COMPARATIVE KINEMATIC ANALYSIS OF SOFTBALL SWING IN FEMALE AND MALE PLAYERS

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Abstract

The purpose of this study was to compare softball swing performance of two athletes, male and female, and comparison of the achieved results with results from previous similar researches. Both players were members of the Croatian national senior team, and hade been playing softball for a long time. Each player hit 24 balls (two sets of 12 balls) after a standard warm-up. Three video cameras, operating at 60 frames per second, were positioned to provide 3D analysis and used for recording the performances. The best hit of each player, chosen by the expert team of coaches, players and umpires, was subjected to further analysis. Although the functioning of kinetic chain was efficient in both analyzed hits, significant differences occurred in the variables of elbow angles. In the female swing a much larger angle was registered than in the male one, which led to a slower elbow extension speed. The female player opened her shoulder prematurely, and pushed the knob too much off, instead of staying inside the ball trajectory and keeping the knob close to her body. Players often mistakenly go around the ball, instead staying in and then push properly through the extension phase. Speed of elbow extension is very important for the ball trajectory, as much as the knob path.

Introduction

Softball is one of the most competitive amateur sports played in USA. In Europe, it has not yet reached the USA popularity level. The European Softball Federation was established in 1976 with only six memeber countries. Its membership has been enlarged over the years to 33 countries. Nowadays, softball is mostly played, and at a high level, in the Netherlands, the Czech Republic, Italy and Germany. Outside of Europe, it is popular in Japan, where there is also a professional league.

It has developed from baseball, on which much research has been done focusing mainly on hitting and kinematics of swinging (Adiar, 2002), whereas few scientific investigations were done on softball and especially on female players.

Hitting the ball in softball takes a lot of time to be learned since a high level of coordination is needed. Rubinoff (2016) states that balance and consistency are the crucial factors in achieving success.

Milanovich and Nesbit (2014) demonstrated that since the research by Messier and Owen (1984) most research works were about the bat and its mechanical performance as on all the effects of its speed.

The purpose of this study was to compare softball swings of two athletes – one male and one female, and to compare the obtained results with previous ones.

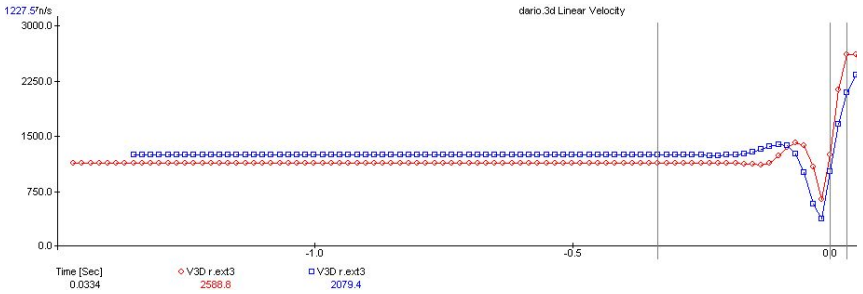
Methods

One female (age 23 years, body height 160.5 cm, body weight 53 kg) and one male (age 20 years, body height 180 cm, body weight 77 kg) were the subjects of this study. The analyzed hitters were members of the Croatian senior national team and had been playing softball for a long time. After a standard pre-competition warm-up, each player hit 24 balls, i.e. 2 sets of 12 balls each.

The videometric data were acquired by three video cameras operating at 60 frames per second and positioned in such a way to provide 3D analysis. The best hit of each player, chosen by the expert team of coaches, players and umpires, was subjected to further analysis. The data were processed according to the standards of the APAS procedure (3D analysis, DLT, Cubic Spline), considering specifics of the analyzed movements.

Results and discussion

The focus of the softball hitting analysis was mostly on speed of the ball after the impact with the bat and on the height at which the ball was hit.



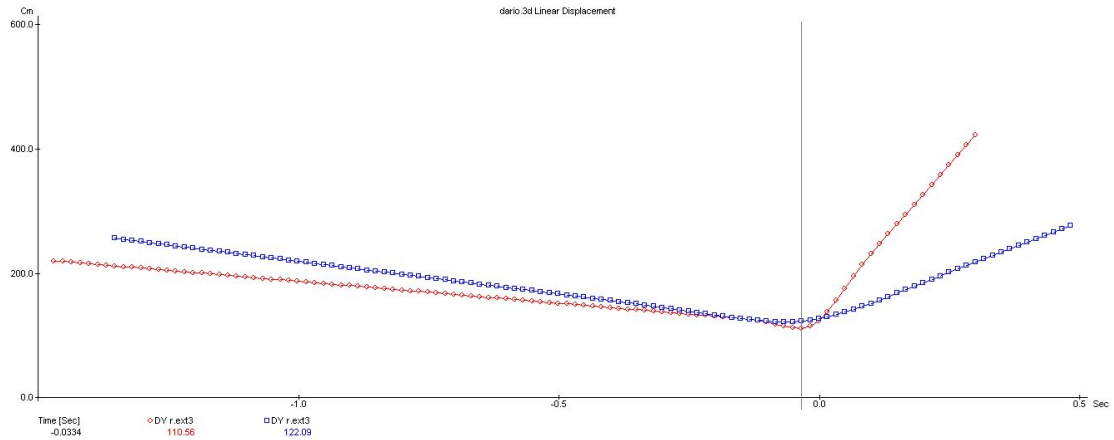
Male RED; Female BLUE

Graph 1. Ball speed after the impact with the bat

The measured ball speed in the present study was lower than in other studies – the average speed was reported to be between 31 m/s and 22 m/s (Koenig, et al., 2004), whereas in our study ball speed after the collision with the bat was 25.92 m/s and 21.73 m/s for the male and female subject, respectively (Graph 1).

Apart from the obvious anthropometric differences between our two subjects, as well as between their physical abilities, there was also a difference between their performance techniques and the resulting ball trajectory. The first and most obvious difference was the height at which the ball was hit (Graph 2).

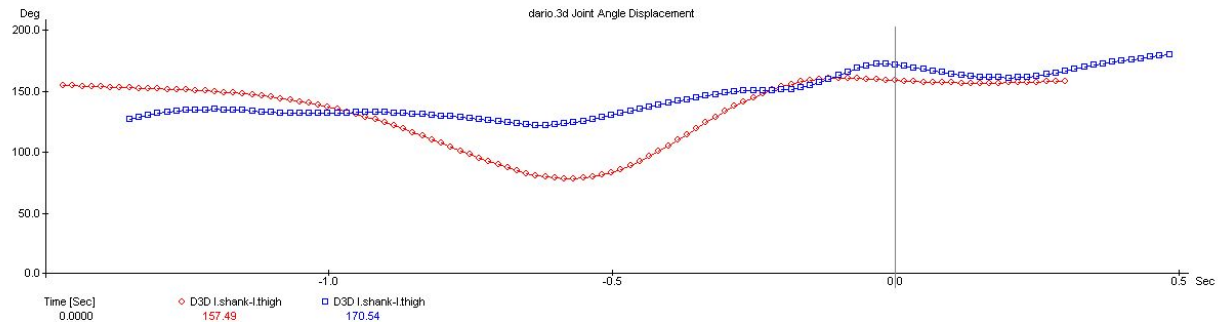
The female subject hit the ball at the height of 122.09 cm, which was significantly higher than in the case of the male subject (110.56 cm). The ball hit by the female subject was at the top of the strike zone and therefore her ball trajectory was more vertical than the male's. The male subject hit the ball in the middle of the strike zone, thus demonstrating a more efficient timing of hitting the ball.



Male RED; Female BLUE

Graph 2. Height at which the ball was hit

Also, the knees of the female subject were much more extended than the male's, especially the left (leading) knee, 170.54° comparing to 157.49° (Graph 3).



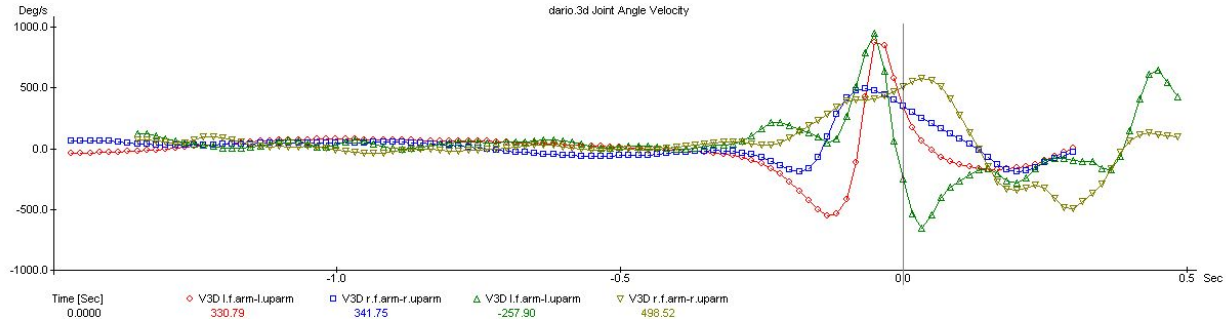
Male RED; Female BLUE

Graph 3. Angles in the left knee

During the softball swing analysis, it is common to divide the movement in five performance phases: stance, load (negative phase/movement), contact with the ball, extension and finishing phase (Bahill, 2004). Stance is individual for every player; commonly, their feet are parallel, static, and can be shoulder width or more apart. Feet apartness depends on the player's sense of comfortability (Escamilla et al., 2009b; Flyger, Button, & Rishiraj, 2006; Welch et al.,1995). The eyes are focused on the pitcher (Monteleone & Chrisfield, 1999). In the second phase, it is important to produce a negative momentum – the body weight shifts on the rare leg, preparing to transfer all the body energy to the ball. The batter lifts the front leg off the ground to make more force while he/she is landing it on the ground again. We can compare two ways of negative momentum generation in the current study – the male participant lifted his front leg way much more and made the angle in knees of 77° while the smallest female angle was 120.7°. So far in the recent research works both techniques have been proven as successful ones. The third phase – the ball and bat collision, is the most important phase; its performance depends on the angles at which the ball is being approached, on the way the knob is travelling to the ball and, of course, on the bat speed. After the contact, the elbows are extending through the ball.

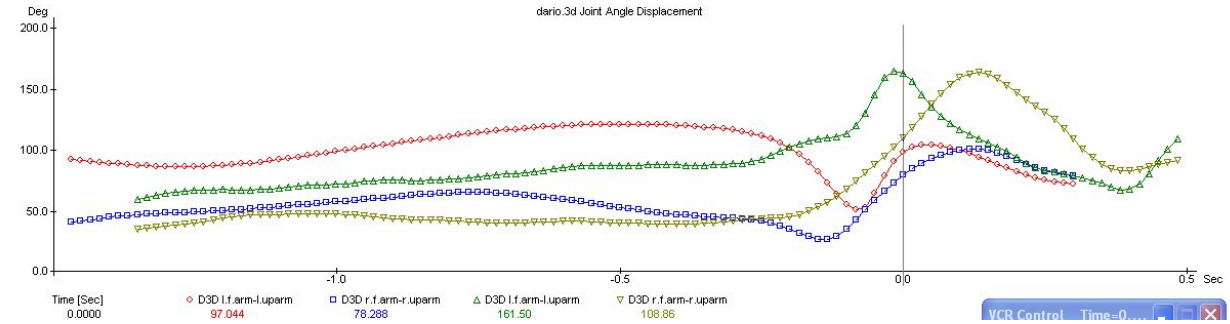
The female subject demonstrated a bigger angle at the contact with the ball; her arms/elbows were more extended than they should have been, which led to a poorer hit. Because of a greater angular velocity (Graph 4.) of the extending elbows – 940,11 °/s at the left elbow and 562 °/s at the right elbow, compared to 861,7 °/s and 482,1 °/s measured in the male participant, at the end of the swing

performance she had a bigger angle (Graph 5.), caused by the mentioned higher angular velocities in the elbows. The maximum speed was reached 0.03 seconds after the contact, which is corresponding to some previous studies.



Male left RED and right BLUE; Female left GREEN and right OLIVE GREEN

Graph 4. Angular velocities in elbows

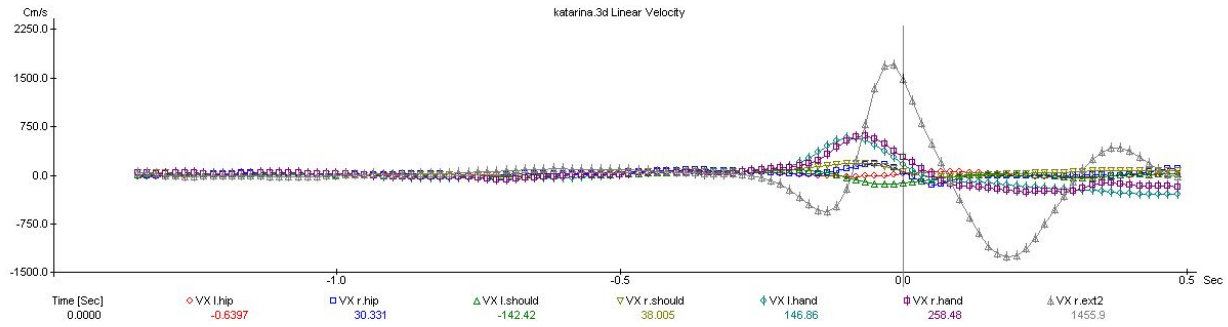


Male RED; Female BLUE

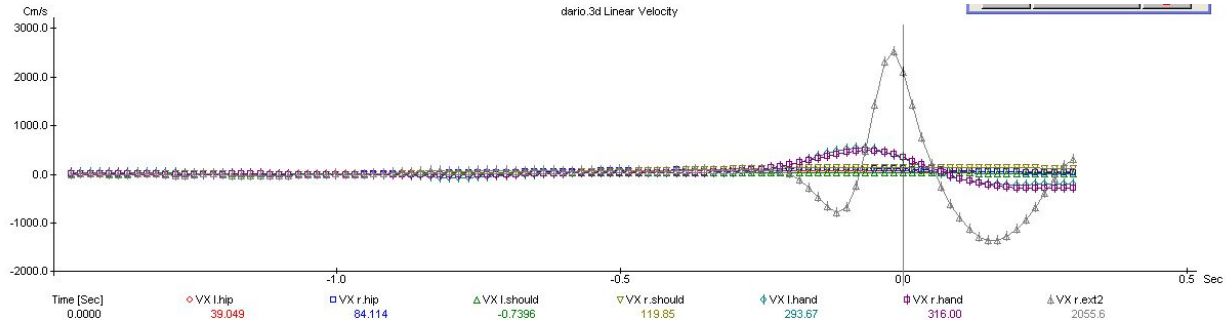
Graph 5. Angles in the elbows

During a swing, the kinetic chain makes all the energy needed to transfer it to the ball. Starting from the feet through the legs, hips, abdominal muscles, arms, wrists to the – bat (Race,1961; Welch et al., 1995).

In previous studies, researchers concluded that the hips were the ones leading the swing and giving the starting acceleration and then came the shoulders and arms. Timing is crucial for the success of a hit – the right body parts should start moving at the right moment. In case of the current study, in both participants the functioning of the kinetic chain was efficient (Graph 6. and 7.).



Graph 6. Kinetic chain of the female model



Graph 7. Kinetic chain of the male model

Conclusion

The comparison between the male and female models has shown significant differences in their softball swings. One of the variables in which they significantly differ were angles in the elbows. In the female model we can see a bigger angle than in the male one, which leads to a lower speed of elbow extension. The female player opens her shoulders too early and pushes the knob too much off, instead of staying inside the ball lane and keeping the knob close to her body. Players often make such a mistake that they go around the ball, instead staying in and then pushing properly through the extension phase. Speed of elbow extension is very important for the following ball trajectory, as much as the knob path.

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