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EFFECTS OF SHOE COLLAR HEIGHT ON SAGITTAL ANKLE ROM, KINETICS AND POWER OUTPUT DURING SINGLE-LEG AND DOUBLE-LEG JUMPS

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The aim of this research was to examine the effects of high-top shoes and low-top shoes on sagittal ankle ROM, kinetics and power output during single-leg and double-leg jumps. Twelve male subjects were requested to wear high-top and low-top shoes to perform single-leg and double-leg jumps. Ankle joint kinematics and kinetics data were collected using Vicon system and force plates. Shoe collar heights did not influence the jump height in both single-leg and double-leg jump tasks. However, high-top shoes adopted in this study resulted in a significant smaller sagittal ankle ROM during a quasi-static movement. In addition, wearing high-top shoe could also decrease the dorsiflexion ankle joint torque and power output during the push-off phase in single-leg jump. These findings provide preliminary evidence suggesting that a changed ankle kinematic and kinetic behaviour in the sagittal plane may be induced when wearing high-top shoes.

KEYWORDS: high-top shoes, ankle joint, kinematics, kinetics, jump

INTRODUCTION:

Basketball is an intense sport. Basketball players were requested to do a lot of jumps, physical contacts and accurate movements. So they are often troubled by the sport injuries especially for the ankle joint. To prevent such kind of injure, sports equipment manufacturers and researchers work hard and update the protection effect of sport products. Early high-top shoes were manufactured to restrict ankle joint movement for reducing the risk of sports injuries. However, more attention from recent studies was focused on the effect of high-top basketball shoes on sport performance.

Some studies considered that high-top shoes would decrease the sport performance on sagittal plane by restricting the dorsiflexion of ankle joint (Clercq 1997,Bocchinfuso, Sitler et al. 1994). But other researchers have different point of view. They figured out that high-top shoes did not limit the dorsiflexion of ankle joint during sport; on the contrary it increased ankle joint's stablility to improve sport performance(Gross, Batten et al. 1994,Wiley and Nigg 1996). In addition, Robinson et al. found that high-top shoe would decrease athletes' sensibility by comparing high-top shoes and low-top shoes (Robinson, Frederick et al. 1986). Up to now, the effects of high-top shoes on ankle joint behaviour and sports performance is controversial.

Therefore, the purpose of this study was to examine the effects of high-top shoes and low-top shoes on sagittal ankle ROM, kinetics, power output and sport performance during single-leg and double-leg jumps.

METHODS:

Subjects: Twelve physical education students (age: 23.7±0.6 years, heights: 179.5±4.8 cm, mass: 73.5±7.8 kg) who had 4-5 years of experience in basketball were recruited in this study. Each participant signed an informed consent approved by the Local Ethics Committee.

Equipment: Vicon system (frequency: 120Hz) and Kistler force plates (9287B, frequency: 1200Hz) were used synchronously to collect kinematics and kinetics data. High-top shoe (HS) and low-top shoe (LS) were both made by the same footwear manufactory. Specifically, two kinds of shoes had the same main structure. The only differences between the two types of shoes were in the shoe collar height.

Testing Protocol: Random double blind principle was applied in the test. Firstly, we gave all subjects a random order to make sure which shoes they wear first and the assistant who gave

subject shoe also did not know which group each pair of shoes belong to. Two types of jump were designed, one is drop jump another is single-leg jump. When subjects did drop jump they should stand on a 60 cm height platform hold their shoulders and slip to the force plate then try their best to jump upward following landing. Single-leg jump was used to simulate the layup action in basketball. All subjects should warm up by practicing the two type jumps for 5min before test. Three trials of successful data were taken into account for each subject.
The variables included were jump height, contact time, ankle static range of motion (sagittal planes), ankle dorsiflexion maximum torque, ankle dorsiflexion passivity maximum output power and ankle initiative dorsiflexion maximum output power.
Data analysis: In this study, the touchdown of each movement was set to be zero initially by force plate and the contact phase was then treated as 100%. The kinetics and power data were standardized by their weight. Paired T-test was used with a significant level of $p<0.05$.

RESULTS:
Jump Height:
No significant differences in the jump height were found between high-top shoe and low-top shoe group in both two types of jump.
Contact time:
The percentage taken push-off time in contact time for high-top shoe group was significantly larger compared to low-top shoe group during single-leg jump. During drop jumps there were no significant differences between two shoe groups.
Ankle Quasi-static ROM (sagittal planes):
The ankle quasi-static ROM of LS group was significantly larger than HS group for about 5° ($p<0.01$).The high-top shoe reduced the ankle joint range of motion (Figure 1).

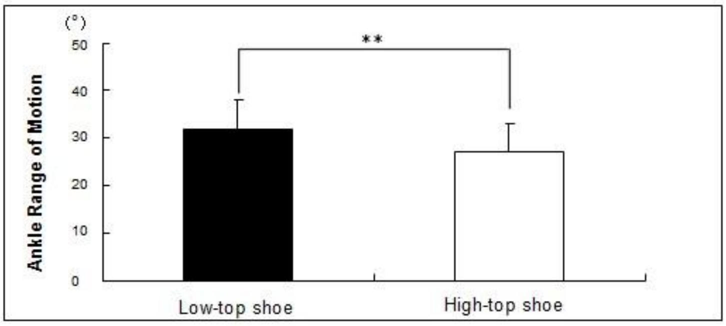

Figure 1 Ankle joint static range of motion

Ankle Kinetics data:
The pattern of ankle joint torque was similar when subjects performed single-leg jump and drop jump .But the maximum torque had an obviously difference in different shoes group(Figure 2).

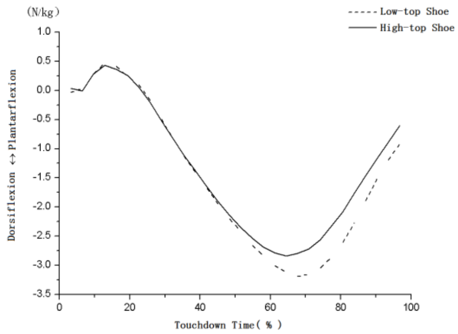

Figure 2 The dorsiflexion torque of ankle joint during one step single jump

The dorsiflexion ankle torque of high-top shoes group was significantly smaller than low-top shoes group during single-leg jumps. However, no differences were observed between two shoe groups in drop jumps (Figure 3).

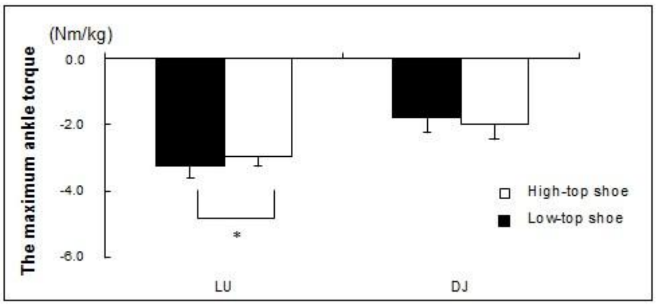

Figure 3 The maximum ankle torque during different type of jump (LU: single-leg jump. DJ: drop jump, *p<0.05)

We tried to use the output power as an obviously variable to analysis the effects of different top shoe. And we did not find any significant differences in output power between two groups of shoe during the downward phase. But there was a significantly difference on output power between two groups of shoe during push-off phase in single-leg jump (Figure 4).

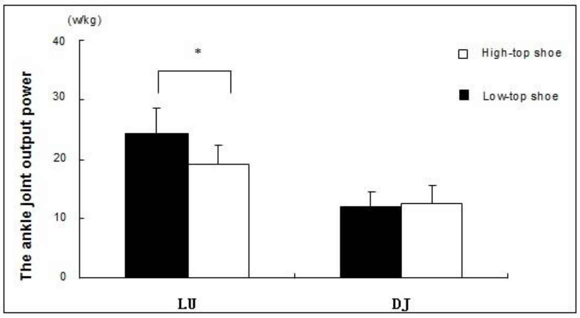

Figure 4 The ankle joint output power of different types of jump during push-off phase.

DISCUSSION:

The high-top shoe could restrict ankle range of motion significantly and this result supported previous research (Rowson, McNally et al. 2010). Meanwhile, different shoe collar height had obvious effects on ankle output power in push-off phase during single-jump. The value of high-top shoe groups was significantly smaller than low-top shoe groups. The reason may be that the push-off time of high-top shoe groups was significantly longer than low-top shoe groups during single-leg jump. The shorter push-off time means a larger ankle push-off velocity to finish the same movement. Based on the formula: P=Fv, we could explain why the ankle output power was bigger in low-top shoe condition on push-off phase during single-leg jump But this effect didn't change the knee output power. So the relationship between this effect and the low-limb chain deserves further investigation.

CONCLUSION:

Shoe collar heights did not influence the jump height in both single-leg and double-leg jump tasks. However, high-top shoes adopted in this study resulted in a significant smaller sagittal ankle ROM during a quasi-static movement. In addition, wearing high-top shoe could also decrease the dorsiflexion ankle joint torque and power output during the push-off phase in single-leg jump. These findings provide preliminary evidence suggesting that a changed ankle kinematic and kinetic behaviour in the sagittal plane may be induced when wearing high-top shoes. Further investigation of the effect of shoe collar structure on ankle dorsiflexion & plantarflexion kinematics, kinetics, energetic, and their relevance to sports performance is warranted. *J Biomech*

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