Additional Proprioceptive Stimulation Enhances an Acute Effect of Lower Limbs Resistance Exercise on Balance

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This study compares the parameters of balance after lower limbs resistance exercise performed under the influence of proprioceptive stimulation and those under normal conditions. A group of 24 physical education students underwent in different days 6 sets of 6 semi squats performed with an additional load of 75% of body weight (each session was separated by 2 min of rest) either under normal conditions or under the influence of proprioceptive stimulation. Vertical counter shocks (frequency 10 Hz, amplitude 3 mm) were applied by means of a special platform. One minute prior to and two minutes after exercise the velocity of the centre of pressure (COP) was registered at 100 Hz using stabilographic system FiTRO Sway check based on dynamometric platform. The results showed a significantly (p<0.01) higher increase in velocity of the COP immediately after squats performed under the influence of proprioceptive stimulation (from 6.8 ± 1.1 to 11.8 ± 1.4 mm/s) as compared to those under normal conditions (from 6.9 ± 1.2 to 9.8 ± 1.2 mm/s). However, in both cases its values returned to pre exercise level within 70 seconds. It may be concluded that additional proprioceptive stimulation enhances an acute effect of lower limbs resistance exercise on the parameters of balance.

**key words:** balance, semi squats, serial mechanical proprioceptive stimulation

**Introduction**

Several authors have documented that some forms of lower limbs resistance exercises, such as repeated calf rises (Lundin et al., 1993 Yaggie & McGregor, 2002), sustaining stance on tiptoe (Vuillerme et al., 2002) and squats performed with an additional load (Zemková et al., 2006), adversely affect balance.

On the other hand, it has been shown (Hamar et al., 2004) that postural stability
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may be temporary improved by a short period of proprioceptive stimulation (duration 15 sec, frequency of 10 Hz, amplitude of 3 mm) applied to the lower limbs. A similar tendency toward improvement of postural stability after whole body vibration (30 Hz oscillations at 3 mm of amplitude) has been indicated not only in healthy individuals, but also in unilateral chronic stroke patients (Van Nes et al., 2004).

However, its combination (duration 4 minutes, frequency 25, 30, 35, 40 Hz, amplitude 2 mm) with light exercises (squatting, standing in erect position and with slightly flexed knees, light jumping, alternating the body weight from one leg to another, and standing on the heels) has been found to cause no changes in balance when compared to pre-exercise level, and to the same exercises performed under normal conditions (Torvinen et al., 2002). Post-measurement carried out two minutes after termination of exercises was, in the case of balance, very probably too late in spite of the fact that such an interval is known to induce the greatest twitch and reflex potentiation. Interestingly, EMG activity in the vastus lateralis and gluteus medius muscles decreased during vibration, indicating muscle fatigue.

In contrast, during simple standing in a semi-squat position on a vibrating platform (amplitude 10 mm and frequency 30, 40, and 50 Hz randomly applied in 4 sets of 60 s 60 s rest in between) higher EMG responses in vastus lateralis muscle has been recorded as compared to those in non-vibrating conditions (Cardinale & Lim, 2003). Such ahas been found to be optimal for triggering vastus lateralis stimulation (Escamilla et al., 1998). It may be ascribed to the fact that sensitivity to vibrations increases when the target muscles are stretched (Eklund & Hagbarth, 1966; Nordin & Hagbarth, 1996). Recent evidence (Warman et al., 2002) also suggests that vibrations are more effective on improving force-generating capacity when applied during concentric rather than isometric or isokinetic activations.

However, this has been proved only in case of strength and there is a lack of information as to how the application of proprioceptive stimuli while performing semi-squats actually influence postural stability.

Therefore, the aim of the study was to evaluate the effect of resistance exercise in the form of semi-squats performed under the influence of proprioceptive stimulation applied to the lower limbs and under normal conditions on parameters of balance.

Methods

Subjects

A group of 24 physical education students (male of mean age 21.0 ± 2.4 years,