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Proprioceptive Training versus Progressive Adaptive Physical Activity on Balance in Subjects with Sub-Acute Stroke

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ABSTRACT

Background: Post-stroke, gait and balance are often affected increasing the risk of fall, social isolation and sedentary lifestyle. Proprioceptive training has always been a part of post-stroke rehabilitation which has seen to improve muscle strength, balance and gait. Progressive adaptive physical activity has also shown to improve balance, cardiovascular fitness and gait after stroke. This study aims to compare the effect of proprioceptive training and progressive adaptive physical activity on balance in sub-acute stroke subjects.
Method: 30 subacute stroke subjects were randomly assigned to one of the two groups. Group A received proprioceptive training while Group B received progressive adaptive physical activity for 30 minutes, 3 times a week for eight weeks. Subjects in both the groups were assessed for balance using Berg Balance Scale and Functional Reach Test prior to the intervention and post-intervention.
Result: Both the groups showed significant improvement in the pre to post FRT and BBS scores ($p<0.001$). Post-intervention, when compared between groups, Group A showed better improvement than Group B on the FRT scores ($p<0.001$) but no difference was seen in the BBS scores (p value>0.05).
Conclusion: Proprioceptive training is found to be more effective than the progressive adaptive physical activity in improving balance among sub-acute stroke subjects.

Key Words: Stroke, Balance, proprioceptive training, progressive adaptive physical activity.

INTRODUCTION

Stroke is the sudden loss of neurological function caused by an interruption of the blood flow to the brain.[1] Mortality rates related to cerebrovascular accidents have been increasing and among the surviving individuals, 15–30% become severely disabled, and 40% have functional deficits affecting various components of functional independence like motor, sensory and cognitive functions.[2,3,4] These disturbances disrupt balance, gait, increase fall risk, social isolation and sedentary lifestyle. Post-stroke physical inactivity adds to cardiovascular deconditioning, motor weakness, gait abnormalities and associated decrease in physical and social functions. Balance is essential for normal locomotion and for carrying out various activities of daily living. Accurate balance assessment is essential for prescribing appropriate mobility aids, planning effective treatment interventions, and understanding safe and unsafe activities.[5]

Proprioceptive signals from mechanoreceptors are needed for the neural control of movement. The loss of proprioceptive afferents may affect the muscle tone, disrupt postural reflexes and severely disturb the spatial as well as

temporal aspects of voluntary movement.[6] After stroke, functional weakness of the lower extremity is caused not only by muscular weakness, but also by reduction in muscular endurance, joint stability and loss of proprioceptive sense.[7] Post-stroke, around 65% of individuals experience the loss of tactile sense, protective reaction and proprioception.[8, 9]

Adaptive physical education is developing and implementing a carefully designed physical education instructional program for an individual with a disability, based on a detailed assessment, to give the individual the skills necessary for a lifetime to improve physical fitness and wellness.[10] Progressive adaptive physical activity intervention was developed and was based on increased dynamic balance challenge, enhanced structure of activity progression and high-intensity stepping for better fitness gain.[11,12] To promote fitness, promote motor learning, reduce learned non-use, and to optimize mobility and recovery, exercises must be integrated into everyday lives of stroke survivors. The adaptive physical activity-stroke exercise protocol was planned and designed for stroke survivors, based on evidence from previous research.[13]

The ability to react to various environments and tasks is decreased after stroke because of decline in the weight transfer ability, lower limb support time on the affected side and stability limits. Also, the disturbance in standing is increased as much as two times, compared with normal individuals of the same age.[14, 15, 16] Though both proprioceptive training and adaptive physical activity were found to be beneficial in post-stroke individuals, there is a lack of understanding regarding the most beneficial approach. Hence, the aim of the present study was to compare the effect of proprioceptive training and the progressive adaptive physical activity on balance in subjects with subacute stroke.

MATERIALS AND METHODS

30 subacute stroke subjects with middle cerebral artery involvement, between 3 to 6 months post-stroke duration, ability to stand for at least 1 minute, Mini-Mental State Examination score of 24 or greater, ability to comprehend and follow simple instructions, Brunnstrom voluntary grading of 4 and above were included for the study. Subjects were excluded if they had any chronic comorbid conditions such as congestive heart failure, unstable angina, peripheral arterial occlusive disease, global or major receptive aphasia, uncorrected hearing and visual impairments and other unstable medical, neurological, orthopaedic conditions. Subjects were recruited from the outpatient department of a Tertiary Care Centre in Bangalore. After the study procedure was explained to the participants, written consent was taken from them. Ethical Clearance was obtained from the Institutional Ethical Committee. Subjects who fulfilled the inclusion criteria were randomly assigned into two groups. Subjects were then assessed for balance using the Berg Balance Scale (BBS)[5] and Functional Reach Test (FRT)[17]. Both groups received treatment for 30 minutes, 3 times a week for eight weeks. Subjects in both the groups were again assessed for balance after the intervention using the same outcome measures. BBS and FRT are reliable and valid tools and have been studied extensively for their use in assessing stroke subjects.[17, 18, 19]

Group A received proprioceptive training in two phases. For the initial 4 weeks, training was conducted on a balance pad and it consisted of 5 tasks. Subjects were allowed to take a break of 10 seconds after performing each task, and 5 trials were regarded as 1 set, and a total of 5 sets were performed in 30 minutes. From 5 weeks to 8 weeks, the training was conducted on a balance board and it consisted of 5 tasks. It was conducted in the same way as the initial 4 weeks; the training was conducted under the instruction and support of a physiotherapist, given the difficulty of the training, to ensure the safety of subjects.

Proprioceptive Training Program was as follows:[20]

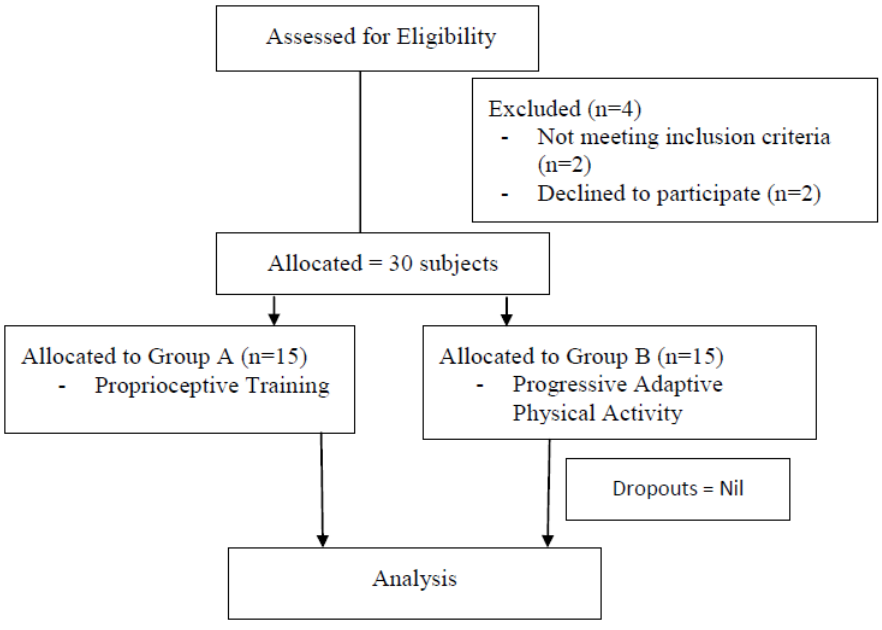
- Training with balance pad (1-4 weeks)

1. Subjects were asked to stand with bilateral foot support.
2. Lifting both heels up and down while standing.
3. Subjects were asked to bend and stretch both the knees.
4. Moving forward and backward in standing while placing the normal foot on the floor and the paretic foot on the balance pad.
5. Subjects were asked to close the eyes and stand.

- Training with balance board (5-8week)

1. In standing position, subjects were made to transfer the weight on to both the lower limbs alternatively.
2. In standing, ask the subjects to shift the weight forward and backward.
3. In standing, ask the subjects to bend and stretch the knees.
4. While standing, subjects were asked to lift the heels up and relax.
5. Subjects were asked to perform sit-to-stand.

Subjects in Group B received progressive adaptive physical activity training. Starting with timed walking as a warm-up session in the indoor track, subjects performed balance exercises which included weight-shifts, leg lifts, foot placements and half squats. They were asked to march while supporting themselves with the help of a bar for a gradually increased number of minutes, also concentrate on lifting the knees higher and alternating the legs symmetrically, as far as possible. Subjects were then asked to sit in chairs and complete upper body exercises that mainly were designed to help in trunk stability and postural correction which included sit-to-stand, timed walking on an obstacle course like that of a serpentine walk, stepping in and out of hoops on the floor, and negotiating a wide step.[22]



CONSORT FLOW DIAGRAM

RESULT

Table 1: Distribution of subjects according to their age, gender, duration of stroke, side affected, Brunnstrom stage of motor recovery and MMSE grading

S. No.	Variables	Group A	Group B
1	Age in Years	54.67±5.88	57.20±9.11
2	Male / Female	10(66.66%) / 5(33.33%)	8(55.33%) / 7(46.66%)
3	Duration of Stroke in Months	4.6±1.13	4.67±0.95
4	Side Affected – Left / Right	6(40.0%) / 9(60.0%)	4(26.7%) / 11(73.3%)
5	Brunnstrom Stage of Motor Recovery	4.46±0.63	4.46±0.51
6	MMSE Grading	26.6±1.18	26.00±1.13

Table 2: Range, mean and SD of BBS and FRT scores of the subjects in Group-A

S. No.	Outcome measures	Group-A				Wilcoxon test & Paired t test	p-value
		Pre test		Post test			
		Range	Mean ±SD	Range	Mean ±SD		
1	BBS	34-42	39.47±2.35	45-48	46.87±1.18	Z = 3.42*	p =0.001
2	FRT	76-88	80.53±2.94	86-96	90.73±2.76	t = 16.28*	p = 0.001

*Note: * denotes –Significant (p < 0.05)*

Table-3: Range, mean and SD of BBS and FRT scores of the subjects in Group-B

S. No.	Outcome measures	Group-B				Wilcoxon test & Paired t test	p-value
		Pre test		Post test			
		Range	Mean ±SD	Range	Mean ±SD		
1	BBS	39-45	43.73±1.58	40-51	46.87±2.77	Z = 3.21*	p = 0.001
2	FRT	75-83	79.66±2.60	80-88	85.00±2.33	t = 8.46*	p = 0.001

*Note: * denotes –Significant (p < 0.05)*

Table-4: Comparison of pre and post-test BBS and FRT scores of subjects in between the groups.

S. No.	Outcome measures	Pre test		Post test	
		Group-A	Group-B	Group-A	Group-B
		Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD
1	BBS	39.47±2.35	43.73±1.58	46.87±1.18	46.87±2.77
2	FRT	80.53±2.94	79.66±2.60	90.73±2.76	85.00±2.33
Between group comparison Mann Whitney U test (BBS) Unpaired t test (FRT)		BBS: Z = 4.285 (p<0.001) S FRT: t = 0.852 (p>0.05) NS		BBS: Z = 0.359 (p>0.05) NS FRT: t = 6.143 (p<0.001) S	

Note: S-denotes significant (p<0.05); NS-not significant (p>0.05).

DISCUSSION

The objective of the study was to compare the effect of proprioceptive training and progressive adaptive physical activity on balance in subacute stroke subjects. Participants in Group A received proprioceptive training and the results suggested that proprioceptive training helped in improving balance as measured by both BBS and FRT. Yu-Hyung Park and colleagues suggested that the dynamic balance ability can be improved by increasing the ankle joint position sense through proprioceptive control.[22] Proprioceptive training can activate the cerebrum, cerebellum, visual and vestibular organs that responsible for balance ability, mainly the joint proprioceptors.[21] Ankle proprioceptive inputs improve the center of pressure[24] and also, exercising on an unstable surface trains the central nervous system and helps in better weight transfers which could have helped in improving balance in these individuals.[25] Participants in Group B who were given progressive adaptive physical activity also showed significant improvement. This can be supported by Kathleen Michael who suggested that structural physical activity produces meaningful functional improvements.[22] Adaptive physical activity training modified the position of center of gravity significantly and increased dynamic balance.[26] Adaptive physical activity program is seen to be feasible and effective in improving balance, physical performance, walking endurance and quality of life.[27]

When BBS scores were compared prior to the intervention, they were found to be statistically significant (p<0.001) showing that both the groups were not homogenous on the balance scores. Subjects in Group A had more balance difficulties compared to the subjects in Group B. That could be the reason why there was no significant improvement in the BBS scores in between the groups, post-intervention. The FRT values improved significantly in Group A compared to Group B (p<0.001), again indicating that proprioceptive training was more beneficial in improving balance in these individuals. Proprioceptive exercises improve balance through peripheral and central mechanisms. Peripheral mechanisms involve morphological adaptations in the mechanoreceptors in the muscle spindle. Muscle spindle adaptations can occur at a micro level with training. At the central level, proprioceptor training can modify proprioception by regulating the increase in mechanoreceptors and inducing plastic changes in the central nervous system.

During exercise, an increase in muscle spindle force can be achieved via the gamma pathway to improve joint proprioception by facilitating its cortical projections. Thus, it is believed that repetitive activity of motor skills can improve muscle spindle performance and cause plastic changes in the central nervous system, such as the cortex, due to the repetitive placement of the joints in spatial position as required by the exercises.[28] The major limitation of the study was the differences in the balance scores among subjects from both the groups prior to the intervention which could have influenced the results. Dominance and BMI of the subjects were not considered.

CONCLUSION

Though both the interventions were beneficial in improving balance, based on the results of the study, it can be concluded that proprioceptive training is more effective than progressive adaptive physical activity in improving balance in subjects with subacute stroke.

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