KINEMATIC ANALYSIS OF GOLF SWING PERFORMED WITH INTENDED LATE HITTING

Jae-Moo So, Young-Tae Lim*, Kyung-Ok Lee,**
Chul-Jung Jung*, and Woen-Sik Chae******
Department of Physical Education, Konkuk University, Seoul, Korea
***Divison of Sport Science, Konkuk University, Chungju, Korea**
****Divison of Exercise, Sport, & Leisure Science, Ewha Womans University, Seoul**
*****Department of Physical Education, Sungkyunkwan University, Suwon, Korea**
******Department of Physical Education, Kyungpook National University, Daegu, Korea**

The purposes of this study were to analyze and compare the kinematic parameters for standard and purpose golf swings. The purpose golf swing is characterized as intended late hitting and increase displacement of ball through the air (carry). Twenty-five male college golfers were recruited as subjects and Science eye field 3 camera system was used to measure the parameters of deterministic model. Paired t-test was used to compare between two different golf swings and correlation coefficients between selected parameters and carry were also computed. As results, a significant difference between standard and purpose golf swings was found in terms of increasing carry. Coefficients of correlation indicated that post-impact ball velocity, pre-impact club head velocity, and meet rate were positively correlated with carry. However, backspin, and angle of release were negatively correlated with carry. These results represented that the parameters of deterministic model were very useful indicators to determine performance and the purpose swing is beneficial to increase carry.

KEY WORDS: golf swing, late hitting, deterministic model, kinematics.

INTRODUCTION: It is well known fact that the existence of the deceleration phase of the wrist motion before impact (late hitting) has mechanical merits to increase the distance of ball through the air (carry). Late hitting is characterized as delay of uncocking timing of wrist during a down swing while keeping a constant cocking angle as long as possible. This late hitting completes with complex sequential movements of leg, hip, trunk, shoulder, grip, and club head and is believed as a mechanically credible technique to increase carry (Neal & Wilson, 1985). The scientific explanation of this phenomenon was well described by Jorgensen (1994) but the effectiveness of this late hitting in real situation was seldom identified. Thus, the aim of this study was the comparison of two golf swing types (standard swing vs. intended late hitting (purpose swing)) in terms of carry. This study also identified the kinematic parameters of purpose swing that are most closely related to the carry.

METHODS: Twenty-five male college golfers (22±1.4 yrs, 173.8±4.2 cm, 69.5±5.3 kg, handicap=5±2.4) served as the subjects. Each subject used a driver (1-wood) and wore his own golf shoes during the tests.

Data Collection: Science eye field 3 camera system (Bridgestone Co., Japan) was used to measure the selected kinematic parameters (Figure 1).

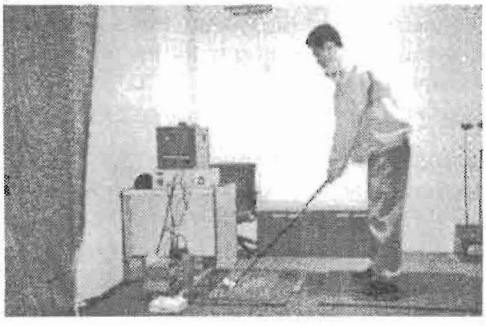

Figure 1: Measurement system and setup for real trial.

This system consists of CCD camera, strobe scope, and head speed measurer and automatically detects velocities (club head and ball), release angle, and backspin. Each subject performed 10 trials (5 swings per each swing type) in a laboratory setting and rated his own performance using a 5-point scale (5 = excellent, 1 = poor) at the end of each trial.

Data Reduction: The trial with the highest rating of each swing type for each subject was selected for analysis. For each trial being analyzed, brief deterministic model was used to evaluate selected kinematic parameters that affect to carry (Figure 2). Velocities (club head and ball), release angle, backspin, and meet rate are considered very important parameters to influence carry. Meet rate at impact is defined as level of contact between ball and club head. It can be measured as the percentage of post-impact ball velocity over pre-impact club head velocity.

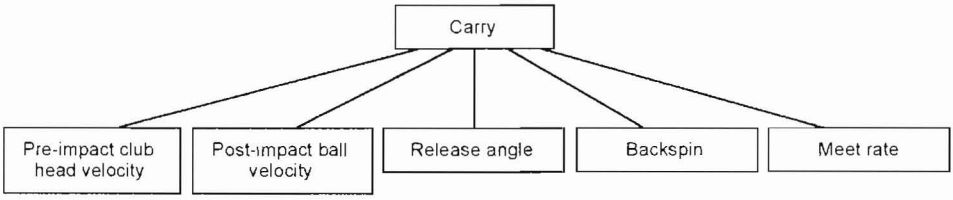

Figure 2: Deterministic model of golf swing.

Data Analysis: Means and standard deviations were computed for each parameter. Paired t-test (p .05) was used to find the difference between two golf swings in terms of carry. The Pearson correlation coefficients were also computed to find the relationships between selected parameters and carry during purpose golf swing. Correlation coefficient of $|r| \geq 0.483$ was required to attain statistical significance at the 0.01 level of probability (n=25).

RESULTS AND DISCUSSION: Mean and standard deviation values of the selected parameters are shown in Table 1.

Table 1 Mean and standard deviations of selected parameters during a golf swing.

Swing type	Club head velocity (m/s)	Ball velocity (m/s)	Release angle (°)	Back spin (rpm)	Meet rate (%)	Carry (yds)
Standard	48.41±3.41	61.8±4.35	10.17±1.86	3734.0±553.81	128±2.88	227.04±22.85
Purpose	48.81±3.46	62.74±4.18	11.04±2.73	3513.6±699.41	129±2.45	243.28±4.28*

Significant difference between two swing types at *p . .05.

Kinematic parameters of standard and purpose golf swings: The average carries of standard and purpose golf swings were 227.04 yards and 243.28 yards, respectively. Paired t-test indicated that there was a significant difference between the two golf swings in terms of carry (p .05). This result proved that the late hitting can increase the carry and seems to be very effective technique to improve the performance. The pre-impact club head velocity of purpose swing also increased by 0.4 m/s compared to that of standard swing. This value is a bit faster than previous studies, which were found as 43.45 m/s, 44.70 m/s, and 47.00 m/s, respectively (Milburn, 1982; Cochran & Stobbs, 1968; Nagao, 1977). The post-impact ball velocity of purpose swing increased by 0.94 m/s compared to that of standard swing and it seems that this value also affect to increase carry considerably. The post-impact ball velocities of elite golfers from previous studies were 63.95m/s, 69.2m/s, and 65.81 m/s, respectively (Yoon, 1992; Choi, 1991; Na, 1994) but current study showed a little slower ball velocity than those previous studies. The release angle of ball for standard swing was 10.17 but this angle was increased by 0.87 for purpose swing. This is unexpected result because greater release angle is usually inversely related to the carry. The backspin of standard swing was 3734 rpm but this

was decreased by 221 rpm for purpose swing. This value is relatively high spin rate compared to the previous report that the rate of backspin from professional golfer was 3244 rpm (Choi, 1991). Meet rate (%) of standard swing was 128% and this increased by only 1 % for purpose swing. According to So's data (2002), proper meet rate for solid impact was 140%. It seems that the meet rate of current study reflects poor impact but the increment of meet rate with purpose swing may contribute to carry considerably.

Correlation coefficients between selected parameters and carry: Correlation coefficients between selected parameters and carry during purpose swing are given in Table 2. Pre-impact club head velocity and post-impact ball velocity were positively correlated with carry. The high correlation coefficients, ranging from r=0.82 (p<.01) to r=0.90 (p<.01), indicate that the club head and ball velocity are major determinants of the variation in carry observed in this study. Meet rate was also positively correlated with carry but statistically insignificant r=0.05, p .05). However, a significant negative correlation coefficient was found between backspin and carry (r=-0.48, p<.01). Release angle was also negatively correlated with carry but statistically insignificant r=-0.26, p .05). The level of variables to contribute carry was post-impact ball velocity, pre-impact club head velocity, backspin, release angle and meet rate in order. These results represented that the variables of deterministic model were very useful indicators to determine the performance of golf swing and the purpose swing style is beneficial to increase carry.

Table 2 Correlation coefficients between selected parameters and carry.

Variables	Carry
Pre-impact club head velocity	0.828*
Post-impact ball velocity	0.901*
Backspin	-0.483*
Release angle	-0.262
Meet rate	0.056

Significant at *p ≤ .01

CONCLUSION: From the results and within the limitations of the study, it can be concluded that the purpose golf swing style with intended late hitting could produce significantly longer carry than the standard swing. Correlation coefficients also indicated that club head and ball velocity factors and backspin rate were major contributors to determine the carry. This demonstrated that the purpose swing is beneficial to increase carry so it is recommended to include the intended late hitting during a swing motion in his/her practice protocol in order to lengthen the carry as long as possible.

REFERENCES:

Choi, W. (1991). Kinematic analysis of impact motion during a golf swing. Unpublished thesis. Hanyang University.

Cochran, A., & Stobbs, J. (1968). The Search for the Perfect Swing, J.B. Lippincott Co., New York.

Jorgensen, T. (1994). The physics of golf. American Institute of Physics, New York.

Milburn, P. (1982). Summation of Segmental Velocity in the Golf Swing, Medicine and Science in Sports and Exercise, Vol.14(1), 60-64.

Na, S. (1994). Study of kinematic variables for optimum golf swing. Unpublished thesis. Sekang University.

Nagao, N. (1977). A kinematic analysis of the golf swing by means of fast motion picture in connection with wrist action. Journal of Sport Medicine, 17.

Neal, R. & Wilson, B (1985). 3D Kinematics and Kinetics of the Golf Swing, International Journal of Sports Biomechanics, Vol.1, 221-232.

So, J. (2002). Biomechanical solution of golf swing. Hong-kyung Publishing Co., Seoul.

Yoon, J. (1992). Kinematic comparisons between novice and expert during a golf swing. Unpublished dissertation. Kyungki University.