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Motion analysis of sickle kick techniques in pencak silat PPLP DIY athletes: A biomechanical analysis

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Abstract

This study is intended to determine the performance and the motion errors of the sickle kick technique. The population and samples were 5 PPLP DIY martial arts (pencak silat) athletes. This research was a descriptive study. The instrument used a sickle kick on a kickstand. To analyze the data, researchers utilized Kinovea Software. The results showed that the performance of the sickle kick technique at the attitude stage, the flexion of the back leg tends to be smaller than the leg in front so that the sickle kick is less effective and efficient, while at the point of contact stage, the head position tends to bow, the eyes are fixed on the kickstand, the position of the togek tends to hunch over not maintained in an upright position. Thus, the performance of pencak silat athletes' sickle kicks at the posture and point of contact stages is not effective and efficient.

Keywords: Biomechanics, sickle kick, pencak silat

1. Introduction

Pencak silat is a traditional martial art sport which is the original culture of the Indonesian people ^[1]. The development of pencak silat sport in Indonesia has increased rapidly. As an indication, many championships are held in single events and multi-events and many new pencak silat schools have emerged in the regions. The increase in the number of people and pencak silat championships does not guarantee good achievements. For this reason, the introduction stage needs to be balanced with a good and correct coaching pattern, so that it will make it easier to attract talented athletes.

The basic principle of pencak silat competition is to get points by attacking and defending. In other words, it takes a lot of points that may enter the target field and are not blocked by the opponent's parry. To be able to carry out these attacks and defenses, mastery of good and correct movement skills of basic pencak silat techniques is very necessary. Basic techniques in pencak silat include: (1) stance; (2) posture; (3) step pattern; (4) defense techniques (blocking and avoidance); (5) attack techniques (punches, elbows and kicks); (6) slam/fall techniques ^[2]. These basic techniques that can be used to get points are punching techniques, kicking techniques, falling or slamming techniques. Of the three basic techniques that can be used to obtain points above approximately the results of the study showed that 57% of the fight consisted of kicks and punches where the kicking action was carried out 101 times while the punching action was carried out 34 times ^[3].

There are many types of kicking techniques, including front, sickle, and back kicks. Of these three techniques, it is the sickle technique that is widely used by fighters. The sickle kick technique has advantages, namely: the direction of the trajectory occurs from the outer side towards the inner top direction so that it has maximum speed and has a high level of balance. The sickle kick is a kick with the targeting tool of the back of the foot with a trajectory from the outside to what is shaped like a sickle. If there is also a kick using the instep but the trajectory is not the same then, the kick is considered wrong because the sickle kick itself only has two elements that characterize the kick itself, namely the targeting tool of the back of the foot and its sickle-shaped trajectory from outside to inside ^[4].

Motion efficiency and maximum power are obtained from coordination between the upper limbs and lower limbs which are whipped, starting from the rotation of the fulcrum followed by the rotation of the hips. To be able to perform the sickle kick technique, good biomotor components are needed. The biomotor components needed in pencak silat matches are endurance, strength, speed, coordination, and flexibility [5]. Thus, a good physical condition component is required to become pencak silat athletes and use the sickle kick technique effectively and efficiently. According to [6], the correct technique from the start will not only save energy to move so that it can move longer and succeed well but also is the basic foundation for higher achievement. For this reason, in learning techniques, especially the sickle kick technique, the emphasis must be on the correct technical movements, so as to produce mastery of the correct technical movements.

In the process of forming these techniques, it does not only rely on cursory observations but requires support from science and technology. This is because the movements in pencak silat, especially sickle kicks, are very explosive, so it is not clearly visible errors when performing sickle kick techniques if not supported by technology. Motion analysis not only helps in identifying technical problems, but also in designing effective solutions to improve athletes' technical movements and optimize their overall performance. In the field of sports, whose goal is the achievement of the highest possible achievement, it is absolutely necessary to apply science and technology what they need is actually nothing but knowledge about how to analyse skill movements [7]. Sciences that can support the process of forming techniques include motion analysis through kinesiology and biomechanics approaches. Biomechanics is the study of internal and external forces and work on the human body and the consequences of the forces produced. Biomechanics is the science of the mechanics of muscle activity and the study of its principles and

relationships, the application of the laws of mechanics to living structures, especially to the motion system of the human body, the study of the structure and function of biological systems using mechanical methods [8].

Based on the previous explanations and reviews, this research aims to (a) Analyse the motion of the sickle kick technique, then the results of the appropriate analysis are used as a contribution to the development of pencak silat, especially the efficiency of motion, and (b) Produce findings that can hinder the efficiency of the sickle kick technique. For this reason, pencak silat coaches are expected to be able to analyse technical movements from a biomechanical point of view, so that they can provide information on correct techniques and provide therapy for technical movements that are not correct to their trainees. Currently, not many coaches have analysed these techniques, due to the limitations of tools that support analysis, such as: biomechanical analysis applications and motion recording devices.

2. Materials and Methods

The research was exploratory descriptive research conducted at Mandala Krida Hall. The research subjects were 5 PPLP Yogyakarta members of pencak silat athletes. In this study, the instrument used was kicking with the sickle kick technique. This test aimed to find out the sickle kick technique displayed by PPLP DIY martial arts athletes. Each athlete kicks the sickle towards the target, starting with a posture or posture ready to kick. The tools used are Handycamp, Treepod, and heavy bag. Each sickle kick technique consists of several stages, namely: the first stage when doing the attitude, the second stage when doing the movement, the third stage when following through. In order to provide an overview of the stages when performing the sickle kick analysed in this study, the instrument grid is presented as follows:

Table 1: Grid of analysis sheet

Stages	Analyse items
Ready stances	<p>The placement of the fulcrum foot at the time of the sickle kick is not in a straight line, the leg that is behind tends to open slightly.</p> <p>The distance between the front and back of the fulcrum is adjusted to the target and limb length.</p> <p>The front and back knee flexion angles must be greater than the back flexion angle.</p> <p>The togok position must be upright.</p> <p>The arm position is in the middle of the front of the chest and slightly bent</p> <p>The head position is slightly lowered adjusted to the view of the target height.</p>
While performing	<p>The movement of the performing leg has the knee as the pivot of the lower leg.</p> <p>The movement or rotation of the hips is in the same direction as the movement of the limbs.</p> <p>The position of the head must not bow or look towards the target.</p> <p>The togok position is maintained in an upright position.</p> <p>The trajectory of the kick must be from the bottom side.</p> <p>Point of contact is made using the instep.</p> <p>The center of gravity is positioned at the point of contact.</p>
Follow through	The position of the fulcrum foot is placed in front.

Collecting data for this study was by recording the movements of the sickle kick technique performed by all PPLP Yogyakarta pencak silat athletes. Taking photos was done from various directions, namely the right, left, and back sides. Researchers also took pictures accompanied by experts so that valid data could be produced in the observation. Then, for data analysis purposes, the researcher was assisted by experts and the data was analyzed using the Kinovea software analysis system. The handy camp used to take pictures was connected to a laptop that had Kinovea software installed. The Kinovea program offers a complete range of video analysis equipment including simulcam and stromotion which makes

the stages of movement can be seen clearly and in detail, especially the sickle kick technique. Furthermore, the data that has been entered in the observer is useful for knowing and providing angles and possible errors that will hinder the effectiveness of the sickle kick technique.

3. Results & Discussion

To be able to analyze the sickle kick technique, the test used was to perform the sickle kick technique using a punching bag target, so that the appearance of the sickle kick technique would be known. The results of the data collection of the five athletes are as follows:

Table 2: Testimonial anthropometry measurement results

No	Name	Sex	Height	Weight	Limb Length		
					Upper	Lower	Overall
1	Hr	L	166	60	41.5	43.0	84.5
2	Ag	L	174	65.5	45.2	44.1	89.8
3	By	L	178	67	45.0	44.5	89.5
4	An	L	164	63	41.4	42.3	83.7
5	Er	P	167	56	42.2	43.4	85.6

Table 3: Measurement results of knee flexion angle and distance between attack legs in the setup stance

No	Name	Sex	Knee Flexion Angles		Distance Between Attack Legs
			Front	Back	
1	Hr	L	128.6°	146.6°	0.76
2	Ag	L	127.8°	125.8°	0.72
3	By	L	119.3°	119.2°	0.92
4	An	L	129.7°	123.1°	0.74
5	Er	P	137.4°	150.5°	0.72

3.1 Ready Stance Stage of the Scythe Kick Technique

The ready stances in pencak silat matches is carried out in accordance with the technique to be used. To perform the crescent kick technique, ideally use the attitude of one pair, which is the attitude of the pairs carried out with the fulcrum foot in front not in a straight line with the fulcrum foot behind and tends to open slightly. To gain speed, the body weight should be on the front fulcrum, the knee is not bent too low. Knees that are bent too low will result in the condition of the athlete's posture in a stable balance, so that to perform this movement becomes increasingly heavy. This results in the movement of the sickle kick tending to be slower. At the attitude stage there are several things that influence.

3.2 Front knee flexion angle

Based on the analysis shown to the five participants, the smallest front knee flexion angle of 119.3° was displayed by the third participant and the largest angle of 137.4° was displayed by the fifth participant, while the flexion angles of the first, second, and fourth participants were 128.6°, 127.8°, 129.7° respectively. The smallest flexion angle is because the third participant has a wide distance between the front and rear fulcrum of 0.92 m, so that the knee will be bent shorter and the fulcrum in a stable balanced position. The wider the pedestal area, the greater the stability^[9]. This results in the movement of the kick will be slower. The fifth participant has a distance between the front and rear fulcrum legs tends to be shorter, namely 0.72 m, so that the knees are not bent too low. This is in the balance of fifth participant tends to be more unstable than third participant, so that the speed of the kick produced by fifth participant is faster.

3.3 Back knee flexion angle

The appearance of the five participants has different rear knee flexion angles. Of the five participants, there were two participants who had relatively large angles, namely the first and fifth participants, 146.6° and 150.5° respectively. The speed produced by the first and fifth participants was relatively faster than the other three testers. The angles produced by the second, third and fourth participants were relatively small. This resulted in the movement during the sickle kick tending to be slower. In the picture above, it affects the work of body segments in the sickle kick technique. The amount of back knee flexion angle shows the position of the body's weight point and the height of the tide attitude performed by the testers during the sickle kick. The smaller the knee flexion angle, the shorter the posture. A short

posture affects the body's weight point closer to the earth so that it will be heavier when moving. This results in movement when kicking relatively slower.

3.4 Point of contact stage in the sickle kick technique

Point of contact is the stage where the attack foot or the foot to kick touches the target field. The success of the sickle kick technique is determined at this stage. At the point of contact stage, ideally the position of the sights is focused on the target, the position of the togok is sideways and maintained in an upright state, and the balance is in a stable condition, so it is not easy to drop. Power generated at the point of contact is obtained from the movement of each body segment. The movement of the body segments begins with the rotation of the fulcrum outward then followed by the rotation of the hips and upper limbs rising and whipping the lower limbs towards the target. At the point of contact stage, there are several that affect the sickle kick, namely head position, arm position, togok, hip rotation and trajectory direction.

4. Conclusions

The performance of the sickle kick technique of PPLP DİY members at the ready stance stages, the angle of flexion of the attacking leg or the back leg tends to be lower than that of the front leg so that the sickle kick is less effective and efficient. Furthermore, the performance of the sickle kick technique of PPLP DİY members at the point of contact stage, the position of the head tends to bow and the gaze is fixed on the target, the position of the togok tends to be hunched not maintained in an upright position.

Based on the above conclusions, to be able to perform sickle kicks effectively and efficiently, at the posture stage the body weight point must be in front and the knee flexion angle of the attacking leg is greater than that of the leg in front, and the position of the togok is maintained in an upright position and the gaze is fixed on the target.

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