

The Symmetry In Kinematics Between The Dominant And Non-Dominant Legs In Taekwondo Turning Kick

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Abstract : The objective of this study was to determine the differences between dominant and non-dominant leg in Taekwondo Turning Kick. There were 5 subjects who are Johor state national level black belt Taekwondo players with the mean age 21.71 ± 2.58 years old, mean weight 55.87 ± 6.76 kg and mean height 170.22 ± 5.41 cm. This research was carried out in the XF Dance and Martial Arts Studio, located in Bandar Putra, Kulai, Johor. A Sony DCR-HC38 digital video camera with 25 frames per second (fps) was used for the sagittal view recording. Movements analysis software - *SiliconCoach 7* were used in the digitizing process, which were done manually with a reference point marked at the tarsal bone. The results were focused, firstly, on the comparison of the dominant and non-dominant kicking speeds and secondly, the relationship between the vertical kicking angle and the maximum height at the target spot. The results showed that mean peak velocity for the dominant and non-dominant kick were 12.93 m/s and 12.27 m/s respectively. T-test showed that there were no significant differences in velocity between dominant and non-dominant legs in Taekwondo turning kick. Therefore the null hypothesis of this research was achieved. The mean dominant vertical angle was lower than the mean non-dominant angle which were 70.62° and 72.68° respectively, whereas the mean height of the kick by dominant leg was higher than mean height of the kick by non-dominant leg (1.23m and 1.20m respectively). In conclusion, the expert Taekwondo players were equally fast and efficient during the turning kick when using both dominant and non-dominant legs.

Keyword : symmetry in kinematics, the dominant, non-dominant legs, taekwondo turning kick

Overview

Taekwondo is not merely a form of Korean martial arts for self-defence against assailants and wild animals. It is also a form of physical exercise to develop ones strength and agility as well as to maintain both physical and mental health.

Taekwondo is distinct from Chinese Kung Fu and Japanese Karate. “Tae” (*Hangul*: 태, *hanja*: 踏) means to kick, attack or defend with the feet. “Kwon” (*Hangul*: 권, *hanja*: 拳) means to punch, strike, or smash with the hand or fist to defend and attack. “Do” (*Hangul*: 도, *hanja*: 道) means the art and the way, the methodology of application of our human body parts.

Taekwondo is known as one of the combat-oriented sport. This sport uses only hands and feet without any weapons. Due to the unique variety of kicking techniques practiced in Taekwondo, many people have come to call it the “Kicking Martial Arts” although it also practices a fair amount of hand and fist techniques.

Taekwondo is famed for its use of kicking techniques, which distinguishes it from others martial arts. Under the latest World Taekwondo Federation (WTF) rules and regulations, sparring takes place between two competitors in an area measuring 10 meters square. Each match or bout consists of three non-stop rounds of contact. Breaks are given between rounds. Points are awarded for permitted, accurate and powerful techniques to the legal scoring areas. Light contact or insufficient impact of kicking to the scoring area does not merit any points. Unlike soccer which determines its’ winners easily by the total number of goals, Taekwondo is “a very subjective sport” when it comes to scoring. “*Even if you have one of the best fights of your life, you can still lose based on the scoring.*” (Cogan, 2008).

In Taekwondo, one has to move all the muscles and joints of the human body. Therefore, it involves the dominant and non-dominant limbs in the kicking techniques. Taekwondo athletes may be filled with anxiety having to anticipate the opponents' techniques, and over scoring instead of worrying about the training conditions. Therefore, the turning kick relationship between the dominant and non-dominant leg plays an important part in the training program.

The main aspect of the turning kick is the speed of lifting the knee. According to the biomechanical definition, the purpose for this movement is to decrease the Moment of Inertia (MoI) of the segment and decrease the distance between segment from the axis of rotation to a point (the radius of rotation, r). All of these refer to the segment against the rotation while doing the kick and the rotation is predominant by the waist. Therefore, the lack of the MoI will produce a faster rotation against the joint. This basic movement provides an advantage because it increases the potential to produce a variety of kicks using the same mechanical movement.

Statement of Problem

Instructors should know of the difference between the kicking movement of the dominant and non-dominant limbs so they can assist their athletes on ways of improving their performance. Furthermore, they can also create tailor-make training programs according to each athlete's abilities based on this research. This research should benefit all Taekwondo instructors and players alike.

Objectives

The objectives of the present study are to analyze:

1. The differences in speed between the dominant and non-dominant leg during the turning kick.
2. The differences of the kicking angle between the dominant and non-dominant leg during the turning kick.
3. The differences height at the target spot between dominant and non-dominant leg while using turning kick.

Significance of Study

Turning kick has been known as the most popular kicking technique in the tournament. According to Lee (1998), it is also the most common technique used to score points compared to other kicking techniques available in Taekwondo competition. Turning kick is by far the fastest kicking technique compared with other kicks.

This research also aims to identify the kinematics parameter between the dominant and non-dominant leg during turning kick. This study will help the subject and coaches to know the ability about oneself. The coach can help the subjects to improve their performance in the turning kick based on this research.

This research has the potential to provide useful information to the other instructors or coaches. Hopefully, this research can also serve as a guideline to all the other instructors and coaches, not only in Malaysia but even throughout the world. This information on the kinematics of kicking technique can be made into the ideal model and it can be used as a reference while comparing the movement in the learning motor process.

In Malaysia, traditional training methods for Taekwondo have been practiced since 1960. However, the scientific studies on Taekwondo were lacking. It is important to develop applicable scientific training methods in order to improve the competitive ability of Malaysia's Taekwondo athletes in the world level competition. The systematic and scientific methods that are developed in this study will be useful in evaluating the performance and technique of Taekwondo athletes in Malaysia.

Research Design

The purpose of this experimental research is to determine and to analyse the kinematics and the speed differences between the dominant and non-dominant leg during the turning kick. Furthermore, the average ability of the subjects who are the national level athletes will be able to be identified.

During the research, a digital video camera will be used to capture the subject in sagittal plane. When the subjects demonstrate the turning kick, the video camera will record the movements simultaneously. The video will then be transferred to the computer and the software, *SiliconCoach* will be used to analyse the movements.

The data collection was done in XF Dance and Martial Arts Studio in Bandar Putra, Kulai, Johor. The subjects were wearing short pants and bare footed. The subjects were wearing ankle guards that were used as markers.

Instrument

A fixed kicking bag is set up in the studio for targeting purposes. The research will be analysed using the computer, on the kicking movement. The digitizing software *SiliconCoach* is used to edit and analyse the recorded video during the data collection process. This software was used to analyse the speed, angle and the maximum kicking height at the target spot.

Data Analysis

Comparison of Subject A's Dominant and Non-dominant Kicking Velocity

The D leg had a total of three peaks during the turning kick. The first peak occurred at frame 8 with 5.34 m/s, second kick at frame 12 with 8.88 m/s and the third peak at 17 with the highest velocity recorded at 16.79 m/s. On the other hand, the average of the ND leg's kicking velocity also had three peaks. In the beginning, the velocity grew quiet smoothly. Subject A achieved the first peak at frame 10 with 6.95 m/s, second peak at frame 14 with 10.10 m/s and the third peak with the maximum velocity at 15.37 m/s. The data shows that subject A's D leg's kicking velocity is faster than the ND leg's kicking velocity.

Comparison of Subject B's Dominant and Non-dominant Kicking Velocity

Both D and ND leg's kicking velocity had three peaks. Their speed line are also similar, the three noticeable peaks were at frame 8, frame 10 and frame 14. During frame 8, the dominant leg's kicking velocity was recorded at 6.93 m/s which is lower than the ND kick with a 0.07 m/s gap. However, the D leg's kicking velocity was higher than the ND leg's kicking velocity during the second and third peak. The dominant leg's kicking velocity that resulted in the second and third peak was 10.46 m/s and 17.70 m/s respectively. The second peak and the third peak of the ND leg's kicking velocity were recorded at 9.82 m/s and 16.53 m/s. The data shows that subject B's D leg's kicking velocity is faster than the non-dominant leg's kicking velocity.

Comparison of Subject C's Dominant and Non-dominant Kicking Velocity

Subject C's pick up velocity for the ND leg was faster than the D leg. From the average velocity, the ND leg's kicking velocity kept growing until frame 6 at 6.32 m/s. The velocity decreased on frame 8 to 1.48 m/s. After the drop, the velocity had an aggressive growth before the contact phase during frame 12 with the highest velocity 20.48 m/s. The velocity slowed down during the recovery phase. On the other hand, the C's D leg achieved the first peak at frame 9 with 9.10 m/s. The velocity decreases from frame 10 to frame 11 with a velocity of 6.20 m/s and 3.21 m/s respectively. C's D leg achieved the highest velocity as well as the ND leg situation at frame 13 with

speed 18.94 m/s. The data shows that the subject C's ND kicking velocity is faster than D kicking velocity.

Comparison of Subject D's Dominant and Non-dominant Kicking Velocity

D's D leg's kick had two peaks which occurred at frame 8 and frame 14 with the velocity of 8.31 m/s and 14.39 m/s respectively. However, after the first peak, the velocity has slowed down to 3.26 m/s at frame 10. On the other hand, D's ND leg's kick had three peaks which occurred at frame 6, frame 11 and frame 14 with the velocity of 4.52 m/s, 6.25 m/s and 12.90 m/s respectively. Similar to D leg's kick, velocity slowed down after first peak from frame 7 to frame 8 with the lowest velocity 1.17 m/s during the movement phase. There was only a little drop after the second peak, from 6.25 m/s to 5.94 m/s at frame 13. However, D's D and ND leg's kicking velocity achieved the maximum velocity at the same peak, which is at frame 14. The data shows that the subject D's D kicking velocity is faster than the ND kicking velocity.

Comparison of Subject E's Dominant and Non-dominant Kicking Velocity

E's ND leg's initial kicking velocity was faster than the D leg's kicking velocity. However, E's D leg's kicking velocity reached the first peak earlier than the ND leg at frame 6 with 2.83 m/s. The D leg had four noticeable peaks at frame 6, frame 9, frame 12 and frame 15 with a velocity of 2.83 m/s, 4.29 m/s, 10.92 m/s and 21.16 m/s respectively. On the other hand, the average velocity for the ND leg only had three peaks. They were at frame 7, frame 12 and frame 14 with a velocity of 5.31 m/s, 9.75 m/s and 18.83 m/s respectively. The data shows that the subject E's D leg's kicking velocity is higher than ND leg's kicking velocity.

Discussion

The discussion discusses on the kinematic comparison of the dominant leg's kick (D) and the non-dominant leg's kick (ND) according to the objectives of the research. The analyst will explain the kinematics of the Taekwondo turning kick by dividing it into three phases according to the graph. The three phases are the movement phase, the contact phase and the recovery phase. Measurements are taken the moment the subjects lift their foot to kick. Hence, the preparatory phase is not considered in the discussion.

The results from this research show that the mean maximum velocities for the D and ND leg's kicks were 12.93 m/s and 12.27 m/s respectively. From the t-test result, the mean score shows that the dominant and the non-dominant leg's kicking speed at 20 frame per second had the value of $t(38) = 0.176$, $p = 0.861$, $p > 0.05$. Hence, there were no significant differences in kicking speed between the D and ND leg. The subjects in this research can be classified as experts due to their experiences and achievements. Therefore, we can assume that the experts should not have any significant difference between the D and ND leg.

Another research which was done by Hiroyuki et al in year 2006 had the same calculation although the research was more related to the soccer sport. The research was a study on the segmental dynamics of the soccer instep kicking with the D and ND leg; they found that highly skilled soccer players achieved a well-coordinated inter-segmental motion for both the D and ND leg.

From the data, the mean maximum velocities for the D and ND leg's kicks were 12.93 m/s and 12.27 m/s respectively. These data came up to be different from the research done by Tang et al in 2007. From their research, the mean maximum velocity for the D leg was 17.62 m/s which is 36.27 % faster than 12.93 m/s. The mean maximum velocity for the ND leg was 17.29 m/s which is 40.91 % faster than 12.27 m/s. However, the result of the mean maximum velocity was closer to the result gotten from Pearson who had done a research in year 1997. The mean maximum velocity from his subject's D leg was 13.4 m/s which is just 3.63% faster than 12.93 m/s. The differences between

the velocities may be caused by the different methodology used during the data collection. Tang et al (2007) used the Motion Analysis System with 10 high speed cameras to collect data.

From the average of the kicking velocities result, two peaks were produced by the D and ND leg during the kicking process. The kicking velocity rises up from zero during the initial movement phase, the kicker lifts up the leg by the flexion at the knee of the back leg which brings the knee to the torso and maintains a minimal relative angle from the knee to the thigh. The first peak occurred when the knee is lifted to its maximum by the kicker. The velocity will reduce the moment the knee is lifted because the kicker needs to do the lateral rotation on the grounded foot between 90 to 120 degrees, and an additional lateral flexion of the spine. The velocity decreases due to the change of the movement's direction. However, the velocity increases again during the movement phase.

Based on the data, all of the highest recorded velocity occurred during the movement phase. According to Woo (2004), she had come to realize that she had a similar situation in her research. Compared with the research done by Tang et al in 2007, the mean maximum velocity data they had was much more different from this research because Tang et al chose national players who had won many medals of international levels (including the 2004 Olympic Games). The subjects that were involved in this research were not elite athletes but the result of the mean maximum velocity is closer to the result gotten from Pearson who had done a research in year 1997. The average maximum velocity from his subject was 13.4 m/s. From his research, he described the subject as an expert. Therefore, the subjects in this research may have a standard almost equivalent to that of an expert. However, in Pearson's report, he does not mention the leg which was used by the subject. Hence, the analyst assume he was using the D leg.

The relationship between the vertical angle from the centre of gravity to the kicking leg and the height of the kick on the target spot is being researched on for the first time although there were some other researches on the angle parameter with the kicking performances. The vertical angle and the kicking height data were taken when the leg reaches a maximum height towards the target. When the kicker hits the target, the kicker's leg would have fully extended the knee; hence, it would be the ideal time to calculate the vertical angle from the centre of gravity with the kicking leg. From the data, the vertical angle will influence the height of the kicking, the smaller the vertical angle from the centre of gravity, the higher the kick and vice versa. According to Woo (2003), there is strong relationship between the height of the centre of gravity during the contact phase and the physical height of the individual concerned. This statement will help some to increase their ability to kick higher. Besides that, the muscle's flexibility also influences the kicking height.

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