

AN INVESTIGATION OF SOCCER BALL VELOCITY ON INSTEP KICK WITH AND WITHOUT ARM SWAYING

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INTRODUCTION: Many biomechanical researches of soccer try to understand the kinematic and kinetic effects of kicking; the most widely concerned is maximal force instep kick (powerful instep kick). Kellis and Katis (2008) reported that the ball velocity in instep kick on related researches were surpass in 72 Km/h (20m/s), and the highest was 115.6 Km/h (32.1 m/s). The higher ball speed, the lower time a keeper react. The kicking skills are complicated, and multiple factors must be measured. Not only lower limbs involve on kicking task, but also upper body affects the kicking performance. Kicking with arm swaying is a common motion in goal kick, directly free kick, penalty kick, and instep kick. The arm (non-kicking side) begins to sway when a player run-up to kick a ball at the last step and it may provide more strength to kick a ball. Arm swaying motion also applies in other sports. It advances the jumping performances in standing long jump due to maintaining balance and increasing the velocity of the body's center of gravity (Ashby & Heegaard, 2002). The muscle pre-lengthening and stretch by arm swaying increased the strength of kicking; skilled soccer players had significantly larger knee flexion-extension movement (Shan and Westerhoff, 2005). The range of motion (ROM) of knee and the foot segment velocity are the important parameter for understanding the skill of players. The distance between right ankle and left ankle (while the support-foot landing) was measure to understand the hip and body stretch, and this distance affect the time of acting force for kicking the ball. To improve the ball velocity on kicking, the purpose of this study was to compare the ball velocity and kinematic data on different motions of arm. The motions were arm swaying and arm fixed (without arm swaying) while kicking the ball. The results were a useful reference for soccer players and instructors.

METHOD: An elite football player serviced in national team (age: 25 years-old, height: 175 cm, weight: 80 Kg, right foot dominant), without lower extremity injuries within six month volunteered to participate in this study. A motion capture system with 10 cameras (sampling at 250Hz, VICON MX13⁺, Oxford Metrics Ltd, England) was used to collect kicking data. A radar gun (sampling at 300 Hz, STALKER Ltd, USA) was used to measure the peak ball velocity (FIFA approved Adidas soccer ball, model: final8, size: 5, Pressure: 0.6 bar). The force plate (sampling at 1000Hz, model: 9187, KISTLER, Switzerland) was used to define the landing time of support-foot during instep kick. The kicking tasks were arm swaying and arm fixed on instep kick. A self-selected approach angle (30 degree) and step (2 steps) by participant were used for the test trial, and following trial were succeed the same angle and step, which would allow a maximal instep kick. The participant was asked to sway the left arm (non-kick side) over 90 degree (shoulder extension) and arm fixed (kicking with arms akimbo) to kick the ball 10 times separately with instep kick (as fast as possible) into the target net (width: 1m and height: 0.8 m, the distance from ball to target net was 1.5 m), then the data were collected. All subjects were tested using a full-body plug-in-gait marker set. The Visual3D V4.0 software (C-motion Inc, USA) was used to calculate the foot velocity, the range of motion (ROM) of knee, ROM of shoulder, and the distance between right ankle and left ankle (while the support-foot landing). The descriptive analysis was used to analyze kinematic data.

RESULTS: The data of ball and foot velocity and the ROM of knee and shoulder are shown in Table 1. The distance between right ankle and left ankle was 98.1±2.1cm (arm swaying) and 93.8±2.7cm (arm fixed). The instep kicks with arm swaying had the higher ball velocity, foot velocity, knee movement, and right and left ankles distance then arm fixed. The range of ball velocity on arm swaying was 94~100 Km/h, and arm fixed was 90~95 Km/h.

Table 1. The ball and foot velocity and ROM of knee and shoulder

	Ball velocity (Km/h)	Foot velocity (m/s)	ROM of knee (degree)	ROM of shoulder (degree)
Arm swaying	96.87±2.03	13.60±1.07	92.80±6.43	177.90±1.77
Arm fixed	93.00±1.41	13.07±0.61	86.40±3.65	27.25±1.74

DISCUSSION: In this study, there had two reasons for causing the higher ball speed in instep kick with arm swaying. The first was the arm swaying provides more range of motion on hip and knee joint, thus the ROM of knee and kicking distance were greater than that without swaying in instep kick. The second was instep kick with arm swaying produced more strength or strength translation to the ball due to muscle pre-lengthening or the greater balance controlled on body. Thus, the kicking leg had the better position to kick the ball. Finally, the results could reliably be used to evaluate a player's kicking ability (Shan and Westerhoff, 2005).

CONCLUSION: Base on this study, the arm swaying advanced the effective instep kick. The instep kicks with arm swaying caused the higher ball velocity and body stretch. This investigation may provide a useful reference to coaches or teachers for approach optimal instep kick. Future studies could describe the functions of arm swaying during instep kick on motor control perspective.

REFERENCES:

- Ashby, B. M. & Heegaard, J. H. (2002). Role of arm motion in the standing long jump. *Journal of Biomechanics*, 35, 1631–1637.
- Kellis. E. & Katis. A. (2008). Biomechanical characteristics and determinants of instep soccer kick. *Journal of Sports Science and Medicine*, 6, 154-165.
- Shan, G. & Westerhoff, P. (2005). Full-body kinematic characteristics of the maximal instep soccer kick by male soccer players and parameters related to kick quality. *Sport biomechanics*, 4 (1), 59-72.