AN EXPLORATION OF BALANCE AND SKILL IN THE JUMP SHOT

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INTRODUCTION

The jump shot is the primary offensive weapon in basketball, and accuracy is critical to success. In free throw shooting, accuracy has been associated with low horizontal mobility and high stability (Hudson, 1985). In jump shooting, low mobility is desirable for avoiding fouls, but high stability may be counter-productive to achieving a good jump. That is, a large, stable base of support is less effective for jumping than a smaller base on the balls of the feet. How do jump shooters resolve this apparent conflict between high stability for accuracy and low stability for good jumps? Opting for low stability may be problematic if, according to the generally inverse relationship between stability and mobility, it leads to high mobility. And any solution in the anteroposterior plane can be threatened by instability in the mediolateral plane. Given these complexities of choice in the components of balance, players of diverse abilities may adopt different strategies. The purpose of this study was to explore how advanced and intermediate performers regulate balance in the jump shot.

METHODS

Two right-handed young adult males served as subjects in this study. The advanced performer (ht = 183 cm) was an intercollegiate basketball player with an excellent jump shot. The intermediate performer (ht = 188 cm) was a recreational basketball player with an inconsistent jump shot.

Six jump shots per subject were taken from a portable Kistler force plate positioned at the free throw line (about 4.25 m from the basket). Each subject began with his feet in a comfortable position, received a pass from his left diagonal, and then shot without hesitation. Force data were collected at 250 Hz, reduced with Bioware software, and expressed relative to body weight (BW). For both anteroposterior (A-P) and mediolateral (M-L) planes, stability was assessed with center of pressure (CoP) and mobility was assessed with horizontal force.

For each subject three shots were videotaped from the front and three shots were videotaped from the right side at 60 Hz. A representative trial from each perspective was digitized and optimally smoothed with the Butterworth filter in the Peak5 software. Standard body segment data were used to compute the position and velocity of the body's line of gravity (LoG). For both A-P and M-L planes, stability was assessed with horizontal position of the LoG and mobility was assessed with horizontal velocity of the LoG. The M-L base of support

(BoS) was calculated as the difference between the most extreme left and right points of contact with the force plate during stance. Similarly, the most extreme posterior and anterior points of contact were used to determine the A-P BoS. The posterior point was demarked by the heel of the trailing foot until it lifted during the crouch; the metatarsal head was used thereafter. For reference a forefoot line (FFL) was drawn approximately through the metatarsal heads (see Figure 1).

RESULTS AND DISCUSSION

During data collection the advanced performer (AdP) was consistently accurate (616 successful shots). This compares favorably with the highly skilled subjects of Elliott (1992) who made 86% of their jump shots from a similar distance. The intermediate performer (ImP) was consistently inaccurate (016 successful) while being filmed. These results are in accord with the finding of Hudson et al. (1986) that highly skilled free throw shooters increased accuracy and poorly skilled free throw shooters decreased accuracy during filmed trials.

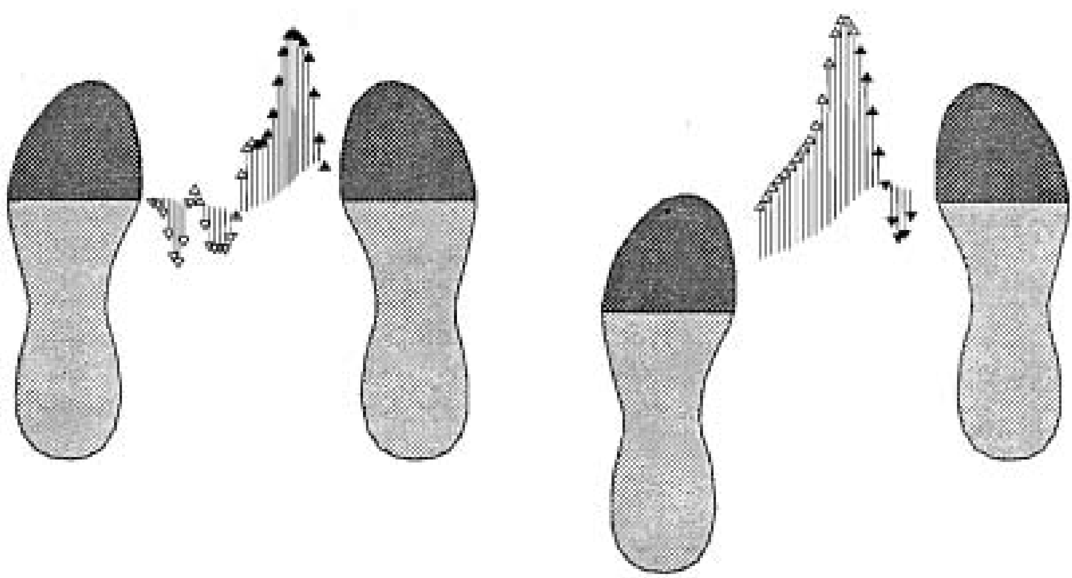

Figure 1. Depictions of stability and mobility in the jump shot of the advanced performer (left) and the intermediate performer (right). Gray scaling represents the base of support during (dark) and before (dark + light) the jump. Position and velocity of the line of gravity in the A-P plane are denoted every 17 ms during the crouch (open arrows) and the thrust (closed mows). For each arrow the tail shows the position of the LoG with respect to the feet, and the length represents the velocity of the LoG (upward is forward). See text for magnitudes.

At the end of the thrust phase of the jump shot, the center of gravity (CoG) of the AdP was moving upward at 2.82 m/s. In contrast, the ImP had an upward velocity of 2.23 m/s. Elliott (1992) reported a maximum vertical velocity of the hip of 2.4 m/s. Thus it seems that the AdP, but not the ImP, was following the advice of Knudson (1993) to have a "vigorous" jump.

Several aspects of balance are depicted in Figure 1. The AdP used a parallel rather than a staggered stance. The ImP had a 9-cm stagger with his right foot ahead of his left. The subjects of Elliott (1992) used a 12-cm stagger, but they were shooting off a dribble (i.e., moving before the shot) rather than off a pass (i.e., standing before the shot). Perhaps a staggered stance, as recommended by Knudson (1993), is not necessary for highly skilled players who are shooting off a pass.

Prior to the crouch of the jump both subjects had their heels on the ground. The A-P BoS was 30 cm for the AdP and 39 cm for the ImP. Soon after the temporal midpoint of the crouch, both subjects reestablished their BoS over the balls of their feet. From this point until about the end of the thrust, the functional BoS was 9.5 cm for the AdP and 18.5 cm for the ImP. At the beginning of the crouch the AdP had his LoG positioned 1 cm in front of the FFL of both feet (see Figure 1). During the crouch his LoG moved backward to the rear edge of his BoS and then forward during the thrust. While he was on the balls of his feet, the AdP shifted his LoG through an excursion of 4 cm or from 0% to 40% of his BoS. For the ImP the LoG was 4 cm in front of the FFL of his left foot at the beginning of the crouch and near the FFL of his right foot by the end of the crouch. Overall, his LoG had a 6-cm excursion. While he was on the balls of his feet, the ImP moved his LoG from 35% to 56% of his BoS. In sum, the AdP had a smaller excursion of his LoG in the A-P plane, but this represented a greater percentage of his BoS (40% vs. 21%) and took him closer to the edge of his BoS (0% vs. 35%).

As for A-P CoP, the AdP had small oscillations (± .5 cm) early in the crouch and a total excursion of 6 cm before take-off. The ImP had an oscillation (±1 cm) near the end of the crouch and a total excursion of 7 cm. For both subjects the CoP excursion was similar to, but somewhat larger than, the LoG excursion.

In terms of A-P mobility, the LoG of the AdP reached velocities of ±10 cmls during the crouch (see Figure 1). Forward velocity increased to 25 cmls during the thrust, but subsided to 0 cmls at the end of the thrust. The ImP was moving forward at the beginning of the crouch and reached 32 cmls at the end of the crouch. Midway through the thrust his direction reversed; his velocity at the end of the thrust was -5 cmls. Each subject had an oscillation in velocity, but it was during the crouch for the AdP and during the thrust for the ImP. The minimal take-off velocities of these subjects is in contrast to velocities of 22 cmls for skilled women shooting off a pass (Walters, et al., 1990) and 45-50 cmls for skilled women and men shooting off a dribble (Elliott, 1992; Elliott & White,

1989) and poorly skilled free throw shooters (Hudson, 1985). The AdP applied his greatest A-P force (-.34 BW) during the crouch; thereafter he applied smaller forces (±.10 BW). The ImP applied his peak backward force (-.17 BW) during the crouch and his peak forward force (.22 BW) during the thrust.

The M-L BoS was 38 cm for the AdP and 39 cm for the ImP. These values support Knudson's (1993) statement that the BoS should be slightly less than shoulder width. Overall the AdP's LoG moved 2 cm and the ImP's moved 3 cm. The CoP excursion was comparable to the LoG excursion. Both players put slightly more weight on the left foot. The greatest LoG velocity was 11 cm/s in the crouch for the AdP and 21 cm/s at take-off for the ImP. The AdP had higher M-L forces in the crouch (-.12 BW) than in the thrust (.03 BW). The ImP also had higher M-L forces in the crouch (-.10 BW) than in the thrust (.08 BW).

CONCLUSIONS AND APPLICATIONS

Both performers had excellent M-L stability, and the AdP had low M-L mobility. Both performers had little A-P mobility at take-off, but the ImP may have achieved this at the cost of accuracy and height. His moderate BoS may have been too small for him to prevent the oscillation in mid-thrust and too large for him to get an effective push from each leg. The AdP has shown that low stability, low mobility, good height, and high accuracy can coexist.

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