THE GOLF SWING: AN EXPLORATION OF BALANCE AND SKILL

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INTRODUCTION

Golf is a sport of both distance and accuracy. Distance is enhanced by greater mobility, but accuracy is associated with greater stability and lesser mobility. This apparent conflict in the mobility and stability components of balance may be resolved differently by performers of diverse skill. The purpose of this study was to explore how golfers of advanced and intermediate skill regulate balance in the golf swing.

METHODS

The advanced performer (AdP) in this study was a male golf professional with previous intercollegiate experience. The intermediate performer (ImP) was a male recreational golfer with no formal competitive experience. Both right-handed golfers hit several shots with a six iron and an indoor golf ball. Some shots were hit with both feet on a portable Kistler force plate (40x60 cm), and other shots were hit with either the left or right foot on the force plate and the other foot on a platform which was adjacent to and flush with the force plate. Force data were collected at 250 Hz, processed with Bioware software, and converted to units of body weight (BW). Mediolateral (M-L) and anteroposterior (A-P) center of pressure (CoP) was used as an indicator of stability. Similarly, M-L and A-P force was used as an indicator of mobility.

The front of each subject was videotaped at 60 Hz, and a representative shot was analyzed to obtain information about balance in the M-L plane. Segmental end points as they appeared in the M-L plane were digitized and filtered with the optimal Butterworth procedure of the Peak5 software. Standard body segment parameters were used to obtain M-L position and velocity of the body's line of gravity (LoG). Base of support (BoS) was computed as the distance between the most extreme left and right points of contact with the force plate at address.

RESULTS AND DISCUSSION

The AdP had a BoS of 47 cm and the ImP had a BoS of 50 cm in the M-L plane. For both golfers, as well as for a group of Japanese professionals (Nagao & Sawada, 1974), the BoS was 26% of standing height. The LoG of the AdP moved through a 19-cm excursion (39% of the BoS) from the backswing to contact when it was 27 cm from the right edge of the BoS. Similarly, the LoG of the ImP moved through a 25-cm excursion (51% of the BoS) until contact when it was 36 cm from

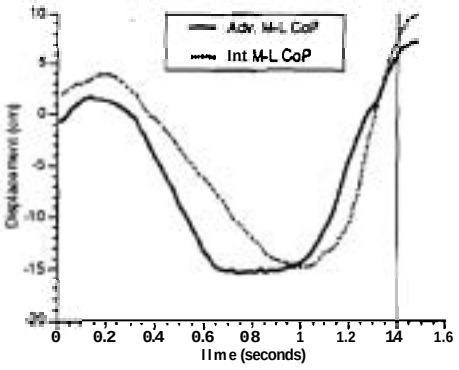
the right edge of the BoS. Thus both golfers shifted their weight from the right foot in the backswing to the left foot at impact. Koslow (1994) found that only 27% of beginning golfers could make this weight shift. Also, novice golfers have about half the lateral movement of elite golfers during the downswing (Sanders & Owens, 1992). Perhaps a greater range of motion leads to a better weight shift which marks the transition from beginning to intermediate golfer. At a more advanced level, a typical intercollegiate golfer moved his LoG to a position 75% of the distance toward his left foot at contact (Cooper, et al., 1974). The ImP was comparable at 72% but the AdP at 57% was not. Data for M-L CoP are presented in Figure 1. The AdP had a 21-cm excursion and the ImP had a 23-cm excursion of CoP. Both golfers had similar CoP patterns, but the AdP had a flatter curve while his weight was on his right foot. In terms of both LoG and CoP, the AdP appears to have greater stability in the M-L plane.

Forces in the M-L plane (Figure 2) were similar in pattern to M-L CoP. Again, the AdP had a relatively invariant application of force while his weight was on his right foot. For both golfers M-L forces were generally less than ±.15 BW. The M-L velocities (Figure 3) had similar patterns for both golfers; peak velocity away from the target was less than half of peak velocity toward the target. The AdP was less mobile in that his peak values were about two-thirds as high as the ImP's. The biggest difference in M-L mobility between the golfers can be seen in horizontal velocity of the left hip (Figure 4). In addition to greater peak values, the ImP had no period of constant velocity, and his velocity was .56 m/s at contact. On the other hand, the AdP held his left hip firm for a lengthy period in mid-swing and had a near zero (.07 m/s) velocity of his left hip when contacting the ball. This result is in keeping with Koenig and coworkers (1993) who reported that skillful golfers try to stabilize their lateral motion at impact and with Sanders and Owens (1992) who showed that elite but not novice golfers minimized lateral movement of the head at impact.

Both golfers were relatively stable in the A-P plane. The excursion of the AdP's CoP was 4.5 cm and the ImP's was 2.5 cm (Figure 5). These results are similar to those of Lange et al. (1993) who noted a CoP excursion of 3.5 cm in skilled golfers. Richards et al. (1985) reported that the CoP of low- and high-handicap golfers traversed 20% and 5% of the A-P BoS, respectively; and they suggested that the larger value was related to more effective lower-body rotation.

Using A-P forces as an indicator of mobility (Figure 6), the AdP was comparable to the skilled golfers studied by Koenig et al. (1993) and Williams and Cavanagh (1983). In contrast, the ImP had rather dramatic oscillations in force during the .2 s prior to impact. Carlsoo (1967) showed a similar but relatively attenuated example of pre-contact oscillation for an elite golfer. Erratic anterior forces are not surprising given that a driver can change anterior velocity from 0 to 15 m/s during this phase of the swing (Neal & Wilson, 1985). Coincident with the

oscillations, the ImP moved his left heel about 6 cm medially relative to the left toe which did not appear to move. According to Koenig and colleagues, greater movement of the feet is characteristic of the less skilled.



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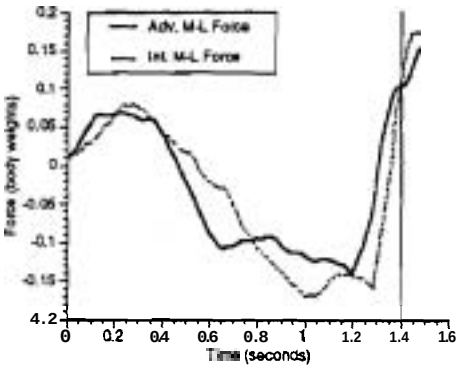
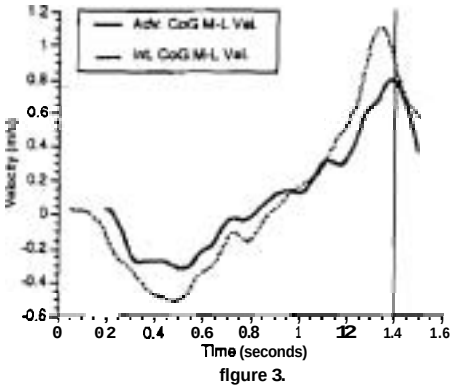


Figure 2



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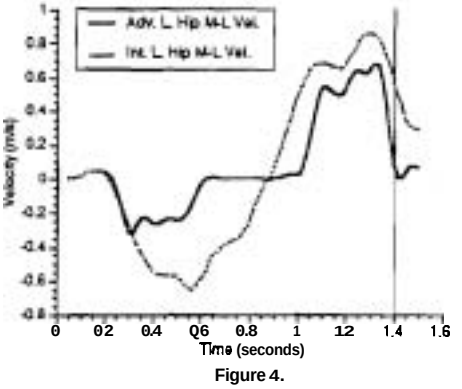

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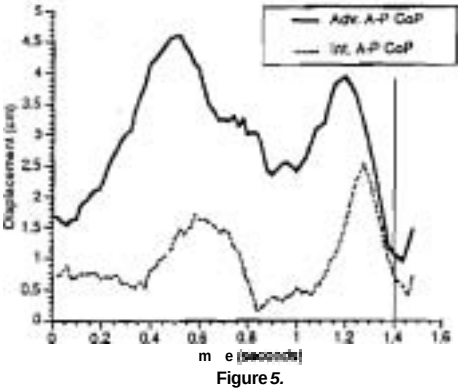

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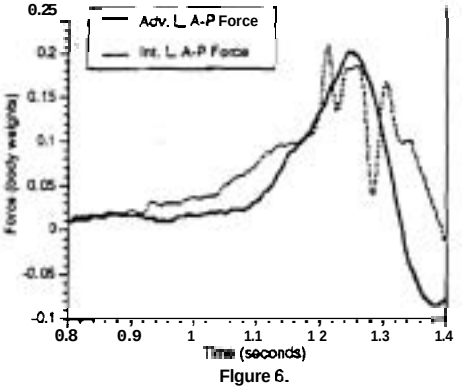

Figure 6.

Figures 1-6. Indicators of stability and mobility in the golf swing for advanced and intermediate performers. Contact occurs at 1.4 s. For M-L data, positive values are toward the left/target. For A-P data, positive values are anterior.

CONCLUSIONS AND APPLICATIONS

The ImP seems to have reached an advanced level in M-L stability but not in M-L mobility. In particular he should arrest the mobility of his trunk at impact, and this could be facilitated by reducing his velocity away from and toward the target. In the A-P plane the ImP had too much stability and too much mobility (in the form of oscillations). Both of these problems seem to be related to suboptimal long-axis rotation in the lower body. Appropriate shoes and plenty of practice may be the solution. Even though the AdP had good clubhead velocity on his iron shots, his M-L stability was greater than expected. If the distance on his drives is not satisfactory, he should consider moving his LoG through a wider range.

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