KINEMATIC COMPARATIVE ANALYSIS OF THE COORDINATION PATTERN OF THE BASKETBALL FREE THROW

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INTRODUCTION

There were many definitions of coordination, biomechanists focused on intersegmental coordination of the pattern of movement (Hudson & Hills 1991). The timing of the pattern may have been put on a continuum described by Hudson (1986). He stated that tasks in which velocity was important, the object was light, and/or the distal end of the linkage was open (e.g., baseball throwing) were presumed to be sequentially timed. In contrast, tasks in which accuracy was the key, the object was heavy, and/or the distal end of the linkage was closed (e.g., the squat in weight lifting) were expected to be timed simultaneously. Intermediate tasks (e.g., shot putting) would be predicted to have intermediate timing. The sequential pattern of coordination, also known as transfer of momentum, was most clearly described by the summation of speed principle put forth by Bunn (1972). He stated that in activities where the highest speed at the moment of release was necessary, the speed was developed when the movement of each segment started at the moment of greatest velocity of the preceding segment. Due to this explanation, the angular velocity of the specific body segment involved were used to examine coordination patterns in order to distinguish between simultaneous and sequential skills. The purpose of this study was to conduct a comparative biomechanical analysis of the system of coordination of the basketball free throw using four individuals differing in ability. The free throw was a skill determined by the researcher to be an intermediate task in which both velocity, to throw the ball to the ten foot basket fifteen feet away, and accuracy, to hit the target were factors.

METHODOLOGY

The four subjects used in this study were classified as follows: elite, a professional basketball player in his seventh year in the National Basketball Association; advanced, seventeen year old high school senior in his second year on the varsity team; intermediate, an eighth grade fourteen year old in his second year on the middle school team; novice, an eleven year old sixth grade boy who played in a neighbourhood boys league for three years. All subjects shot with their right hand.

The data were collected in a gymnasium on a regulation basketball court with a ten foot hoop and backboard. The foul line markings were a perpendicular distance of fifteen feet from the backboard. The subjects were filmed (60 fps) in the sagittal plane on their right side. The trial began when the subject was holding the ball at its lowest point, and it was complete after release. The video was analyzed and digitized using the PEAK Performance 2-dimensional movement analysis system. The angular velocity of the shoulder, elbow and wrist of the shooting arm and the hip, knee and ankle of the same

side were examined.

RESULTS AND DISCUSSION

In all graphs, positive was in the clockwise direction and the arrows denoted the moment the subject released the ball. All subjects exhibited simultaneous or nearly simultaneous movement of the legs. The elite subject displayed a very small time difference between plantar flexion and the knee and hip extension. The advanced subject showed a slightly larger delay with the most distal segment, the ankle, last. The intermediate subject accentuated this proximal-to-distal pattern including a small time delay between both the hip-knee and then the knee-ankle. Finally, the novice subject exhibited complete simultaneous movement of the three leg joints. These findings were consistent with those of Hudson (1986) who found that jumping was a simultaneous activity.

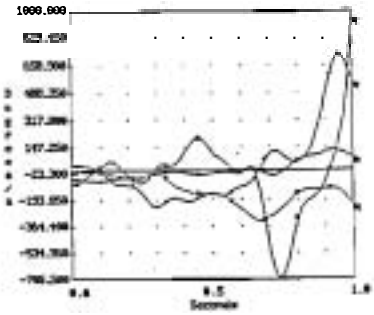
The elite subject exhibited nearly perfect transfer of momentum of the shooting arm. His shoulder peaked in angular velocity as the elbow began its movement toward the basket. Next, his elbow peaked in angular velocity almost at the same moment that the wrist began its forward movement. Also to be noted was the lapse between the leg maximum angular velocity and the elbow peak was smaller than that of any other subjects. The entire event performed by the elite subject most closely resembled the findings of Jackson and Tanner (1993) when they found that disc golf putting was both simultaneous and sequential.

The advanced subject followed the same basic pattern as the elite subject with small timing differences. His shoulder flexion angular velocity maximum occurred slightly before his elbow changed direction. Unlike the elite subject, the wrist of this subject began to flex after peak angular velocity of the elbow, and the release was simultaneous with the elbow maximum. The time difference between the leg peak and the aforementioned elbow peak was only slightly larger than that shown by the elite performer. These small differences showed a slight deviation from the pure sequential pattern the elite performer exhibited.

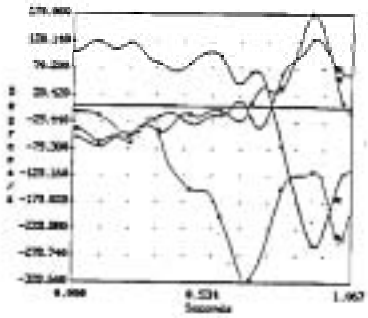
More simultaneous qualities were dernonstrated by the intermediate subject. When the upward thrust of the leg was completed, he showed a larger delay than the elite subject before the elbow peaked in angular velocity. This subject displayed a change of direction of the elbow long before the peak angular velocity of the shoulder as compared no delay between these events in the elite subject. The wrist of this subject began to flex slightly before the elbow reached peak angular velocity. The greatest indication that this subject was rnore simultaneous than sequential was that the maximum angular velocity of shoulder flexion, elbow extension, and ball release all occurred at the same time.

The novice subject presents the opposite end of the continuum from the elite performer. His performance was nearly complete sirnultaneous movement. First, his shoulder and elbow together reached maximum angular velocity before the wrist began to change direction where the elite subject's wrist changed direction before the elbow peaked. This subject also showed a significant time delay between the change of direction of the elbow and the shoulder peak where the elite performer showed those

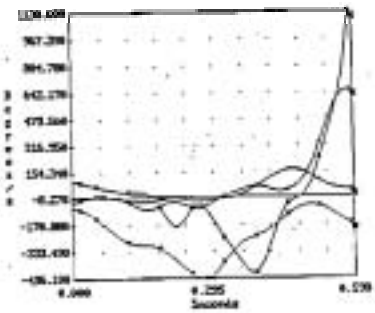
Elite Arm



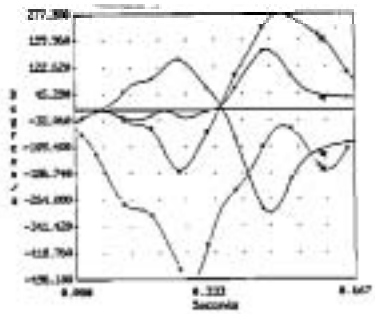
Elite Leg



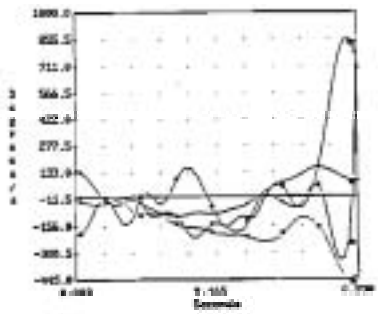
Advanced Arm



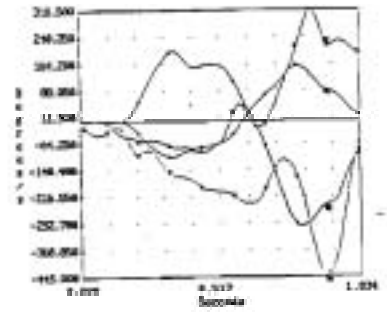
Advanced Leg



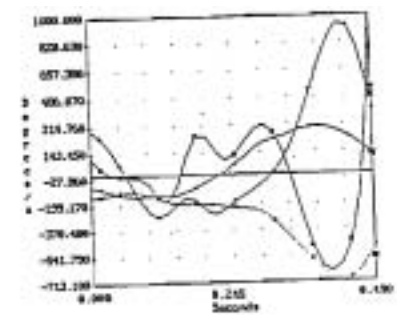
Intermediate Arm



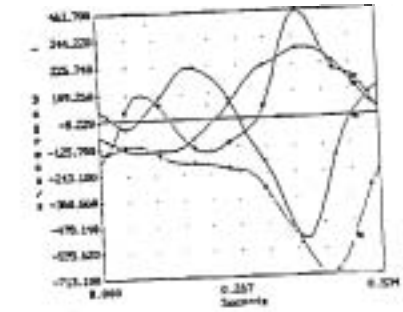
Intermediate Leg



Novice Arm



Novice Leg



-⊖-U: right wrist -+-U: right hip
-Y-: right elbow *U: right shoulder

-⊖-U: right ankle -+-U: right hip
-Y-: right knee -*-U: right shoulder

together. The time lapse between the peak angular velocity of the leg and that of the elbow was larger than that exhibited by the elite performer.

APPLICATIONS AND CONCLUSION

The results of this study showed that as an athlete obtained more experience and practice, the coordination of the skill of shooting a free throw became more efficient, and. therefore, the accuracy improved.

This analysis furthered the understanding of the basketball free throw. The information provided may be used as a teaching tool for this skill. A player of any level may improve his technique by studying a detailed analysis of the patter of coordination of a professional player then finding which subject on the provided continuum he rnost closely resembles to discover where improvement is most needed.

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