Jump Fatigue on Area Elastic Surfaces

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Summary

This study investigated whether variations in hard court surface properties influenced athlete jumping fatigue. Fifteen male athletes performed repeated maximum-effort jumps on three surfaces: BC (rubber bio-pads), MVP (foam cushioning with wooden channels), and UM (continuous foam cushioning). Athletes had improved performance on the MVP and UM surface compared to the BC surface, which may be related to reduced muscle activity in the muscles crossing the ankle joint (tibialis anterior) or in a reduction in the vibrations on the MVP and UM surfaces.

Introduction

Sport surfaces such as wood hard courts are critical components in sport, with studies indicating that the surface properties such as the stiffness can alter athletic performance and biomechanical injury risk [1,2]. Changes in sport surface properties may hold potential in reducing athlete fatigue by altering the muscle activity and kinematics during landing. Therefore, the purpose of this project was to determine if changes in hard court sport flooring can influence athletic jumping fatigue.

Methods

Fifteen male athletes participated in this study performing repetitive standing countermovement squat jumps on three different sport surfaces i) Bio-Cushionin Classic (BC), which consisted of commodity unanchored rubber padded plywood, ii) Maximum Vibration Protection (MVP) which contained fully laminated double plywood foam and iii) Unimax 100 (UM) which contained fully laminated single plywood foam. Athletes performed three fatigue jump tests in total over the course of three testing sessions. During each testing session athletes performed jumps on a single sport surface, with the order of the sport surfaces being randomized. Following a warmup, each athlete performed maximum effort countermovement squat jumps every twenty seconds until they were fatigued. An athlete was classified as fatigued if the athlete could no longer maintain 88% of their maximum jump heights for three consecutive jumps (failure jumps) or if the athlete verbally stated they were fatigued and no longer wished to continue jumping [3]. During each jump, kinetic ground reaction force data and kinematic data of the right leg and hips were recorded with a motion capture system. Concurrently, lower extremity electromyography were recorded of the tibialis anterior, biceps femoris and vastus medialis, while IMU's were placed on each sport surface to measure surface vibration properties.

For analysis, to normalize the fatigue protocol between participants, the total number of jumps each participant performed was divided into 5 sections with each section representing 20% of the fatiguing protocol. Within each section, ten jump trials were randomly selected for analysis. A repeated measures ANOVA with factors of surface was used to identify any significant differences ($\alpha=0.10$).

Results and Discussion

When the number of jumps to fatigue was compared between surfaces, a significant surface effect was present ($F=3.780$, $p=0.035$), with the BC reducing the number of jumps compared to the MVP ($p=0.055$) and UM (0.044). Limited kinematic differences were present between conditions with athletes having similar ankle, knee and hip joint angles during landing. No differences were present in the muscle activity of the quadriceps or hamstrings; however, both the MVP ($p=0.072$) and UM ($p=0.095$) surface decreased the muscle activity of the tibialis anterior muscle (Table 1). Lastly, both the MVP ($p=0.013$) and UM ($p=0.030$) increased the damping coefficient indicating these surfaces were effective at reducing the surface vibrations.

Table 1: Muscle activity and the damping coefficient when jump landing on the different sport surfaces.

		BC	MVP	UM	p-value
Mean Muscle Activity [%MVC]	Biceps Femoris	13	13	14	0.252
	Vastus Medialis	75	71	62	1.173
	Tibialis Anterior	74	46	46	0.098
	Damping Coefficient [/s]	49	62	62	0.009

Conclusions

MVP and UM surfaces increased athlete performance, allowing them to perform a greater number of jumps before their performance was reduced. The exact mechanisms require further research but may be related to reduced muscle activity in the muscles crossing the ankle joint (tibialis anterior) or in a reduction in the vibrations on the MVP and UM surfaces.

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References

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