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Research Article

COMPARISION OF EFFECTS OF TRICEPS SURAE STRETCHING BY TS STRETCHING DEVICE VS MANUAL STRETCHING IN SPASTIC CP DIPLEGICS

Arun Kumar Satpathy, Mrs. Monalisa Pattnaik and *Dr. Patitapaban Mohanty

Department of Physiotherapy, SVNIRTAR, Cuttack - 754010, Odisha, India

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ABSTRACT

Equinus foot in spastic diplegic children is a major problem due to spasticity in gastrocnemius muscle that affects normal gait cycle, balance, and ADL. As per literature, though stretching is used as a technique for therapeutic management of spasticity, but current level of evidence to support the effectiveness of passive stretching in reducing spasticity in spastic CP children remains weak.

AIM OF STUDY: To study effect of sustained static passive stretching on the reduction in spasticity of gastrocnemius, improving ankle dorsiflexion ROM, and improving GMFM in diplegic cerebral palsy by using a stretching device and conventional manual stretching.

DESIGN: 30 subjects with mean age (4.94 ± 1.70) years of both male and female were taken in pre-post control experimental design and assigned randomly into two groups with 15 subjects in each group, viz. group-1 with mean age (4.85 ± 1.29) years treated by prolong static stretching given for 15minute using TS stretching device and group-2 with mean age (5.03 ± 2.08) years treated by manual stretching given for 1 minute. After 4 weeks of intervention data collection and data analysis was done.

CONCLUSION: Prolong static stretching (15minute) has added benefits in decreasing in spasticity, gaining passive and active range of motion and improvement in GMFM as compared to conventional short duration stretching.

INTRODUCTION

Cerebral palsy (CP) is defined as a group of nonprogressive, but often changing motor impairment due to lesions of nervous system in early stage of development (Archie Hinchcliff, 2007). Although the lesion is nonprogressive, but the impairment and disability are progressive. In India, its incidence is up to 3 cases per 1000 live births (Apexa G.Vyas, 2013). Based on clinical features CP is classified (Marcia Stammer, 2000) as - i) Spastic, ii) Athetoid, iii) Ataxic, iv) Hypotonic, v) Mixed. Among all types, spastic CP represents the highest percentage group (Albright AL, Cervi, 1996). Spasticity has been defined as a motor disorder characterised by velocity dependant increase in tonic stretch reflexes with exaggerated tendon jerk, resulting from hyper excitability of the stretch reflexes, as a component of UMN syndrome (Lance, 1980). Spasticity contributes to the structural and biomechanical abnormal changes and often found to interfere with motor function of CP children like dressing, toileting, bathing and ambulation (Marcia Stamer, 2000). Over time the amount of movement possible at the joint decreases and the function is lost.

****Corresponding author: Dr. Patitapaban Mohanty,***
Asst Prof (PT), Dept of Physiotherapy, SVNIRTAR, Cuttack - 754010, Odisha, India.

Reduced movement leads to adaptive shortening and loss of elasticity of the muscle, as a result contracture develops (Deleplanque 2002). Clinicians and researchers have attempted to alter motor neuron excitability through variety of methods viz- stretching, cryotherapy, casting, biofeedback, electrical stimulation, stretching in combination with others like vibration, muscle taping, massage etc. Among all, stretching is applied widely in clinics as it is safe, conventional and economical (De vries, 1981).

There are various types of stretching techniques among which sustained static stretching and progressive static stretching have been found to be very effective in reducing tightness. This approach capitalizes on the stress relaxation property of soft tissue. Stress-relaxation occurs when a load is applied to stretch a tissue keeping length of the tissue constant (Beaulieu, 1981). A review study on effectiveness of passive stretching in children with cerebral palsy has shown that sustained stretching of longer duration was preferable in improving range of motion and reducing spasticity in spastic CP children than manual stretching (Tanus pin *et al*., 2006). This static stretching has been linked to durations ranging from 15 seconds to several minutes when manual or self-stretching is applied (Magnuson, 2000).

The results of reviewed studies on passive stretching concluded that the current level of evidence to support the effectiveness of passive stretching in reducing spasticity in children with spastic CP remains weak. To our knowledge there is less study comparing between prolong static and conventional short duration manual static stretching for reduction of spasticity in cerebral palsy children and we hypothesize that effect of prolong static stretching will bring effective results in CP diplegic. So our primary objective is to investigate the effect of sustained static stretching with stretching device for 15 minutes in comparison to manual stretching for 1 minute, in the reduction of spasticity, improving Range of motion (ROM) and improving Gross Motor Function Measurement (GMFM) in diplegic cerebral palsy children.

MATERIALS AND METHODS

The study was a pre-post control group experimental blind study design, in which 30 children of 21 male and 9 female were taken as per selection criteria from Pediatric unit, Department of Physiotherapy, SVNIRTAR, Olatpur, Cuttack, Odisha and then assigned randomly to two groups . The study was carried out for 4weeks with intervention 5days/week.

Inclusion criteria: 1) Spastic CP of age group 3-9 Years, 2) Able to stand independently or with support, 3) Children with good cognition

Exclusion criteria: 1) Severity of spasticity >3 in MMAS , 2) Any past surgery or plan for surgery during the course of research 3) Any steroid therapy or Botulinum toxin injection shouldn't taken recently (within 6month), 4) Children with athetoid, ataxic, flaccid CP 5) Convulsion 6) Severely deformed foot like midtarsal breakage, rocker bottom foot, severely varus.

Independent variable- i) Sustained static stretching done by Triceps surae (TS) stretching device for 15 minutes, ii) Sustained static stretching done manually for 1 minute.

Dependent variable: i)Tone measured by MMAS ii) Active ROM of ankle for dorsiflexion measured by 180 degree Goniometer iii) Passive ROM of ankle for dorsiflexion measured by 180 degree Goniometer, iv) GMFM by using GMFM-66 scale of D type v) Foot contact area measured by graph paper and stamp pad.

Procedure

After proper evaluation, the children who fulfilled the inclusion and exclusion criteria were assigned randomly to two groups using chit system. In evaluation , testing of tone was done with MMAS, active ROM and passive ROM of dorsiflexion of ankle measured by 180 degree goniometry, GMFM for standing using GMFM-66 scale of D type , foot contact area measured by graph paper and stamp pad. Written consents were taken from parents for being the part of study. Before intervention, all children were asked to rest on the bed for 5 min and remain comfortable and relaxed. Group-1 received sustained static passive stretching using TS stretching device for 15 minutes and Group-2 received static stretching manually for 1 minute. The same protocol was repeated for 5 days per week and continued for 4weeks. Along with this all the children continued their conventional treatment every day in the Department. Pain feedback was taken from child's perception during stretching and after stretching. After 20 sessions, children were again tested for all dependent variables. Testing data were then transcribed onto a data sheet for each child separately.

Data Analysis

Data were analysed using SPSS 16.0 software. Tone and GMFM was analysed using Mann-Whitney U test. Likewise data of active and passive range of motion, foot contact area for both limbs were analysed using 2×2 ANNOVA, where there was one between factors with 2 levels (group-1 and group-2) and one within factors with 2 levels (pre test and post test). P value was set at 0.05 for all comparisons.

RESULTS

Serial no.	Demographic haracteristics	Group-1	Group-2
1	No. of subjects	15	15
2	Age(year)	3-7 years	3-9 years
3	Mean age	4.85 ± 1.29	5.03 ± 2.08
4	Gender (M/F)	9/6	12/3

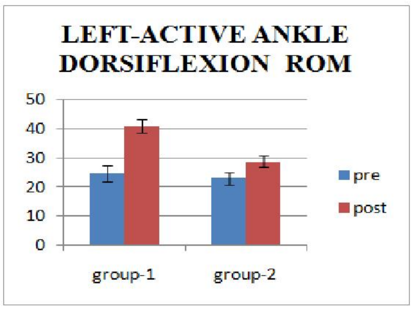
Active Ankle Df Rom

LEFT

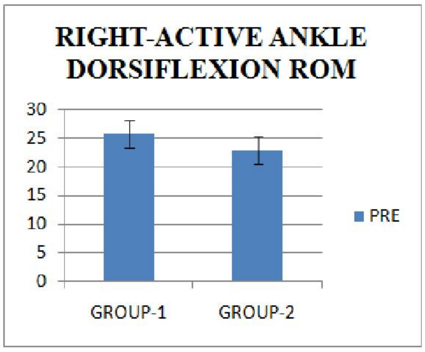
Graph-I shows improvement in active range of ankle dorsiflexion in both the groups from pre to post test evaluation. However post-test value in group-1 shows more improvement as compared to group-2. There was a main effect for time (F=427.257, p=0.000). There was main effect for group (F=4.489, p=0.043). The main effect also qualified for time × group interaction (F=30.975, p=0.000). Post hoc analysis reveals statistically significant difference at 4 week scores between both the group as well as significant improvement in both groups individually after 4 weeks

RIGHT

Graph-II shows improvement in active ankle DF range of motion in both the groups from pre to post test evaluation . However post-test value in group-1 shows more improvement as compared to group-2. There was a main effect for time (F=258.021, p=0.000); there was main effect for group (F=4.524, p=0.042). The main effect also qualified for time×group interaction with (f=30.975, p=0.000). Post hoc analysis reveals statistically significant difference at 4 week scores between both the group as well as significant improvement in both groups individually after 4 weeks.



Graph-I.



Graph-II.

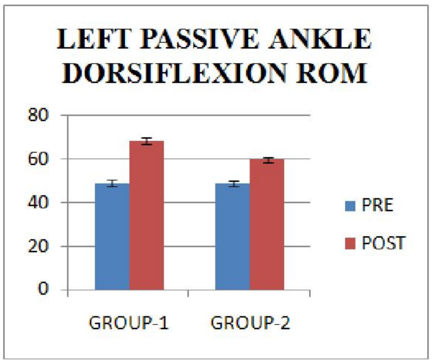
PASSIVE RANGEOF MOTION

LEFT

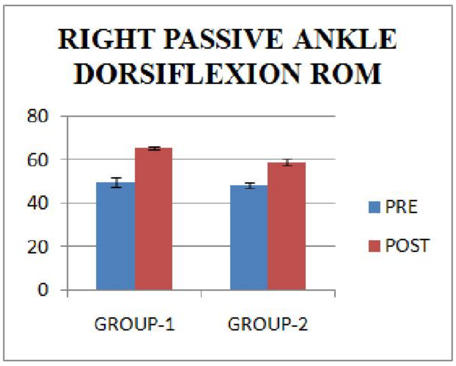
Graph-III shows improvement in active ankle DF range of motion in both the groups from pre to post test evaluation. Post test value in group-1 shows more improvement as compared to group-2. There was a main effect for time (F=477.077, P=0.000); there was main effect for group (F=10.071, P=0.004). The main effect also qualified for time×group interaction (F=46.471, P=0.000). Post hoc analysis reveals statistically significant difference at 4 week scores between both the groups as well as significant improvement in both groups individually after 4 weeks.

RIGHT

Graph-IV shows improvement in active ankle DF range of motion in both the groups from pre to post –test evaluation. Post-test value in group-1 shows more improvement as compared to group-2.



Graph-III



Graph-IV

There was a main effect for time (F=477.077, p=0.000); there was main effect for group (F=4.251, p=0.049). The main effect also qualified for time×group interaction (F=5.291, p=0.029). Post hoc analysis reveals statistically significant difference at 4 week scores between both the groups as well as significant improvement in both groups individually after 4 weeks.

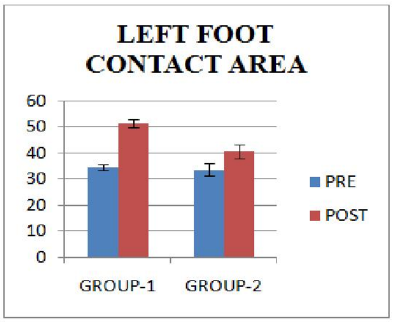
FOOT CONTACT AREA

LEFT

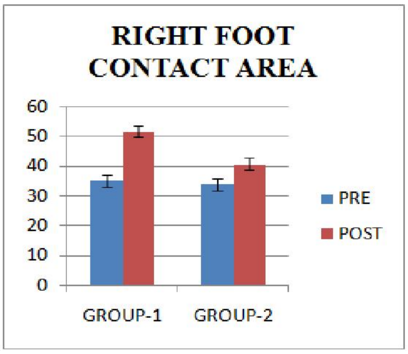
Graph -V shows improvement in foot contact area in both the groups from pre to post test evaluation. Post-test value in group-1 shows more improvement as compared to group-2. There was a main effect for time (F=598.858, p=0.000); there was main effect for group (F=4.342, p=0.046) The main effect also qualified for time×group interaction (F=109.974, P=0.000) .Post hoc analysis reveals statistically significant difference at 4 week scores between both the groups as well as significant improvement in both groups individually after 4 week

RIGHT

Graph-VI shows improvement in foot contact area in both the groups from pre to post test evaluation. However Post-test value in group-1 shows more improvement as compared to group-2. There was a main effect for time (F=581.416, p=0.000); there was main effect for group (F=4.696, p=0.039) The main effect also qualified for time×group interaction with (F=104.927, p=0.000). Post hoc analysis reveals statistically significant difference at 4 week scores between both the groups as well as significant improvement in both groups individually after 4 weeks



Graph-V



Graph-VI

TONE

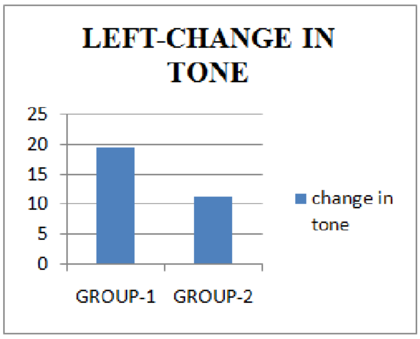
LEFT

Graph-VII illustrates there was change in tone more in group-1 than group-2.

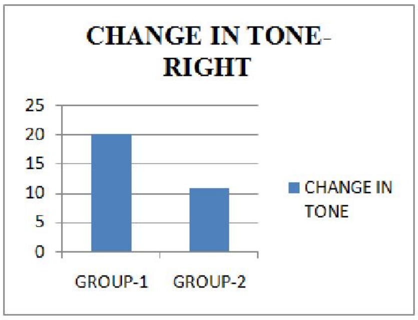
Mann-Whitney U test shown that there was significant difference in change in muscle tone between group-1 and group-2 (Z= -2.950, P=0.003)

RIGHT

Graph-VIII illustrates there was change in tone more in group-1 than group-2. Mann-Whitney U test shown that there was significant difference in change in muscle tone between group-1 and group-2 (Z= -3.287, P=0.001)



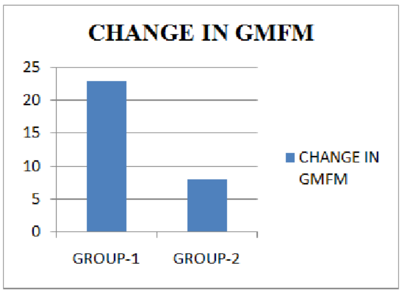
Graph-VII



Graph-VIII

GMFM

Graph-IX illustrates there was change in GMFM more in group-1 than group-2. Mann-Whitney U test shown that there was significant difference in change in GMFM between group-1 and group-2 (Z= - 4.775, p=0.000)



Graph-IX

DISCUSSION

The overall results of this study showed both groups have improved over 4 weeks period ,but the experimental group which was treated with TS stretching device had significantly better improvement than other group that had given manual stretching in active, passive ankle dorsiflexion range and foot contact area. The improvement in tone and gross motor function was also significantly more in the experimental group.

PASSIVE RANGE OF ANKLE DORSIFLEXION

Result shows improvement in passive range of motion in both the groups from pre to post test value and post value in group-1 shows significant improvement as compared to group-2 and same result was obtained for both the lower limbs. Probable causes of improvement in ankle passive dorsiflexion range of motion in both the groups following stretching may be due to (i) stress relaxation (Eadric Bressel *et al*., 2002) ii) change in viscoelastic properties of muscle ii) reduction in muscle stiffness due to fibrosis or change in muscle fibre properties iii) change in active muscle stiffness due to no. of cross bridges attached during contraction or an increase in stiffness per cross bridges (Jared R H Foran *et al*., 2005) (v) stretch induced hypertrophy that occurs at the end of muscle resulting in addition of sarcomeres in series and hence an increase in muscle length and permanent deformation occurs (Patrick G Deyen (2001) (vi) and protein synthesis would have possibly cause an increase in muscle length and thereby increase in passive range of motion (Beaulieu, 1981) and Irion.

Both groups of children were continued with conventional exercises like bridging, sit to stand, squatting to standing, standing and weight shifting. In these type of activities plantar flexors of foot remain in lengthened position and whole exercises were given for about 15 to 20 minutes. So, in addition to stretching, these conventional exercises may have added some effect to improvement in passive range of motion. Donatelli (1981) in a systemic review reported stretching changes viscoelastic properties, increases mobility due to destruction of cross linkage; increase the length of muscle and periarticular connective tissue.

Magnusson (2000) has reported that stress relaxation is one of the factors for increase in range of motion, but this stress relaxation lasts for about 1 hour. Similar change has been suggested by Thamar *et al*. (2008), Halbertsma and Goeken (1996) in their studies. Tanus pin *et al* after reviewing 7 studies suggested that sustained static stretching for longer duration i.e. 30minutes was most preferable to improve range of motion. These studies also mentioned that with short duration stretching the deformation has been found to be short lived and transient.

In the study there occurs more improvement in group-1 children who were given prolong stretching for 15 minute as compared to group-2 children who were given manual stretching for 1minute. The probable cause for it may be with prolong stretching the deformation lasts for long time. After similar repetition for 4 weeks, a lasting stretchability has been achieved. Whereas with short duration stretching there occurs change in flexibility due to increase in stretching tolerance of muscle to stretching rather than change in passive stiffness of muscle.

ACTIVE RANGE OF ANKLE DORSIFLEXION

Result shows improvement in active dorsiflexion ranges of motion following stretching in both the groups and the improvement is significant in both the groups from pre to post test value. Post value in group-1 shows more improvement as compared to group- 2 following stretching in both the lower limbs. With conventional treatment continued by the children like bridging, sit to stand, squatting to standing, standing and weight shifting, the plantar flexors remain in lengthened position as well as foot dorsiflexors get recruited with these activities. This may be responsible for increase in active dorsiflexion range of motion.

Also following stretching, there occurs: i) release of mechanical factor that inhibits active movement of dorsiflexion ii) decreased motor neural excitability of gastrocnemius via inverse stretch reflex. So with decrement of both factors, dorsiflexors of foot might have obtained a dorsiflexion range with less resistance from antagonist muscle; and that might helped in increase in active range of dorsiflexion (Berta Bobath, 2002). With prolong stretching; the deformation lasts for more duration (Magnuson, 2000). Hence prolong stretching has added better increament to increase in dorsiflexion range of motion in conjuction with conventional exercises in group-1 children.

Kuen-Horng Tsai *et al*.(2002) in their study on 17 spastic hemiplegics patients who underwent prolonged muscle stretch of tricep surae by standing with feet dorsiflexed on a tilt table for 30 min. The result indicated that reduced the motor neuron excitability of the tricep surae and significantly increased the activity of tibialis anterior. Clark frank and Robert Lardna (2010) shown that stretching causes reciprocal inhibition and there by causes an increase in range of motion of muscle as well as joint. Ingrid Odeen *et al* (1981) in his study have shown that 30 min of mechanical stretching 2-5 times a day is more effective in reducing spasticity and increase in voluntary range of motion. Another cause may be due to relaxation of calf muscle that resulted in more increase in active dorsiflexion range. Hence the result of increase in range of motion may be due to combined contribution from stretching as well as conventional exercises But group -2 children show less improvement in active dorsiflexion range of motion. The cause for it may be conventional exercises given at Department, short duration stretching

FOOT CONTACT AREA

Study shows foot contact areas in both the groups have been improved from pre to post test value. Post value in group-1 shows more improvement as compared to group-2 on both the limbs. The probable reason of increase in foot contact area in both groups is due to increase in passive range of motion and decrease in tone.

TONE

Study shows change in tone was more in one group-1as compared to group-2 after 4 weeks of stretching. Conventional exercises like weight shifting from 1 foot to other in standing posture,sit to stand,squat to stand with proper alignment of foot and knee and hip (NDT, Kathryn Levit,2002), decreases spasticity in both the groups of children. Reason for decrement of tone can be due to change in neurally mediated reflex stiffness in gastrocnemius and soleus muscle. Muscle possess spindle and golgi tendon organ as the highly sensitive receptors among which golgi tendon act to prevent over stretch. So an increase in tension due to stretching, golgi tendon organ inhibit muscle contraction and induces relaxation. In another way descending influences on monosynaptic reflex between muscle spindle, afferent and alpha motor neuron reduces tone following stretching.

Schimdt etal.have demonstrated that benefit of relatively brief stretch in spasticity management. Hence needs to be applied for more time for a longer period. This is supported by another study that was done using lycra garment that provides a stretch of 3 hours demonstrated that there was reduction of spasticity. Mc Pherson *et al.* (1984)also found same result with his single subject design comprising 4 CP children that with application of stretching and there occurred reduction of tone .Similar findings were also obtained by Micdanar *et al* (1987)and Tremblay *et al.* (1990)with their study on 13 CP and 21 CP children respectively on tricep surae stretching. So while doing conventional exercises due to stretching like bridging, sit to stand, squatting to standing, standing and weight shifting there occurs reduction in spasticity, but this becomes more evident in group-1 children as prolonged stretching, deformation lasts for longer duration.

GROSS MOTOR FUNCTION MEASURE

There occurs increase in Gross Motor Function Measure (dimension-D) following stretching in both groups and more in group-1. For proper posture and balance in upright position in standing, child needs a good trunk. Probably child had acquired this by continuing conventional exercises like push up, short sitting with foot placed over ground and oblique (opposite side) reaching to objects facilitate recruitment of oblique muscles, sit to stand, weight shifting sideways, bridging **.** In addition to conventional exercises, decrease in neural and mechanical factors responsible for hypertonia and increase in base of support area in standing increases gross motor function measure in Dimension-D (standing)

John a sterba *et al*. (2002**)** reported that Horse Back Riding Therapy was given to 17 children 1hour daily for 6 days for 18 weeks and found improvement in dimension (A-E) as well as total score on Gross Motor Function Measure and hypothesised that complex movement of horse influences the rider by passive and active stretching and stimulated rider's balance and postural control. As there is reduction in spasticity and increase in range of motion which contribute to increase walking speed. It can be explained by Bobath (2002) a relationship between spasticity and movement considering muscle weakness due to the opposition of spastic antagonists. This method consists of trying to inhibit increased muscle tone by passive mobilization associated with tactile and proprioceptive stimuli**.** Hence in conjuction to conventional exercises, the additional effect of stretching device on ROM, tone improved function to a greater extent in group-1 than the conventional exercises alone as given in group-2 children

Conclusion

Though conventional exercises have their role, prong static stretching (15minute) has added benefits in decreasing in spasticity, gaining passive and active range of motion and improvement in GMFM as compared to conventional short duration stretching.

CLINICAL UTILIZTION

Mechanical device may be used for prolong stretching musculo tendinous structures to stretch tight muscle that will ultimately save time and energy of therapist

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