INTRODUCTION

The purpose of the present study was to investigate the kinematic characteristics of javelin throwing movement in order to clarify the mechanism involved and the most effective technique.

METHODS

The subjects were 49 male javelin throwers, whose throwing movement was filmed at 200 fps using two high-speed video cameras during three official athletic competitions. Twenty-four body landmarks and 3 points on the javelin were digitized and their three-dimensional coordinates were calculated using the DLT method.

RESULTS AND DISCUSSION

1. Segment angle of the throwing arm at javelin release

Figure 1 shows that elite throwers had a tendency to keep the elbow joint angle and adduction angle smaller at the moment of javelin release ($r=-0.437$, $p<0.001$; $r=-0.454$, $p<0.01$, respectively). These results suggest that elite throwers accelerated the javelin by extension and rotation of the shoulder joint. That is, internal rotation of the shoulder joint was one of the most important movements for obtaining a high initial velocity.

2. Force applied to the javelin: The force for accelerating the javelin was calculated as the product of the acceleration of the center of mass of the javelin and the javelin mass. The peak force and the force at the moment of javelin release showed a significant positive correlation with the initial javelin velocity ($r=0.727$, $p<0.001$; $r=0.586$, $p<0.001$, respectively). Although the peak force showed a significant positive correlation with the acceleration of the forward arm swing (subtracting the acceleration of the shoulder from that of the grip; $r=0.835$, $p<0.001$), the angular acceleration of forward rotation of the trunk showed no significant correlation.

These results suggested that the arm swing was the main contributor to the force required for javelin acceleration.

CONCLUSION

Elite throwers generate a higher peak force and apply it until the moment of javelin release. The force is generated mainly by the arm swing. The small elbow and adduction angle during the forward arm swing might work effectively to generate the force and transfer the angular velocity of internal rotation of shoulder to the initial velocity of the javelin.

REFERENCES