SEGMENT-INTERACTION AND ITS RELEVANCE TO MOTOR CONTROL DURING SPRINT RUNNING

Shutao Wei[1] Yu Liu[1] Yunjian Zhong[1] Li Qing[2] Weijie Fu[1]
[1]School of Kinesiology, Shanghai University of Sport, Shanghai, China
[2] Teaching and Research Division of Physical Culture, Tsinghua University, Beijing, China.
Email: qfwst@126.com

INTRODUCTION

In athletics, superior sprint running performance is often attributed, at least in part, to the athlete having powerful musculature that can make lower extremity move quickly during swing phase and withstand the maximum ground reaction force in stance phase. Therefore, the study about the function of torque on the hip and knee joint can help us to understand the movement control and to get insights into the mechanisms of lower extremity muscles during swing and contact phase. The intersegmental dynamics [1, 2] was used to study multi- relationship of the active muscle torques (MUS) , the passive motion-dependent torques (MDT), ground reaction torque (GRT), gravitational torque (GRA) and net joint torque (NET) during the swing phase and the stance phase , and from this to quantify the contribution of each torque to the joint motion of lower extremity.

METHODS

Eight male national level sprinters took part in this study. Their best personal performance for 100m ranged from 10.27 to 10.80s · Their age, body height and body mass were 21.12±1.89yr, 181.53±3.87m, and 74.71±4.11 kg, respectively. 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) located at 40m from the sprint start line was used to measure 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) , torques at knee joint produced by GRF and muscles was calculated by intersegmental dynamics methods.

RESULTS AND DISCUSSION

In this study, it explored the relationship of the joint movement during swing phase and stance phase from the intersegmental dynamics, which data was obtained from eight male international level sprinters running with maximum efforts. the MUS functioned to counterbalance the effect of the MDT, while the GRT and other kind torques were smaller than MUS and MDT, and have no significant contribution to the joint motion (Fig. 1). The maximum MUS and MDT of knee and hip joint appeared in the late swing phase (Table 1). During the late swing phase, the MUS counteract the MDT and make the knee joint flex at the knee joint; meanwhile, the MUS counteract the MDT and make the hip joint extend at the hip joint. The torque due to leg angular acceleration on the knee and hip joint was the main inertial torque in the MDT during swing phase. During the initial contact phase, the MUS functioned mainly to counteract the GRT created by the GRF on the knee and hip joint (Fig.1), other kinds of torques were smaller and has no significant contribution to the joint motion, The MUS and GRT have a peak value on the knee joint during initial stance phase as well on the hip joint, meanwhile, the MUS flex the knee and extend the hip joint to counteract the GRT of GRF.

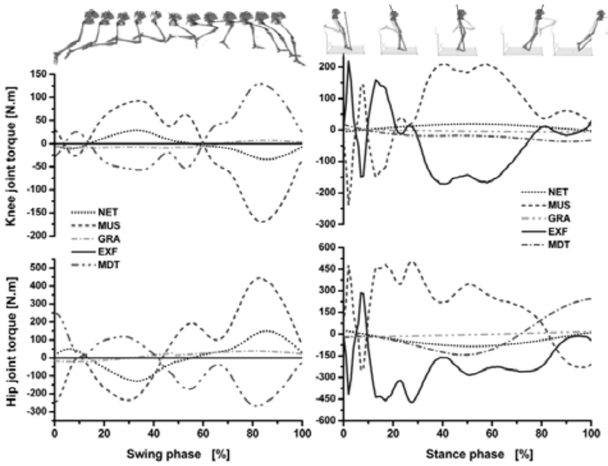

Figure 1: Time curves of joint torques at knee and hip joint during swing and support phase.(+: extension , - : flexion)

CONCLUSIONS

Segmental motion during swing phase is controlled entirely by MUS and MDT, and two opposing torques were canceled out. The torque due to leg angular acceleration on the knee and hip joint was the main inertial torque in the MDT during swing phase. The GRT and the MUS were the main torque and tend to counteract each other during stance phase, the MUS flex knee joint and extend hip joint, the GRT extend knee joint and flex hip joint during initial stance phase.

ACKNOWLEDGEMENTS

This study was supported by the National Natural Science Foundation of China, under grants 10672105, 30871210. The Project of Science and Technology Commission of Shanghai Municipality, under grant 08490512700.

REFERENCES

1. J. P. Hunter, R. N. Marshalla, P. J. McNair, "Segment-interaction analysis of the stance limb in sprint running", *J. Biomech.*, **37**, 1439-1446, 2004.
2. R. V. Mann, "A kinetic analysis of sprinting," *Med. Sci. Sport. Exer.*, **13(5)**: 325-8, 1981.

Table 1: The maximum MUS, MDT and EXF at the knee and hip joint during swing and stance phase

Joint	Swing phase		Stance phase	
	MUS (N·m)	MDT (N·m)	MUS (N·m)	EXF (N·m)
Knee	249.32±38.81	194.01±30.90	203.40±93.60	96.82±76.07
Hip	650.81±101.06	410.80±78.67	455.24±198.72	218.58±130.99