Vestibular visual cues and proprioception exercises both improve postural control in elderly

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Abstract- Background: Healthy elderly people have difficulties with posture and balance. Vestibular visual cues exercise and proprioception exercise could be beneficial to improve postural control in elderly.

Objective: Aim of this study was to compare the effect of vestibular visual cues and proprioception to improve postural control in elderly.

Methodology: Parallel designed, randomized clinical trail was conducted at physiotherapy department of Imran Idrees Hospital, Sialkot. Group A was given (n=22) vestibular visual cues exercise and group B (n=22) was given proprioception exercise. 44 stable elderly participants aged from 65 to 75 years were included. The following parameters were analyzed before and after training for both groups: Berg balance scale (BBS) and Clinical test of sensory organization and balance (CTSIB).

Results: The present findings revealed that there's no statistically significant difference according to BBS and CTSIB between both groups. But in CTSIB condition 2 showed significant difference that vestibular visual cues exercise group was more effective in relation to proprioception exercise group.

Conclusion: We found that both vestibular visual cues exercises and proprioception exercises are equally effective for improving postural control in elderly population. One of the intervention is not superior to the other. But CTSIB condition 1 showed that proprioception exercise group was more effective than vestibular visual cues exercise group and CTSIB condition 2 showed significant difference that vestibular visual cues exercise group was more significant than proprioception exercise group.

Index Terms- Postural control, Proprioception, Vestibular, Elderly, Balance

I. Introduction

Traditionally, the "elderly" is considered to be those persons age 65 and older. Postural regulation is a term used to explain how sensory input from other systems is governed by our central nervous system (CNS) in order to generate sufficient motor activity to sustain a balanced, upright posture. The principal sensory systems involved in postural regulation and equilibrium are the visual, vestibular, and somatosensory systems. When people lives longer and older individuals form an ever-growing proportion of the community, there is an increasing demand to create and introduce successful fitness strategies to help mitigate some of the aging-related issues [1]. Via incorporating vestibular, visual, and somatosensory details, postural control is achieved. These sensory impulses lead to the alignment and equilibrium of the head/body in span [2]. Balance challenges are one of the variables that negatively affect the day by day movement of old individuals [3]. The vision and proprioceptive senses are compromised when the vestibular system is impaired or the central nervous and musculoskeletal systems are compromised [4]. Impaired postural control will eventually bring about falls, i.e, a fall is the consequence of lacking functional equilibrium [5]. The CNS, which gains input from peripheral subsystems, regulates postural stabilization. The vestibular organs, the exteroceptive and proprioceptive nerve endings, and the sensory system are the principal receptors involved [6]. Postural control sensory inputs come essentially from three mechanisms (visual, vestibular and sensorimotor), all of which need to be combined and used to organize and control the multisegmented body on the basis of a consistent and secure association among sensory input and sensorimotor interaction [7]. Vestibular activity is affected by advancing age because of depletion of vestibular afferents [8]. The vestibular system integrates through multiple areas that affects eye motions & regulation of posture [9]. The vestibular, sensory and proprioception system plays a very important component in regulating the stance appropriate for walking [10]. The central nervous system (CNS) uses feedback from the eyes to construct a sensory diagram of world in which we can easily determine the speed and location of objects in motion [11].

Proprioception has been defined as "the perspective of joints or body motion and also the position of the body or body segments in space and is regarded to be the most significant spatial mechanism in restoration of postural stability in the aged people [12]. Feedback on joint location sensation, reaction (kinesthesia) and touch is provided by sensory input from receptors in the muscles, tendons and joints. These tasks are referred to collectively as "proprioception" [13]. Mechanoreceptors of joints and muscles give data while walking the optimal positioning of the foot [14]. Proprioceptive acuity and exact muscle coordination are necessary for postural equilibrium. Proprioception is the related information that leads to the feeling of consciousness (muscle sense), complete posture (postural balance), and segmental posture (jointstability) [15]. A lot of experiments have shown that proprioception declines with age [16]. For elderly adults, poor proprioception makes it very difficult to perceive body posture changes before compensatory action is too late to avert slides [17]. Indeed, multiple studies have shown that decreased proprioception is a important factor in decreases in older people. Retaining this skill is also important for elderly people. Regular physical exercise can be one technique to decrease the frequency of impaired proprioception and falls with age. A variety of sensorimotor mechanisms that lead to equilibrium can be strengthened by exercise [18]. Balance regulation, based on somatosensory, vestibular and visual input, is a complex system of synchronized muscular responses [19]. The activation and control of motion may be impaired by incorrect or inadequate input from either of such sensory systems or deficiency influencing transmission of certain signals [20]. Therefore, capacity to preserve stability in place and the mobility is based on the consistency of the receptor structures. The decrease in the processing of sensory organs is an element of the mechanism of ageing. The sensory system deteriorates, the feeling in the lower extrimity reduces, and vestibular system disorder is fairly normal in elder persons [20]. It is plausible to expect a transition in the postural control respond as the motion sensors experience changes. Therefore, balance deficiency in the elderly may partially be caused by sensory receptor systems malfunctioning. Several studies confirm this assumption [21]. In otherwise stable elderly persons, reduced sense of sensation increased body sway and vestibular interference have been associated with postural imbalance and also with falls and fractures. In addition, as age grows, the capacity to use visual knowledge for postural stabilization reduces [22].

Decrease in muscle strength, loss of flexibility and balance effects the postural control. There are evidences available on the impact of vestibular visual cues exercise and proprioception exercise on healthy elderly to improve postural control however this study was conducted to compare the of vestibular visual cues and proprioception to improve postural control in elderly. The reason for research was to compare the effects of vestibular visual cues and proprioception to improve postural control in elderly in both males and females before and after six weeks training.

inception of ideas till their publications. Research papers are highly recognized in scholar fraternity and form a core part of PhD curriculum. Research scholars publish their research work in leading journals to complete their grades. In addition, the published research work also provides a big weight-age to get admissions in reputed varsity. Now, here we enlist the proven steps to publish the research paper in a journal.

II. METHODOLOGY

It was a retrospectively registered, parallel designed, randomized controlled trial with concealed allocation, conducted in physical therapy department of Imran Idrees Teaching Hospital, Sialkot, Pakistan. Patients who met the eligibility criteria were informed about the aim of the study. All eligible participants who agreed to participate in the study signed the consent form. Eligibility was first determined by the therapist (HM) and then double checked by the researcher (BA) before the randomization. After baseline assessment, eligible patients were randomly assigned (in a 1:1 ratio) vestibular visual cues exercises group (Group A) or proprioception exercises group (Group B). Randomization was done by one of the research team members (MHUK) using fish bowl method. Randomization assignments were kept in opaque, sealed envelopes and unsealed by the researchers (MAK, AA) after baseline testing. Patients were instructed not to talk about the content of their exercise program during the post intervention visit and could contact their therapists (HM, SB, MHUK) in case of any problems during trial participation. A sample size of 44 was calculated by G-power analysis and considering 10% of attrition rate with power of 0.80 and 5% margin of error and 95% confidence interval. Data was entered and analysed by SPSS version 25.

The trial was retrospectively registered in US Clinical Trials Registry: NCT04824196

Inclusion/exclusion criteria.

Both male and female patients of age between 65-75 years. Both male and female patients were included. Potential to walk with no equipment with history of falls, fractures, stumbling, dizziness. Capable of following basic instructions, such as left, right, up, or down. Either using visual aids.

Patients were excluded if they have presence of orthopedic problems, neurological disorders, psychological problems, cognitive issues, people with severe visual issues, participants with other medical complications. Subjects who were not perform Fakuda test and VOR were also excluded.

Outcome measures

The Berg Balance Scale (BBS) was developed to measure balance among older people with impairment in balance function by assessing the performance of functional tasks. It is a valid instrument used for evaluation of the effectiveness of interventions and for quantitative descriptions of function in clinical practice and research. Reliability: intrarater and interrater reliability (ICC =.98,) , Test-retest reliability in elderly people is also high (ICC =.98).

It is valid and reliable tool. This is a timed test that systematically measures the influence of visual, vestibular, and somatosensory input on standing balance. Intrarater and intertester reliability (ICC) have been reported as high, in elderly populations, from ($r=0.75$, $p<0.05$), sensitivity 60% and specificity 87%have been reported.

Intervention

At the first visit the researchers (HM, BA) completed a through case history, full physical examination. Treatment was then continued according to the allocated groups. In group A (vestibular visual cues) 5 minutes' walk and general stretching was performed as a warm-up an then following vestibular visual cues exercises were performed

In crook lying position

Pelvic rolling to right and left with head movement and stop first on right side for 3 minutes. Do this exercise in front of the mirror. Then repeat the same activity and stopped on left side.

In sitting

Straight legs stretched, doing side bends to rest the limbs behind the body on the mat, rotating on the left and right hand. Stop in the right side bend position after 10 repetitions of 3 minutes with upper limbs bent and head held motionless. Do this exercise in front of the mirror. Then repeat the same activity and stopped on left side.

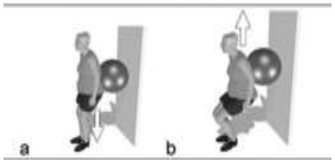
Rectilinear exercise activities on a swiss ball: anterior, lateral, left, and right. For five minutes each, anterior, dorsal, left and right rectilinear gestures were performed. Do this exercise in front of the mirror. General stretching was performed as a cool-down at the end of every session. The preparation regimen for vestibular visual cues, administered 2 days a week, consisting of 2 sets of 10 repetitions over a span of 30 minutes per day over six consecutive weeks. Vestibular visual cues and was reassessed at the end of 6 weeks on CTSIB and BBS.

In group B (propriocetion exercise) 5 minutes' walk and general stretching were performed as a warm-up. According to the exercise, preparation was gradually structured into 3 phases:

Initial phase: week 1- 2

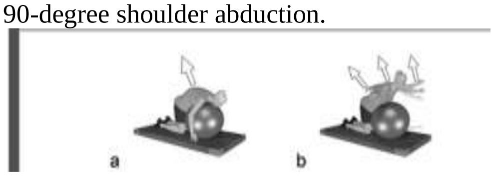
Alternate knee flexion-extension with extended trunk posture using both hands for support.

Hip and knee flexion-extension with swiss ball between the back and wall.



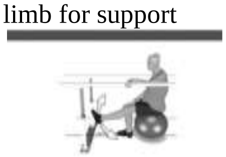
Hip rises lying with their back on the floor with both legs on the swiss ball. Upper limbs leaning on the floor to help with the exercises.

Knees on the ground and their chest resting on the swiss ball. Trunk extension and raisings with their upper limbs extended and 90-degree shoulder abduction.

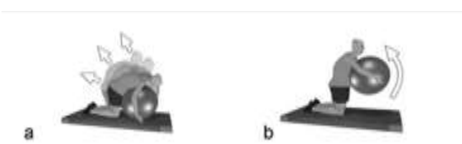


Intermediate phase: weeks 3-4

Alternate knee flexion-extension using the homolateral upper limb for support



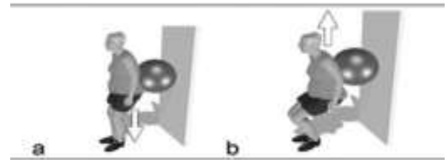
Same execution criteria but the swiss ball in their arms.



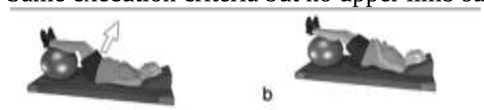
Advanced phase: weeks 5-6

Alternate knee flexion-extension with no upper limb support.

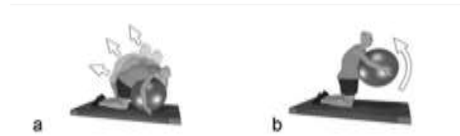
Same execution criteria but reaching 90 degree of hip and knee flexion.



Same execution criteria but no upper limb support.

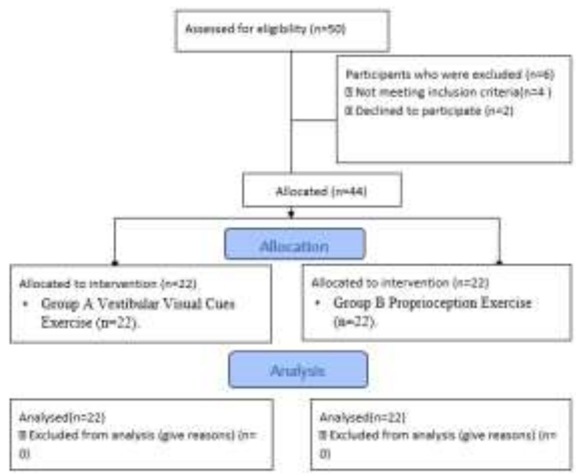


Same execution criteria that intermediate phase but with eye closed.



General stretching were performed as a cool-down. The preparation regimen for proprioception, administered 2 days a week, consisting of 2 sets of 10 repetitions with one min of rest over a span of 30 minutes per day over six consecutive weeks.

Proprioception was reassessed at the end of 6 weeks with BBS and CTSIB.



III. Results

50 subjects were assessed for eligibility criteria and 44 were recruited who were meeting inclusion criteria and were divided into group A and Group B and was given vestibular visual cues exercises and proprioception exercises respectively. Data was analysed through SPSS 25 after six weeks of training.

The mean age of participants in vestibular visual cues exercise group was 69.45±3.233 and participants in proprioception exercise group was 69.23±3.023 years. The mean weight of participants in vestibular visual cues exercise group was 83.26±11.372kg and 84.32±13.029kg in proprioception exercise group. The mean height was 5.47±0.354ft in vestibular visual cues exercise group and 5.47±0.313ft in proprioception exercise group, BMI in vestibular visual cues exercise group was 29.98±3.392kg/m2 and in proprioception exercise group was 29.68±3.438kg/m2.

The Shapiro-Wilk test tested the normality of data, demonstrating that data was normally distributed ($p<0.05$) that's why parametric test were applied. Table 1 shows Within and between group comparisons of both groups.

Table 1: Mean (SD) of groups, paired sample t-test within groups, and independent t-test between groups.

Outcome	Groups				Difference within groups		Difference b
	Week 0		Week 4		Week 4		Week 0
	Exp (n = 10)	Con (n = 10)	Exp (n = 23)	Con (n = 22)	Exp (p value)	Con (p value)	p value
BBS	36.86 (6.61)	36.36 (5.62)	46.95 (4.08)	47.81 (4.28)	0.000*	0.000*	0.78
CTSIB	11.18 (2.88)	11.77 (2.15)	9.45 (2.59)	8.81 (2.03)	0.000*	0.000*	0.45

Exp = experimental group, Con = control group, BBS = berg balance scale, CTSIB = clinical test of sensory organization and balance, (*): p-value <0.05: Significant

IV. DISCUSSION

The purpose of this study was to compare the effects of vestibular visual cues & proprioception exercise to improve postural control in elderly population. While training regimen varies from that used in previous studies, our results are compatible with these studies, and our protocol appears to be successful in enhancing postural control, leading to an increase in postural equilibrium. The research will accept null hypothesis except CTSIB condition 2 showed significant difference that vestibular visual cues exercise group was more significant as compared to proprioception group.

Consequently the results can be compared straight with the results of other study and we use BBS and CTSIB as an outcome measure. Past studies were used different outcome measures some studies was measured by BBS scale. Countless studies have seen the sound effects to improve postural control on different neuromuscular deformities [23-25].

Very significant finding recorded by Fatih Soke, PT et al was the BBS test score, they suggest that postural control-enhancing fitness programs could be helpful [26], Berg balance test score was improved obtained by Bechir Freh et al [27]. 12-week training program for proprioception in elderly is successful in postural control according to BBS score [12]. Our findings revealed a non-significant increase in the BBS rating after proprioceptive training and vestibular visual cues training. According to mean±S.td of BBS score the results showed that vestibular visual cues group was more effective than proprioception exercise group.

Murat Giray MD et al was suggested that CTSIB test score was (standing on a firm surface with eyes open, standing on a foam surface with eyes open, standing on a foam surface with eyes closed) in favor of customised exercise group [28]. The increase in the two challenging conditions of the Clinical Test of Sensory Interaction for Balance (Condition5: eyes closed, unstable surface, and Condition6: eyes open, visual confrontation, unstable surface) in almost half of the patients were another optimistic finding of another study by Company Carter et al [29]. Our findings revealed a nonsignificant improvement in CTSIB conditions (1, 3, 4, 5, and 6) and total CTSIB conditions after proprioceptive training and vestibular visual cues training. Except CTSIB condition 1 showed that proprioception exercise group was more effective than vestibular visual cues exercise group and CTSIB condition 2 showed significant difference that vestibular visual cues were more significant as compared to proprioception training group. According to mean±S.td of CTSIB condition 1,3,4,5 and total CTSIB conditions score showed that proprioception training group was more effective than vestibular visual cues training group. CTSIB condition 2 and 6 score showed that vestibular visual cues training group was more effective than proprioception training group.

In this gaze, the results of vestibular exercises to improve postural control are reliable with findings of Vita Lucya concluded that the vestibular exercise was useful in reducing the risk of falling in the nursing home for older people [30]. Yusuke Ueta et al that gaze stability exercise can boost the equilibrium of the static body in a situation that needs vestibular control in particular [31]. It is demonstrated that vestibular exercises to improve postural control respectively [32].Above stated studies have found the significant effect to improve postural control with vestibular and gaze stabilization exercises. Another research indicates that in elderly patients with instability, VR can greatly improve equilibrium, which can in turn lead to a substantial decrease in falls [24]. Preceding studies used the vestibular visual cues exercises and proprioception exercises alone [12].The aim of this study was to compare the effect of vestibular visual cues exercises and proprioception exercises to improve postural control in elderly.

In comparison, previous studies have shown that static and dynamic equilibrium can lead to an improvement in the capacity for gait and balance and a decrease in the risk of dropping in adults 65 years of age and older (31). The strongest effect on posture control and accuracy tends to be proprioceptive exercise. Moreover, even though bioenergetic exercise increases postural regulation in basic postural activities, more difficult postural tasks show that neurosensory proprioceptive feedback thresholds are still not developed by this form of activity, possibly due to the higher visual afferent contribution. Previous experiments have demonstrated that they use various methods for vestibular visual cues [29, 32-34]. On the contrary, the preceding results shown that proprioception exercises can improve postural control [25], [12]. Ana Ferlinc investigated a systematic review, in order to achieve the best possible physical condition, adequate proprioceptive training is necessary [34]. Pilar Perez et al they concluded that 12-month home proprioception exercise program minimized the rate of falls in older adults living in vulnerable and pre-frail societies [35]. There was decreased in post treatment readings.

Therefore according to the outcomes of present study, it is concluded that vestibular visual cues exercise and proprioception exercise alone have the same results as of combination therapy to improve postural control in elderly. Moreover, some additional exercises needed to enhance postural control in elderly. In the elderly, the effect of physical exercises appears to be helpful, particularly by increasing postural control and restabilization, thereby reducing falls. Exercises relating to eye and head movements are vital to improving the flexibility of the gaze, whereas exercises done on a small base or a pillow with closed eyes are essential to improving postural stability. Propriocetion exercises offer flexibility and balance in the exercise protocol of this research, promotes motor learning, helps in maintaining proper body position and equilibrium, and enhances body control, while vestibular visual cues exercises decreased incidents of fall.

V. CONCLUSION

Both vestibular visual cues exercises and proprioception exercises are equally effective for improving postural control in elderly population. One of the intervention is not superior to the other. But Ctsib condition 1 showed that proprioception exercise group was more effective than vestibular visual cues exercise group and CTSIB condition 2 showed significant difference that vestibular visual cues exercise group was more significant than proprioception exercise group.

Conflict of Interest

There was no conflict of interest.

Financial Statement

No funding's were given by any authorities; it was a project thesis of Masters in Physical therapy.

Data availability

Data will be provided on the demand by corresponding author. proprioception exercise groups.

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