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**AN INVESTIGATION INTO THE EFFECT OF THE  
ROLL OF A GOLF BALL USING THE C-GROOVE  
PUTTER**

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**Abstract**

This study examines the effect that a C-Groove putter has on the roll and skid performance of a golf ball during the first 500mm of a twenty-foot straight putt. Video analysis at 25 frames per second was used to record distance travelled and ball rotation during the initial stages of putts. Thirty European Tour Professionals performed their typical putting action under two test conditions. These test conditions were to use their own personal tour putter (Brand X) and the C-Groove putter (C-Groove). None of the thirty golfers participating in this study were familiar with the C-Groove putter. Each subject used both their own putter (Brand X) and the C-Groove to perform twenty-foot putts on PGA Tournament Greens (10-11 Stimpmeter). Significant differences were found between the Brand X and C-Groove putters in the amount of forward roll and skid of the golf ball during the first 500mm of the putt. This study shows that the C-Groove putter reduced skid and increased forward rotation on the golf ball in the initial stages of a 20-foot putt.

*Keywords:* Golf Putting; Roll, Skid, C-Groove, Performance.

## Introduction

“The putting stroke is only one of several different types of golf swings, yet it accounts for nearly half of all swings made”

43 percent (Pelz 2000) 45% (Swash 2001)

Putting has been described as a game within a game on numerous occasions. The majority of coaching magazines, manuals, textbooks suggest ‘**feel**’ as the key to success, along with a ‘**good technique**’. A good technique is required in order to create the confidence necessary to hole putts. There is no recovery opportunity from bad putting or back luck. Bad luck may be due to spike marks, pitch marks, footprints or even the ragged edge of a cup can cause a putt to go off line and miss the target. Swash (2001) states that “..The key to more accurate putting is to achieve rolling motion immediately upon striking the golf ball..” and “..with immediate and pure forward roll, a ball has a much better chance of staying on line to the hole and not being deflected by a footprint or even a spike mark..”.

The C-Groove putter designed by Swash has concentric grooves machined into its face at a 20-degree angle. Swash (2001) suggests that when the crown of the grooves strikes a golf ball, the ball is held onto the face of the putter a fraction of a second longer than is possible with a smooth-faced putter (‘dwell time’) and this helps to improve the roll characteristics of the ball. This paper reports on a set of experiments which tests the ability of the C-Groove putter to impart an early forward roll to the golf ball during the first 500 mm of a typical 20 foot straight putt.

## Method

### *Test Condition*

There were two test conditions:-

Test Condition 1 : Brand X Putter ‘PGA European Tour Golfer – Own Putter’

Test Condition 2 : C-Groove Putter. There are 5 C-Groove putter types:

Traditional Blade, Mallet, Centre Shafted, Insert and Face Balanced Blade models. All PGA European Tour subjects were allowed to choose from the range of C-Groove putters that which most suited their style of putting. (Figures 1,2 and 3 show details of the C-Groove)

The C-Groove putters used in this experiment were all designed with steel ‘True Temper’ shafts, Golf Pride Grips and a standard lie with a 2° / 3° loft angle.

Figure 1: Face Balanced Blade Model Figure 2: Cross Section of the C-Grooves

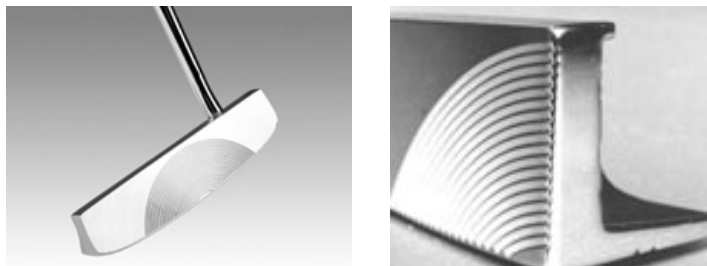
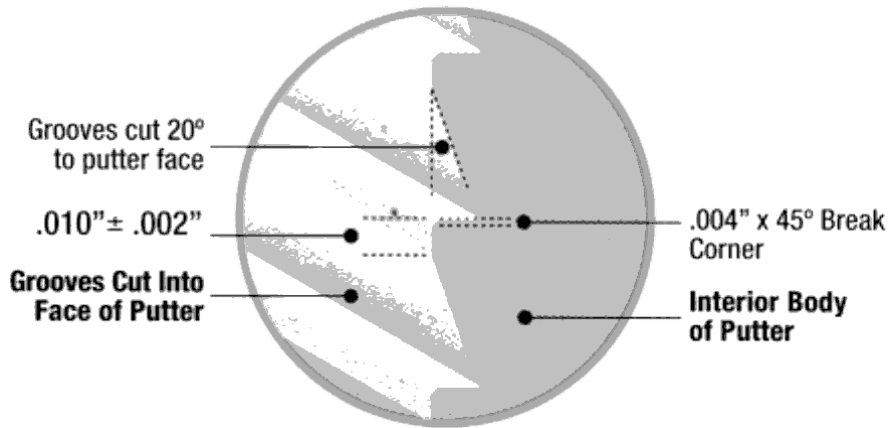


Figure 3: Enlarged Cross Section View of Putter Face.



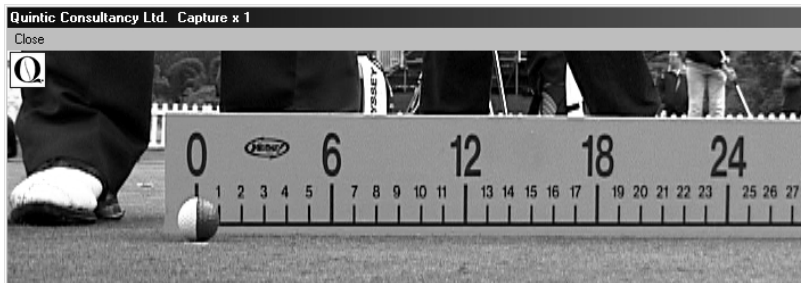
### Subjects

Thirty male PGA European Tour Golfers performed their typical putting action under both test conditions for this study. A total of 5 out of the 30 subjects finished in the top10 European Order of Merit 2001. All subjects were given a number of practice putts with both their own putter and their selected C-Groove putter to familiarise themselves with the length of putt required (10-11 Stimpmeter). At the time of the experiments none of the thirty golfers participating in this study were familiar with the C-Groove putter. Each subject putted towards a hole positioned twenty feet away in a straight line. Subjects wore their personal golf shoes and attire. The weather conditions during the testing period consisted of nil wind with temperatures of plus 20°C. The trials were carried out over a period of three months during the competitive PGA European Tour 2001 season. The distance of a 20 foot putt was chosen as the test distance because this is the length of a medium to long demanding putt.

### Data Acquisition and Analysis

The putting stroke was filmed using a standard digital video Sony TRV 900E camcorder. The camcorder was placed at 90° to the path of the golf ball, level with the putting surface. Figure 4 shows a typical set-up for the experiments.

Figure 4. Experimental Design



The analysis was performed for the thirty golfers using their normal putting stroke. Digital video film (25Hz) was recorded giving the contact and first 0.5 metres of the path of the golf ball. After processing, the film was analysed using a Sony VAIO PCG-F409 personal computer running Quintic 6.01 video analysis software. Two-dimensional scaling, prior to digitisation was carried out using two-dimensional calibration. All putting strokes were digitised at a rate of 25Hz. On average between 6 and 7 frames were digitised per golfer. For each frame, the distance travelled (mm) together with the amount of rotation ( $^{\circ}$ ) was recorded.

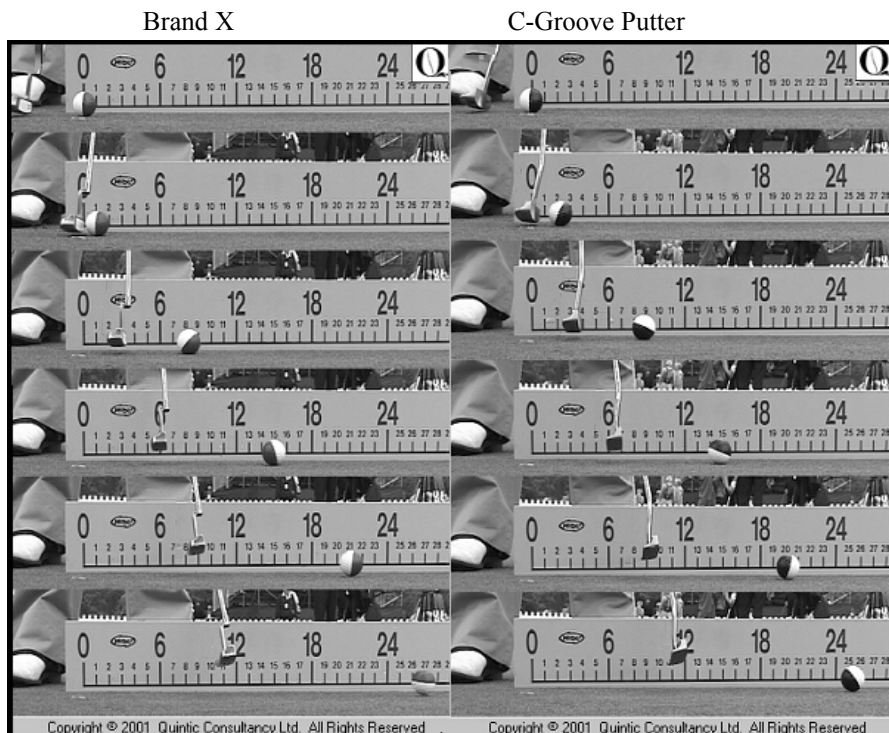
Each subject started with their own tour (Brand X) putter and used it until they were able to hole the putt. This was deemed to be a successful putt. The same approach was used for the C-Groove putter. Each subject was allowed to have as many putts as required until the putt was holed. Hence two successful putts from each subject, one using a Brand X putter and one using a C-Groove putter was used in the subsequent analysis. The test was not randomised since the objective, for each subject, was to obtain data of two successful putts.

### Statistical Analysis

Descriptive statistics were calculated for the rotation and distance travelled for both Brand X and C-Groove putting conditions. This was followed by using a cubic spline technique to estimate the rotation of the ball for the first 500mm of its path. This is described in more detail below. A paired t-test was then used to investigate for any significant differences in the amount of roll and skid induced by using the C-Groove or Brand X putters.

### Results and Discussion

Figure 5 gives an example of how the video images are presented within the Quintic (2000) software.



For each of the thirty golfers, the distance travelled (mm) and amount of rotation (degrees) was obtained (see table 1). This was calculated for each frame. The first image of each sequence shows the datum or starting point prior to contact.

Table 1: Rotation and Distance for Brand X and C-Groove Putters

Brand X Putter: Rotation (°) and Distance Travelled (mm)

	Image 1		Image 2		Image 3		Image 4		Image 5		Image 6	
	(°)	mm	(°)	mm	(°)	mm	(°)	mm	(°)	mm	(°)	mm
Mean	0	0	7	80	42	245	138	400	284	542	499	666
S.D.	0	0	10	41	40	47	81	53	122	65	171	70
S.E.	0	0	2	8	7	9	15	10	22	12	32	13

C-Groove Putter: Rotation (°) and Distance Travelled (mm)

	Image 1		Image 2		Image 3		Image 4		Image 5		Image 6	
	(°)	mm	(°)	mm	(°)	mm	(°)	mm	(°)	mm	(°)	mm
Mean	0	0	39	86	129	250	282	399	500	535	762	657
S.D.	0	0	23	40	43	41	61	48	101	61	104	61
S.E.	0	0	4	7	8	7	11	9	18	11	20	12

Difference: C-Groove – Brand X Rotation (°) and Distance Travelled (mm)

	Image 1		Image 2		Image 3		Image 4		Image 5		Image 6	
	(°)	mm	(°)	mm	(°)	mm	(°)	mm	(°)	mm	(°)	mm
Diff:	0	0	32	6	87	5	145	-1	216	-6	263	-9

It is interesting to note that six subjects, using their own tour putter, actually made the ball jump in the air and rotate backwards for the first part of their putt. Not one of the C-Groove putters created any type of backspin on the golf ball. Table 1 highlights the average results for the thirty subjects. It is clear from Image 2 onwards that there is a greater amount of forward rotation on the golf ball using the C-Groove putter. By Image 4, on average there has been a 145° increase in rotation, and by Image 6 a 263° increase, nearly ¾ of a rotation of the golf ball.

As previously described in this paper the data for each putt was obtained from typically six images. These images captured the distance from the origin of each putt and the degree of rotation of the golf ball up to that point. Thus for each putt the data consisted of pairs of data points i.e.  $\{x_0, r_0\}$ ,  $\{x_1, r_1\}$ ,  $\{x_2, r_2\}$ ,  $\{x_3, r_3\}$ ,  $\{x_4, r_4\}$ ,  $\{x_5, r_5\}$  and  $\{x_6, r_6\}$  where  $x_i$  is the distance from the origin of the putt and  $r_i$  is the current rotation of the ball (degrees). The results, shown in Table 1, can give only an approximate indication of the different roll characteristics between Brand X and C-Groove putters because the video capture rate used was 25 frames per second. This means that after the ball is struck the next image recorded could occur between 0 and 0.04 seconds after impact. For this reason a more detailed analysis, using a cubic spline (Press 1990), was implemented. This technique fits a cubic equation of the form ' $r = f(x)$ ' through the six data points for each of the 30 C-Groove and 30 Brand X putts. Using a spline equation for each of the 30 C-Groove and 30 Brand X putts it is possible to estimate the amount of rotation for each putt after 10, 20, 30, 40, 50...500mm and so obtain a fair comparison. A paired t-test (see Kanji 1994) was then

used to compare each subject when they used their own ‘tour’ putter (Brand X) and their selected C-Groove putter. Since each subject was using their own putting style and were asked to make a putt of approximately 20ft then any differences in the initial roll of the ball should be more likely to be due to the different putter used and less due to any changes in their putting technique. The following graph (Figure 6) gives an example of this paired test and shows the difference in the amount of roll induced for Subjects 1-5 using the C-Groove when compared with their Brand X putter. Since the graphs are always positive this indicates that the C-Groove putter always gave more rotation, an earlier roll and less skid than the Brand X putter for Subjects 1-5.

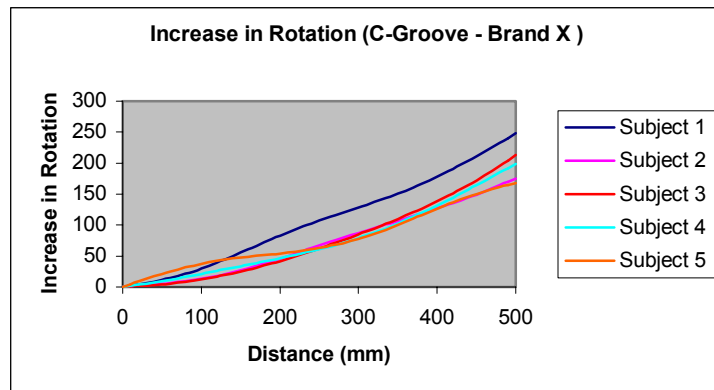


Figure 6: Paired Test -Increase in Rotation C-Groove less Brand X Rotation for Subjects 1-5

This ‘paired difference’ was then obtained for all 30 subjects and the following graph (Figure 7) shows the average increase in rotation when using the C-Groove when compared with subjects using their own Brand X putter. The upper and lower 95 percent confidence intervals of the mean show the statistical significance of using the C-Groove to obtain increased rotation.

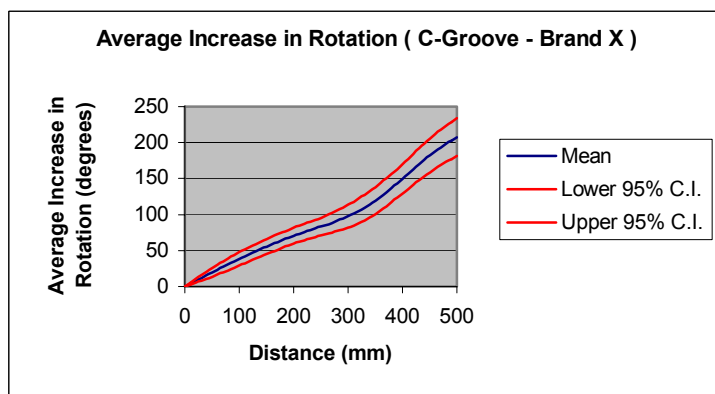


Figure 7: Paired Test - Average Increase in Rotation C-Groove less Brand X

The development of the cubic spline, obtained from the data from each of the subject's putt, enabled the average roll for both the C-Groove and Brand X putters to be determined. This is shown in Figure 8.

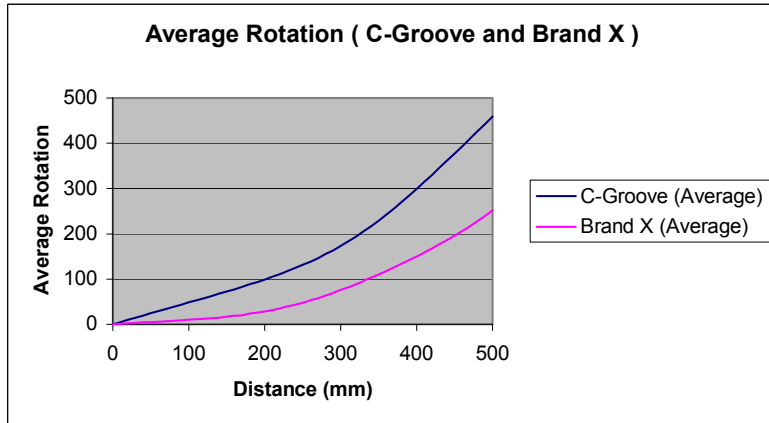


Figure 8: Average Rotation C-Groove and Brand X

Since the degree of rotation of the golf ball is known over the first 500mm, it is also possible to calculate the amount of skid that occurs over the first 500mm of the putt. This is shown as a percentage in Figure 9. (See below) This graph indicates that on average the Brand X putters have almost 100% skid at the start of their putt and are still skidding by an average of 55% after 500mm. The C-Groove putt starts with an average of 80% skid which has been reduced to 40% skid by 500mm.

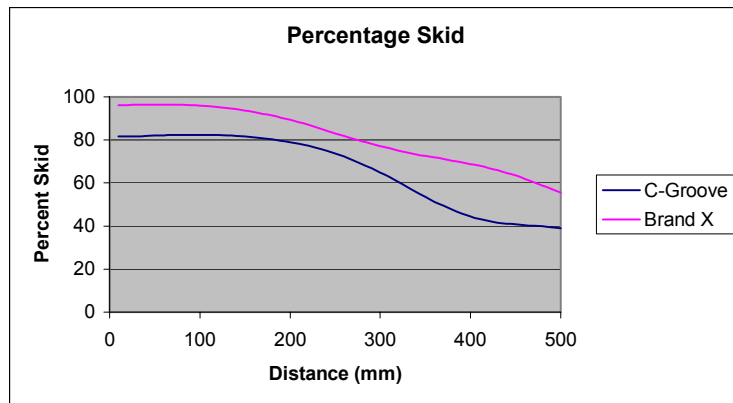


Figure 9: Percentage Skid

The results of these experiments suggests that the C-Groove putter does induce more roll and produce less skid during the initial stages of a typical 20 foot putt when compared with other (Brand X) putters. No evidence can be offered, at the moment, as to why extra rotation is obtained. It may well be that the case suggested by Swash (2001) that the C-Groove putter allows more 'dwell time' on the ball. It is also interesting to note that the C-Groove putt takes on average longer to travel the first 500mm of a putt, but will still cover the same distance (20 feet) because it has more initial rotational energy. Experiments are in progress, using high-speed cameras (2000Hz), to investigate the actual strike of the putter with the ball.

### **Conclusion**

This paper has reported on experiments which have compared the roll characteristics of a golf ball when using a C-Groove putter compared with Brand X putters. The experiment analysed the ball rotational results of putts from 30 current European Tour Professional Golfers on putts of twenty-foot length. On all occasions the C-Groove putter induced a greater degree of roll and less skid over the initial 500mm of travel when compared with a similar putt that used the tour professional's own personal tour putter. Further experiments are now in progress to compare the effects of C-Groove and Brand X putters during the later path of the golf ball's journey to the hole and also to find out when 'skidding' finally stops and the true 'roll' of a golf ball occurs for various putting distances.

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