HOW THE VGRF CHANGES WITH THE CHANGES OF THE CLUBS IN GOLF SWING

RakJoon Sung

Dept. of Leisure and Sports Studies, Hoseo University, Asan, Korea

It is assumed that the ground forces would be different according to the club used because the length and swing weight of each club is different. This study focused on the investigation of the changes of the vertical ground reaction forces (VGRF) by the change of the club length. The subjects were three professional male golfers. Four clubs swing (driver, iron 3, iron 5, and iron 7) for each subject were taken by two high speed video cameras. Two AMTI force platforms were used to measure the VGRF simultaneously. Maximum VGRF was occurred at the club horizontal position in the downswing for the left foot. The shorter club produced more maximum forces than longer ones in the left foot, but reverse were true for the right foot. Maximum VGRF at impact shows the same patterns.

KEY WORDS: club length, vertical ground reaction force (VGRF)

INTRODUCTION:

It is necessary to have a correct knowledge about the vertical ground reaction forces (VGRF) during the swing for the purpose of good teaching and improve the swing performance. One of the questions that a golfer could have is “How the GRF changes with the changes of the golf clubs? Longer clubs need more VGRF than shorter ones?” But there were only a few studies which investigate this topic. Cooper, Bates, Bedi, & Scheuchenzuber (1974) and Koenig, tamres & Mann (1994) analyzed the swings of 3 different clubs (Driver, Iron 3, Iron 7), Barrentine, Fleisig, Johnson & Woolley (1994) analyzed only 2 different clubs (driver, Iron 5). Nevertheless we can’t draw any answer from these articles, because of these were focused on the comparison between expert and novice players. Koenig et al (1994) reported that the weight shifting pattern is different between clubs. Other researchers, Cooper et al(1974), Koenig et al (1994), Barrentine et al(1994), reported that the vertical GRF of driver swing was the greatest compare to other club swings. Therefore this article focused on the investigation of VGRF changes during the swing made by various clubs such as driver, long iron, middle and short iron.

METHOD:

Data Collection: The subjects were three right handed male professional golfers who have more than 12 years career, and their mean height and weight were 175.3cm, 86.7 kg respectively. GRF data were collected using two force platform (AMTI) mounted on the laboratory floor. Sampling rate of the force platforms were 1000 Hz . Swing motions were captured using two high speed digital cameras (Photron PCI 500). For the synchronization of cameras and platforms, a synchronize device (Visol, www.visol.co.kr) was used. Four clubs - driver, long iron (I3), middle iron (I5), short iron (I7), were selected for the experiment and same clubs used for all subject to diminish the effect of the club. Subjects requested to swing the shorter club first and every subject made a swing three times. After the data collection for one club was done for all subjects, the next data collection was made.

Data Analysis: Among the three trials for each club, one trial that the subject most satisfied was chosen. From this selected trials, GRF data for the specific events were collected. Total 11 events were set for the analysis based on Sung (2004). From the setup (event 0) to the finish (event 10), every 90 degree rotation of the club viewed from front was set as an event. VGRF at every event collected from the trial of each subject and mean of each event calculated for the four clubs used. GRF data was normalized by each subject’s weight and the unit of VGRF is %BW.

RESULTS:

Total pattern of VGRF was similar to that was reported by Barrentine et al (1994). VGRF changes of each subject had a unique pattern but each subject shows consistent pattern for all swings. This consistency of low handicappers was reported by other studies (Carlsoo, 1967; Cooper et al, 1974; Richards, Farrell, Kent & Kraft, 1985; Williams & Sih, 1998). Most studies agree to the maximum vertical ground reaction force (VGRF) of the left foot is the one of the most important factor to increase the speed of the head of the club at impact. But the magnitude and occurrence time of this force is not coincide. Calsoo (1967), Cooper et al(1974) and Richards et al(1985) reported that this is occurred before the impact, but others reported this is occurred at impact (Okuda, Armstrong, Tsunezumi, & Yoshiike, 2002) or after the impact (Cooper et al, 1974). Analyzed result shows that occurrence time of maximum VGRF of the left foot was different from subjects. Therefore the VGRF at event 6 (club horizontal at downswing) was used as a time when the maximum VGRF was occurred. This is because of the VGRF of this event was the maximum among the entire events and shows 91.3%~96.3% range of the real maximum.

VGRF changes of each foot: Figure 1 shows the mean VGRF of left (Fz_L) and right foot ((Fz_R) for four club swings. There was no significant VGRF differences between clubs until the evt 4 (top of backswing). VGRF of right foot increase rapidly at evt 2 (club horizontal in the backswing) and this is the maximum VGRF of the right foot. From the beginning to evt 5 (club vertical in the downswing), VGRF of left foot shows symmetry that of right foot. This is because of the proper weight shifting to the right side at backswing. After this time, this force increasing rapidly and reaches the maximum at evt 6 (club vertical in the downswing). The order of maximum VGRF of left foot at evt 6 was I7 (0.93 %BW), I5 (0.86 %BW), I3 (0.84 %BW), driver (0.79 %BW) respectively and shows the maximum VGRF of left foot became smaller for the longer clubs. Same pattern was showed at evt 7 (impact). On the other hand, right foot shows reverse pattern that of left at evt 6. The order of max VGRF was I5 (0.67 %BW), driver (0.65 %BW), I3 (0.62 %BW), I7 (0.61 %BW) respectively. Except the I5, it shows the maximum VGRF of right foot became greater for longer clubs. Also same pattern was showed at evt 7 (impact).

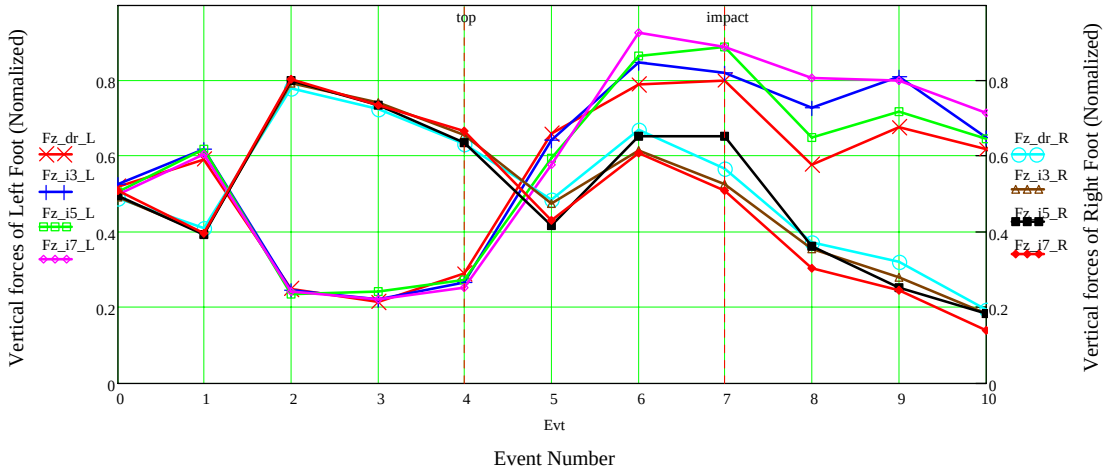

Figure 5: Mean VGRF of left (Fz_L) and right (Fz_R) foot for four clubs. Fz_dr_L denotes mean VGRF of Left foot for Driver.

Sum of mean VGRF of each foot: Figure 2 shows the sum of mean VGRF of each foot. During the backswing, from setup to evt 4, the net VGRF maintain the weight and shows little variation. After the downswing begin, the net VGRF increase rapidly and reaches the maximum at evt 6. The order of the maximum VGRF at evt 6 was I7 (1.54 %BW), I5 (1.51 %BW), I3 (1.46 %BW), driver (1.46 %BW). This shows the same pattern that of the left foot described above. This means that the maximum net VGRF became smaller for longer clubs. Also net VGRF at evt 7 (impact) showed same pattern.

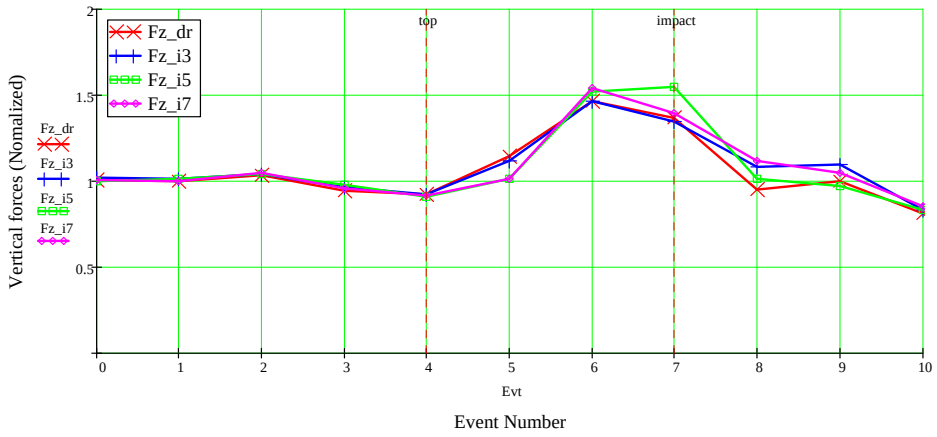

Figure 6: Net VGRF. Each value denotes the sum of mean VGRF of each foot.

DISCUSSION:

The result of this study might be confusing because there were many studies that report driver swing had maximum VGRF at impact for left foot. On the other hand, there were many studies that support the result of this study. Calsoo(1967) reported 0.88 %BW for I5 swing. Hur, Moon & Lim (2005) reported 0.63 %BW, 0.84 %BW, 0.95 % BW for driver, I4, I7 clubs respectively. Also Lee & Lee (2005) reported 60.2 kg, 64.6 kg for drive and I7 swing. Therefore it seems to be the result of this study is valid because the lie angle of the club became lager for the longer shafted club, and the swing plane of longer club became more flatter(Sung, 2004).

CONCLUSION:

Maximum VGRF was occurred at the club horizontal position in the downswing for the left foot. The shorter club produced more maximum forces than longer ones in the left foot, but reverse were true for the right foot. Net VGRF shows same pattern that of the left foot. This result coincides with the general golf theory - the swing plane of a shorter club became stiffer, so you have to hit the ball more down blow. This is the reason why the max VGRF of driver is the less.

REFERENCES:

Barrentine, S. W., Fleisig, G. S., Johnson, H., & Woolley, T. W. (1994). Ground reaction forces and torques of professional and amateur golfers. In A.J. Cochran & M.R. Farrally (Eds.), *Science and golf II*. pp. 33-39. London: E&FN SPON.

Carlsoo, S. (1967). A kinetic analysis of the golf swing. *J. Sports Med. Phys. Fitness*, 7(0), 76-82.

Cooper, J. M., Bates, J. M., Bedi, J., & Scheuchenzuber, J. (1974). Kinematic and kinetic analysis of the golf swing. *Biomechanics*, IV.

Hur, Y.J. Moon, G.P. & Lim, J. (2005). A study of ground reaction forces during professional golfer's swing with different golf clubs. *Korean journal of sport Biomechanics*, 15(2), 103-111.

Koenig, G., Tamres, M., & Mann, R. W. (1994). The biomechanics of the shoe-ground interaction in golf. In A.J. Cochran & M.R. Farrally (Eds.), *Science and golf II*. pp. 40-45. London: E&FN SPON..

Lee, B.J, Lee, D.K. (2005). Analysis of plantar foot pressure during golf swing motion of pro & amateur golfers. *Korean journal of sport Biomechanics*, 15(2), 41-55.

Okuda, I., Armstrong, C. W., Tsunezumi, H., & Yoshiike, H. (2002). Biomechanical Analysis of Proffessional Golfer's Swing: Hidemichi Tanaka. In E. Thain (Ed.), *Science and golf* IV. pp. 18-27. London: Routledge.

Richards, J., Farrell, M., Kent, J., & Kraft, R. (1985). Weight transfer patterns during the golf swing. *Res. Quarterly Exerc. sport*, 56(4), 361-365.

Sung, R. J. (2004). A study on the swing path and plane of the colf club in golf swing. *Korean journal of sport Biomechanics*, 14(1), 99-115.

Williams, K. R., & Sih, B. L. (1998). Ground Reaction Forces in Regular-Spike and Alternative-Spike golf Shoes. In M.R. Farrally & A.J. Cochran (Eds.), *Science and golf III. pp.* 568-575. Human Kinetics.