INTRODUCTION

Cold has been shown to decrease maximal muscle force and increase time to peak tension and relaxation (Bergh, et al. 1979 & Bigland-Ritchie, et al. 1992) and neuromuscular performance (Oksa, et al. 2002). The stiffness of the muscles, tendons and joints also increase under cold condition (Hunter, et al. 1952 & Rice, 1967).

Although cold can affect muscular performance, it is not known whether it affects kinetic and kinematic patterns of dynamic movements, e.g. drop-landing movement. Many winter sports (e.g. football, soccer, and cross country skiing) and occupational outdoor activities (e.g. railroad workers jump off a box-cart) have landing components. Exposure to cold during such activities may impose an increased risk to musculoskeletal system of lower extremities. Therefore, it is important to investigate how cold affects the mechanics of landing. Furthermore, it is of interest to know the kinetic and kinematic patterns of landing following cooling at different levels of the lower body (ankle, knee, and hip levels). The purpose of the study was to investigate the kinetic and kinematic patterns of drop-landing movement after cold-water immersion to ankle, knee, and hip joint levels.

METHODS

Ten healthy males volunteered to participate in the study. Participants’ age, body weight, and body height (means and standard deviations) were 23.5 (2.8) years, 74.7 (8.3) kg, and 1.71 (0.07) m, respectively.

After familiarization, subjects performed drop-landing tests following still immersion in water at neutral (34 °C) temperature (control condition) (N) to hip level (immersion to the anterior iliac spine), and cold water (20 °C) to the ankle (20 mm above the malleolus) (A), knee (40 mm above the femoral epicondyles) (K) and hip (H) levels. Kinematic and kinetic analyses were performed following drop-landing from a platform situated 0.6 m above a force plate. The four tests and treatment conditions were administered on separate days and presented in a counterbalanced fashion.

Two high speed video cameras (120 Hz) were used to track participants’ motion. A force platform (1080 Hz) was used to monitor ground reaction force (GRF). Inverse dynamic method was used to calculate joint reaction forces (JRF), moments, and powers of ankle, knee, and hip joints. Repeated measure ANOVAs were used to determine the kinematic, kinetic, differences between the N and the other three cold-water immersion conditions (A, K, and H) (α = 0.05).

RESULTS AND DISCUSSION

There were kinematic and kinetic differences between the control condition and the three cold water conditions. The A condition showed greater knee and hip joint flexion velocities (3.4 % and 6 % greater, respectively) than the N condition (P <
The K condition showed greater hip flexion velocity (9 % greater) than the N condition (P < 0.05). Most importantly, the H condition showed greater hip and trunk flexion (11 ° and 10 ° greater, respectively) and less anteroposterior (AP) and vertical ground reaction forces (10 % and 8 % lesser, respectively) than the N condition during landing (P < 0.05).

Increasing joint flexion velocity activates the stretch reflex (Duncan, et al. 2000) and increase the eccentric force (Katz, 1939). In the present study, the increasing knee and hip joint flexion velocities seen in the A condition appears to use to compensate the reduction of impact absorption of the cooled-ankle joint during landing. Similarly, the K condition increased the hip joint flexion velocity to compensate for the reduction of impact absorption from the cooled-ankle and knee joints, as well as lower-leg muscles. Moreover, the H condition used kinematic adaptation by increasing hip and trunk flexion to dissipate the landing impact.

The findings concerning various levels of cold-water immersion show that, during drop-landing movement, local cooling of the ankle showed no kinematic changes at the ankle, while changes were demonstrated at the non-affected (non-cooled) muscle/joint complexes of the knee and hip. During cold-water immersion to the knee, kinematic changes were noted at the ankle, which appear to be the result of cooling the muscles supporting the ankle; similar to the results during ankle immersion, kinematic changes were observed in the non-affected hip joint. Finally, the most pronounced effects on kinematic and kinetic changes were seen following hip immersion. These data suggest that the kinematic changes noted during cold are more the result of muscle-tissue cooling, rather than changes in joint-tissue stiffness.

REFERENCES


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