Eur J Transl Myol - Basic Appl Myol 2015; 25 (4): 253-256

Mobility test protocols for the elderly: a methodological note

Nejc Sarabon (1,2), Stefan Löfler (3), Gabriella Hosszu (3), Christian Hofer (3)

(1) University of Primorska, Andrej Marusic Institute, Department of Health Study, Koper, Slovenia; (2) S2P, Science to Practice, d.o.o., Laboratory for Motor Control and Motor Behaviour, Ljubljana, Slovenia; (3) *Ludwig Boltzmann Institute of Electrical Stimulation and Physical Rehabilitation, Vienna, Austria*

Abstract

Consequences of falls are a major health problem in elderly. Poor balance is the precursor of falls and balance impairment has been evidenced after an injury. On the other hand, balance and stability can be improved with training. At the beginning of the project Mobility in Aging one of the questions was how to measure dynamic and static balance in order to get reliable and sensitive parameters to follow the effect of decay in movement functions in elderly or to track the improvement after training. In this short report we will give a couple of answers to a long standing debate. There is indeed evidence in literature that stability and balance is very important. Elderly people often shift from the so called ankle strategy to the hip strategy for balancing. The reflex reactions are the more to decay and we observed more co-contractions. Also, inactivity causes slower muscles contractions. Our goal should be a combination of trainings, where we can see changes at neuromuscular, structural and molecular levels, but we would like to say that our training protocols did not touch all the aspects of movement function we aimed to observe. Future projects will hopefully provide the missing information.
Key Words: older adults, falls, balance, strength, performance

Eur J Transl Myol - Basic Appl Myol 2015; 25 (4): 253-256

Consequences of falls are a major health problem in elderly. Poor balance is the precursor of falls in different ways.[1,2] Balance impairment has been evidenced after an injury.[3,4] On the other hand we also have evidence that balance and stability can be improved with training.[5-7] So, at the beginning of our project (Mobility in Aging) one of the questions was how to measure dynamic and static balance, in order to get reliable and sensitive parameters to follow the effect of decay or to track the improvement after trainings.[8-11] In our opinion this combination will give a couple of answers to a long standing debate.

There are three main components of movement: strength/power, stability/balance and flexibility/mobility (Figure 1). If they are coordinated, a safe and effective movement function takes place, but we will focus on strength/power and stability/balance and what should be the minimal optimal testing protocol. Among other factors, the test has to avoid an "overshoot/undershoot phenomenon" in its outcome results. Basically, we want to have a test that discriminates among subjects and that is highly repeatable.

A static balance test, that was part of our research, identify the center of pressure, then motion is registered when the center starts shifting. We may use a force plate for this purpose. One of our first studies involved 40 subjects. The question was about how repeatable this task is and how the position of the feet affect swinging of the body's centre of gravity.

There were great changes when using different feet positions for a quiet stance balance test. The second study focusing on a quiet stance balancing, included a bigger number of subjects. In this study we asked what the final and optimal test protocol for this testing should be. Our first question was how many subjects are capable of standing in four different positions (parallel, semi-tandem, tandem, and single-leg stance) for at least 30 s with eyes open or closed. Almost all subjects were capable of doing so for the following tasks: (1) parallel stance with eyes open and closed and (2) semi-tandem stance with eyes open. All the tasks that were more demanding than that (expl. tandem stance open eyes or semi-tandem closed eyes) resulted in a considerable drop of the percentage of the subjects being capable of completing the 30-s quiet stance task. It showed that the amount of the effect of closing the eyes differs considerably for different stances.

Then there is the next field: dynamic balance tests (Figure 2). This was quite a big study, where we

Fig 1. *Schematic presentation of the components of functional (i.e. effective and safe) movement.*

carried out different tasks: the out step, lunge test, the limit of stability test, functional reach test, etc.
Another test was the maximal strength test. For this purpose we developed mechanical, electronic and software components, all encompassed in the custom developed isometric knee dynamometer.

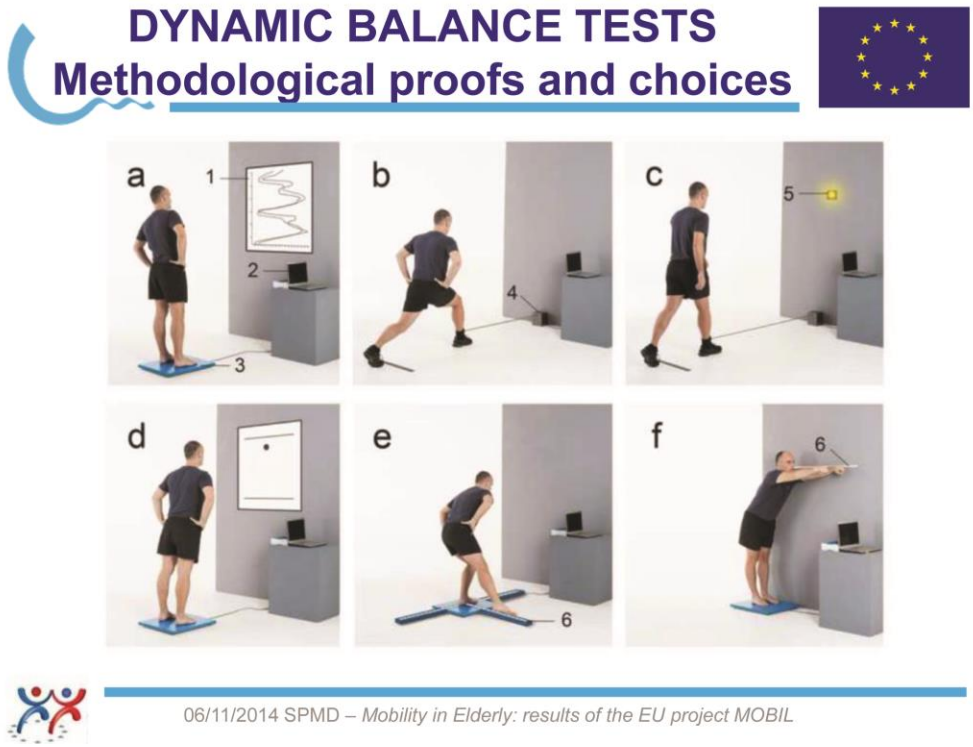

Fig 2*. Dynamic balance tests used in our studies in order to find the most sensitive and reliable test*

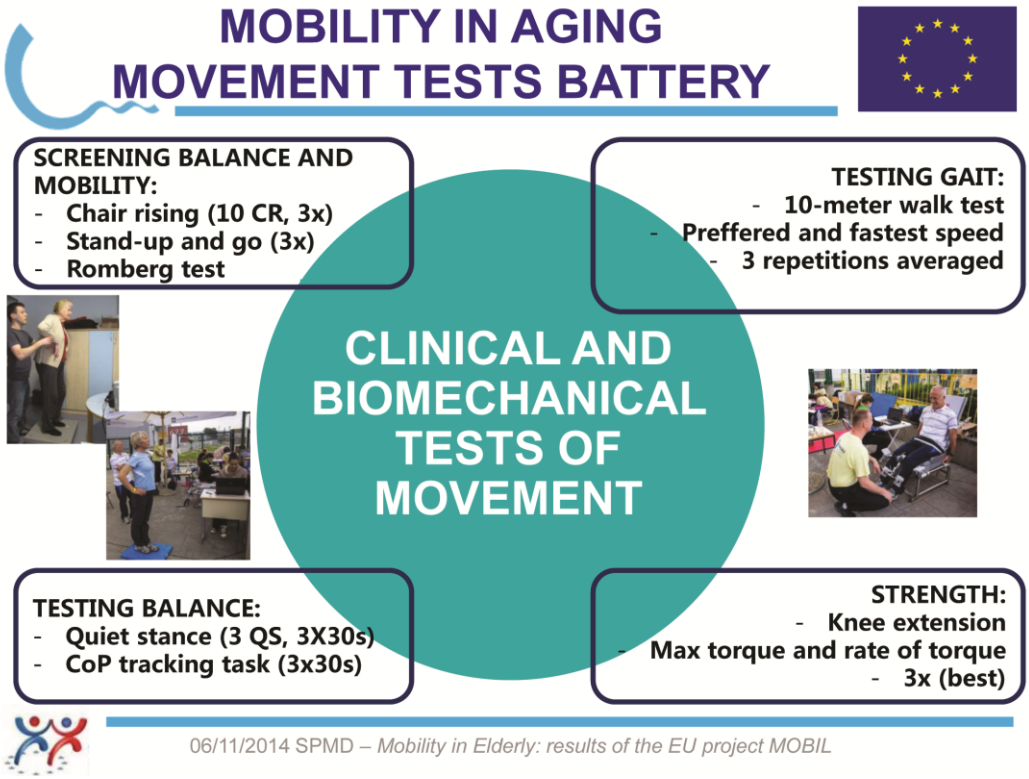

Fig 3. *Set of tests used in our clinical trial training intervention study in order to evaluate sensory-motor functions.*

The best, out of 3 repetitions measured, was used for further statistical analyses. This device enables the measurement under isometric conditions for knee extension and flexion. The angle can be changed by 10 degrees. The lower leg is fixed. In short, our test battery for mobility in aging involves, as already presented, screening balance and mobility, testing gait, testing balance and also strength (Figure 3).

From there on, we were curios and wanted to know what the relationship between the maximal torque and stability or balance is. In our subjects we found no correlation between the two groups of parameters. Stronger subjects are not more stable. Therefore, we suggest for future studies that these movement components should be trained and tested separately.

Our aim was to find the effects of strength training on balance in elderly subjects undergoing either-leg press training or electrical stimulation. We had three groups of subjects: a control group, the electrical stimulation group and the leg press group. The training groups improved balance at a statistically significant level when compared to the control group (2-way rmANOVA, $p < .05$). However, the differences partly resulted from the obvious pre-post changes in the control group. We could say that those that did not train got worse in matters of balance ability. If we go back to the beginning, we have to say that our training (and testing) protocol did not address all the important elements of the movement function. Mostly, the training protocol focused on strength and partly on power.

In summary, there is evidence in the literature that stability and balance are very important. The elderly often shift from the so called ankle strategy to the hip strategy for balancing. The reflex reactions are directed more toward to decay and thus more co-contractions are observed. Also, inactivity causes slower muscle contractions. We believe our goal should be a combination of training strategies, where we can see changes at the functional neuromuscular levels as well as at the structural and/or molecular levels.

Acknowledgement

We would like to acknowledge the co-financing support of: (1) the European Regional Development Fund for funding the Cross Border Cooperation Programme Slovakia – Austria (Interreg-IVa), project Mobilität im Alter, MOBIL, N_00033 (partners: Ludwig Boltzmann Institute of Electrical Stimulation and Physical Rehabilitation, Austria, Center for Medical Physics and Biomedical Engineering, Medical University of Vienna, Austria and Faculty of Physical Education and Sports, Comenius University in Bratislava, Slovakia) and (2) the Austrian Federal Ministry of Science and Research.This paper is a transcription of the talk presented to the Interreg IVa Final Meeting November 8 2014, Vienna, Austria.

Corresponding Author

Nejc Sarabon
University of Primorska, Andrej Marusic Institute, Department of Health Study, Muzejski trg 2, SI-6000 Koper, Slovenia. E-mail: nejc.sarabon@s2p.si

References

1. Ostrowska B, Giemza C, Wojna D, Skrzek A. Postural stability and body posture in older women: comparison between fallers and non-fallers. Ortop Traumatol Rehabil 2008;10:486-95. Available at: http://www.ncbi.nlm.nih.gov/pubmed/19043354.
2. Baczkowicz D, Szczegielniak J, Proszkowiec M. Relations between postural stability, gait and falls in elderly persons--preliminary report. Ortop Traumatol Rehabil 2008;10:478-85. Available at: http://www.ncbi.nlm.nih.gov/pubmed/19043353.
3. Tsang WW, Wong VS, Fu SN, Hui-Chan CW. Tai Chi improves standing balance control under reduced or conflicting sensory conditions. Arch Phys Med Rehabil 2004;85(1):129-137. doi:10.1016/j.apmr.2003.02.002.
4. Lamoth CJC, van Lummel RC, Beek PJ. Athletic skill level is reflected in body sway: a test case for accelometry in combination with stochastic dynamics. Gait Posture 2009;29:546-51. doi:10.1016/j.gaitpost.2008.12.006.
5. Kern H, Barberi L, Löfler S, et al. Electrical stimulation counteracts muscle decline in seniors. Front Aging Neurosci 2014;Jul 24:6:189. doi: 10.3389/fnagi.2014.00189. eCollection 2014.
6. Mosole S, Carraro U, Kern H, et al. Long-term high-level exercise promotes muscle reinnervation with age. J Neuropathol Exp Neurol 2014;73:284-4.
7. Zampieri S, Pietrangelo L, Loefler S, et al. Lifelong Physical Exercise Delays Age-Associated Skeletal Muscle Decline. J Gerontol A Biol Sci Med Sci 2015;70:163-73.
8. Sarabon N, Rosker J, Loefler S, Kern H. The effect of vision elimination during quiet stance tasks with different feet positions. Gait Posture 2013;38:708-11.
9. Sarabon N, Rosker J, Fruhmann H, et al. Reliability of maximal voluntary contraction related parameters measured by a portable isometric knee dynamometer. Phys Med Rehab Kuror. 2013;23:22-7.
10. Sarabon N, Rosker J, Loefler S, Kern H. Sensitivity of body sway parameters during quiet standing to manipulation of support surface size. J Sport Sci Med 2010;9:431-8.
11. Sarabon N, Kern H, Loefler S, Jernej R. Selection of body sway parameters according to their sensitivity and repeatability. Eur J Transl Myol – Basic Appl Myol 2010;20:5-12.