EFFECTS OF UPPER EXTREMITY FATIGUE ON BASKETBALL SHOOTING ACCURACY

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The purpose of this study was to investigate the effect of upper extremity fatigue on basketball shooting accuracy. Twenty-four elite male basketball players from 2 teams the top 3 Taiwan High Schools were chosen as subjects. After a warm-up and proper practice, they were asked to shoot from 3 varied distance positions before and after fatigue protocols. The protocols used were the chest press and wrist curls. Results show that the shooting accuracies in different distance positions declined significantly after the chess press protocol, however, there was no significant difference in shooting accuracy after doing the wrist-curls protocol. The results suggested that avoiding shoulder muscle fatigue should keep the shooting accuracy constant and in return helping them win a basketball game.

KEY WORDS: basketball, fatigue, shooting, accuracy

INTRODUCTION: Basketball is one of the most popular activities in the world, and its main objective is getting a good shot in order to score a basket. Therefore, shooting is probably the best-known fundamental skill in this game, and good shooting basically requires proper movement of the upper extremity on the dominate side plus the balance and jumping power by the lower extremities (Krause, et al, 1999). In common, there were three elements that influenced shooting accuracy, one is distance of the shot, the others were velocity and angle of releasing the ball (Miller & Bartlett, 1996). However, the competition rules have changed since 2000 to increase the attendance of the audience in one game as well as gain players' condition consumption. A declining in condition during a game would affect the shooting accuracy because of muscle fatigue caused by failed power output by repeated contractions (Sterner et al, 1998) and even loss of coordination of joints (Hiemstra,2001 ; Skinner,1986). Although some reports have shown that lower extremity fatigue influences the jump performance that may effect the shooting performance, this present study observes upper extremity fatigue and how it effects shooting accuracy. Hence, the purpose of this study was to investigate the effects of upper extremity fatigue on shooting accuracy in varied-distance positions.

METHODS: Two schools from the top 3 elite male Taiwan High Schools were recruited as subjects. However, there were a totally of twenty-four elite male players consisting of Guards and Forwards (age: 17.5 ± 1.3 years old; height: 185.7 ± 6.8 cm; weight: 78.6 ± 8.7 kg; playing ball duration: 4.4 ± 1.56 years) except for Centers who seldom shoot 3-point shots. Figure1 outlines the full experiment procedure of this present study. Before this study, they had to do a 1 RM (Repetition of Maximum) test for the chest press and wrist curls to determine the fatigue protocol intensity. Then, they all were asked to warm up and practice shooting in 3 varied distance positions randomly as shown in the Figure 2: (1) free throw (FT), the distance between FT line and the rim was 4.45 meters, (2) two-point (2P) shot was defined as behind the FT line by one meters, away from the rim by 5.45 meter and (3) three-point (3P) shoot, which was 625 meters from the rim. After that, one school did the chest press protocol (A) and the other one did the wrist curl protocol (B) first and then changed protocols after one week.

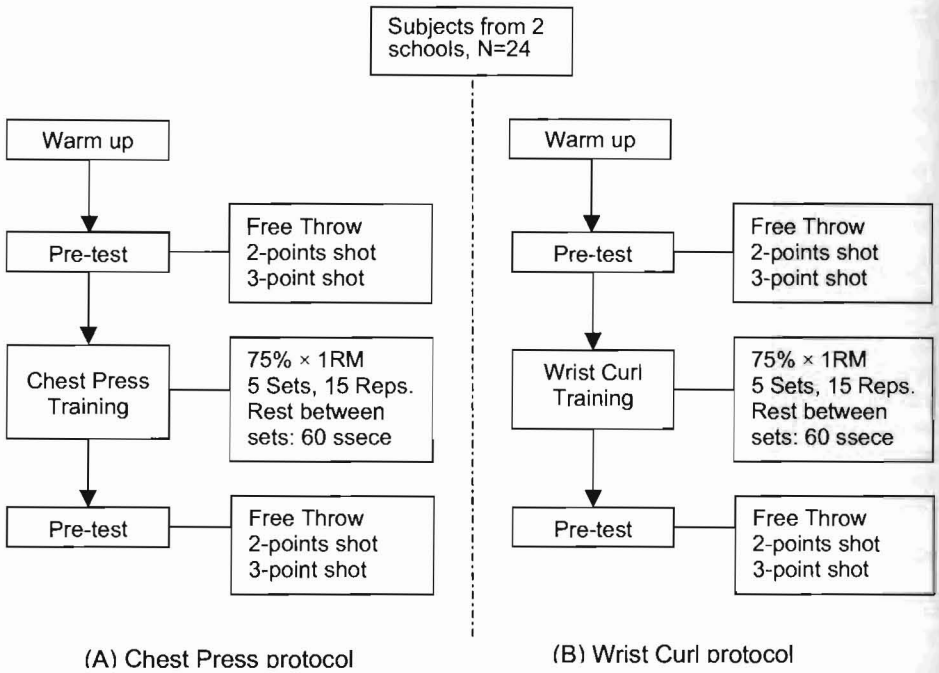

Figure 1 2 experimental protocols with chest press (A) and wrist curl (B) training.

A dependent *t*-test was executed to determine the differences in shooting accuracy between the two schools pre protocol, and there was no significant variances. Then a pair t-test was used to compare the effect of upper extremity fatigue on shooting accuracy in three different positions, the α level was set at .05.

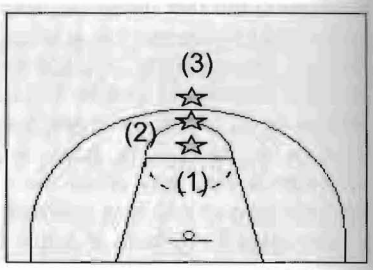

Figure 2 Shooting position

RESULTS: The results of the shooting accuracy before and after fatigue protocol in three different shooting positions (Table 1) shows that the shooting accuracies after the chest press protocol were significantly lower than those before in all shooting positions, and however, the shooting accuracies were not significant difference.

Table 1 The shooting accuracy of 3 varied distance position before and after 2 kinds of fatigue protocols.

n=24	Chest press			Wrist curl		
	Pre	Post	t	Pre	Post	T
FT	72.7 (13.6)	52.7 (16.9)	4.630*	69.6 (13.8)	70.0 (15.0)	-.141
2P shot	56.7 (13.0)	46.5 (12.4)	3.647*	54.4 (12.5)	56.9 (13.9)	-.669
3P shot	40.0 (10.9)	30.6 (10.9)	3.476*	45.8 (17.2)	41.9 (13.6)	1.446

Mean (SD),*Significant difference, $p < .05$

DISCUSSION: The further the distance of shooting, the lower percentage of shooting accuracy was recorded. Before the fatigue protocols, the shooting accuracy of FT was about 70%, however, there was only 50% on the 3P shot. This result was supported by the idea that the distance from shooter to the rim was a basic point that affected the shooting accuracy (Walters, M. et al., 1990). Furthermore, after the chest press fatigue protocol, shooting accuracies in 3 different positions were decreased significantly as shown in Figure 3, and there were generally a 10% drop in each position. Muscle soreness and swelling of shoulder horizontal abductors by repeated chest press with the loading of 75% 1 RM caused the elbow to be improperly positioned at the beginning of shooting that lead to unstable shooting accuracy. Muscle fatigue by repeatedly doing muscle contractions reduced the neuromuscular coordination and it would be tough to control the shooting angle and power

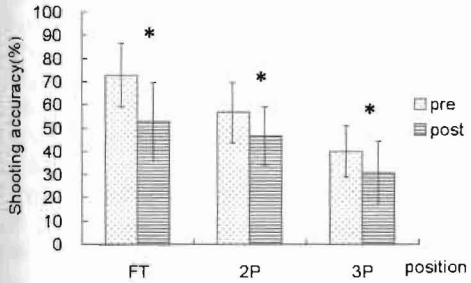

Figure 3 Chest press protocol

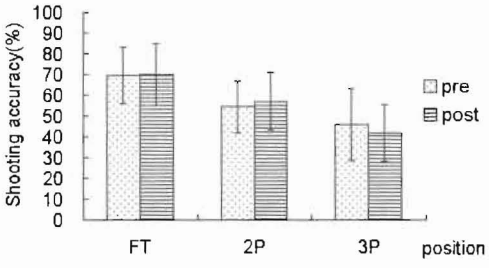

Figure 4 Wrist curl protocol

output, the main factors that influence shooting accuracy while releasing the ball.
Moreover, Shooting skill are one continues movement chain that starts with the feet standing and moves up thhough the dominate hand. Releasing demands the coordination of the whole body segment and the wrist movement is also one important element during shooting because backspin produces a soft shot that could hit the rim and bounce in. However, the shooting accuracies before and after the wrist curl protocol shown in Figure 4 were not significantly different as the result of the strategies of adjustment by the elite players to maintain the shooting accuracy with the wrist fatigue (Tsarouchas et al., 1990).

CONCLUSION: According to the results of this study, the shooting accuracy was affected by the distance of the shot and the muscle soreness after doing repeated contractions that leaded to poor neuromuscular coordination among shoulder joint. However, the elite players compensated other segments to keep the stability of the shots while the wrist muscle was fatigued. Further studies need to be conducted to compare the deviated distribution of those miss-shots in more varied shooting positions to understand the effects of muscle fatigue on shooting accuracy, and try to provide some suggestions of conditioning and training principles for coaches and shooters.

REFERENCES:

Elliott, B.C. and White, E. (1989). Kinematic and Kinetic analysis of the female two point and three point jump shots in basketball. *The Austrailian Journal of Science and Medicine in Sport,* 21(2), 7-11.
Elliott, B.C. and White, E. (1992). A kinematic comparison of the male and female two point and three point jump shots in basketball. *The Austrailian Journal of Science and Medicine in Sport,* 24(4), 111-118.
Hagbarth, K.E., and Macefield, V.G. (1995). The fusimotor system: it's role in fatigue. *Advances in Experimental Medicine Biology*, 384, p 59-70.
Hiemstra, L.A., Lo, K.Y., and Fowler, P.J. (2001). Effect of fatigue on knee proprioception : implications for dynamic stabilization. *Journal of Orthopaedic & Sports Physical Therapy*, 31(10), p 598-605.

Miller, S. & Bartlett, R. (1996). The relationship between basketball shooting kinematics, distance and playing position. *Journal of Sport Medicine*, p243-253.
Krause, J.V., Meyer, D., Meyer, J. (1999). Basketball skill and drills. *Human Kinetics*.
Skinner, H.B., Wyatt, M.P., Hodgdon, J.A., Conard, D.W. and Barrack, R.L. (1986). Effects of fatigue on joint position sense of the knee. *Journal of Orthopaedic Research*, 4, p112-118.
Sterner, R.L., Pincivero, D.M., and Lephart, S.M. (1998). The effects of muscular fatigue on shoulder proprioception. *Clinical Journal of Sport Medicine*, 8, p96-101.
Walters, M., Hudson, J. L., & Bird, M. (1990). Kinematic adjustments in basketball shooting at three distances. In: M. Nosek, D. Sojka, W.E. Morrison, & P. Susanka (Eds.), *Biomechanics in Sports VIII* (pp. 219-223).