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Artikel Penelitian

The Effectiveness of Sidearm Throw in Softball Players

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Abstract. Introduction: The good throws need acceleration, and acceleration starts from maximum lateral rotation with the ball come quickly to the target. The aim of this study was to investigate the comparison between sidearm and overhand throws. Method: 60 players participate in this study (age 20.9±0.4, Height 168.9±5.3, Weight 58.8±5.3 and BMI 20.6±1.8). All participants are beginner and they are right handed. Throw test in this study were sidearm and overhand throws technique with ten meters in one minute. Stopwatch is used to calculate the time for sidearm throw and overhand throw, and Dartfish software version 4.5.2.0 is used to analyze throwing motion. The paired t-test in this study was $p < 0.05$ to analyze the data. Result: The sidearm and overhand throws had significant differences with the average in one minute was 18.08 times and overhand throw was 15.55 times. Base on the motion analysis view in Dartfish, sidearm throw is simpler and faster, which meant side arm throw was more easy to use than overhand throw by the players. Conclusion: sidearm throw more effective than overhand throw, because the movement is shorter and simpler.

Key words: Effectiveness, Sidearm throw, Softball.

INTRODUCTION

Man cannot fly, run faster than cheetah, jump longer than kangaroo or swim faster than a dolphin. But we can throw farther, stronger, and better than any other animal. Some anthropoids such as chimpanzees and gorillas are known to throw, but their motion is mainly underhand. We are very weak creatures, and our physical ability is very limited. But throwing is one given-talent, only humans can throw (Sakurai, 2000).

The good throw needs acceleration, and acceleration starts with the maximum lateral rotation. The human shoulder is made up of three bones: the clavicle, the scapula, and the humerus as well as associated muscle, ligament and tendons. Scapula and humerus position is in the horizontal forward flexion (Giriwijoyo, 2005). In additional, this motion initiated during the late phase of cocking, activation humeral medial rotation and elbow extension. The center of gravity of the body continues to shift forward rapidly (Moynes et al., 1986). Basically, there are several types of throwing techniques in softball: 1) overhand throw, 2) underhand throw, and 3) sidearm throw (Homer, 2011). In general, there are some basic skills that are needed in softball such as: throwing, catching, hitting and base running. These four basic skills must be controlled by player as soon as possible (Carruth & Jensen, 2007).

Everyone who familiar with baseball is agree that softball is an easy sport to play. Softball is a sport that have much fun but not too familiar in Indonesia, because the previous reason is softball only played by people who at least have a lot of money to having the equipment. Softball is a team sport that uses a ball and bat, and it is a simplification of the baseball game. In the end of the 60's, softball development increased dramatically. Many schools and universities began to introduce this sport to public. To enhance physical education and physical activity in schools, a comprehensive approach at the state, district, school, and classroom levels is necessary. Policies, practices, and comprehensive staff development at the state and district levels might enable schools to improve opportunities for students to become physically active adults (Lee et al., 2007).

Based on observations in the softball field, infielder player had not shown significant performance, especially to get the runners

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out. It can be seen from the infielder that cannot make the batter-runner force out, and throws late than runner. Throwing at maximum speed involves conditions where the applied force increases with mass, but is not directly proportional to the mass. The force also varies with time, the object moves in an arc of varying radius, and the force acts in a direction that is neither parallel nor perpendicular to the object path (Cross, 2004). Hence a further to improve the learning process was that the players will be able to provide a starting point for students who want to develop the ability to play softball in the game. Learning is the basic of educational processes. In other words, learning is a process to help learners to learn well.

Sidearm throw is the one of the throw technique that can make the runner out, not only for the batter runner when they want to run to the first base but also for the runner who stolen the base and player who want to go to home base to get a score. According to the issues identification in the background, the author wants to analyze the quality throwing of the players. Therefore, the aim of this study was to investigate the comparison between sidearm and overhand throws.

METHODS

The participants of this study were 60 players. The participants are fresh man in the softball club. The reason for selecting the participants was because their skills are in the beginner level and they do not have any experience about how to throw the ball in softball before. Throwing tests were performed for one minute and all participants are right handed. Before test begin the participant fill the informed consent and warming up as they need. The participants had an average of age 20.9 years, with mean body weight and height 58.8 kg and 168.9 cm, and body mass index (BMI) average 20.6 kg/m² (Table 1).

Table 1. Subject Information

	Mean ± SD (n=60)
Age (year)	20.9 ± 0.4
Height (cm)	168.9 ± 5.3
Weight (Kg)	58.8 ± 5.3
BMI (kg/m²)	20.6 ± 1.8

Procedures

Each participant started to throw the ball to warm up. The level warm-up significantly increased both throwing velocity and accuracy. Throwing velocity increased by approximately 5 to 10 % due to the overweight warm-up (Escamilla et al., 2000). Participants are expected to be ready by the time when the test conducted. Balls, softball field, and glove are needed. The intervals that create each step of the throwing test allow constant reinforcement to improve interest and reduce boredom (Axe, 2009). Finally, the whole throwing test is outlined with detailed instructions for throwing progression. After initial instruction, supervision by an assistant, timer or any other member of the participants might only be necessary to ensure that the subjects understand all the instructions.

Overhand and sidearm throws test carried on the softball field. Throwing test performed in pairs, target is the participants who are located on the opposing side in a catch position, and the partner throwing vice versa. Position of catcher partner are standing with both feet shoulder width, and the glove facing towards in the direction of the balls' coming. After catching the ball, participants directly do the same throw towards to his partner and so on. The throw conducted with foot remain behind the boundary line throw. The participants were given the opportunity to try the throw before the test. After trials, participants were given the opportunity to throw for one minute. An error throw doesn't count. Overhand and sidearm throws performed with ten meters, the reason was because the ideal distance to throw on infield not too far and the participants able to throwing in that distance.

Procedure for the data collection in this study is by counting the number of throws for one minute and to distinguish the throwing angle and throwing motion using software. Two experts in the softball field displayed to see and to provide validation of overhand and sidearm throws motion. They are a softball coach and physical education teacher. The two experts tasked to monitoring the throwing motion that participants did the correct or not in the motion. Overhand throw stated correctly when wrist movement is above the shoulder's line and near to the head (figure 3), while the sidearm throw declared right when the wrist moves parallel to or below the shoulder's line and the elbow closer to the body (figure 4). In these throwing motion the function of the biceps muscle is primarily as an elbow flexor and forearm supinator (Ferry et al., 2009).

In this study the author used a quantitative data to support the research. Statistics

used to make inferences and predictions based on the data gathered (Navarro & Maldonado, 2007). Every participant has chances to do the test three times, and the average score of participant dealing with participants' throwing. Each test was monitored by an assistant who calculated the number of students' throwing in each minute. Stopwatch is used to measure the time in sidearm and overhand throws.

This study focuses in the infield player, because the sidearm throw is matched on the player who near by the target and the distance is not too far. It same like Rojas et al. (2009) that stated the second base position will guard much more of the right side of the infield, short stop tries to stop or catch any ball hit towards left field, and the third base usually take throws made to third. These three players of this position needs good reflexes and good throwing acceleration.

Data analysis

Statistical analysis was performed with the SPSS-II (version 22.0.0.0). Data were initially analyzed by repeated measured Pear t-test. The data collection was valued based on accuracy and speed of the students' throwing. The statistical test was used in significant level of $p \leq 0.05$ to analyze the data. Dartfish software version 4.5.2.0 also used to analyze throwing motion. Data were collected and processed on each average of the results of overhand and sidearm throws.

RESULT

Based on the findings above, the mean score of overhand throw in one minute was 15.55 and 18.08 for the sidearm throw. The standard deviation in this study was 2.71 for overhand and 3.34 for sidearm throws and it can be seen in Table 2.

Table 2. Overhand and Sidearm Throws Analysis

	N	Minimum /times	Maximum /times	Mean	Std. Deviation
Overhand Throw	60	10.00	20.00	15.5500	2.71484
Sidearm Throw	60	10.00	26.00	18.0833	3.33595

The Paired t-test showed significant difference ($p < 0.05$) between sidearm throw and overhand throw (Table 3). The Paired t-test significant difference was performed to identify between overhand throw and sidearm throw were different ($p < 0.05$).

Table 3. Paired t-test between overhand and sidearm throw

	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper	T	df	Sig. (2-tailed)
Sidearm Throw – Overhand Throw	2.53333	2.58724	.33401	1.86498	3.20169	7.585	59	.000

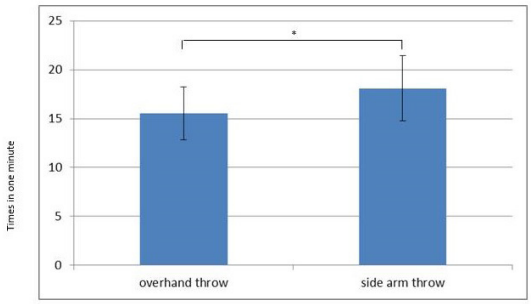

Figure 1. Comparison between overhand and sidearm throws in one minute.

The standard deviation between overhand and sidearm throws were 2.59 and the mean 2.53, it is mean the figure showed that there was different between overhand throw and sidearm throw ($p = 0.000$).

DISCUSSION

The sidearm throw is usually used in infield position that require in a short time. Moreover, the possible throwing errors that occur on the sidearm technique were in the left or right direction of the target. In addition, the sidearm throw is properly used in a short distance from base to base with speed needed (Fleisig et al., 2011).

The motion of sidearm throw is considered to be very simple comparing with overhand throw. The biomechanics system in the sidearm throw includes several steps: (1) Ready position: standing on two legs at a distance equal to the shoulder width or more, (2) Initial motion: Pull the hand holding the ball towards to the back side accompanied by rotating the waist. (3) Throwing motion: Throw the ball from the back side, then through the side of the body below the shoulders towards to the target, (4) Follow through motion: After the ball release from the hand, body motion is accompanied follows throw from the wrist and the finger (Bethel, 1993).

Maximal elbow angle was approximately 130^{o} in overhand, and 150^{o} in the sidearm throws. Elbow angle on sidearm throw during

acceleration also different, in the overhand throw the angle is 60º vs 13º for sidearm throw. Sidearm throw in deceleration phase is higher than overhand (147º vs 140º) because when arm release the ball, the arm line moves straight toward to the target and it make sidearm faster than overhand throws (Figure 2). Maximal shoulder angle in the overhand throw was approximately 110º, and only 90º for the sidearm throw. The linear velocities of arm segments in both throwing technique showed significant increases as the segment became more distal to the body.

Figure 2. Comparison between overhand and sidearm throws angle

Throwing phases

The success of the players when he can catch the ball and throw accurately to a target. These are the foundations to get succeed. It takes a time to elevate the skills of catching and throwing to the peak performance and become automatic. The overhand throw is a complex motor skill that involves the entire body in a series of linked movements starting from the legs, progressing up through the pelvis and trunk in a ballistic motion in the arm that encourage the projectile forward.

In softball, sidearm throw describes balls thrown along a low, approximately horizontal axis rather than a high. Sidearm throw is a common way of throwing the ball in the infield position. The throwing motion can be divided into three basic steps: preparation, acceleration, and follow through (Bartlett, 2000).

Preparation started when the preliminary activity dominated by upper extremity flexion with both hands holding the ball (Moynes et al., 1986). Proper technique when performing the sidearm throw is on side player and facing 90º from the intended targets. In this motion, there is no significant difference between sidearm throw and overhand throw. This phase prepares when the arm to be able to throw the ball. The posterior shoulder muscular is extremely active and the position of the shoulder is in external rotation. The body begins to move forward towards its target during this phase. The lead shoulder is directed at the target and the throwing arm continues to move into extreme external rotation.

The acceleration step begins when the throwing arm moves forward to the target. The anterior upper quadrant muscles are concentrically active and begin to move the arm from extreme external rotation to internal rotation. Proper body mechanics places the shoulder in the proper position during the acceleration phase to generate great velocity and accuracy without causing an injury to the throwing shoulder. The end of this phase is marked by release the ball.

The final phase of throwing is the follow-through. This phase slows down all the body motions and stops the forward movement of the body. The body comes to the rest position, and the muscle activity returns to a quiet state. If this phase is completely correct, the thrower's body position is in under control and balanced. Overhand throw involves movement in all parts of the body. If the mechanics are performed properly, the ball can be thrown with great velocity and accuracy. If the body is trained correctly, the act of throwing can be performed repetitively without causing an injury in the shoulder.

The author agree that the overhand throw is going to be easier on the arm motion. However, in any condition if player don't have enough time to make motion faster they will out of position to bring the arm up and wind up. The best way to say it is the player use the side arm throw only in certain situations. The sidearm windup and delivery is almost like the overhand throw, except the arm comes around full sidearm or three-quarters. The follow through is a little different because the arm will swing around more towards the non-throwing hand side of the body instead of down. However, they immediately swing their both hands towards to the front and they are ready in a fielding position.

The first stage of the throwing motion includes the time from the start of the motion to the time when the shoulder has reached its maximum external rotation. The throwing motion is initiated by first taking a stride toward the target with the leg opposite of the throwing arm. Cocking on overhand throw is not too clear if it compared to sidearm throw, the direction of the movement is moving forward supported by follow-through. While to sidearm throw, can be up to 45º close to our body and make it more stable. The throwing arm by Sakurai (2000) has seven degrees of

freedom of the joint motion; three at the shoulder, one at the elbow, one at the radio-ulnar, and two for the wrist.

Acceleration phase is initiated once the projectile begins in a forward motion, which is also about the same time as the stride foot makes contact with the ground. The stride foot should be in line with the thrower's stance foot and the target. Placing the wide of foot facing to the target creates a breakdown of the motion due to over-rotation of the pelvis, and placing the foot inward from the target forces of the thrower to crosswise to the body. The stride foot between overhand throw and sidearm throw is no different, only in the sidearm throw that the body leaning to the right side (right handed) to stabilize the body weight when throwing. As Sakurai (2000) said that human shoulder joint is considerably flexible because we do not need to support our body weight with the forelimbs (arms). The purpose of the stride is to increase the distance over which linear and angular trunk motions occur, allowing more energy to be produced and transferred up the body. But the acceleration phase is the most explosive part of the overhand throwing motion, as the projectile's velocity increases from zero to its maximum velocity in this short amount of time. The ball is brought forward while the throwers body rotates towards the target starting from the stride foot, moving up to the pelvis, followed by the trunk and spinal rotation, and then move up to the shoulders (figure 3).

In the throwing motion, sidearm throw acceleration is shorter than overhand throw. When sidearm throw moves, the elbow is in the below position of the shoulder when entire the arm motion and keep the stability when the ball is released. The sidearm throw placing is more emphasis on forearm and wrist movement than using shoulder. The arm acceleration phase in overhand throwing by Escamilla & Andrews (2009) and Escamilla et al. (2000) begins at maximum shoulder external rotation and ends at ball release. Arm movement is more in the horizontal position. The players must be sure that the thumb rotates down on releasing to produce proper spin (Figure 4). To show the ball when it close to the receiver, the fielder holds the balls' up in their hand just above the shoulder and little more far away from the body, maintaining a bend in the elbow of about 90 degrees. By using a smaller arm circle, the player can keep the ball always visible to the receiver when they use sidearm throw, Cross (2004) state that muscle torque acting on the forearm was almost independent of the thrown mass, and the total kinetic energy of the hand, forearm, and mass in the hand was essentially independent of the mass of the thrown object. An overhand movement preparation should not be used, because it waste a time and the motion will cause the ball disappear behind the body. The last but not least, the players throw the ball in a short distance, so a large arm circle is not necessary.

Follow through: where the ball is released depends on the distance of the player's target; a farther target requires a higher release point when use overhand throw but not necessary if players using sidearm throw in the short distance. The purpose of the follow through is to decelerate the throwing arm. Once the projectile is released the throwing arm keeps moving across the body (Morris, 2009). In (Figure 4) we can see that follow through in sidearm throw is simple than overhand throw, sidearm throw only release the ball from the arm and follow the arm motion to the left side of the body, but for overhand throw (Figure 3) not only the arm moving away after released the ball but also the foot had to move to make the body balance and not falling.

Figure 3. Overhand throwing phases in softball throwing motion.

Effectiveness movement

Sidearm throw is also called a three-quarter throw, the sidearm throw is usually used when players need speed and can be maximize with the strength in the short distance. The force varies with the time, the object moves in an arc of varying radius, and the force act in a direction that is neither parallel nor perpendicular to the object path (Cross, 2004). The second baseman and other players who are close to the receiver should throw sidearm, the ball remains visible to the receiver and easy to track, react, and catch. Players should not use sidearm throw in over long distances. The weight of the ball and increased stress on the elbow can lead to the elbow injuries if players throwing in a wrong technique. The first baseman also prefers to throw the ball across the

target not in a curveball (Moynes et al., 1986).

Sidearm throw is a common way of throwing the ball in the infield position. According to the skills of throwing between overhand throw and sidearm throw, the information that obtained in overhand throw is used for all long distance and outfielders use it in most of the time. Whereas, the sidearm throw used for short distance and to save the power when infielder throw in the infield area. Player only need good reflex, elbow motion and follow through from the wrist. Cross (2004) reccomended the muscle forces exerted when throwing an object are difficult to determine from kinematic data due to the large number of muscles and relations involved. In addition, sidearm throw effectively used for short distances, especially for the second baseman to the first baseman.

In this study, the time in sidearm throw is better than overhand throw (Fig 1). The reasons why sidearm throw better than overhand throw can be divide into two parts, first for throwing movement, and second for catching the ball. Motion of throwing influenced by the gravity. In the most real-life situations, air resistance affect the horizontal component of projectile velocity. This is supported by Hall (2011) in the three mechanical factors can determine a projectile's motion (projectile angle, projection speed, and relative height of projectile).

Overhand throw has same theory with a projectile's flight time (Hall, 2011). When the ball released, the ball trajectory angle is oblique, that mean overhand throw is suitable for the long distance because of parabolic trajectory. The sidearm throw projectile trajectory is horizontal (at an angle of 0º) and it make the ball faster to the target. The purpose of simplification is the effects of aerodynamic forces will be disregarded in the discussion of projectile motion.

Wilk, Meister, and Andrews (2002) reported that most player exhibit an obvious difference motion whereby external rotation is excessive and internal rotation is limited at 90° of abduction. Good movement in the throwing also reduce the risk of injury, the efficiency of energy transfer from the lower extremity to the upper extremity is probably an important factor influencing injury, that's mean stabilization of the pelvis by the gluteal muscles group to be extremely important (Oliver, 2010).

Figure 4. Sidearm throw phases in softball throwing motion.

There were some limitations in this study, there was no information about the arm length and muscle strength from each participant. The data differences between acceleration and power of participants also became one of the issue that are not addressed in this study, as we know the speed of the throw also affected by long or short arm and also the power of the arm. So, the basic strength of throws each participant is not known, either from the overhand and sidearm throws. Future research is expected to complement the previous research.

CONCLUSION

Based on the above findings, sidearm throw technique was more effectively used by infielder. Sidearm throw movement is shorter and simpler than the overhand throw. Due to the nature of the throw that requires a short time, sidearm throw can be used by an infielder to get the runner out in softball game. By applying the basic technique and movement of sidearm throw it is believed that will be easier for the students to understand and practice it.

This study will help to determine the efficacy of throwing when athletes want to be infielder player. If throwing mechanics are good between basic throw and motion analysis, there are some benefits to training with high level program to elevate their throwing skill.

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