



Effect of 14 days of bed rest in older adults on parameters of the body sway and on the local ankle function



Nejc Sarabon^{a,b,*}, Jernej Rosker^{a,b}

^a University of Primorska, Science and Research Center, Institute for Kinesiology Research, Koper, Slovenia

^b S2P Ltd., Laboratory for Motor Control and Motor Behaviour, Ljubljana, Slovenia

ARTICLE INFO

Article history:

Received 10 March 2013

Received in revised form 19 August 2013

Accepted 10 September 2013

Keywords:

Inactivity
Microgravity
Strength
Balance
Elderly

ABSTRACT

This study explored the effects of a 14-day horizontal bed rest (BR) without countermeasures on postural sway, maximal voluntary torque and precision of voluntary torque matching. Sixteen subjects were tested before, immediately after and two weeks after BR. The increase in frequency and amplitude after BR was comparable for both sway subcomponents (rambling and trembling) in medial-lateral direction. But in anterior–posterior direction, rambling increased more in frequency (–7% vs. +31%, $p < 0.05$) while trembling increased more in amplitude (+35% vs. +84%, $p < 0.05$). The drop in maximal voluntary torque after BR was present for plantar flexion ($p < 0.05$) but not for dorsal flexion. After the BR, the subjects were less precise in the dorsal flexion torque matching task ($p < 0.05$). All the observed parameters, except the dorsal flexion torque matching error, returned back to the pre-BR values after the two weeks of re-conditioning. Results of this study indicate that body sway subcomponents responded differently to BR. Based on these findings, it was not possible to draw clear assumptions on the effects of neural and structural changes on body sway.

© 2013 Elsevier Ltd. All rights reserved.

1. Introduction

Prolonged bed rest (BR) is unfortunately a common experience, particularly in elderly people, following trauma, surgery or serious infectious diseases. Among others, loss of balance is an important functional impairment following lack of gravitational stimuli experienced during BR (Kouzaki et al., 2007; Viguier et al., 2009). Quiet stance tasks primarily involve shank and foot musculature to control body oscillation over the support surface (Gatev et al., 1999; Winter et al., 1996). Plantar flexors have been shown to be more susceptible to the BR inactivity than dorsal flexors (Fitts et al., 2001). In general, the following morphological and functional changes have been reported to occur as a result of BR induced inactivity (Koryak, 2002a,b): drop in muscle activation, peak voluntary force and rate of force development, impaired steadiness of voluntary muscle force, decrease in muscle mass and changes in characteristics of the spring-like muscle and tendon properties (“apparent stiffness”, see Latash and Zatsiorsky, 1993).

Although above mentioned morphological and functional changes suggest general deconditioning of the musculature following BR, it is questionable how these changes affect the ability to

maintain balance during quiet stance tasks. In these tasks lower force levels and accuracy of force production could play an important role. Proper control of muscle force and temporal muscle activation patterns during standing postural control is dependent on central balance controlling mechanisms and peripheral sensory information (Mergner, 2010). Both, central processing and muscle derived peripheral sensory input have been shown to be altered after BR (Ali et al., 2009).

Increased body sway could be a result of various alterations in the neuro-muscular system that are believed to occur both at the peripheral and central level. In this study we used two approaches to explore the potential effects of changes at different levels of the neuromotor system, specifically to postural sway. First, we used the method of sway decomposition into two components, rambling (Rm) and trembling (Tr) (Zatsiorsky and Duarte, 2000) hypothesized to reflect processes at the supraspinal and peripheral/spinal levels, respectively. This method is based on an idea that body equilibrium during quiet standing is maintained with respect not to a fixed but a moving point. In this case, the centre-of-pressure (CoP, coordinates of application of the resultant vertical force acting on the body) trajectory represents a superposition of two processes, one of which reflects migration of the equilibrium set point while the other reflects body oscillations about that moving set point. The latter oscillations are functions of many variables including the mechanical body properties (e.g., inertia) and reflex feedback effects.

* Corresponding author. Address: University of Primorska, Science and Research Centre, Institute for Kinesiology Research, Garibaldijska 1, SI-6000 Koper, Slovenia. Tel.: +386 40 429 505; fax: +386 5 66 37 710.

E-mail address: nejc.sarabon@zrs.upr.si (N. Sarabon).

Second, we explore changes in body sway characteristics together with changes in maximal torque (MT) during maximal voluntary contraction tests and accurate submaximal force production tests after BR and following a two-week recovery. Since both Rm and Tr are mediated by the peripheral neuromuscular apparatus we expected similar patterns of their changes with BR, namely an increase in both. Several studies have documented detrimental effects of BR on supraspinal mechanisms reflected, specifically in longer reaction time (Lipnicki et al., 2009; Liu et al., 2012). Based on the hypothesis that Rm reflected supraspinal processes, we hypothesized that it could show stronger changes with BR and possibly slower and incomplete recovery as compared to Tr. Given the predicted increase in the sway (cf. Kouzaki et al., 2007; Viguier et al., 2009) we expected the subjects to produce more frequent corrections of upright posture resulting in an increase in the median Rm frequency. No such increase was expected in Tr.

There are reports on different effects of BR on performance of different muscles (Alkner and Tesch, 2004; Miokovic et al., 2012). Based on the cited studies, we hypothesized that BR would lead to an overall decline in MT and an increase in torque matching accuracy and a significant correlation between torque matching accuracy and body sway characteristics. We expected a recovery of all the characteristics after two weeks that would parallel recovery of sway characteristics.

2. Methods

2.1. Participants

The study was conducted during the Bed-Rest Campaign from August to October 2012 at the Valdoltra Hospital (Ankaran, Slovenia). Sixteen men aged 55–65 ([mean ± standard deviation] 59.6 ± 3.4 years; body height 173.3 ± 4.9 cm; body mass 77.3 ± 11.8 kg, BMI 25.8 ± 3.7) were recruited from the local community. Before the enrolment, each participant underwent a medical evaluation. Exclusion criteria included diabetes, active malignancy, uncontrolled hypertension, history of cardiovascular disease including stroke, history of deep vein thrombosis/pulmonary embolism, significant hepatic or renal disease, chronic inflammatory disease, any significant impairment of the locomotor system and vestibular or visual disturbance. Before the enrolment each participant was informed of the protocol and potential risks of the study. A written informed consent was obtained, confirmed by the National Committee for Medical Ethics.

The participants were physically inactive, except for three, who participated in recreational sports (~2 sessions/week). Two subjects reported history of surgically treated disk herniation and one subject had mild scoliosis. Five subjects reported low back pain (visual analogue scale 4.6 ± 2) on the second evaluation.

2.2. Study protocol

During the 14 days of horizontal BR without countermeasures, the participants were required to restrict physical activity and minimize deviations from horizontal lying position to a minimum also during showering and toileting. Adherence to the protocol was monitored by continuous video surveillance. After BR, the participants returned to their normal daily routine and participated in a supervised rehabilitation protocol for 14 days. The training was performed three times per week. The typical session consisted of dynamic warm-up followed by four strength exercises, balance training and 30 min of Nordic walking. The participants were evaluated on three occasions; (i) before BR, (ii) immediately after BR and finally, (iii) 14 days after BR, i.e. after the rehabilitation

protocol. During the assessment protocol participants were evaluated for their static balance, ankle joint maximal capacity for torque development and ankle joint submaximal torque matching error.

2.3. Measurement procedures

2.3.1. Static balance assessment

During the balance assessment the participant was instructed to stand as still as possible on a force platform (9260AA, Kistler, Winterthur, Switzerland). The subject performed three 60-s trials of upright stance with feet placed parallel at hip-width. He was instructed to look at the black point (2.5 cm radius) placed 1.5 m away at the eye height. Throughout the measurement, the hands were on the hips, while the knees were fully extended, avoiding hyperextension. Three components of the ground reaction force (vertical (F_z), horizontal (F_x and F_y) – right handed coordinate system) were measured using the force plate. The signals were sampled at 1000 Hz and stored on a PC for later analysis.

2.3.2. Maximal torque production and submaximal torque matching error

The participant was positioned into an ankle dynamometer (S2P, Ljubljana, Slovenia). Ankles, knees and hips were at a 90° angle. The back was straight and hands positioned on the dynamometer bars in front of the subject. The dominant (right in all subjects) foot was fixated to the foot pad of the dynamometer. The medial malleolus was aligned with the axis of the foot pad (rotating around the frontal axis). Torque during plantar flexion and dorsal flexion was measured using a strain gauge based torque sensor (model Z6FC3-200 kg, HBM, Darmstadt, Germany) fixed to the end of the foot pad. Visual feedback was provided on a computer screen positioned at 1-m distance at the eye height. Before the torque matching task, three 3-s trials of maximal torque production were measured for plantar flexion (MT_{PF}) and for dorsal flexion (MT_{DF}). MT production during each maximal voluntary contraction trial was quantified as the maximal 1-s mean value for MT_{PF} and MT_{DF} , respectively. During the torque matching tasks the participant had to produce and hold constant a reference torque level with no visual feedback for 5 s. Five trials were performed at 30% of MT_{PF} and five trials at 30% of MT_{DF} , separated by 15-s rest. Before each trial the subjects produced a reference torque level with the help of the visual feedback for 5 s. Then, after an interval of 3 s, they were required to produce the same torque without visual feedback; they were given 5 s to complete the task.

2.4. Signal analyses

The signals acquired during the quiet stance balance task were quantified through the centre of pressure (CoP) trajectory, a representative measure of body sway. CoP in Y-direction (i.e. anterior-posterior (AP)) was calculated as:

$$CoP_{AP} = ((F_{AR} + F_{PR}) - (F_{AL} + F_{PL}))/F_{TOT}, \quad (1)$$

where F_{TOT} is total vertical force and the other F_s represent vertical force sensed by each of the four force plate sensors: AR, anterior-right; PR, posterior-right; AL, anterior-left; and PL, posterior right. CoP in Y-direction (i.e. medial-lateral) was calculated in a similar way.

Pre-processing of the signals consisted of filtering: (a) F_x and F_y , 10 Hz low-pass, Butterworth zero-lag fourth-order; and (b) CoP components, 0.04–10 Hz band-pass, Butterworth zero-lag fourth-order. Decomposition of the medial-lateral (ML) and anterior-posterior (AP) components of the CoP into rambling (Rm) and trembling (Tr) was done as described by Zatsiorsky and Duarte (1999, 2000). Briefly, instantaneous equilibrium points in each direction (AP and ML) were defined as CoP coordinates when the

Download English Version:

<https://daneshyari.com/en/article/4064833>

Download Persian Version:

<https://daneshyari.com/article/4064833>

[Daneshyari.com](https://daneshyari.com)