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Efficacy of Adjustable Abduction Spreader Bar in Correction of Adduction Deformity of the Hip in Spastic Diplegic Cerebral Palsy Children

AHMED M. AZZAM, P.T.D.

The Departments of Physiotherapy for Developmental Disturbance and Pediatric Surgery, Faculty of Physical Therapy, Cairo University.

Abstract

Objective: The aim of this work was to show the effect of adjustable abduction spreader bar in improvement of hip stability, motor control, decrease tightness of hip adductors and increase range of hip in abduction.

Method: Thirty children were enrolled in this study and randomly assigned into two groups of equal number: Group A (traditional physiotherapy program plus adjustable abduction spreader bar) and group B (traditional physiotherapy program only). Both groups had tightness of hip adductors, decrease in ROM in abduction, all of the children can stand with support and all children who had surgical release of tightness are excluded from the study. Standard plastic goniometer was used to detect and follow hip abduction, tape measure was used to measure the knee to knee distance in the point of abduction limitation and flexibility tests was used to detect hip adductor flexibility. These measurement were taken before initial treatment and after 12 weeks post treatment. The children parents in group A were instructed to wear adjustable abduction spreader bar during standing and sleep.

Results: Data analysis were available on 30 spastic diplegic CP children and it was insignificant difference in the variables related to age, sex ($p>0.05$). The mean value of hip abduction pre and post treatment for the right lower limb was highly statistical significant difference ($p<0.01$) for the study group while statistically non significant difference ($p>0.05$) to the right lower limb in group (B). On the other hand there was a highly statistical significant difference of the (Lt) lower limb pre and post treatment in the study group ($p<0.01$) and significant difference to the (Lt) lower limb in the control group ($p<0.05$). The mean value of distance between both knees being highly statistical significant pronounced ($p<0.01$) in the traditional PT plus adjustable abduction bar group than traditional only ($p<0.05$).

Conclusion: The use of traditional physiotherapy program plus adjustable abduction spreader bar are superior to traditional physiotherapy alone for all measurements that include hip mobility and hip adductor flexibility after 12 weeks follow-up.

Key Words: *Adjustable abduction spreader bar – Adduction deformity of the hip – Spastic diplegia.*

Correspondence to: Dr. Ahmed M. Azzam, The Departments of Physiotherapy for Developmental Disturbance & Pediatric Surgery, Faculty of Physical Therapy, Cairo University.

Introduction

CEREBRAL palsy (CP) is a deficiency of both motor activities and sensory functions that is characterized by permanent motor and postural defects and results from damage occurring in developing brain tissue. The clinical form of spastic diplegic CP is 35% of all childhood spastic CP cases. Spasticity is especially prominent in the lower extremities, although the upper extremities are not totally spared. The spasticity in spastic diplegic CP leads to extreme internal rotation and bilateral adduction in the lower extremities. Lower-extremity adductor and internal rotator muscle group spasticity might result in the development of hip subluxations and dislocation **[1,2]**.

The most frequently encountered deformities of the lower extremities in cerebral palsy children are equinus deformity of the ankle, flexion deformity of the knee and adduction deformity of the Hip. Rehabilitation of those children was depend not only on the restoration of muscle balance in the extremities but also on the proper alignment of the joints used in weight bearing and the establishment of correct posture **[3]**.

Adduction deformity of the hip may be caused by (spasticity of the adductors combined with flaccidity of the abductor, spasticity of the adductors combined with over stretching or weakness of the abductors, spasticity of the adductors and internal rotators and spasticity of the gracilis muscles) **[4,5]**.

Hip dislocation in children with cerebral palsy is caused by a combination of factors, including spastic muscle imbalance, persistent fetal femoral geometry, acetabular dysplasia, and flexio-nadduction contracture. The incidence of dislocation correlates with the severity of the spasticity, and the prevalence is close to 50% in neurologically immature, spastic diplegic children **[6]**.

Hip disorders are common in patients with cerebral palsy and cover a wide clinical spectrum, from the hip at risk to subluxation, dislocation, and dislocation with degeneration and pain. Although the hip is normal at birth, a combination of muscle imbalance and bony deformity leads to progressive dysplesia. The spasticity and tightness usually involves the adductor and iliopsoas muscles thus, the majority of hips subluxate in a posterosuperior direction. Soft-tissue lengthening is recommended for children as soon as discernable hip subluxation (hip abduction <30 . is recognized). Dislocation caused by muscle imbalance due to the hip abductors become weaker than adductors due to unbalanced paralysis in childhood. The greater trochanter fails to develop properly, the femoral neck become valgus and hip may subluxate or dislocate **[7,8]**.

The adductor muscles are not just functional adductor muscles of the leg They are also designed to assist in hip extension (adductor magnus), knee flexion (gracilis) and hip flexion (pectineus). In order to help a chronically internally rotated femur to rotate more out, it seems indeed useful to do some work on the adductors. Also for chronically extended hip joint structures i.e. posterior pelvis tilt. It makes sense to include some releasing work on the adductor magnus **[9]**.

Dislocation of the hip joint is a common complication in patients with spastic cerebral palsy. The variation incidence probably being due to differences in age, type and severity of cerebral involvement. Disproportion of the related muscles is one of the main factors related to dislocation of hip. Predominant hyper-tonicity of the adductor and flexors lead to tightness of adductor and flexors against the weak extensors and abductors seems to be particularly responsible **[10]**.

Muscle shortening brought about by such an imbalance precedes derangement of the hip joint. There is a relation between range of hip abduction and derangement of hip joint. Limited abduction of less than 45 degree was a warning sign of dislocation. Valgus and ante-torsion of the femur are also important factors, but these deformity are considered to be secondary changes due to muscle imbalance **[1,11]**.

Muscle shortening associated with adduction, flexion and internal rotation of the hip joint are frequently observed in children with spasticity due to perinatal brain damage. In these patients the longitudinal growth of the muscles tend to lag behind skeletal growth during the entire growth phase this is particularly the case during periods of high growth velocity that is within the first 3 years of life. Therapeutic ex. can prevent such shortening to a considerable degree if started within the few months after birth **[10,12]**.

Material and Methods

Thirty children from both sexes with spastic diplegia were enrolled for this study. They had tightness in both hip adductor and limitation in hip abduction. Post operative released of hip adductor were excluded. Their age ranged from 3 to 6 years.

Children were randomly assigned into two groups of equal number, 15 diplegic C.P. patients each:

Group A (study group): Received traditional physiotherapy program in addition to wearing of adjustable abduction spreader bar during sleep and standing.

Group B (control group): Received traditional physiotherapy program only.

Assessment of hip adductor flexibility:

- In cases of pure adductor spasticity, the limbs do not internally rotate when forcibly abducted if the patient in supine.
- When adduction deformity is due to spasticity of the internally rotators of the hip it is usually combined with an internal rotation deformity.
- In cases of pure adductor spasticity the limbs will be brought together but will not cross unless the hip flexors are involved.
- The scissor gait most often results from hip flexion, internal rotation deformity in which the tensor-fasciaelatae is the major deforming factor.

To detect the flexibility of hip adductor the child lie in his back, passively bend knees and put the feet flat on the floor maintaining the heels together touching buttocks, gently spread both knees apart stretching the muscles on the inside of child thigh, flexibility of hip adductor tightness detected from (limitation in hip abduction, resis-

tance in hip abduction, facial expression). To concentrate on the flexibility test for gracillis muscle the child was placed in supine lying position the tested limb taken passively from extended knee to abduction hip.

Assessment of hip mobility:

- By using standard plastic goniometer used to detect passive range of hip abduction (normal range 60 degree passive abduction on each side with hip, knee flexed 90 degree or 40-45 degree abduction with hip, knee extended). The child was placed in supine with thorax firmly strapped to the table to prevent body shift. By using goniometer therapist measure hip abduction pre and post treatment.
- Another method to detect limitation in hip abduction, alternatively measure the knee to knee distance in the point of abduction limitation pre and post evaluation. This can be a very accurate way of detecting small alterations in range and is useful for checking progress in treatments.

Treatment procedure:

The children were treated 3 times per week, each session lasted 1 hour for both group in addition to wearing of adjustable abduction spreader bar after sessions, during sleep and all over the day for study group only. The treatment program for both group include:

Traditional physiotherapy program which includes the following:

- Faradic stimulation of anterior tibial group for triggering the mass flexion of lower limb with support ankle in dorsi-flexion to prevent cross electricity to reach calf muscles because these spastic muscles are more sensitive to electric stimulation than weak muscles and for hip abductor by putting electrodes on lateral aspect of thigh from side lying.

- Prolonged stretch to hip adductor muscle to gain relaxation via: At first quick stretch occur lead to stimulate gamma fibers lead to stimulate contractile part of intrafusal muscle fiber lead to stimulate non contractile part which include stretch receptors sending afferent signals to PHC Then to AHC then to alpha motor neuron causing contraction of extrafusal muscle fibers. At second step just one contraction or repeated contraction occurred stimulate GTO sending 1b afferent to PHC then to 1b inter neuron which reverse the stimulated signals into inhibitory signals inhibiting PHC. Then inhibit AHC then inhibit alpha motor neuron then relaxate extrafusal muscle fibers. Techniques used as prolonged stretch (positioning, night splint, reflex inhibiting pattern, Bobath technique) **[13]**.

- Facilitation of anti-spastic muscles (tapping followed by movement, quick stretch, triggering mass flexion, biofeedback, weight bearing, clenching to toes, compression on bony prominence, rapping the muscle, approximation, tonic vibrationreflex, irradiation to weak muscles by strong muscles, ice application for brief time).

- Passive stretching to tight muscles to destruct adhesions in muscles and sheath (most common tight muscles are; calf muscles, hamstring, hip flexor and hip adductor). It must be decent gentle gradual stretch not over stretch at all. To increase the flexibility of hip adductor the child lie in his back, passively bend knees and put the feet flat on the floor maintaining the heels together touching buttocks, gently spread both knees apart stretching the muscles on the inside of child thigh, lasting 20 second then relaxation 20 second lasted 3-5 times per session. To maintain the new range adjustable abduction spreader bar after session, all over the day and during sleep was used **[14]**.

- Graduated active exercise for trunk muscles (abdominal, Para-spinal, lateral flexors).

- Gait training using aids in closed environment using obstacles, side walking then by pass walking).

- Hot packs to improve circulation and relax muscle tension.

- Balance training program which include static and dynamic training.

- Special graduated active ex. for hip abductor started from tapping followed by abduction till minimal resistance exercise to avoid the transient increase of spasticity caused by increased resistance.

After physiotherapy program an adjustable spreader bar attached above the knee was utilized for at least 12 weeks for the study group. It can be recommended for a further period of several months. Early initiation of physiotherapy program for the activation and strengthen of the hip abductor muscles is urged to restore muscle balance about hip. Repeated testing of gluteus medius demonstrate Voluntary power in the abductor particulary after wearing of the braces to overcome the stretching of the abductor caused by the force of the spastic antagonist adductor muscles.

Results

Data analysis were available on 30 spastic diplegic CP children. 15 Subject were randomized to traditional physiotherapy program plus adjustable abduction bar and the remaining 15 subject were randomized to traditional program only. Demographic data in (Table 4) revealed that p-value <0.05 for variables and groups, this means that both of them have affected on the study at 5% level of significant. But, p-value >0.05 for age and sex.

Hip mobility: A comparison of the pre and post treatment for the right lower limbs in both groups as shown in Table (1) revealed that there is highly statistical significant difference (p<0.01) for the (Rt) lower limb pre and post treatment of the study group (A) while statistically non significant difference (p>0.05) to the right lower limb in group (B) (Table 1 and Fig. 1). On the other hand there is a highly statistical significant difference of the (Lt) lower limb pre and post treatment in the study group (p<0.01) and significant difference to the (Lt) lower limb in the control group (p<0.05). The percentage of improvement in hip abduction in group A was 10% on Rt side and 8% on the Lt side in study group and 1.1% Rt and 1.3% on Lt in control group as shown in Table (3).

Distance between both knees: A comparison between pre and post treatment in both groups as in Table (2) and Fig. (2) revealed that the trend being highly statistical significant pronounced (p<0.01) in the traditional PT plus adjustable abduction bar group than traditional only (p<0.05). The percentage of improvement in the distance between both knees was 45.8% in group A and 6% in group B (Table 3).

Since p-value <0.05 for variables and groups, this means that both of them have affected on the study at 5% level of significant. But, p-value >0.05 for age and sex, this means that both of them have not affected on the study at 5% level of significant.

Table (1): Mean values of Hip abduction pre and post treatment in degree.

Data	Group A				Group B			
	Pre-rt	Post-rt	Pre-lt	Post-lt	Pre-rt	Post-rt	Pre-lt	Post-lt
Mean	31.67	34.8	31.73	34.27	31.93	32.27	31.87	32.27
Standard deviation	2.52	1.86	2.22	2.46	2.12	1.9	2.19	2.01
Difference mean	3.13		2.53		0.33		0.4	
p-value	<0.01		<0.01		>0.05		<0.05	

Table (2): Mean values of distance between knees in the point of abduction limitation pre and post treatment in cm.

Data	Group A			
	Pre-	Post-	Pre-	Post-
Mean	8.8	12.46	8.27	8.73
Standard deviation	2.21	2.61	2.05	2.15
Difference mean	3.67		0.47	
p-value	<0.01		<0.05	

Table (3): Percentage of improvement in Hip abduction and distance between both knees.

Side	Hip abduction		Distance between both knees	
	A	B	A	B
Rt	10%	1.1%	45.8%	6%
Lt	8%	1.3%		

Table (4): Spastic diplegic children demographic data (ANOVA).

Source	df	ss	Adj ss	Adj ms	f	p-value	Test
Variables	1	21221.4	21221.4	21221.4	3581.18	0	Sig.
Age	3	36.9	19.3	6.4	1.8	0.36	No sig.
Sex	1	17.5	8.2	8.2	1.37	0.244	No sig.
Group	1	60.2	6.2	60.2	10.1	0.002	sig.
Error	173	1030.9	1030.9	6			
Total	179	22366.9					

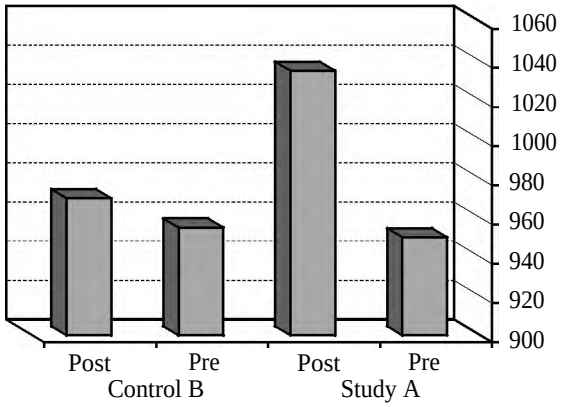

Fig. (1): Values of Hip abduction pre and post treatment for group A and B in degree.

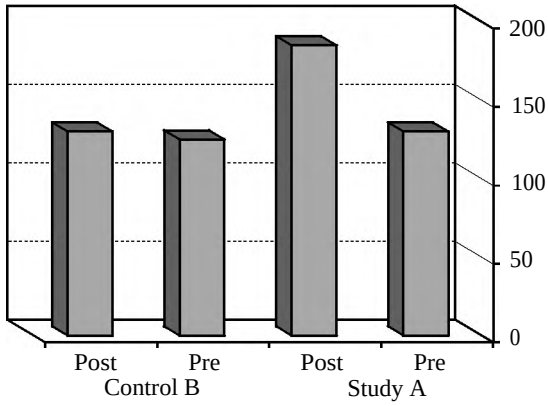

Fig. (2): Values of distance between both knees pre and post treatment for group A and B in cm.

Discussion

A course of traditional physiotherapy program plus adjustable abduction bar were significantly more effective than traditional physiotherapy only. Hip abduction was increased by 8-10% in study group in comparison with control group which increased by 1-1.3% also the distance between both knees increased by 45.8% in comparison with control group which increased by 6%.

It has been appeared that most long standing adduction deformities are due to a combination of contracture of the involved muscles and their sheaths in addition to spasticity of the involved muscles. Tight hip adductor put the hip joint in loosed packed position (adduction and internal rotation) cause an imbalance in the ball and socket joint which lead to subluxation and eventually dislocation of the hip so it is extremely beneficial to deal with subluxation before the hip fully dislocated in addition to tight hip adductor produce very difficult for toilting and hygine care.

In most cases the adduction deformity of the hip is due to combined forces of contracture and spasticity of the involved muscles (long-standing uncontrolled spasticity results in contracture of the muscle fibers and muscle sheath). So these combined pathological mechanism is in bad need for proper physiotherapy program (via eliminate hyperirritability of the spastic muscles) plus adjustable abduction spreader bar (decrease and release of muscle and sheath contracture, relaxation of spastic muscles, stimulate proprioceptive and cutaneous receptors by creating a deep pressure effect on the skin, inhibitions of pathologic reflexes and create the support needed to stabilize the extremities). The decrease of spasticity and tightness in the hip adductor also help in development of muscle balance, partially achieve the lateral balance through improvement of hip abductor. The combined treatment not only help in reducing the adduction deformity but at the same time remove an insidious source of knee flexion deformity. Repeated testing of gluteus medius will demonstrate voluntary power in the abductors particularly after the wearing of adjustable abduction spreader bar to overcome stretching of the abductor caused by the force of the spastic antagonist adductor muscle.

The gracilis muscle contributes to the adduction deformity, this is particularly true in patients with adduction deformity of the hip associated with flexion deformity of the knee. So the decrease of spasticity and tightness in gracilis muscle increase hip abduction and knee extension.

The adjustable abduction spreader bar depend on its mechanism on prolonged stretch via stimulation of muscle spindle and golgi tendon organ,first step is firing of gamma fibers which connected with contractile part of intrafusal muscle fiber producing contraction of contractile part and stretching of non contractile part of intrafusal muscle fiber which stimulate stretch receptors (flowerspray, annulospiral receptors) sending impulses to Ia andII afferent to PHC to AHC to alpha motor neurone which produce contraction of extrafusal muscle fiber lead to stimulation of golgi tendon organ which sending impulses to Ib afferent to PHC to Ib interneurone which reverse signals into inhibitory impulses which inhibit AHC which inhibit alpha motor neurone which inhibit extrafusal muscle fiber producing relaxation of spastic muscles. The adjustable abduction spreader bar produce also passive stretch to contracted muscle and sheath which overcome adhesions in the muscle and sheath increasing their elasticity and maintaining it elongated.

Conclusion:

The combined physiotherapy program which includes (traditional physiotherapy program +

adjustable abduction spreader bar) is recommended because it is extremely beneficial to deal with hip instability before the hip sublaxated and may be fully dislocated, to help child who trying to walk and having trouble with scissoring and cross over each other and to improve the ability to provide perineal care and less difficulties in toilting and hygine care so this combined program can be used as the program of choice in the correction of adduction deformity of the hip in spastic diplegic C.P.

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