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Effect of Eccentric Exercises Versus Core Stability Exercises on Falling Risk and Functional Capacity in The Elderly A Randomized Clinical Study

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ABSTRACT

Background and aim: to compare the effects of eccentric and core stabilization exercises in elderly patients with risk of falls.

Materials and Methods: The present randomized study included 60 patients with risk of falls. Patients were equally and randomly assigned to one of the two groups: Group 1 (n=30) received 3 eccentric exercises for the muscles of the lower limbs (according to the patient selection and his abilities) and Group 2 (n=30) received 3 core stability exercises for the trunk muscles using the Swiss ball (according to the patient selection and his abilities). Balance and aerobic capacity were reassessed for all patients after the last session of exercise. Balance was assessed using three tests (Berg Balance Scale (BBS), Functional Reach Test (FRT) and Balance Y-MED). The aerobic capacity of participants was assessed using 6-minute walk test (6MWT), timed up and go test (TUG) and Borg scale for perceived exertion (RPE).

Results: No statistically significant differences between the studied groups regarding Berg Balance Scale, Functional Reach Test and Balance Y-MED measured at baseline or after end of exercises. However, in both groups all the three outcome parameters showed significant improvement after end of exercise. Likewise, no statistically significant differences between the studied groups regarding 6-minute walk test, timed up and go test and Borg scale for perceived exertion. However, in both groups all the three outcome parameters showed significant improvement after end of exercises. **Conclusion**: Both eccentric and core stabilization exercises have positive impact on balance and physical performance parameters in older adults with risk of falls.

Keywords: Falls, Eccentric exercises, Core stabilization exercises.

1. Introduction

Falls are one the most prevalent health risks in the elderly with significant impact on patients' morbidity, mortality and health system use (Kimura et al., 2023). Yearly, it's estimated that one of every four older adults in the United States experience falls (Shankar and Li, 2023). Consequences of falls include head and/or neck injuries, upper extremity injuries, trunk injuries, lower extremity injuries, fractures, dislocations and/or sprains, loss of consciousness, disabilities and hospital admissions (Biswas et al., 2023). Risk factors of falls among elderly populations include use of psychotropic medications (Hughes, 2022), polypharmacy, history of falls, history of fracture, walking aid use, dizziness (Guo et al., 2023), orthostatic hypotension, sensory impairment and balance disorders (Colón-Emeric et al., 2024).

Considering the detrimental effects of on patients' quality of life, prevention of falls has been a top health priority in this population. Suggested interventions include management of underlying medical conditions, multicomponent podiatry interventions and environmental modifications (Colón-Emeric et al., 2024). Enhancement of physical activity that includes various types of exercises has been also reported among the most effective interventions in prevention of falls (Papalia et al., 2020; Wiedenmann et al., 2023).

Eccentric exercises are frequently used for prevention and management of miscellaneous musculoskeletal conditions (Kanniappan and Sathosh, 2020; Mansur et al., 2021). Advantageously, eccentric exercises were found to trigger endogenous neuroplastic processes which may be particularly useful in elderly people (Clos et al., 2021). Moreover, it was reported that eccentric exercises proved to be more effective in management of age-related muscular atrophy in older adults when compared with traditional strengthening programs. This is probably attributed to the fact that eccentric force shows relatively less decline with age (Lim, 2016).

In contrast, core stabilization exercises (CSE) is known as a vital element in clinical rehabilitation and competitive athletic training. It comprises of a complex network of hip, trunk and neck muscles exercises (Sannasi et al., 2023). CSE have the potential to significantly enhance balance control by fortifying the intersegmental musculature, including the multifidus, transversus abdominis, and rotators, while simultaneously optimizing physiological functions in a coordinated manner. When integrated with Swiss ball exercises, CSE elicits a robust

stimulation of proprioceptive mechanisms, thereby refining the sense of equilibrium and augmenting the capacity for sustained postural stability (Ko et al., 2014).

Aim of Work

The current work sought to comparatively analyze the effects of eccentric and core stabilization exercises in elderly patients with risk of falls.

2. Material and methods

Setting and participants

The present study was conducted at the Palestinian Red Crescent Society, Cairo, Egypt. The study protocol was approved by the ethical committee of the Faculty of Physical Therapy, Cairo, University. Written informed consent was obtained from all the participants. The study included 60 patients older than 60 years with risk of falls. Patients were excluded if they were smokers, underweight, obese or diagnosed with any clinical diseases e.g. ear diseases, pulmonary disorders, metabolic disorders, coronary artery disease, neurological diseases, recent musculoskeletal injuries, renal diseases or hepatic diseases.

Baseline evaluation

At baseline, all participants were subjected to careful history taking and thorough clinical assessment. In addition, balance was assessed using three tests (Berg Balance Scale (BBS), Functional Reach Test (FRT) and Balance Y-MED). BBS assesses balance and risk of falls through direct observation of the participant's performance by trained health care professionals in a variety of settings. It is a 14-item list with each item consisting of a five-point ordinal scale ranging from 0 (lowest) to 4 (highest). The test takes approximately 20 minutes to complete. All subjects were well informed about this scale and about how the scores are determined (Berg et al., 1992). FRT is clinical outcome measure for assessment of dynamic balance in simple task. It measures the limits of stability of individuals while reaching forward in a standing position. Subjects were given two practice trials, and then their performance on an additional three trials were recorded and averaged. Scores less than 15 or 18 centimeters indicate limited functional balance. Most healthy individuals with adequate functional balance can reach 25 centimeters or more (Duncan et al., 1990). Balance Y-MED is a smartphone application validated for assessment of postural balance (Gwangju Health College, South Korea) (Park et al., 2013).

The aerobic capacity of participants was assessed using a battery of clinical tests including the 6-minute walk test (6-MWT), timed-up and go test (TUG) and Borg scale for perceived exertion (RPE). 6MWT is used to measure the maximum distance that a person can walk in 6 minutes (ATS Committee on Proficiency Standards for

Clinical Pulmonary Function Laboratories, 2002). TUG test is a reliable, cost-effective, safe, and time-efficient way to evaluate overall functional mobility. The patient started in a seated position and is asked by the therapist to stand up walk 3 meters, turn around and then walks back to the chair and sit down with documenting the assistive device if it will be used (Shumway-Cook et al., 2000). RPE is a tool for measuring an individual's effort and exertion, breathlessness and fatigue during physical work and so is highly relevant for occupational health and safety practice.

Randomization and blinding

All participants were randomly and equally allocated to one of the study interventions using computergenerated random sequence and sealed envelope technique. Randomization and allocation of participants were supervised by an independent researcher who wasn't aware of the study nature. While blinding of patients to interventions wasn't possible, baseline and final outcome assessment was performed by nurses blinded to patients' allocation.

Interventions

The 60 participants received balance training exercises in the form of weight shifting side to side from standing on the ground and then progressed to balance training on the balance board. In addition, they were equally and randomly assigned to one of the two interventional groups that received the interventions described below: Group A: received 3 eccentric exercises for the muscles of the lower limbs (according to the patient selection and

his abilities).

Group B: Received 3 core stability exercises for the trunk muscles using the Swiss ball (according to the patient selection and his abilities).

In both groups, participants received the same warming up and cooling down exercises. Exercise regimen was continued for 3 times weekly for 3 consecutive months and each session lasted 40 minutes.

Outcome assessment

Balance and aerobic capacity were reassessed for all patients after the last session of exercise.

Statistical analysis

Statistical analysis was conducted by using statistical SPSS Package program version 25 for Windows (SPSS, Inc., Chicago, IL). Quantitative data were expressed as mean and standard deviation (SD). Intergroups comparisons were achieved using student t test while intragroup comparisons were achieved using paired t test.

Qualitative data are expressed as number and percentage and compared using chi-square test. p value less than 0.05 was considered statistically significant.

Results

The present study included 60 elderly patients with history of falls equally and randomly assigned to eccentric exercises of the lower limbs (Group A) or core stabilization exercises (Group B). Comparison between the studied groups regrading the baseline data revealed no statistically significant differences regrading age, sex distribution, weight, height and body mass index (Table-1).

Comparison between the studied groups regarding balance assessment scales revealed no statistically significant differences between the studied groups regarding Berg Balance Scale, Functional Reach Test and Balance Y-MED measured at baseline or after end of exercises. However, in both groups all the three outcome parameters showed significant improvement after end of exercises (Table-2).

Likewise, comparison between the studied groups regarding aerobic capacity assessment scales revealed no statistically significant differences between the studied groups regarding 6-minute walk test, timed-up and go test and Borg scale for perceived exertion. However, in both groups all the three outcome parameters showed significant improvement after end of exercises (Table-3).

Discussion

The present study comparatively assessed the effect of eccentric and core stabilization exercises on balance and aerobic capacity in elderly patients with history of falls. The study found that both types of exercises can significantly improve balance and aerobic capacity in the study participants with no advantage of any intervention over the other.

The rationale of using eccentric exercise in older adults at high risk of falls is justified by many studies. In a recent one, older adults were found to have less eccentric work, higher postural sway and impaired swinging leg balance control as compared to young counterparts (Jeon et al., 2023).

The positive impact of eccentric exercises in our patients is supported by conclusions of previous reports. Eccentric exercise proved to muscle strength, muscular activity, balance, gait speed, and functionality in healthy people (Katsura et al., 2024) and in patients with many clinical conditions including stroke (Perez et al., 2024), other neurological diseases (Le Sant et al., 2023) and other chronic conditions (Sadacharan, 2023). The two recent systematic reviews of Kulkarni et al., (2022) and Kim et al., (2022) concluded that eccentric exercises can be as effective as conventional exercises in older adults with history of falls. Evidence suggests that such exercise interventions can lead to an improvement in multiple domains of geriatric functions.

Many mechanisms were provided to explain the benefits of eccentric exercises. It was found that eccentric exercise results in increase of nuclear factor erythroid 2-related factor 2 activity in human peripheral blood mononuclear cells (Thorley et al., 2023). In addition, eccentric exercise like other types of exercise is involved in the exercise-mediated reinnervation of skeletal muscle in elderly people (Coletti et al., 2022). Moreover, it was found that eccentric exercise can enhance myocardial oxygenation balance with decelerating aortic diastolic pressure deterioration (Tagawa et al., 2023).

As for core stabilization exercises, their contribution to enhancing balance and gait control was previously approved in patients with multiple conditions including hereditary ataxia (Cabanas-Valdés et al., 2024), hip osteoarthritis (Dalmas et al., 2023) multiple sclerosis (Yaşa et al., 2022) and back pain (Ge et al., 2022).

In older adults, core strengthening and balance exercises were found to be essential for better balance and fall prevention in postmenopausal women (Ozsoy-Unubol et al., 2021) and were associated with better physical performance, improved psychological functions and less fear of falling in elderly women vulnerable to falling (Ko et al., 2014). Even in patients with fall-related hip fracture, core stabilization exercises increased lower extremities strength, ambulation distance and speed, active range of motion, and transfer ability (Stivala and Hartley, 2014).

Findings of the present study may be limited by the relatively small sample size and by being a singlecenter study.

Conclusion

In conclusion both eccentric and core stabilization exercises have positive impact on balance and physical

performance parameters in older adults with risk of falls with no advantage of one program over the other.

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Disclosure

Authors of the present study declares no conflict of interest.

	Group A N=30	Group B N=30	p value
Age (years)	66.1 ± 3.0	67.3 ± 3.1	0.13
Sex (Male/female)	23/7	21/9	0.56
Weight (kg)	84.5 ± 5.9	81.8±6.1	0.09
Height (cm)	173.6 ± 4.9	173.4 ± 4.9	0.88
BMI (kg/m ²)	28.1 ±1.9	27.2 ±1.6	0.10

Tables and graphs

Table-1 Baseline data in the studied groups

 25.7 ± 2.9

< 0.001

 766.1 ± 37.6

 905.9 ± 46.4

< 0.001

0.25

0.06

0.43

BMI: Body mass index

Final

p value

Baseline

Final

p value

Balance Y-MED

	Group A N=30	Group B N=30	p value
Berg Balance Scale	11.50	11-50	
Baseline	49.57 ± 3.4	50.3 ± 3.1	0.49
Final	52.67 ± 2.3	53.2 ± 2.2	0.23
p value	< 0.001	< 0.001	
Functional Reach Test			·
Baseline	21.8 ± 3.0	22.4 ± 2.9	0.58

Table-2 Baseline and final balance assessment scales in the studied groups

Table-3 Baseline and final aerobic capacity assessment scales in the studied groups

 24.7 ± 2.7

< 0.001

 724.6 ± 28.8

 905.9 ± 35.9

< 0.001

	Group A N=30	Group B N=30	1		
			p value		
6-minute walk test			·		
Baseline	161.6 ± 53.6	189.2 ± 61.7	0.08		
Final	213. 7 ± 60.6	245.4 ± 87.7	0.15		
p value	<0.001	< 0.001			
Timed up and go test		I	I		
Baseline	15.2 ± 5.8	13.5 ± 4.3	0.054		
Final	10.9 ± 3.2	10.7 ± 4.0	0.11		
p value	< 0.001	< 0.001			
Borg scale for perceived exertion					
Baseline	9.1 ± 2.1	8.5 ± 1.1	0.32		
Final	7.2 ± 1.9	6.4 ± 1.3	0.13		
p value	<0.001	< 0.001			

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