



Biomechanical Study of Pencak Silat Athletes' Sickle Kicks in Terms of Initial Angle Variation

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Abstract

This study aims to analyze the biomechanics of pencak silat athletes' crescent kicks based on variations in waist rotation angle using the Kinovea application. The research subject was one athlete who performed crescent kicks with small and wide rotations. The results of the analysis showed that small rotations produced shorter execution times, higher kick speeds, and longer trajectories compared to wide rotations. Meanwhile, wide rotation slows down execution and reduces speed, although it has the potential to increase attack force through momentum accumulation. These findings confirm that variations in waist rotation angle affect the effectiveness of the crescent kick, with small rotation being more suitable for fast attacks and wide rotation being more beneficial in generating powerful attacks.

Keywords: *Pencak Silat, Crescent Kick, Biomechanics, Waist Rotation, Kinovea*

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INTRODUCTION

Pencak silat is a traditional Indonesian martial art that emphasizes not only art and culture, but also technical skills and the effectiveness of attacks. In the context of competition, kicking techniques play an important role because they are one of the main attacks that can score points and weaken opponents. One of the most commonly used types of kicks is the crescent kick, which is characterized by a curved trajectory, high speed, and flexibility in the direction of the attack. According to Suryadi (2019), the crescent kick is a dominant technique because it provides a combination of speed, power, and variety of attacks that are difficult for opponents to anticipate.

From a biomechanical perspective, the roundhouse kick is a complex movement that involves coordination between the leg muscles, hips, and upper body. Hip rotation is one of the

main determinants of kick effectiveness, as hip rotation plays a role in generating torque, momentum, and leg swing speed. Hall (2014) emphasizes that an athlete's movement performance is influenced by the interaction between internal forces, such as muscle contraction, and external forces, such as gravity and floor reaction. This is supported by Knudson (2007), who explains that an increase in the angle of rotation of a body segment can increase the rotational force (torque), which then affects the acceleration of the movement. Thus, variations in hip rotation during the execution of a roundhouse kick have the potential to produce differences in speed, power, and trajectory of the kick.

Greater hip rotation is expected to generate stronger torque, resulting in more powerful kicks, although this may require a longer execution time. Conversely, smaller hip rotation allows for faster kicks, but with relatively lower thrust. This phenomenon is in line with the biomechanical principle of trade-off between strength and speed of movement. McGinnis (2013) mentions that in sports movements, an increase in strength through a wider angle of movement is often inversely proportional to the speed of execution, so athletes need to adjust their strategy according to the situation of the game.

Advances in motion analysis technology enable more accurate measurement of biomechanical aspects. The Kinovea application, for example, can be used to analyze hip rotation angles, speed, and kicking trajectories. Through this analysis, the biomechanical differences between crescent kicks and variations in waist rotation can be understood in greater depth. Therefore, this study focuses on the biomechanics of crescent kicks in pencak silat athletes by examining variations in waist rotation in an effort to provide a scientific basis for improving the effectiveness of training and athlete performance.

METHOD

This study uses a quantitative descriptive approach with a single case study design. The research subject is a pencak silat athlete who was selected purposively because he was considered to have mastered the sickle kick technique well and actively practiced regularly. The focus of the study is to analyze the sickle kick with two variations of waist rotation angles, namely small rotation and large rotation.

The instruments used in this study included a high-speed video camera to record movements from the side and front, as well as Kinovea software to analyze the angle of waist rotation, kicking speed, and foot movement trajectory. In addition, the execution time of the kick was recorded to compare the difference in speed between the two rotation variations.

The research procedure began with explaining the purpose and stages of the research to the subjects, followed by standard warm-up exercises. Subjects were asked to execute five scissor kicks with a small hip rotation and five with a large hip rotation. All trials were recorded using a camera placed parallel to the plane of motion. The recordings were then analyzed using the Kinovea application to determine the magnitude of hip rotation, kick speed, and foot trajectory patterns.

The collected data were analyzed descriptively by comparing the results of the two variations of hip rotation. Quantitative analysis was used to process numerical data such as rotation angle and speed, while qualitative analysis was performed to describe the phases of the crescent kick. The results of this study are expected to provide an understanding of the effect of the magnitude of waist rotation on the effectiveness of the crescent kick in pencak silat.

RESULTS AND DISCUSSION

Results

Analysis using the Kinovea application shows a difference between hook kicks with a small waist rotation and a wide waist rotation. Kicks with a small rotation result in a shorter execution time and higher speed compared to a wide rotation. Interestingly, the trajectory of the foot in a small rotation is actually longer, while a wide rotation tends to result in a shorter trajectory.

Table 1. Analysis Using the Kinovea Application

Variable	Small Rotation	Wide Rotation
Execution Time (seconds)	0.90	1.07
Kick Speed (m/s)	4.2	2.85
Trajectory Length (m)	1.08	81
Waist Rotation	44.3	72.6



Figure 1. Small Rotation

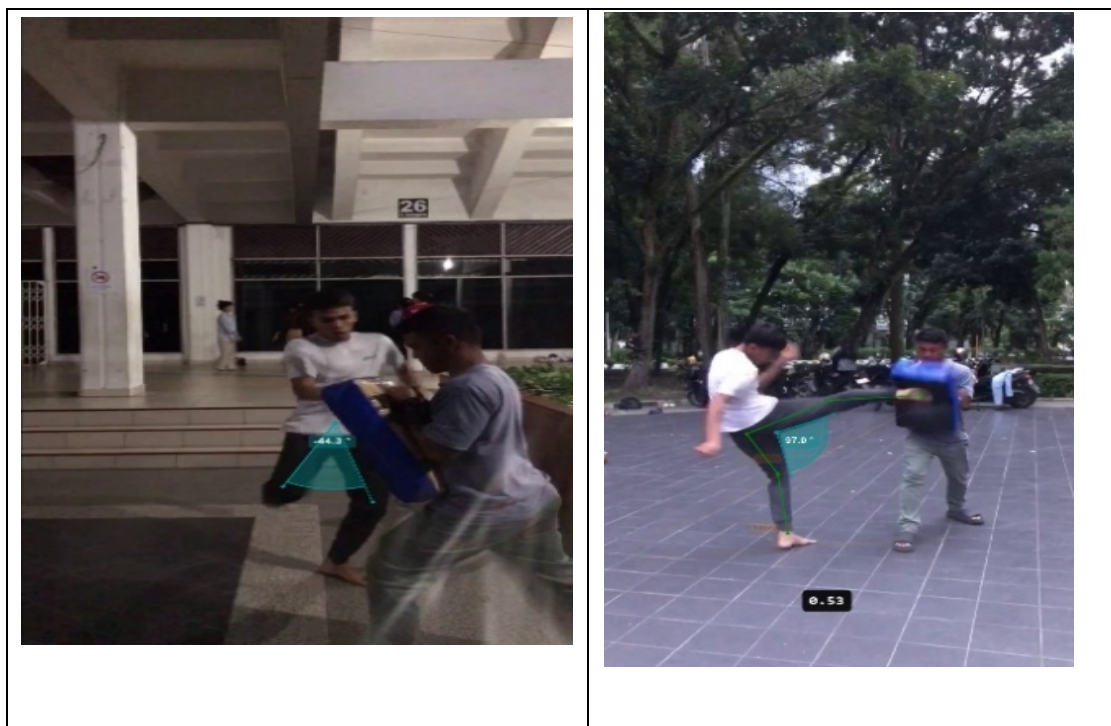


Figure 2. Width Rotation

Discussion

This difference can be explained by the principles of rotational biomechanics. A small hip rotation shortens the preparation phase, allowing energy to be transferred to the leg segment more quickly. This makes the kick shorter and results in higher speed. The longer trajectory in

a small rotation occurs because the arc of the leg movement is longer, even though the execution time is shorter.

Conversely, a wide hip rotation increases the angle of pelvic rotation. This condition allows for greater angular momentum accumulation, potentially resulting in stronger torque and power. However, this process takes longer, reducing execution speed. This phenomenon is consistent with the concept of trade-off in biomechanics, where increased strength often reduces movement speed (Hall, 2014; Knudson, 2007).

These findings have practical implications for pencak silat training. Small rotations can be used in situations that require quick attacks to surprise opponents, while wide rotations are more effective when attacks emphasizing power are needed. Therefore, mastery of both rotation variations is important so that athletes can adjust their strategies according to the context of the match.

CONCLUSION

Based on the results of biomechanical analysis using the Kinovea application, variations in the angle of hip rotation have a significant effect on the characteristics of a roundhouse kick. Kicks with a small hip rotation were found to result in faster execution times, higher kick speeds, and longer trajectories. Conversely, a wide hip rotation tends to slow down execution and reduce speed, although it has the potential to increase thrust through momentum accumulation. These findings indicate that the choice of hip rotation angle should be adjusted according to the tactical objectives of the match. Small rotations are more effective for quick attacks and surprising opponents, while wide rotations are more relevant for generating powerful attacks. Thus, mastery of both hip rotation variations is important in efforts to improve the effectiveness of crescent kicks in pencak silat athletes.

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