

### 3D KINEMATIC ANALYSIS OF THE KUDA AND SILA SERVICE TECHNIQUE

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The aim of this study was to identify differences in kicking kinematics between the kuda and service technique. Nine highly skilled male sepak-takraw players performed both kuda and sila serves. All trials were captured using seven Qualisys ProReflex MCU 1000 cameras operating at 240 Hz. The best kuda and sila serve (highest ball velocity, net clearance and ball placement accuracy) was selected and analyzed for final analysis. Comparisons of selected kinematic variables were made between the two techniques at ball-contact using the paired Student *t*-test ( $p < 0.05$ ). 3-D analysis revealed differences in kicking patterns between the two serves from start of force-production to follow-through. No differences were observed for thigh, shank and foot angular velocities at ball-contact between the two techniques. However, significantly larger kuda hip flexion and abduction range of motion at ball-contact suggests possibly that technique is the major contributor of high velocity kuda serves in sepak-takraw. The implication to sepak-takraw coaches is to improve the player's hip joint mobility and to work on the technique of a single segment leg action.

**KEY WORDS:** sepak-takraw, kicking pattern, coaching, skill acquisition, hybrid sport.

**INTRODUCTION:** Sepak-takraw is a highly complex net-barrier kicking sport that involves dazzling displays of quick reflexes, acrobatic twists, turns and swerves of the agile human body. The kuda and sila technique are the two main service techniques used in sepak-takraw. Since the serve in sepak-takraw is the only time a player has complete control of ball speed, direction and placement, coaches and players have generally acknowledged and accepted the efficacy and superiority of kuda over the sila technique in producing high velocity serves. This is evident in the influential role high velocity serve plays in other net-barrier games, e.g. the power serve in tennis (Fleisig, Nicholls, Elliott and Escamilla, 2003) and volleyball (Katsikadelli, 1998). Research on the kuda and sila service technique in sepak-takraw, however, is totally unrepresented. This limits coaches and players understanding of the kuda and sila kicking mechanics and results in a non-systematic and ineffective coaching method based on personal observations and past playing experiences. In view of these concerns surrounding the efficacy and superiority of the kuda over sila technique, the purpose of this study was to identify technique differences between the kuda and sila serve.

**METHOD:** Nine highly skilled elite male sepak-takraw players, with at least three years of competitive playing experience, performed 20 kuda and sila service trials respectively. Each trial was assessed by a certified International Sepaktakraw Federation (ISTAF) coach and only the best kuda and sila trial (highest ball velocity, net clearance and ball placement accuracy) were selected for final analysis. Research was conducted indoors within a controlled environment on a standard official sepak-takraw court fitted with standard netting in the physical education and sports science biomechanics laboratory of the National Institute of Education of Singapore. Seven infra-red high-speed cameras (Qualisys ProReflex MCU 1000, Qualisys Medical AB, Gothenburg, Sweden) operating at 240 Hz were strategically positioned around the court to ensure a convergence field of view between any two cameras and providing a 360 degrees area of foci on the serving circle. Dynamic and static calibration of 3-D space were conducted using standard the Qualisys (749.5) 'L' and 'T' calibration frame. Qualisys Track Manager (QTM) and Visual 3-D (V3D) motion analysis software were used to digitize and analyze the kuda and sila service technique based on Cartesian coordinate system. A direct linear transformation (DLT) method established by Abdel- Aziz and Karara (1971) was used to generate the 3-D spatial coordinates and to ensure accuracy of the reconstructed 3-D coordinates. All selected kinematic variables were smoothed using Butterworth digital low-pass filter at a cut-off frequency of 7Hz (Winter, 1990). Anatomical landmarks (Maslan, 1997) selected for placements of 3M reflective ball markers were; the

temple, protruding point of mandible, acromion process of scapula, epicondyle of humerus, wrist, iliac crest of pelvis, greater trochanter of iliac crest, epicondyle of femur, malleolus, and the 5<sup>th</sup> metatarsal of foot. Markers were placed on lateral and medial aspect of each landmark to demarcate a 15 segment full-body model comprising the: (a) head; (b) trunk; (c) pelvic; (d) upper arm (e) lower arm; (f) hand; (g) thigh; (h) shank; and (i) foot. Hip angle was defined as right thigh with reference to the pelvic and knee angle was defined as right shank with reference to right thigh. Comparisons of selected kinematic variables were made between the two techniques at point of ball contact using two-way paired Student *t*-test. The criterion for statistical significance was  $P < 0.05$  for all analyses.

**RESULTS AND DISCUSSIONS:** Results showed that the kuda and sila service technique consisted of preliminary, corking, ball-contact, follow-through and recovery phase (Figure 1). Through out the entire serving movement, the stance leg acted as a rotating pivot to accommodate external and internal rotation of the upper body as well as the movement of kicking leg. Differences in the kicking pattern between the two techniques were observed from start of force-production to follow-through. Looking at Table 1, hip flexion and hip abduction were significantly different between the two techniques at ball-contact. Three-dimensional analysis further revealed that the kicking leg of the kuda technique followed a 'from behind over-head' path whereas the kicking leg of the sila technique followed a 'forward side-volley' kicking path from the start of force-production to recovery (Figure 1). The placement of ball at point of ball-contact could also account for the significant difference in hip flexion and abduction at ball-contact (Table 1). The point of ball-contact for kuda technique was almost vertically above the head where foot-to-ball contact occurs on the superior metatarsal of the kicking foot. However, the point of ball-contact for sila technique occurs slightly in-front-of the body and diagonally above the head where the foot-to-ball contact occurs on the inside foot between 1<sup>st</sup> metatarsal.

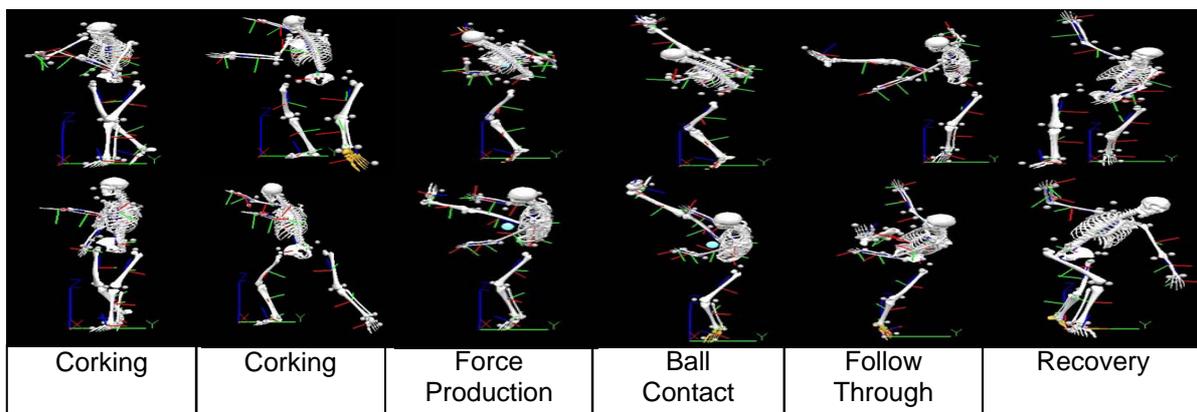


Figure 1: Motion sequence of kuda (top) and sila (bottom) serve observed from Y-Z plane based on Cartesian coordinate system (orthogonal planes)

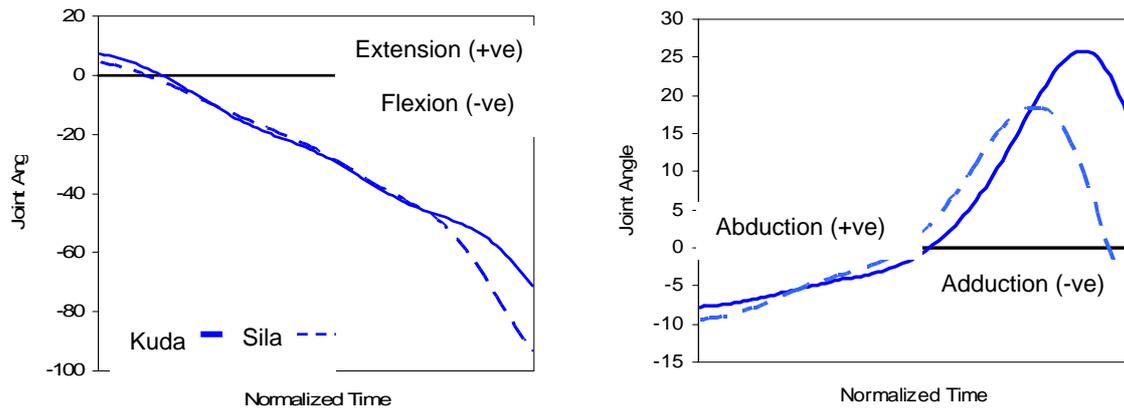


Figure 2: Mean hip flexion-extension (left) and abduction-adduction (right) between kuda and sila technique from start of force-production to ball-contact

No significant difference however were observed for the thigh, shank and foot angular velocity respectively between the two techniques at ball-contact despite the kuda technique producing slightly higher thigh, shank and foot angular velocity at ball-contact (Table 1). Looking at Figure 2, the hip joint range of motion between the two techniques is similar for much of the force-production phase. However due to placement of ball at point of ball-contact, differences in hip joint range of motion were observed between the two techniques coming into ball-contact during which the kicking leg swing as one rigid body segment. Significantly larger kuda hip flexion and abduction at ball-contact resulted in an increased rotary upward motion of the kuda kicking path where maximum extension of the knee generates a larger force over a longer distance, and hence, increasing the momentum of the kicking leg for kuda technique at force production phase. These differences in lower limb movement characteristics could account for the significant difference in ball velocity between the two techniques (Table 1).

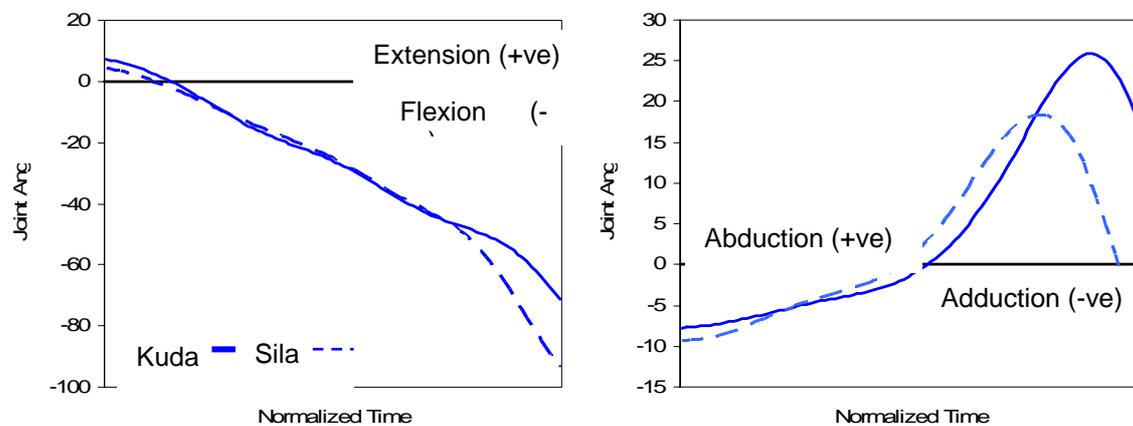


Figure 3: Mean hip flexion-extension (left) and abduction-adduction (right) between kuda and sila technique from start of force-production to ball-contact

Table 1 Mean (SD) Comparison of Selected Kinematic Variables between Kuda and Sila Technique ( $p < 0.05$ )\*

	Kuda	Sila	Sig. (2-tailed)
Ball velocity immediately after foot-contact	22.8 ± 2.4	17.6 ± 1.9	.001*
Thigh angular velocity at ball-contact (rad.s <sup>-1</sup> )	14.76 ± 2.0	15.55 ± 2.4	.354
Shank angular velocity at ball-contact (rad.s <sup>-1</sup> )	17.76 ± 2.3	16.98 ± 2.1	.378
Foot angular velocity at ball-contact (rad.s <sup>-1</sup> )	18.91 ± 2.2	17.71 ± 2.1	.271
Hip Flexion at ball contact (deg.)	-71.46 ± 12.2	-93.62 ± 8.1	.000*
Hip Abduction at ball contact (deg.)	17.19 ± 15.5	-7.15 ± 15.8	.000*

**CONCLUSION:** Understanding highly complex skills in its relevant phases prevents one from being too overwhelmed with information (Bartlett, 1999; Koh and Tan, 2005; Lees, 2002). Breaking the kuda and sila serve into phases highlighted differences in kicking patterns between the two techniques. Our data showed that angular velocity pattern between both techniques were comparable with no significant difference observed for the thigh, shank and foot angular velocities at ball-contact. A significantly larger kuda hip flexion and abduction range of motion at ball-contact however suggests possibly that technique could be the major contributor of high velocity kuda serves in sepak-takraw. The implication to coaches is to improve on player hip joint mobility and to work on the kicking technique of a single segment leg action. Increasing the hip joint range of motion as well as improving the kicking technique is important as the former converts forward and upward linear momentum into angular momentum and the latter accelerates the kicking segments into achieving maximal kicking foot prior to ball-contact. Holistically, this research forms the platform for future research pertaining to understanding sepak-takraw and data obtained will provide coaches with an objective measure of efficient movement patterns that would serve as a suitable yardstick for beginners as well as advanced sepak-takraw players. Further studies are required to look at the kinetics of the kicking leg to supplement our understanding on the kicking kinematics of the kuda and sila service technique.

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