RELATIONSHIP BETWEEN JAVELIN PERFORMANCE AND THE THROWING MOVEMENT OF
MALE JAVELIN THROWERS (PART 1):
OPTIMAL JAVELIN RELEASE PARAMETERS AND THE TRUNK MOVEMENT

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INTRODUCTION

There have been various studies on the release parameters of a javelin, such as the release angle, attitude angle, attack angle and initial velocity (Bartlett et al, 1996; Best et al, 1993; Best et al, 1995). These studies suggested that initial velocity was the most important factor for obtaining the throw distance. However, the rational throwing movements for obtaining a higher initial velocity were not clarified. The purpose of the present study was to investigate the kinematic characteristics of javelin throwing movement in order to clarify the most effective technique and its mechanism.

METHODS

The subjects were 49 male javelin throwers, whose throwing movement was filmed at 200 fps using two high-speed video cameras at three official athletic competitions in Japan. The range of the throwing trials investigated was 45.25 m to 77.22 m. Twenty-four body landmarks and three points (tip, grip and tail) on the javelin were digitized and their three-dimensional coordinates were calculated using the DLT method. The optimum cut-off frequency (4.5 – 20.5Hz) was determined using the residual analysis method, and the coordinates were smoothed using a 4th order Butterworth digital filter. The items calculated were release parameters (initial velocity, release angle, attitude angle and attack angle), the movement of the body’s center of gravity and the body’s segments.

RESULTS AND DISCUSSION

1. Javelin release parameters

Although a significant positive correlation ($r =0.797$, p<0.001) was observed between the initial velocity of the javelin and throw distance (performance), no significant correlations were obtained between the throw distance and the release angle, attitude angle or attack angle (Figure 1). The release angle, attitude angle and attack angle ranged independently of throwing distance from 27-37 degrees, 30-45 degrees and –2-10 degrees, respectively. Bartlett et al (1996) have reported that the average release angle (in 6 elite throwers) was 37.1 degrees and the attack angle was 0.74 degree. Their results were similar to the present study and support the validity of the present results.

The present results suggested that the throw distance was determined mainly by the initial velocity of the javelin. However, it was true that the release angle, attitude angle and attack angle also affected the path of the javelin, and consequently the throw distance. Therefore, the initial velocity was adopted instead of the throwing distance to investigate the relationship with various items to clarify the rational throwing movement and its mechanism.

Figure 1: Relationship between throwing distance and the initial javelin velocity (a), the release angle (b), the attitude angle (c), and the attack angle (d). ***; p<0.001
2. Velocity of the body’s center of gravity in the final phase of the approach run

Figure 2 shows the changes in the forward angular velocity of the trunk, the velocity of the center of gravity (BCG) and the horizontal velocity of the front hip joint during the phase just prior to release in elite, middle and novice groups. RFC, LFC and JRL indicate the right (rear) foot contact, left (front) foot contact and javelin release, respectively. The characteristics were as follows. Although elite throwers maintained a high velocity of the BCG until the JRL, the hip velocity of the front leg decreased markedly.

These results suggested that elite throwers had a tendency to maintain the approach run velocity to obtain a high forward angular velocity of the trunk at the moment of javelin release. That is, elite throwers were able to change the approach run velocity into forward rotation velocity of the trunk by effectively reducing the horizontal velocity of the front hip joint.

3. Trunk movement at the moment of javelin release

Figure 3 shows the relationship between the initial javelin velocity and forward rotation angle and angular velocity of the trunk at the moment of javelin release. The results suggest that elite throwers had a tendency to rotate the trunk forward more with a higher angular velocity (r= 0.412, p<0.01; r= 0.484, p<0.001, respectively).

Figure 4 shows the relationship between the initial javelin velocity and the lateral rotation angle and the angular velocity of the trunk at the moment of javelin release. The results show a negative correlation between the initial velocity of the javelin and the lateral rotation angle and the angular velocity of the trunk (r= -0.443, p<0.01; r= -0.523, p<0.001, respectively). These results suggested that elite throwers rotated the trunk forward with a higher angular velocity keeping the trunk at right angles to the frontal plane to obtain a higher initial javelin velocity.

SUMMARY

The throwing distance was determined mainly by the initial velocity of the javelin and not by the release angle, attitude angle and attack angle. The characteristics of the trunk movement of elite throwers were (1) effective transfer of the horizontal velocity of the approach run into forward rotation of
the trunk, (2) a large and rapid forward rotation of the trunk, and (3) a small and slow lateral rotation of the trunk. That is, the results suggested that the contribution of the forward trunk rotation movement was important in order to gain a higher initial javelin velocity.

**REFERENCES**


**Figure 4**: Relationship between the initial velocity and lateral rotation angle and angular velocity of the trunk at the moment of javelin release. ***; p<0.001, **; p<0.01