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ORIGINAL ARTICLE

Effect of The Close Chain Kinematic Exercises on Lower Limb Spasticity and Postural Control by Modified Tardieu Scale And Trunk Impairment Scale in Post Stroke Patients – An Interventional Study

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ABSTRACT
Stroke or brain attack leads to paralysis (hemiplegia) or weakness (hemiparesis), is seen on the side of the body opposite to the side of the lesion. One of the most commonly encounteredsymptom is increased tone of muscles i.e. spasticity. Thus, prevention and treatment and proper diagnosis of spasticity are the specific goals of treatment of patients with an upper motor neuron lesion. 30 Post-stroke patients according to inclusion criteria were selected and were divided into two groups. Experimental Group: A given close chain kinematic exercises and postural control exercises and Group: B given conventional exercises. MTS & TIS scale for pre and post data were taken. Statistical Analysis was completedby using SPSS Version 20.0 for windows. Paired t-test (intra-group comparison) and unpaired t-test (inter-group comparison) for TIS. Wilcoxon signed rank test (intra-group comparison) and Mann Whitney U test (inter-group comparison) for Modified Tardieu Scale. Pvalues for after intervention for all the parameters were <0.05. Close kinematic chain exercises and postural control exercises were effective in reducing spasticity and improving postural control in post stroke patients.
KEYWORDS:*Stroke, Spasticity, Modified Tardieu Scale, Trunk Impairment Scale, Close Kinematic Chain Exercises, Postural Control Exercises*.

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INTORDUCTION

Stroke is termed as "the sudden loss of neurological function caused by an interruption of the blood flow to the brain [1]."This interruptthe supply of oxygen and essential nutrients to the brain tissue. The WHO has clinically defined stroke as "rapid development of clinical features of focal neurological disturbance lasting more than 24 hours or leading to death with no evident cause other than vascular origin." [2]In India, the prevalence for stroke is lie between 84 – 262 per 100,000 in rural area [3] and between 334 – 424 per 100,000 in urban areas [4]. Stroke is broadly divided in two main categories e.g. ischemic (50-85 %) and hemorrhagic (7-27 %) [5]. Men are more affected than females, the M:F ratio 7:1. [6] Mean age for beginning of stroke for men in India ranges from 63-65 years and for women 57-68 years [7-9].

"Spasticity is a motor disorder identified by a velocity-dependent increase in tonic stretch reflex that result from abnormal intra-spinal processing of primary afferent input" [10]. In post-stroke patients, the prevalence of the spasticity is around 19% after 3 months and 20% after 18 months.

Closed Kinetic Chain Exercise (CKSE) is a movement pattern where the distal aspect of the extremity is fixed to an object that is either stationary or moving. These exercises are particularly weight-bearing exercises. There is a multi-joint movement. There are many prevalent theories that emphasize that CKCE are functional and they docreate a co-contraction; particularly in lower extremity because they closely

simulate the actual movement patterns meet in daily activities [10]. Post stroke patients have to deal with postural control and postural adjustment alterations. Postural control is termed as "The act of maintaining,achieving or restoring a state of balance during any posture or activity."It's the capacity to maintain the body's centre of gravity over the base of support during quiet standing and movement [11]. According to the evidence found close kinematic chain exercises stimulates the proprioceptors, increases the joint stability, increases co-contraction of the agonists and antagonists of the muscles, allow the better application of the SAID principle (particular adaptions to imposed demands) and permit additional functional pattern of movement particularly in because they closely stimulate the actual movement pattern meet in daily activities. As in the post stroke patients spasticity is the major hindrance that leads to alteration of activity and affects the quality of life. Along with the spasticity there is impairment in the postural control (either static or dynamic) in the post stroke patients.So, there is need to know the results of close kinematic chain exercises and postural control exercises on the spasticity and postural control in the post stroke patients. The aim of the study was to investigate the effect of close chain kinematic exercises on lower limb spasticity and postural control in post stroke patients.

MATERIAL AND METHODS

Study setting: Shri KK Sheth Physiotherapy College OPD, Rajkot.
Source of data: In and around Rajkot city.
Study population: Post stroke patients.
Sample size: 30 Post stroke patients.
Sampling method: Purposive sampling for selection of patients simple random sampling for group allocation.
Study duration: 5 days per week for 4 consecutive weeks.
Study design: An interventional study.

INCLUSION CRITERIA:

- Age: Between 40-65 years.
- Willing to participate in the study.
- Gender: Both male and female.
- Subjects having hemiparesis with Brunnstrom recovery stage 2-4 for lower limb.
- Type of stroke: Both ischemic and hemorrhagic type of stroke.
- Ability to understand and follow instructions.
- Berg balance score within 21-40.

EXCLUSION CRITERIA:

- Subjects with visual, or cognitive impairments,History of fracture or surgery causing pain in affected paretic lower limb. (> 6 months)
- Patients on any stimulant or relaxant medicines (including anti-spasticity and anticonvulsants, injections).
- Uncooperative patient and non-consent**.**

METHODOLOGY:

Sample size was calculated using previous article's mean and SD was found to be 15 in each group. Ethical clearance was obtained from Shri KKSheth Physiotherapy College, Rajkot-360001.Total number of 30 post stroke patients were selected for the study. After proper explanation about the purpose and procedure of the study, patient who were found suitable according to inclusion criteria were asked to sign consent form. Selection of patients was done by purposive sampling and group allocation done by simple random sampling.And the patients were divided into two groups. Total 30 patients were divided into two groups; 15 in group a and 15 in group b.

MTS and TIS were measured before and after giving the intervention in both the groups.

CLINICAL INTERVENTION:

GROUP-A (EXPERIMENTAL GROUP)

Close kinematic chain exercises were given which included:

- ✓ Step up and step down exercises
- ✓ Heel rises
- ✓ Toe rises
- ✓ Modified squats
- ✓ Lateral step up

- Postural control exercises included:
  - ✓ Stepping correction forward: In this the therapist stood ahead of the patient with one hand on each shoulder and asked the patient to lean forward until the patients shoulders and hips were in front of

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toes. Once therapist feels the patient's body weight in her hands very suddenly the support has to be released. And patient was allowed to take step forward if needed.

- ✓ Stepping correction backward: In this the therapist stood behind the patient with one hand on each scapula and asked the patient to lean backward until the patients shoulders and hips were in back of toes. Once therapist feels the patient's body weight in her hands very suddenly the support has to be released. And the patient was allowed to take step backward if needed.
- ✓ Stepping correction lateral: In this the therapist stood to the side of the patient with one hand on the side of the patient's pelvis and asked the patient to lean their whole-body weight on therapist hand until the midline of the pelvis is over the right (or left) foot and then suddenly therapist has to let go the hold. And the patient was allowed to take step lateral if needed.
- ✓ Trunk rotation.
- ✓ Reaching in all directions, sitting or standing.
- ✓ Each positions adopted during the exercises were maintained for 10 sec with 10 repetitions of each.

GROUP-B (CONTROL GROUP)

- Conventional therapy was given to the patients which included:

- ✓ Range of motion exercises (active or active assisted exercises) for the upper limb consisting shoulder, elbow, forearm, wrist, and for the lower limb consisting hip, knee, and ankle.
- ✓ Balance training and coordination exercises.
- ✓ Passive or active stretching of tight muscles (hamstrings, calf).
- ✓ Bridging exercises.
- ✓ Strengthening exercises of the weak muscles.
- ✓ Gait training.
- ✓ And the intervention was given for 4 weeks – 5 days in a week.

OUTCOME MEASURURES:

- **MTS:**The patients were evaluated for spasticity using MTS before giving the intervention. In this the evaluation of the following muscles were done: adductors of hip, flexors of knee, plantarflexors of ankle & invertors of foot [12].
- For evaluation of hip adductors spasticity, the patient was asked lied in supine position.Then the hip joint was moved from the leg in midline to maximal abduction. For R2 joint was moved from midline tomaximal abduction with velocity V1 i.e. as slow as possible. Then for R1, patient was given 2 minutes of rest and then the joint was positioned in the angle of catch or clonus with the velocity V2 that is as fast as possible [13].
- For evaluation of flexors of knee spasticity, the patient was asked to lie in supine position with hip in 90 degree of flexion. Then the knee joint was moved from maximal knee flexion till maximal knee extension. For R2 joint was moved from knee flexion to maximal knee extension with velocity V1 i.e. as slow as possible. Then for R1, patient was given 2 minutes of rest and then the joint was positioned in the angle of catch or clonus with velocity V2 that is as fast as possible. [13]
- For evaluation of plantar flexors of ankle spasticity the patient was asked to liein the supineposition along with knee and ankle in the extension. Then ankle joint was moved from the plantar flexion to the maximal ankle dorsiflexion. For R2 joint was moved from plantar flexion to maximal ankle dorsiflexion with velocity V1 i.e. as slow as possible. Then for R1, patient was given 2 minutes of rest and then the joint was positioned in the angle of catch or clonus with velocity V2 that is as fast as possible.[13]
- For evaluation of invertors of foot spasticity the patient was asked to lie in supine position with knee in the extension as shown infig 3.4. Then the foot was moved from dorsiflexion, inversion and supination to the planter flexion, eversion and pronation. For R2 joint was moved from DF, inversion and supination to PF, eversion and pronation with velocity V1 i.e. as slow as possible. Then for R1, patient was given 2 minutes of rest and then joint was positioned in the angle of catch or clonus with V2 that is as fast as possible. [13]
- The patients were evaluated with Trunk impairment scale before giving the intervention.

RESULT

- The statistical analysis done by using SPSS 20.0 version for windows software**.** Microsoft excel was used to calculate mean and Standard Deviation (SD), and to create graphs and tables.Means and Standard Deviation (SD) were evaluated as a measure of central tendency and measure of dispersion respectively.Analysis of pre and postintervention in group a and group b were usingWilcoxen Sign Rank Test for modified tardieu scale (MTS) and paired student's t-test for trunk impairment scale (TIS).
- Between groups comparisons of obtained values of Modified tardieu scale (MTS) were done by using

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Mann Whitney U test while between groups comparison of obtained values of trunk impairment scale (MTS) were done by using unpaired student's t-test.

- Level of significance (p value) was kept as 0.05.

TABLE 1: Inter group analysis of MTS (X Component) for hip adductors

MTS	MEAN+SD	p-VALUE	Z-VALUE	RESULT
Before intervention	0.46+ 0.51	0.217	-1.44	Not Significant
After intervention	0.5+ 0.51			

TABLE 2: Inter group analysis of MTS (Y Component) of hip adductors

MTS	MEAN+SD	p-VALUE	Z-VALUE	RESULT
Before intervention	2.33+ 3.14	0.001	-3.61	Significant
After intervention	0.5+ 0.51			

TABLE 3: Inter group analysis of MTS (X Component) of knee flexors

MTS	MEAN+SD	p-VALUE	Z-VALUE	RESULT
Before intervention	0.5+ 0.51	0.367	-1.07	Not Significant
After intervention	0.5+ 0.51			

TABLE 4: Inter group analysis of MTS (Y Component) of knee flexors

MTS	MEAN+SD	p-VALUE	Z-VALUE	RESULT
Before intervention	1.0+ 3.57	0.003	-3.81	Significant
After intervention	0.5+ 0.51			

TABLE 5: Inter group analysis of MTS (X Component) of ankle plantar flexors

MTS	MEAN+SD	p-VALUE	Z-VALUE	RESULT
Before intervention	0.63+ 0.49	0.367	-1.17	Not Significant
After intervention	0.5+ 0.51			

TABLE 6: Inter group analysis of MTS (Y Component) of ankle plantar flexors

MTS	MEAN+SD	p-VALUE	Z-VALUE	RESULT
Before intervention	3.17+ 3.82	0.004	-3.19	Significant
After intervention	0.5+ 0.51			

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TABLE 7: Inter group analysis of MTS (X Component) of foot invertors

MTS	MEAN+SD	p-VALUE	Z-VALUE	RESULT
Before intervention	0.4+ 0.49	0.683	-0.52	Not Significant
After intervention	0.48+ 0.51			

TABLE 8: Inter group analysis of MTS (Y Component) of foot invertors

MTS	MEAN+SD	p-VALUE	Z-VALUE	RESULT
Before intervention	2.83+ 3.39	0.029	-2.38	Significant
After intervention	0.5+ 0.51			

TABLE 9: TIS for group A & B

TIS	MEAN+SD	p-VALUE	t-VALUE	Df	RESULT
Before intervention	2.53+ 1.06	0.001	4.92	28	Significant
After intervention	0.27+ 1.44				

DISCUSSION

The intention of this research was to find out effect of close chain kinematic exercise on lower limb spasticity and postural control in post stroke patients.

In the present study, between group analysis of modified tardieu scale & trunk impairment scale was done and statistically significant difference was found in between two groups. The result of the study indicates their wasexceedingly significant difference in MTS & TIS in group A which is experimental group when compared with group B which is control group. And when the comparison was done in between the same groups, then group A that is experimental group showed significant improvement in MTS & TIS. While group B that is control group showed no significant improvement in Y component of MTS & TIS, while X component of MTS showed significant improvement.

The result of the present study supported the experimental hypothesis which stated that there is a significant difference after close chain kinematic exercises on lower limb spasticity and postural control in post stroke patients.

Na Kyung Lee et al, muscle activation for the rectus femoris and biceps femoris were significantly increased in the CKC and OKC exercise groups when it was compared with the control group. However, muscle activation of the gastrocnemius and tibialis anterior were significantly increased only in the CKC exercise group when compared with the OKC exercise and control groups [14].

Mi-Kyoung Kim et al, CKC exercises used to activate antagonistic muscle groups across multiple joints and therefore cannot be used to isolate a single muscle group. Examples of CKC exercises consideredpullups, push-ups, lunges and squats. The study found that CKC exercise could be used more than OKC exercise for improving proprioceptive sense. The CKC exercise helps to improve balance in chronic stroke patients, which may result into an improvement in daily performance [15].

Yong Keun Park et al, concluded that the CKCE group and the OKCE group showed a greater increase in improvement of muscle activation and balance ability in comparison to the control group. In particular, CKCE were helpful in improving muscle activation and balance ability [16].

The postural control during static and dynamic conditions needs a complex interaction between musculoskeletal and neural system.[17] Musculoskeletal components consists of biomechanical constraints such as the joint range of motion, limits of stabilitymuscle properties and. Neural components consistsof perceptual sensory & processes, motor processes involved in organizing muscles into neuromuscular synergies & higher level processes essential to plan and perform actions required for postural control.

The mechanism behind significant improvement in the spasticity among the experimental group as compared with control group could be attributed to the effects of closed kinematic chain exercise, which aims that CKC exercise been found as producing better eccentric contraction and co-contraction of

muscles, along with reducing shear forces while adding compressive forces to the joints, thereby increasing joint stability. The movement pattern is characterized by linear stress in the joint. Multiple joint movement occur with recruitment of multiple muscles. Movement patterns are functional creating compressive forces in a joint leading to co-contraction of the muscles surrounding the joint with movement occurring in multiple planes simultaneously; loading of muscles and joints provides normal proprioceptive or kinesthetic feedback. Movement causes compression of the joint surfaces, thereby increasing joint stability, and these exercises are more functional.

CONCLUSION

From the study it can be concluded that close kinematic chain exercise and postural control exercise were effective in decreasing the spasticity and improving postural control in post stroke patients. And this exercise could be administered in the patients with stroke for therapeutic purpose.

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CONFLICT OF INTEREST: N/A

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