

# KINEMATIC STRUCTURE OF TAEKWON-DO ITF SIDE KICK

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## Abstract

*Taekwon-do ITF (International Taekwon-do federation) is a kicking type of combat sports. Detailed biomechanical analysis of Taekwon-do techniques is necessary for proper teaching of this sport.*

*The aim of the study is investigation of the biomechanical structure of Taekwon-do ITF side kick.*

*Investigating biomechanical structure of the kick, scientific publications in biomechanics of karate, taekwondo WTF, kickboxing and football (soccer) were analysed.*

*10 blue- and green-belt level Taekwondo athletes participated in the study (age: 12-14 years; body height: 150-162 cm; bodyweight: 38-52 kg; experience in sports: 3-5 years). Side kicks were videorecorded using two highspeed Basler videocameras (100 Hz), SIMI Motion software was used for data analysis.*

*Taekwon-do side kick of 12-14 years old Taekwondo athletes lasts 1,24 s, excluding preparation phase. The kick consists of four phases – preparation phase, kicking phase (0,33 s), target contact phase (0,15 s), and post-kicking phase (0,76 s). Further training process will be aimed on development and mastering of kicking phase (loading and kick execution) speed capabilities.*

**Key words:** *taekwon-do ITF, side kick, biomechanics of kick.*

## Introduction

Taekwon-do ITF is a kicking type of combat sports, and rapid-force techniques have a major role in this sport. Teaching of Taekwon-do requires detailed analysis of its techniques.

First of all it should be investigated how is the kick composed, and how do movement phases follow each other. Kinematic characteristics of the movement are registered when studying movement exterior form. It is critical to know how long do individual parts of the movement (phases) last in time. Different movements are distinguished by their kinematics (their outer form), and kinetics (the way the forces work) (Зациорский, 2009). In this study we will concentrate on the duration in time of the side kick phases.

The **aim** of the study is investigation of the biomechanical structure of Taekwon-do ITF side kick.

## Materials and methods

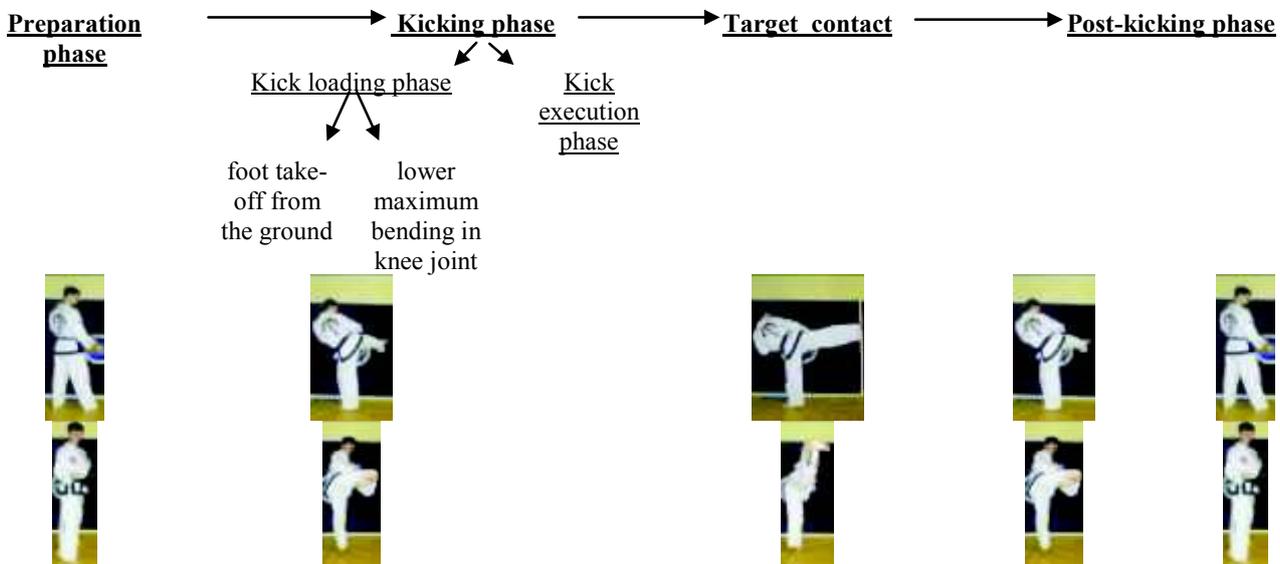
When investigating biomechanical structure of the kick, related scientific publications in karate (Gianino C.), taekwondo WTF, taekwon-do ITF (Falco, 2009, Saulite, 2008) and football (soccer) (Kellis, 2007) were analysed.

10 blue- and green-belt level Taekwondo athletes participated in the study (age: 12-14 years; body height: 150-162 cm; bodyweight: 38-52 kg; experience in sports: 3-5 years).

The athletes performed the side kick two times. Videorecording was done using two highspeed Basler videocameras (100 Hz), SIMI Motion software was used for data analysis. In order to investigate biomechanical parameters of motion, light-reflecting markers were placed on hip (Iliac Crest), knee (Condylus Lateralis), and ankle (Malleolus Lateralis) body landmarks.

## Results

Taekwon-do kick consists of four phases – preparation phase, kicking phase, target contact phase, and post-kicking phase (Figure 1).



**Figure 1.** Kinematic structure of the side kick

Duration of the preparation phase depends on the athlete. When preparing the kick, Taekwondo athlete may stay still, perform slight jumps up and down or in motion, or move in different directions and use step combinations.

Kicking phase lasts 0,33 s and consists of two subphases – kick loading subphase (0,23 s) and kick execution subphase (0,10 s). There are two parts in kick loading – foot take-off from the ground (0,06 s) and maximal flexion in knee joint (0,17 s). Target contact lasts 0,15 s, and post-kicking phase is the longest – 0,76 s.

Ratio of kick phases' duration is calculated taking into account time from heel take-off from the ground till target contact moment. Kick loading in average lasts 0,23 s, i.e. 70 % of the kicking phase total duration, which is 0,33 s. Kick execution phase in average lasts 0,10 s, that makes 30 % of the kicking phase. In kick loading, foot take-off from the ground takes 0,06 s, i.e. 18 % of the kick loading time, and maximal flexion in knee joint lasts 0,17 s (52 %).

## Discussion

There are different data on time distribution of kick phases in literature. Football researchers (Kellis, Katis, 2007) distinguish initial, backswing, forward swing, pre-impact, collision and final phases. Utkins writes on throwing and kicking biomechanics in football, and indicates backswing, throw (kick) object contact phases.

In combat sports performance of kicks differs from other throwing and kicking sports. Kicking in Taekwon-do shall be studied in more details. In the current study important results were achieved; four basic phases of the kick were distinguished – preparation phase, kicking phase, target contact phase, and post-kicking phase. Each phase has its own role in successful kick execution.

During preparation phase the athlete achieves an optimal body position depending on current sparring situation. It is important to have legs slightly bent in knee joints, this would advantage in faster

and technically optimal performance. Duration of preparation phase depends on athlete's goal, technical level and current situation. When athlete consider preparation done, and kick shall be performed, the support leg extends in kicking direction, and athlete enters kicking phase.

Kicking phase consists of kick loading subphase and kick execution subphase. Kick loading consists of two parts: foot take-off from the ground and maximal knee joint flexion.

Foot take-off begins with heel take-off from the ground. At this moment hip flexes forward and rotates inward, also knee flexes at this time. When the foot of the kicking leg completely leaves the ground, knee continues its flexion till around  $88.36^\circ$ , and hip continues flexion and rotation, till kicking leg is parallel to the ground, and ankle, hip and shoulder joints are in one line in the direction of the kick.

During kick execution subphase, hip and knee joint extend till foot touches the target.

Target contact phase lasts until the kicking foot takes-off from the target; its duration depends on stretching and shortening capabilities of athlete's muscles.

In post-kicking phase the kicking leg goes back and almost repeats the kick trajectory. The faster the athlete returns the leg in initial position or to the loading phase, the sooner he or she is able to perform the next motion.

Coaches shall plan the training process thoroughly and consider aims and goals of the training. Preparatory exercises shall be in close relation with athletes' technical development. Further training process and side kick development in Taekwon-do will be performed taking into account each phase and the whole kick duration and execution trajectory. To achieve this goal, special preparatory exercises that correspond to kinematic structure of the side kick will be developed and tested.

### Conclusions

Taekwon-do side kick of 12-14 years old Taekwondo athletes lasts 1,24 s, excluding preparation phase. The kick consists of four phases – preparation phase, kicking phase (0,33 s), target contact phase (0,15 s), and post-kicking phase (0,76 s). Further training process will be aimed on development and mastering of kicking phase (loading and kick execution) speed capabilities.

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