DOI: 10.5455/msm.2019.31.219-221
Received: Jun 25 2019; Accepted: Sep 15, 2019

REVIEW Mater Sociomed. 2019 Sep; 31(3): 219-221

The Importance and Role of Proprioception in the Elderly: a Short Review

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ABSTRACT

Introduction: Aging causes alterations in various body functions, such as motor, sensory, cognitive and psychosocial. One of the factors associated with aging is also the decline in proprioceptive function. **Aim:** This paper provides an overview from the literature about the definition and importance of proprioception and the correlation with the elderly population. **Material and Methods:** The scientific literature was reviewed through PubMed, Medline and Science Direct. The articles were chosen in correlation with the study objective and their scientific relevance. **Results:** Proprioceptive training is fundamental in the rehabilitation and prevention of sports injuries. With the loss of proprioception during aging, the biomechanics of joints and the neuromuscular control of the limbs may change, resulting in impaired balance and a higher possibility of falls. Appropriate and proper physical activity can slow the age-related decline in proprioception. **Conclusion:** An appropriate proprioceptive training is important for maintaining the best possible physical fitness. It encompasses exercises for stability and coordination, stimulates motor learning, helps in maintaining proper body posture and balance, and improves body control.

Keywords: proprioception, the elderly, falls, rehabilitation, movement.

1. INTRODUCTION

Aging causes alterations in various body functions, such as motor, sensory, cognitive and psychosocial. Among the factors associated with aging is also the decline in proprioceptive function, which is essential for normal functioning of the body during movements and in maintaining balance (1). As a result of decreased sensitivity of the body and limb position, alteration and decline of proprioception during aging may significantly affect mobility and increase the risk of falls. In the aging population, falls are a serious health problem. According to the reports, approximately 30% of falls result in grave injuries that require medical attention (1-3). Adults aged 65 years and older are more often affected and such injures are an important cause of morbidity and mortality (2, 3). Postural stability, gait and balance that decline with age, however, are not the only reason for falls and complications during treatment (3, 4).

2. AIM

This paper provides a brief overview from the literature about the definition and importance of proprioception and its correlation with the elderly population.

3. MATERIAL AND METHODS

Literature search was conducted for this review. The data about the significance of proprioception, falls and rehabilitation for the elderly population was collected from various sources. These included electronic databases PubMed, Medline and Science Direct. The search was performed using a combination of the following terms: proprioception, elderly, falls, rehabilitation and movement. The articles were selected in correlation with the study objective and their scientific relevance.

4. RESULTS AND DISCUSSION

4.1 Proprioception and its mechanisms

Proprioception was first defined by neuropsychologist Charles Sherrington at the beginning of the 20th century. Sherrington concluded that in the body, there are specific receptors in the musculoskeletal system where various stimuli

are triggered by alterations in the organism that are perceived in space, depending on the position of the body, limbs and contact with the substrate. He claimed that the stimuli to the receptors are triggered by the organism itself and therefore he called this area of sensory perception the proprioceptive field. Sherrington defined proprioception as the perception of position and motion of joints and body in space, which is in fact very close to today's understanding of proprioception (5). The definitions of proprioception may vary. Today, proprioception is defined as the ability of an organism to perceive the position and motion of joints and the perception of force, in space (6-10). It can be defined as the cumulative neural input to the central nervous system from mechanoreceptors (10).

Proprioception demands coordinated action of different types of receptors. Mechanoreceptors, more precisely proprioceptors, are located in tendons, muscles, ligaments and joint capsules (9, 11). Included among the proprioceptors are the Golgi tendon organ, the muscle spindle, the Pacini corpuscle, free nerve endings and the receptors in the joint capsules and skin (12). The mechanoreceptors transmit information on the position and motion of the joints to the central nervous system (7, 10). They are sensitive to mechanical stimuli. The mechanical changes in the tissues with the proprioceptors cause the activation of these specific receptors, thereby releasing stored sodium into the cells, which is the first step in provoking the action potential. The nerve signal is then transmitted through the afferent sensory pathways to the central nervous system (11). Here, the sensory information is processed and integrated with other sensory input into the nervous system. The response is sent via the efferent motor pathways to target tissues (10, 11). Sending proprioceptive signals to the central nervous system via afferent sensory pathways is essential for the control of body movement. Proprioception itself has an unconscious and a conscious component. At the unconscious level, the signals protect the overstretching of the joint capsule, which is reflected at the level of reflex movement, control of muscle tone and posture (13). At the conscious level, proprioception enables the awareness of the joint, body movements and the awareness of the joint position (12).

4.2 The importance and role of proprioception in the elderly

Proprioception plays an important role in the planning of precise and coordinated movements, in maintaining balance and controlling body posture. It also exerts its influence on motor learning and re-education (14). Proprioception enables the stability and orientation of the body during static and dynamic activities (15, 16). The awareness of body segments in space is crucial for the organism to communicate effectively with the environment (17). The importance of proprioception is evident in various areas. In sports, proprioception has an important role in the prevention and rehabilitation of injuries. The role of proprioception has increased in the aging population, especially in the case of falls. With aging, proprioception is also affected, among other functions, which may result in poor perception of the position of body in space. A decline in proprioception can change the joint biomechanics and the neuromuscular control of the limbs, resulting in impaired balance and a higher possibility of falls (10, 16, 18).

The deterioration of the proprioceptive mechanisms with aging involves changes in peripheral and central nervous system. Due to alterations in proprioception, the biomechanics of the joints and the neuromuscular control of the limbs change, resulting in the balance disturbances. The proprioceptive functions decline during the aging process, which has been associated with the balance deficits. A poor balance and a poor proprioception function increase the likelihood of falls (10, 19). An age-related decline in the proprioception is most likely associated with a decrease in the dynamic response of muscle spindles and the atrophy of axons that cause defects in the processing and input of sensory information. This reduces the speed of translation by nerve fibres. At the central level, therefore, the age-related decline in proprioception reflects as a progressive decline of dendrites in the motor cortex, the appearance of neurochemical modifications in the brain and the loss of neurons and receptors. In older people, motor units are on average longer and slower, which is reflected in the field of organization and thus the production of muscular strength and control. This is also reflected in the proprioceptive functions (10). Without appropriate proprioception, the onset of movements is slowed whereas movement planning is defective and inadequate (14). Both balance and motor coordination problems coincide with aging, whereby proprioception plays at least a partial role. Deficits in proprioception lead to a poorer perception of the position of the body in space, leading to inadequate biomechanics of joints during everyday activities, while long-lasting inadequate biomechanics causes degeneration of joints over time (10). Due to changes in proprioception, the neuromuscular control of the lower limbs changes and as a result there is a poor balance in the elderly (8, 10, 20).

The sense of perception and awareness of the body's position is crucial in order for the organism to communicate effectively with the environment. The proprioception decline in the lower limbs has already been associated with problems of balance in the elderly. All changes in the proprioceptive field have a significant impact on the individual's movement, which is also associated with the high incidence of falls in the elderly (10, 18). According to statistical surveys, falls are an important cause of mortality and can significantly impair the quality of life. The highest share of fatal falls is in people just over 65 years old (21). Proprioceptive exercise is not only important in preventing falls (4, 8, 22), but also in the field of rehabilitation in other diseases. Thus, favourable effects of proprioceptive exercise were confirmed in patients with multiple sclerosis, where it turned out that after proprioceptive training, balance was improved, and the number of falls decreased (4, 8, 22). The authors predicted that with the appropriate exercise program, which could reduce the incidence of falls and related injuries, they could improve the quality of life and thus lower the costs of health care. Research describes various proprioceptive exercise programs, although there is no single point of view about exactly what such training should look like (12, 13). Proprioception is closely related to movement; the movement of body segments and the

movement of tissues are essential for the stimulation of proprioceptors (13). Exercise programs, which are carried out as training for increasing the proprioceptive inflow, include various exercises, from active exercises, coordination exercises, resistance exercises, balance exercises, plyometric exercises, exercises on vibrating plates, as well as the exercises that repeat muscular activation with the selected force (12).

Appropriate proprioceptive training can be effective in improving proprioceptive function. It may improve somatosensory and sensorimotor function; more precisely, it can lead to a better outcome in postural stability, static and dynamic balance (13). Nevertheless, it can lead to a decrease in the risk of falls in older adults (4). More importantly, with the appropriate training program adults may be more confident with their movement, which can also reduce their fear of falling and improve their quality of live.

5. CONCLUSIONS

Proprioception as the ability of an organism to perceive the position and movements of joints and the perception of force in space allows us to better understand our movement and posture. Proprioception is closely related to balance. Mechanoreceptors transmit proprioceptive information to the central nervous system, which is important for better control of movement. The field of proprioception plays an increasingly important role in the aging population. Physiological changes connected with aging lead to a decline in proprioceptive functions. Regular and appropriate physical activity can help improve proprioceptive functions and reduce the risk of falls that represent a global problem in the elderly. In the future, further studies will be needed on the content and effectiveness of various proprioceptive exercise programs.

- **Author's contribution:** A. F., E. F., T. V. and L. G. . gave substantial contribution to the conception or design of the work and in the acquisition, analysis and interpretation of data for the work. A. F. had role in drafting the work and revising it critically for important intellectual content. A. F. and E. F. gave final approval of the version to be published and they agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.
- **Conflicts of interest:** There are no conflicts of interest.
- **Financial support and sponsorship:** Nil.

REFERENCES

1. Bauer CM, Groger I, Rupprecht R, Tibesku CO, Gasssmann KG. Reliability of static posturography in elderly persons. Z Gerontol Geriatr. 2010; 43(4): 245-248.
2. Berry SD, Miller RR. Falls: Epidemiology, pathophysiology, and relationship to fracture. Curr Osteoporos Rep. 2008; 6(4): 149-154.
3. Baloh RW, Ying SH, Jacobson KM. A longitudinal study of gait and balance dysfunction in normal older people. Arch Neurol. 2003; 60(6): 835-883.
4. Martínez-Amat A, Hita-Contreras F, Lomas-Vega R, Caballero-Martínez I, Alvarez PJ, et al. Effects of 12-week proprioception training program on postural stability, gait, and balance in older adults: a controlled clinical trial. J Strength Cond Res. 2013; 27(8): 2180-2188.
5. Kim OJ. Development of neurophysiology in the early twentieth century: Charles Scott Sherrington and The Integrative action of the nervous system. Uisahak. 2001; 10(1): 1-21.
6. Lephart SM, Pincivero DM, Giraldo JL, Fu FH. The role of proprioception in the management and rehabilitation of athletic injuries. Am J Sports Med. 1997; 25(1): 130-137.
7. Myers JB, Guskiewicz KM, Schneider RA, Prentice WE. Proprioception and Neuromuscular Control of the Shoulder after Muscle Fatigue. J Athl Train. 1999; 34(4): 362-367.
8. Westlake KP, Culham EG. Sensory-specific balance training in older adults: effect on proprioceptive reintegration and cognitive demands. Phys Ther. 2007; 87(10): 1274-1283.
9. Riemann BL, Lephart SM. The Sensorimotor System, Part I: The Physiologic Basis of Functional Joint Stability. J Athl Train. 2002; 37(1): 71-79.
10. Ribeiro F, Oliveira J. Aging effects on joint proprioception: the role of physical activity in proprioception preservation. Eur Rev Aging Phys Act. 2007; 4(2): 71-76.
11. Myers JB, Lephart SM. The Role of the Sensorimotor System in the Athletic Shoulder. J Athl Train. 2000; 35(3): 351-363.
12. Puh U, Dečman M, Palma P. Vsebina in učinki programov proprioceptivne vadbe za spodnje ude-pregled literature. Fizioterapija. 2016; 24(2): 50-58.
13. Aman JE, Elangovan N, Yeh IL, Konczak J. The effectiveness of proprioceptive training for improving motor function. Front Hum Neurosci. 2015; 8: 1075.
14. Ghez C, Gordon J, Ghilardi MF. Impairments of reaching movements in patients without proprioception. II. Effects of visual information on accuracy. J Neurophysiol. 1995; 73(1): 361-372.
15. Laskowski ER, Newcomer-Aney K, Smith J. Refining Rehabilitation With Proprioception Training: Expediting Return do Play. Phys Sportsmed. 1997; 25(10): 89-104.
16. Han J, Waddington G, Adams R, Anson J, Liu Y. 2015. Assessing proprioception: A critical review of methods. J Sport Health Sci. 2016; 5(1): 80-90.
17. Suetterlin KJ, Sayer AA. Proprioception: where are we now? A commentary on clinical assessment, changes across the life course, functional implications and future interventions. Age Ageing. 2014; 43(3): 313-318.
18. Tinetti ME, Speechley M, Ginter SF. Risk factors for falls among elderly persons living in the community. N Engl J Med. 1988; 319(26): 1701-1707.
19. Petrella RJ, Lattanzio PJ, Nelson MG. Effect of age and activity on knee joint proprioception. Am J Phys Med Rehabil. 1997; 76(3): 235-241.
20. Shaffer SW, Harrison AL. Aging of the somatosensory system: a translational perspective. Phys Ther. 2007; 87(2): 193-207.
21. World Health Organization (WHO), 2018. Falls. Available from: http://www.who.int/mediacentre/factsheets/fs344/en/.
22. Prosperini L, Leonardi L, De Carli P, Mannocchi ML, Pozzilli C. Visuo-proprioceptive training reduces risk of falls in patients with multiple sclerosis. Mult Scler. 2010; 16(4): 491-499.