The 2010 regulations on golf club groove design: impact on ball flight characteristics during a controlled shot.

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Abstract

The purpose of this study was to investigate the difference in the amount of spin that can be generated during a controlled golf shot, as a result of the 2010 rule change regarding restrictions applied to the design of the grooves on the clubface implemented by the United States Golf Association and the Royal & Ancient Golf Club. Ten experienced golfers (mean ± SD; age, 23.0 ± 0.67 yr; playing experience, 13.2 ± 1.6 yr; handicap, 1.6 ± 1.4) were required to play a total of 120 shots inside a state of the art golf simulator with 3 clubs consisting of 'old' pre 2010 U-groove design and 'new' post 2010 V-groove design. With the U and V grooved clubs, participants played 10 shots from a fairway mat and 10 shots from a rough mat using a 9 iron, PW and SW. Backspin (RPM) and, as a measure of accuracy, distance landed from the pin (yds) were recorded. Compared to the U-grooves, the newer V-groove design imparted significantly less backspin from both the fairway and rough surfaces ($P < 0.05$), additionally, shots with all clubs were consistently further away from the pin ($P < 0.05$). The newer groove design does not enable players to impart as much backspin on the ball as they previously could and our data suggest that the recent change in golf club design might therefore reward driving accuracy.

Key words: clubface, grooves, backspin, accuracy.

Introduction

On January 1st 2010 the United States Golf Association (USGA) in association with the Royal & Ancient Golf Club (R&A) implemented changes to the way in which golf club grooves are designed. The intention of the rule change was to remove a player's ability to generate as much spin out of the rough as can be created on the fairway. This was achieved by changing the size and sharpness of the previous large, deep and sharp edged U-grooves into shallower, smaller and round-edged V-grooves (USGA & R&A,2006). It was anticipated that this change to the grooves would produce less spin in the rough, and as a result, not allow players to achieve as good a shot as they might have had they landed on the fairway. This, the officials hoped, would promote accuracy from the tee and be a form of punishment for those who do not find fairways. Thus, the intention of this rule change was to reward players for driving accuracy (Acimovic & Fearing, 2011). It is not yet known what the impact of this change is on golf ball flight characteristics.

Being able to impart spin on a golf ball from a fairway position is a key requirement to land shots close to the hole, ultimately increasing the chance of success. Subsequently, it is important to know how much of a reduction in spin, if any at all, there is between the old and new groove designs. The rule change does not just apply to elite tour professionals. The USGA and R&A are enforcing this change throughout the game so it will eventually apply to golfers at every level. The rule was first introduced into the professional game in 2010, changes will apply to all amateur professionals in 2014 and subsequently will apply to all remaining golfers by 2024 (R&A, 2010). Thus, it is essential to understand how this important change might impact the professional game but also how it might affect golf in the future. Due to the timing of this rule change, there is currently a paucity of peer reviewed literature on the topic. Opinions however, have been expressed extensively in other forms of media, particularly online.

We currently have an understanding of how surface roughness, ball hardiness and loft angle of a club effect the ability to produce backspin (Farrally et al., 2003). There are, however, elements within this process that are not fully understood and have not yet been tested to any great extent. Surprisingly, very limited research into the full functionality that grooves provide during golf shots and the role grooves play in contributing towards the production of backspin have been overlooked in previous studies (Cochran & Farrally, 1994; McCloy, Wallace, & Otto, 2006). The 'old' pre 2010 U-grooves are larger and deeper in size compared to the 'new' V design. U-grooves have sharp right angle edges and the greater overall volume of the groove filters debris and water away from the surface of the club very efficiently allowing for a clean, clear contact with the ball and the clubface. This allows the sharp edges of the grooves to grip the ball causing it to roll and generate a large amount of backspin, this make them very effective when playing a shot from the fairway or rough. The 'new' post 2010 V -grooves are 40% smaller in volume than the previously used U-grooves; the edges are rounded lessening their ability to grip the ball at contact thereby reducing the spin imparted. The depth of groove has also been reduced and is most commonly in a V shape, although square designs with curved edges are available. Sauerhaft (2010) has explained that the decrease in volume makes the new grooves less efficient at filtering away debris and moisture in the rough, leaving behind water and debris on the clubface at ball strike resulting in less spin. However, this is yet to be elucidated in a peer reviewed manner.

To our knowledge, peer reviewed literature is not available specifically regarding the rule change and golf shot performance. Thus, the aim of the present study was to assess the effect of the change in groove design on the backspin and accuracy of controlled golf shots played by experienced, low handicap golfers from the fairway and rough. It was hypothesised that shots taken with the post 2010 conforming V-grooves would reduce backspin and accuracy compared to shots played with the pre 2010 non-conforming U-grooves from both the fairway and rough.

Methods

Participants

Ten male golfers volunteered to participate in the study (mean ± SD, age, 23.0 ± 0.67 yr; playing experience, 13.2 ± 1.6 yr; handicap, 1.6 ± 1.4). All participants gave written, informed consent before the commencement of the study. Upon arrival to the laboratory, experimental procedures, associated risks and potential benefits of participation were explained. The study was approved by Northumbria University's School of Life Science Ethics Committee.

Experimental Design

The testing was carried out using an indoor golf simulator (Gold Simulator, Sports Coach System Ltd, Surrey, UK). Each testing session lasted 1-2 h and before testing began, each participant was required to perform a warm up consisting of stretching, mobility exercises, rotation and 5 practise shots with each club. Each participant played 20 shots with 6 clubs (9 iron, PW and SW of 'old' and 'new' groove conformation); 10 shots were played from a fairway mat and 10 shots were played from a mat simulating rough grass. In total, 60 shots were played with the U-groove clubs and 60 shots were played with the V-groove clubs, completing the 120 shot data collection. The order of the conformation and the club used was randomised and the same hole and pin position was set for each participant (Celtic manor 18^{th}). Conditions were set to fine; there was no wind and each shot was played at a set distance from the hole (9 iron, 120 yds; PW, 100 y and SW, 80 yards). Participants were instructed to play the most accurate shot they could in order to land the ball as close to the hole as possible. From each shot, the amount of backspin (RPM) and, as a measure of accuracy, the distance landed from the pin (yds) was recorded.

Golf Club Design and Equipment

The non-conforming U-groove clubs used were 2004 Callaway Big Bertha (Callaway Golf, CA, USA) and the conforming V-groove clubs used were 2010 Cleveland CG-16 (Cleveland Golf, CA, USA). Brand new sets of the same golf ball (Z-Star Srixon, Cleveland Golf, CA, USA) were used for each participant.

Golf Simulator

The simulator and associated software (Gold Simulator, Sports Coach System Ltd, Surrey, UK) consisted of a booth, a high spec computer and projector system. This golf simulator was used as it allows for control of many variables that have an impact on the generation of spin (i.e., wind, rain, wet and dry greens). This allowed for data to be collected in a valid and repeatable environment. The golf simulator contained two high speed cameras set to track the ball and transmit data to the receiving computer. A side camera monitored the launch angle and speed of the ball, while the camera located above monitored direction and spin. The two high speed cameras worked simultaneously at separate 90° angles to create a 3D model of ball flight. Each camera utilised high quality CMOS sensors, that were processed at 60 Hz. Images were produced on screen in front of the golfer via an XGA projector delivering 4500 lumens with a throw distance of between 1.5 m and 7 m and native 1024 × 768 display. The overhead camera tracked the ball from impact and informed the software that the ball had been hit. At the same time exact data relating to the horizontal launch angle, club speed, ball spin, swing path and face angle relative to the target line were determined. The lateral camera constantly tracked the golf ball from impact as it travelled towards the screen enabling accurate measurement of the vertical launch angle, ball speed and spin, determining the carry of the ball through the air.

Statistics

Data are presented as means ± SD within the text and displayed as means ± SE in the figures. Following verification of underlying assumptions, 2×2 ANOVA with repeated measures on groove type and surface was used to test for within group differences in spin rate and shot accuracy between pre 2010 U-grooves and post 2010 V-grooves, between fairway and rough and for interaction effects between groove type and surface. Significant main effects were further examined using Tukey simultaneous 95% confidence intervals to provide a plausible range for the true population mean differences. Data analysis was performed in Minitab (v16.2.2, Minitab Ltd, Coventry, UK) and statistical significance was set at $P < 0.05$.

Results

Nine iron spin rates

There were significant effects of groove (F_1 = 195.65, $P < 0.01$) and surface (F_1 = 311.66, $P < 0.01$) on spin rate and a significant groove by surface interaction (F_1 = 4.42, P = 0.04). Spin rates were higher from the fairway than the rough for both U-groove (9027 ± 130 vs. 8084 ± 222 RPM, 95% CI 757 to 1127 RPM) and V-groove (8259 ± 203 vs. 7518 ± 146 RPM, 95% CI 557 to 926 RPM) clubs. Spin rates were higher with the U-groove than V-groove clubs from the fairway (95% CI 582 to 952 RPM) and from the rough (95% CI 382 to 751 RPM). The loss of spin from fairway to rough did not differ between U-groove and V-groove clubs (95% CI 10 to −359 RPM).

Nine iron accuracy

Both groove type (F_1 = 18.99, $P < 0.01$) and playing surface (F_1 = 8.64, $P < 0.01$) affected nine iron shot accuracy but there was no groove by surface interaction (F_1 = 1.87, P = 0.183). Regardless of playing surface, shots with the U-groove club were nearer to the target than shots taken with the V-Groove club (95% CI −1.26 to −0.45 yds). Regardless of groove type, shots from the rough landed further from the target than shots from fairway (95% CI 0.17 to 0.98 yds).

Pitching wedge spin rates

Groove type (F_1 = 241.84, $P < 0.01$) and playing surface (F_1 = 296.07, $P < 0.01$) had a significant effect on spin rate and there was a significant groove by surface interaction (F_1 = 6.59, P = 0.02). Higher spin rates were evident from the fairway than from the rough for U-groove (9612 ± 85 vs. 9015 ± 188 RPM, 95% CI 438 to 754 RPM) and V-groove clubs (9082 ± 138 vs. 8277 ± 108 RPM, 95% CI 648 to 963 RPM). As with the nine iron, spin imparted to shots was higher with U-groove than V-groove clubs both from the fairway (95% CI 371 to 686 RPM) and the rough (95% CI 580 to 896 RPM). There was no difference between U-groove and V-groove clubs in the amount of spin lost from fairway to rough (95% CI 90 to -225 RPM).

Pitching wedge accuracy

There were independent effects of groove type (F_1 = 39.02, $P < 0.01$) and playing surface (F_1 = 34.10, $P < 0.01$) on shot accuracy, but no interaction effect (F_1 = 0.02, P = 0.89). Shots played with the U-groove club landed closer to the target than those played with the V-groove club regardless of the playing surface (95% CI −1.22 to −0.62 yds). Shots played from the rough landed further from the target than shots played from the fairway regardless of groove configuration (95% CI 0.56 to 1.16 yds).

Sand wedge spin rates

There were significant and independent effects of groove (F_1 = 877.18, $P < 0.01$) and playing surface (F_1 = 872.38, $P < 0.01$) on sand wedge spin rates, but no interaction between groove type and playing surface (F_1 = 0.27, $P = 0.60$). Higher spin was imparted by U-groove than V-groove clubs for both playing surfaces (95% CI 853 to 980 RPM) and spin was lower from the rough than the fairway for both groove configurations (95% CI −978 to −851 RPM).

Sand wedge accuracy

Similarly to the nine iron and pitching wedge, there were independent effects of groove type (F_1 = 42.19, $P < 0.01$) and playing surface (F_1 = 18.04, $P < 0.01$) on the accuracy of shots played with the sand wedge, but no groove by playing surface interaction effect (F_1 = 1.96, $P = 0.17$). Again, the U-grooves resulted in shots less far from the target than the V-grooves regardless of playing surface (95% CI −1.71 to −0.89 yds) and shots from the rough landed further from the target than shots from the fairway regardless of groove type (95% CI 0.43 to 1.26 yds).

Discussion

The aim of the present study was to address the effect of the newly introduced regulations in golf club groove design enforced by the USGA and R&A in 2010. We examined whether the 'new' post 2010 V-groove design reduces the amount of spin and accuracy during a controlled golf shot compared to the 'old' pre 2010 U-groove design. Compared to the U-grooves, the newer V-groove design imparted significantly less backspin on shots both from the fairway and rough; additionally, shots with all 3 clubs were consistently less accurate. The newer groove design does not enable players to obtain as much control of the ball as they previously could, such that the recent regulatory change in golf club design might reward driving accuracy.

Relation to Previous Research

Peer reviewed work on this topic is sparse which makes comparisons to previous literature difficult. The USGA and R&A, however, have released details of 'in house' testing carried out using the U- and V-grooved clubs (USGA & R&A, 2006, 2007). Their findings correspond to our data, in that a reduction of backspin in shots played from the rough with V-grooved irons was reported. Our data add to these previous results by demonstrating a reduction in backspin with shots played from the fairway as well as the rough and examining the effect of this spin reduction on shot outcome. Another previous investigation that focused solely on the issue of the ban, found that the change in regulation did not produce any significant difference in terms of difficulty hitting from the rough (Acimovic & Fearing, 2011). However, the results of this study oppose that of Acimovic & Fearing (2011); shots played from the rough with the new V-groove clubs were more difficult to control and less accurate.

Previous work by Cochran & Stobbs (1968) suggesting that clubface surface roughness does not influence backspin seems contrary to our data. Figure 1 demonstrates that even when clubs of the same loft are used, the amount of spin differs as a result of the amount of grip and friction caused which is in line with other research (Chou, Liang, Yang, & Gobush, 1994). However, research exists that would suggest our findings are a direct result of ball softness (Gobush, 1996; Monk, Davis, Otto, & Strangwood, 2005). These data would suggest that soft shelled golf balls must have been used and it is predominately the ball softness that differences in spin rate can be attributed to. However, soft shelled golf balls were not specifically used in the present study. A popular middle range golf ball was used and, despite the precise composition not being known, the balls are not regarded as 'soft'.

Theory to explain findings

In order to understand what happens upon impact of the clubface and golf ball, one must appreciate that what determines a ball's fate happens within half a millisecond. Thus, what happens in this small time frame is imperative to understanding how the clubface and ball interact (Cochran & Farrally, 1994). Johnson and Lieberman (1996) examined this interaction and found that when a golf ball makes contact with the club head, two things happen: sliding and rolling. The sliding and rolling occur due to friction; as the ball contacts the club it begins to climb up the clubface, such that the surface of the clubface determines whether the ball begins to roll or slide up the clubface. A golf ball that *rolls* up the clubface develops backspin; however, a golf ball that *slides* up the clubface drastically reduces the backspin imparted. Therefore, the extent that the surface of the clubface promotes rolling and prevents sliding, ultimately determines the generation of spin. This is where the grooves on the clubface make their contribution to the generation of spin (Johnson & Lieberman, 1996). Lieberman (1990) found that grooves do not just provide a form of friction to encourage the ball to roll, they essentially work like the tread on a tyre. The grooves on a clubface are used to filter away water, grass and other debris away from the clubface so a clean contact and ultimately spin, can be imparted to the ball (Lieberman, 1990). Should water and debris not be filtered away, but instead be left between the ball and clubface at impact, the grooves will be prevented from gripping the ball, causing the ball to slide up the clubface reducing the amount of spin.

In addition to the surface of the clubface it is also important to understand the aerodynamics of a spinning golf ball as it is launched into flight. Initially, with a stationary ball, air flow is slowed as it comes into contact with the front of a ball; airflow then increases as it moves around the ball and this increase in airflow causes low pressure (Smith, Beratlis, Balaras, Squires, & Tsunoda, 2010). Similarly, Smits & Smith (1994) found that when a ball is spinning air flow is slowed at the point of contact; due to air flow moving over the ball at a heightened pace compared to when stationary, a much lower pressure is caused above the ball and the airflow underneath the ball is slower creating high pressure. That high pressure will force the ball into the area of low pressure and lift is created (Bearman & Harvey, 1976).

However, a golf ball will only lift once the high and low pressures overcome the weight of the ball; Aoki, Nakayama, Hayasida, Yamaguti, & Sugiura (1999) identify that this is where 'Bernoulli's Principle' comes into play. Bernoulli's principle states that spin rate and the pressure differential between the bottom and top of the ball are positively correlated. Thus, if the spin rate is high enough, pressures will be created that overcome the weight of the ball and lift will occur. This might, in part, explain why accuracy was reduced when shots were taken with the new V-groove clubs. The V-grooved clubs imparted a significantly lower spin rate and ultimately less lift; thereby a shallower trajectory and lack of backspin could not counteract the forward momentum of the shot when landing on the green.

Limitations

There were a few unavoidable sources of error within this study. One of which was being unable to use a real grass surface to play shots from, a synthetic fairway and rough replacement mat had to be used which might limit the generalisation of the results. Also, even despite this cohort's skill level, human nature does introduce an element of error. We tried to minimise the level of error by standardising conditions, however, our data may lack external validity. For progression within this topic, it would be ideal for future investigations to assess how the rule change might affect the ability of clubs to execute shots; a suggestion would be to assess the relationship between backspin and distance between the conforming and non-conforming clubs. Upon analysis of our findings and that of previous literature, it seems that one of the key influences upon backspin production is the skill level of the player. Elite amateur golfers notice a reduction in spin from the grooves, whereas elite professional golfers do not (Acimovic & Fearing, 2011; McFall, Todd & Treme, 2012). The rule change may have failed to affect current elite professionals due to their highly advanced skill level. In the future, the change may impact tour professionals by enforcing driving accuracy up through the amateur levels.

However, upon review of literature, there might be a way of combating this problem, it would seem that if the friction between the ball and clubface is compromised particularly by the rounded edges, players might be able to create more spin by using a softer golf ball to allow more chance of gripping, but in addition to the longevity of the golf ball, a sacrifice of distance is would also be apparent with a softer ball.

Conclusion

In conclusion, the ‘new’ post 2010 V-groove clubs imparted significantly less backspin compared to the ‘old’ pre 2010 U-groove clubs on shots taken from the fairway and the rough. Additionally, shots played with the V-grooved clubs landed consistently further from the pin, indicating a reduction in accuracy. Thus, the recent change in golf club design might reward accuracy from the tee.

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Disclosures

No authors have any conflict of interests to declare.

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Table Legends

Table 1. Average distance (yds) away from the hole with 'old' U-groove and 'new' V-groove configured clubs.

Figure Legend

Figure 1. The amount of backspin produced with shots taken from the fairway and rough using a 9 iron (A), PW (B) and (SW) with the 'old' U-groove (○) and the 'new' V-groove (●) configurations. $ = P < 0.05 fairway vs. rough; * = P < 0.05 U-groove vs. V-groove.