Relationship between rotational movement and translational movement during the golf swing

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INTRODUCTION

Several studies of golf swings were investigated the rotation of the trunk and the movement of arms and hands by many researchers. However, a good performance in golf swing is the result of a complex multi-joint movement that is dependent on the forces applied at the feet.

The purpose of this study was to measure and analyze ground reaction forces (GRF) from both feet during the golf swings using a driver. Furthermore, we attempted to clarify the relationship between the rotational movement of the body and the free moment about a vertical axis in the golf swing.

METHODS

Fifteen right-handed male golfers (8 professional golfers in Japan and 7 amateur golfers), with a mean (±S.D) age, height, body mass of 36.2 ± 9.1 years, 170.1 ± 4.0 cm, 72.8 ± 8.0 kg respectively, volunteered to participate in this study. Each golfer carried out 5 shots using a driver. The measurements of kinematics data during the swings were established with the optical motion capture system VICON612 (Vicon Motion Systems Ltd., Oxford, UK) with ten cameras operating at 250 frames per second placed around the subject who performed the golf swing.

At the exact same instant, the GRF's acting at both feet was recorded using one Kistler force platforms. Forces and moments were sampled at 1K Hz using standard coordinate conventions where the positive Fx force was the subject pushing forward, positive Fy was pushing toward the right (away from the direction of the ball flight), and positive Fz was down. We analyzed the golf swing from the start of the downswing to the impact with the ball.3 trials were randomly selected from the 5 shots, and then the data was normalized according to total time

RESULTS AND DISCUSSION

1. Swing time and club head speed

Table 1 show the swing time and club head speed (HS) at impact, hip and shoulder range of the motion (ROM) with the mean (±S.D) respectively.

Table1. Club head speed and hip and shoulder ROM

subject	HS max (m/s)	Time (s)	ROM Hip (deg)	ROM Shoulder (deg)
Mean±SD	38.8±2.7	0.3±0.04	86.0±10.9	114.2±13.1

2. The patterns of GRF and free moment forces

The free moment about the vertical axis increased toward middle range between start of downswing and impact with ball, then reached its maximum value (Mzm). Rotations of both the hip and shoulder were going at maximal value in order to build up energy at the top of the backswing. In addition to that, forces acting the both feet also exert a turning effort on trunk rotation. After Mzm appeared, the vertical GRF attained the maximum value (Fzm), which indicates that the free moment decreased toward the impact, resulting in the transfer of force to the target foot (left foot; right-handed). While forces transferred, knee joint and hip joint tended to be flexed. As a result of forces acting on the entire body appeared maximum value in order of increasing the free moment and the vertical GRF during middle downswing. This phenomenon occurred in all subjects for this study.

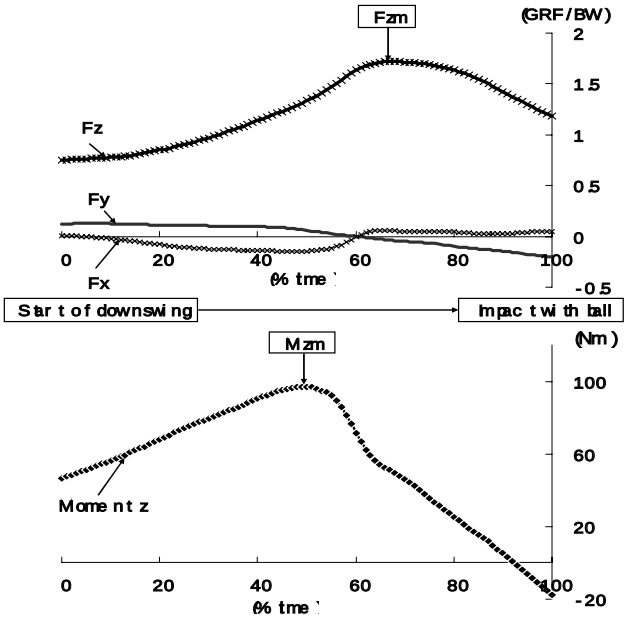

Figure1. The GRF and free moment patterns

CONCLUSIONS

The maximum value of free moment about the vertical axis appeared first during middle downswing in the golf swing, and then the maximum value of vertical GRF appeared in all of the golfers. This suggested that a result of forces acting on the entire body was changed by rotations of hip and shoulder and the flexions of the knee joint and hip joint.

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