Effect of backward walking on balance and gait in healthy elderly: a randomized controlled trial

Dr. Manisha Rathi (Ph.D.)¹, Dr. Deepa Chauhan², Dr. Tushar J. Palekar (Ph.D.)³
¹Professor, ²Resident, ³Principal
Dr. D.Y. Patil College of Physiotherapy, Dr. D. Y. Patil Vidyapeeth, Pimpri, Pune

Received: 10 May Revised: 18 May Accepted: 26 May

Abstract

**Background:** Balance is the general term used to narrate the dynamic action by which the body’s position is preserved in equilibrium. It is an essential factor for activities of daily living in elderly. Hence purpose of the study was to find the effect of backward walking on balance and gait in healthy elderly. **Method:** 34 samples with age group between 60-70 years of both genders were divided randomly into two groups. Group A received backward walking with conventional therapy and group B received only conventional therapy for 4 weeks, 3 days/week. Outcome measures were Timed Up and Go test (TUG), Multi-Directional Reach Test (MDRT), Gait Speed, Step length and stride length. **Results:** Both groups showed significant improvement in TUG, MDRT, gait speed, step length, stride length (p<0.05). Whereas Group A showed more improvement than group B. **Conclusion:** Backward walking with conventional therapy is effective in improving balance and gait in healthy elderly.

**Key Words:** Backward walking, balance, gait, healthy elderly.

Introduction: Good balance in elderly who are living independently, capably and proactively is an essential factor for cooking, travelling, doing household work, shopping and activities of daily living.[1] Balance is essential for keep going a position, continue to exist stable while going from one position to another, conducting daily living activities, and going freely in the community.[2]

Balance and postural stability are the general term used to narrate the dynamic action by which the body’s position is preserved in equilibrium. When body’s center of mass (COM) or center of gravity (COG) is sustained over base of support (BOS), it result in maximum balance.[3]

It is a combination of vision, proprioception, vestibular sensation, strength of muscle and reaction time. As age increases, there is a accelerating mislaying of work of these systems which can subscribe to balance shortfall.[4] The potential to balance can be hampered by disease, medications and the task of aging.[5]

There are several factors which leads to impairment in balance in elderly population, some of the factors are been discussed below. In a study, it is showed that the elderly people have reduced flexibility and range of motion, which would hamper their ability to recover balance following an external disturbance.[6]
In a study "lower- extremity muscle force and balance performance in adults aged 65 years and older" it was suggested that the force generating capability of the distal musculature is important in the maintenance of balance in older adults.\cite{6} Hence it is important to focus on the strength of the lower limb muscles as well for the improvement of balance in elderly.

India comprise the second largest geriatric population, which is about 1/8th of the total geriatric population of the world. As per census 2011, 103.2 million people in India were of the age 60 years or more, count for 8.6% of total population. Among many health matter that are faced by the elderly, falls are major issue.\cite{7}

Falls are one of the most major issue in the elderly and been considered as the “geriatric giant”.\cite{8} There are several exercise programs which are useful for fall prevention in elderly. Some of them are Otago home exercise program, multi-system group exercise program incorporating a circuit of activities, Tai Chi balance training, pilates mat exercise and virtual reality game exercise.\cite{3}

Backward walking is something different from forward walking. During backward walking the leg reverses its movement direction and also travels in opposite direction with virtually same path like in forward walking.\cite{9} A pre-stretch of the hamstring is seen prior to thigh reversal because of greater hip flexion and lesser hip extension in backward walking. Hence backward walking helps in providing stimulus to increase hamstring flexibility and reducing low back pain in persons with hamstring tightness.\cite{10}

Backward walking appears to be a novel task. During backward walking hip extension and flexion of knee is greater as compared to forward walking. Increased extension of hip joint and associated lumbar spine extension increasingly load the facet joints opening up the disc space, resulting in reduction of compressive force in the intervertebral disc. Hence backward walking intervention remarkably improve low back range of motion and leading to reduction in low back pain.\cite{11}

During backward walking, older adults displayed notable improved range of motion of the ankle join and stability. Ankle kinematics may be responsible for the result of benefit related to decreasing occurrence of fall in older adults and other population at risk for falls following backward walking.\cite{12} Demonstration has been done that backward walking helps in improving quadriceps strength and power and also decreases patellofemoral joint reaction force at knee joint.\cite{13}

During Backward walking there is enhanced cardiopulmonary demand as compared to forward walking at the same speed. It is also suggested that backward walking enhances energy expenditure to such a level which is sufficient to maintain cardiopulmonary fitness.\cite{8} Backward walking is also responsible for improving balance in school aged boys. As backward walking origin neural adaptations and progressive training induces adaptation of soleus H-reflex. During backward walking muscle synergy or neuromotor control reorganization occurs in lower limbs which could be the cause of improvement of balance.\cite{14}
As backward walking improves muscle flexibility, lower limb range of motion, core muscle strength, lower limb strength, so these may lead to improvement in balance. Also backward walking is cost-effective, easy to perform, doesn’t require much assistance once the technique is being learnt by the individual. Hence objective of the study was to assess the effect of backward walking on balance and gait in healthy elder people.

**Materials and Method:** Ethical clearance was taken from the Institution Sub Ethics committee. In this randomized controlled trial, 34 participants were randomly selected from community as per inclusion and exclusion criteria. Simple random allocation was done to divide participants into two groups using chit method. Written informed consent was taken from all the participants. The sample size was calculated using the software Primer, where it was derived to be 16 participants in each group with desired power: 0.800 and alpha: 0.05 and it was calculated using previously done studies with mean and standard deviation as 18.1, 10.5 respectively. Considering 5% drop out chances, 34 participants were recruited for the study. Study setting was Dr. D.Y. Patil college of physiotherapy OPD, Pune, India. 34 participants with age group between 60-70 years and of both genders, who were walking independently, (45-50 score on berg balance scale) and with cognition level (24 and above on mini mental scale) were included in the study. Individuals with recent fracture and surgeries of lower limb and spine (past 6 months), neurological conditions (parkinson’s, stroke, vertigo), use of any assistive walking device, visual and hearing impairment, medications that interfere with balance (anti histamine, Anti-depressant) were excluded from the study. Total 32 participants (16 in each group) completed the study and 2 were dropped out due to following reasons mentioned below.

Participants in the group A received backward walking with conventional therapy and group B received conventional therapy alone. Timed up and go test, Multi-directional reach test, gait speed, step length, stride length was taken to assess baseline parameters. Backward Walking
Protocol- Initially the patient was made to walk 10 steps forward and 9 steps backward under observation in parallel bar where mirror was giving visual feedback to the subjects. During this participant was observed for any discomfort. Three trials were given to the participant, if still participant felt any discomfort he/she was not taken for the study. Once the participant became confident to start backward walking without any discomfort then only participant was made to walk backward for 10 minutes and a turn was taken at 10 metre. Therapist was also walking along with participant for safety and to avoid any fall and discomfort during backward walking. This was done for 10 minutes per session along with conventional therapy. Intervention was given for 12 weeks for 3 days/week for 30 minutes per session.

**Conventional treatment**

<table>
<thead>
<tr>
<th>SN.</th>
<th>EXERCISES</th>
<th>DURATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Hip abduction in standing of both lower limbs</td>
<td>10 repetitions, 1 set</td>
</tr>
<tr>
<td>2.</td>
<td>Spot marching</td>
<td>10 repetitions, 1 set</td>
</tr>
<tr>
<td>3.</td>
<td>Standing up from chair with arms folded</td>
<td>10 repetitions, 1 set</td>
</tr>
<tr>
<td>4.</td>
<td>Standing on one leg</td>
<td>10 sec, 10 reps, 1 set</td>
</tr>
<tr>
<td>5.</td>
<td>Tandem walking</td>
<td>20 steps, 1 set</td>
</tr>
</tbody>
</table>

In this study three outcome measures were used to assess the results of group A and group B. Timed up and go test, Multi-directional reach test, gait speed, step length, stride length was taken to assess static and dynamic balance and gait.

**Statistical Analysis**: Test of Normality was checked using SPSS software version 14.0 with the help of Shapiro Wilk’s Test of Normality for the Baseline parameter. Pre and post treatment score of timed up and go test, multi-directional reach test, gait speed, step length, stride length for both the groups were compared. Within the group comparison was done by paired t-test and between groups comparison was done by t test. P value was kept at 95% confidence interval throughout the analysis.

**Table 1: Demographic Data of both the groups**

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Group A</th>
<th>Group B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>63.18± 0.67</td>
<td>64.81± 0.79</td>
</tr>
<tr>
<td>No. of females</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td>No of males</td>
<td>11</td>
<td>5</td>
</tr>
</tbody>
</table>

**Table no 2: TUG, MDRT, Step Length, Stride Length, Gait Speed of both the groups**

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Group</th>
<th>Pre Mean</th>
<th>Post Mean</th>
<th>Mean diff.</th>
<th>P value</th>
<th>Intergroup comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td>TUG</td>
<td>A</td>
<td>10.31± 0.70</td>
<td>8.62± 061</td>
<td>1.69</td>
<td>HS</td>
<td>p=0.59</td>
</tr>
</tbody>
</table>
Results: Pre and post intervention results for both groups showed significant improvement in TUG score when assessed individually, using paired t-test as p value was <0.001. When both groups were compared, non significant improvement was observed as p=0.72, whereas group A showed more improvement than group B when mean difference was compared. Both groups showed significant improvement of MDRT in forward, backward, left lateral direction and right lateral direction score when assessed individually, using paired t-test as p value was <0.05. When post intervention parameters of both groups were compared, significant improvement was observed as p=0.02 for forward, backward and left lateral direction and non significant improvement was observed as p=0.11 for right lateral direction. Whereas group A showed more improvement than group B when mean difference was compared for forward direction, backward direction, left lateral and right lateral direction. Pre and post result of gait speed, step length and stride length of both groups showed significant improvement when assessed individually, using paired t-test as p value was <0.05. When both groups were compared, non significant improvement was observed as p=0.73, whereas group A showed more improvement than group B when mean difference was compared.

Discussion: The purpose of this study was to investigate the effectiveness of a backward walking exercise program on balance and gait in healthy elderly aged 60-70 years. Results showed that there was highly significant improvement in score of timed up and go test. This shows that backward walking gives effective improvement in balance score on TUG outcome measure for most of the subjects. Balance gets affected with ankle flexibility and strength, so as ankle range and strength improves, balance improves. Backward walking improves ankle flexibility and strength. So study done by Janet S. Dufek, showed beneficial effect of backward walking on balance.[12] Study done by Manisha Rathi et al (2014) shows that backward walking improved quadriceps strength significantly, as backward walking reduces compression forces

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>Mean difference</th>
<th>HS</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MDRT-FD</td>
<td>24.63± 3.80</td>
<td>22.62± 1.83</td>
<td>2.01</td>
<td>HS</td>
<td>p=0.02</td>
</tr>
<tr>
<td>MDRT-BD</td>
<td>17.79± 3.15</td>
<td>14.05± 2.64</td>
<td>-3.74</td>
<td>HS</td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td>MDRT-LD</td>
<td>21.30± 1.39</td>
<td>19.04± 2.25</td>
<td>-2.26</td>
<td>HS</td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td>MDRT-RD</td>
<td>20.70± 1.97</td>
<td>19.54± 2.55</td>
<td>-1.16</td>
<td>S</td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td>Step Length</td>
<td>45.09± 9.98</td>
<td>33.29± 6.07</td>
<td>-12.82</td>
<td>HS</td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td>Stride length</td>
<td>71.86± 4.00</td>
<td>63.87± 7.20</td>
<td>-8.03</td>
<td>HS</td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td>Gait Speed</td>
<td>68.98± 7.61</td>
<td>72.05± 12.84</td>
<td>3.07</td>
<td>S</td>
<td>p&lt;0.001</td>
</tr>
</tbody>
</table>

Where HS- Highly significant and S- Significant
on the patellofemoral joint and reduces the absorption of force at knee joint. This occurs due to reduced eccentric function of the quadriceps strength. It has been demonstrated that backward walking improves quadriceps strength.\textsuperscript{[9]} Core strength is required for maintaining balance and backward walking improves core strength hence backward walking is effective in improving balance\textsuperscript{[16]}

It is also suggested that hamstring flexibility and perhaps low back flexibility may increase when walking backward. As backward walking provide stimulus for increasing the length of the hamstring muscle.\textsuperscript{[11]} Similarly Teres liu-Ambrose (2008) showed that Otago home based program which consist of resistance training and balance retraining showed significant improvement when assessed on timed up and go test and physiological profile and hence improved executive functioning and therefore reduces the risk of falls in older people.\textsuperscript{[16]} Study done by Ladda Thiamwong (2013) concluded that 12 weeks of simple balance training program is effective in improving balance of rural older adults when assessed on time up and go test. Fear of falling was also decreased in people who received balance training.\textsuperscript{[15]}

When balance measured by using multi-directional reach test (MDRT) results showed that there is a significant improvement in all the directions i.e. forward direction, backward direction, left lateral and right lateral direction followed by backward walking program.

Similarly Robert A. Newton concluded from his study that, when elderly performed the MDRT in a freely surrounding which does not have support of wall. Where as while performing FRT (functional reach test) subjects had support of wall for reaching forward direction. This fact that there was no support of wall in MDRT could have lead to reduced mean measured in MDRT (8.89 in) as comparative to mean values observed in FRT (10.9 in.).\textsuperscript{[17]}

The present study also showed that when gait speed assessment was done after 4 weeks of backward walking program, it is found that backward walking showed significant improvement in improving gait speed.

A study done by Lien Quach (2011) has shown that their is relationship between gait speed and risk of fall in community dwelling older adults. He suggested that people walking with faster and slower gait speed are at risk of falls. Such that people with slower gait are more prone for inside fall, whereas people with faster gait are at high risk of outside falls, presumably where they are uncovered to environmental danger. Lastly, a reduction in gait speed is an important risk factor for future falls. It is well recognized that slow gait is related to risk of fall. The decrease in gait speed may gives a signal for a reduction in physical functioning, risk for diseases, or reduction in motor control centers in the frontal lobe.\textsuperscript{[18]}

D. L. Sturnieks (2008) showed that older adults tends to walk slowly as compared to younger population. He told, its not clear whether the reduction in speed is due to physical limitation or adaptive strategy for safety improvement. These spatiotemporal gait patterns are more profoundly found in fallers than non fallers. As age advances, kinetic and kinematic alteration
occurs in older people such as reduction in hip range of motion, increased anterior pelvic tilt, reduced ankle power generation capacity, increased hip extension.[4]

On contradictory to this study, Wei-Ya Hao (2011) showed that followed by 12 weeks backward walking program in school-aged boys, the gait speed decreased as compared to forward walking.[18]

When step length and stride length assessment was done after 4 weeks of backward walking program, it is found that backward walking showed significant improvement in improving step length. Similar results were observed by Elizabeth T. in her study (2007).[19]

Thus in our study, we found that all subjects were able to perform backward walking. There was no complaints of fall or any kind of discomfort while performing backward walking. Thus, our study conclude that backward walking was effective in improving balance and gait in healthy elderly.

In this study small sample size was taken. Short duration of backward walking was given to subjects thrice in a week. There was no follow up taken whether the participants are continuing the exercises or not and effects will retain further. Further study can be done with long duration of backward walking. Studies can be done to know the effect of backward walking on people who complaints of impaired balance. Future studies can be done on backward walking with footwear and without footwear and to understand the effect of backward walking on joint forces on incline surface.

Conclusion: This study concludes that backward walking along with conventional physiotherapy treatment is effective in improving balance and gait in healthy elderly people. So it can be given as alternative treatment for improving balance and gait in healthy elderly population.

Acknowledgement: I thank authority of Dr. D.Y. Patil College of physiotherapy for smooth conduction of study.

Conflict Of Interest declared none.

References:
8. Dr. B. Krishna Swamy, Dr. Gnanasambandam Usaha. Falls in older people national/ regional review India, department of geriatric medicine, Madras Medical College and Government General Hospital, Chennai city, Tamil Nadu state., available at www.who.int

Corresponding Author:
Dr. Deepa Chauhan, MPT in Community Based Rehabilitation
Dr. D.Y. Patil College of Physiotherapy, Pimpri, Pune-411018
Email address: deepachauhan9992@gmail.com