HAMSTRINGS COACTIVATION IN TRAINED LONG JUMPERS AND UNTRAINED INDIVIDUALS DURING DROP JUMPING

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The purpose of this study was to examine the EMG activity patterns of the hamstrings during drop jumping from different heights in trained longer jumpers and controls. A group of trained long jumpers and a group of untrained subjects performed maximal drop jumps from 20cm, 40cm and 60 cm on a force platform. The surface EMG activity of the hamstrings was recorded using bipolar electrodes. The ground reaction forces (GRF) and 3-D kinematic data were also recorded. Two-way analysis of variance tests indicated non-significant differences in hamstring EMG amplitude between trained and untrained athletes. However, the long jumpers had significantly higher vertical GRF values and some kinematic differences compared to untrained individuals. The absence of higher hamstrings activity in the long jumpers may have been a contributing factor in their higher performance compared to controls. However, the same result indicates that this increased performance may be accompanied by a possible increased risk of knee joint instability.

KEY WORDS: knee stability, antagonist, jump.

INTRODUCTION: The role of hamstring muscle group for knee joint stability has been extensively emphasized (Kellis, 1998). Previous studies have examined the activity of the hamstrings during gait, cutting and various strength exercises (squat, isometric, isokinetic maximal efforts) (Kellis, 1998). A few studies examined the role of hamstring musculature during sport-specific movements. The neuromuscular adaptations and muscular coordination during drop jumps have been extensively investigated (Schmidtbleicher and Gollhofer, 1985; Bobbert, Huijing, and Schenau, 1987. Neubert, Schwirtz, and Buehrle, 1998). For example, previous studies have reported significant differences in the electromyographic (EMG) activity of the gastrocnemious and quadriceps muscle groups between trained and untrained athletes (Schmidtbleicher and Gollhofer, 1985; Bobbert, Huijing, and Schenau, 1987; Neubert, Schwirtz, and Buehrle, 1998). Fewer studies studies reported hamstring muscle EMG activity during drop jumps in trained and untrained athletes (Viitasalo et al. 1998). The hamstring muscles are activated immediately after first contact and immediately after the feet leave the ground (Viitasalo et al , 1998). Their role has mainly two aspects: first, they can stabilize the knee joint by counteracting some of the forces that are exerted at the knee and, second, this hamstring antagonist activity may cause a reduction of the moment exerted around the knee, thus making the movement more inefficient. If this were the case, then a difference in the role of hamstrings between trained and untrained individuals as well as different drop jumping conditions should be expected. However, the EMG activation patterns during jumps from different heights and the role of knee joint flexors - if any - have not yet been specifically investigated. The purpose of this study was to examine the antagonist activity of the hamstrings around the knee during drop jumps from different heights in trained and untrained athletes.

METHODS: Ten trained long jumpers (age = 21.5 ± 0.3 years; mass = 77.1 ± 4.3 kg, height = 1.85 ± 0.03 m) and ten untrained (age = 21.9 ± 0.5 years; mass = 76.3 ± 3.4 kg, height = 1.82 ± 0.04 m) individuals participated in the study. The subjects jumped from a stand to a Kistler force platform and after the bilateral contact they rebounded immediately as high as possible while keeping their hands on their hips. Five-drop jumps from three different heights, 20, 40 and 60 cm were performed. They also performed a maximum squat jump. The electromyographic activity of the biceps femoris was measured using bipolar surface electrodes (center-center distance = 1 cm) of the dominant leg. The raw EMG during the drop jumps was normalized as a percentage of the maximum EMG during the squat jump.Ground reaction force (GRF) data was recorded using Kistler pre-amplifiers whereas three-dimensional video data was measured using two video cameras recording at 60 Hz. All data were synchronized and connected to an Ariel Performance Analysis System. Each jump was divided into three main phases: pre-contact, braking and propulsive phases. For each phase, the mean vertical GRF and power, knee angular position, velocity and acceleration, the average and the maximum raw and normalized EMG were analysed. Two-way (2 x 3) analysis of variance designs were used to examine the differences in various kinematic, kinetic and EMG parameters between the two groups during drop jumping from three different heights.

RESULTS: The ANOVA results indicated that the mean and maximal hamstring EMG during each phase of the drop jumps did not significantly differ between trained and untrained subjects (Figure 1). The long jumpers demonstrate shorter preactivation times of the hamstrings compared to untrained athletes (Figure 2). However, during the contact phase, the temporal EMG patterns of the BF were not significantly different between the two groups. The results also indicated significant group differences in other muscle EMG parameters and several kinematic and kinetic variables ($p<0.05$). Particularly, the amplitude of the quadriceps EMG in trained athletes was significantly higher and reached its maximum earlier compared to the untrained subjects.

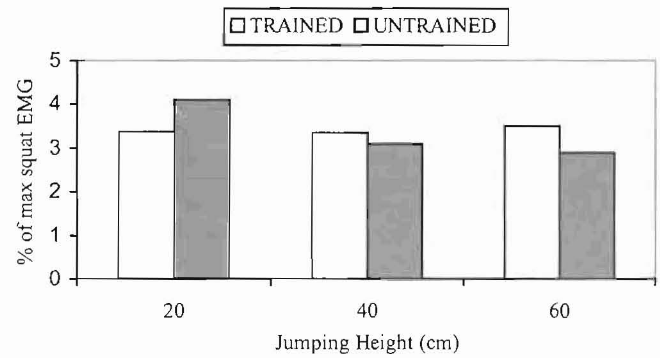

Figure 1. Mean normalised EMG of biceps femoris during the contact phase of drop jumps from three different heights in trained and untrained subjects.

The trained group demonstrated a higher ankle angular velocity during both braking and propulsion phases and a higher knee range of motion during the braking phase ($p<0.05$). From the kinetic data, the trained subjects demonstrated significantly higher maximal vertical GRFs and power throughout the contact phase ($p<0.05$) (Figure 3). In terms of temporal parameters, the long jumpers had significantly ($p<0.05$) shorter times to maximum GRF and a shorter duration of contact time.

DISCUSSION: The results of this study indicate that the normalised hamstring EMG does not differ between trained and untrained athletes. This is in disagreement with the findings by Viitasalo et al. (1998) who reported significant differences in raw hamstring EMG between trained triple jumpers and controls. This may be attributed to differences in analysing the EMG data (normalisation techniques) between the two studies. The use of raw EMG data for group comparisons is also problematic because of known methodological EMG problems and therefore, it was not used in the present study. The higher vertical ground reaction forces and raw EMG of the quadriceps provide an indirect indication of higher muscular and joint forces around the knee in the long jumpers. This indicates that these athletes demonstrate enhanced mechanical efficiency, but on the other hand, there is a higher risk of increased instability around the knee, especially as the dropping height increases.

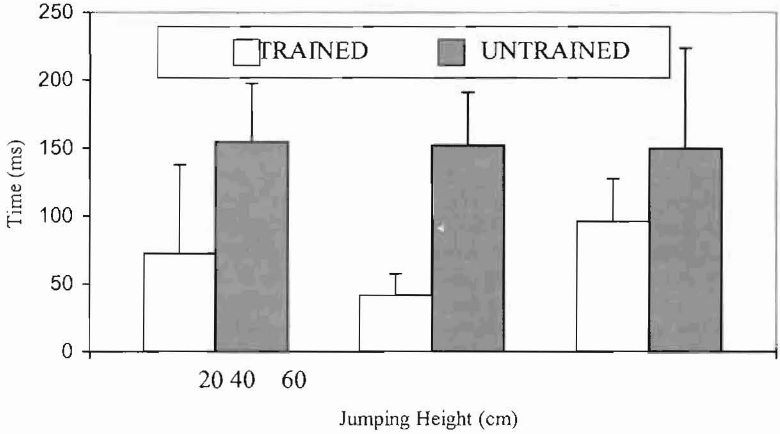

Figure 2. Mean preactivation time of BF EMG during drop jumps from three different heights in trained and untrained subjects (vertical bars indicate standard deviation).

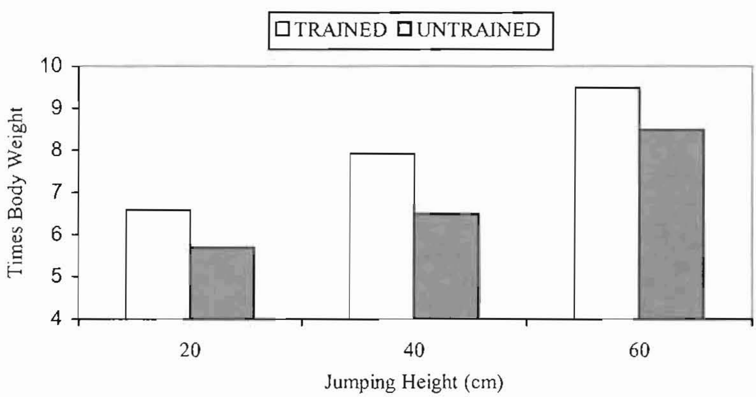

Figure 3. Mean maximum vertical GRF of trained and untrained athletes during drop jumps from three different heights.

Viitasalo et al. (1998) suggested that the differences in GRF between the two groups may indicate that the jumpers were better prepared to withstand and use the high muscle stretching which takes place during the braking phase and produce higher GRF values during the propulsion phase. Both the present results and those reported by Viitasalo et al. (1998) suggest that trained athletes can achieve better performance in drop jumps from different heights, not because of lower activation by the antagonist muscles but from higher activation of the agonist muscles, such as the quadriceps and gastrocnemius.

CONCLUSION: The results of this study indicate that trained athletes demonstrate better performance and GRF values compared to untrained individuals which is independent of the drop jumping height. From a clinical point of view, the exertion of higher joint forces in the trained group, which is accompanied by the same antagonist activity of the knee flexor muscles, may indicate that there is a higher risk of increased instability around the knee in trained long jumpers as opposed to controls. These findings should be considered by coaches and clinicians when using drop jumping exercises in training programs of long jumpers. For example, strengthening the hamstring musculature alongside the use of drop jumps as part of the conditioning programmes for long jumpers may reduce the risk of knee injury.

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