BIOMECHANICS OF THE KARATE FRONT-KICK

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INTRODUCTION

The front-kick (*mae geri*) in karate is one of the strongest and most easily mastered kicks. This project examined the powers produced by the lower extremity joints of the kicking leg of two elite (fourth dan) martial artists performing both closed and open stance front-kicks. The purpose was to determine the contributions and sequencing of the ankle, knee and hip moments.

METHODS

The subjects (one a specialist in Tae-kwon-do, the other in Karate) kicked against a padded board held by an assistant while filmed by a VHS camera. The subjects performed several trials each using both an open stance (kicking leg back) and closed stance (legs beside each other). The video was digitized with the Ariel Performance Analysis System and analyzed with the Biomech Motion Analysis System (Robertson, 2002). Inverse dynamics were used to compute the net moments and their associated powers for the ankle, knee and hip joints.

RESULTS AND DISCUSSION

The powers produced by the ankle moment of force were too small to warrant analysis. Figure 1 shows the angular velocities, moments of force and their powers for the knee and ankle of a typical trial. Notice that the moments of force of the hip and knee reverse direction at precisely the same instant just prior to contact with the board (right arrow). This was common to all trials and both subjects.

The powers produced by the closed stance kicks, as expected, always produced larger moments and powers than the closed stance kicks. Obviously, the added range of motion enabled the subjects to generate greater impulses and foot velocities.

The sequencing of the moments were consistent across all trials and both subjects. The motion began with almost simultaneous flexing of the hip and knee joints. The hip flexors were responsible for flexing both joints as shown by the burst of positive work done by the hip flexors while the knee moment of force was relatively inactive.

After the hip reached its maximum velocity, the hip moment of force became extensor (presumably due to eccentric contraction of the gluteals) causing the hip to slow its flexion and begin knee extension. Not surprisingly, based on similar research on the mechanics of soccer kicking (Robertson & Mosher, 1985) and sprinting (Lemaire & Robertson, 1989) the knee extensor moments did not contribute to increasing knee extension. Instead, the knee moment was flexor producing negative (eccentric) work to presumably protect the knee from hyperextension at the end of the kick.

SUMMARY

Peak powers were greater for the open stance than the closed stance. The hip extensors and flexors were the prime movers of both the hip and knee actions. The knee moments were primarily used to reduce knee flexion and extension.

REFERENCES

Lemaire, E.D., Robertson, D.G.E. (1989) Track & Field J, 35, 13-17.

Robertson, D.G.E., Mosher, R.E. (1985) *Biomechanics IX-B*, 533-538

Robertson, D.G.E. (2002) http://www.health.uottawa.ca/-biomech/csb/software

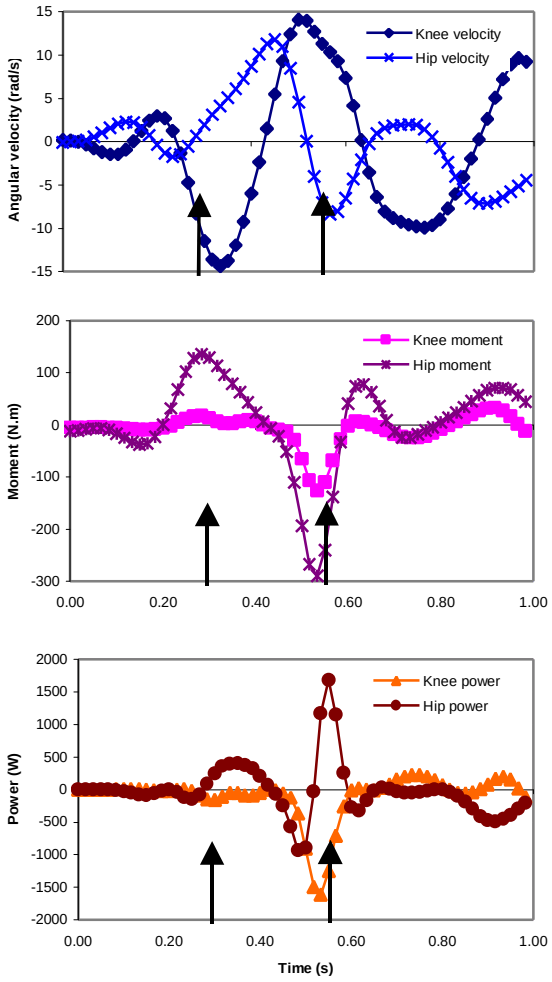

Figure 1: Typical angular velocities (top), moments of force (middle) and moment powers (bottom) of the knee and hip moments during an open stance karate front-kick. Left arrow indicates lifting of kicking leg; right arrow is contact.