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Effectiveness Of Modified Planks on Trunk Stability in Post-Stroke Hemiplegic Patients: A Randomized Control Trial.

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ABSTRACT-

Introduction- Stroke patients who are treated in their early stages of recovery have better chances of achieving maximum optimal functioning of their body. It is also important to continue the protocol in progression according to patient's stage of recovery. A plank is a type of isometric core exercise which is not regularly used in Out-Patient department (OPD) protocol of stroke patient's rehabilitation. But planks have effect in strengthening core muscles, which will ultimately improve trunk control helping stroke patients to achieve their goals. These planks can be modified according to ability of stroke patient for their trunk control.

Aim- To discover effect of modified Planks exercises on trunk stability in post-stroke hemiplegic patients.

Methods & materials- 20 consenting stroke patients with Brunnstrom recovery stage 4 and above were included according to inclusion criteria. They were evaluated on outcome measure -Trunk Impairment Scale (TIS) and Timed Up and Go test (TUG). 1 week of exercise interventional program was followed by them.

Results- About 20% of the participants were in Brunnstrom recovery stage 6. The average TIS score post the intervention was 19 and 15 in experimental and control group respectively. P value (0.0002 & <0.0001) of TIS & TUG scores is statistically significant in experimental group.

Conclusion- Modified planks seemed to be significantly productive in enhancing trunk stability in hemiplegic patients with Brunnstrom recovery stage 4 and above. In comparison with control group, experimental group has significant improvement in trunk stability, according to TIS and TUG scores.

Keywords- *Modified Planks, Post-stroke hemiplegic patients, Trunk stability.*

1. INTRODUCTION

Cerebrovascular syndrome (CVA) is a clinical syndrome distinguished by developing signs of focal or global distress of cerebral functions, continuing for more than 24 hours or resulting in death, without obvious causes other than vascular reasons like, hemorrhage, ischemia, thrombosis, etc.[1] Certain common and known risk factors are responsible for this condition to occur which includes, high blood pressure, smoking, presence of comorbidities and heart diseases, sedentary lifestyle and use oral-contraceptives. When the blood flow to the brain is restricted, it is obviously fatal but when precautionary measures are taken in-time person can be saved from death. Provided the blood flow stagnation for even a little time it causes neurological derangements. This leads to muscle weakness, which limits in the motor recovery after stroke. In hemiplegia, refers to paralysis of one side of the body due to brain damage where trunk on the other hand is involved bilaterally in hemiplegic stroke patients [1]. The core or trunk happens to be the part that provides mechanical

stabilization to a human body which also contributes to the prime change in motion of body parts or segments during balancing. This contributes in strength transmission between the upper as well as lower part of the body. Trunk muscles have potential to sustain an upright attitude of body, also adjusting weight shifts as well as performing selective movements of trunk and upper as well as lower limbs during static and dynamic postural adjustments with maintenance of required base of support (BOS), which is happen to be called as body control. Good body control means superior trunk or optimum body and core control that results in better mobility, balance and performance.

Trunk impairments are common in stroke patients which are identified by a poor posture, diminished sitting balance, muscle strength and trunk coordination. Bilateral impairment in stroke i.e., damage on both sides of the trunk, result in reduced activities between the paralyzed and non-paralyzed muscles of the body and the synchronization of the body or core musculature is also reduced or weakened. This means that even if hemiplegia affects activity of unilateral limb, it has ability to decline the function of trunk and core bilaterally, which ultimately affects the control of proximal body segments. The lack of proximal stabilization has a significant effect on the movable limbs in the joint structure which influences the limbs to be moved only in spastic synergy patterns.[2] Majority of patients having hemiplegia therefore face challenges in handling their trunk part during postural adjustments. The body's trunk helps us to maintain posture in opposition of gravity, so when trunk is affected in stroke patients, balance is impaired. The trunk also facilitates central movement, allowing our body to adapt to new positions and posture [3] and adapt to any given postural adjustments. The transversus abdominis and multifidus muscle reciprocally contracts upgrading the stability during static and dynamic motions of the spine. The abdominal muscles, multifidus, transversus abdominis, and obliques provide stability and control of the spine when rotating the trunk or core and lifting weights. Considering the short length of these muscles, the response time is very brisk which is vital for preserving balance and body stability. [4,5]

Impairment of trunk muscles after stroke will automatically limit activities of daily living (ADL). Sitting up straight, walking without losing balancing, all such ADLs require trunk control and mobility.[6] Physiotherapy involving trunk training improves body control, sitting and standing, and mobility of trunk in stroke patients. It is important to achieve trunk control as early as possible to be able to perform all required ADLs and core muscle functions. In this context, Physicians and Physiotherapists plays an important role in designing treatment approaches in the early-stage recovery and rehabilitation of stroke patients. Physiotherapy, an important factor of rehabilitation and recovery of stroke patients, has shown to impact positively and significantly on end result of outcomes. [7] Stroke patient who has been receiving Physiotherapy treatment in its early stages will be having better chances of improving to its maximum capacity. A Physiotherapy session to a typical stroke patient has recommended to receive minimum of 45 minutes of rehabilitative exercises and programmed protocol, five days in a week.[8] Although, this is hard to anticipate uninterrupted and make easily available for patients in continuity [9-11] also stroke survivors face troubles in receiving rehabilitation facilities and resources after the discharge.[9,12-15] Hence it is crucial and inevitable as well to treat patients in continuity and in early stage to attain desirable maximum effects of therapy. In addition to rehabilitation of extremities, trunk stability and strength along with good core control is equally important to achieve at the earliest of recovery stages.

This study aims at finding effect of a modified isometric core hold (plank) on impaired trunk stability of stroke patients who has achieved Brunnstrom recovery stage 4 and above. Where spasticity starts to decline and voluntary control begins to improve, allowing more isolated movements in the end of recovery stage. There are multiple approaches, methods, scales and devices to evaluate functional activity of trunk and its performance. The stroke impairment assessment set-trunk control subscale, the motor assessment scale- trunk subscale, trunk control test, trunk impairment scale (TIS) are some of the most used and common scales. [16] TIS has been used in this study for assessing trunk impairment.

The plank also called as hover, or abdominal bridge, prone bridge plank. This exercise helps in core muscle strengthening. The muscle activity in planks is associated with the posture of the exercise and location of the muscle. Plank exercises can also be used in general therapy and medical care also, individuals who face trouble in performing the traditional plank, can start with the modified planks. [17,18] Improving body's posture, planks also help in strengthening the core muscles effectively improving body's posture, planks also help in strengthening the core by challenging it. [19,20] All the dimensions of trunk will be active while performing planks and therefore has given positive results in minimizing trunk impairment. This study aims in evaluating trunk control by plank in hemiplegic patients. Hypothesis of this study is that modified isometric plank holds significantly improve trunk stability and postural control in stroke patients compared to conventional physiotherapy alone. No previous studies includes planks in trunk control rehabilitation hence this study can impact on protocol of hemiplegic patients for better trunk improvement.

2. METHODS AND MATERIALS

Ethical committee of the institute has approved this randomized control trial study. With the help of biostatistics department of institute, sample size (n=10) was calculated with respect to parent article. Patients coming to Neuro physiotherapy OPD of physiotherapy college of the institute were screened.

20 willingly consenting subjects both men and women, fulfilling the inclusion criteria were included.

Inclusion criteria- 45 to 65 years' age group, Stroke patients with Brunnstrom recovery stage 4 and above. Both male and female stroke patients. Ability to walk independently without assistive device. Patients with score 7 static sitting balance in TIS.

Exclusion criteria- Stroke patients below Brunnstrom recovery stage 4. Any neurological deficits other than stroke.

Out of all participants, 45% participants were coming regularly to OPD while 35% were follow up patients, 20% had home protocol and so were called to OPD for exercise intervention of this study. All 20 participants willingly consented and participated in the study. Participants were randomly divided by chit method into 2 groups: Group I- Experimental group (EG) and Group II- Control group (CG) using a computer-generated random sequence and sealed-envelope allocation. Baseline characteristics including age, gender, affected side, stroke duration, and baseline TIS and TUG scores hemiplegic side as well as Brunnstrom recovery stage, were assessed. Outcomes measure like Trunk impairment scale (TIS) score and Timed Up and Go test (TUG) were evaluated. Both the outcome measures were measured before and after the 1 week of exercise intervention protocol. TIS is considered for evaluation of trunk instability, TUG is considered for evaluation of mobility and balance impairments. Control group (n=10) participants were asked to follow their usual OPD based rehabilitation protocol only, while Experimental group (n=10) participants followed designated protocol of this project along with their usual treatment protocol. Participants had to follow a set protocol with respective duration of modified plank hold, twice a day, for 1 week. There were no dropouts as modified planks were performed daily under physiotherapist's supervision along with their current OPD protocol. Following table presents the exercise protocol of both the groups with duration of plank hold-

Conventional treatment includes Bed mobility exercises, ADL and hand training, reach outs in sitting unsupported, quadripod and gait training.

Table 1: Experimental group- Modified plank treatment protocol

DAY 1	DAY 2	DAY 3	DAY 4	DAY 5	DAY 6	DAY 7
10 seconds hold	15 seconds hold	20 seconds hold	25 seconds hold	30 seconds hold	35 seconds hold	40 seconds hold

Modification of simple traditional elbow plank is necessary when stroke patients with hemiplegia would face difficulties in performing with affected extremity. Participants of our study were able to do knee planks with lesser amount of effort and difficulty than simple elbow planks. The modified plank involved supporting on forearms and knees with neutral spine alignment, holding for durations starting at 10 seconds and increasing by 5 seconds daily (10s to 40s). Ease in performance of participants was certainly important considering their ability and strength of hemiplegic or affected side. All the participants in experimental group did knee planks with minimum struggle, hence knee planks were considered as modified planks in case of experimental group of this study. Each patient was assessed before the initiation of the protocol, their outcome measures were taken, participants of experimental group were given the task to perform the modified planks (with designated time period of plank hold) before and after the end of their OPD protocol. This was followed in all 10 participants of experimental protocol for the next 7 days. At the end of interventional period (after 7 days), outcome measures were taken and patient was informed about their progress and asked to continue this protocol if they wish for. On the other hand, participants of control group were asked to follow their usual OPD protocol and exercises. They too were assessed pre and post the interventional period of this project.

3. STATISTICAL ANALYSIS

Statistical analysis was done post the intervention by using paired t-test. Values were obtained by data input in Instat software. Analysis of the data has been done according to P value which is considered significant when results in $P < 0.05$. The P values which are not significant are mentioned as NS in the following results section.

4. RESULTS

Table 2: Demographic data

Parameters	Mean ± SD	
	Experimental group	**Control group**
Age	52.2 ± 12.42	48.7 ± 9.01
Brunnstrom stage	5 ± 0.81	4.6 ± 0.7

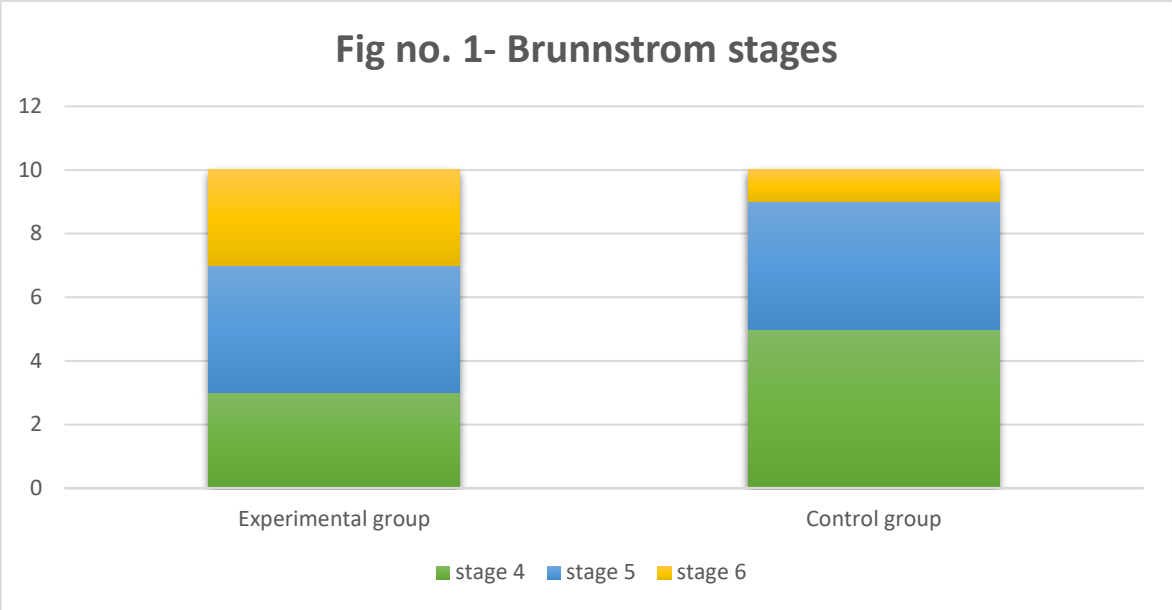

Figure 1: Brunnstrom stages

Table 3: Analysis of Experimental group using unpaired t-test (n=10)

Parameters		Mean ± SD	P value	t value
TIS scores	Pre	15.7 ± 1.33	0.0002	4.629
	Post	19 ± 1.82		
TUG score (sec)	Pre	37.65 ± 3.53	<0.0001	21.404
	Post	33.64 ± 4.97		

Table 4: Analysis of Control group using unpaired t-test (n=10)

Parameters		Mean ± SD	P value	t value
TIS scores	Pre	14.5 ± 0.97	0.0643 NS	1.971
	Post	15.4 ± 1.07		
TUG score (sec)	Pre	41.42 ± 7.80	0.6076 NS	0.5227
	Post	39.69 ± 6.98		

Table 5: Comparison of both the groups

Comparison		Mean difference	P value	95% CI-From	To
TIS score	Pre-EG vs pre-CG	1.20	P>0.05 NS	-4.942	7.342
	Post-EG vs post-CG	3.60	P<0.001	-2.542	9.742
TUG (sec)	Pre-EG vs pre-CG	-3.770	P>0.05 NS	-9.914	2.370
	Post-EG vs post-CG	-6.050	P>0.05 NS	-12.184	0.1003

Demographic characteristics of all participants (n=20) are shown in Table no. 2 and figure no. 1. Brunnstrom stages of all participants were the same pre and post the exercise intervention. No. of Participants with stage 4, 5 & 6 in experimental group are 3,4 & 3 respectively, while in control group it is 5,4 & 1 respectively. About 80% participants were of

Brunnstrom recovery stage 4 as well as 5 (n=8) equal in both the groups, remaining 20% participants (n=4) were of stage 6 of Brunnstrom recovery. In this study, youngest participant being 29 years old and oldest being 74 years old. The mean age is 50. Gender distribution is same in both the groups, 2 females and 8 males in experimental as well as control group.

Analysing pre and post values of TIS and TUG scores in experimental group and control group (Table no. 3 & 4) gives significant P value of TIS & TUG scores in experimental group, while in control group P values of both the outcome measures are not significant but shows difference in mean and SD values as some form of improvement has occurred during the period. On comparison of only the post intervention period mean and SD values of both the groups, P values were found significant (<0.0001) in TIS as well as TUG scores. This shows that there is significant result of performing 1 week of modified planks on trunk stability in hemiplegic stroke patients. Hence, this exercise can be used in improving trunk control. Improvement in TIS score was seen 100% in experimental group and 70% in control group. Almost all the participants (19) achieved lesser time (seconds) of TUG in comparison to pre values of the parameter. By analysing the data in age variable, it has determined that the youngest participant achieved the highest TIS score while 2 participants in each group were in older age group (above 60 years). Among those, results showed average improvement in TIS score of experimental group participants compared to participants of control group. There was no such a significant variation in analysis of data in sex variable. Both men and women showed variable improvement.

Table no. 5 gives information comparing mean difference values of TIS and TUG score of both Experimental group (EG) as well as Control group (CG) with 95% of confidence interval.

5. DISCUSSION

Based on a systemic review, the TIS is the most widely used assessment tool to evaluate trunk impairment. It is also the most versioned tool: TIS by Verheyden,[21] Fujiwara TIS, [22] Verheyden and Kerten's TIS 2.0,[23] and TIS-modNV by Gjelsvik [24] . This suggests that TIS is most studied and one of the first scales proposed. TIS is considered to be used in clinical because for many years it has been the most effective in indicating psychometric credibility over the years and it also has been acknowledged in several editions by various authors. [25] It also estimates the motor dysfunction of the trunk through the assessment of both static and dynamic coordination as well as balance tasks. [26]

Planks as a form of exercise to improve trunk control and stability among stroke patients in out-patient rehabilitation setting is not usual, but its isometric effect on core muscle activity is worth to focus on. Effect of such isometric core exercise has been achieved in this randomised control trial.

A previous study selected abdominal muscles like rectus abdominis, erector spinae, and external & internal obliques to assess changes in the muscle activities examined before and after the exercise, and the experimental group revealed notable differences in the activity of core muscle (P<0.05). Their findings suggested that activation of core muscles in patients with Cerebrovascular accident (CVA) -induced hemiplegia is produced by a 4-week core stability-improving exercise program. Mean and SD values of TIS score were 10.86 ± 2.67 in pre-test and 14.86 ± 1.77 in post-test evaluation of experimental group (n=10). [27] Our study involved 1 week of exercise intervention period and showed greater value of mean and SD of TIS scores in pre and post-test evaluation (Table no. 3). A study included trunk stabilization exercises for evaluating lumbar muscle activity and balance in hemiplegia gave, 26.41 ± 9.69 and 17.31 ± 7.98 as mean and SD of TUG score (P<0.001) of pre and post-test evaluation respectively. [28] Our study also evaluated trunk control and balance in terms of TUG scores with higher values of mean and SD with P<0.0001, which is considered extremely significant (Table no. 3).

One study stated that result of trunk stability training on abdominal muscles thickness showed significant change ($p < 0.05$) in the experimental group post the intervention. The balance and gait measures like, Functional Reach Test (FRT), TUG, Berg Balance Scale (BBS), and 10-meter walk test (10MWT), showed significant improvement post the intervention ($p < 0.05$).[29] Another systematic review and meta-analysis study expressed that effect of trunk training was more in trunk control parameter with 1.08 standardized mean difference (SMD), 0.84 SMD in standing balance and then in mobility SMD was 0.88.[30] Our study stated that post the intervention TIS score SMD is 3.60 with P<0.001 (Table no. 5).

The limitations of this study were, less sample size, variable OPD based treatment protocol of each participant according to his/her stage of recovery and progression, and short duration of intervention. Sample size can be more for studying effects on larger scale, also patients can be administered same conventional protocol with same Brunnstrom stage of recovery to reduce bias. Future studies on effect of this exercise in stroke patients with same OPD protocol, same stage of recovery could be done with longer study duration of 2-3 weeks.

6. CONCLUSION

According to the authors, this is the only study to derive clinical benefits of modified planks on trunk stability in hemiplegic patients. Statistical analysis done post the exercise intervention suggests that modified planks are considered effective in improving trunk stability, trunk control and balance as per TIS and TUG scores. Clinically as well as statistically modified planks are effective for post-stroke hemiplegic patients with Brunnstrom recovery stage 4 and above. Thus, effective planks exercise programs must be developed and included in OPD protocol to improve the stability and function of the core muscles in early trunk rehabilitation of hemiplegic patients.

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Conflicts of interest

There were no conflicts of interest

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Abbreviations-
OPD- Out-Patient Department
TIS- Trunk Impairment Scale
TUG- Timed Up and Go Test
BOS- Base of Support
ADL- Activities of Daily Living
EG- Experimental Group
CG- Control Group
NS- Not Significant
SD- Standard Deviation
CVA- Cerebrovascular Accident
FRT- Functional React Test
BBS- Berg Balance Scale
10MWT- 10 Minute Walk Test
SMD- Standardized Mean Differences