

Original article

Determine an effective golf swing by swing speed and impact precision tests

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Abstract

Background: To understand an effective golf swing, both swing speed and impact precision must be thoroughly and simultaneously examined. The aim of this study was to perform both swing speed test and impact precision test to ascertain what swing type determines an effective impact.

Methods: Seven golfers from a college team (handicap: 0–12) were recruited to complete a swing speed test and impact precision test using a 5-iron club. A force plate and electromyography (EMG) system were used to collect data in the swing speed test to compare the difference between two motion sequences. High speed video cameras were used to determine the displacement of rotation center for impact precision test. **Results:** The results showed a significant difference ($p < 0.01$) in clubhead speed with different motion sequences and muscle contraction patterns. In the impact precision test, the displacement of the rotation center which defined as the inner center point of the C7 was significantly different ($p < 0.05$) between different ball impacted marks on club face.

Conclusion: The vertical peak ground reaction force on left foot occurring before impact and the left latissimus dorsi contracting prior to the right pectoralis major represent a superior skill by allowing the club to strike the ball with normal collision at a faster speed.

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Keywords: Clubhead speed; Impact; Motion sequence; Rotation center

1. Introduction

A fast clubhead speed and accurate ball impact comprise a good golf swing motion. This makes the golf ball to travel a substantial distance through the air along the target line, accompanied by a strong back spin.^{1,2} The principles of a superior swing skill for an effective impact should include swing speed and impact precision. Many previous studies have examined the performance of golf swing³ with focus on upper body or lower body motion or on swing speed without probing how to perform a precise impact. In view of above facts, the current study examined the movement of both upper body and lower extremity to determine clubhead speed and body

rotation stability toward understanding a fast and precise impact clearly.

According to kinetic chain principle, swing speed was based on the sequencing from lower limb motion to the upper torso pendulum during a downward swing. Previous studies, with a force plate and experienced golfers, have found that the early outward torque, lateral shear force, and a vertical peak ground reaction force on the lead foot before impact could contribute to a faster swing speed.^{4–6} Although a similar previous research⁶ studied the vertical peak ground reaction force on lead foot before impact which collected data using a force plate without using electromyography (EMG) detection, some other EMG literatures^{7–9} indicated that the vertical peak ground reaction force on lead foot before impact could be represented by the sequential muscle firing of the lead (left) latissimus dorsi prior to that of the trailing (right) pectoralis major. After the left foot increased the ground reaction force¹⁰ to the vertical peak value,⁶ the synchronic motion of the hip

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pivoting counterclockwise direction and the right elbow moving down toward the body during the initial downswing was determined to be helpful in increasing clubhead speed.¹¹ The right elbow moving down toward the body in the early downswing meant that the active left foot gained the reaction first; thus, the upper pendulum motion had to relax until being dragged down in the late acceleration stage when the maximal grip pressure occurred immediately before impact.¹² Therefore, the vertical peak ground reaction force on left foot before impact was considered a superior movement sequence for a golf swing.

Previous swing speed studies regarding the shoulder pivoting around the torso axis have not indicated the rotation center.^{13–15} Almost all previous researchers who have conducted works on the upper torso double pendulum^{16–18} have defined the rotation center as “center point of the shoulder” or “left shoulder tip at a fixed point” upon impact.¹⁹ In addition to many qualitative observers, writers or coaches in golf magazines have expressed unanimously that the instant rotation center at the impact stage was the left shoulder tip or the body center around the navel. Consequently, the shoulder tips moving forward and allowing the shoulder line and its middle point to move ahead of the seventh cervical vertebrae (C7) was considered problematic, and the same phenomenon occurs when the shoulder line moves backwards. Although Coleman and Rankin¹³ and Myers et al.¹⁴ have attached markers on the surface of the C7 as the proximal end of the upper torso triple pendulum model, it was neither for rotation nor for precise impact analysis. Aside from the shoulders’ middle point and posterior point of the C7, a point near the sternum was also considered as an instant rotation center.²⁰ The point of the rotation center should be in the spinal axis and at the same height as the proximal end of the shoulder joining the C7. Therefore, it is feasible to assume that the rotation center was an inner center point of the C7, and the length from the inner center point to the distal end of the pendulum (clubhead) was the swing radius.

Swing speed skill involves a motion sequence that is demonstrated as the vertical peak ground reaction force on left foot occurring before impact, and as the precise impact concerning the stability of the instant rotation center during swing. Therefore, the aim of this study was to perform both swing speed test and impact precision test to ascertain what swing type determines an effective impact. The hypothesis was that the clubhead speed of the motion sequence with vertical peak ground reaction force on the left foot before impact would be significantly higher, and the shifting of an inner center point of the C7 would affect the impact precision.

2. Methods

2.1. Participants

Seven right-handed volunteer participants with estimated handicaps (the average of three best scores within 1 year) ranging 0–12, 19 ± 3 years old, body mass 78.4 ± 4.0 kg, and height 174 ± 5 cm, were randomly selected from a college

golf team to complete a swing speed test and impact precision test. Each participant signed an informed consent to participate in this study. They dressed in black spandex with markers attached on the C7 at the back, the proximal and distal sides of both shoulders, and the clubhead (Fig. 1).

2.2. Data collection

Experimental devices were arranged in an indoor laboratory, as shown in Fig. 2. A reference frame was established as its origin on the force plates. JVC DVL9800U digital video cameras (120 frames/s; JVC KENWOOD Corporation, Kanagawa, Japan) were fixed on the superior view to analyze the rotation stability of an inner center point in the C7 on the horizontal plane and on the posterior view to analyze the C7 height difference on the vertical plane. Photo images were trimmed, calibrated, and digitized using the Ariel Performance Analysis System to capture all parameters of the rotation center point shifting on the two planes.

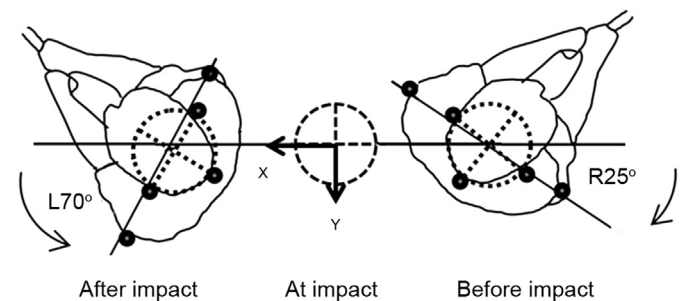


Fig. 1. The rotation center point was defined as the midpoint of two markers on proximal side of both shoulders which near the seventh cervical vertebrae. Rotation stability was calculated from down swing phase ($+25^\circ$ between chest line and target line) to the follow through phase (-70° between chest line and target line) using the mean distance between each rotation center position (X_i , Y_j) and the rotation center position at impact (X_0 , Y_0).

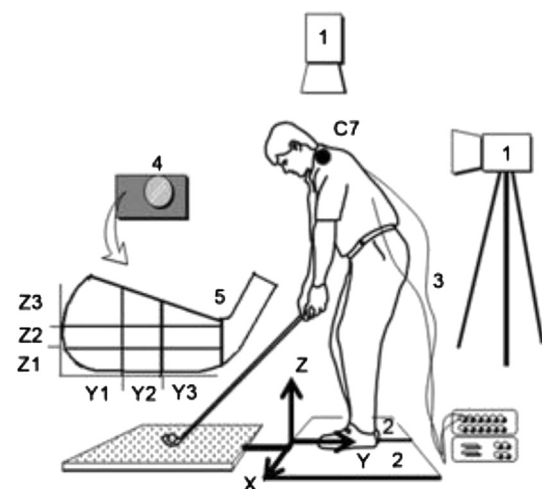


Fig. 2. The arrangement of experimental devices: (1) digital videos; (2) two force plates; (3) EMG electrodes; with (4) a camera taking pictures of impacted ball marks on the nine sections of (5) clubface.

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