SEGMENT-INTERACTION AND ITS RELEVANCE TO THE HAMSTRING MUSCLE INJURY DURING STANCE PHASE OF SPRINT RUNNING

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INTRODUCTION

Hamstring muscle strain injury is one of the most common injuries in sports [1,2], such as sprinting, soccer, and football. Many mechanisms and risk factors of hamstring injury were implicated. The purpose of this study was to analyze the segment-interaction and its relevance to hamstring muscle (HM) injury during sprint running by means of intersegmental dynamics [3] combined with kinematics, ground reaction force (GRF) measurement.

METHODS

Eight male international level sprinters were recruited for this study (age: 21.1±1.9, mass: 74.7±4.1 kg, height: 181.5±3.9 cm). Their best personal performance for 100m race ranged from 10.27 to 10.80s. The athletes sprinted by their maximal-efforts on a synthetic track and three-dimensional kinematics data were obtained at a sampling rate of 300Hz from eight Vicon High Resolution Cameras (Vicon, England). The video capture volume was approximately 10.0m long, 2.5m high and 2.0m wide ,and was centered at 40m from the sprint start line. A recessed force-plate (60X90cm) (Kistler Corporation, Switzerland) was located at 40m from the sprint start line which was used to collect ground reaction force (GRF). The force signals were amplified and recorded in Vicon System at a sampling rate of 1200Hz. Data were processed by Visual 3D software (C-motion Corporation , Franklin ,USA), and torques at knee and hip joint produced by muscles and GRF were calculated by intersegmental dynamics methods [3].

RESULTS AND DISCUSSION

The ground reaction force (GRF) and the arm of GRF during initial contact phase were given in table 1. The biggest flexion torque was produced by muscle at knee joint. The Fig. 1 showed that the muscle torque (MUS) and the contact torque (EXT) had a peak value on the knee and hip joint during initial stance phase. The GRF passed anterior to the knee joint, and the GRF produced an extension torque at knee and a flexion torque at hip at the beginning of stance phase; meanwhile, the knee flexor (HM) and the hip extensor (HM was involved) were required to generate a flexion torque at knee and extension torque at hip in order to counteract the effect of contact torques (EXT) due to GRF (Table.1). As a consequence, the hamstring muscle must create torques at both the knee and the hip joint to neutralize the contact torque (EXT) produced by GRF. This may lead to the occurrence of hamstring muscle injury. On the other hand, considering the moment arm of GRF and the moment arm (20-40mm) of the hamstring muscle simultaneously, the contraction force produced by the hamstring muscle at the time of initial stance phase must be higher than the ground reaction force. Considering the impact of GRF at this stage was considerably great and the moment arm of GRF was far bigger than the muscle's moment arm on the knee joint, the stress loading on HM ought to be great as well. If the strength of HM was insufficient, it was likely to induce strain injury.

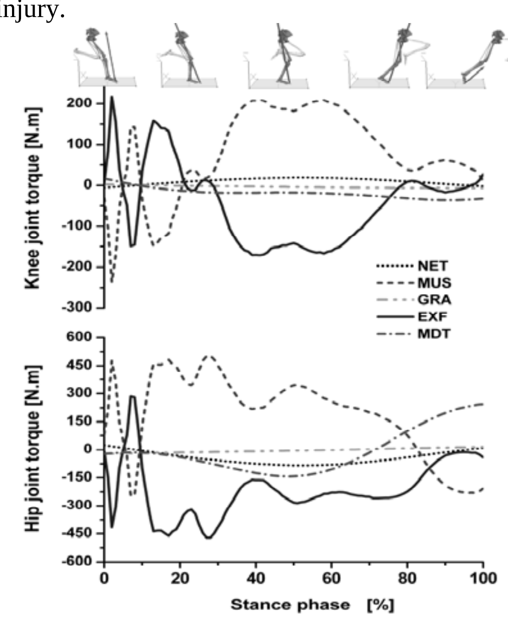

Figure 1: Joint torques at knee and hip joint during support phase.

CONCLUSIONS

The findings of intersegmental dynamics analysis revealed that the GRF produced large torques at knee and hip joint during the initial stage of stance phase, meanwhile, the muscles (the HM) were required to counteract the effect of GRF, this may lead to the occurrence of HM injury. Based on the present study, the HM has the higher risk of strain injury during the initial stance phase.

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Table1: The maximum MUS and EXF torque at the knee and hip joint, maximum GRF, moment arm during initial stance phase.

Joint	MUS (N • m)	EXF (N • m)	GRF（N)	Moment arm（m）
Knee	203.40±93.60	96.82±76.07	789.94±225.58	0.08±0.07
Hip	455.24±198.72	218.58±130.99	1037.91±350.33	0.19±0.07