# SUCCESSFUL FACTORS OF 540° DWIHURYEOCHAGI IN TAEKWONDO

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The purpose of our study was to provide fundamental information about success factors of 540° Dwihuryeochagi in Taekwondo. Twenty Taekwondo athletes who participated in the 2012 Taekwondo Kyukpa Wang (breaking king) championship: ten successful athletes (S, age: 23.1±1.6 yrs, height: 171.0±3.5 cm, body mass: 66.4±7.1 kg) and ten failed athletes (F, age: 22.3±1.8 yrs, height: 172.1±5.4 cm, body mass: 64.4±4.2 kg) were selected. Three-dimensional motion analysis using a system of 3 video cameras with a sampling of 60 fields/s was performed during the competition of 540° Dwihuryeochagi. Based on the findings, it is concluded that success factors of 540° Dwihuryeochagi were horizontal velocity of COM during P1, vertical velocity of COM during P2, and the time, kick distance, velocity and angle of lower extremities of P3-P4.

**KEY WORDS:** Taekwondo, demonstration, 540° Dwihuryeochagi

**INTRODUCTION:** The 540° Dwihuryeochagi in Taekwondo demonstration is difficult technique even for high level athletes because it must be performed all of the 540° rotation, and kick in the air (Kang, D. K., Kang, S. J., & Yu, 2013; Yoo, Ryu, Park, & Yoon, 2013). However, recent studies investigating successful factors in this technique have not been well understood because of too small sample size or simple method used in their studies (Kang, 2012; Kang, D. K., Kang, S. J., et al., 2013; Lee, 2013; Ma, 2007; Son, Cho, & Lee, 2007). Therefore, the aim of this study was to provide fundamental information of success factors in techniques through kinematic analysis based on the success and failure of 540° Dwihuryeochagi in Taekwondo competition.

**METHODS:** Twenty Taekwondo athletes who participated in the 2012 Taekwondo Kyukpa Wang (breaking king) championship: success group (n: 10, age: 23.1±1.6 yrs, height: 171.0±3.5 cm, body mass: 66.4±7.1 kg) and failure group (n: 10, age: 22.3±1.8 yrs, height: 172.1±5.4 cm, body mass: 64.4±4.2 kg) selected in this study. Three-dimensional motion analysis using a system of three video cameras (HXR-MC 2000, Sony, Japan) with a sampling of 60 fields/s was performed during the competition of 540° Dwihuryeochagi (Figure 1). Kwon 3D 3.1 software (Visol, Korea) and Matlab R2009b software (The Mathworks, USA) was used for the analysis of the video data of 540° Dwihuryeochagi. Global coordinate system was set by applying DLT (direct linear transformation) methods, and ten joints (left acromion, right acromion, left greater trochanter, right greater trochanter, left femoral condyles, right femoral condyles, left malleolus, right malleolus, left 1st phalange and right 1st phalange) of a body was set for the coordinates. Analysis data was filtered with butterworth 2nd order low-pass filter, and cut off frequency was set at 12Hz. Criteria of success and failure was depending on whether the player completed 540° Dwihuryeochagi breaking in Taekwondo Kyukpa Wang (breaking king) championship. Time, displacement of center of mass (COM) COM velocity, hip joint angle, knee joint angle, kick distance, and kick velocity were calculated to investigate the differences between two groups. Motions were divided into four phases (Figure 2): ground rotation phase (P1), aerial rotation

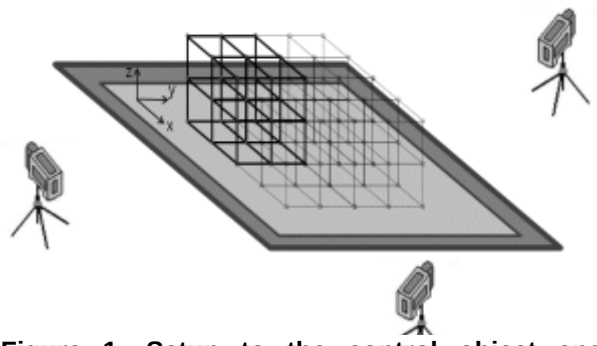

**Figure 1. Setup to the control object and cameras**

phase (P2), kicking phase (P3) and landing phase (P4). Independent t-test using a statistical software package (SPSS 18.0, IBM SPSS, USA) was applied at an alpha level of 0.05.

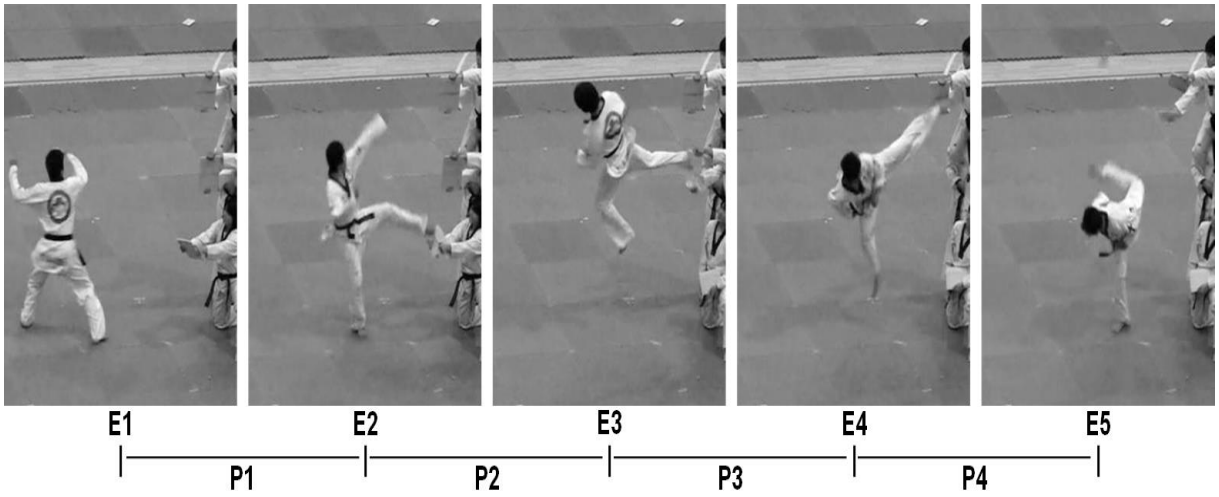


**Figure 2. Event(E1: pivot foot landing, E2: pivot foot toe off, E3: COM max height, E4: kick impact, E5: landing) and phase(P1: E1-E2, P2: E2-E3, P3: E3-E4, P4: E4-E5)**

**RESULTS**: Figure 3 shows the comparison of time differences between two groups. The time was longer for success group than failure group at P4 ($p$ <.001). Figure 4 and Table 1 shows COM displacement and velocity between two groups. COM displacement in vertical direction was greater for success group than failure group at P2, P3, and P4 ($p$ <.05) while COM vertical velocity was greater for success group than failure group at P2 ($p$ <.05).

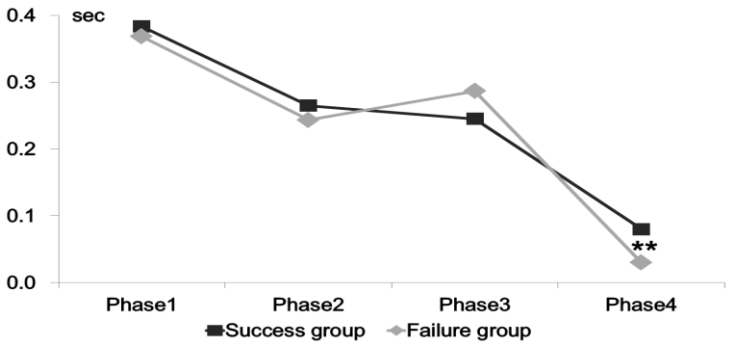


**Figure 3. Comparison of time differences between two groups (*means p<.05, **means p<.001)**

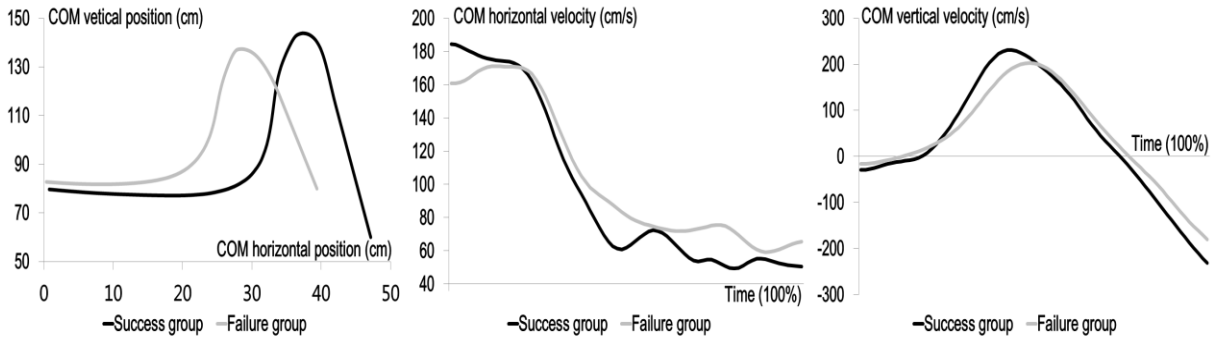


**Figure 4. Patterns of COM displacement and velocity between two groups**

**Table 1. Comparison in COM displacement and velocity between two groups**

| Variables | | Success group | Failure group | t | Variables | | Success group | Failure group | t |
|---|---|---|---|---|---|---|---|---|---|
| COM | P1 | 29.56 ±18.14 | 22.40 ±15.32 | -.954 | COM | P1 | 139.83 ±14.97 | 139.35 ±28.79 | -.047 |
| horizontal | P2 | 4.15 ±9.15 | 3.44 ±7.32 | -.191 | horizontal | P2 | 62.06 ±23.53 | 73.40 ±24.46 | 1.056 |
| displacement | P3 | 5.59 ±7.10 | 6.80 ±7.55 | .369 | velocity | P3 | 53.50 ±17.06 | 65.05 ±22.90 | 1.279 |
| (cm) | P4 | 1.65 ±2.60 | 0.44 ±1.01 | -1.367 | (cm/sec) | P4 | 53.87 ±16.84 | 70.59 ±36.60 | 1.312 |
| COM | P1 | 29.36 ±6.83 | 27.2 9±4.06 | -.822 | COM | P1 | 78.56 ±12.59 | 78.74 ±23.52 | .022 |
| vetrical | P2 | 36.78 ±7.27 | 29.35 ±4.39 | -2.766* | vertical | P2 | 137.51 ±16.10 | 120.33 ±14.94 | -2.473* |
| displacement | P3 | -29.10 ±5.31 | -36.8 6±8.71 | -2.407* | velocity | P3 | -118.44 ±14.41 | -129.59 ±11.53 | -1.911 |
| (cm) | P4 | -22.00 ±7.26 | -8.50 ±5.73 | 4.617** | (cm/sec) | P4 | -275.54 ±14.95 | -247.07 ±86.33 | 1.027 |

Figure 5 shows the comparison of kick distance and velocity between two groups. Kick distance was greater for success group than failure group ($p$<.05). Figure 6 shows the patterns of hip and knee angles between two groups. Knee angle was greater for success group than failure group at E4 ($p$ <.05) while hip angle was greater for success group than failure group at E5 ($p$ <.05)

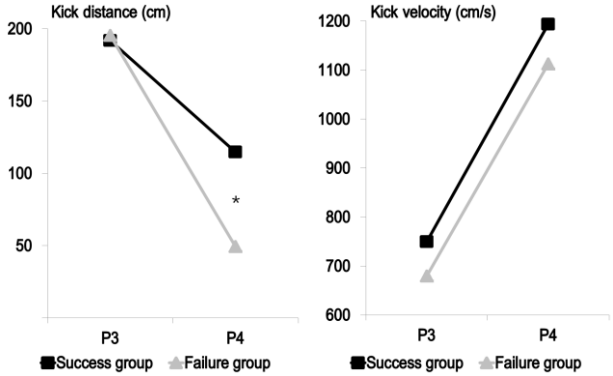


**Figure 5. Comparison of kick distance and velocity between two groups**

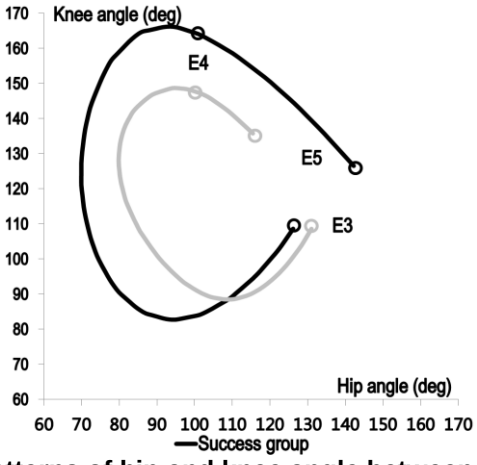


**Figure 6. Patterns of hip and knee angle between two groups**

**DISCUSSION:** Based on the findings, success factors of 540° Dwihuryeochagi were increased COM horizontal velocity at P1, COM vertical velocity at P2, and time at P2 in order to keep long time in the air (Lee, 2013; Ma, 2007). In addition, Dwihuryeochagi must be performed with decreased time at P3, and maximized extension of the hip and knee joints at P3-P4 to increase the size and velocity of the motion.

**CONCLUSION:** The time was longer for S than F during P4. COM vertical displacement and velocity was greater for S than F. At E4, knee angle was greater for S than F. At E5, hip angle was greater for S than for F while kick distance was greater for S than F. Our data would provide useful information for the development of Taekwondo demonstration techniques. Further analysis will be required to investigate biomechanical characteristics of 540° Dwihuryeochagi with increased rotation angles.

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