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Effect of Core Muscle Stabilization Exercises in Improving Upper Extremity Physical Performance and Trunk Control in Middle Cerebral Artery Stroke

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ABSTRACT

Background: Stroke in middle cerebral artery (MCA), causes impairment of trunk muscles and contralateral upper limb. Impairment of upper extremity (UE) function contributes greatly to functional disability after stroke.
Studies showed that trunk control is correlated to upper extremity physical performance. Strengthening trunk muscles using core stabilisation exercises may have a positive effect on improving upper limb and lower limb function. Nevertheless, there is paucity of literature proving the effect of core stabilisation exercises on upper extremity function in subjects with MCA stroke.
Objectives: To find the effect of core muscle stabilization exercises on upper extremity physical performance and trunk control in subjects with MCA stroke.
Methods: Thirty subjects were divided into two groups with 15 in each. Group A received core muscle stabilization exercises, with conventional therapy while Group B received conventional therapy alone. Duration of treatment was 5 days/week for 6 weeks. Fugl Meyer Assessment for Upper Extremity (FMA-UE) was used to assess upper extremity physical performance and Trunk impairment scale (Verheyden) [(TIS (V)] was used to assess trunk control. Measurements were taken on the first day before the treatment and last day after the treatment.
Results: The statistical analysis was done using Mann Whitney U test and Wilcoxon Signed Rank test. Both the groups showed significant improvement when assessed using FMA- UE and TIS (V). Post-test mean of FMA-UE for group A was 47.20 and Group B was 39.46 whereas, TIS (V) for group A was 14.6 and Group B was 11.4. Group A showed significant changes in FMA- UE and TIS (V) when compared to Group B.
Conclusion: Core muscle stabilization exercises is effective in improving upper extremity physical performance and trunk control in subjects with MCA stroke.

Keywords: Core stabilisation exercise; trunk control; upper extremity physical performance; MCA stroke

INTRODUCTION

Cerebrovascular accident is a common nervous system disorder that occurs due to abnormal blood circulation in the brain with a completely developed nervous system.[1] World Health Organization (WHO) clinically defines stroke as the rapid development of clinical signs and symptoms of a focal neurological disturbance lasting more than 24 hours or leading to death with no apparent cause other than vascular origin.[2] Studies found that upper limb weakness is accounted for 77% and lower limb weakness is accounted 72% in patients.[3] 15 million people suffer stroke worldwide each year.[4] In India the estimated adjusted prevalence rate of stroke range from, 84-262/100,000 in rural and 334-424/100,000 in urban areas.[5] Kerala is becoming the hotspot of lifestyle diseases and the annual incidence rate of stroke is 1.8/1000.[6] Motor deficit is the most common impairment in stroke patients, with weakness of contralateral upper limb, lower limb and trunk musculature.[3,7] After stroke, 67% of survivors are left with impairments in arm function.[8]

Trunk muscles plays an important role in maintaining body upright, adjust weight shifts and perform selective movements which helps in maintaining the base of support during static and dynamic postures.[9] It is evident that there is involvement of trunk post stroke which has been evaluated by isokinetic, isometric and EMG studies.[10,11,12,13] Trunk imbalance in hemi paretic stroke patients results from proprioceptive sense impairments or paralysis of the limb and trunk. [13]

The trunk is thought to play an integral role in postural stabilization by supporting controlled movement of the extremities during task performance.[8,14] The development of trunk stability and control is considered to be a prerequisite to upper extremity function and use of the hand.[15]Trunk control is an early predictor of comprehensive activities of daily living function in stroke patients[16]

Unilateral stroke potentially result in functional deterioration of the trunk muscles on both the contralateral and ipsilateral side of the body.[17] Many stroke patients cannot use their impaired upper limb properly despite long term intensive therapy because damage to the upper limb after stroke is one of the most common and severe side effect of stroke.[18] After stroke, impairments in upper limb function which is associated with reduced health related quality of life.[19] This study is trying to find out the effect of core muscle stabilization exercises in improving upper extremity physical performance and trunk control in MCA stroke.

Core is the biggest part of our body and plays an important role in stabilization and movement of body segment. The core muscle have a great function in stability and mobility of body parts in maintaining posture and assisting the mobility of upper and lower limbs, against gravity, so facilitating function of arms and legs.[20] Strengthening trunk muscles using core stabilization exercises may have a positive effect on improving upper limb function.[21] However, there is no research currently which builds upon these findings to investigate the impact of trunk control on recovery of UE function in people with stroke.[22] Nevertheless, there is paucity of literature proving the effect of core muscle stabilization exercises on upper extremity function in subjects with MCA stroke.

MATERIALS AND METHODS

PARTICIPANTS:

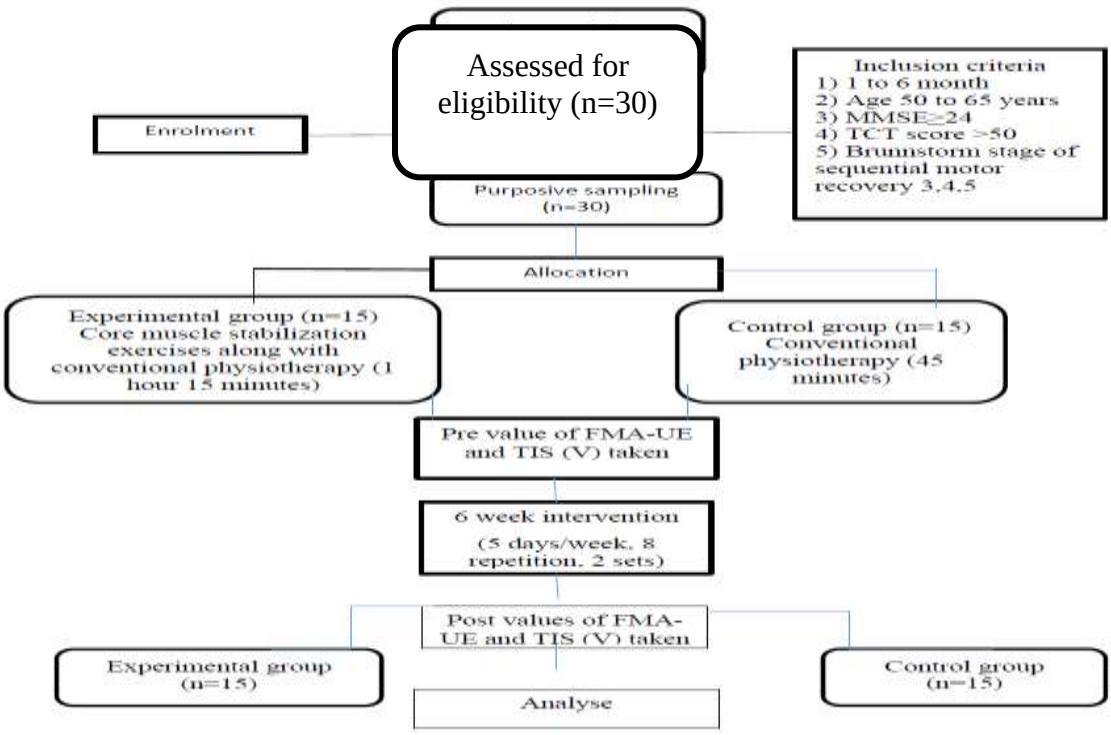
A total of 30 subjects clinically diagnosed with middle cerebral artery stroke, who fulfilled the inclusion criteria were randomly assigned into two groups. Subjects were recruited from Department of Neurology and Physiotherapy, Little Flower Hospital and Research Centre, Angamaly. Ethical clearance was obtained from the Institutional Review Board and Ethical Committee of the institution. 30 subjects who fulfilled the inclusion criteria were randomly assigned into two groups: 15 in

group A and 15 in group B. Written informed consent was obtained from the subjects. Subjects in Group A received core muscle stabilization exercises along with conventional exercises, whereas subjects in Group B received conventional exercises alone. All subjects met the following inclusion criteria: (1) Subjects having MCA stroke with duration of one month to six month (2) Hemiparetic stroke and hemiplegic stroke with Brunnstrom stage of sequential motor recovery include 3,4,5 (3) Mini mental state examination score 24 and above (4) Age group 50-65 years (5) Trunk Control Test (TCT) score above 50. Subjects were excluded with following exclusion criteria: (1) Haemorrhagic stroke (2) Subjects continuing the stage of flaccidity and have hemiplegic shoulder(3) Subject with perceptual deficit, (4) Subject have previous history of stroke and younger onset stroke (5) Neurological problems including multiple sclerosis, degenerative, demyelinating, vestibular, and cerebellar diseases (6) Subjects with autonomic dysfunctions (7) Subject with spinal deformities like scoliosis, kyphosis (8) Orthopaedic problem like recent fracture, arthritis, Intervertebral disc prolapse, Ankylosing spondylosis, (9) Systemic disease such as Systemic lupus erythematosus, Rheumatoid Arthritis (10) Psychiatric and non- co-operative patients (11) Malignancy. Subjects were required to sign a written informed consent document approved by the ethical committee at Little Flower Hospital and Research Centre, Angamaly.

STUDY DESIGN:

This study was an RCT, pre-test –post-test experimental design taking place during study period. After obtaining approval from ethical committee, thirty subjects were randomly allocated into two groups by the investigator who was involved in data collection, treatment implication, and data analysis. Subjects in group A (experimental group) received core muscle stabilization exercises along with conventional physiotherapy, while subjects in group B (control group) received conventional physiotherapy only. Duration of treatment was 5 days/week for 6 weeks.

Fig (1) Consort flow chart



INTERVENTIONS:

	Exercises in supine	**Exercise in sitting**
1 to 2 weeks	Crook lying Lifting the pelvis Rotation of the lower trunk Abdominal hollowing pelvic floor muscle contractions Lifting both scapula head, off the table Rotation of upper trunk [11,12,23,24,25,26]	Short sitting Forward reach with hands grasping together Rotation of the upper trunk with hand cross to the chest Rotation of the lower part of the trunk Shuffling forward and backwards on exercise table[11,12,23,27,28] High sitting Lateral flexion of the trunk initiated from the shoulder Lateral flexion of the trunk initiated from the pelvis[11,12,26,27]
2 to 4 weeks	Supine unilateral bridge Crook lying lift and rotate both knees by grasping a ball between the knees. Upper trunk flexion rotation Crossed extension[11,13,26]	Forward reach Lateral reach Multi directional reach (upward, downward, diagonal) Sit to stand Stand to sit Quadripode position Cat and camel exercises Lift each extremities alternatively [11,13,24,26,29]
4 to 6 weeks (by using physio ball)	Pelvic bridge Unilateral bridge Lower trunk flexion rotation Upper trunk rotation Ball under knees, lift and rotate head and one side of scapula.[26,28,29]	Sitting on physio ball Forward reach (grasp both hand) Multi directional reach Upper trunk lateral flexion Lower trunk lateral flexion Upper trunk rotation Lower trunk rotation by moving the knees side to side Weight shifting Forward reach with grabbing object by height of shoulder Lateral reach with grabbing an object. Sit to stand and stand to sitting.[24,27,28,29]
Conventional treatment	ROM exercises Spasticity management Functional re-education Scapular stabilization exercises Postural control exercises Balance and gait training.[30,31]	

RESULTS

Data was analysed using the SPSS 17.0. Normality of data was established using Shapiro-Wilk test for the baseline values of Trunk Impairment Scale Verheyden (TIS (V) and Fugl-Meyer Assessment of upper extremity Physical Performance (FMA-UE). The corresponding *p*-value of less than 0.05 was considered to significant for each outcome.

Data collected from subjects were analysed using non parametric test such as Wilcoxon Signed Rank Test and Mann-Whitney U Test for TIS (V) and FMA-UE. Mann Whitney U test is used to analyse between group comparisons. Wilcoxon Signed Rank test was applied on the pre- test and post-test value difference of the same group.

Table 1: Demographic presentation of age

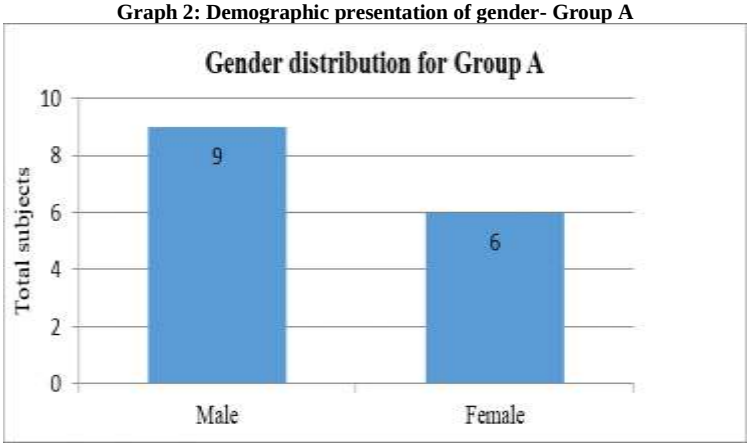
Group	**Mean age**	**SD**
A	58.67	±3.79
B	59.60	±3.46

Graph 1: Demographic representation of age

Table 2: Demographic presentation of gender

SL. NO.	GROUP A		GROUP B	
	M	F	M	F
	9	6	10	5

Graph 2: Demographic presentation of gender- Group A



Graph 3: Demographic presentation of gender- Group B

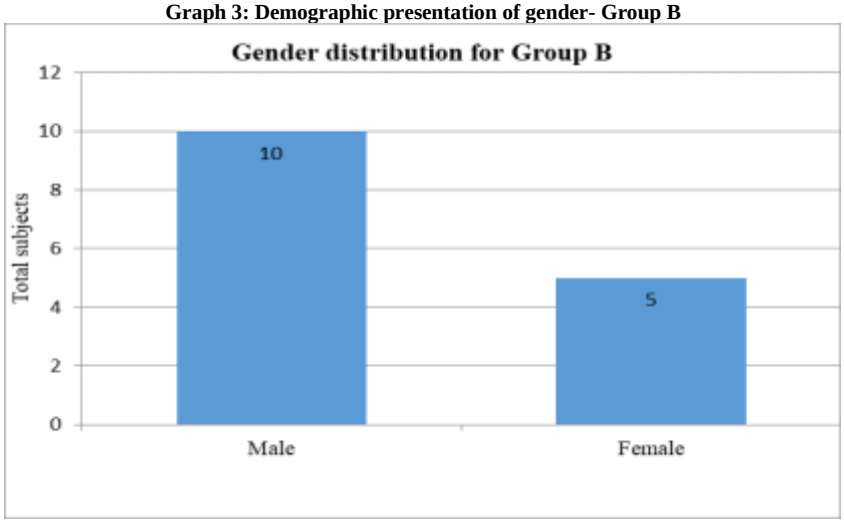
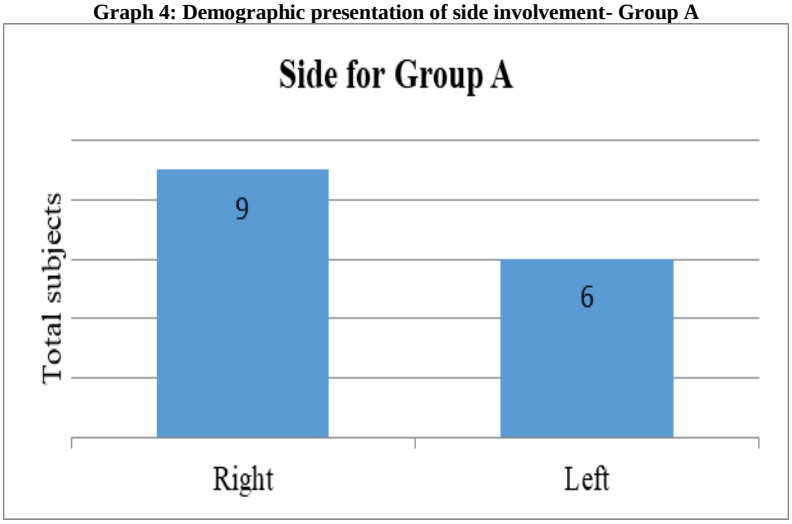


Table 3: Demographic presentation of side involvement

Group A		Group B	
R	L	R	L
9	6	10	5

Graph 4: Demographic presentation of side involvement- Group A



Graph 5: Demographic presentation of side involvement- Group B

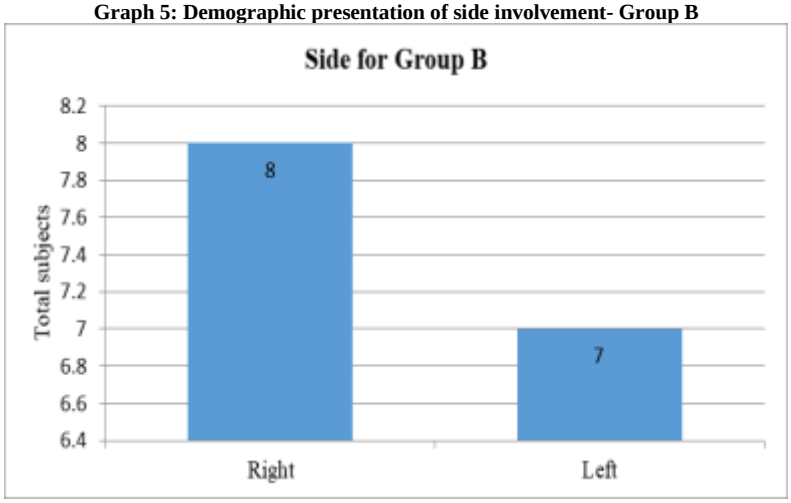
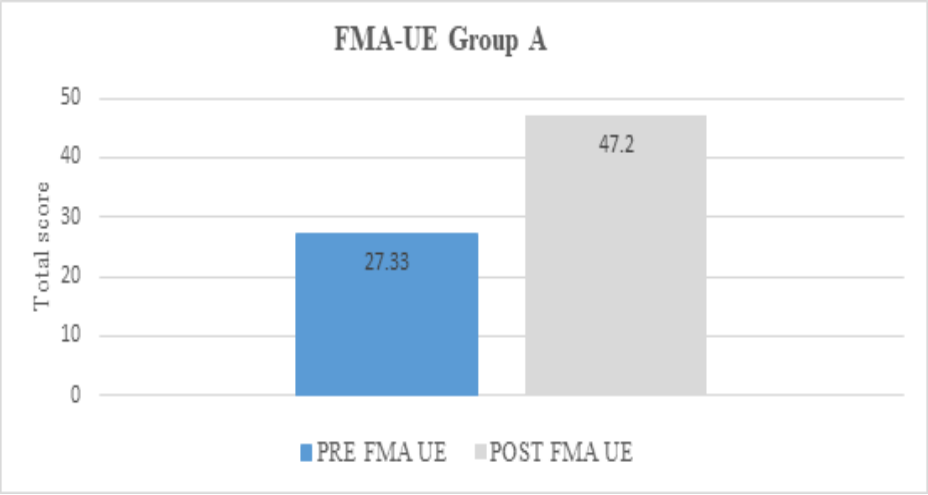


Table 4: Mean of FMA-UE

Group	FMA-UE Mean values			
	Pre test value	SD	Post test value	SD
Group A	27.33	±8.43	47.20	±10.17
Group B	26.46	±9.54	39.46	±9.32

Graph 6: Mean of FMA-UE in Group A



Graph 7: Mean of FMA-UE in Group B

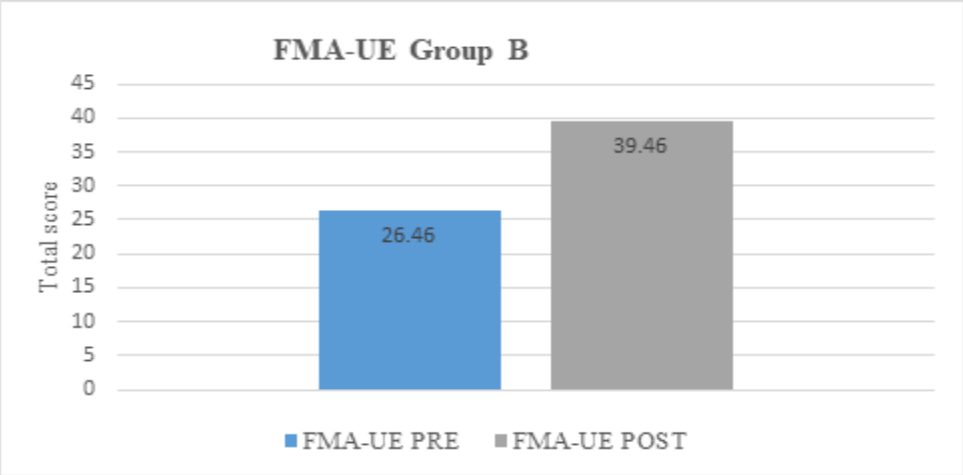


Table 5: Statistical results - FMA-UE

FMA-UE	Pre test score	Mann Whitney U value	Post test score	Mann Whitney U value	Wilcoxon signed rank test's T value
Group A	27.33	103	47.20	60.5	0
Group B	26.46		39.46		0

Graph 8: FMA-UE using Mann Whitney U Test

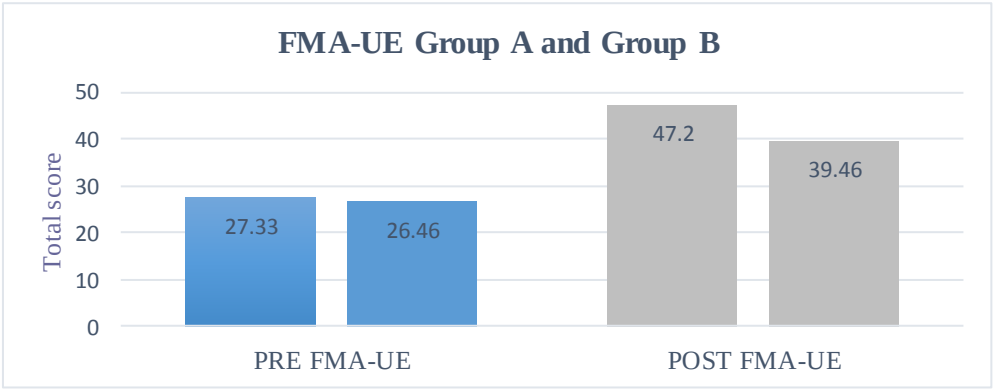
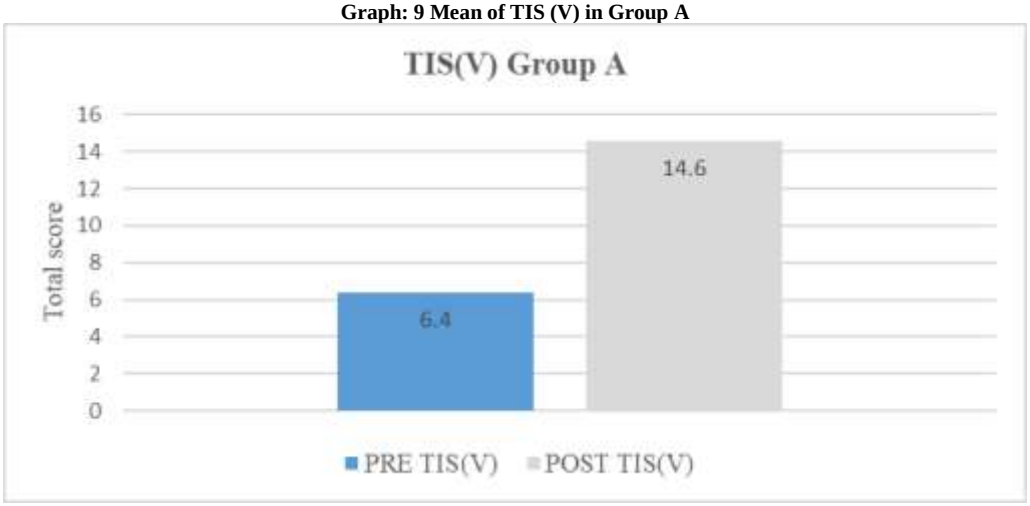


Table: 6 Mean of TIS (V)

Group	TIS (V) Mean Values			
	Pre test value	SD	Post test value	SD
Group A	6.4	±2.64	14.6	±3.83
Group B	6.53	±2.87	11.4	±3.77

Graph: 9 Mean of TIS (V) in Group A



Graph 10: Mean of TIS (V) in Group B

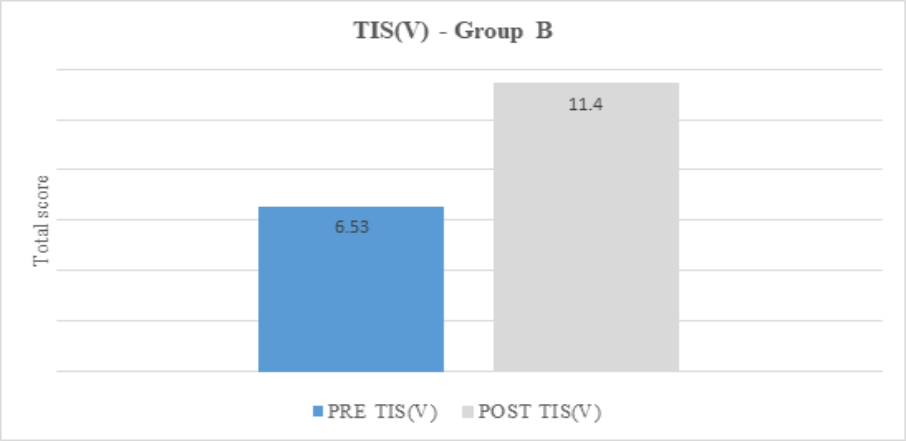
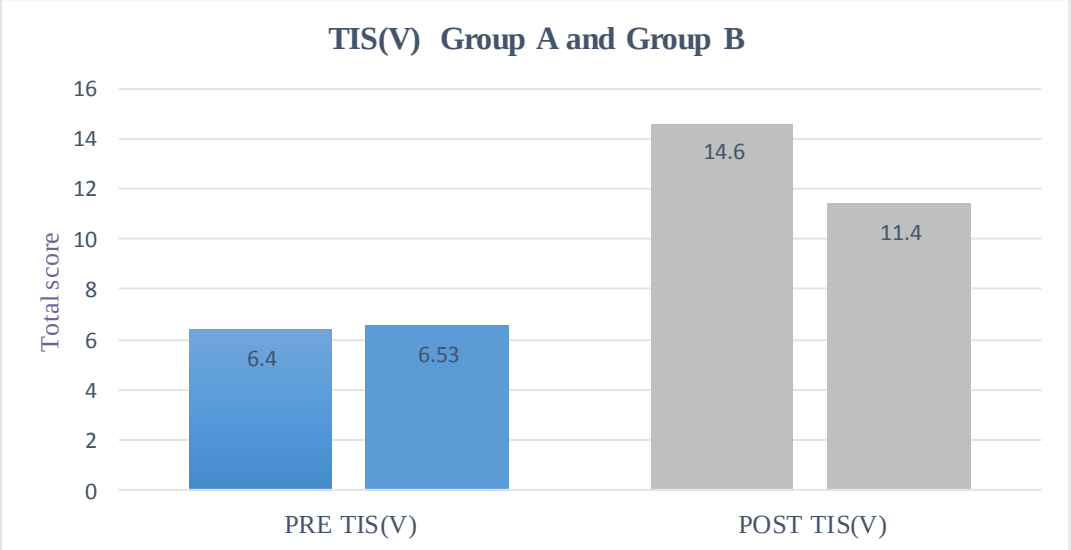


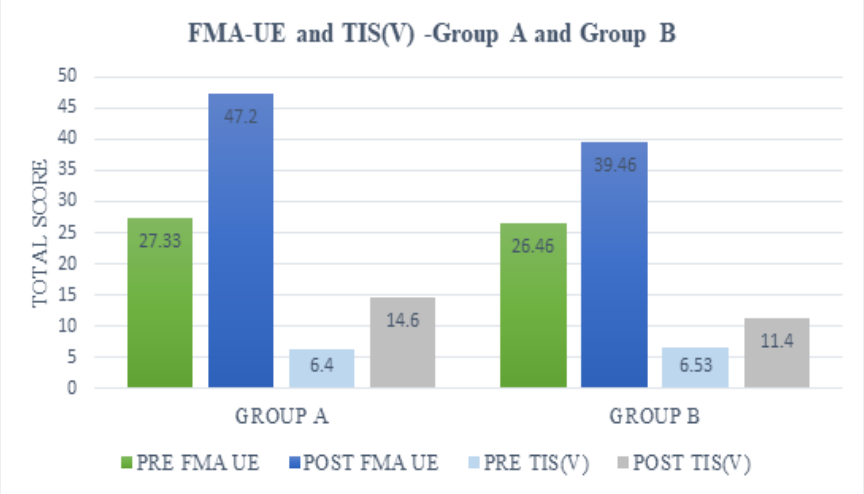
Table 7: Statistical result - TIS (V)

TIS (v) score	Pre test score	U value	Post test score	U value	Wilcoxon Signed Rank test's T value
Group A	6.4	111.5	14.6	58	0
Group B	6.53		11.4		0

Graph 11: TIS (V) using Mann Whitney U test



Graph 12: FMA-UE and TIS (V) Group A and Group B



The purpose of the study was to find out the effect of core muscle stabilization exercises in improving upper extremity physical performance and trunk control in subjects with MCA stroke along with conventional therapy on subjects with MCA stroke.

Pre and post- test scores of each group were analysed using Wilcoxon Signed Rank Test and pre- tests scores of both the groups and post test scores of both the groups were analysed using Mann Whitney U Test.

On statistical analysis of FMA-UE and TIS (V) using Wilcoxon Signed Ranks Test showed significant difference in the pre-test and post test scores of both groups.

On statistical analysis of FMA-UE and TIS (V) using Mann-Whitney U test showed significant difference in post test scores of Group A over the Group B. In the pre-test scores, calculated value was greater than table value so there proved no significant differences between two groups. In post test scores as the calculated value was less than table value, there proved significant differences between two groups since $p<0.05$.

DISCUSSION

30 diagnosed cases of MCA stroke within the duration of 1-6 months who met the inclusion criteria were divided into two groups of 15 each, Group A and Group B. Informed consent were obtained from all patients. Group A received core muscle stabilization exercises along with conventional therapy whereas Group B received conventional therapy. The age of subjects was almost identical in both groups (mean age of Group A were 58.67 years and Group B were 59.6 years). The duration of condition was 1 to 6 month after onset. 9 males and 6 females were in Group A and 10 males and 5 females were in Group B. FMA-UE and TIS (V) were assessed on the first day before and last day after the treatment. It has been shown to be valid and reliable tool of measurement. Group A was given core stabilization exercises along with conventional therapy. The Group B received ROM exercises, stretching exercises, spasticity management, posture, balance and gait training.

The results projected a significant improvement in upper extremity physical performance and trunk control in both groups. Even though both group showed improvement, Group A showed more improvement in FMA-UE and TIS (V) than group B. It indicates that core muscle stabilization exercises along with conventional physiotherapy is effective to improve upper extremity physical performance and trunk control in subjects with MCA stroke.

According to Shankar *et al* (2011) core muscle stabilization exercises improve strength, endurance, proprioception and flexibility of trunk muscles.[32] A stable trunk provides a solid foundation for the torque generated by extremities and the core region functions as a muscular corset where forces are generated and transferred to the extremities.[33] Studies proved, trunk muscles are activated before movements of upper extremities and movement of upper extremities are associated with trunk muscles activity.[33,34] Thus we can infer that, the strengthening of core may helped in improving strength and endurance of trunk muscles and thus more efficient and effective transfer of energy or forces to the extremities may have happened and this can be one of the contributing factor for the improvement of trunk balance and upper extremity physical performance.

Sequenced physiologic muscle activation in the upper and lower extremity result in an integrated biomechanical task. This sequencing is known as kinetic chain. Kibler W.B *et al* (2012) stated that, in order for the task to be effective and efficient, the kinetic chain that links the different segments of the body must have optimal amounts of muscles flexibility, strength, proprioception, and endurance. Core drives kinetic chain function.[35] To promote a properly functioning kinetic chain system, a properly functioning core musculature has been advocated.[35,36] Researchers proved that core exercises elevate trunk stability to

facilitate skilled motor behaviour of the upper extremities.[37] Efficient functioning of core muscles after the core stabilisation exercises may helped in proper functioning of kinetic chain and this could be the contributing factor in improving upper extremity physical performance.

During upper extremity dominant task, the energy development and output follows a proximal to distal sequencing.[35] According to Yuki Miyaki, (2016) trunk stability has an effect on the stability of the shoulders which in turn, improves the movement of the elbows, wrist and fingers.[38] Improved shoulder stability as a result of increased trunk stability can be the another reason for improvement in upper extremity physical performance.

Thus we can conclude that effect of core muscle stabilization exercises have an important role in improving upper extremity physical performance and trunk control in subjects with MCA stroke.

CONCLUSION

The study primarily tried to analyse the effect of core muscle stabilization exercises in improving upper extremity physical performance and trunk control in subjects with MCA stroke. Statistical analysis of data collected recommends that core muscle stabilization exercises along with conventional therapy have significant effect on upper extremity physical performance and trunk control in subjects with MCA stroke than conventional therapy alone.

Hence the study reveals that addition of core muscle stabilization exercises to conventional therapy enhances faster recovery in subjects with MCA stroke. Hence we concluded that core muscle stabilization exercises along with conventional therapy is effective in improving upper extremity physical performance and trunk control in subjects with MCA stroke.

List Of Abbreviation Used

FMA-UE - Fugl Meyer Assessment of Upper Extremity
MCA - Middle Cerebral Artery
MMSE -Mini Mental State Examination
ROM -Range of Motion
TCT - Trunk control test
TIS (V) - Trunk Impairment Scale (Verheyden)
UE -Upper Extremity

Author's Contributions: The author's confirm contribution to the paper as follows: study conception and design: Seenu Mathew and Remya N. Data Collection: Seenu Mathew; Analysis and Interpretation; Manju Unnikrishnan, Chinchu Alwin and Rejimol Jos Pulicken; Draft manuscript: Seenu Mathew, Remya N, Reethu Elsa Baby. All the authors reviewed the results and approved the final version of the manuscript.

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Ethical Approval: Approved

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