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Evaluation of geriatric slips and falls using induced slip training or an obstacle course

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Abstract: Falls in older individuals are a common cause of injury-related hospitalisation or death. In the context of adaptation and longer term retention generated by repeated-slip training, this paper reviews a novel conceptual framework on dynamic stability and weight support in minimising the likelihood of falls and slips, based on induced slip training or an obstacle course principles. Despite the fact that an unexpected fall can be extremely disruptive, regardless of age, a recovery step can frequently be sufficient for recovering equilibrium. As a result, inadequate weight support is the most important factor of slip-related fall risk, rather than instability. A session of induced slip training or an obstacle course appears to improve neuro-mechanical control of dynamic stability and weight support, which can last for several months or more. These concepts offer the theoretical foundation for developing task-specific adaptive training that aids in the development of preventive measures for preventing falls in older individuals.

Keywords: Geriatric slips and falls, Induced slip, Obstacle course

I. INTRODUCTION

The older population faces a significant health risk as their susceptibility to falling increases with age [1]. Accidental falls were the seventh highest cause of mortality for individuals 65 and over in the United States in 1999. Falls are linked to a high rate of death, morbidity, impaired functioning, and nursing care admissions [2]. 31% of community-dwelling elderly are at danger of falling. One in every three people over the age of 65 is projected to fall at least once a year. While small children may fall more frequently than the elderly, the elderly have a greater injury rate, particularly for catastrophic injuries.

Because of a fear of falling, fall-related injuries might result in lower mobility or reduced activity levels. Falls are commonly connected with severe morbidity and can be indicators of poor health and diminishing function. In either scenario, the effect is a reduction in living activity. Because human upright posture is intrinsically unstable, the central nervous system's (CNS) primary goal must be to prevent falls, which begins with preventing unintentional loss of balance. When the motion state (i.e., instantaneous position and velocity) of the body center-of-mass (COM) in relation to the base of support (BOS) exceeds specified stability constraints, it is called loss of balance. To increase the CNS's capacity to prevent balance loss, adaptive improvement of the internal representation of postural stability to account for real or anticipated disturbance may be necessary. To counter the disturbance and avoid any unwanted balance loss, the CNS can pick and execute an appropriate action in a feed forward control way. To protect older people from slipping and falling, a variety of intervention measures are utilised. Induced slip training and obstacle training are two of them. [3-6].

Low friction surface training is an intervention technique that strengthens an older person's neuromuscular protection system, which helps them avoid falling. It focuses on motor training in scenarios that are similar to real-life events. It focuses on preventing slip-related falls as a result of frequent unexpected exposure to slips when performing daily tasks including transitioning from a sitting to a standing posture and walking. The motor skills needed to overcome real-life obstacles, such as slip accidents, are best learned in scenarios that are similar to real-life events [7-8]. The CNS can be trained at the same time to avoid balance loss and slow down the body's decline after a slip. When a person is repeatedly exposed to slips, the CNS most likely creates new internal representations or updates old ones to increase feed forward control while reducing dependence on input [9].

In comparison to obstacle course, modified obstacle course has become a safer and more traditional training technique, offering immediate and exact feedback to the patient [10]. Currently, the only way to teach stepping over reactions is to expose participants to real-world risks such as walking over various sized items of various forms, colours, and positions in their path [11]. Some obstacles will be positioned near walls, eliminating the need for parallel bars or an extra person to swap

obstacles. Both of the aforementioned strategies are effective in preventing older people from falling due to slips.

II. METHODOLOGY

Through simple selection, 30 participants were chosen from community centres and communities in Agra and Mathura for the experimental study.

2.1 STUDY POPULATION

The following criteria were used to choose the sample: elderly above 65 years old, ability to walk freely, both genders, and More than one fall has occurred in the last two years.

During the sample selection process, the following criteria were used to rule out any previously identified neurological conditions: Any musculoskeletal ailment that has been identified, as well as the capacity to participate in the study is hampered by a cardiopulmonary impairment. Visual impairments that cannot be corrected with a lens Cognitive deficits in the past, Osteoporosis that has been medically diagnosed.

2.2 STUDY PROTOCOL

Through easy sampling, 30 participants were chosen. Two participants dropped out of the research because they couldn't find enough time to attend the daily intervention sessions. After the participants gave their informed permission and met the inclusion requirements, they were randomly allocated to one of two groups: group I, which included the first, third, fifth, and seventh grades, and group II, which included the second, fourth, sixth, and eighth grades. For three weeks, all of the individuals were subjected to a single intervention session every day with three repeats.

2.3 MEASURMENT TOOLS

For the observations and outcomes, the following tools were used:

- saw dust,
- stop watch,
- chair (46.5cm seat height),
- Artificial grass, jute carpet,
- Height (95cm W22cm H) and low (4" high 30" W) stairs
- Sand,
- Marble chips in a small pan (61 cm 2.4m 5.1 cm), Ramps that go up and down (30" W x 6" D x 12" H).

2.3 PROCEDURE

Participants who satisfied the inclusion criteria were chosen from among the eligible subjects after signing an informed consent form. Participants were examined using the Berg Balance Scale and a modified timed up and go test before the intervention, and demographic data and a brief fall history were collected. Subjects were divided into two groups. Before the intervention, the participants were given thorough instructions regarding the process, and the researcher remained at the patient's side during the procedure to prevent him from collapsing. Participants from each group were tested again using the Berg Balance Scale and a modified Timed up and Go after completing their respective intervention regimens. Data from both groups will be compared before and after the intervention.

2.4.1 Berg balance scale

The Berg balance scale was created to examine the performance of functional activities to assess balance in older persons with balance impairment [12]. It's a 14-item scale that takes 15-20 minutes to complete. Participants were told to do the activity at their own pace, with no assistance from others.

2.4.2 Timed ‘Up and Go’

Timed up and go is a short mobility test developed for fragile elderly people. Subjects were told to get out of a straight-backed arm chair, move 3 metres away from the chair's front legs, return, and sit down. Administering time is 1-3 minutes. The time it takes to complete this series of moves is the outcome.

2.4.3 Low friction surface training

During sit-to-stand and walking across the surface, slips were created. The individual is seated in a chair in a standardised posture with the heels aligned, knees bent at 100 degrees from the anatomic position, and ankles in a 10 degree dorsiflexion. The participants were advised to walk at their regular and comfortable speed on a low friction surface without wearing shoes. Slips were introduced utilising a sawdust-based low-friction basis. The subjects were first told that they would be doing non-slip trials first, and then slip trials would be done afterwards. Following three ordinary walking trials on a normal

Berg Balance Scale	Group A		Group B	
	Mean	SD	Mean	SD
Pre – Interventi	39.28	1.85	38.00	3.41
Post – Interventi on	44.78	2.66	43.07	2.81
MD (Pre – Post)	5.50	1.65	5.07	1.97

surface, a block of five consecutive slip trials on a low friction surface was added. After the initial slip experiment, individuals were told that a slip 'may or might not' happen in subsequent trials. For the final two sessions, the same process was followed. To keep the patient from falling, the researcher stood by their side. The route was designed to be completed at a comfortable speed for all participants.

2.4.4 Obstacle course training

The course was designed so that participants may complete it without wearing shoes. Everyone was told to follow the researcher's directions. The researcher performed a trial walk around the obstacle course. Following that, each player had to walk through each obstacle course.

The Functional Obstacle course is made up of 12 simulations of functional mobility activities or circumstances that are prevalent at home. Four alternative floor textures are included in each station. Surfaces with varying degrees of gradation may be seen in two of the stations (up & down ramps). Different types of staircases may be found in two stations (exercise stairs commonly used in rehabilitation settings). Functional tasks are available at four locations. The ramp was aligned with the wall so that the patient could readily access it.

2.5 STATISTICAL ANALYSIS

These strategies were used for statistical data analysis. For data analysis, SPSS version 11.5 was employed. The p value of < 0.05 was deemed significant. For data analysis within the two groups, the Wilcoxon signed rank test was utilised. Mann Whitney is a character in the film Mann Whitney the data between the two groups was analysed using the U test.

III. RESULT & DISCUSSION

The data was evaluated for 28 patients, 17 men and 11 females, all of whom had experienced a fall in the previous year. In each group, there were 14 people. The average age of participants in groups A and B was 68 years and 66.12 years, respectively, with standard deviations of 2.5 and 2.4.

3.1 COMPARATIVE ANALYSIS WITHIN THE GROUP

Table 1 - Berg Balance Scale (BBS) Mean and SD at Pre, Post, and Mean Diff. (Pre-Post) for Group A and Group B participants

Table 2 - Mean and SD of TUG at Pre, Post and Mean Diff. (Pre-Post) for the subjects of Group A and Group B

TUG	Group A		Group B	
	Mean	SD	Mean	SD
Pre – Intervention	19.92	1.73	20.14	**2.03**
Post – Intervention	16.00	1.46	17.71	**1.77**
MD (Pre – Post)	**3.92**	**1.32**	**2.42**	**1.08**

Table 3 - Comparison of mean value for Berg Balance Scale (BBS) between Pre and Post Interval within Group A and Group B

Berg Balance Scale	Group A		Group B	
	z value	p value	z value	p value
Pre – Interval Vs Post – Interval	-3.311	0.001	-3.321	0.001

Table 4 - Comparison of mean value for Berg Balance Scale (BBS) at Pre, Post Interval and Mean Diff. (Pre – Post) between Group A and Group B

Berg Balance Scale	Group A Vs Group B	
	U value	p value
Pre – Interval	-1.367	0.171
Post – Interval	-1.623	0.105
MD (Pre – Post)	-0.748	0.454

Table 5 - Comparison of mean value for TUG at Pre, Post Interval and Mean Diff. (Pre – Post) between Group A and Group B

TUG	Group A Vs Group B	
	U value	p value
Pre – Intervention	-0.164	**0.870**
Post – Intervention	-2.481	**0.013**
MD (Pre – Post)	**-2.820**	**0.005**

3.2 LOW FRICTION SURFACE TRAINING COMPARED WITHIN THE GROUP

Subjects become used to slipping on a slick surface after repeated exposure. The majority of slips happen when moving from a sitting to a standing posture [12]. Low friction surfaces encourage participants to get up from a sitting position and walk over them, training them to acquire a posture that reduces the danger of falling. Proactive adjustments, which occur before or in anticipation of disturbance initiation and rely mostly on feed forward control, exhibit adaptive changes in stability control. They can also happen in the reactionary response, which is dependent on feedback systems. As the intervention progressed, the subject's recall of earlier fall prevention measures helped him modify his posture when getting up and walking after each slip exposure after non-slipping trials.

Trials on slick and non-slick surfaces allow individuals to distinguish between the two types of surfaces using sensory input, allowing for optimal postural changes [13]. Controlling the relative motion state (position and velocity) between the body's centre of mass (COM) and its base of support is what stability control is all about (BOS). When the centre of mass of the body shifts, the base of support shifts as well. Recent research based on producing slips during the sit-to-stand task have revealed that frequent exposure to such a low friction surface can be utilised to adaptively increase one's COM state stability, and therefore lower the risk of falling. The subject's response to a slide from reduced surface friction in the walkover pattern mirrored a normal walking pattern with negligible forward BOS displacement [12]. After repeated exposure to slips, the individual develops a posture that keeps the centre of mass inside the base of support, lowering the chance of falling and replacing the protective stepping reaction with a walkover approach under low-friction conditions.

Because they have a lower degree of mobility than young adults, older people have a harder time developing a quick reflexive postural reaction when they fall [14-15]. Slip-training seems to prepare both the reflexive commencement of the recovery step and the conscious control of step length. These individuals learnt to adjust their walking speed in response to the surface's stability needs, resulting in improved stability on low-friction surfaces as well.

3.3 OBSTACLE COURSE TRAINING COMPARED WITHIN THE GROUP

The findings show that the obstacle course might be a valuable tool for assessing older people with balance and mobility issues [16]. The majority of slips among the elderly occur when they come across barriers such as varied floors, rugs, and objects along the path [17-18]. The obstacle course is made up of a variety of surfaces with varying textures and materials, all of which might induce slipping.

The respondents' frequent practise of crossing and moving over barriers allows them to distinguish between different shapes and textures, reducing the danger of falling [19]. Through sensory input acquired from each surface, the individuals learnt to maintain a specific stride length and velocity at each barrier, supporting them in maintaining balance [20].

Vision appears to be the only sensory modality that permits a person to recognise a surface prior to stepping on it. Both avoidance and accommodation techniques for visual regulation of locomotion have been identified. Change the foot location, increase ground clearance, change the gait direction, and alter the velocity of the swing foot are all examples of avoidance tactics. Longer-term changes, such as lowering step length on a slick surface, are part of accommodation methods [22]. Subjects also learned how to adjust their stepping and crossing over pace to achieve safe mobility by using their visual awareness of impediments [20].

The capacity to step over things is an important aspect of ambulation that allows a person to operate safely in real-world situations. During an obstacle course, switching from one surface to the next immediately reduced the response time for a specific surface each time the subject moved over it, which helped them avoid sliding.

3.4 GROUP COMPARISONS OF BERG BALANCE SCALE

The berg balance scale is used to assess a person's performance on 14 items (1 sitting item and 13 standing items) related to everyday balance function tasks. The Berg balance scale is a tool for assessing balance in older people [21]. The individuals' balance improved significantly after completing low friction surface training and an obstacle course. Due to the greater involvement of dynamic components in both training methods, the subjects learned strategies to adapt to various

surfaces, textures, and obstacles in the pathway leading to falls, but because the berg balance scale does not include a gait component [21], the subjects scored lower on the berg balance scale.

Adaptation is reactive in nature and includes the coordination of the neuro musculoskeletal system, whereas anticipation is proactive and involves navigating through complex and sometimes congested situations while utilising various sensory inputs to aid with stability management and adaptation [23].

Both training procedures included activities that provided the requisite sensory input, resulting in improved balance, but berg balance was restricted to a few trials with little sensory input, resulting in scores that were equal for both groups.

3.5 GROUP COMPARISONS OF TIMED UP & GO TEST

Timed up & Go is a balancing test for elderly people that focus on their walking speed and functional abilities. When it comes to issues of balance, functional viewpoints are crucial. Both training approaches include all of the practical parts that a person needs to carry out his or her everyday tasks, which might result in a slip while walking. Low-friction surface training is a type of intervention that uses feedback and feed forward processes to help people achieve balance. In both training methods, proactive adaptation strategies developed through sensory perception of various objects, textures, and surfaces resulted in improved balance in both groups [23].

When both training groups were scored after training on timed up and go, they showed an improvement in balance, but the low friction surface group showed a faster time to walk over the same surface without losing balance due to the inclusion of almost similar tasks in TUG and repeated practise of the same components. They were able to correct their posture according to the pressures presented by using strategies learned via repeated practise, resulting in more stable and safe mobility.

In timed up and go, the low friction surface trained group kept their balance while walking at their normal speed, but the obstacle course group took longer to accomplish the tasks because they had more practise crossing over or stepping over obstacles.

IV. CONCLUSION

Due to the inclusion of nearly identical tasks in TUG and repeated practise of the same components, both training groups showed an improvement in balance after training on timed up and go. However, the low friction surface group showed a faster time to walk over the same surface without losing balance. They were able to adjust their posture in response to the stresses by applying tactics learnt via repetition, resulting in more stable and safe movement.

The low friction surface trained group maintained their balance while walking at their regular speed in timed up and goes, while the obstacle course group took longer to complete the tasks because they had more experience crossing over or stepping over obstacles.

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