

Impact of target selection on front kick kinematics in taekwondo - pilot study

Authors' Contribution:

A - Study Design
B - Data Collection
C - Statistical Analysis
D - Manuscript Preparation
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Jacek Wąsik^{1ACDEF}, Tomasz Góra^{1BDEF}

¹Institute Physical Education, Tourism and Physioterapy, Jan Długosz University of Czestochowa, address: ul. Armii Krajowej 13/15; 42-200 Czestochowa, email: tomek_gora@op.pl

Abstract

Velocity and accuracy of strike are important factors that help in achieving victory. The question is if the target selection can have an impact on the strike kinematics. The topic is especially important in the case of the traditional taekwon-do, in which a single kick might decide who the winner is. The aim of the paper is knowledge about the influence of the target on the kinematic factors of the front kick technique. In this study, a Polish Taekwon-do Championship runner-up was examined. The taekwon-do athlete (age: 28 years; body mass: 68 kg; height: 172 cm) is holding a 2nd degree, Motion analysis and data processing was prepared in HML (Human Motion Lab) using 10 NIR Vicon MX-T40 cameras with the acquisition speed of 100 to 2000 frames per second at full frame resolution of 4 megapixels. During the research various measurements were collected to perform dimensional analysis of foot and knee movement, describing their velocity changes as a function of time. The following strike speeds were recorded. No physical target: dominant leg foot 12.25 ± 0.18 m/s, non-dominant leg foot 13.92 ± 0.87 m/s. Small ball target/Punching ball: dominant leg foot 10.27 ± 0.29 m/s, non-dominant leg foot 10.03 ± 0.15 m/s. Kicking Shield/Shield: dominant leg foot 11.17 ± 0.34 m/s, non-dominant leg foot 10.06 ± 0.46 m/s. The quickest strike was registered when the athlete had no physical target in front of him. No focus on the target caused the fastest results. The shield target provoked a stronger and slower strike, as the speed has been slightly slower than in the non-target situation. The velocity of the foot was reduced the most when the most precision was needed. Aiming into a little ball caused the biggest speed to decrease the most. The main conclusion is that the more precision is needed, the more speed decrease will be observed

Key words: kicking velocity, precision, dynamic balancing, taekwon-do, movement analysis, kicks kinematics

INTRODUCTION

Taekwon-do and other martial arts are focused on fast and precise strikes that hit the selected point on the body of an opponent. Speed and accuracy are crucial to achieve victory. The question is if the target selection can have an impact on the strike kinematics? The topic is especially important in the case of the traditional taekwon-do, in which a single kick might reveal the winner.

Front kick (in taekwon-do terminology referred to as *ap chagi*) is considered easy to learn, however it is very difficult to bring it to perfection. A number of scientists analyzed the strike. It was proved that the velocity of the knee and the time of the move influence the speed

of the kick [1] Sorensen et.al [2] wrote, that in the case of high front kick slowdown of thigh is caused by the start move of lower limb, not by the inhibition activity. A difference in execution of front kick was spotted when observing karate Shotokan athletes [3]. Depending on the level of advancement, a greater repeatability in kinematic of strike was recorded, particularly in pre-loading phase, which precedes the phase of the attack. It was shown that the time of the strike and lower limb speed can be useful in selection of best karate athletes on the highest level and monitoring their physical performance.

Strikes aimed at different targets use a different move pattern [4]. It was proved that the distance from the target influence the kick [5]. Distancing makes the strength of the kick lower and makes reaction time worse. Speed is the main element of success in combat sports and self-defense. It is common that reaction time decide about winning or losing a fight.

Regardless of fighting style, it is important to react quickly and precise [6]. At the same time, it was noticed that accuracy and speed seem to be precisely opposite.

The aim of the paper is knowledge about the influence of the target on the kinematic factors of the front kick technique. The following research questions arise:

1. If the physical target has an influence on the foot velocity during execution of the front kick?
2. Can we observe difference in velocity between dominant and non-dominant foot?

MATERIAL

Subjects

In the study, a Polish Taekwon-do Championship runner-up was examined. The taekwon-do athlete (age: 28 years; body mass: 68 kg; height: 172 cm) is holding a 2nd dan.

He train regularly 5 times a week. During the experiment, athlete adopts the L-stance forearm guarding block (in Taekwon-do terminology referred to as niunja sogi palmok debi maki) and executed front kicks (ap chagi) without a physical target, into a small table tennis ball hung on the fishing line and into martial arts shield. Every target was hit three times.

Human Subjects Research Committee of the University scrutinized and approved the test protocol as meeting the criteria of Ethical Conduct for Research Involving Humans. All subjects in the study were informed of the testing procedures and voluntarily participated in the data collection.

Protocol

Motion analysis and data processing was prepared in HML (Human Motion Lab) using 10 NIR Vicon MX-T40 cameras with the acquisition speed of 370 frames per second at full frame resolution of 4 megapixels (2352 × 1728 px) in 10-bit greyscale. Test space had a shape of an elliptic cylinder with height of 3m and based on the axes 6.47m, 4.2m.

During the research, various measurements were collected to perform dimensional analysis of foot and knee movement, describing their velocity changes as a function of time. The mean values of the parameters were used to determine the curve of velocity changes, as a function of the relative length of athlete lower limb (the leg performing the strike). This way the maximum speed of knee and foot was determined in axis X, Y and Z.

Statistics

For all designated indicators a mean value and standard deviation was calculated. All calculations were made using MS Excel 2000.

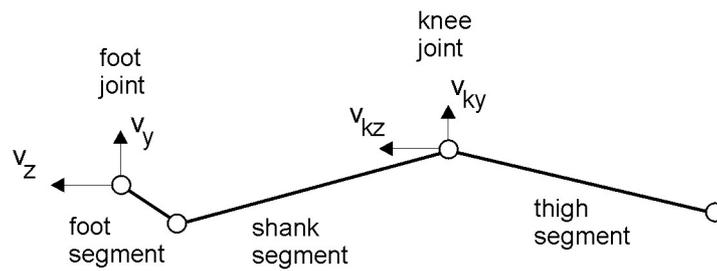


Fig. 1. General view presenting relevant joints and segments of the kicking leg.

RESULTS

Table 1 shows the recorded values of speed for the foot and knee of both legs for different strike targets.

Table 1. Velocity during front kick execution in [m/s].

	Front kick target		
	Air	Table tennis ball	Shield
Dominant leg foot	12,25 ± 0,18	10,27 ± 0,29	11,17 ± 0,34
Non-dominant leg foot	13,92 ± 0,87	10,03 ± 0,15	10,06 ± 0,46
Dominant leg knee	6,32 ± 0,06	6,07 ± 0,05	6,35 ± 0,14
Non-dominant leg knee	5,81 ± 0,11	5,32 ± 0,14	5,42 ± 0,24

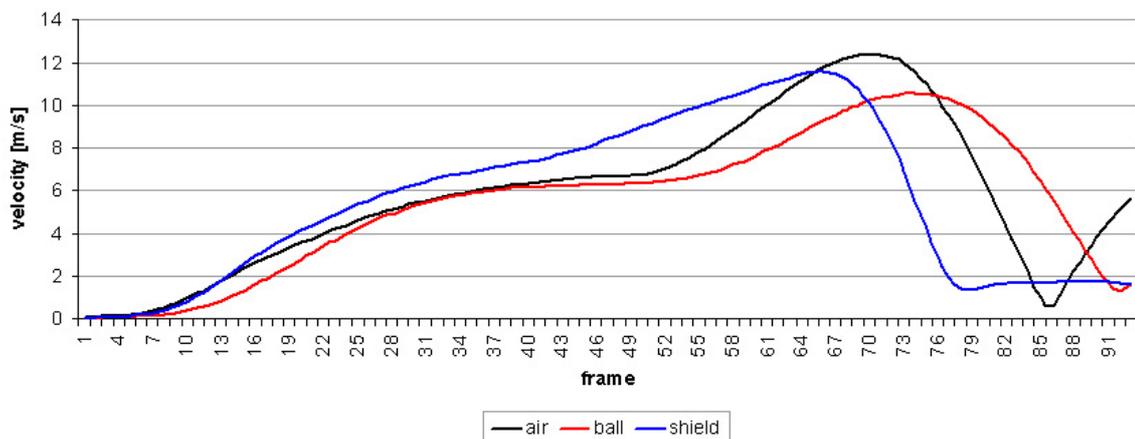


Fig. 2. Change of foot velocity during the front kick depending on the aim.

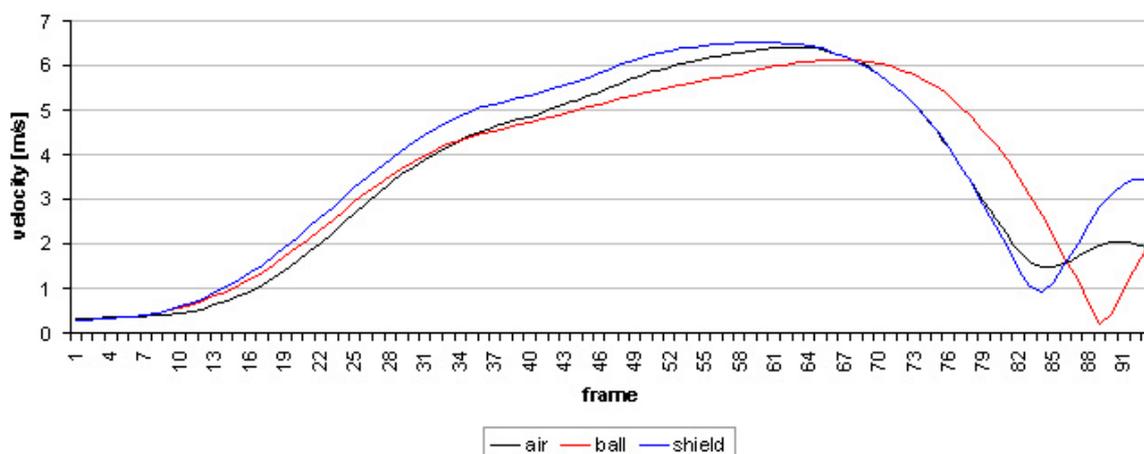


Fig. 3. Change of knee velocity during the front kick depending on the aim.

DISCUSSION

The front kick velocity determined in this research was between 10.03 – 13.92 m/s. The results are similar to those obtained in other studies [7]. After analysis of data collected in table 1, we can assume that the change of target influences the kinematics of lower limb during front kick. The highest velocity was recorded when there were no physical target in front of him. The speed of the dominant leg knee was faster than the non-dominant one. The difference appeared in all samples. Similar differences was observed for the foot, except the case with no physical target, where the results were opposite. It could be a matter of some additional move performed just before hitting the target. The lowest foot velocity was recorded during the table tennis ball strike (10.27 ± 0.29 m/s – dominant leg; 10.03 ± 0.15 m/s – non-dominant leg). The maximum velocity of foot and knee was reached at the end of the move when hitting the target. (Picture 2,3). From the graphs we can conclude that the front kick was the longest one. In opposite the shield strike was the shortest one

The athlete was executing the fastest front kick move when he did not have to concentrate on the physical target. The shield target provoked a stronger and slower strike, as the speed has been slightly slower than in the no-target situation. The velocity of the foot was reduced the most when the most precision was needed. Aiming into a little ball caused the speed to decrease the most. The main conclusion is that the increase of accuracy and strength is decreasing the speed of the strike [8].

This confirms the know mechanism of speed-accuracy trade off [9]. According to it the fastest strikes are introducing problems with accuracy and control. In other words, the fighters who wish to hit the target accurately and have maximum control of their move should not use all their power and strength.

The speed-accuracy trade off describes two opposite priorities. Those are represented by two endpoints: endpoint of accuracy and endpoint of velocity. The accuracy endpoint exists if there is no time limits. The velocity endpoint exists if there is a time limit. In light contact fights the players gain points for hitting selected area of the opponent body. It is not important if the athlete hits a specific part of the body, but only the area which makes accuracy less important. In opposite many self-defense situations mix those priorities. Sometimes it is a choice between one accurate strike or few faster hits, but with less precision. This choice can result in life or death [10].

In summary, after the analysis we can say that the target determine the front kick move pattern. Since there are only several biomechanical studies on the mechanism of compromise between speed, power and precision, further investigation can be done. This study is only a part of the problem. The results presented in this research may be a material for comparisons and may point the way for further research.

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Address for correspondence:

Tomasz Góra, Institute Physical Education, Tourism and Physioterapy, Jan Długosz University of Czestochowa, address: ul. Armii Krajowej 13/15; 42-200 Czestochowa, email: tomek_gora@op.pl

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