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Exploring the Effectiveness of Multi-Component Exercise Training & Environmental Strategies to Prevent Falls in Geriatric Age-Group – A Case Study

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Abstract

Abstract fall is defined as a sudden and unintentional loss of balance, which usually results in landing on the floor. The increase in number of geriatric population will lead to increase in the problem of falls. Its causes can be multifactorial & results are often devastating. Studies have shown that loss of strength, balance, coordination, endurance, and environmental hazards have been strongly associated with falls.

Objectives: The purpose of this study was to determine the efficacy of the home-based rehabilitation including balance, resistance & endurance training and the environmental modification strategies to prevent the risk of falls in the geriatric population.

Aims: The main aim of management was to maximize independence in mobility and functions and prevent further falls.

Methodology: Single subject case study of an 82-years-old male with the chief complaint of falls and minor injuries due to it. Along with the loss of strength, balance & coordination. He was given a home-based rehabilitation for 2months, 5 times a week which included resistance training, balance training & endurance training on alternate days (walking, static cycling). Along with that home setting modifications were done through a home Safety Checklist. Alternations in function were assessed by the Timed Up & Go Test, Five Times Sit to Stand Test, Single Leg Stance Test and The Fall Efficacy Scale International (FES-I).

Result: A decline in the rate of falls in the individual. TUG, 5XSST showed a reduction in time taken, time taken for SLST increased, reduction in score of FES-I and environmental modifications found out to be quite effective.

Conclusion: Home-based rehab program together with home settings modification are an effective way to prevent falls in the elderly.

Keywords: Geriatric population • Falls • Exercise therapy • Environmental modification • Timed up & go test • Individualised home-based rehabilitation

Introduction

Aging is a progressive decline and deterioration of functional & physiological properties at the cellular, tissue, and organ level that lead to loss or decreased ability to adapt to internal or external stimuli and increased vulnerability to disease and mortality [1]. WHO has defined elderly as a chronological age of 65 year or older [2]. According to United Nations Department of Economic and Social Affairs there were 703 million persons aged 65 years or over in the world in 2019. The number of older persons is projected to double to 1.5 billion in 2050 There were 703 million persons aged 65 years or over in the world in 2019. The number of older persons is projected to double to 1.5 billion in 2050 [3]. With this growing geriatric population, the problem of age-related falls is growing tremendously. Falls are the main cause of morbidity and mortality in the elderly. It is a leading cause of injury deaths, unintentional injuries, fractures, and hospital administration. It can be a major threat to the quality of life.

A WHO's Global Report on Falls Prevention showed that among community-dwelling older people over 64 years of age, 28-35% fall each year. Of those who are 70 years and older, approximately 32%-42% fall each year. The prevalence of falls increases with age and frailty level. The majority of falls (56%) happen outside the home. Falls that occur inside the home (44%) happen while carrying out activities like bathing, toileting, walking, and change in position. 67% of the patient sustained injury [4].

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Falls in the geriatric age group can be precipitated by multiple underlying factors. It is majorly divided into intrinsic and extrinsic factors. Intrinsic factors include Age-related physiological changes – Decline in the Sensory component (proprioception, vibration, vestibular system) & Motor component (postural control strategies, musculoskeletal response). Pathological diseases-Musculoskeletal disorders (Pain and disease of joints, loss of muscle strength, myopathies, balance and gait impairments, foot problems, fractures, and dislocations), Neurological disorders (parkinsonism, epilepsy, cerebellar disorders), Cardiovascular disorders (arrhythmia, postural hypotension, decreased cardiac output), Visual disorders (cataract, refractive errors). Deterioration of Postural Control System (due to aging and pathological changes) and Polypharmacy. Extrinsic factors include Environmental hazards – Indoor (slippery floors, clutter obstructing walkways, cupboards/shelves too high or too low, rugs/carpets, improper shoes, bathroom fixtures, the height of chair and bed, unstable furniture, staircase without handrails), Outdoor (sloping, slippery, obstructed or uneven pathways snow or ice). Environmental hazards are often neglected but can be the major cause responsible for falls in the elderly [5-8].

Systemic clinical approach for a multidisciplinary examination and evaluation should guide the management for the prevention of falls in older adults. A detailed patient history along with higher functions, sensory/motor, balance, coordination, gait examination is important to rule out the cause/causes. Fall risk assessment and Environmental assessment is of utmost importance [5,6].

A Cochrane Review, "Exercise for preventing falls in older people living in the community" found that exercise programs and environmental modifications reduce falls rate (by 23%), reduce the number of people experiencing more than one fall (by around 15%), and may reduce the risk of fractures (by 27%) [9]. Starting at 30 years our muscles can lose up to 8% of their strength every decade. By the time of 80 years, we potentially lose 40% of our strength. It is evident that it could be reversed by working on the strength, balance, flexibility & coordination. An older person with impaired physiology may fall easily in an unchallenging environment. The study shows that the individual's risk for falls

can be reduced by the interaction of mobility, behaviour and environmental modification interventions. A barrier-free environment with proper illumination, non-skid floor & rugs, grab bars, railings along the stairways, etc, reduces the risk of falls significantly [10,11].

Objectives

The objective of the study was to see effectiveness of individualised home-based rehabilitation program along with environmental modification strategies to prevent the risk of falls in the geriatric population.

Method

Design: Single subject case study

Subject: 82-year-old male

Material used: chair, stopwatch, measuring tape, Chalk, 1 kg weight cuff, rehabilitation board of lower limbs (which includes slant board, foot roller, band for toes extension & curling).

Case Description

Patient's consent was taken before beginning with the case study.

Patient history

The case study includes an 82year old man. His chief complaints are of frequent falling (getting out of bed, tripping on the carpet, falling in the living room/bedroom) & minor injuries due to fall along with generalized weakness, pain in knee joints, frequent urination and decreased joint movements. He has a history of hypertension which is generally controlled by medications and visual impairment. He uses a walker for mobility in the house & rarely goes out of his house due to fear of falling. He is capable of doing activities of daily living with little assistance. At present, he has a sedentary lifestyle and denies the use of alcohol, tobacco, or illicit substance.

Examination

On observation, the subject was found to have a lean body build with a stooped/ flexed posture. When asked to walk without a walker, he could walk some steps. The subject walked cautiously with minimal arm swing, trunk, and pelvic rotation. The stride length was quite small during the gait cycle. On examination higher functions, cranial nerves, sensations, and deep tendon reflexes were normal. There was no occurrence of vertigo when evaluated for vestibular function. The time recorded for Five-Time Sit to Stand Test [12]. (Assesses functional lower extremity strength, transitional movements, balance, and fall risk in older adults) was 22 seconds which indicates a risk for falls. On MMT Plantar flexors and dorsiflexors had grade 4 strength and hip abductors had grade 3+ strength. Decreased muscle tone and range of motion of joints. Tightness in hamstrings and gastrocnemius soleus [13]. The static and dynamic balance of sitting were normal. Static balance was ok on standing but the dynamic balance wasn't good. He was able to perform Non-equilibrium coordination tests. Equilibrium coordination tests were poorly performed due to poor dynamic balance. He was able to perform a single-leg stance test for only a couple of seconds. He loses his balance after 3.5 seconds in the tandem stance. He took 19 sec for Timed up & go test [14]. With a walker. The Falls Efficacy Scale International result was 22 [15].

Environment assessment included a home safety checklist [10,11]. Lightings were proper. Walking space inside the house was limited & insufficient because of more furniture. Height of the bed was high. Use of rugs outside the washroom, in the living & bedroom. Absence of grab bars in the toilet, near the bed & walking area. Slippery tiles in the bathroom. Ill-fitting footwear, assistive devices was good and stable (Figures 1, 2 and Tables 1, 2).

Diagnosis & Plan

The assessment pointed towards the lack of strength, balance, flexibility & coordination in the patient due to aging. The environmental evaluation showed unorganized space to live in, for the older person and lack of awareness of environmental hazards which can cause falls in the elderly. Based on the above assessment, the patient seems to be prone to falling.

Aim for the treatment: The main aim of management was to maximize independence in mobility and functions and prevent further falls.

Goals for the treatment: The goals for the home-based rehabilitation were to improve lower limb muscle strength (foot intrinsic muscle, Knee flexors, knee extensors, and hip abductors, Ankle dorsiflexors, and plantar flexors), stretching of tight muscles, to gain dynamic balance and coordination. Also, to do alteration in the home, to create a safe environment, and to add safety tools that can help to prevent falls.

Intervention

Before beginning of the intervention, the patient was thoroughly explained about the procedure. It was given in presence of assistance.

F - The intervention was done for 2 months, 10-12 repetition, 2 sets, 5 times a week, static cycling & walking in-between days (changes were made). Adequate rest was given in between to avoid any discomfort.

I - moderate

T- 30 -45 min approximately

T- Strength, balance training

1) Warm Up- for 5-10min. Head, Neck, shoulder, wrist, Trunk, Ankle movements, Back extension x 5 each side.

2) Strengthening exercise- in supine lying, static quads ex, one leg raising ex, bridging ex. In standing position, Front knee extension ex Back knee flexion ex, Side abduction ex, Calf raises hold and support, Toe raises hold and support. Progression – 1 kg of weight cuff [16-18].

3) Balance & coordination training- with support of a firm chair. Knees bend hold and support, Heel to toe standing - hold and support, sit to stand- with both hands & at a normal pace, Clock reach hold and support, Walking and turning around with a walker, Sideways walking with a walker, Stair walking. The patient was asked to take a handkerchief at different arm lengths [16-18].

4) Exercise on the rehabilitation board (in presence of some assistance)- 25° angle for calf, hamstring, and plantar fascia stretch. Toes extension, curling with a resistance band, and use of a foot roller for the strengthening of foot muscles.

5) Following environmental alterations were done in the house-

I. Installation of grab bars near the toilet seat, bathing area, near the bed, and in the living room.

II. The bed was adjusted to low height.

III. Replacement of normal doormats with a non-skid doormat outside washroom, bedroom.

IV. Removal of rugs from the living area and bedroom.

V. Application of PVC anti-slip mats on the bathroom floor.

VI. Arrangement & elimination of unwanted furniture to allow broader space for wide walkways.

VII. Clutter & cords free walkways.

6) He was taught how to get up from the chair and bed. Instructions were given to get up from a chair-

I. Move your bottom to the edge of the chair.

II. Place both feet firmly and flat on the floor.

III. Place both hands on the armrests of the chair. If there are no armrests, place both hands on the edge of the seat.

IV. Lean forward so that nose is over the toes (this helps to move centre of gravity forward).

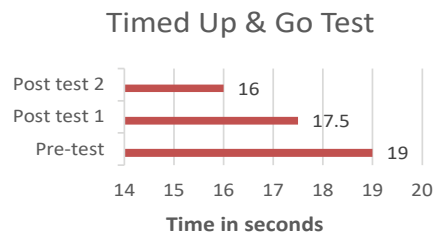

Figure 1. Graphical presentation- pre-post intervention Timed up & go measures.

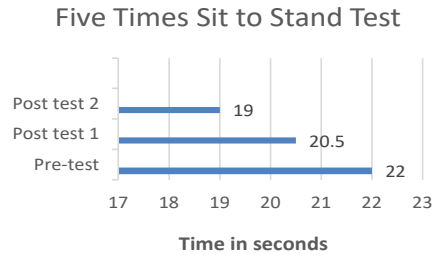

Figure 2. Graphical presentation pre-post intervention 5 SST measures

Table 1. Home Safety Check List.

Entrance and Exits	Check for railings, lightings and surfaces.
Floors	Check for clutter, cords, rugs removed or stapled down, smooth surfaces.
Washroom	Check for anti-slip flooring, grab bars, non-slip mats near toilet seat, bath tub.
Bedroom	Check for Lamps, essential things and phones within reach of bed.
Kitchen	Height of the cabinets should be within reach, Safe step stool, refrigerator opens easily and non-slip mats.
Stairs	Railings run full length of stairs, ideally both sides, well brightened.
Walkways	Check for wide walk area, clutter or any obstacle.
Furniture	Check for its stability, height.
Shoes	Non-slip soles made from hard rubber, not leather.
Emergency phone no.	Should be written in the diary or near landline.

Table 2. Fall Efficacy International Score before and after the Intervention.

		None	**A little**	**Medium**	**A lot**
		No concern	Somewhat concerned	Fairly concerned	Very concerned
1.	**Getting dressed or undressed**	1	2	3	4
2.	**Taking a shower or a bath**	1	2	3	4
3.	**Getting in or out of a chair**	1	2	3	4
4.	**Going up or down stairs**	1	2	3	4
5.	**Reaching for something above your head or on the ground**	1	2	3	4
6.	**Walking up or down a slope**	1	2	3	4
7.	**Going out to a social event**	1	2	3	4

Total = 22 (before intervention), 19(after intervention).

V. Push down through arms as you help unload your weight off the chair.

VI. As you begin to rise, straighten your legs.

VII. Let go of the chair and finish straightening your legs.

VIII. Stand up nice and straight.

Instructions were given to get up from the bed-

I. Move about 10cm away from the edge of the bed (this will allow you to get up without the risk of falling out of the bed).

II. Bend your knees that the sole of your feet is flat on the bed and close to your buttocks.

III. Turn to the side from where you have to get down. Hold on the edge of the bed with the hand farthest from it to keep yourself stable.

IV. Sitting up. Start by putting both the legs over side of the bed. Push down with your left hand and take the support of the right hand to sit up in one go while keeping back straight.

V. Once you sitting up, hold up to the edge of the bed, bend forward and pull yourself up.

Results

The home-based rehabilitation program was found to be quite effective in preventing falls in the patient. There was an improvement in all the parameters used for the assessment. The Timed Up and Go Test showed a gradual reduction in time taken to complete the task(16sec), The Five Times Sit to Stand Test took 19 seconds to complete, he was able to stand 6 seconds in tandem stance. The Fall Efficacy Scale International score was 19.

There was a reduction in no. of falls due to environmental hazards. The patient took the support of the grab bars during different activities. No incidence of falls due to slipping or tripping on the rug or doormat. Anti-slip mats in the bathroom prevented slip in that area. Lowering of the bed height allowed him to practice safe & easy transfer. The patient and the family members were now more cautious about any obstacle which can cause falls.

Discussion

Exercise in the elderly plays a major role in improving their health. It lays an important effect on various systems of the body. It also reduces stress/ anxiety, improves self-confidence, and helps to improve the physiological as well as psychological changes occurring during aging. People are aware of the benefits of doing exercise but in the case of the elderly, it is not preached to that extent.

Falls in older adults has become a very common phenomenon. A rehabilitation program along with the treatment of risk factors can drastically prevent this event to occur. In this study, we found that the score on the assessment scales markedly improved after 2 months of intervention. Individualized home rehab program found to have a significant effect on the patient's strength, balance & coordination. Strength and balance training helped the individual to be functionally independent without fear of falling. Aerobic exercises like walking and cycling helped to increase the patient's endurance. Environmental modifications were found out to maximize & support the ambulation and transferring functions of the patient. Chair & bed transfer techniques allowed safe transfers.

However, the major limitation of this study is that it cannot be generalized. Generalization of the findings of this study would require a controlled trial of the treatment protocol on a greater number of similar subjects. Also, the protocol used in this study has to be modified according to the condition and the needs of the older individual.

Conclusion

It was concluded that the risk of falling is preventable in older Adults. The basic aim of the intervention was to provide quality of life to the older individual and to promote healthy and safe living. A comprehensive assessment should guide the management of falls in older adults. A physiotherapist has a crucial role to screen the individual for risk of falls and to manage a fall prevention program. PT can prescribe specific exercises, activities, and interventions and provide advice on managing environmental risk. The results of this case study suggest a practical and cost-effective way of imparting a physiotherapeutic individualized intervention comprising strength, balance, coordination & endurance training along with environmental alterations for preventing falls in the elderly. Exercise in the elderly should be a part and parcel of their lives.

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