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Effect of yoga on static surface with visual feedback on balance in patients with chronic stroke: A randomized clinical trial

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Abstract
Introduction: Stroke causes chronic disability leading to frequent falls, balance impairment and poor quality of life. The complexity of balance control and the individual's need to be independent in functions with confidence required to study the effects of other approaches in addition to the conventional rehabilitation for enhancing the balance after stroke.
Objective: To compare post treatment balance between conventional treatment group and yoga therapy on static surface with visual feedback in addition to conventional treatment and to assess pre and post treatment balance in both the groups using BBS, TIS, PASS and TUG.
Method: 60 post-stroke hemiplegic subjects were assigned into two groups randoml, 30 in each group. The primary outcome data was collected pre intervention, after 4 weeks and after 8 weeks.
Results: All subjects had statistically significant increase in BBS score and reduced TUG score post intervention.
Conclusion: The results suggest that yoga may be beneficial to post-stroke hemi paretic patient.

Keywords: Stroke, balance, Yoga, visual feedback

1. Introduction

Stroke is one of the leading cause of adult disability associated with increased risk of falls [1]. Stroke is one of the leading cause of death and disability in India [2]. The estimated adjusted prevalence rate of stroke, 84-262/100,000 in rural and 334-424/100,000 in urban areas [2]. The high prevalence, negative stroke sequel and subsequent disability after stroke make it most commonly treated physical disability by rehabilitation therapists [3]. Muscle weakness, restrictive mobility and loss of balance and co-ordination has been observed in people following a stroke. Forster and Young reported that 73% of elderly people who have had stroke fell within 6 months after discharge from the hospital [4, 5]. Stroke being one of the most common cause for disability in India, there is an immense need for exercise program to improve physical fitness and maintain quality of life. Several investigators, however have found that improvements in muscle force, balance and aerobic capacity and timed mobility in subjects with chronic post-stroke hemiparesis can be achieved with exercise training [5, 6]. Patients with stroke showed an increased pattern of postural sway during quiet standing due to motor, sensory and cognitive impairments [7, 8], which increases risk of fall as well as limits their ability to independently perform activities of daily living [19, 10].

Visual feedback training using a mirror is a method that can lead to improvement in postural control by providing feedback on induced movements through reflection of body image in the mirror [11]. In addition, most of the studies only measured the effect on stable surfaces [13]. Hence, there is more need to study the effects of visual feedback on balance in patients with stroke [13].

Yoga is one of the India's oldest and most extensive psycho -spiritual traditions [12, 14]. The word 'yoga' is derived from Sanskrit verb 'yuj' meaning to yoke or unite [2]. Commonly, yoga is translated to imply the union of body, mind and spirit [14]. Union of body, mind and spirit translates to the term 'yoga'. There are 8 main forms of yoga, which encompasses 8 elements known as 'eight fold path of yoga', which includes Yamas (moral discipline), Niyamas (self-restraint), Pranayama (breath control), Asansas (Physical poses), Pratyahara (sensory inhibition), Dharana (concentration), Dhyana (meditation) and Samadhi (blissful state) [14]. Yoga therapeutics is defined by International association of yoga therapeutics as application of yoga benefits [15]. A regular practice of yoga has been shown to improve flexibility and muscle force in adults without known pathology [16]. Studies of varied outcomes have revealed that voluntary muscle force is closely co-related to gait performances in people following a stroke [17] and it may contribute to the balance and mobility problems of these people [17, 6].

This study aims to investigate the effect of yoga on static surface with visual feedback on balance in patients with chronic stroke.

2. Materials and Methodology

The study design used for this research was randomized clinical trial. Firm mat and mirror were used for the study. The outcome measures used were Berg Balance Scale (BBS), Trunk Impairment Scale (TIS), Postural Assessment Scale for Stroke (PASS), Timed Up and Go Scale (TUG). The sample size was 60 which was calculated based on the prevalence. The study was done for 8 weeks in Neurophysiotherapy OPD, MGM School of Physiotherapy, Aurangabad. The subjects were selected based on inclusion and exclusion criteria given as below:

Table 1: Inclusion and Exclusion criteria

Inclusion Criteria	Exclusion Criteria
1] Age 45-65 years.	1] Age below 45 years and above 65 years.
2] Patients sustaining stroke for more than 6 months.	2] Psychological conditions that interfere with participation in exercise program.
3] Patients who are diagnosed with chronic stroke who could stand independently for one minute on a stable surface.	3] Patients with visual defect.
4] Patients without visual defect.	4] Patients with vestibular defect.
5] Patients with no vestibular defect.	5] Reported medical contraindications.
6] Patients who are able to understand and follow simple verbal instructions.	6] Patient receiving palliative care.
7] Score of scales:	7] Score of scales:
a) Berg balance scale:>45/56	a) Berg balance scale: <45
b) Timed up and go :>14sec	b) Timed up and go :<14
c)PASS:>28/36	c)PASS:<28
d) Trunk impairment scale:>18/23	d) Trunk impairment scale:<18
e) MMSE:>24/30	e) MMSE:<24

All the participants with clinical diagnosis of stroke after considering inclusion and exclusion criteria were included in the study of 8 weeks. Total 70 patients were screened out of which 10 patients did not fit into the inclusion criteria, so 60 patients were included for further assessment and were divided randomly into 2 groups by chit method i.e Group A as conventional therapy group and Group B as Yoga on static surface with visual feedback in addition to conventional physiotherapy group. All subjects were interviewed, demographic information and descriptive information was collected. Then their physical performance was assessed and their ability to stand for one minute was assessed, for assessment of their cognitive performance MMSE test was performed and after that the physical therapist collected data for primary outcome variables. The outcome measures were BBS, TUG, PASS and TIS. Conventional physiotherapy treatment was given to both groups daily and yoga therapy on static surface with visual feedback was given on alternate days to the yoga therapy group in addition to conventional physiotherapy. Participants were briefed about the study, intervention and a written consent was taken. Institutional permission was taken for the study. The scores of the outcome measures were taken before the study, after 4 weeks and 8 weeks.

Group A was given conventional physiotherapy as follows

Table 2

Group A	
Activity	**Description**
1) Physiotherapy treatment	Passive stretching, core strengthening, sit to stand, lunges, wall squats, heel raise, gait training, active range of motion exercises for lower limb and upper limb.

Group B was given yoga on static surface with visual feedback in addition to conventional physiotherapy as follows: [23]

Table 3

1) Education 2)Body awareness 3)Breathing 4)Physiotherapy treatment 5) Asanas 6) Relaxation	Subjects were given a brief description of basic anatomical structures and explanation of yoga and physiotherapeutic concepts related to the protocol. The goal was to facilitate a greater understanding of one's physical body and thought process. The therapist verbally led the subject through bringing conscious awareness to various parts of the body by instructing the patient to look into the mirror. The goal was to promote awareness of body sensation, position and activity of the mind. Voluntary breathing activities were taught and practiced such as diaphragmatic breathing and alternate nostril breathing. The goals were to promote awareness of the sensation of breath in the body and awareness of how the breath can facilitate movement of body segments and to promote concentration. Passive stretching, core strengthening, sit to stand, lunges, wall squats, heel raise, gait training The subject were instructed and assisted as necessary in performing a variety of 6 yoga postures on static surfaces in front of mirror. The goal was to improve flexibility, muscle force, balance, endurance and coordination of body segments. The subjects were allowed to relax all the body segments by using Jacobson's Technique. The goal was to elicit a relaxation response.

Following yoga postions were given to patient in front of mirror for correction of their position with visual feedback,if needed assistance is provided to achieve these yoga positions.

Table 4

Yoga poses	Benefits
Tadasana	▪ Improves posture.

	▪ Strengthens thighs, knees, and ankles. ▪ Increase awareness.
Trikonasana	▪ Strengthens your leg, feet, and ankles. ▪ Strengthens back, neck and abdominals. ▪ Open chest and shoulders.
Virbhadrasana 1	▪ Opens your hips, chest and lungs. ▪ Stretches your arms, legs, shoulders, neck, belly, groins and ankles.
Virbhadrasana 2	▪ Opens hips, chest and improves breathing. ▪ Stretches arms, legs, ankles, groin and belly.
Vrukshasana	▪ Improves balance and stability in the legs. ▪ Assist the body in establishing pelvic stability. ▪ Strengthens the ligaments and tendons of the feet.
Utkatasana	▪ Tones the leg muscles excellently. ▪ Reduces symptoms of flat feet.

3. Results

Unpaired T test was performed for inter group comparison of BBS, trunk impairment scale, postural assessment scale and TUG test between both the groups i.e. group A and group B pre interventional, after 4 weeks and post interventional i.e. after 8 weeks.

Paired test was done for intra group comparison of BBS, trunk impairment scale, postural assessment scale and TUG for group A and group B pre interventional, after 4 weeks and post interventional after 8 weeks.

The significance has been considered as the data obtained from the patients was well organized in the master chart with different tables and graphs were derived from statistical analysis for easy result interpretation.

Comparison was done for the score of all the four outcome measures in both the groups. There was statistically significant increase in both the groups when intra group comparison was done.

When inter group comparison was done between group A and B there was statistically significant increase in BBS and TUG scores but there were no significant changes seen in trunk impairment scale and postural assessment scale after the inter group comparison.

Comparison in both groups is as follow:

Table 6: Pre and post treatment comparison of different outcome measures

SR NO.	Outcome Measures	PRE treatment		POST treatment	
		Group A	Group B	Group A	Group B
1.	BBS	45.5±0.568	45.26±0.445	49.906±0.9625	51.871+1.02443
2.	TIS	18.4±0.49	18.2±0.4	20.656±0.7453	20.7097±0.5287
3.	PASS	28.5938±0.49899	28.1612±0.3738	32.781±0.7507	32.8065±0.6435
4.	TUG	24.125±1.8794	25.387097±1.0855	17.033±0.795124	15.3±0.942

Paired T Test

Table 2: Paired T test group A

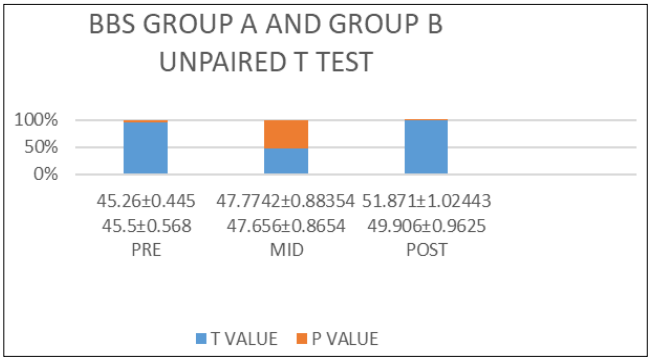
Group A		Mean Difference	T Value	P Value	Sign
BBS	PRE VS MID	2.150	11.753	0.00000045	Highly Significant
	MID VS POST	2.250	9.875	0.000006311	Highly Significant
	PRE VS POST	4.400	22.395	0.00000083	Highly Significant
TIS	PRE VS MID	1.038	7.081	0.000087	Highly Significant
	MID VS POST	1.218	6.881	0.0000342	Highly Significant
	PRE VS POST	2.256	14.312	0.000000011	Highly Significant
PASS	PRE VS MID	2.188	12.765	0.000000971	Highly Significant
	MID VS POST	2.000	10.100	0.000000352	Highly Significant
	PRE VS POST	4.188	26.315	0.000000032	Highly Significant
TUG	PRE VS MID	-2.938	-9.360	0.0000042	Highly Significant
	MID VS POST	-2.155	-5.065	0.0000981	Highly Significant
	PRE VS POST	-7.092	-19.049	0.00000094	Highly Significant

Table 3: Paired T test group B

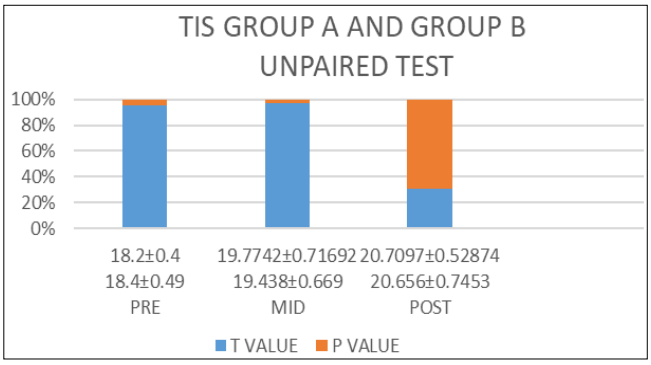
Group B		Mean Difference	T Value	P Value	Sign
BBS	PRE VS MID	2.510	14.204	0.00000012	Highly Significant
	MID VS POST	4.100	16.945	0.000000643	Highly Significant
	PRE VS POST	6.610	33.130	0.00000096	Highly Significant
TIS	PRE VS MID	1.570	10.727	0.000000872	Highly Significant
	MID VS PIST	0.940	5.947	0.00068	Highly Significant

	PRE VS POST	2.510	21.302	0.00000054	Highly Significant
PASS	PRE VS MID	1.960	11.432	0.000000131	Highly Significant
	MID VS POST	2.680	13.713	0.00000075	Highly Significant
	PRE VS POST	4.640	34.947	0.00000001	Highly Significant
TUG	PRE VS MID	-6.194	-24.937	0.00000098	Highly Significant
	MID VS POST	-4.094	-17.975	0.00000015	Highly Significant
	PRE VS POST	-10.257	-39.124	0.00000004	Highly Significant

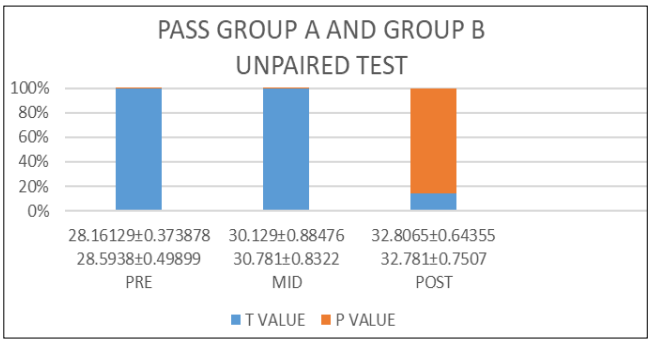
Unpaired T Test



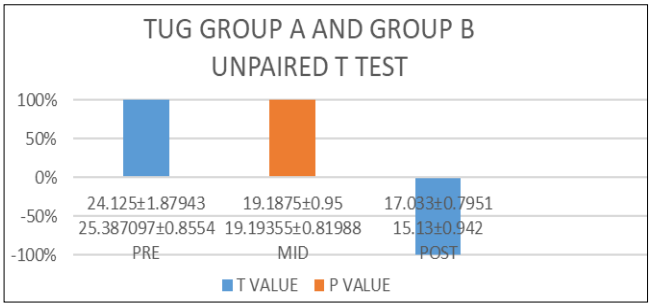
Graph 1: Unpaird T test for intergroup comparison on BBS SCALE



Graph 2: Unpaird T test for intergroup comparison on TIS SCALE



Graph 3: Unpaired T test intergroup comparison on PASS SCALE



Graph 4: Unpaired T test intergroup comparison on TUG SCALE

Discussion

Balance requires the ability to generate focus to control the body segments and position in space. Musculoskeletal problems may greatly influence postural stability and control [18]. Decreased range of motion and muscle weakness have been observed in patients following a stroke.[19] Studies of outcomes have revealed that voluntary muscle force is closely related to the gait performance in patients following a stroke,[20] and it may contribute to the balance and mobility problems of these individuals [21, 22]. We were interested in knowing whether yoga therapy might be useful for individuals who have suffered stroke. The purpose of this study, therefore was to investigate the effects of yoga-based exercise program on balance in individuals who have suffered from stroke [23].

Stroke results in significant changes in balance and patients typically exhibit delayed, varied or absent balance response with impairments in latency, amplitude and timing of muscle activity [24]. Lower limb muscle weakness and slowed force build-up are associated with functional disability, immobility, poor standing, balance and high anticipatory, ongoing, and responsive postural adjustments and risk of falls. [25]

There is an increased evidenc suggesting that challenging balance exercises in standing with feet close together and practicing controlled movements of centre of mass, is an optimal way to improve balance during performance of everyday actions when performed with sufficient dosage and without reliance on upper limbs [30].

Sherrington *et al* in their study showed that exercises like sit-to-stand activity, lunges, heel raises, one leg stance and random stands can be used to improve coordination, strength, endurance and balance in older adults [27]. For stroke patients exercise intervention to prevent falls, enhance mobility and improve physical activity in community dwellers, which involves weight-bearing exercises like sit to stand, forward and lateral step ups, heel raises which challenge balance and improve lower limb muscle strength [28]. Another correlation study related to sit to stand movement and its correlation to falling in stroke patients, showed that greater postural sway while rising or sitting down and asymmetric weight distribution may be useful in identifying stroke patients who are at risk of falling [31].

Balance improvement in conventional group in all patients could be attributed to increase in strength of weak muscles concentrically and eccentrically and improving segmental limb control, creating a loading response and activating extensors activity, improving symmetrical weight shift, increasing flexibility and lower limb range of motion, eventually enhancing motor activity, functional mobility and walking [27, 28, 30, 31].

In yoga therapy group also, BBS and TUG scores showed significant improvement. Leslie Kaminoff internationally

recognized specialist in fields of yoga and breathe anatomy, studied yoga anatomy under the team of human kinetics. He analyzed asanas and proposed the effects of asanas on muscular system. According to his analysis standing asanas like Utkatasana, veerasana, Trikonasana, Tadasana and vrukshasana increase activity of lower limb muscles such as gluteus medius and minimus, adductor group, quadriceps, tibialis anterior, soleus and intrinsic muscles of the feet [29].

George Saleman studied physical demand profiles of hatha yoga postures performed by older adults by quantifying biomechanically using 3D motion analysis, force platforms and electromyography (EMG). Surface electromyography signals (EMG) were collected from lower limb muscles like gluteus medius, hamstrings, vastus lateralis and gastrocnemius. Results showed that there was appreciable increase in core activity in all postures, increase in quadriceps activity in Utkatasana, virasana and trikonasana. Increase in the activity occurred in gluteus medius, minimus and Maximus muscles in Vrukshasana [32].

Increase in isometric muscular endurance could be attributed to holding poses for prolonged period of time with controlled breathing implies the mind and body to focus on active muscles responsible for stabilizing the body in the various poses and alternating recruitment of different motor units to execute the specific task. Repetitive stretching and force resistance movements of yoga postures increases blood circulation to the muscles, connective tissues and also improve proprioception by stimulating intrafusal and Golgi tendon Organ feedback mechanism [32].

Hip abductors are important stabilizers of pelvis and their muscular performance is correlated with balance and fall risk in seniors. Hip flexors are important in pulling the limb forward during the swing phase of the gait and their performance is related to walking speed and fall recovery in older adults [33]. Core stability is important because it influences trunk orientation which in turn affects hip, knee and ankle position during yoga practice and joint kinematics during ambulation. Traditionally important aspect of yoga practice is increase in flexibility of upper and lower limb muscles. Increase in flexibility can be attributed to static stretching nature of the asanas. Increase in range of motion is due to increase in length of connective tissue due to property of plastic elongation and muscle tissue length due to addition of sarcomere to the ends of muscle fibers [34]. Mark D Tran *et al* found out in a study that with stretching there is decrease in neuromuscular activity in antagonist muscle and increase efficiency in agonist group of muscles and stitching is associated with increase in capillarization and oxidative enzymes [23].

There are similarities between asanas and as and some rehabilitation exercises that are intended to correct faulty motor patterns for example movement and instructions for performing utkatasana and rehabilitation exercises like rising from chair pose are essentially the same. There are similarities between virasana and forward lunges, vrikshasana and one leg stance pose. But main difference is; rehabilitation exercises require multiple repetitions to learn and develop a motor pattern where as in yoga, a pose has to be achieved slowly and held for a longer duration. Holding poses for prolonged period of time along with controlled breathing is one of the important aspect of yoga [21]. Latest studies suggest that along with increase in balance which ultimately reduces the risk for falls; yoga is also beneficial in reducing state of anxiety, depression [37, 39]. So improvement in balance in yoga group could be attributed to increase in strength and endurance of abdominals, back extensors, hip abductors and flexor, quadriceps, ankle plantar flexors, lower limb range of motion, spine flexibility, increase in concentration and awareness of oneself and surroundings [29, 32, 36].

The visual feedback with Yoga was helpful in correction and maintenance of those yoga positions during therapy in patients with hemiparesis. The sensory stimulus are used before, during and after the movement permitting the anticipation (feed forward) as preparation for risks that can appear, and the retro feeding (feedback) that permits necessary adjustments to the movement that is being performed, or correction for future movements [40]. A comparison was done between the conventional physiotherapy and the balance training with visual feedback through the Wii Fit in twelve hemiparetic Stroke patients in the chronic stage, which demonstrated in both groups, significant improvements on the static and dynamic balance when evaluated by BBS. The group that made use of the visual information obtained an advantage in relation to the evaluation on the force plate, where the results were significant in the decrease of anteroposterior oscillation comparing with the conventional therapy [41]. As per mentioned by Shamway Cook, feedforward and feedback plays very important role in improving balance and preventing falls in elderly. In hemiplegics additional benefit will be provided by visual input in improving balance, reducing risk of fall and hence improving quality of life.

All subject in our study demonstrated some positive effect in the outcome variables. Not all the subjects had similar response to the yoga intervention, and there were several differences among the subjects that may have contributed to the variance in the results. Improvement was seen more after 8 weeks as compared to after 4 weeks. T value for BBS after 4 weeks was 16.94 and after 8 weeks was 33.13 and for TUG T value after 4 weeks was -17.97 and after 8 weeks was -39.12.

In this study, both conventional and yoga therapy group showed significant improvement. That means both interventions seem to have an equal potential for an intervention period of 8 weeks. Both groups showed significant results which could be because of similarities in posters attend in both groups.

Conclusion

This study suggest that both conventional therapy and yoga therapy enhance balance in post stroke patients at the end of 8 weeks of treatment. There was statistically significant difference in scores of BBS and TUG but not in TIS and PASS. Yoga therapy may be used as an alternative approach to conventional training in stroke patients in chronic stages of recovery. This preliminary investigation of the effects of yoga-based exercise program lends support to the growing evidence that improvement in impairments and mobility limitations can be achieved with people with chronic stroke. Further studies are needed to offer more conclusive evidence of the benefits of yoga-based exercise program along with Physiotherapy on balance for stroke population.

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