Original Research Paper

Volume - 12 | Issue - 03 | March - 2022 | PRINT ISSN No. 2249 - 555X | DOI : 10.36106/ijar

Health Science

EFFECT OF SENSORIMOTOR INTEGRATION TRAINING ON BALANCE, NEUROMUSCULAR CONTROL AND REACTION TIME IN ELDERLY.

Ritika Mani Researcher, Department Of Physiotherapy, Dibns, Dehradun.

Deptee Warikoo* Hod, Departmentof Physiotherapy, Dibns, Dehradun. *Corresponding Author

Sunil Bhatt Asst Professor, Department Of Physiotherapy, Dibns.

ABSTRACT

Background: SMT (sensorimotor training) is a form of exercise aiming to decrease the muscle imbalance by maximizing the sensory input coming from three sites in the body where there is a large number of propioception(the foot, sacroiliac joint ,cervical spine).The purpose of study is to check the effect of SMT on neuromuscular control, balance and reaction time using three levels i.e. stable surface , unstable surface and sand in elderly population.

Method: The study was an experimental study with a sample size of 30 elderly subjects of age group 60-80 years. They had performed exercises in three levels 1st in stable then foam then sand. They were assessed using SOT test, test for neuromuscular control and reaction time.

Conclusion: The study shows that the sensorimotor training which is given in three levels i.e., in stable surface , foam and sand are effective in improving balance, increasing neuromuscular control and decreasing reaction time in elderly for decreasing risk of fall and improving quality of life in elderly.

KEYWORDS : Sensorimotor training, reaction time, neuromuscular control.

INRODUCTION:

The most important factors underlying morbidity in the elderly population are injurious falls and the restriction of activity as a result of falls. Approximately 25 % to 35% of community dwelling persons older than 60 to 65 years of age fall at least once a year and approximately 40% to 50% of fallers experience two or more falls.[1]

Aging induces decrease in balance, neuromuscular control and reaction time. Balance is considered a key component in many activities of daily living such as quite standing or walking. The maintenance of posture and ability to move about the environment depend on orientation and balance[2]. Sixty five percent of individuals older than 60 years of age experience loss of balance, often on a daily basis.[3]

Sensory information has an important influence on balance activity in elders and the integration of visual, vestibular and somatosensory information is necessary to generate appropriate balance responses.[2] Maintenance of postural balance requires an active sensorimotor control system.[4]Early studies of sensorimotor skills indicate that reaction time become slower with advancing age.[5] The ability to react quickly and appropriately is important for maintaining balance and avoiding a fall when exposed to a postural challenge or threat. There is a 25% increase in simple reaction time from the twenties to the sixties, with further significant slowing beyond this age. Age-related slowing of reaction time becomes more significant during demanding cognitive tasks and more complicated movement responses such as stepping. Increased simple reaction time is an independent risk factor for falls in populations of older people [6]

SMT (sensorimotor training) is a form of exercise aiming to decrease the muscle imbalance by maximizing the sensory input coming from three sites in the body where there is a large number of propioception (the foot, sacroiliac joint, cervical spine) which in turns increases the nervous system ability to generate a fast and optimal muscle firing pattern, increase dynamic joint stability and improve motor control. SMT emphasizes motor control through progressive challenges to sensory motor system through static, dynamic and functional situations to restore normal motor programs.[7] it may also be a helpful tool at the beginning of a strength training intervention.

Sensorimotor training had a great impact on the neuromuscular system at the initiation of force production.[8] It is well documented that improvements in force production capacity can be achieved either by enhancement of the muscular protein mass or by adaptation in the neural control of the muscle.[9] Sensorimotor training is highly efficient for attaining increased proprioceptive input to the neuromuscular system or for processing information of the proprioceptive system more appropriately[10]. The gain in neuromuscular activation may arises from enhanced reflex contributions acting on a spinal level and there is gain in neural drive, induced by the training itself.[11] SMT shows improvement in reaction time because there is increase in rate of force production during exercise in elderly.[8]

Unstable surfaces such as foam wobble board, air filled rubber bags, sand all reduce or effectively remove the person's foot contact with the solid surface. [12] The underlying theory is that balancing on such surfaces will lead to heightened proprioception when foot is on the solid surfaces during normal activities.[13] Research on age related changes in balance control has shown an increase in body sway during quite stance both with eyes open or eyes close.[7] Greater muscle activity and body movement are observed when standing on an unstable surface.[12]

METHODOLOGY

Subjects were randomly selected from the community who volunteered to participate in the study.Thirty subjects participated in the study based on inclusion and exclusion criteria. Subjects were recruited from the community of Premnagar, Manduwala, Selaqui and Suddhowalla, Dehradun, Uttarakhand.

Study Design

Experimental study.

Inclusion Criteria

1- Age above 60
2- Can walk independently for 15 meters.
3- Not undergoing or have taken physiotherapy treatment within last one year.

Exclusion Criteria

1- Stroke patients
2- Psychiatric patient
3- Those having hearing difficulty
4- Unstable cardiac arrest
5- Complete blindness
6- Degenerative muscle disease
7- Those using walking aids

Instrumentation Of Data Collection

1- Foam of 4 inch.
2- Horizontal chest panel
3- Mask (for blind condition)
4- Visual conflict dome
5- Stopwatch
6- Switch board.
6- Sand box of 3 inch.

Outcome Measure

1. SOT test(Sensory organisation balance test)
2. Neuromuscular control (NMC) measure by checking the ability of doing switch on and off with foot as many times as possible in

8sec.

3. Reaction time(RT) is measured using a simple reaction time with a light as a stimulus and depression of a switch by foot as the response.[14]

Procedure

In our study we have given sensorimotor training for improving balance, neuromuscular control and reaction time in elderly. The outcome measures were used to see the effectiveness of the training compared to pre intervention values. After 3 weeks intervention program subjects reassessed for the outcome measures.

All the exercises were performed in three levels properly under the guidance of therapist.

- First in the stable surface with all the four sensory conditions, therapist made the participants to stand properly on the surface. Therapist told the participants that follow my commands properly while performing exercises.

1- In first exercise therapist shift the pelvic in saggital and frontal plane in irregular intervals.
2- In second exercise the subject done weight shifting from one leg to other leg in continuous manner without hold
3- In third exercise therapist told the subject to relax one leg then do movement in three direction anterior, posterior and lateral side from other leg without hold . Then the person had done the same with other leg too. No rest time was taken.

In all the above exercises therapist command the participant to do 8 repetitions and rest time between all the exercises will be of 30 sec or as per required. Then all these exercise will performed with eyes close , with chest panel to mask the vision of feet then wearing visual and vestibular conflict dome(VD). Same commands will be done on all.

- Then secondly subjects performed all the exercises in foam surface. In this therapist had given command and check the balance and stand beside the participant. Subjects had performed all the exercises properly by maintaining balance.
- In sand too therapist command the subject during the exercise session and subject maintained their balance while performing all the above exercises.

Data Analysis

The data was analysed by using Gen Stat Version 32.
Paired t test was done within the group. Level of significance was set of 0.05.

Table 1: SOT analysis (eye open)

	Pre mean	Post mean	t value	T critical	Result	Significance
Stable	29.96	30	1	1.699	Cal t<cri t Not sig	Not sig P< 0.05
Unstable	22.93	27.74	5.38	1.699	Cal t>cri t Sig	Sig P<0.05

Interpretation:

standing time of subjects with eye open in stable surface during SOT did not improve after SMT. While the standing time on unstable surface with eyes open improved significantly after SMT.

Table 2 : SOT analysis (eye close)

	Pre mean	Post mean	t Value	T critical	Result	Significance
STABLE	27.62	29.79	4.966	1.699	Cal t>cri t	Sig
UNSTABLE	17.55	26.77	8.16	1.699	Cal t>cri t	Sig

Interpretation:

standing time of subjects with eye close improved significantly after SMT in stable and unstable surface.

Table 3: Analysis of VD

	Pre mean	Post mean	t value	T critical	Result	significance
STABLE	27.75	29.56	4.36	1.699	Cal t>cri t	Sig P<0.05
UNSTABLE	20.86	27.48	5.89	1.699	Cal t>cri t	Sig P<0.05

Interpretation:

standing time of subjects with visual dome improved significantly after SMT in stable and unstable surface.

Table 4: Result of NMC

	Mean values of RT		Significance	CD
Period	Post	Pre	*(p < 0.001)	0.152
	0.931	1.48		

Table 5: Result of RT

	Mean values of NMC		Significance	CD
Period	Post	Pre	*(p <0.05)	0.78
	6.29	5.33		

Interpretation:

Improvement was seen in both NMC and RT in subjects in post intervention analysis.

DISCUSSION

Our result showed that the sensor motor training which is given in three levels i.e, in stable surface, foam and sand are effective in improving balance, increasing neuromuscular control and decreasing reaction time in elderly for decreasing risk of fall and improving quality of life in elderly. This exercise program resulted in increased level of physical activity, which has several other proven health benefits in elders.

Improvement in balance

One of the reasons for improvement in balance can be a change in sensory strategies used by patients in controlling their standing posture. Studies have confirmed deterioration in the somatosensory, vestibular and visual systems with age.[15]Older subjects rely more upon visual than somatosensory inputs for controlling standing stability. [18] Also aging processes can affect the appropriate selection of muscles and or strategy in response to postural perturbation.

Thus following exercise training aimed to progressively inducing the patient to use lower limb somatosensory inputs for controlling standing stability, subjects are able to improve their ability to stand even in conditions in which somatosensory input has been altered in several ways.

Sensory motor training enhances the ability to sense the joint position in space. It improves mental and neural functioning for maintaining balance. It also trains central nervous system and sensory receptors to be more receptive to muscular length/tension relationships, weight shifts and range of motion.[16]

Jean Franco investigated stroke patients and showed that balance training performed with manipulation of propioception of feet and ankles and for vision showed greater improvement in balance as compared to balance exercise performed on normal condition.[17]

In the current study, it was determined that older people could significantly improve their postural stability under complex sensory training conditions. This result suggests that the integrative ability of higher brain centres was encouraged.

Other studies have demonstrated that higher brain centers retain plasticity at the molecular level and that practice can induce the modulation of neuronal activities in the cerebellum. [18]From this study it is possible that the older subject were able to optimize intersensory interactions within higher brain centers where in turn increased sensory convergence 12 days (40min) period of sensory balance training. Thus the older adults were able to reweight their sensory input and to select reliable sensory information for postural control under changing sensory conditions. Since the cerebellum receives both ascending input from the spinal cord and descending input from the cerebellum, it is likely candidate as the control center for this improvement.

In our study subjects performed all the exercises and showed significant improvement in balance in unstable surface than that of stable surface.

Sensorimotor exercises on an unstable surface had a greater effect on sensory motor function than exercises on a stable surface, and a report that postural reactions were faster on a moving surface.[19]

There is increase in neuromuscular control after performing 3 weeks of exercise in elderly.SMT retrain altered afferent pathways so as to enhance the sensation of joint movement. It is supposed that SMT is related to improved afferent feedback of propioception , which might

result in faster and more intensive neuromuscular activation of trained muscles in voluntary contraction. SMT maximize sensory input about joint position and change in muscle length and tension to the central nervous system which in turn improves nervous system's ability to generate a fast and optimal muscle firing pattern.

Our study shows that there is decrease in reaction time after performing sensorimotor training. SMT is related to improved afferent feedback of propioception as mentioned above may be one of the factor for decrease in reaction time. [20] It increases the rate of force production which also influences the improvement in reaction time.

REFERENCES

1. S R Lord , G A Caplan, J A Ward. Balance, reaction time, and muscle strength in exercising and nonexercising older women: a pilot study. Arch Phys Med Rehabilitation. 1993 Aug;74(8):837-9.
2. Impact of sensorimotor training on the rate of force development and neural activation. Markus at el European journal of applied physiology: 92(2004),1-2-S.98-105.
3. Markus Gruber, Albert Gollhofer. Influence of sensory inputs on standing balance in community -dwelling elders with a recent history of falling. European Journal of Applied Physiology. 2004. 92(1-2):98-105.
4. Robert H Deupree, Richard Simson.Reaction time and movement time as a function of age , stimulus duration and task difficulty. Ergonomics.2007; vol 6(4): 403-411.
5. D.L. Sturnieks, R. St George, S.R. Lord. Balance disorders in the elderly. Neurophysiology. 2008; 38: 467 -478.
6. Amal F. Ahmed. Effect of Sensorimotor Training on Joint Proprioception and Isokinetic Strength Ratios in Subjects with Unilateral Functional Ankle Instability. Bull. Fac. Ph. Th. Cairo Univ. 2010; Vol. 15, No. (2):25-34.
7. Cressey, EM,West, CA, Tiberio, DP, Kraemer, WJ, and Maresh, CM. The effects of ten weeks of lower-body unstable surface training on markers of athletic performance. J Strength Cond Res. 2007; 21: 561–567.
8. Markus Gruber, Albert Gollhofer. Impact of sensorimotor training on the rate of force development and neural activation. European journal of applied physiology. 2004; 92, 1-2-S.98-105.
9. W. Taube at el. Spinal and supraspinal adaptations associated with balance training and their functional relevance. Acta Physiol (Oxf). 2008. Jun; 193(2):101-16.
10. W Taube, N Kullmann, C Leukel, O Kurz, F Amtage, A Gollhofer. Differential reflex adaptations following sensorimotor and strength training in young elite athelets. Int J Sports Med. 2007 Dec; 28(12):999-1005.
11. Brian K at el. Effects of unstable surface training on measures of balance in older adults. J Strength Cond Res. 2009 Jul; 23(4):1211-6.
12. Tai T. Tran at el. Effects of Unstable and Stable Resistance Training on Strength, Power, and Sensorimotor Abilities in Adolescent Surfers. International Journal of Sports Science & Coaching. 2015; 10(5):899-910.
13. Stephen Lord, Sally Castel. Effects of exercise on balance, strength and reaction time in older people. Australian Journal of Physiotherapy. 1994; Volume 40, Issue 2: 83-88.
14. Jean-François Bayouk , Jean P Boucher, Alain Leroux. Balance training following stroke: effects of task-oriented exercises with and without altered sensory input. International J. Rehabilitation Res. 2006 Mar; 29(1):51-9.
15. P.F. C.Gilbert al el. Purkinje cell activity during motor learning. Brain reaearch . 1977; 128: 309,328.
16. D Manchester et al. Visual, vestibular and somatosensory contributions to balance control in the older adult. Journal of gerontology. 1989; vol 44(4): 118-27.
17. Nicoleta Bugnariu, Joyce Fung. Aging and selective sensorimotor strategies in the regulation of upright posture. *Journal of NeuroEngineering and Rehabilitation.* 2007; 4:1-7.
18. Shrikant Bhimrao Darade, Shyam Devidas Ganvir. Effectiveness of sensory motor training programme in community dwelling elderly individuals with history of fall. Journal of Physiotherapy & Physical Rehabilitation . 2017; 2(2): 3-8.
19. R G Bellomo et al. Balance and posture in the elderly: analysis of a sensorimotor rehabilitation protocol. international journal of immunopathy and pharmacology. 2009; 22(3 Suppl):37-44.
20. Amal F, Ahmed, PT. D. Effect of Sensorimotor Training on Joint Proprioception and Isokinetic Strength Ratios in Subjects with Unilateral Functional Ankle Instability age aging Bull. Fac. Ph. Th. Cairo Univ. 2010 Vol. 15, No. (2) Jul.