JOINT KINETICS AND POSTURE CONTROL DURING DROP LANDINGS

Yasuyuki Yoshda and Takeo Maruyama
Graduate School of Decision Science and Technology,
Tokyo Institute of Technology, Tokyo, Japan

INTRODUCTION

Landing movement from vertical direction has been investigated in biomechanics since force platforms were developed to measure ground reaction forces. In drop landing studies, control of rotary stability based on the net effect of the three joint moments has not been investigated, previously. Devita & Skelly [1] investigated the relationship between knee joint flexion and kinetic parameters during stiff and soft drop landings. However, this study did not consider rotary stability. Ashby & Heegaard [2] quantified rotary stability in standing long jump study by using the moment about center of mass by ground reaction force (M_{CM}). The purpose of the present study is to investigate the relationship between lower extremity joint kinetics and posture control during drop landings.

METHODS

Ten healthy male subjects (mean±SD: age 22.9±0.99 years; body mass 68.2±7.00 kg; height 174.5±3.57 cm) participated after providing written informed consent. All subjects wore tight fitting shorts and a T-shirts, and were tested in bare feet.
A force platform (Kistler type 9287BA Kistler Instruments, Switzerland) was used to measure the ground reaction force (GRF) at 1kH. The left sagital view was recorded using two high-speed cameras (FASTCAM Photoron, Japan) at 0.25kHz. The motion capture and recording GRF were synchronized using a synchronized pulse generator (PH-1460, DKH, Japan).

Soft and stiff drop landing conditions from a 0.48m height was tested. In soft landing (SOFT), the subjects were instructed to land as soft as possible by using joint flexion. On the other hand, in stiff landing (STIFF) the subjects were instructed to land with minimum joint flexion. Subjects placed their hands on their hips, pushed off from the platform with one leg, closed their legs in midair, and landed on the force platform and dummy platform by each foot simultaneously.

The ankle, knee and hip joint moments were calculated using inverse dynamic analysis combining anthropometric, kinematic, and kinetic data. The segmental masses, the mass center location of the lower extremity, and their moment of inertia were estimated using a four segmental mathematical model [3]. In this study M_{CM} was also calculated

RESULTS AND DISCUSSION

Figure 1 shows a typical example of joint negative work contribution at ankle, knee and hip during STIFF and SOFT. In STIFF, joint negative work contribution was 52.48%, 35.24% and 12.29% in ankle, knee and hip. In SOFT, joint negative work contribution was 30.62%, 48.05% and 21.33% in ankle, knee and hip.

The pattern of power curve was different between STIFF and SOFT. In STIFF after touchdown negative ankle power increased dramatically. On the contrary, in SOFT knee joint negative power decreased slightly after the middle of movement.

In M_{CM} two style landings started with a forward moment, then the moment decreased and became backward. The peak of backward of STIFF was greater than that of SOFT. While M_{CM} is in backward direction, knee flexion moment and hip extensor moment appeared.

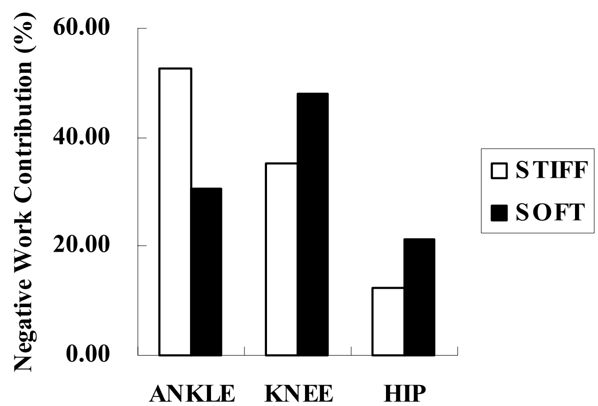

Figure 1: Typical example of ankle, knee and hip joint negative work contribution during STIFF and SOFT.

CONCLUSIONS

In conclusion, these findings indicate that ankle and knee joint contributed shock absorption. Hip joint did not much contributed shock absorption, however, contributed posture control during drop landings.

REFERENCES

1. Devita & Skelly. *Med Sci Sports Exerc* **24**, 108-115, 1992.
2. Ashby & Heegaard. *J Biomech* **35**, 1631-1637, 2002
3. Winter DA *Biomechanics and Motor Control of Human Movement*, 2nd ed, 11-50, John Wiley & Sons, New York, 1990