THE EFFECTS OF COMPRESSION SHORTS ON MUSCLE OSCILLATION AND LONG JUMP PERFROMANCE.

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Compression garments were used to explore their effect on athletic performance and muscle oscillation during a 3-step long jump task. The study consisted of a 3 dimensional kinematic analysis (Vicon Motus 9.2) with force data collected by a Kistler force platform. Ten male subjects performed 6 jumps under 2 conditions, bare leg (control condition) and with the compression shorts. Two-tailed paired samples T-test were conducted to discover significant changes in the measures of Muscle Oscillation (MO), Peak Vertical Ground Reaction Force (PVGRF), Peak Horizontal Ground Reaction Force (PHGRF) and Jump Length. The findings of the study suggest that long jump performance can be increased (.18m) while wearing compression shorts, although the legs ability to disperse force may be reduced by the garment.

KEY WORDS: acceleration**,** wobbling mass, jump length

INTRODUCTION: In the current competitive sporting domain athletic equipment and apparel is constantly evolving to improve sport and exercise performance (Duffield and Portus, 2007). Often modern athletic clothing is worn simply as a fashion garment; however, the literature suggests that compression clothing may provide vital performance benefits (Doan et al., 2003). Another suggested benefit of compression garments is focusing the direction of the muscle fibres increasing the number recruited during a contraction. This is done by reducing muscle oscillation which can hinder the alignment of muscle fibres when moving, reducing the function of the muscle (Kraemer et al., 1998). This suggests that reducing the oscillation of a muscle could help improve technique and maximise the ability for a muscle to recruit fibres, which in turn would enhance performance (McComas, 1996). However, the concept of reducing muscle oscillation and making the segments of the body more rigid may not be totally beneficial. It has long been discussed in the area of computer simulation that the human body is not constructed of solely rigid. A segment also comprises of skin, adipose tissue, muscle and connecting tissue (Challis and Pain, 2008) and is what Gruber et al. (1998) describes as ‘wobbling mass’. Challis and Pain (2008) believe that the wobbling effects of these tissues are a functional mechanism within the musculoskeletal system that may reduce the overall acceleration and distribution of load.

The 3 step running long jump was selected to test the effectiveness of the compression garment. The rationale for using this activity is that the long jump has been extensively researched in recent times and many of the factors effecting performance have been identified (Graham-Smith and Lees, 2005). The goal of a long jumper is to obtain vertical velocity of the centre of mass while retaining as large a horizontal velocity as possible (Muraki et al., 2008). Due to the recent increase in popularity of compression garments there is a need to establish the effect of these on a dynamic movement that involves a substantial impact. Therefore, the aim of the study is to explore the effect of the compression garment on athletic performance and its influence on muscle oscillation during the take-offs phase of a long jump. A secondary aim of the study was to investigate how the compression garments affect the force and load experienced during the task.

METHODS: Ten males (age: 25.30 ±5.66 years; mass: 76.14 ±10.00Kg; height: 1.82 ±0.54) volunteered for the study. All were free from injury and able to perform the task efficiently with no health problems. Informed consent was obtained and the subjects were free to withdraw from the study without prejudice at any time. The study had received university ethical clearance.

Subjects performed 6 3 step long jumps under 2 conditions, bare leg (control condition) and compression shorts. The compression shorts used were Adidas's PowerWeb shorts and for the control condition ordinary gym shorts were used with the shorts of the limb being filmed taped to above the hip leaving the leg bare for analysis. Lower-body jump performance kinematics and kinetic data were recorded using 6 camera Vicon Motus system sampling at 250Hz and a Kistler 9851 piezoelectric force plate (Kistler, Hook, UK) sampling at 500Hz respectively. Three retro- reflective spherical markers (19mm in diameter) were used to measure the muscle oscillation. The markers were attached to the dominant leg and marker 2 was placed between the greater trochanter and lateral condyle of the knee. The girth was measured and then marker 1 and 3 were placed 12.5% to the posterior and anterior side of marker 2. This measurement system allowed there to be control over marker placement as anatomical landmarks were unable to be used. Acceleration data were chosen to analyse muscle oscillation as it provided greater sensitivity with regard to the movement velocity associated with the jump studied during this investigation.

All data acquisition was conducted on the same day with several familiarisation trials prior to performance. The participants were asked to perform the jump with their normal technique as powerfully as possible. To aid the analysis the movement was broken down into braking (eccentric) and propulsion (concentric) phases of the jump for analysis. The point at which the phases were divided was at the instant of maximum knee flexion as suggested by Muraki et al. (2008) as during the first half of the takeoff the joints in the leg are flexing and then extend for the second phase. The main measures taken were Muscle Oscillation (MO), Peak Vertical Ground Reaction Force (PVGRF), Peak Horizontal Ground Reaction Force (PHGRF) and Jump Length. To establish whether there were any significant differences two-tailed paired sampled *t*-tests were used on the means with the statistical significance set at $p \leq 0.05$.

RESULTS AND DISCUSSION: There was a statistically significant difference in distance jumped ($t(9) = 3.972$, $P < 0.003$) with table 1 showing that on average the subjects were able to jump 5.8% (0.18m) further with the compression garments compared to when the subject performed the jump under the bare leg condition. The findings are supported by the literature with Kraemer et al. (1998) noting an enhancement in athletic performance, specifically in the increase in repetitive jump power. This was further supported by Doan et al. (2003) who found that while wearing compression shorts the subjects were able increase their jump height by 0.24m compared to a controlled condition. This does suggest that wearing compression garments a person's performance can be increased.

Table 1: Means and Standard Deviations for Distanced Jumped and percentage difference. * represents significant.

	Bare Leg Condition	Compression garment condition	% difference of compression garment compared to bare leg.
Distance Jumped	**2.73 ± 0.22**	***2.92 ± 0.33**	**5.8%**

There was a significant difference in muscle oscillation peak accelerations between the conditions during the braking phase at the anterior marker (t (9) = 3.012, P < 0.015) and the posterior marker (t (9) = 4.641, P < 0.001), although there was no significant difference at the mid-thigh marker (t (9) = 1.034, P > 0.328). During the propulsion phase only the posterior marker was statistically significant (t (9) = 7.321, P < 0.000) with the mid-thigh marker (t (9) = 1.162, P > 0.275) and the anterior marker (t (9) = 1.650, P > 0.133) not significant. Although there was no significant difference at a number of the marker positions there was a percentage decrease in muscle oscillation during all compression garment trials compared to the bare leg condition. The most enlightening of these results is the reduction in oscillation at the posterior marker, which was significantly reduced by 60.4% at the braking and 72.7% at the propulsion phase. During the propulsion phase the quadriceps is the prime mover generating the explosive force for take-off, leaving the hamstrings to stabilise the body. Therefore, if the oscillation of the hamstring is reduced in this phase it possibly aids the performance of the quadriceps as greater propulsion force can be generated from a stable base (Kraemer et al., 1998).

The average data for the ground reaction force during the take-off phase can be seen in table 2. The largest peak occurred during the initial impact with a smaller second peak occurring before the propulsion phase. The results for the peak VGRF were significant (t (9) = -3.373, P > 0.008) and the subjects experienced on average 23.4% more force during the peak impact while wearing the compression garment. This result suggests that the force experience by the body is increased by wearing the compression garments, which could have negative aspects with unaccustomed force linked to an increase risk of injury. This is supported by Speed et al. (1996) who investigated stress fractures of the tibia. He found that increasing the force to which the body had become accustomed to lead to the development of fatigue stress injury.

Table 2: Means and Standard Deviations for Maximum Peak Ground Reaction Force (GRF). * represents significant (P<0.05).

	Bare Leg Condition	PowerWeb condition	% difference of compression garment compared to bare leg.
Peak Vertical GRF (BW)	**2.9 ± 0.5**	**3.8 ± 0.7**	**23.4%**
Peak Horizontal GRF (BW)	**0.8 ± 0.3**	**0.7 ± 0.2**	**5.3%**

Although still greater than the bare leg condition the peak HGRF (5.3%) was not statistically significant (t (9) = 1.209, P > 0.257). the research has suggested that more force transferred to the ground, utilising as much of the horizontal approach speed as possible, is linked to a further distances being jumped (Muraki et al., 2008). This could be the possible explanation for the increase in the performance measure in the compression garment condition.

CONCLUSION: The results suggest compression shorts appear to increase jump length performance. This could due to the reduction of muscle oscillation, although the present study found that not all of the marker peak accelerations were reduced compared to a control condition there was still reductions in areas such as the posterior marker. However, the study has highlighted that this reduction in oscillation may have a negative aspect when wearing the compression shorts. This may be due to the garment restricting the muscles ability to disperse energy, which could lead to higher forces being experienced.

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