of muscle which significantly causes reduction in range of motion and adductor spasticity in cerebral palsy children show higher muscle tension leads to reduction in hip abduction range of motion. Literatures proved that static stretching reduces spasticity in hip adductors[15,16,18]. While riding on HRS, children in the experimental group assumes abducted posture with externally rotated leg which provides positional stretching to the rider and improves range of motion in hip abduction.[22,23] Lespargot et al (1994)[24] stated that 15 to 20 minutes of positional stretching of hip adductors found reduction of spasticity in children with CP. Muscle tone is considered as one of the significant factor underlying changes in motor function. Adductors in hip show higher muscle tension in spastic CP. In this study adductor

tone in hip was evaluated by MAS which is the common outcome measure used to quantify the spasticity. The distribution of adductor tone in both groups show similarity before intervention. After 12 weeks there is difference in the distribution of adductor tone in both groups, which shows significant reduction of muscle tone in both groups after the intervention, which is statistically proved. Children in the experimental group show better improvement than the children in the control group. This result may be due to prolonged stretching of adductors while sitting on HRS leads to reduction of spasticity around the pelvis and hip joint. The results well supported by Pablo et al (2010)[25] and Mergillano et al (2004)[26] stated that 15 minutes sitting on mechanical horse riding simulator decreases muscle tone especially in adductors. The appropriate posture maintained on HRS offers prolonged stretching and relaxes the muscle tone around hip joint and consequently improving range of motion in hip abduction[27].

Literature supported that sustained stretching of lower extremity muscles can result in reducing spasticity as a consequence an improvement in the range of motion can be attained. This result supported by Mohamed Ali Elshafey (2014)[15] declared that CP children treated with mechanical saddle found improved passive range of motion compared to static saddle. The control group children received manual stretching which also leads to improvement of range of motion in hip abduction. This result was supported by Fragala et al (2003)[28] found improvement of range of motion in hip abduction after manual stretching with similar protocol. These findings indicate that HRS reduces hypertonicity which results in reduction of muscle tone in adductors in children with spastic CP.This study shows the consistent pattern of improvement related to the HRS intervention. The magnitude of improvement at baseline, 2 weeks, 4 weeks and 6 weeks was analysed. All the comparisons between baseline and 2 weeks, 2 weeks and 4 weeks, 4 weeks and 6 weeks were found to be statistically significant which indicates that there is a significant improvement existing on each assessment after the intervention in both groups. The experimental group shows better improvement than the control group in all the weeks.

This result indicates hip abduction range of motion gradually improved from baseline to 6 weeks in both groups. Even though both groups were improved, the observed improvement in the experimental group was better in the experimental group than the control group in all the weeks. It was concluded that the children who received MHRS showed better improvement in hip abduction range of motion than the children who received therapy without MHRS. This study included only spastic diplegic CP children with mild and moderate disability levels, further studies are needed with the inclusion of other types of cerebral palsy and children with severe disability levels. Using simple outcome measures like range of motion and adductor spasticity is one of the limitation of this study. In addition, the hip joint and other joints of the lower limb could be included in future research. The observed results suggested that the MHRS is effective in reducing adductor spasticity and improving hip abduction range of motion and recommended including this type of complementary therapy in the rehabilitation of children with CP.

5. CONCLUSION

It was concluded that there is a gradual improvement in hip abduction passive range of motion observed in both groups. Children who receive complementary therapy (MHRS) show better progress than those in the control group. MHRS is one of the effective complementary therapy reducing adductor spasticity and improving hip abduction passive range of motion (both sides) in children with spastic diplegia and the provision of MHRS in longer duration provides more benefits than the shorter duration.

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CONFLICT OF INTEREST

The authors declared that they have no conflicts of interest.

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