Instrument Model of Tennis Forehand Stroke through Biomechanics Movement Analysis for National Tennis Athlete

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Abstract. In a tennis game, effective and efficient biomechanics motion is very important to produce maximum explosive power. In addition to blocking the flow of ball power, the wrong stroke motion is also expected to cause injury. This study uses R&D with a sampling technique using purposive sampling of 10 national athletes. The instrument developed is biomechanical motion including foundation, rotation, force position, impact and follow through. The results show that the most crucial aspect of the foundation is how athletes use the forehand grip correctly, namely the semi western. Correct rotational motion plays an important role in gathering energy by means of good and fast body elasticity. A good strength position utilizing the position of the shoulders, chin, inactive hands, body position and elbows must carry out their functions properly in a regular series of movements. The correct impact is done at perfect momentum and the eyes are focused on the ball, the racket is slightly horizontal, the weight is transferred forward through the left knee and the shooting distance is not too far or too close to the body. The folow trough should be accelerated and let it flow naturally until it runs out to the sides. The conclusion of the forehand technique if done with the correct biomechanical motion will affect the power of the stroke, the more effective the movement, the greater the power generated

Keywords: instrument, biomechanics, forehand.

1 Introduction

A professional athlete certainly wants his technical ability to play tennis to be perfect. Because perfection in any sport, including tennis, will support future achievements. A building must have a strong foundation. In technical tennis, physical and mental is a pyramid that forms a unity in achieving an achievement. The correct biomechanical motion will produce the correct punch technique so that the results of the blow become effective and efficient. Effective movement in tennis, especially the forehand technique, will produce super explosive power. Besides, if the biomechanical motion sequence is correct, it will minimize injury.

Mastery of basic techniques correctly is very fundamental. In tennis, there are at least 5 basic techniques: 1) forehand, baghand, volleyball, smash and serve. Of the five techniques, the forehand is the first technique mastered by a player. The main basic tennis technique that must

be mastered is the forehand stroke [1]. For a professional player to form the correct forehand technique is very important because the amount of power generated is influenced by the truth when the athlete performs the forehand stroke technique or often called biomechanical motion. An aggressive early approach is the key to the forehand shot [2]. The magnitude of the speed of the blow produces a large force or power stroke [3].

There are actually a lot of talented tennis athletes in Indonesia who have the potential to achieve maximum performance. However, due to mishandling from the start and lack of knowledge of the coach in identifying the athlete's biomechanical motion errors, the athlete's performance became mediocre. Even some of Indonesia's top tennis players, such as Angelia Widjaya, Daniel Haryanto, Johan Samawi, etc., suffered serious injuries which resulted in the athlete retiring from the world of tennis. This was identified in addition to an excessive training program also due to a biomechanical motion error when performing a tennis stroke technique. There are various types of injuries in tennis, such as ankle, back, shoulder, elbow, knee injuries and others. According to RSON, the average tennis injury in 2015 reached 6.3% [4].

Several observations have been made in the field, athletes are often frustrated because the forehand strokes produced are not as desired. The power of the forehand stroke is not maximized due to errors in the athlete's biomechanics when performing the forehand technique so that the athlete's performance development automatically stagnates and it is not uncommon for athletes to experience injuries so that many athletes end up not continuing their careers in the world of tennis.

From some of the findings above, the researcher can conclude that biomechanical motion errors in performing the forehand technique are very influential on the development of progress in mastering the athlete's forehand stroke technique and the risk of injury, kinematic analysis in forehand drive is very important to determine the quality of the technique [5]. Even more crucial if there is no comprehensive improvement will cause the athlete's achievement to decline. Departing from these problems, researchers are interested in developing a forehand biomechanics motion evaluation instrument in analyzing athlete motion. The purpose of this research is as a tool for analyzing motion errors made by athletes so that athletes and coaches can make corrections and interventions to improve the athlete's stroke technique and minimize the occurrence of injuries to athletes in order to support athlete's achievement in the future.

2 Methods

The design used in this research is Research and Development (R&D) to develop a biomechanical motion analysis instrument for the forehand stroke technique [6]. The sampling technique uses purposive sampling with the following criteria: 1) athletes are advanced players, 2) athletes are male players, 3) athletes are regional and national level players. The instruments developed in this study include foundation, rotational motion, positional force, impact and follow-up.

In compiling the instrument involved 3 experts, namely 1 tennis expert, 1 tennis coach and 1 biomechanics expert. The test trials were carried out 2 times on a small and large scale. Small-scale trials were carried out 2 times using 10 field tennis UKM students and large scale trials were carried out 1 time using 4 national athletes.

Data collection techniques with observation, questionnaires, tests & measurements and documentation. Observations were made to identify the initial fault in the biomechanics of regional athletes when performing the forehand technique. After researchers know the athlete's motion problems, the next step is to make an initial draft of the instrument which is given to 3 experts to get an assessment of the feasibility of the product. In compiling the instrument involved 3 experts, namely 1 tennis expert, 1 tennis coach and 1 biomechanics expert. Tests & measurements using small scale trials were carried out 2 times using 10 regional athletes and large scale trials were carried out 1 time using 4 national athletes. Documentation in the form of videos and photos which will then be included in the Dartfish Motion Analysis program or software.

Data analysis using Daftfish Motion Analysis and quantitative descriptive. Dartfish analysis by recording the athlete's movements or samples with video then entered into the dartfish software and the video is cut into photos to make it easier to obtain the angle or target of the movement to be analyzed. The movements that have been analyzed are then used as benchmarks in compiling the forehand biomechanics movement instrument using a quantitative descriptive formula.

3 Results

The results were obtained by means of 10 athletes doing groundstrokes in pairs for 5 minutes. When the athlete performs a groundstroke, a video recording session is conducted. The video is then converted with Dartfish software. The assessment model for each aspect is 0-5 points. The maximum value per aspect item is 5 and the maximum value for all aspects is 25. The five aspects assessed include foundation, rotational motion, position strength, impact and follow through. The results of the study after being analyzed are as follows: the foundation aspect has an average of 4.6 and an SD of 0.52. The rotational motion has a mean of 4.1 and an SD of 0.87. Strength positions have a mean of 4.4 and SD of 0.52. Impact has a mean of 3.6 SD 1.26. The mean follow-through was 4.7 and SD 0.48.

The overall results of the biomechanics of the forehand technique show that 4 national level athletes are in the good category with scores of 25, 25, 24, 24. At the regional level athletes there are 6 less category scores, namely 20, 20, 20, 19, 19, 18. Average The average forehand technique of 10 people is 21.4 with an SD of 2.76. The biomechanical motion parameter table for the forehand stroke technique can be seen in table 1.

Table 1. Parameters motion biomechanics forehand technique

Item	Category
Very good	> 26
Good	24-26
Enough	21-23
Less	17-20
Very Less	< 17

The results of the study which were validated by 3 tennis experts showed that the foundation had a percentage of 91.7% (very high), rotational motion 91.7% (very high), position strength 83.3% (high), impact 91.7% (very high) and 100% follow-through (very high). These results

indicate that the acceptability of the product is very high and can be used in the evaluation and analysis of forehand biomechanics motion instruments. The table of product acceptance by experts can be seen in Figure 1.
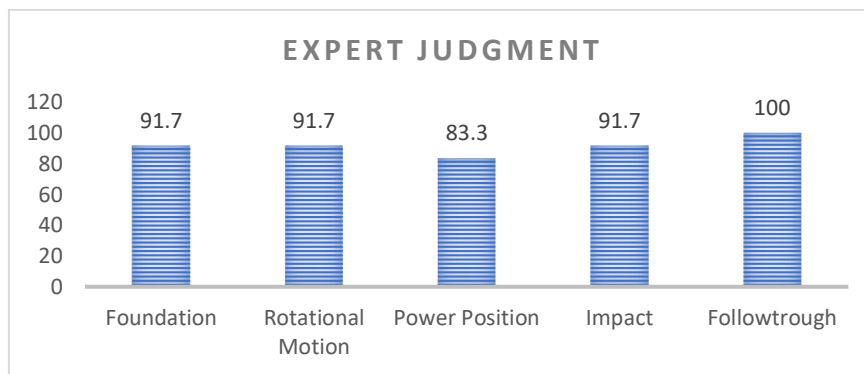
Fig. 1. Expert evaluation percentage.

4 Discussion

The foundation has a major role in the continuation of the biomechanical motion of the forehand technique a regular series of motion will produce an optimal forehand stroke [7]. The right motion means that it will have the right effect on the other movements. The correct foundation based on this study uses a semi-western grip which is often used by regional and national level athletes. grip contributes to the biomotor quality of an athlete [8].study concluded that the horizontal grip speed of the estern grip racket is faster than the continental grip on the backhand technique [9]. When the athlete is in a position ready to receive the ball from the opponent, the head of the racket is above the grip. In the next aspect of the foundation that is no less important when the player is about to hit, all hands are functioning properly, if the right hand holds the grip, the left hand holds the neck of the racket. In the position of the feet, both feet are opened shoulder width apart with the body slightly bent forward so that it will produce a good balance in the body. In a study, the movement of the leg that is perpendicular to the forehand stroke has the potential to cause injury compared to both bent legs [10], the elbow flexion movement in the forwardswing step is better than the elbow extension movement [11]. Players must always focus and concentrate their eyes on the incoming ball.

The movement of rotation or rotation plays an important role in gathering power before releasing a forehand shot. To improve forehand performance, coaches should focus on proper hip and torso rotation [12]. Legs, hips and chest must move in synchrony so that athletes can take full advantage of the kinetic chain [13] . When the opponent's ball comes towards us as quickly as possible, the body rotates stating that agility is needed in making forehand strokes [14]. For right-handed players, the left shoulder is facing the net, use the index finger of the left hand (if not a left-handed player) to aim at the ball as well as the navigator the ball will be shot in the desired direction. The use of the index finger also acts as a counterweight to the body so that the body is balanced and does not float around. The position of the open stand foot (left and

right feet parallel) when going to fire a forehand shot. And when the body does a round of both legs bent.

Forehand strokes require the right position of strength so that the resulting ball can be fast and effective. To get high explosive results, the racket head must be higher than the grip, this is possible if the racket head is above the power in the hand will not run out first. When the racket is swung down, there is a gravitational attraction of the earth which will naturally increase the power of the blow. The shoulders and hips are wrapped around to form a square before hitting. The wrapped shoulders and hips can be said to produce Hooke's law, which is to form the elastic properties of the shoulders and hips so that they will produce a spring force hip flexion increased by 38% after impact from slow to fast [15].

Ball impact or often called ball hitting is a crucial phase in the biomechanics series of forehand stroke techniques. The player must create the right momentum when there is an impact between the racket and the ball so that it will create the desired ball speed. In producing the right ball impact, the player must focus on the ball to be hit, swing the shoulders quickly, the hand position must be upright and the racket is horizontal, when the ball impact is straight then transfer the body weight forward through the ball bent left knee for a powerful hitting runway [16].

The correct follow through is that after contact, the swing is accelerated to allow the racket to flow naturally. Use the right and left foot as a pivot when the player swings and let the foot stabilize the movement naturally and then end with a pronation movement. At the time of follow through, so that the biomechanics of the forehand stroke is correct, let the elbow stabilize the movement naturally. The muscles stabilize the elbow as a unit during a hit to the ground in high-level players [17]. Effective follow-through movements can reduce the risk of injury [18].

This developed instrument can be used to analyze motion errors when performing a series of forehand strokes so as to optimize the performance of the hips and shoulders in creating explosive forhand strokes. This instrument can also minimize the occurrence of injury because it can correct wrong movements into correct and effective movements.

5 Conclusion

This research instrument is highly recommended in analyzing the biomechanical motion of the forehand stroke technique. The coach from the beginning must emphasize to the athlete to use a semi-western grip when making forehand strokes in order to produce effective and high explosive forehand strokes. Athletes should pay attention to the rotation of the shoulders and hips when performing rotations to be carried out as quickly as possible. Coaches and athletes must pay attention to the position of the racket head always above during the backswing in order to collect the power that will be fired from the racket to the ball. In order for the shot to reach the desired target, it is important that the impact racket is always in a horizontal position and the key is to focus on the ball and train players to hit at the right momentum. Let the follow through occur naturally in order to reduce the risk of injury when making forehand strokes.

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