

Original Article

EFFECTIVENESS OF 4-WEEKS EXERCISE PROGRAM USING ELASTIC TUBING AS PERTURBATION FORCE ON BALANCE IN ELDERLY SUBJECTS

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ABSTRACT

Background: Ageing commonly disrupts the balance control and compensatory postural responses that contribute to maintaining balance and preventing falls during perturbation of posture due to the weakness of ankle Dorsiflexors and plantar flexor. This can lead to increase of falling in older adults over the age of 65.

Materials and Methods: Study Design: Pre – Post-test Experimental Design, 40 elderly subjects both male and female in the age group of 60-70 years were randomised in to two groups : Subjects in Experimental (n=20) were treated with 4-week exercise programme using elastic tubing with conventional Physiotherapy and Control(n=20) were treated with conventional Physiotherapy for 4 weeks. The duration of treatment was 4 weeks in both groups. Outcome measures included were Berg Balance Scale and Manual Muscle Testing.

Results: In Experimental group Berg Balance score was found to be significant (EXP-45.00±2.4 P<0.001). Manual Muscle Testing score for post intervention for Right and Left ankle Dorsiflexors and Plantar Flexors in experimental group was not found to be significant. (EXP- Right ankle DF- 3.40±0.50, P >0.108, Right ankle PF- 3.45±0.51, P > 0.059, Lt DF-3.45±0.51, P > 0.3.17, Left ankle PF 3.40±0.50, P >0.157). In control group post intervention Berg Balance and Manual Muscle Testing score was not found to be significant. **Conclusion:** The 4-week exercise programme using elastic tubing is effective on balance in elderly subjects.

KEY WORDS: ELASTIC TUBING; BALANCE; PERTURBATION; ELDERLY SUBJECTS

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Access this Article online

Quick Response code



International Journal of Physiotherapy and Research

ISSN 2321- 1822

www.ijmhr.org/ijpr.html

Published: 11 August 2013

Received: 12 June 2013

Accepted: 13 July 2013

INTRODUCTION

Ageing is characterized by a failure to maintain homeostasis under conditions of Physiological stress and this failure are associated with a decrease in viability and increase in vulnerability of an individual.¹

Ageing commonly disrupts the balance control and compensatory postural responses that contribute to maintaining balance and preventing falls during perturbation of posture due to the weakness of ankle Dorsiflexors and plantar flexor. This can lead to increase of falling in older adults over the age of 65.²

The age - related reduction in muscle mass is a direct cause of decline in muscle strength. This reduction in muscle strength and muscle power appears to be determined by an impaired contraction velocity, as well as muscle mass per force generating capacity. Since strength and power are major components of gait, balance, and ability to walk.³

The primary muscle groups used to activate these balance strategies are the ankle dorsiflexors, plantar flexors, knee extensors, knee flexors, hip abductor and adductors.⁴ In response postural perturbation, a human subject will slow the center of mass by

generating muscle torque at the ankle or hip (ankle and hip strategy) or by taking a step.⁵

In stance, a subject seems to respond to large external postural perturbations through hip strategy, and to smaller perturbations through ankle strategy.⁶ The ankle strategy requires adequate ankle muscle force to correct the postural sway and to keep the center of mass located above the foot.^{7,8}

A crucial role seem to be played by the ankle dorsiflexors, as they stop backward movement produced by a destabilizing movement, lift the forefoot and contribute to the creation of counter-movement that helps to re-equilibrate the body. Older adults with a history of falls have less than half of the knee and ankle strength than non-falling subjects.⁹

The strength training program was performed in ankle muscles (dorsiflexors and plantar flexors), because these muscles have a major role in the maintenance of balance and functional mobility.⁴

Compared to the muscles of the lower limb, the dorsiflexors seem to be the best predictor of falls in older people.^{10,11} Moreover, ankle dorsiflexor and ankle plantar flexor muscle strength help to differentiate between elders who had experienced multiple falls and elders who had not fallen.¹²

Balance is defined as the ability to maintain the projection of the body's center of mass within manageable limits of the base of support, as standing or sitting, or in transit to a new base of support, as in walking. The base of support is composed of the area between all points of contact also include of the body with another surface; points of contact also include extensions of the body through assistive devices e.g. walking sticks and frames.

Diminished ability to maintain balance may be associated with an increased risk of falling. In older adults, falls commonly lead to injury, loss of independence, associated illness and early death. Although some exercise interventions with balance and muscle strengthening components have been shown to reduce falls.³

Elastic tubing and elastic bands are often used in therapeutic exercise programs. There are

highly versatile and finally they impose a weight bearing overload on the joint to be rehabilitated. Physical therapist often uses elastic tubing exercise in conjunction with other rehabilitation exercises to promote ankle strength and balance.¹³

Older adults may not have adequate money or transport to enable them to obtain access to equipment, usually available in health clubs, which has been shown to produce increases in strength. In addition, they may be self-conscious and intimidated by the idea of self-exercising with younger people. Thus, their ability and willingness to take part in regular exercise away from home may be inhibited.

In order to make the benefits of resistance exercise available to as many older adults as possible, alternative modes of resistance exercise which are more economical and practical need to be developed and evaluated for effectiveness. Elastic tubing could be used in home based in strength training program for older adults.

The studies determine that home-based resistance training program utilizing elastic tubing can serve as a practical and effective means of eliciting strength gains over the age of 65 by intensity, frequency and duration.¹⁴

As literature shows that 4-week exercise program on balance using elastic tubing as a perturbation force shown a significant effect in history of with or without ankle sprains in younger individuals and their by improve balance. As there is lack of literature regarding whether there is increase in balance using elastic tubing in elderly people so, there exists a need for this study to find out effects of 4 week exercise program on balance using elastic tubing as a perturbation force for elderly individuals. So the study will find out whether 4-week exercise program using elastic tubing will improve balance or not in elderly subjects.

MATERIAL AND METHODS

A total of 40 subjects who belongs to age group 60-70 of both the gender with Berg Balance Score of 21-40 and subjects with no history of neurological, cardiovascular, and orthopedic problems were participated in the study.

After screening for inclusion and exclusion criteria and then assigned in to two groups as an experimental and control by simple random sampling. Pre-treatment assessment of subject's Height, weight, Body Mass Index, Age, Gender, Dominant Foot will be considered. Pre-treatment of Berg Balance Scale score and Manual Muscle Testing of both right and left hip flexors, extensors, knee flexors and extensors. Post-treatment Manual Muscle Testing of ankle plantar flexors and dorsiflexors and Berg Balance Score were taken for both the groups after 4 weeks. Prior to participation in this study, all subjects read and signed the informed consent.

Exercise protocol

Exercise program on balance consists of front pulls, back pull, crossing over, and reverse cross over using elastic tubing on balance and subjects were given as 3 sets of 15 repetitions, 3 times per week for 4 weeks and there will be given 30-seconds rest between each exercise and a 2-minute rest between sets¹³. And conventional physiotherapy as Functional balance training like Sit to stand, standing weight shift, functional reach- side ward's and anterior for touching targets set by therapist, bipedal heel rise, unipedal standing, unipedal standing with knee bending, tandem walking, spot marching for 15 minutes, 3 times per week for 4 weeks.¹⁵

Statistical analysis

Data analysis was performed by SPSS version 17 in the present study and alpha value Set at 0.05. Descriptive statistics was used to find out Mean, Standard Deviation for the Demographic variables & outcome variables. Unpaired t -test was used to find out the significant difference among demographic variables such as Age, Weight, Height, and BMI. Chi-square test was performed to find out Gender and Dominance difference among the groups. Wilcoxon signed rank sum test was used to find significant difference between groups for Manual Muscle Testing and Balance and Mann-Whitney 'U' test was used to compare the post- test balance and Manual Muscle test in between groups. Microsoft word and Excel have been used to generate graphs, tables etc.

RESULTS

The 4-week elastic resistance exercise Program caused a significant improvement in balance for the Experimental group where BBS score was found to be significant ($P < 0.001$). MMT score for post intervention for Rt and Lt ankle DF and PF in experimental group was not found to be significant and In control group post intervention BBS and MMT score was not found to be significant.

Table 1: Pre and post scores of Experimental group –MMT and BBS.

Variables	Pre	Post	p-value
Right ankle DF	3.20±0.41	3.40±0.50	<0.046
Right ankle PF	3.20±0.41	3.45±0.51	>0.059
Left ankle DF	3.40±0.50	3.45±0.51	>0.317
Left ankle PF	3.25±0.44	3.35±0.49	>0.257
BBS	36.70±1.84	45.00±2.41	<0.0001

Table 2: Pre and post scores of Control Group – MMT and BBS.

Variables	Pre	Post	p-value
Right ankle DF	3.10±0.31	3.10±0.31	1
Right ankle PF	3.30±0.47	3.30±0.47	1
Left ankle DF	3.30±0.47	3.30±0.47	1
Left ankle PF	3.35±0.49	3.40±0.50	>0.317
BBS	36.15±1.69	36.70±2.74	>0.180

DF-Dorsiflexors, **PF** - Plantar flexors, **BBS** - Berg Balance Score, **MMT**- Manual Muscle Testing.

DISCUSSION

The main objective of this study was to determine the effectiveness of 4-week exercise program on balance using elastic tubing as a perturbation force in elderly subjects. It appeared that 4-week exercise program using elastic Tubing was found to be effective in increasing Balance. Though there was not much significance difference in increasing muscle strength.

There has been statistically significant difference between groups in BBS as an outcome measure which measure balance. The difference between groups was analysed using unpaired t test and within group was analysed by paired t test. There results have shown that a value between groups is 45.00 for balance with ± 2.41 and in control group, 36.70 for balance with \pm of 2.74.

For balance within experimental group, the pre to post-tests values were 36.70 to 45.00 and for within control group, the pre to post-tests values were 36.15 to 36.70. So, there was statistically significance in these results. According to this result there was a significant change in improvement of balance in experimental group when compared to control group. In this study it is sought to quantify the effect of 4 weeks of training, utilizing elastic resistance exercise and conventional PT on balance. It is anticipated that the perturbation imposed by the elastic resistance exercise would elicit meaningful improvement in balance. The elastic resistance exercise program was equally effective in improving balance in elderly subjects.

The 4 elastic resistance exercises utilized in this training program (front Pull, back pull, crossover, and reverse crossover) impose a postural control Challenge that ankle, knee, and hip joints of the support limb must effectively resist maintaining balance. To maintain balance in response to the balance disrupting force imposed by elastic tubing, the weight bearing ankle must actively resist in the opposite direction against the imposed perturbation. Because the human body is not statically stable even during quiet double-limb stance, the central nervous system must constantly make adjustments to keep the centre of mass over the base of support.¹³

In accordance to the study of Loram and Lakie suggested that the central nervous system utilizes a "throw-and catch" pattern to generate joint torques on opposite sides of the joint to maintain equilibrium while standing.¹⁶ Here, subjects were required to maintain balance while resisting against the balance disturbing force caused by the tension in the elastic tubing. It is possible that the perturbation caused by the elastic tubing imposes an accentuated neural training effect.

In accordance with Hertel suggested that balance or postural control training might impose a neural stimulus that causes the central nervous system to "retune" input and output processing of somatosensory information necessary to control balance.¹⁷

The strength variable was assessed using MMT. There was increase in muscle strength which was not statistically significance in these results. This was hypothesized that muscle strength was not improved In accordance with Andrea Macaluso et al suggested that first phase of resistance training exercise about 1-2 weeks, a rapid improvement in the ability to perform a training exercise. This mainly results in learning effect, which is mediated by changes in motor skills and level of motivation.

In the second phase, which lasts for 3-4 weeks, muscle strength gains are obtained without a matching increase in size of the trained muscle. The improvement in this phase is mainly due to neural training. The term neural adaptation includes many elements such as increased activation of prime movers (number of recruited motor units or firing rate and synchronization of the individual's motor units). A better coordination of synergistic and antagonist muscles, and an increased neural drive from the higher levels of CNS.

The third phase of adaptation to strength training (>6 weeks) is characterised by an increase in both size and strength of the exercise muscles.¹⁸ so, these study result shows that increase in strength is due to neural training.

Limitations of the study are female population is more which may not generalized the findings to both the genders, viscoelastic creep and fatigue displayed by elastic tubing should be replaced frequently and as with free weights there is no source of stabilization or control of extraneous movements when elastic tubing is used for resistance and we suggest future investigations should increase the duration of the study to find out of the significant improvement in the muscle strength by using elastic tubing.

CONCLUSION

It can be assumed that the 4-week exercise programme on balance using elastic tubing with conventional PT was effective over conventional PT in elderly subjects.

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How to cite this article:

R. S. Divya, Mallikarjuniah. H. S, Maheshwari. P, Effectiveness of 4-week exercise program using elastic tubing as perturbation force on balance in elderly subjects. *Int J Physioth Res* 2013; 03:88-92.