

## KINEMATIC ANALYSIS OF DIVING BACK PIKE SOMERSAULT IN PLATFORM ACCORDING TO PLAYERS' SKILL LEVEL

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The purpose of this study was to investigate the kinematic difference in Back Pike somersault in platform diving according to players' skill level and to assist them to improve performances. Ten Korean diving athletes participated in this study and they were divided into skilled group (n=5) and less-skilled group (n=5) and t-test was performed to find the difference at the moment of take-off between groups. The results showed that the hip extension angle was greater and the extension velocity of knee and hip joints were faster in skilled group compared to less-skilled group. It is recommended, therefore that the flexibility training of hip joint and muscle strength training to enhance extension velocity of knee and hip joints are needed.

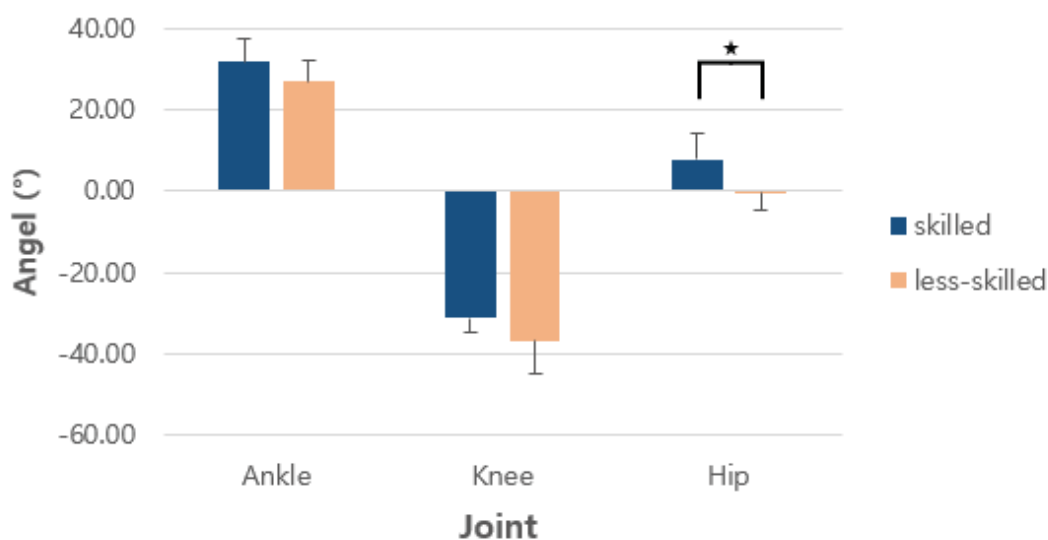
**KEY WORDS:** diving, platform, back, pike, take-off

**INTRODUCTION:** The current diving is evolved from a training designed for safe practice of air phase motion by artistic gymnastics. This event is divided into two types, platform and springboard ones and the scores assigned to three steps of take-off, flight, and entry are summed to determine winner. This means that players should seek to improve the completeness of these three motions to receive high score and errors from any of these motions have negative effects on performance (Kang & Nam, 2010). It is reported that take-off is the most important element in determining the result of diving (Lee, 2006). In the platform diving, unlike the springboard diving utilizing the elasticity of the board, players take-off using only his/her physical ability on rigid floor. In this event six technical groups i.e. Forward, Back, Reverse, Inward, Twist, and Armstand are required ones and should be performed by classifying into three flights, i.e. Straight, Pike, and Tuck according to somersaults. The Pike somersault from Back technical group (Back Pike) is one with the most difficulty therefore have been used by many players in attempts to getting higher score. The Pike motion, however, generates high moment of inertia that requires higher jump, more rotational strength and flexibility, making players to experience difficulty in performing this motion. A previous study reported that divers need to have the sufficient rotational strength and high take-off in order to achieve excellent performance of Back Pike (Hamill, Golden, & Williams, 1985) and the increasing in angle velocity is achieved by changing the tilted angle of body at jumping moment (Hamill, Golden, & Williams, 1985). Lee(2006), in addition, suggested that the angles and angular velocities of knee and hip joints are important influential factors in take-off. The purpose of this study was, therefore, to analyze the difference in Back Pike somersault according to players' proficiency and to assist them to improve performances.

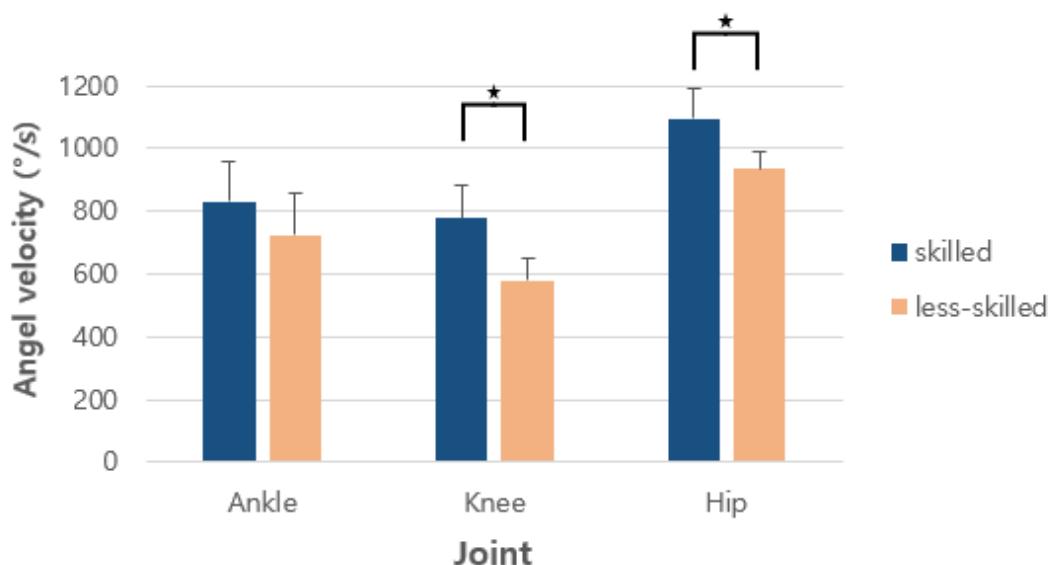
**METHODS:** Ten Korean diving athletes with carrier of over seven years and left foot as dominant foot participated in this study. Five of them who had career of national team and were capable of performing Back Pike motion with difficulty of 3.2 and over in platform event were classified as skilled group (age 21.6±4.2 years, weight 62.0±3.9 kg, height 1.68±0.03 m), and remaining five who had career of national reserve team and were incapable of such performance were classified as less-skilled group (age 20.6±2.7 years, weight 64.8±6.8 kg, height 1.72±0.05 m). After sufficient warming-up, each participant was asked to perform Back Pike somersault ten times. The movements of lower limbs during Back Pike motions were quantified with 20 reflective markers attached to lower extremities. The moment of take-

off was defined as one when the foot is separated from ground completely. A 3-D motion analysis with seven infrared cameras (Oqus 300, Qualisys, Sweden) was performed and the cameras sampling rate were set as 200 Hz. The random errors were minimized by using 2<sup>nd</sup> Butterworth low-pass filter and setting cut-off frequency as 10 Hz. All experiment of this study was done at the university laboratory. The t-test was performed to analyze the difference in movement of Back Pike somersault between groups and the statistical significance was set as  $\alpha=.05$ .

**RESULTS:** The joint angles and angular velocities of left lower limb joints were calculated and there were no significant differences in all planes except for sagittal plane. The angles and angular velocities of lower limb on sagittal plane is shown in Fig. 1 and Fig. 2, respectively. The flexion of knee and hip joints and dorsiflexion of ankle joint were set as negative(-) while the extension of knee and hip joints and plantarflexion of ankle joint were set as positive(+). For the joint angle, the results showed that there were no significant difference in ankle and knee joints between groups however, in hip joints, skilled group showed higher extension angle compared to less-skilled group ( $7.86\pm3.47^\circ$  vs  $-0.30\pm4.24^\circ$ ,  $p<.05$ ; Fig.1). For the joint angular velocity, there was no significant difference in ankle joint between groups while, in knee and hip joints, skilled group showed faster extension velocity compared to less-skilled group ( $p<.05$ ; Fig.2).



**Figure 1:** Joint angles of left lower extremities at take-off on sagittal plane between groups



**Figure 2: Joint angular velocities of left lower extremities at take-off on sagittal plane between groups**

**DISCUSSION:** The most prominent difference in joint angle at the moment of take-off according to skill level was in hip joint. Considering that the change in angular velocity at take-off results from change in angle of upper body (Hamill, Golden & Williams, 1986), it is speculated that the difference in measurements from hip joint between two groups observed in this study is from a movement by skilled group members of leaning body more posteriorly to achieve effectively an angular velocity needed to somersault. It is also estimated that the faster angular velocity of knee and hip joints observed in skilled group is from attempts by higher level players, compared to lower level players, to acquire more vertical distance and longer time for successful completion of skill, resulting in superior performance. It is suggested, therefore, that the sufficient extension angle of hip joint and faster angular velocity of knee and hip joints are significantly important factor in successful performance of Back Pike somersault and that it needs to develop training methods to improve these abilities of lower level players for their performance-enhancing.

**CONCLUSION:** The differences in Back Pike somersault according to skill level were found in angle of hip joint and angular velocity in knee and hip joints. It is recommended, therefore, for the improvement of performance of diving players, that the stretching exercise to maintain extension position of hip joint at take-off and muscle strength training to enhance extension velocity of knee and hip joints are needed.

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