Two-dimensional biomechanical analysis of front kick and front toe kick of female national level taekwondo players

Sweety Gulia and Dhananjoy Shaw

Abstract

Front kick and front toe kick are two of the important attacking skills in the game of taekwondo. Similar in outlook, but subtle differences exist between the two kicks, so far not reported in the literature. The primary objective of this study was to quantify the differences with the help of the kinematic variables using the methods of sports biomechanics. 2-D video graphic recording of the selected skills was performed on highly skilled female Taekwondo Players (Age:17 to 22 years; 55.5±8.98 kilogram; 165.66±6.43 centimeter). Subsequently, KINOVEA was used to analyze the footage after due processing such as digitizing and collaborating the videos. In the statistical analysis, descriptive statistics were calculated and furthermore, a t-test was employed to evaluate the differences in the velocity variable between the selected kicks. The t-test revealed a significant difference in the kicking velocity between the front kick and the front toe kick. This suggests that different feedback should be given in order to develop each kicking skill. This further has implications for the training methods to be employed to develop one kick or the other.

Keywords: Front kick, front toe kick, kicking velocity, kicking kinematics, taekwondo

Introduction

Taekwondo (TKD) is a Korean martial art form that was originally taught for warfare, self-defence and physical fitness. In competition taekwondo, points are scored when contact to the torso or head produces a ‘trembling shock’. With the opponent required to produce a ‘trembling shock’ for the acknowledgement of points, there have been many injuries caused [1]. As a direct result of these high number of injuries chest protection and head protection are now required for participation in Kyorugi (fight) [2].

Front Kick (ap chagi) is a very linear kick. The practitioner raises the knee to the waist, pulls the toes back and quickly extends the foot at the target. It is also known as the snap kick. The front kick is one of the first kicks learned in taekwondo; if mastered it can become one of the most powerful kick. This technique is meant to be used to push the attacker away, but can injure the opponent as well [3].

Front Toe Kick is old-style martial arts kick was used in order to deliver a sharp narrow strike to soft vital targets such as the groin and abdomen. The toe kick is usually delivered like a front kick or roundhouse kick but with the toes as the striking surface. The toe kick is used by some traditional Karate styles and is known as Tsumasaki Geri. This type of kick is also practiced by a few other more traditional martial arts such as Kung Fu [4].

Description and analysis of a sport technique constitute the fundamentals for the development of adequate technical training. They build on the laws and premises of biomechanics with the aim of enhancing sport performance [5]. Such systematic use of biomechanics perspectives is of great importance in taekwondo, where a single strike might differentiate the winner from the non-winner. In taekwondo, where both explosive strength and velocity are relevant for performance, it is needed to analyse the execution technique by using reliable devices and by developing procedures that guarantee objective measurements and equal analysis of athlete’s movements. Few studies have been conducted in same direction [6, 7, 8]. Most studies have been conducting on male taekwondo players, while the kicking technique of female taekwondo players remains largely unexplored. Likewise, the objectives if this study were twofold.
First to describe both the techniques with the help of velocity variables. Second objective was to compare between two dimensional front toe kick velocity and front kick velocity of national level female taekwondo players.

Fig 1: Front toe kick (A) and front kick (B)

Methodology

Data Collection
Six (6) female volunteers were randomly selected as subjects for the purpose of the study. All of them were regular participants in Taekwondo sport with at least national level games/sports participation as their achievement. The age of the subjects ranged from 17 to 22 years, the weight of the subject was 55.5±8.98 kilograms and height was 165.66±6.43 centimetres at least each participant was with of three years’ experience of taekwondo practice. Each subject had performed technique namely front kick and front toe kick for ten repetitions each, which was recorded with a video camera using two dimensional methods independently.

Video Recording Protocol
The distance between subject and camera was 330 centimetres. The camera was placed 70 centimetres above the ground for recording the techniques.

Protocol of 2D Analysis
For analysing the videos KINOVEA 0.8.21 was used. Total time taken to perform each repetition was taken in seconds. Separate time was taken for each repetition in different internal clocks of KINOVEA [9].

Analysis of the Data
Keeping in view the objectives of the study, feasibility, and natures of the selected variables the statistical techniques employed were mean, standard deviation and t-test. The hypothesis was tested at 0.5 level of significance.

Results

Table 1: Repetition Wise Front Kick Velocity (FKV)

<table>
<thead>
<tr>
<th>S.no</th>
<th>Subject</th>
<th>Velocity (m/s)</th>
<th>Std. Error</th>
<th>95% Confidence Interval for Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sub 1</td>
<td>5.33</td>
<td>0.34</td>
<td>4.44 – 6.16</td>
</tr>
<tr>
<td>2</td>
<td>Sub 2</td>
<td>4.88</td>
<td>0.22</td>
<td>4.32 – 5.44</td>
</tr>
<tr>
<td>3</td>
<td>Sub 3</td>
<td>5.04</td>
<td>0.12</td>
<td>4.73 – 5.34</td>
</tr>
<tr>
<td>4</td>
<td>Sub 4</td>
<td>5.16</td>
<td>0.17</td>
<td>4.74 – 5.59</td>
</tr>
<tr>
<td>5</td>
<td>Sub 5</td>
<td>5.07</td>
<td>0.22</td>
<td>4.51 – 5.64</td>
</tr>
<tr>
<td>6</td>
<td>Sub 6</td>
<td>5.16</td>
<td>0.17</td>
<td>4.74 – 5.59</td>
</tr>
<tr>
<td>7</td>
<td>Sub 7</td>
<td>5.07</td>
<td>0.22</td>
<td>4.51 – 5.64</td>
</tr>
<tr>
<td>8</td>
<td>Sub 8</td>
<td>5.16</td>
<td>0.17</td>
<td>4.74 – 5.59</td>
</tr>
<tr>
<td>9</td>
<td>Sub 9</td>
<td>5.07</td>
<td>0.22</td>
<td>4.51 – 5.64</td>
</tr>
<tr>
<td>10</td>
<td>Sub 10</td>
<td>5.16</td>
<td>0.17</td>
<td>4.74 – 5.59</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>4.92</td>
<td>0.07</td>
<td>4.78 – 5.05</td>
</tr>
</tbody>
</table>

Rounded to two digits after the decimal

Table 2: Descriptive statistics of front kick

<table>
<thead>
<tr>
<th>Repetitions</th>
<th>N</th>
<th>Velocity (m/s) Mean</th>
<th>Std. Deviation</th>
<th>Std. Error</th>
<th>95% Confidence Interval for Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>One</td>
<td>6</td>
<td>5.3</td>
<td>0.83</td>
<td>0.34</td>
<td>4.44 – 6.16</td>
</tr>
<tr>
<td>Two</td>
<td>6</td>
<td>4.88</td>
<td>0.54</td>
<td>0.22</td>
<td>4.32 – 5.44</td>
</tr>
<tr>
<td>Three</td>
<td>6</td>
<td>5.04</td>
<td>0.3</td>
<td>0.12</td>
<td>4.73 – 5.34</td>
</tr>
<tr>
<td>Four</td>
<td>6</td>
<td>5.16</td>
<td>0.41</td>
<td>0.17</td>
<td>4.74 – 5.59</td>
</tr>
<tr>
<td>Five</td>
<td>6</td>
<td>5.07</td>
<td>0.54</td>
<td>0.22</td>
<td>4.51 – 5.64</td>
</tr>
<tr>
<td>Six</td>
<td>6</td>
<td>4.67</td>
<td>0.25</td>
<td>0.1</td>
<td>4.42 – 4.92</td>
</tr>
<tr>
<td>Seven</td>
<td>6</td>
<td>4.77</td>
<td>0.77</td>
<td>0.32</td>
<td>3.97 – 5.57</td>
</tr>
<tr>
<td>Eight</td>
<td>6</td>
<td>4.92</td>
<td>0.23</td>
<td>0.1</td>
<td>4.69 – 5.15</td>
</tr>
<tr>
<td>Nine</td>
<td>6</td>
<td>4.76</td>
<td>0.56</td>
<td>0.23</td>
<td>4.18 – 5.34</td>
</tr>
<tr>
<td>Ten</td>
<td>6</td>
<td>4.6</td>
<td>0.55</td>
<td>0.23</td>
<td>4.02 – 5.17</td>
</tr>
<tr>
<td>Total</td>
<td>60</td>
<td>4.92</td>
<td>0.54</td>
<td>0.07</td>
<td>4.78 – 5.05</td>
</tr>
</tbody>
</table>

Rounded to two digits after the decimal

Table 3: Comparison among the repetitions of front kick velocity

<table>
<thead>
<tr>
<th></th>
<th>Sum of Squares</th>
<th>DF</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>2.734</td>
<td>9</td>
<td>0.304</td>
<td>1.088 (NS)</td>
<td>0.388</td>
</tr>
<tr>
<td>Within Groups</td>
<td>13.964</td>
<td>50</td>
<td>0.279</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>16.697</td>
<td>59</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

DF = degree of freedom, F = F-ratio, NS = Not significant

According to table – III, the comparison among the repetitions of front kick velocity was insignificant, F (9,59)=1.088, p=.05.
Table 4: Repetition wise front toe kick velocity (FTKV)

<table>
<thead>
<tr>
<th>S. No</th>
<th>Subject name</th>
<th>Repetition wise front toe kick velocity (FTKV)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>Sub 1</td>
<td>6.96</td>
</tr>
<tr>
<td>2</td>
<td>Sub 2</td>
<td>6.45</td>
</tr>
<tr>
<td>3</td>
<td>Sub 3</td>
<td>8.87</td>
</tr>
<tr>
<td>4</td>
<td>Sub 4</td>
<td>6382</td>
</tr>
<tr>
<td>5</td>
<td>Sub 5</td>
<td>6.36</td>
</tr>
<tr>
<td>6</td>
<td>Sub 6</td>
<td>6.36</td>
</tr>
<tr>
<td>7</td>
<td>Sub 7</td>
<td>6.52</td>
</tr>
</tbody>
</table>

N = 6; Repetitions = 10, m/s = meter per second

Table 5: Descriptive statistics front toe kick

<table>
<thead>
<tr>
<th>Repetitions</th>
<th>N</th>
<th>Velocity (m/s) Mean</th>
<th>Std. Deviation</th>
<th>Std. Error</th>
<th>95% Confidence Interval for Mean</th>
<th>Minimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>One</td>
<td>6</td>
<td>7</td>
<td>0.95</td>
<td>0.39</td>
<td>6.01</td>
<td>7.99</td>
</tr>
<tr>
<td>Two</td>
<td>6</td>
<td>7.53</td>
<td>0.86</td>
<td>0.36</td>
<td>6.63</td>
<td>8.43</td>
</tr>
<tr>
<td>Three</td>
<td>6</td>
<td>7.48</td>
<td>1.34</td>
<td>0.55</td>
<td>6.07</td>
<td>8.88</td>
</tr>
<tr>
<td>Four</td>
<td>6</td>
<td>7.52</td>
<td>0.86</td>
<td>0.36</td>
<td>6.62</td>
<td>8.42</td>
</tr>
<tr>
<td>Five</td>
<td>6</td>
<td>7.05</td>
<td>0.45</td>
<td>0.19</td>
<td>6.58</td>
<td>7.52</td>
</tr>
<tr>
<td>Six</td>
<td>6</td>
<td>7.24</td>
<td>0.65</td>
<td>0.27</td>
<td>6.56</td>
<td>7.92</td>
</tr>
<tr>
<td>Seven</td>
<td>6</td>
<td>6.85</td>
<td>1.29</td>
<td>0.53</td>
<td>5.5</td>
<td>8.19</td>
</tr>
<tr>
<td>Eight</td>
<td>6</td>
<td>7.44</td>
<td>0.57</td>
<td>0.24</td>
<td>6.84</td>
<td>8.04</td>
</tr>
<tr>
<td>Nine</td>
<td>6</td>
<td>7.15</td>
<td>0.75</td>
<td>0.31</td>
<td>6.37</td>
<td>7.94</td>
</tr>
<tr>
<td>Ten</td>
<td>6</td>
<td>7.05</td>
<td>0.65</td>
<td>0.27</td>
<td>6.37</td>
<td>7.72</td>
</tr>
<tr>
<td>Total</td>
<td>60</td>
<td>7.23</td>
<td>0.85</td>
<td>0.11</td>
<td>7.01</td>
<td>7.45</td>
</tr>
</tbody>
</table>

N = number of samples, m/s= meter per second; Rounded to two digits after the decimal

Table 6: Comparison among the Repetitions of Front Toe Kick Velocity

<table>
<thead>
<tr>
<th>Sum of Squares</th>
<th>DF</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>3.293</td>
<td>9</td>
<td>0.366</td>
<td>.474(NS)</td>
</tr>
<tr>
<td>Within Groups</td>
<td>38.598</td>
<td>50</td>
<td>0.772</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>41.891</td>
<td>59</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

DF= degree of freedom, F = F-ratio, NS= non-significant at 0.5 level

According to table – VI, the comparison among the repetitions of front toe kick velocity was non-significant at (F=.474) at 0.5 level of significance.

Fig 2: Comparison between means of front kick velocity and front toe kick velocity
According to table VII, there was a non-significance difference between front kick and front toe kick velocity in repetition one (t = -7.103), between front kick and front toe kick in repetition two (t = -6.302), between front kick and front toe kick in repetition three (t = -10.117), between front kick and front toe kick in repetition four (t = -3.417), between front kick and front toe kick in repetition five (t = -9.104), between front kick and front toe kick in repetition six (t = -6.941), between front kick and front toe kick in repetition seven (t = -6.078), between front kick and front toe kick in repetition eight (t = -4.359), between front kick and front toe kick in repetition nine (t = -6.410), between front kick and front toe kick in repetition ten (t = -3.330), between front kick and front toe kick in total (t = -17.983), at 0.05 level of significance.

Discussion
The front toe kick is one of the kicks that taekwondo players use from their repertoire of skills to deal a soft blow to the opponent. This technique uses one leg as support and other leg as support while the other leg is free to probe the opponent when the opportunity presents. The motion begins when the hip and knee are extended as you reach the opponent with the toe. This technique uses one leg as support and other leg as free to probe the opponent. This technique uses one leg as support and other leg as free to probe the opponent while the other leg is free to probe the opponent.

Conclusions
- Front kick and front toe kick have been sufficiently described in term of velocity.
- Front kick and front toe kick technique are significantly different in velocity in each repetition and as a whole.
- The front toe kick was found to have higher velocity in each repetition and as a whole than that of front kick.

References

