EFFECTS OF PERCEIVED NEUROMUSCULAR FATIGUE ON KINEMATIC VARIABLES OF THE BASKETBALL JUMP SHOT

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INTRODUCTION

Since the invention of the game of basketball by Dr. James Naismith in 1891, the game has undergone many changes. Over the years, the game evolved from a slower, more deliberate play into an intense game of strength, stamina, speed, agility and, most importantly, shooting ability (Brancazio, 1984). The two-hand set shot was the common method of shooting in the early days of the game. However, players and coaches realized the importance of getting the shot off faster and higher in order to get the ball over the defense. Thus, the jump shot was developed. The success of a jump shot in the game of basketball partly depends on reaching optimal height in the air as quickly as possible. Additionally, success depends on the player's ability to main consistency of the shot throughout the course of a game. Given the intensity of a typical game, what happens to the shot when fatigue sets in ?

A few studies have looked at biomechanical changes during fatigue conditions in other sports. Sardinah and Zebas (1987) investigated the effects of perceived fatigue on the volleyball spike skill performance. They found that during the fatigued condition, the height to which the spiker could jump and the velocity with which the hand contacted the ball were diminished. Chapman (1982) noted that the step length, cycle time, and overall velocity were reduced during fatigue in sprinters. Elliot and Roberts (1980) and Richards (1980) found similar results in distance runners.

To answer the question of what happens to basketball players when fatigue sets in, this study was undertaken. The purpose was to determine the effects of perceived neuromuscular fatigue on selected kinematic variables of the basketball jump shot.

METHODOLOGY

Fourteen skilled male basketball players performed 5 consecutive jump shots under the conditions of non-fatigue (NF) and perceived fatigue (PF). The shots were executed from a dribble at a designated area at the free throw line. Following the first series of jump shots, the subject was asked to mount the stationary bike. Following a warmup, each subject began pedaling as fast as possible at a predetermined level of resistance (.75 kg x body weight). The subject performed the Wingate test continuously until an RPE of at least 18 was established. When the subject verbally reported an RPE of 18 or higher, the subject was told to return to the filming area and perform 5 consecutive jump shots again.

The jump shots performed in the NF and PF conditions were filmed with a Peak5 2D video camera (120 Hz), and later were analyzed with the Peak5 system software. The specific parameters under investigation were center of mass horizontal and vertical displacement, center of mass vertical velocity at release, resultant ball velocity at release, angle of ball at release, knee and hip flexion and forearm and trunk inclination changes during the jump. Intraclass correlations were done to determine the trial to trial consistency of the kinematic variables. Paired sample ttests were performed to compare the kinematic variables for the NF and PF conditions. The Bonferroni Inequality test was used to adjust for Type I error and significance was then set at $p < .0035$.

RESULTS AND DISCUSSION

Reliability coefficients between .80 and .99 were calculated for all kinematic parameters from the intraclass correlations. It was determined that there was consistency in the among the 5 jumps in each of the kinematic parameters.

Table 1 summarizes the statistical findings between the NF and PF conditions for all variables.

Parameter	Condition		Mean and S.D.	p
Knee flexion (deg)	Prep	NF	112.2 ± 10.9	.009
		PF	114.9 ± 10.5	
	Rel	NF	172.3 ± 6.2	.355
		PF	171.4 ± 7.3	
Hip flexion (deg)	Prep	NF	135.9 ± 12.6	.933
		PF	135.8 ± 14.8	
	Rel	NF	183.0 ± 6.5	.265
		PF	182.1 ± 6.5	
Trunk lean (deg)	Prep	NF	84.6 ± 11.2	.434
		PF	83.9 ± 13.4	
	Rel	NF	94.2 ± 4.8	.247
		PF	93.6 ± 4.8	
Forearm inclination (deg)	Prep	NF	102.0 ± 24.8	.217
		PF	92.2 ± 32.3	
	Rel	NF	74.4 ± 14.6	.090
		PF	72.7 ± 13.4	
Ball angle (deg)		NF	65.8 ± 10.2	.639
		PF	64.6 ± 11.2	
Ball velocity (m/s)		NF	5.7 ± 1.4	.652
		PF	5.8 ± 1.0	
COM vertical velocity (m/s)		NF	.83 ± .33	.055

	PF	.73 2.37	
Horizontal displacement (m)	NF	.06 ± .12	.22
	PF	.08 ± .11	
Vertical displacement (m) before release	NF	.44 ± .09	.002*
	PF	.39 ± .11	
Vertical displacement (m) at release	NF	.41 ± .10	.001*
	PF	.35 ± .11	

Note. NF = non fatigue
PF = perceived fatigue
Prep = preparatory phase
Rel = release
* = statistically significant at $p < .0035$

From a statistical standpoint, significant differences were indicated only for center of mass vertical displacement. However, there was an observable difference in the velocity with which the player was able to jump from a position of deep knee flexion to release of the ball. It was noticed that a player's speed was diminished during the PF state. Researchers stress the importance of obtaining maximal height for a successful performance in the jump shot (Brancazio, 1981; Hay, 1993; Knudson, 1993; Elliot & White, 1989). Hess (1980) stated that the foundation of a jump shot is the players's ability to obtain optimum height in the air as quickly as possible to outmaneuver the opponent. Practically speaking, this means that if a player is not able to generate enough power to achieve optimum height and speed in the execution of the jump, he may not be able to shoot the ball over the defender, or the angle of the shot may have to be altered.

Brancazio (1981) and Hay (1993) concurred that maximizing the height of release increases the accuracy of the shot and also increases the margin of error. Knudson (1993) added that an optimal height of release provides for a more favorable angle of entry. When a player is fatigued in a game situation, he may not be able to effectively execute a jump shot while being defended. Training for peak physical condition then becomes a key factor to delay the onset of fatigue in games. If this is achieved, optimal height and increased vertical velocity will be possible throughout the game resulting in better performance. Great coaches understand the importance of prime physical condition. John Wooden (1988) summed up the importance of condition. "Success is built on fine condition. Fundamentals and form leave you as you begin to lose condition" (p. 39).

CONCLUSIONS

Within the assumptions and limitations, the following conclusions were made: (1) When fatigued, basketball players lose height on their jump shot; (2) Ball velocity and angle of release are not affected in the fatigued state; (3) Body position as reflected by hip and knee flexion and trunk and forearm inclination are not affected by fatigue; (4) Although not statistically significant, the center of mass speed in the upward direction was slowed during the fatigued state; and (5)

Practically speaking, the defensive player gains an advantage when the offensive player reduces the height to which he can jump and the speed with which he can reach peak height.

REFERENCES

Brancazio, P. J. (1981). Physics of basketball. American Journal of Physiology 49(4):356-365.

Brancazio, P. J. (1984). Sport Science: Phvsical Laws and Optimum Performance. New York: Simon & Schuster.

Chapman, A. (1982). Hierarchy of changes induced by fatigue in sprinting. Canadian Journal of Applied Sport Science 7(2): 116-122.

Elliot, B. and Roberts, A. (1980). A biomechanical evaluation of the role of fatigue in middle distance running. Canadian Journal of Applied sport Science. 5(4):203-207.

Elliot, B. and White, E. (1989). A kinematic and kinetic analysis of the female two point and three point jump shots in basketball. The Australian Journal of Science and Medicine in Sport. 21(2):7-11.

Hay, J. G. (1993). Biomechanics of Sports Techniques. pp. 225-249. Englewood Cliffs, N. J.: Prentice-Hall, Inc.

Hess, C. (1980). Analysis of the jump shot. Athletic Journal 61(3): 30-58.

Knudson, D. (1993). Biomechanics of the basketball jump shot-six key teaching points. JOPERD, Feb. 67-73.

Richards, J. (1980). Mechanical analysis of gait during a marathon. In J. Cooper (Ed.) Biomechanics: Symposium Proceedings. pp. 275-285. Bloomington, IN: Indiana University Publishing.

Sardinah, L. and Zebas, C. J. (1987). The effect of perceived fatigue on volleyball spike skill performance. In J. Terauds, B. A. Gowitzke, & L. E. Holt (Eds.) Biomechanics in Sports III & IV (pp. 249-257). Del Mar, CA: Academic Publishers.

Wooden, J. (1988). Practical Modem Basketball. p. 39. New York: MacMillan Publishing Co.