DETERMINANT OF LEG SPRING STIFFNESS DURING MAXIMAL HOPPING

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INTRODUCTION: Understanding stiffness of the lower extremities during human movement may provide important information for developing more effective training methods during sports activities. It has been reported that leg stiffness (K_{leg}) during submaximal hopping depends primarily on ankle stiffness (Farley & Morgenroth, 1999), but the way stiffness is regulated in maximal hopping is unknown. The aim of the present study was to investigate a major determinant of the leg stiffness during maximal hopping.

METHOD: Ten well-trained male athletes performed two-legged hopping in place with a maximal effort. Hopping was repeated 15 times and five consecutive hops from the sixth to the tenth were used in the analysis. Based on the spring-mass model, we determined the K_{leg} (the ratio of peak vertical ground reaction force to peak leg compression at midstance). Similarly, based on the torsional spring model, hip, knee and ankle stiffness (K_{hip}, K_{knee}, and K_{ankle}, respectively) was calculated. Multiple regression analyses were performed using K_{leg} as a dependent variable and K_{hip}, K_{knee}, and K_{ankle} as an independent variable. Within the multiple regression analysis, a standardized partial regression coefficient (β) was used to determine the relative importance of joint stiffness to K_{leg}.

RESULTS: Average values of hopping frequency, contact time and flight time were 1.272 ± 0.185 Hz, 0.185 ± 0.020 s, and 0.497 ± 0.056 s, respectively. Table 1 shows that the multiple regression model accounted for 84% of the variance of K_{leg} (Adjusted R^2= 0.836, p<0.05). Further, the model revealed that only K_{knee} was significantly correlated with K_{leg}, and that theβ coefficient of K_{knee} (0.644, p <0.05) was higher than K_{ankle} (0.371) and K_{hip} (-0.055).

Table 1. β coefficient of K_{ankle}, K_{knee} and K_{hip}.

K_{ankle}	0.371
K_{knee}	0.644*
K_{hip}	-0.055
Adjusted R^2	0.836*

DISCUSSION & CONCLUSION: Our results contrast with the previous study which stated that leg stiffness during submaximal hopping depends primarily on ankle stiffness (Farley and Morgenroth, 1999). On the other hand, some studies showed that for running velocities ranging from 2.5 to 9.73 m/s the leg spring stiffness is influenced by changes in knee joint stiffness (Arampatzis et al., 1999; Kuitunen et al., 2002). Thus, the present study indicates that knee stiffness is a major determinant of leg stiffness during not only running and sprinting, but also maximal hopping.

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