# BIOMECHANICAL ANALYSIS OF KICKING METHOD IN VOLLEYBALL OFF-COURT FLOOR DEFENSE: A PILOT-STUDY

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In 1995. FIVB implemented ten amendments to the international volleyball rules. The most controvenial amendment was allowing athletes to use their feet in official games. The purpose of this pilot study was to investigate differences in using a kicking method and a traditional roll method in retrieving balls, which were flying away from the court. backward toward the court. The results revealed that there were significant differences in vertical and horizontal displacement of the CG and in execution time. Shorter execution duration and less displacement of the CG in the kicking method might make this more efficient than the traditional skill. Although the average horizontal velocity in the execution phase seems to be similar in both skills, the player using a kicking method might be faster in reaching the ball since he may have more time in the approach phase.

KEYWORDS: floor-defence, kicking, motion analysis, rolling, volleyball

INTRODUCTION: In 1995, the Federation of International Volleyball Board (FIVB) implemented ten amendments to the international rules. The most controversial and criticised one was Rule 14.4.1 which claims that 'The ball may touch any part of the body'. The official interpretation of this new rule is that 'it is irrelevant whether the contact with a foot is accidental or intentional'. Players begin to dig the ball intentionally with their feet, especially those who were also skilled in soccer. There are two traditional skills that are commonly recruited by the volleyball players to dig off-court balls backward. They are the extension roll and dive. Both are complex motor skills and required the player to lean forward with head leading downward. The purpose of the present study was to compare the loci of centre of gravity (CG) in performing traditional skills and the newly permitted skill of kicking, in returning balls backward which are flying away from the court. In this transition period, analysis should be done prior to implementing this kicking skill into volleyball practices. However, there is no scientific research on this issue. The significance of this pilot study was to provide a biomechanical basis for further analysis and development in implementing kicking skills in volleyball defence.

METHODS: One experienced volleyball player (weight = 68kg, height = 178cm) with a background of successful kicking performances in official matches of the Hong Kong elite volleyball league was recruited for this pilot study. The skill that was analysed was confined to retrieving balls that were flying away from the court. For the sake of analysis, motion was divided into three phases: approach phase, execution phase and recovery phase. The approach phase was defined as the player approaches the off-court ball before lowering his CG. The execution phase was defined as the motion starting when the player's CG begins to descend and ended at the moment of foot contact with the ball. The recovery phase was defined as the motion after hitting the ball until the follow-through ended. In this pilot study, the movement of the centre of gravity of the player in performing kicking skills and extensional rolls were compared. The analysis was confined to the execution phase.
The subject was asked to perform his preferred kicking skill to retrieve the balls back to the court with an approximate running distance of 3 metres. The criteria of a successful trial were:

1. ball fed lower than pre-set height (2.5m),
2. ball contacted within the destined position,
3. ball returned either vertically or backward, and
4. ball returned higher than 3 meters.

These criteria were established to simulate a situation of digging a ball, which is flying away from the court (off-court). The most important aspect of the return is to project the ball high enough for subsequent passing over the net in the third-hit or for a back-court spike in the second-hit. Movement patterns were videotaped 2-dimensionally in the sagittal plane of the motion by a high-speed video camera (50Hz). Successful trials were then analyzed by the BAS motion analysis system (Germany). The following figures show the motion of used in a typical kick (Figure la) and extensional roll (Figure lb) in retrieving ball backward.

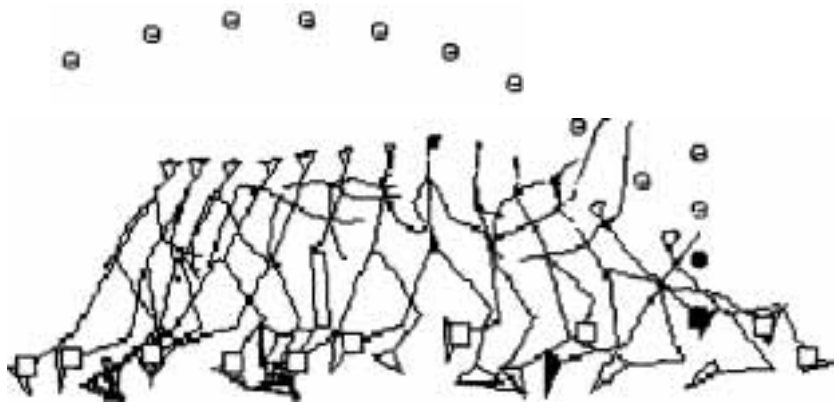

Figure 1 – Kicking method

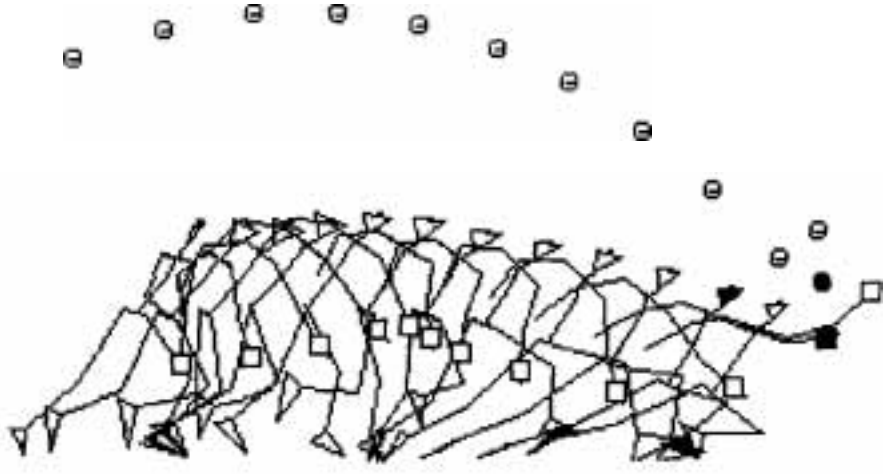

Figure 2 - Extensional roll

The squares in Figure 1 and Figure 2 represent the hitting foot and hand. The filled squares and circles represent the hitting limbs and the ball at the moment of contact with the ball.

RESULTS AND DISCUSSION: The result obtained from eight successful trials of traditional the ball-retrieving skill and the extension roll under the same criteria were compared. Before comparing the two skills, the consistency of the balls fed to the player was validated by checking the location of the balls at the point of contact. The vertical location of the ball at the point of contact failed to show significant differences in the two sets of balls fed to the subject. This implied that the balls in the two sets of trials were fed consistently.
The mean horizontal distance (X) that the CG of player travelled during the execution phase in the kick and in the roll were 1.215 (SD = ,094) and 1.978 (SD = .093), respectively, and are shown in the Table 1.

Table 1 Comparison of Distance (X) Travelled by the CG of the Player in the Execution Phase

| Skill | X(m) | Significant difference |
|---|---|---|
| Kick | 1.215 (SD = .094) | p<.001 |
| Extensional roll | 1.978 (SD = .093) | |

In the execution phase, the horizontal distance that the CG travelled in performing the kicking skill was found to be significantly less than that in performing roll. This implied that the player could execute the ball-retrieving skill nearer to the ball in kicking than in rolling. Moreover, the vertical displacement of CG in kicking was found almost three times less than that in rolling ($p<.001$) in the execution phase. The significantly smaller vertical displacement of the CG in the kicking in the execution phase may imply that using this skill was comparatively more efficient than the traditional roll in returning the ball backward. This might be due to the fact that the hitting foot was nearer to the ground in kicking than the hand in the extension roll.
The mean duration (ms) of the execution phase in kick and in the roll were 0.32 (SD = .0185) and 0.52 (SD = .0262), respectively. The significantly shorter duration of execution in performing the kicking skill implies that the player may spend more time in the approach phase when compared to the same situation using the traditional roll. This implies that the player may either reach farther or have more time in locating the ball to increase accuracy.

Table 2 Comparison of the Duration in the Execution Phase

| Skill | Time (s) | Significant difference |
|---|---|---|
| Kicking | 0.32 (SD = .1085) | p<.001 |
| Extensional roll | 0.52 (SD = .0262) | |

CONCLUSION: In short, the kicking method was found to be faster in executing the return technique, requiring less displacement of CG of the body to have the same effect on retrieving balls from the back court or out of the court under the same initial conditions. Furthermore, the deceleration of CG in the kicking method was found to be steadier than that of extensional roll, implying a more efficient movement in the kicking return. Although the extensional role or diving may be more precise in hitting the ball, kicking is more efficient in re-directing the ball and projecting the ball high enough for subsequent passing over the net in the third-hit and for a back-court spike in the second-hit. The reason for the single subject design in this pilot study was that the kicking skills of different players were not consistent. Further discussion and research should be done to validate the findings of this pilot study and to explore additional implications of the kicking method of return in comparison to the extensional role. The higher position of the body in the kick return and the increased range in playing balls are merits of kicking method. Further investigation on training methods and sport shoes design are needed to more fully understand the implications of the inclusion of the kicking method in volleyball defence.

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