

ANALYSIS OF GRIP FORCE DURING GOLF PUTTING AT DIFFERENT DISTANCES - PILOT STUDY

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The purpose of this study was to explore the grip force performance at different distances during putting stroke. Four golfers (2 professionals and 2 novices) as accurately as possible executed a putt to reach 1, 2 and 3 m target distance, respectively. Putting motions were recorded by JVC video and grip pressure measurement sensor placed on two hands, allowing the force output of all regions of the hands to be measured. The grip force trace among 1 to 3 m distance was repeatable across putting strokes for each golfer but between golfers was inconsistent. Dominant forces appear to arise primarily from the left hand. In this study, the grip force and force distribution were preliminarily discovered during putting stroke at different distances. This research has suggested a potentially important influence of grip force on the golf putting performance in long distance.

KEY WORDS: golf performance, pressure mapping sensor, force measurement

INTRIDUCTION: The final motor skill often executed on a golf hole is putting. For low scores, consistently successful putting skills are necessary. Tiger Woods (2007) indicated that many amateur golfers grip the putter too tightly from the start or increase grip pressure during the stroke. The grip force should be light enough to provide wrist mobility and feel, but sufficiently firm to maintain control throughout the swing. Furthermore, all golfers will be prohibited from anchoring the club either directly or by use of an “anchor point” in making a stroke, due to a new Rules of Golf 14-1b from R&A and the United States Golf Association, which has been in effect since 2016. As this result, the force is just transmitted through the hands to the ball. Hence, this is especially noteworthy in the case of grip force to control the putt. However, professionals and instructors hold opposite views, Couples (1994) proposed that left hand grip the club more firmly; on the contrary, Faldo and Saunders (1989) claimed that right hand dominates grip force. How large the grip force, which is better to control the direction and distance of the ball during golf shots, remains unknown. This study is aimed to investigate the grip force and force distribution at different distances during putting stroke by using the pressure sensor.

METHODS: Four right-handed golfers including two professional golf players (A: LPGA level and B: national level in Taiwan) and two golf novices (C and D) participated in this study (Table 1). Each participant performed at least 3 hole-outs following a grip style (overlapping) at three target distance of 1, 2 and 3 meter (m), respectively. All of the participants performed on a synthetic grass surface (length 4 m × width 2 m) with a golf hole (diameter 0.108 m) and using a putter (ARESo C10). The grip force was measured during each test by utilizing the Grip™ Pressure Measurement System

Table1
Physical and performance characteristics of four participants.

Golfer	Gender	Age(years)	Height(m)	Weight (kg)	Experience (years)
A	Female	23	1.70	61.1	13
B	Male	40	1.78	91	27
C	Female	33	1.65	55	0.5
D	Male	23	1.67	59	0.5

(Pressure Mapping Sensor 4256E, Tekscan Inc., Boston, MA, USA) sampling at 150 frames per second, with two sensors each placed on separate hands. The process of

putting motion was recorded by a high speed JVC camera at 150 Hz and used a LED light, in order that each phase could be determined on the force traces. The golf swing was divided into three distinct regions (Fig.1): Phase I - initiation of swing to the top of the backswing, Phase II – down swing from the top to ball contact, Phase III - follow through from ball contact to the highest point. The time during putting stroke was normalized to 100%. After force profiles from each trial were time normalized to percent of putting stroke, the data obtained was analyzed by and average force profiles ($M \pm SD$) were computed.

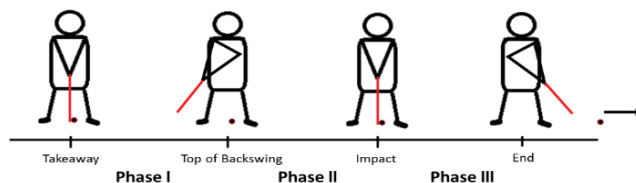


Figure1: The illustration of golf putting stroke

RESULTS: The success rate (%) during the putting test: Golfer A (80, 100, 80); B (100, 80, 60); C (80, 40, 36); D (100, 80, 20) at 1, 2 and 3 m distance, respectively. Basically, all golfers performed quite steadily at 1 and 2 m. Over 2 m distance the success rate obviously dropped; particularly, putting at 3 meter was quite difficult for golf novices. For all golfers, the mean of grip forces are around from 2 to 5 kg during putting test at different distances (Table 2) and grip force is proportional to the distance. Furthermore, a graphic depicting the total, left, and right hand forces for four golfers is provided in Figure 2. The grip force traces were repeatable for each golfer, yet varied from those of the other golfers. Even golfer B reached a slim peak during putting stroke, a peak force was observed at impact the ball, especially at 3 m distance. The professionals had similar force trends among three distances. Nevertheless, the grip force traces at 1m remained constant but sharply increased at impact at 2 and 3 m putting distance for the novices. Additionally, the left-hand force was larger than right-hand force for most of golfers among 1-3 m distance, except golfer C.

Table2

The average of total grip force (kg) during putting test at different distances

	1m	2m	3m
Golfer A	3.44±0.52	3.66±0.21	3.75±0.16
Golfer B	2.18±0.14	2.46±0.04	2.55±0.07
Golfer C	2.80±0.08	3.52±0.30	3.84±0.27
Golfer D	3.60±0.52	4.66±0.46	5.71±1.16

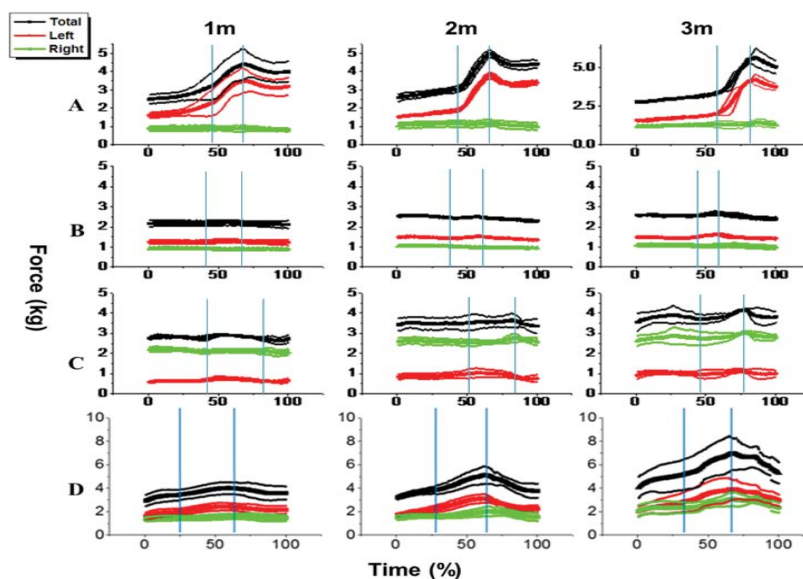


Figure 2: Grip force traces (Black: total, Red: left hand, Green: right hand) for four golfers during putting test at 1-3 m. All shots aligned at 100% (0%: takeaway; first blue line: top of back swing; second blue line: impact; 100%: finish).

In addition, an exemplar describing main forces distribution on the left and right hand applied to a putt by professional golfer A, who maintained the same place during putting stroke in the same distance. Dominant forces arose primarily from left-hand metacarpal bone of the little finger; from right-hand index finger, the middle finger and the little finger. At 1, 2 and 3 m distance, the left and right hand forces in dominant area were calculated by Grip Pressure \times Dominant area (0.64cm^2) = (0.31, 0.08) kg; (0.33, 0.09) kg; (0.34, 0.12) kg at impact the ball, respectively.

DISCUSSION: The data for professional golfer A described that the grip force trace rose gradually in phase I and leapt in phase II reaching a peak near impact and declining during phase III. This result is entirely consistent with the outcomes from Chen et al. (2008) and Yang et al. (2011) reported for golf putting in previous studies. On the other hand, all grip force traces among 1 to 3 m for professional golfer B were quite low comparing with other golfers and fluctuating mildly during the whole putting stroke. The golf putt seems to be executed in different techniques among golfers. For instance, hip and shoulder rotations during the golf swing. In addition, the grip force traces during putting at three different distances for professionals is more steadily than novices. Besides, as shown in the figure 2, professionals had shorter period of phase II during a putting stroke than novices. The putt was modified by increasing the downswing amplitude while target distance increased to reach optimal velocity at impact for accurate putting. (Delay et al., 1997; Leadbetter, 1997). The key to distance control is to roll the ball, not hit it. Additionally, some research indicated that the left hand dominated the golf swing (Komi et al., 2008; Langlais & Broker, 2014). Left hand force appears to provide the dominant grip forces during a putt acceleration, which are larger than right hand force and similar to the total grip force trace.

CONCLUSION: In this study, both the professional and the novice golfers were observed that a peak force was generated at impact at 3 m during a putting stroke and the putting stroke was performed repeatable among 1 to 3 m distance. The professional golfers seem to generate the dominant force from the left hand during a putt. However, the golfers have their own unique grip force trace. Future grip force studies with more participant populations will be needed to strengthen or broaden on some of the comments made in this study. This research suggests a potentially important influence of grip force on the golf putting performance in long distance.

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