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Influence of Ankle Dorsiflexortorque on Balance Performance in Elderly

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ABSTRAC

Objective- Ageing is associated with changes to the structure and function of the foot and ankle, and there is preliminary evidence that foot problems impair balance.The present study was done with the aimto study the effects of resisted ankle dorsiflexors exercises on balance in elderly individual with the help of balance measures FRT, BBS. The lower extremity muscle torque was evaluated using strain gauge., **Method-** 20 elderly subjects both males and females, age-group >60 years were divided into two groups: Group 1(n=10) resisted exercises for 20 minutes and 4 sessions/week for 6 weeks and Group 2 (n= 10) was encouraged active life style. The balance scores were assessed using FRT, BBS., **Result-** Within group analysis shows that both groups had significant improvement in the variables ($p< 0.05$) but there was no significant change between the groups ($p < 0.05$)., **Conclusion-** Interventions to improve the strength and flexibility of the foot improve balance and help to reduce the risk of falls.

INTRODUCTION

An estimated functional 25 to 30% of adults aged 65 years and older fall each year.[1]Maintaining balance and performing functional task depends on interaction of multiple sensory, motor and integrative systems. These systems include vision, vestibular function, peripheral sensation, strength and reaction time. Functioning of each of these factors declines with age. By directly assessing an individual's physiological abilities, impairments in one or more physiological domains can be identified and their contribution to physical ability can be determined.[2] The likelihood of having difficulty in carrying out basic life activities increases as individual ages.[3]Fall in elderly generally affect their quality of life. Risk factors associated with falls include musculoskeletal weakness, balance deficit, history of falls, visual deficit, gait abnormalities, cognitive impairments, arthritis, impaired activities of daily living, cardiovascular diseases, depression, medication, use of assistive device or age (>80 years). However, muscle weakness, impaired gait and diminished balance are the most significant risk factors for falling. (4)

Flexibility at ankle joints provide an important contribution to safe execution of many functional tasks(example walking, negotiating stars, rising from a chair) and added efficiency in maintenance of postural ability. Ankle movements are also necessary for muscular responses used to maintain perturbations to balance, such as rapid compensatory stepping movements. Loss of joint range is considered to be a part of normal aging process. Therefore, decreased ankle ROM with age may compromise balance, thus limiting functional activities such as ambulation. (5)

The ability to maintain control of posture is critical for the successful performance of most daily activities. Visual, vestibular and somatosensory signals are sent to the CNS, which can adjust body sway and posture by integrating the information and by controlling skeletal muscles

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to appropriately generate joint torque and adjust joint angles. Wolfson et al found that torque generated by the ankle muscles were reduced in older adults who were identified as having the greatest balance impairment on the sensory organization test. Impairment in any component of the postural control system can lead to instability and fall in older people. [6]Loss of balance and falls in the elderly constitute a major problem associated with human suffering as well as high costs for society. Falls might occur during various daily activities, such as tripping or tangling the feet, reaching movements or bending. Many of these activities are constrained by limits of stability (LOS). LOS can be described as the maximum distance a person can intentionally displace his/her centre of gravity, and lean his/her body in a given direction without losing balance, stepping or grasping. Ageing is associated with decreased LOS, muscle strength and foot sensation. Investigators have reported significant correlations between postural stability, quadriceps, ankle dorsiflexion and hand-grip strength, tibialis anterior latency and functional clinical balance testing among older adults. [12]

Impairment motor performance of an older individual is often characterized by a slowing of movements, a decline in muscle strength during growth and ageing have been a matter of sporadic scientific interest. Physiological evidence indicates that there is a 30-40% decline in isometric forces and approximately18% reduction muscular mass between 2nd and 7th decade of life. Strength decline was found to correlate significantly with the type-2 fiber atrophy in old age. Simmonson et al (1947) found leg strength has been found to decline more rapidly with the age than handgrip. Maximum strength would be expected to depend on total number of muscle fibers recruited .Consequently, the assumed age dependent decrease in the total number of muscle fibers together with the muscle atrophy might be the primary cause of decline in the strength during ageing. Other mechanisms such as change in endocrine activity , reduction of the intra-muscular blood flow in the neuromuscular system and in contractile protein and protein metabolism have been suggested as associated with decline in muscle strength, with age and may cause the decrease in the total number of muscle fibers.[7]

Maximum isometric force decreases, the muscles fatigue more rapidly and the rate of tension development is slower. Concentric contractions are more affected by age related changes in the neuromuscular system than are eccentric contractions .When poor posture exists, many unfavorable changes takes place altering the structures of the parts, disturbing their normal relations and the normal muscular balance is lost. Elderly people with the history of falls had less than non-fallers. The difference was more prominent at ankle than knee and was most pronounced in the ankle dorsiflexors. [8]

Studies by Sunil Bhatia, et al show that Lower limb and trunk muscle strengthening have positive effect on balance improvement in elderly however no significant differences in clinical outcome between the two groups. [8]Shalini Grover&AbhaKhuranafound a significant differences in ankle and subtalar range of motion and balance scores in females implying correlations exists between ankle dorsiflexors ROM and balance in females[5]. Study by Hylton B. Menz, et al stated that foot and ankle characteristics particularly ankle flexibility, plantar tactile sensation and strength of toe plantarflexors muscles, are significant independent predictors of balance and functional ability in older people. Programs to improve the strength and flexibility of the foot and intervention to augment plantar sensation may be beneficial in improving mobility and reducing the risk of falls.[2]

As studies have shown that improving ankle ROM, especially dorsiflexion has a positive correlation with balance and studies have seen the effect of improving general lower extremity muscle strength on balance, the present study was done with the aimto study the effects of ankle dorsiflexorstorque on balance measurements in elderly and the influence of resisted ankle dorsiflexors exercises on balance in elderly individual with the help of balance measures (FRT, BBS) and IADL was studied. One reliable and valid performance-based functional measurement test is the berg balance scale that addresses various static and dynamic functional capabilities in sitting and standing. [9] The functional reach test evaluates the maximal distance a person can reach forward while maintaining a fixed base of support. [10] Lower extremity muscle force was evaluated using strain

gauge. Studies have shown that the strain gauge to be reliable tool for clinical measure testing. [7] The Lawton IADL is an easy to administer assessment instrument that provides self-reported information about functional skills necessary to live in the community. [11]

METHODOLOGY

Study design was experimental in nature.

Sample20 subjects(n==20) were included in the study,randomly assigned into 2 groups,Group A(n=10) training group and group B(n=10) control group. Subjects were recruited from physiotherapy OPD of BanarsidasChandiwala Institute of Medical Sciences and residents of Karol Bagh. Inclusion Criteria was elderly individuals, age group 65-75 years (both males and females), ability to walk without assistive devices and asymptomatic degenerative conditions like osteoarthritis, lumbar spondylosis etc.[7]Exclusion Criteriawas presence of any musculoskeletal impairment that could account for possible imbalance and falls such as cardiovascular accidents, cardiac problems, transient ischaemic attack or lower limb joint replacement,[7]presence of any neurological impairment such as Parkinson's disease, stroke, Multiple Sclerosis, etc.Persons undergoing balance training and strengthening exercise training for lower limbs, Uncooperative patients, those having any severe respiratory or peripheral vascular diseases, recent fracture in lower limb or upper limb,arthroplasty of hip, knee and ankle, acute symptoms of Lumbar spondylosisand Cervical spondylosis and Rheumatoid arthritis

Dependent variables were BBS, FRT, IADL and Strain gaugeand Independent variablewas Dorsiflexors strengthening exercises.Patients were explained about the nature and purpose of the study and written informed consent was taken from those willing to participate in the study.In both the groups, the measures of balance (FRT, BBS) and IADL and ankle dorsiflexors muscle force using strain gauge was doneas base line measurement on the first day (pre-test scores) prior to startof study, and repeated after 6 weeks at the completion(post test scores).

GROUP A - resisted exercise training for ankle dorsiflexors muscles was done with the patient in supine lying position; manual resistance applied to dorsum of foot to resist dorsiflexion while stabilization applied to lower leg; hold time 30 sec, rest time 30 seconds after each contraction (to avoid fatigue). Duration of exercise training - 20 minutes/session and 4 sessions/ week for 6 weeks was done.

GROUP B - no intervention except encouragement for performing their usual activities of daily living independently.

RESULTS

SPSS-8 was used for data analysis. Paired T-Test applied within the group,unpaired T-Test applied between groups. Level of significance p-value< 0.05 considered significant. The mean pre-test scores for FRT, BBS & Strain gauge nearly the same for both groups indicating both groups were same at starting point. Paired t-test was applied to compare the pretest (Base line score i.e 0 sessions) and post test (completion of 6 weeks) for FRT, BBS & Strain gauge. Within group significant improvement seen in FRT, BBS & Strain

	GROUP	N	Mean	Std. Deviation
FRTPRE	Exp. (1)	10	16.56	3.768
	Cont.(2)	10	17.10	4.094
FRTPOST	Exp. (1)	10	23.65	4.956
	Cont.(2)	10	19.92	4.371
BBSPRE	Exp. (1)	10	48.40	4.551
	Cont.(2)	10	48.60	2.989
BBSPOST	Exp. (1)	10	52.80	2.936
	Cont.(2)	10	51.00	2.944
SGPRE	Exp. (1)	10	4.05	1.860
	Cont.(2)	10	4.13	1.546
SGPOST	Exp. (1)	10	6.92	2.218
	Cont.(2)	10	5.19	1.537
IADLPRE	Exp. (1)	10	3.60	.843
	Cont.(2)	10	5.20	1.317
IADLPOST	Exp. (1)	10	3.60	.8433
	Cont.(2)	10	5.20	1.3166

Independent Samples Test

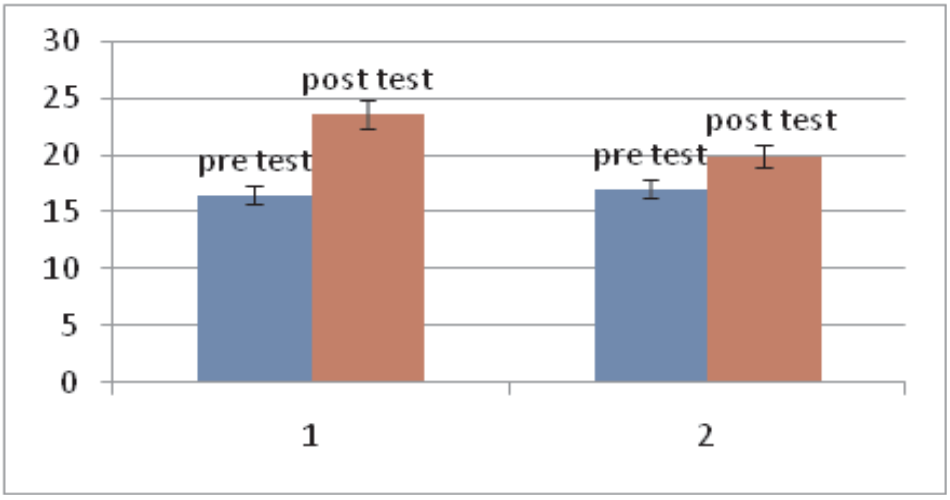
	t-test	Significance (2-tailed) P<0.05
FRT (PRE)	.307	>0.05
FRT(POST)	1.785	>0.05
BBS (PRE)	.116	>0.05
BBS(POST)	1.369	>0.05
SG (PRE)	.111	>0.05
SG (POST)	2.024	**<0.05**
IADL (PRE)	3.236	<0.005
IADL(POST)	3.236	<0.005

Paired Samples Test

		EXPERIMENTAL GROUP (GROUP 1)		CONTROL GROUP (GROUP 2)	
		t-test	Sig.(2-tailed) P<0.05	t-test	Sig (2-tailed) P<0.05
Pair 1	**FRTPRE-FRTPOST**	7.870	<0.05	8.880	<0.05
Pair 2	**BBSPRE – BBSPOST**	6.736	<0.05	6.000	<0.05
Pair 3	**SGPRE – SGPOST**	5.327	<0.05	4.999	<0.05

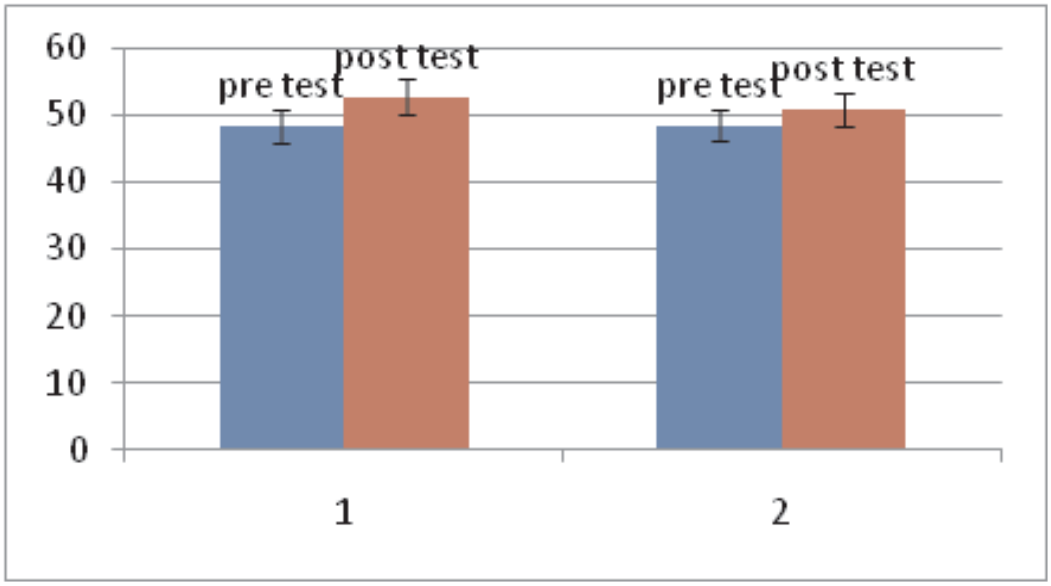
MEAN % IMPROVEMENT	GROUP 1(N=10)	GROUP 2 (N=10)
Functional reach test	42.8%	16.49%
Berg balance scale	8.884%	4.938%
Strain Gauge	70.99%	23.257%

Figure 1: FRT (PRE AND POST test scores)



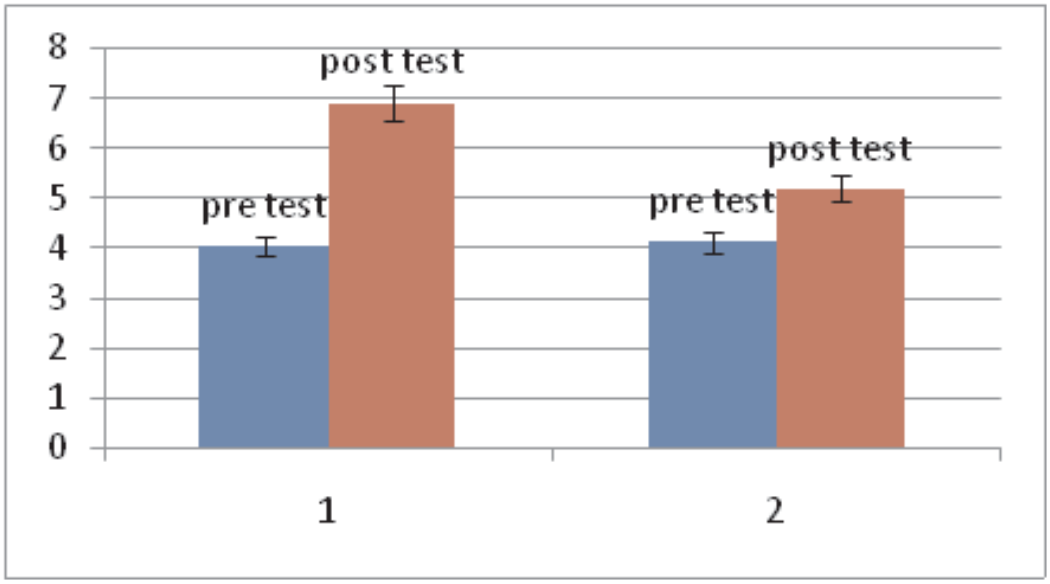
1- EXPERIMENTAL GROUP, 2- CONTROL GROUP

Figure 2: BBS (PRE AND POST test scores)



1- EXPERIMENTAL GROUP, 2- CONTROL GROUP

Figure 3: STRAIN GAUGE (PRE AND POST test scores)



1- EXPERIMENTAL GROUP, 2-CONTROL GROUP

gauge scores inboth group A and group B (p-value< 0.05).

GROUP STATISTICS

DISCUSSION

he results of the study show an increase in the FRT, BBS and ankledorsiflexors muscle torque in both groups,though no statistically significant improvement seen when both groups were compared except in ankle dorsiflexors muscle strength. The study helps us decipher that improving ankle dorsiflexors muscle strength as well as encouraging elderly to maintain their active life style, thus maintaining their ankle ROM helps improve balance.

Study by Hylton B. Menz et al, also show that programs to improve the strength and flexibility of the foot and intervention to augment plantar sensation may be beneficial in improving mobility and reducing the risk of falls. [2]Contribution of

sensorimotor factors [2] and flexibility at the ankle joints [5] by maintaining an active life style contributed to improved scores in FRT, BBS and muscle strength in control group.

By constant use of the ankle and foot muscles the strength and range of motion was maintained & improvement in FRT scores. The capacity to control one's balance while leaning or bending is critical to daily living.A measure of leaning or bending, AP-LOS, may be influenced by (i) ankle muscle strength; (ii) ankle range of motion and (iii) mechanoreceptor sensitivity in the feet.[12]Increased FRT scores reflected increase in muscle force, joints flexibility, balance control as well as self confidence and psychological well being. The possible reason may be that anterior translation of the body during forward reaching, getting up from seated position and walking requires adequate dorsiflexion range of motion which allows superincumbent body weight to rotate over the foot.Ankle dorsiflexion also stops the backward movement produced by the destabilizing force and helps to create an anteriorly directed counter-moment and helps re-equilibrate the body. [5]

As the only source of direct contact with the groundduring weight-bearing tasks, the foot contributes to themaintenance of stability in two main ways: (i) by providingmechanical support for the body via the osteoligamentousarchitecture of the arch and the coordinated function of lower limb muscles, and (ii) by the provision of sensoryinformation regarding body position from plantar tactile mechanoreceptors. It is therefore likely that deficits in foot posture, flexibility, strength, or sensation impair this support function and predispose to loss of balance.[2]This could be the reasons for results seen in both the groups.

Study by ShehabM.Abd El- Kader showed that exercise training in older adults resulted in decrease in stance postural sway and the exercise group had fewer falls during their experimental tests of balance compared with subjects who did not exercise.[1]

The strengthening exercises had positive effect on muscle strength. It has been well established that aging is associated with loss in muscle strength. The resistance training is recognized as beneficial for the health. Progressive resisted exercises in elderly produce the strength that result from the increased motor unit activation of trained muscles and hypertrophy of muscle fibres. In a study done by Laidlaw DH, strength training improves the steadiness of slow lengthening contractions performed by older adults. The older aged should focus on increasing and maintaining the lower extremity strength and power across a range of intensities in order to decrease the functional limitation and disability. [8]

IADL scores were not affected much to start with since the patients were not bed- ridden or having much chronic disabling conditions.

CONCLUSION

Both treatment techniques were effective in improving balance measures. Interventions to improve the strength by resistive training of ankle dorsiflexorsand flexibility of the foot by encouraging in independent ADL's, improves balance and help reduce the risk of falls in elderly.

CLINICAL RELEVANCE

A simple exercise ofimproving ankle dorsiflexors muscle strength in all elderly individuals to improve balance should be undertaken and emphasized in clinical practice. While teaching exercises to patients with OA (knee & hip joints), Lumbar Spondylosis or any other degenerative condition as well as geriatrics healthy population also, considerations should be taken to improve ankle dorsiflexors muscle torque& improve their balance along side.Training to avoid falls should consider functional ankle strength training as well as improvement in ankle range of motion.

LIMITATIONS OF THE STUDY

1. There could be minor variations in the manual resistance applied by the therapist, though for this the same therapist has applied resistance.

FUTURE STUDIES

3 month follow-up can be undertaken.

Comparison of ankle dorsiflexors and plantarflexors muscle strength in balance improvements.

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