ANALYSIS OF THE GOLF SLOPE SHOT BY GROUND REACTION

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INTRODUCTION

The purpose of this study was to develop a method for improving performance by weight transfer of slope shots. The golf swing is a complex movement which, to a large extent, is influenced by the action of the feet. To better understand proper swing mechanics, a number of researchers have studied the reaction between the golfer and the ground. Kawashima (1988) measured the pressure of weight transfer during the golf swing. Studies by Carlsoo (1967) and Cooper et al.(1974) provided an initial scientific description of ground reaction forces and and torques during the golf swing. Similarly, Cooper et al (1974) tested five elite golfers using different clubs and found that the forces causing clockwise rotation were reversed from 70 to 140 ms prior to impact.

It is necessary to comprehend the mechanism in order to achieve effective movement of the slope shot. Weight transfer could be subjectively observed alone in slope shots. It became obvious that there was a difference among the four golfers in the swing movement by comparing the weight transfer of the slope shots.

METHODS

Subjects were a professional golfer (E.N.) and three amateur skilled golfers; Upper-class (M.N.) middle-class(R.E.) and beginner-class (H.H.). All subjects were right handed male golfers and used the seven iron. Subjects stood on top of the plate facing uphill; downhill; uphill and sloping left; and downhill and sloping left. The degree of lie was set at twenty degrees. The experiment measured body turbulence during performance of the slope shot (3 seconds). Input was sampled at a frequency of 200Hz, 5ms with A/D converter device, furthermore strain amplitude was measured by a force plate and filtered by a special computer program. These slope shots were filmed at 60 fps speed, from the front (about 10M) of the subject by using VTR camera. Also, a VTR camera was used to analyze the phase of address, impact, and follow-through. Impact was recorded using a laser sensor (lms). These data were analyzed comparatively. Table 1 shows the physical characteristics and fitness of subjects. Figure 1 shows diagrammatic illustration of the experiment system.

Parameter	Age (yrs.)	Mass (N)	Grip Strength (N)		Back Strength (N)		HDCP (0-36)	Career (yrs.)
			R	L				
E.N.	50	1.66	735	491	431	1421	0	37 (PRO)
M.N.	18	1.70	588	499	470	1332	8	8 (U.C.)
R.E.	20	1.72	637	401	394	1264	13	13 (M.C.)
H.H.	20	1.71	735	480	431	1666	36	0.8 (B)

Note. PRO - Professional; U.C. - Upper Class; M.C. - Middle Class; B - Beginner

Table 1. The physical characteristics of subjects, and physical fitness

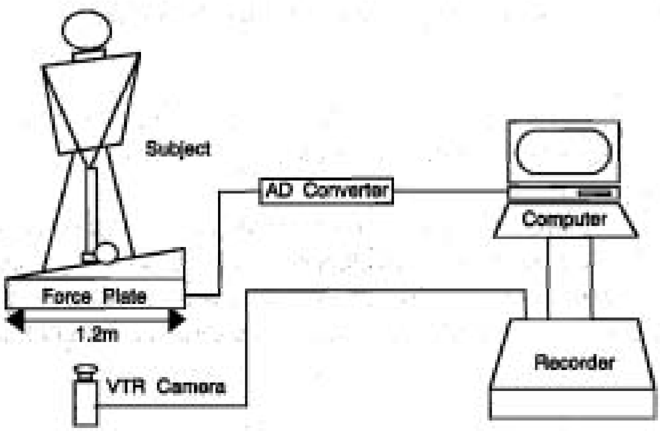

Figure 1. The overall structure of the testing apparatus

RESULTS AND DISCUSSION

Table 2 shows path of the ground reaction values of the phase, while comparing slope shot during the golf shots. Figure 2 shows typical example of locus of ground reaction for the uphill lie, down hill lie, downhill lie of left, and uphill lie of left.

Parameter	X Axis (mm)	Y Axis (mm)	Distance (mm)	Velocity (mm/s)	Area (cm^2)	Pressure (N) (%)
Subj. EN (Professional)						
Uphill	-54.2	135.8	2779	962	773	1421(168)
Downhill	-135.7	147.0	2536	845	492	1323(151)
Downhill(left)	-182.1	130.6	3962	1320	377	1234(142)
Uphill(left)	114.0	109.0	2401	800	512	1195(141)
Subj. **M.N** (Upper-class)						
Uphill	-46.2	63.5	2283	761	401	970(128)
Downhill	15.9	165.8	2774	924	298	1156(152)
Downhill(left)	-223.0	100.9	2120	706	290	1088(141)
Uphill(left)	203.0	139.5	4694	1564	854	1038(137)
Subj. RE (Middle-class)						
Uphill	-6.5	134.7	2983	994	369	783(129)
Downhill	-18.7	161.9	2887	962	276	852(150)
Downhill(left)	-236.0	175.0	3042	1014	455	911(163)
Uphill(left)	172.1	173.0	3059	1019	222	725(130)
Subj. H.H (Beginner)						
Uphill	2.0	118.0	2413	804	476	1087(127)
Downhill	-52.0	192.8	2744	914	622	1234(143)
Downhill(left)	-242.4	166.7	2429	807	678	1185(137)
Uphill(left)	145.0	150.3	2458	819	296	1156(133)

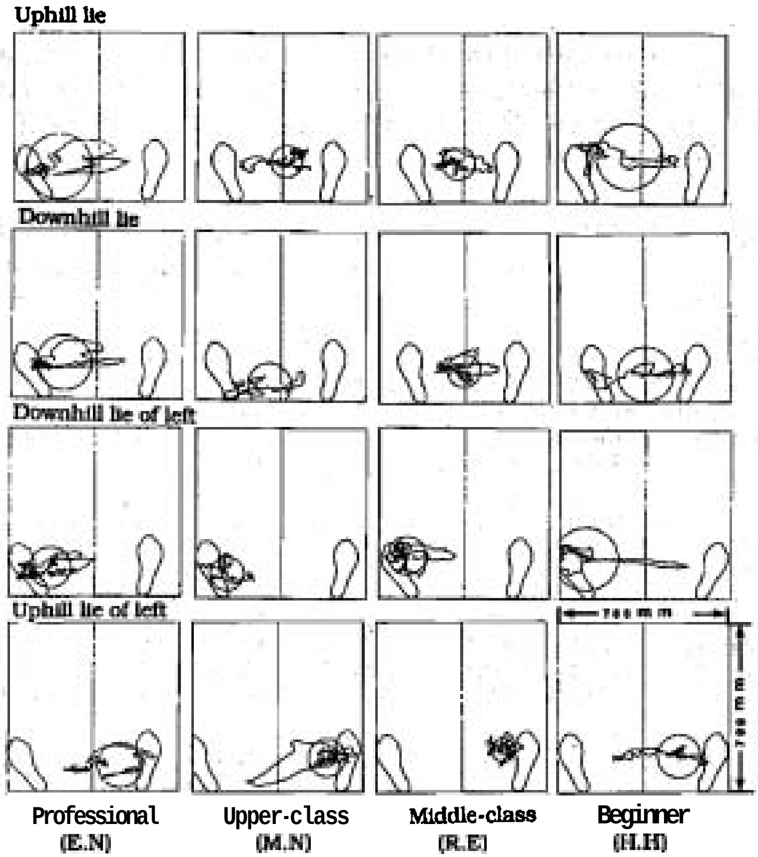

Figure 2. A typical example of locus of ground reaction uphill lie, down hill lie, downhill lie of left, and uphill lie of left.

As for the ground reaction force on an uphill lie, professional golfer E.N. had much larger path way of target foot than that of players of the upper-class M.N., middle-class R.E. and the beginner-class H.H. Theresultant of body weight transfer in the downhill lie were compared among four golfers. Professional golfer E.N. showed loci of weight transfer among the target foot and the center of stance. The center of vertical force by the downhill lie appeared at the orbit on target foot sole pressure of four subjects.

Professional golfer E.N was loaded comer point to a left foot by uphill lie and down hill lie of left. Because a slope shot is not flat of a stance an upper part of the body become instable. The orbits of transfer foot were found to be two types patterns, orbit transferred at small circle with middle-class player, while the straight line were created by beginner, and a square area were observed by professional golfer and upper-class player.

REFERENCES

Carlsoo, S. A. (1967). Kinetic analysis of the golf swing. Journal of Sport Medicine and Physical Fitness, 7:80-81.

Cooper, J. M., Bates, B.T., Bedi. J., and Scheuchenzuber, J. (1974). Kinematic and kinetic analysis of the golf swing. in R. C. Nelson and C.A. Morehouse (Eds.) Biomechanics 15: Proceedings of the Fourth International Seminar on Biomechanics, , Balti more: University Park Press, 289-305.

Rechords J., Farrell, M., Kent J., & Kraft, R. (1985). Weight transfer patterns during the golf swing. Research Quarterly, 56 (4), 361-365.

Kawashima, K. (1987). The biomchanics of golf swing: by weight transfer loci. Japan Journal of Golf Sciences, 1 (1), 34-40.

Kawashima, K. (1988). Changes on movement pattern of practices in golf swing. Proceeding of Japanese Journal of Biomechanics, 9(1), 52-56.