

# ANALYSIS OF ROLL SPIKE TECHNIQUES IN SEPAK TAKRAW PLAYERS REVIEWED BASED ON SPORT BIOMECHANICS

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**Abstract:** Roll spike is a common competitive offensive technique in sepak takraw. Of course, biomechanical analysis is required to achieve effective and efficient results. However, this has not received specific emphasis in the studies conducted. Aside from that, no biomechanical analysis of roll spikes has been conducted on the training ground. The aims of this research are as follows: (1) to examine the factors that influence the success of the roll spike technique, and (2) to determine the effectiveness and efficiency of the movement. The research used a quantitative survey with four male participants of sepak takraw players on the right flank position. The research instruments included a vertical jump, height and weight measurements, and an anthropometer. The data analysis technique was quantitative descriptive analysis, using the formula  $\omega = V_r / r$  and observations with Kinovea. The findings in this research revealed that body height, leg length, leg power, foot kick angle, and ball impact angle in the air all have an effect on the roll spike technique. The roll spike was executed effectively and efficiently, including the preparatory phase, jumping, foot contact with the ball in the air, and landing. It was determined that anthropometry, biomotor factors, and the proper stages in performing the roll spike technique all affected how it performed. This study has the potential to provide information and evaluation material for sepak takraw coaches looking to improve the performance of their athletes. Despite the limitation of relatively small samples, the application employed remains straightforward. Future studies should investigate larger samples and more advanced applications to acquire comprehensive results.

**Keywords:** Analysis, roll spike, Sepak takraw, sports biomechanics.

## INTRODUCTION

Nowadays, sepak takraw is growing very rapidly, as seen by its competition in international events (Aji & Yudhistira, 2023). Although sepak takraw is a team game, a team needs to have good fundamental techniques (Aji & Yudhistira, 2023). Basic techniques include kick-off, inside kicks, horse kick serve, toe kicks, outside kicks, thigh kicks, header, sunback spike, and roll spike (Yudanto et al., 2022). Naturally, once these basic techniques are mastered, they will serve as the team's main resource for combining games to win the match (Aji & Yudhistira, 2023).

Besides, sepak takraw has an acrobatic element, as evidenced by various techniques that require courage to execute technical maneuvers gracefully and attractively to get optimal results. Acrobatic movements, such as roll smashes, are characterized by somersaults in the air (Bais et al., 2023). Smashes in sepak takraw are classified into numerous types, including sunback spikes and roll spikes (Yudanto et al., 2022). In this instance, the roll spike smash is a very fascinating and beautiful smash method because it involves a high success rate of somersault movement that kills the opponent (Aji & Yudhistira, 2023). However, the roll spike is one of the more difficult smash techniques to master. Thus, performing the roll spike technique demands a great deal of confidence. In addition to courage, the rolling spike technique involves flexibility, precision, power, and effective and efficient movements. When it comes to effective and efficient movements, sports biomechanics is undoubtedly the domain.

Biomechanical analysis aids athletes and coaches by determining muscle strength and movements in specific techniques, allowing them to increase performance (Umar & Utama, 2018). Biomechanics is a mechanical concept that studies the anatomical movements of the body during sports (Candra et al., 2021; Umar & Utama, 2018; Yadav, 2016). Sports biomechanics analysis, similar to the rolling spike technique, is required to improve point scoring in sepak takraw matches.

Obviously, studies that discuss biomechanical analysis in sports performance already exist, such as studies from Hollander et al concerning the correlation of static and dynamic foot posture in running performance (Hollander et al., 2019), the effect of walking speed on healthy participants in terms of biomechanical aspects (Fukuchi et al.,

2019), the influence of strength training in terms of biomechanics and neuromuscular long-distance runners (Trowell et al., 2020), analysis of the ability to run a short distance of 100 meters (Rahadian, 2019), analysis of Klay Thompson's three-point shooting movement in a basketball match (Darumoyo, 2019), analysis football players passing in terms of biomechanics (Badawi et al., 2021), running analysis supported by sensors related to speed effects (Hollis et al., 2021), analysis of shooting accuracy at a distance of 6 meters in petanque athletes in terms of biomechanics (Mahardika et al., 2021), analysis of basic martial arts techniques in terms of biomechanics (Suryo Putro et al., 2023), analysis of service movements for sepak takraw in terms of biomechanics (Wulandari & Irsyada, 2019), service accuracy tests in sepak takraw games (Irawan et al., 2021), analysis of sepak takraw serves using a depth camera motion capture system (Kaharuddin et al., 2019), the effect of fixed and moving drill methods on ball reception results in sepak takraw (Mahardika et al., 2023).

Based on a review of several pieces of literature, they are still focusing on secondary data research, namely meta-analysis which focuses on athletic sports, such as looking at movement efficiency in running. Similar studies have also been carried out in basketball, football, and martial arts, especially in the aspects of basic hitting, serving, and shooting technique accuracy. Some research on sepak takraw only examined serving with samples collected from schools, rather than athletes who had completed programming at regional training centers. In other words, the analysis of rolling spike techniques with samples is limited to regional training athletes who received no special attention from the evaluated studies.

The authors performed field interviews and observations to help rationalize the problem. As academics, the authors believe that further examination of movements when conducting sepak takraw techniques is required. This is because sepak takraw athletes lack control over the power and angle at which they launch a rolling spike. Aside from that, it was discovered that trainers at regional training facilities were still inexperienced with biomechanical analysis and had never carried it out. In this regard, the authors sought to perform research on rolling spike analysis using the most recent information and to obtain useful data. The purpose of this study is to identify the factors that influence success in completing the roll spike technique for sepak takraw players, as well as to determine the effectiveness and efficiency of the roll spike movement.

## **MATERIAL & METHODS**

### ***Participants***

This study is a quantitative description using a field test survey approach (Akhiruyanto et al., 2022; Yudhistira & Tomoliyus, 2020). The purpose of this study is to analyze the rolling spike technique of sepak takraw players from a biomechanical perspective. The authors conducted quantitative tests and measurements with numerical findings, whereas qualitatively the author can interpret the data based on in-depth observations as detailed in the narrative. Participants in this study were sepak takraw athletes in the smasher position, specifically second place, four male participants aged 20-23 years with heights ranging from 157 to 173 centimeters. Participants were chosen through purposive sampling using the following criteria: (1) trained athletes from the Central Java region, and (2) male.

### ***Procedure/Test protocol/Skill test trial/Measure/Instruments***

The research procedures are as follows (1) the authors are aided by three research assistants in carrying out data gathering through videos, photos, and measurement tests. (2) The authors gathered data to be examined and analyzed, and (3) the authors presented it in narratives and figures as an interpretation of the findings. The reported results are descriptive regarding height and weight, leg power, leg length, and roll smash accuracy, followed by biomechanical analysis in the form of jump initiation, ball impact angle, and ball movement speed.

### ***Data collection and analysis / Statistical analysis***

Data collection techniques included observations and measurement tests using a Canon 1200D camera, Kinovea 0.8.1.5, vertical leap instruments, height and weight measurements, and an anthropometer (Wiriawan, 2017). The quantitative data analysis technique used was quantitative descriptive analysis, which used the formula  $\omega = V_r / r$ . This procedure was performed using the Kinovea 0.8.1.5 application. The next stage is reflective meaning, which takes the form of observations presented in narrative writing.

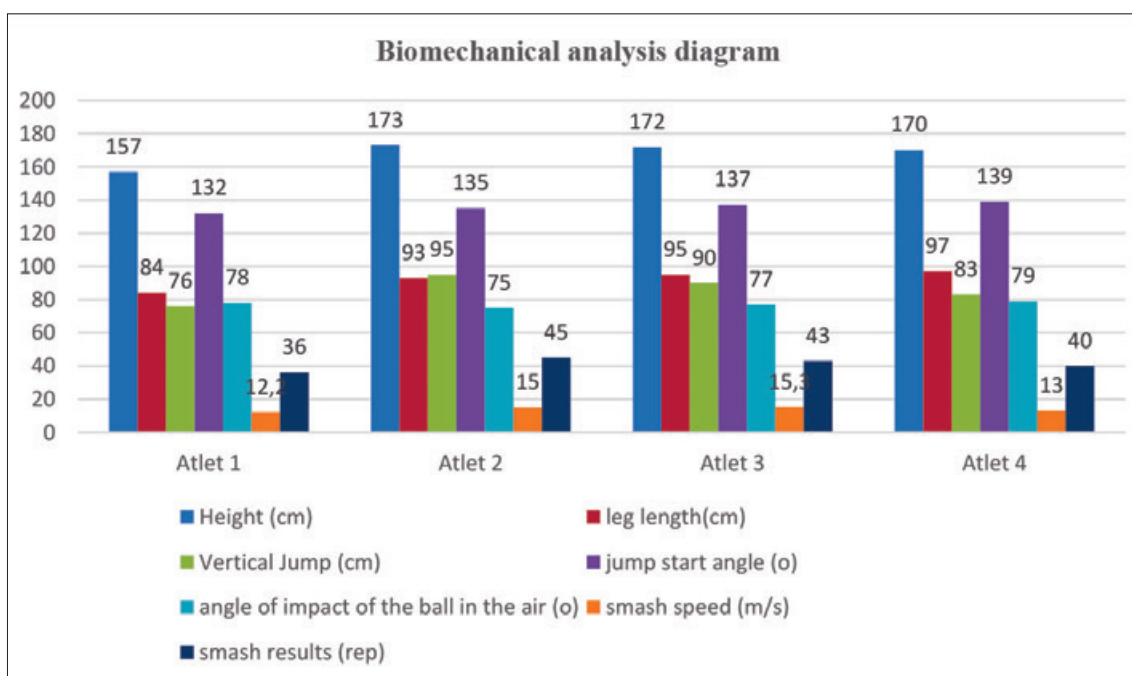
## RESULTS

The results section interprets descriptive data such as body height, leg length, vertical jump, initial jump angle, ball impact angle, and smash results. The findings of this study are shown in Table 1 below:

*Table 1. Results of quantitative descriptive analysis in terms of biomechanics*

| Number of Athletes | Height (cm) | Leg Length (cm) | Vertical jump | Jumpstart angle (degrees) | The angle of impact of the ball in the air (degrees) | Smash ball speed (m/s) | Roll spike | Category  |
|--------------------|-------------|-----------------|---------------|---------------------------|--|------------------------|------------|-----------|
| 1.                 | 157         | 84              | 76            | 132°                      | 78°  | 12.2 m/s               | 36         | Good      |
| 2.                 | 173         | 93              | 95            | 135°                      | 75°  | 15 m/s                 | 45         | Very good |
| 3.                 | 172         | 95              | 90            | 137°                      | 77°  | 15.3 m/s               | 43         | Very good |
| 4.                 | 170         | 97              | 83            | 139°                      | 79°  | 13 m/s                 | 40         | Good      |

The descriptive analysis yielded measurements and observations of four athletes, including body height (157-173 centimeters), leg length (84-97 centimeters), vertical jump (76-95 centimeters), initial jump angle (132-139 degrees), angle of impact of the ball in the air (75-79 degrees), ball smash speed (12.2-15.3 m/s), and rolled spike results (36-43 times). These findings are displayed graphically in Figure 1 as follows:



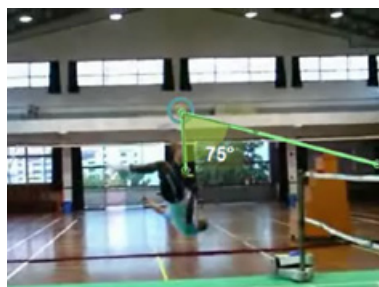
*Figure 1. Results of quantitative descriptive analysis in terms of biomechanics*



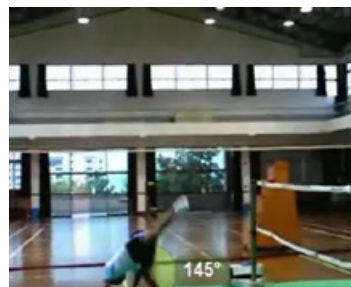
*Figure 2. Preparatory phase*



*Figure 3. Repulsion phase*



*Figure 4. Impact phase in air*



*Figure 5. Landing phase*

## DISCUSSION

The purpose of this study is to analyze the factors that influence the success of the roll smash technique, as well as determine the effectiveness and efficiency of movements used by sepak takraw players when performing the roll spike technique. According to the findings in Table 1, athletes with a height of 172-173 centimeters, a leg length of 93-95 centimeters, and a vertical jump of 90-95 centimeters can get higher roll spike results. The authors found that body height, leg length, and leg muscle power all influence the rolling spike findings.

The study found that an initial jump angle of  $135^{\circ}$  -  $137^{\circ}$  yields better roll spike results than  $132^{\circ}$ . In this situation, if the jump's beginning angle is too large or too tiny, it expends a lot of energy and becomes too heavy to push up. Aside from that, the results of the rolling spike are controlled by one factor: the initial angle of the jump. The results of the rolling spike are controlled by one factor: the starting angle of the jump, which impacts whether or not the leg's muscular power to jump upwards is optimal.

The research results revealed that the ball's angle of impact in the air is between  $75^{\circ}$  and  $77^{\circ}$ , resulting in a better rolling spike. This means that a smaller ball hit in the air will cause the smashed ball to dive into or strike the net, whereas a larger ball hit at a steeper angle will be flatter and may go out of court. Thus, analyzing the angle of impact in the air during a rolling smash is critical.

The results showed that the rolled spike with a higher speed of 15m/s-13m/s was more difficult for athlete 1 to accept with an average ball speed of 12.2 m/s and a rolled spike score of 36, athlete 2 with an average ball speed of 15 m/s and a roll spike score of 45, athlete 3 had an average ball speed of 15.3 m/s and a roll spike score of 43, while sample 4 had an average ball speed of 13 m/s with a roll spike score of 40. This data revealed that rolling spikes with speeds ranging from 15 to 13 m/s are more difficult for opponents to accept. However, this study used an accuracy test, which prevented the ball speed from being maximized while keeping the target direction on target.

According to the findings, some elements influence roll smash in sepak takraw players. The precision of the roll spike is controlled by body height, leg length, and leg muscular strength. According to studies, the smash is a compound movement, which means that it cannot be ideal unless the athlete masters the smash technique well (Ramawan et al., 2021). The success of a smash is influenced by several series of movements such as steps, support, jumping, and hitting while in the air. Aside from that, a smash in sports is determined by the way the body is positioned (Ramawan et al., 2021). In this case, the athlete's height and leg length are used to describe body posture. Height is a vital

factor in executing a smash well. For example, volleyball players who are above average height will be more ideal and simpler to smash the ball in the air (Ramawan et al., 2021).

Aside from that, body structure is associated with sporting activities, implying that body structure is used in sports that need physical performance (Saleh & Syahrul, 2019). Anthropometric measures can be used to study body structure in health and sports research. The goal of anthropometric measurements is to learn about the body's parts so that we can identify them separately. Furthermore, the study states that the activity of measuring the human body is called an anthropometric test, which aims to measure body weight, height, length of body segments such as leg length, body composition such as muscles, bones, organs, body circumference from head, liver, wrists, pelvis, and thighs (Saleh & Syahrul, 2019). As a result, the authors can conclude that body structure, specifically the athlete's height and leg length, has an impact on smash success. The more perfect the height in the sepak takraw sport, the easier it will be to perform smashes in practice and compete in matches.

Smash success is generally related to athletes with strong leg muscles. Football, volleyball, basketball, and sepak takraw are all demanding sports that require strong leg muscles. Another study suggests that good leg muscular power will produce ideal outcomes in smash ability, which means that easier it is to get the ball up and then carry out the smash technique (Gustiawan et al., 2021). Power in the sport sepak takraw is associated with a fast and strong upward jumping force, the higher the upward jump and the momentum, the better results it will produce. The higher the jump when executing a smash, the more optimal the resulting smash will be. In this case, the higher the jump during the smash, the closer the distance the ball falls and the shorter the time taken (Gustiawan et al., 2021).

According to a different study, having strong legs improves smash movements, but having sufficient strength is undoubtedly the first step toward building strong legs (Hakim et al., 2022). This indicates that generating adequate leg muscular power takes methodical stages of training rather than happening suddenly. Power is a mix of strength and speed; therefore, we will naturally achieve better results if we combine fundamental strength training with sport-specific speed training (Yudhistira, 2023). According to the authors' research, sepak takraw athletes with more vertical ability yield better smash results.

In addition, it is necessary to monitor the efficacy and efficiency of movement from the first preparation phase to the phases of upward jumping movement, ball contact in the air, and landing on the spot to produce roll spike results. In this case, the initial preparatory stance analysis begins with the athlete turning his back to the net at a distance of about 0.5 - 1 meter, left leg in front, and then taking a stance by bending the knees of both legs not too deeply, with a foot angle of about 80 degrees which aims of waiting for the ball to be passed. In addition, in a relaxed position, the player's eyes are always focused on the ball, after the ball reaches the highest point of the bounce or pass (Hanif, 2017). This is, of course, driven by the notion of balance. If we want to produce steady movements, we must have a ready attitude that allows for good balance. Equilibrium refers to control and coordination, whereas stability refers to the level of resistance provided by the individual to resist the influencing forces (Daharis et al., 2022)

During the upward jumping movement phase, the athlete instantly steps forward with his left foot and bends his knee to jump. The jump angle is roughly 137 degrees while pushing off the floor to bring the body up (Hall, 2007). When moving the body higher, the striking foot comes before the supporting leg, therefore it pushes with one foot, specifically the left foot. Perform a backward somersault to push yourself up. In this instance, the player must have appropriate leg muscle strength. The more powerful the player, the higher his body may be thrown from the net, allowing him to easily strike the ball into the opponent's area. Leg length also significantly supports jumping (Rezaei et al., 2013). Jumping is required to complete a rolling spike. The combination of leg muscle power and leg length results in a high jump, which raises the center of body weight well over the net and allows the ball to be smashed in any direction according to the planned objective (Hamdan et al., 2012).

After the initial jump is completed properly by rotating the body in the air, the following step is hitting the ball with the rear of the foot. To turn the body in the air, keep an eye on the ball and maintain balance. If the ball bounces close or low, the body movement in the air must be quick to meet the ball with a punch; otherwise, the ball will instantly descend toward the net, and if the player is late, the shot will be caught in the net. On the other hand, if the pass/bounce ball is high, the player adjusts the rotation of his body in the air so that the timing between the rotation and the arrival of the ball is perfect for the smash. As a result, the speed of rotation of the body in the air is controlled so that the timing is correct for the fall of the ball to be hit. The body's radius (body roll) can be lengthened or short-

ened while in the air to allow for faster or slower rotation. This is consistent with the theory of rotational (angular) motion, which states that rotational speed (angular) is inversely proportional to the radius of rotation.

The longer the body radius, the slower the rotation; conversely, the shorter the radius, the faster the rotation (Hidayat, 2005). The ball is hit while the foot is at its highest reach, without waiting for the ball to hit the ground. The impact of the blow between the hitting foot and the ball occurs when the hitting foot is practically straight and the ball strikes the top of the ball (the hitting foot is above the ball), causing the ball to bounce strongly and quickly onto the opponent's court. This is by the formula: linear speed (the toughness of the blow) is exactly related to the rotation speed and radius of the batter (Arifin, 2016). The player can control the direction of the ball hitting the opponent's field goal by twisting the leg to the left, straight, or right as desired. The player's buttocks and legs must be flexible; one of the benefits is the ability to direct the ball to the appropriate aim (Hidayah & Akhiruyanto, 2023).

In the landing phase, after the blow in the air, the next movement is the continuation movement, which consists of completing the backward rotation and landing on the floor in the same position as when it began. To keep the body balanced, land with both legs stretchy and knees slightly bent. If balance is insufficient, both hands can assist by resting on the floor (Cahyaningrum et al., 2018). As a result, the biomechanical analysis of the roll smash technique aims to ensure that the roll smash technique, from the beginning to the end of the movement, can achieve the biomechanical principles, namely the movement's effectiveness and efficacy.

## CONCLUSION

Based on the findings of the research and discussion, it is possible to conclude that body height, leg length, leg muscle power, foot kick angle, and ball impact angle in the air all have an impact on the roll spike technique. Roll spike is effective and efficient in all phases of play: preparation, jumping, contact with the ball in the air, and landing. Furthermore, ideal body anthropometry is crucial in performing good smash movements; athletes should then go through technical training to make the movements more automatic, and then increase coordination movements to improve the rolling spike. The intention is that this research will provide information and evaluation material for sepak takraw coaches, allowing them to improve the performance of their athletes. However, there are some limitations to this study, such as the small sample size and the simplistic application. As a result, if additional study is to be replicated, larger samples and more complex applications are required to acquire comprehensive results.

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