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ORIGINAL RESEARCH

Improvement of postural balance in elderly women with the use of additional sensory information

Melhora do equilíbrio postural em mulheres idosas com o uso de informação sensorial adicional

La mejora del equilibrio postural de ancianas con la utilización de la información sensorial adicional

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ABSTRACT | The natural process of human aging has morphological and physiological changes, such as balance and gait, increasing the risk of falling. Some studies have investigated the use of additional sensory information to improve body balance using a soft touch on a rigid and stationary surface, which showed a significant reduction in the body oscillation. Effects of the additional sensory information were evaluated during gait on elderly women. We evaluated 30 elderly women aged 60 or older. Sensory information was added by an infrapatellar bandage. Participants performed the tests proposed by the Dynamic Gait Index (DGI), the Timed Up and Go (TUG), and the 10-Meter Walk Test (10MWT), with and without infrapatellar bandage. Data comparisons were carried out by using paired t test and Wilcoxon test with $p \leq 0.05$. There was a significant difference in the TUG (without bandage: 10.13 ± 2.1, with bandage: 9.71 ± 2.1, p = 0.0007) and DGI test (without bandage: 20.65 ± 2 1; with bandage: 22.1 ± 2.1, p = 0.002). There was no significant difference in the use of 10MWT sensory addition. The results showed that the use of additional sensory information generated by the infrapatellar bandage promoted improvement of functional mobility and physical performance in elderly women.

Keywords | Aged; Gait; Postural Balance; Bandages.

RESUMO | O processo natural do envelhecimento humano apresenta alterações morfológicas e fisiológicas, como alterações de equilíbrio e da marcha, aumentando o risco de cair. Alguns estudos investigaram a utilização da informação sensorial na melhora do equilíbrio corporal utilizando o toque suave em uma superfície rígida e estacionária, verificando uma redução significativa da oscilação corporal. Avaliou-se os efeitos da informação sensorial adicional durante a marcha em mulheres idosas. Foram avaliadas 30 mulheres com 60 anos ou mais. A adição da informação sensorial foi feita por uma bandagem infrapatelar. As participantes realizaram os testes propostos pelo *Dynamic Gait Index* (DGI), pelo *Timed Up and Go* (TUG) e pelo Teste de Caminhada de 10 Metros (TC10m), com e sem a bandagem infrapatelar. As comparações dos dados foram realizadas com o teste t pareado e o teste de Wilcoxon, com p≤0,05. Houve diferença significativa na comparação do TUG (sem bandagem: 10,13±2,1; com bandagem: 9,71±2,1, p=0,0007) e no DGI (sem bandagem: 20,65±2,1; com bandagem: 22,1±2,1, p=0,002). Não houve diferença significativa no uso da bandagem no TC10m. Os resultados mostraram que o uso da informação sensorial adicional gerada pela bandagem infrapatelar promoveu melhora da mobilidade funcional e do desempenho físico em mulheres idosas.

Descritores | Idoso; Marcha; Equilíbrio Postural; Bandagens.

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RESUMEN | El proceso natural del envejecimiento humano presenta cambios morfológicos y fisiológicos, que altera el balance postural y la marcha, aumentando así el riesgo de caídas. Hay estudios que analizaron la utilización de la información sensorial en la mejora del balance postural empleando el toque suave en una superficie rígida y estacionaria, resultando en una significativa disminución en la oscilación corporal. Se evaluó el resultado de la información sensorial adicional durante la marcha en ancianas. Participaron treinta mujeres de más de 60 años. Se realizó la información sensorial a través de vendajes infrapatelares. Las participantes hicieron las pruebas de *Dynamic Gait Index* (DGI), de *Timed Up and Go* (TUG) y de Caminata de 10 metros (PC10m), con y sin las vendajes infrapatelares. Para la comparación de los datos se emplearon la prueba t pareada y la prueba de Wilcoxon, con p≤0,05. La comparación de la TUG (sin vendajes: 10,13±2,1; con vendajes: 9,71±2,1, p=0,0007) con la DGI (sin vendajes: 20,65±2,1; con vendajes: 22,1±2,1, p=0,002) presentó diferencias significantes. En la PC10m no presentó diferencias significantes con la utilización de vendajes. Los resultados comprobaron que la utilización de la información sensorial adicional por el vendaje infrapatelar mejoró la movilidad funcional y el rendimiento físico de ancianas.

Palabras clave | Anciano; Marcha; Balance Postural; Vendajes.

INTRODUCTION

The physiological decline of the human body generated by aging can occur in several ways, including bone density and muscle mass reduction, increased postural instability, impairment of visual and auditory capacity, higher consumption of medicines, as well as environmental risks that can predispose older people to fall[1].

Falls, defined as an unintended event that results in change of the starting position of the individual to the same level or lower, are an important cause of mortality, morbidity, disability, and hospitalizations in the elderly population[1-3]. A situation was observed within this population: women are the ones who fall the most[2]; 30% fall at least once a year and, out of these, 50% fall very often[4]. Falls are considered the sixth cause of death in patients older than 65, and they amount to70% of the accidental deaths in older people aged 75 or older[5].

Body balance, defined as maintenance of a body posture without causing oscillations, or maintenance of a certain posture during a motor ability performance that is intended to disturb the body's orientation, occurs due to the interaction of sensory, musculoskeletal, and central nervous systems[4].

Balance involves reception and integration of sensory stimuli, planning and execution of movements to control the center of gravity over the support base, being carried out by the postural control system, which integrates information of the vestibular system, visual receptors, and sensory-motor system. In older people, this system's capacity is reduced; therefore, imbalance, instability, and falls may occur. Thus, evaluating body balance in older people is extremely important, since, after identifying the deficit, preventive measures could be taken as early as possible, avoiding the risk of falls in this population[6].

Information related to balance change constantly, depending on the relative positions of the body segments and the magnitude of the forces acting on it. Thus, sensory information is connected to motor action and vice versa. Increase of sensory stimuli could reduce the body oscillation, keeping the body in a particular position and improving balance[7]. Some studies have investigated the use of sensory information in body balance using a soft touch on a rigid and stationary surface, and the results obtained showed a significant reduction in body oscillation. Towards this, additional sensory information can be used continuously for body oscillation reduction[4,8-10].

Thus, an increase of proprioception, balance, and postural control can be obtained by the infrapatellar bandage mechanism[4,7,11,12], increasing motor control organization, which may lead to a decrease in body oscillation[13].

Despite the positive effects of the use of additional sensory information in the postural control[8-10], there is still no evidence of the contribution of this additional information in a more dynamic process, such as the gait. Thus, this study aimed to analyze the effect of additional sensory information in postural balance improvement during the gait of old women.

METHODOLOGY

This was a clinical and randomized trial, with data collection between March and November

2015. Thirty elderly women from Marília (SP) were evaluated. They were aged 60 years or older and selected in basic health units, community centers, and geriatric clinics. This research did not include elderly women with uncorrected vision problems, who took antidepressant medications and sedatives, who used gait support devices, and with sequelae from neurological diseases.

All procedures were carried out in the Building 1 – "Education", from the Faculdade de Filosofia e Ciências of Universidade Estadual Paulista (FFC-Unesp), Marília, state of São Paulo.

The study was approved by the Research Ethics Committee of the School of Philosophy and Sciences (FFC)/UNESP – Marília (SP) under the protocol number 1.151.910. All volunteers signed the Informed Consent Form.

A cognitive screening was performed by the Mini Mental State Examination – MMSE, and the cut-off score was defined according to the educational background (30 points for top score; 18 points for illiterate older people; 21 for older people with 1 up to 3 years of education; 24 points for older people with 4 up to 7 years of education; and 26 points for older people with 8 or more years of education)[14,15].

Evaluation was divided into two phases: 1) condition of normal information (NI): without inclusion of additional sensory information; 2) condition of additional sensory information by including a infrapatellar, Salvape® bandage, 2 cm wide, bilaterally positioned on the skin of volunteers (Figure 1).

Figure 1. Infrapatellar bandage

In each of these phases, three tests were conducted: Timed Up and Go, 10-Meter Walk Test, and Dynamic Gait Index. Test execution and use of additional sensory information followed a random order by draw of the test and the condition (with or without bandage) for each person evaluated.

Functional mobility was assessed by the Timed Up and Go (TUG) test, measuring in seconds the time spent by the volunteer to stand up from a chair without using the arms, walk a 3-meter distance, turn around, and return to the starting point. At the beginning of the test, volunteers kept their back supported by the back of the chair and, at the end, they should lean their back again. Participants receive the instruction "go" to perform the test, and time should be controlled from the voice command up to the moment volunteers lean their back again on the back of the chair. The test should be performed once for familiarization and a second time for time control[16,17].

Physical performance was evaluated in two ways: 1) 10-Meter Walk Test (10MWT); 2) Dynamic Gait Index (DGI).

The 10-Meter Walk Test (10MWT) evaluates the kinematic spatial and temporal attributes of the gait. In order to eliminate acceleration and deceleration, volunteers began to walk 1.2 min before the route start and finished 1.2 min after the 10-meter route in usual speed[18]. The test was performed three times to minimize learning effect, and the best performance was used for data analysis by calculating the mean speed for each participant.

The Dynamic Gait Index (DGI) evaluates postural balance ability and gait. The test consists of eight tasks involving gait in different sensory contexts, including flat surface, changes in gait speed, horizontal and vertical head movements, going over and getting around obstacles, spinning around their own body axis, going up and down stairs. Patients were evaluated by an ordinal scale with four categories and received a score according to their performance in each task: 3 = normal gait; 2 = mild impairment; 1 = moderate impairment; and 0 = severe impairment. The maximum score is 24 points[19].

Data were presented as mean ± standard deviation. The Shapiro-Wilk test was applied to verify data normality. For abnormal data, statistical analysis was carried out by the Wilcoxon test, and, for normal data, the paired t-test was used. The significance level adopted was $p \leq 0.05$.

RESULTS

In the evaluated sample, the mean age was 69.03 ± 5.2. The mean score in the MMSE was 26.8 ± 2.5, while the mean quantity of medicines ingested was 2.6 ± 2.1.

Significant difference was found in the TUG mean time and in the DGI score in the situation with bandage when compared to the situation without bandage. The same result was not found in the mean speed, despite clinical improvement (Table 1).

Table 1. Distribution of values as mean ± standard deviation and p-value for the results of the evaluated variables

	No bandage	With bandage	P
TUG (s)	11.33 ± 2.9	10.80 ± 2.7	0.0001
DGI	20.93 ± 2.2	22.5 ± 1.9	< 0.0001
MS (m/s)	1.20 ± 0.24	1.24 ± 0.28	0.11

TUG: Timed Up and Go; DGI: Dynamic Gait Index; MS: mean speed

DISCUSSION

The number of older people is increasing worldwide[20]. Falls are a serious public health problem, which can lead older people to immobility, hospitalization, and death, as well as generate fear of falling and decrease functional capacity[21]. According to an estimation, falls generate an annual cost around 1% of all health expenses in occidental countries[22]. Therefore, investigating methods to reduce the risk of falling is extremely important for this population and for public health.

The data found support the hypothesis that the infrapatellar bandage improves functional mobility (TUG). The activities proposed by the TUG need strength, agility, and balance[23,24]. Thus, smaller values indicate better functional mobility, better balance, increased gait speed and, therefore, a minor risk of falling, as well as a possible greater independence in daily life activities.

This mobility improvement may have been caused by the increase of proprioceptive feedback and postural adjusting reactions caused by an additional sensory stimulation. The infrapatellar bandage may have stimulated phasic tactile receptors, increasing quality and quantity of sensory information to the Central Nervous System, thus increasing the motor cortex activity[4,13,25].

Only one study was found about infrapatellar bandage use in the balance of older people without associated diseases. Carvalho et al.[4] found similar results regarding additional sensory stimulation in older people with history of falls considering the time to perform TUG test. They concluded that addition of sensory information by infrapatellar bandage use improved mobility of older people who usually fall. Studies that investigated changes in postural balance with use of additional sensory information by infrapatellar bandage were carried out on young people with Patellofemoral Pain Syndrome or anterior cruciate ligament injury, and they concluded that the addition of sensory information improved balance[13,26]. Another study evaluated infrapatellar bandage use on people with knee osteoarthritis and concluded that additional sensory information improved biomechanical parameters during task of overcoming obstacles[27].

Baldan et al.[28] carried out a systematic review to evaluate effects of gentle touch in rigid surface in people with change of balance and, among studies that evaluated various conditions, the authors found three that showed older people could benefit from this technique to reduce postural oscillation. Nevertheless, as discussed above, its use on a daily basis would be impracticable.

DGI mean score showed significant improvement with addition of sensory information. DGI consists of eight tasks involving gait at different sensory contexts, and higher scores suggest a better ability of older people to manage balance and gait on test requirements.

When Cabreira et al.[29] assessed variables in the force platform, they found no improvement in the balance of elderly women by placing Kinesio Taping on gastrocnemius and midfoot muscles.

Regarding mean speed (MS), a value increase was observed, but without statistical significance. In geriatric rehabilitation, increased MS usually predicts advance in independence and mobility[30], as it brings improvement of physical functions and reduces disabilities and use of medical services[31]. MS evaluation is simple, and it can indicate a good aging condition and greater ability to recover in situations in which older people suffer an overload, such as falling[32-34]. MS can be used as a guide to map and categorize older people who present high and low risk of falls. Moreover, it is able to identify the fear of falling in this population[35].

Older people, especially the ones who fall, present mobility reduction and are more likely to have decreased muscle strength caused by aging process and inactivity, with consequent impact on gait, as well as ankle and

hips stabilization[4]. Increased stimulus coming from the infrapatellar bandage can favor kinematics of the knee joint and produce beneficial results in the mobility and speed of this population[4,34].

There are still doubts regarding real benefits of sensory information addition in the improvement of postural balance in older people. Our results indicate an immediate balance improvement, even in challenging situations such as the DGI. However, further studies need to be performed to clarify whether benefits can occur in a long term, in addition to its use on pathological conditions, such as Parkinson's disease, for example.

CONCLUSION

Our results showed it is possible to improve postural balance during gait in elderly women with addition of sensory information.

LIMITATIONS OF THE STUDY

One of the study's limitations was the participation of older people, because, although it was just one day of evaluation, many of them refused to participate. In addition, the difficulty of forming a male group is worth a highlight.

REFERENCES

1. Rosa TSM, Moraes AB, Peripolli A, Santos Filha VAV. Perfil epidemiológico de idosos que foram a óbito por queda no Rio Grande do Sul. Rev Bras Geriatr Gerontol. 2015;18(1):59-69. doi: 10.1590/1809-9823.2015.14017.
2. Freitas MG, Bonolo PF, Moraes EN, Machado CJ. Elderly patients attended in emergency health services in Brazil: a study for victims of falls and traffic accidents. Ciênc Saúde Coletiva. 2015;20(3):701-12. doi: 10.1590/1413-81232015203.19582014.
3. Toledo DR, Barela JA. Diferenças sensoriais e motoras entre jovens e idosos: contribuição somatossensorial no controle postural. Rev Bras Fisioter. 2010;14(3):267-75. doi: 10.1590/S1413-35552010000300004.
4. Carvalho IF, Bortolotto TB, Fonseca LCS, Scheicher ME. Uso da bandagem infrapatelar no desempenho físico e mobilidade funcional de idosas com história de quedas. Rev Bras Geriatr Gerontol. 2015;18(1):119-27. doi: 10.1590/1809-9823.2015.14002.
5. Ganança FF, Gazzola JM, Ganança CF, Caovilla HH, Ganança MM, Cruz OLM. Quedas em idosos com vertigem posicional paroxística benigna. Braz J Otorhinolaryngol. 2010;76(1):113-20. doi: 10.1590/S1808-86942010000100019.
6. Karuka AH, Silva JAMG, Navega MT. Análise da concordância entre instrumentos de avaliação do equilíbrio corporal em idosos. Rev Bras Fisioter. 2011;15(6):460-6. doi: 10.1590/S1413-35552011000600006.
7. Botelhos DC, Bonfim TR. Influência da informação sensorial adicional no treinamento sensório-motor. Fisioter Pesqui. 2012;19(3):268-74. doi: 10.1590/S1809-29502012000300013.
8. Jeka JJ, Lackner JR. Fingertip contact influences human postural control. Exp Brain Res. 1994;100(3):495-502. doi: 10.1007/BF00229188
9. Jeka JJ, Lackner JR. The role of haptic cues from rough and slippery surfaces in human postural control. Exp Brain Res. 1995;103(2):267-76.
10. Bonfim TR, Barela JA. Efeito da manipulação da informação sensorial na propriocepção e no controle postural. Fisioter Mov. 2007;20(2):107-17.
11. Hughes MA, Duncan PW, Rose DK, Chandler JM, Studenski AS. The relationship of postural sway to sensorimotor function, functional performance, and disability in the elderly. Arch Phys Med Rehabil. 1996;77(6):567-72. doi: 10.1016/S0003-9993(96)90296-8.
12. Callaghan MJ, McKie S, Richardson P, Oldham JA. Effects of patellar taping on brain activity during knee joint proprioception tests using functional magnetic resonance imaging. Phys Ther. 2012;92(6):821-30. doi: 10.2522/ptj.20110209.
13. Felicio LR, Masullo CL, Saad MC, Bevilaqua-Grossi D. The effect of a patellar bandage on the postural control of individuals with patellofemoral pain syndrome. J Phys Ther Sci. 2014;26(3):461-4. doi: 10.1589/jpts.26.461.
14. Aveiro MC, Driusso P, Barham EJ, Pavarini SCI, Oishi J. Mobilidade e risco de quedas de população idosa da comunidade de São Carlos. Ciênc Saúde Colet. 2012;17(9):2481-8. doi: 10.1590/S1413-81232012000900028.
15. Brucki SMD, Nitrini R, Caramelli P, Bertolucci P, Okamoto IH. Sugestões para o uso do mini-exame do estado mental no Brasil. Arq Neuro-Psiquiatr. 2003;61(3B):777-81. doi: 10.1590/S0004-282X2003000500014.
16. Ansai JH, Glisoi SFN, Oliveira T, Soares AT, Cabral KN, Sera CTN et al. Revisão de dois instrumentos clínicos de avaliação para predizer risco de quedas em idosos. Rev Bras Geriatr Gerontol. 2014;17(1):177-89. doi: 10.1590/S1809-98232014000100017.
17. Schoene D, Wu SM, Mikolaizak AS, Menant JC, Smith ST, Delbaere K et al. Discriminative ability and predictive validity of the timed up and go test in identifying older people who fall: systematic review and meta-analysis. J Am Geriatr Soc. 2013;61(2):202-8. doi: 10.1111/jgs.12106.
18. Novaes RD, Miranda AS, Dourado VZ. Usual gait speed assessment in middle-aged and elderly Brazilian subjects. Braz J Phys Ther. 2011;15(2):117-22. doi: 10.1590/S1413-35552011000200006.
19. De Castro SM, Perracini MR, Ganança FF. Versão brasileira do Dynamic Gait Index. Rev Bras Otorrinolaringol. 2006;72(6):817-25. doi: 10.1590/S0034-72992006000600014.

20. United Nations. 2015 Revision of world population prospects [Internet]. [Acesso em 18 maio 2016]. Disponível em: http://esa.un.org/wpp/

21. Gillespie LD, Robertson MC, Gillespie WJ, Lamb SE, Gates S, Cumming RG et al. Interventions for preventing falls in older people living in the community. Cochrane Database Syst Rev. 2009;15(2):CD007146. doi: 10.1002/14651858.CD007146.pub2.

22. Heinrich S, Rapp K, Rissmann U, Becker C, König HH. Cost of falls in old age: a systematic review. Osteoporos Int. 2010;21(6):891-902. doi: 10.1007/s00198-009-1100-1.

23. Miotto JM, Chodzko-Zajko WJ, Reich JL, Supler MM. Reliability and validity of the fullerton functional fitness test: an independent replication study. J Aging Phys Activ. 1999; 7(4):339-53. doi: 10.1123/japa.7.4.339.

24. Schenkman M, Hughes MA, Samsa G, Studenski S. The relative importance of strength and balance in chair rise by functionally impaired older individuals. J Am Geriatr Soc.1996;44(12):1441-6. doi: 10.1111/j.1532-5415.1996.tb04068.x.

25. Callaghan MJ. What does proprioception testing tell us about patellofemoral pain? Musculoskelet Sci Pract. 2011;16(1):46-7. doi: 10.1016/j.math.2010.06.013.

26. Bonfim TR, Grossi DB, Paccola CAJ, Barela JA. Effect of additional sensory information in the proprioception and postural control of individuals with ACL lesion. Acta Ortop Bras. 2009;17(5):291-6. doi: 10.1590/S1413-78522009000500008.

27. Pegoretti KS, Moraes R, Masullo CL, Chagas-Neto FA, Miranda A, Kfuri M Jr et al. Additional sensory input improves the strategy of stepping over obstacle in individuals with knee osteoarthritis. J Back Musculoskelet Rehabil. 2015;28(4):689-97. doi: 10.3233/BMR-140570.

28. Baldan AM, Alouche SR, Araujo IM, Freitas SM. Effect of light touch on postural sway in individuals with balance problems: a systematic review. Gait Posture. 2014; 40(1):1-10. doi: 10.1016/j.gaitpost.2013.12.028.

29. Cabreira TS, Coelho KHV, Quemelo PRV. Efeito da Kinesio Taping no equilíbrio postural de idosos. Fisioter Pesqui. 2014;21(4):333-8. doi: 10.590/1809-2950/12320821042014.

30. Santos AS, Tribess S, Pinto LLT, Ribeiro MCL, Rocha SV, Virtuoso Jr JS. Velocidade de caminhada como indicador para a incapacidade funcional em idosos. Motricidade. 2014;10(3):50-60. doi: 10.6063/motricidade.10(3).3186.

31. Pamoukdjian F, Paillaud E, Zelek L, Laurent M, Lévy V, Landre T. Measurement of gait speed in older adults to identify complications associated with frailty: a systematic review. J Geriatr Oncol. 2015;6(6):484-96. doi: 10.1016/j.jgo.2015.08.006.

32. Singh DL, Pillai SG, Tan ST, Sharar S. Association between physiological falls risk and physical performance tests among community-dewling older adults. Clin Interv Aging. 2015;10:1319-26. doi: 10.2147/CIA.S79398

33. Verghese J, Holtzer R, Lipton RB, Wang C. Quantitative gait markers and incident fall risk in older adults. J Gerontol A Biol Sci Med Sci. 2009;64A(8):896-901. doi: 10.1093/gerona/glp033.

34. Marques NR, Laroche DP, Hallal CZ, Crozara LF, Morcelli MH, Karuka AH et al. Association between energy cost of walking, muscle activation, and biomechanical parameters in older female fallers and non-fallers. Clin Biomech (Bristol, Avon). 2013;28(3):330-6. doi: 10.1016/j.clinbiomech.2013.01.004.

35. Moreira MA, Oliveira BS, Moura KQ, Tapajós DM, Maciel ACC. A velocidade de marcha pode identificar idosos com medo de cair? Rev Bras Geriatr Gerontol. 2013;16(1):71-80. doi: 10.1590/S1809-98232013000100008.