International Journal of Latest Research in Engineering and Management" (IJLREM)
ISSN: 2456-0766
www.ijlrem.org Volume 2 Issue 1 ǁ January. 2018 ǁ PP 01-06

Golf Swing Analyses of the Novice Player: Stop Swinging with Your Arms

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ABSTRACT: *All ninety-five right-handed participants took lessons from the Golf Advantage School, which is operated by Kingwood Country Club. All the students were instructed by the same Professional Golfers' Association (PGA) certified instructor. Students were instructed to use seven key principles to improve the right-handed golf swing. The specific aims of this study were to attempt to answer the following three questions. First, does the seven key golf swing principles improve the ability of the novice golfer to hit a straighter ball? Second, does starting the downswing by rotating your legs and hips counterclockwise and just letting your straight left arm track to the ball reduce the over-the-top swing? Third, before golf lessons, what is the mean Hogan's angle created by the novice player starting the downswing over-the-top or under-the-top of Hogan's imaginary glass plane line? Using Apple iPad2 tablet, Hudl Technique Software, V1 Pro Software HD, and V1 Pro cameras it was determined students learned to hit a significantly straighter ball, over-the-top swing was significantly reduced, t(2.13) = 80, p = .036, and the 95 student's mean Hogan's angle was calculated at a positive (M = 4.5, SD = 6.2) degrees over-the-top.*

KEYWORDS: *Biomechanics, Golf slice, Hogan's angle, Square clubface, Strong grip*

I. INTRODUCTION

Golf is one of the most popular of the recreational sports with some 55 million participants throughout the world playing [1]. Unfortunately, many novice golfers do not take golf lessons from a PGA Certified Professional Instructor. Although, the golf swing is one of the most complex and difficult of sport motions to learn and repeat [2]. Golf is not like hitting a 160 km/h fastball in baseball and then adjusting swing speed for the curve. Golf to the casual observer seems simple with a stationary ball teed or grounded just waiting to be hit. However, many golfers complain about slow play due to the casual and/or novice golfer constantly hitting the ball in the rough and then taking too much time to find it. The biomechanics of the golf swing does not have to be so complex and difficult to learn. The novice golfer can be instructed to play the game correctly by using plain language that describes the "natural" golf swing . Golf swing biomechanics can be made simple, easy to learn, and repeatable by learning seven key principles of the modern golf swing. Golf is more enjoyable when the player can consistently hit the ball solid and straight. From literature review, using the following seven key principles to improve the right-handed golf swing may help.

1. Take a strong grip to reduce slicing. The grip is loose and the entire body is relaxed (not tight).
2. The left arm should remain as straight as possible throughout the entire golf swing. Have a feeling of stretching out straight with your left arm during the swing, which will help prevent "arm swinging".
3. During the backswing, rotate your legs, hips, and shoulders clockwise as far back as possible and just let your arms follow without stretching back with your arms.
4. Start the downswing rotating your legs and hips counterclockwise and just let your arms track to the ball. A powerful swing comes from leg and hip rotation, not by "arm swinging". Do not over swing by using only 75-80% of player's maximum club velocity.
5. The wrists should be naturally cocked at the top of the backswing and on the downswing, let the wrists break naturally to square the clubface to the golf ball (occurs with loose grip).
6. During the entire swing, head is perfectly still and slightly behind the ball. Watch the golf ball especially at impact by staring at a colored mark placed on the ball.

7. The follow-through should be smooth and balanced with rotating front of the feet planted on the ground.

Johnny Miller writes that big hitters like Dustin Johnson and Tiger Woods use strong grips and on the PGA Tour practice range, eight out of ten golfers hold the club with a strong grip [3,4]. To create a strong grip, rotate both hands to the right on the handle. The V_S between the index finger and the thumb point toward the right shoulder. Johnny writes that a strong grip increases swing speed and reduces the slice. A very common phrase heard around some golf courses is "keep your left arm straight" [5]. Wagner [5] writes this advice can help right-handed golfers create power in their swings. Professional golfers synchronize their arm swing with their shoulder turn, and this synchronization facilitates both a solid shoulder turn and a straight left arm during the entire swing [6]. However, keeping your left arm straight during the swing requires the proper grip, arm swing, downswing path and body turn [5]. Novice golfers usually stop turning their shoulders too early on takeback, but continue to let their arms swing back which causes a shortened swing arc and a collapsed left arm [6]. Most PGA instructors presently teach golf lessons that focus on the increased twisting of the trunk during the backswing because this motion stores the rotational energy that is released during downswing, which leads to higher ball speed and longer flight distance [7]. Swing the club back with your legs, hips, and shoulders and the wrists will naturally cock at the top of the backswing [5]. Wagner writes keep the left arm extended and straight as you turn your shoulders back, which should feel like pushing your hands away from your chest to keep your left arm extended. The golfer knows when they have fully turned when their left knee points behind the ball and the left heel is off the ground [8]. Chamblee [8] writes that hands should be nice and high at the end of the backswing, which generates serious swing speed, and farther ball carry. Be careful not to excessively twist the lumbar spine and subsequent de-rotation when the golfer reaches the top of the backswing. This could cause low back pain, which is the number one golf related injury [7, 9].

In a kinematic golf study, which used a portable motion analyzer, reported that approximately 70 percent of PGA tour professionals started the downswing motion from their pelvic segment [10]. It appears that the left hip of a right-handed golfer experiences higher rotational velocities than the trail hip during the full golf swing [9]. Start the downswing by rotating lower body to the target, which helps bring the club down along a proper inside-out path [5]. Wagner [5] writes hips should turn toward the target and keep the left arm extended and straight as the player continues swinging down to impact. Also, turn hips through the impact position and hold onto to the wrist hinge until just before the moment of clubface to ball impact. However, the wrists break should be natural without intentional thought. Now the player can simply unleash all the power they have created with the added time and space, which gives a wider downswing arc, leading to more speed and ball carry [8]. Be careful because higher rotational hip velocity is likely to influence the overall stress acting on the hip, which may influence the risk for hip pathology [9].

Because the hands are the only contact with the club, the grip and wrist techniques are essential to hitting a straight shot on a consistent basis. Ironically, the only real secret to proper wrist action is not in what a player does, but in what they do not do [11]. This same author writes the proper wrist motion is a natural one, and if the player keeps forearms relaxed, the weight of the club can cock the club at the top of the backswing without any interference on the player's part. Golf Hall-of-Fame teacher Manuel de la Torre writes that wrist action is an involuntary reaction to swinging the club by letting the weight of the club just naturally uncocks the wrists on the follow through [11]. The most important technique in sports involving a ball is to watch the ball while being struck. This is especially true for hitting a golf ball squarely. In order to watch the ball, the player's head has to be motionless during the entire swing and needs to start behind the ball and stay there all the way through impact [12]. In order to set up with the upper body slightly back is why Jack Nicklaus looked down over his left cheek and stared at the ball. The best technique for watching the golf ball through impact is by fixating both eyes on a colored mark painted on the ball [13].

To finish the swing, the follow-through should be smooth and balanced with rotating front of the feet planted on the ground. The player should keep turning their hips as they swing through impact of the ball. The club rotates over while the arms extend out to the target. Halfway through the follow-through the left arm should finally bend as the player fold both arms to a finish position and the shoulders and hips should face the target at finish [5]. Some golf slices occur because the clubface is open at impact, but the solution is not as simple as adjusting your body or rotating your hands and arms on the downswing [14]. The other reason a player slices is the over-the-top motion at the start of the downswing, which causes the clubface to impact the ball at an angle [4, 15]. This means the over-the-top swing set the club off plane on the downswing and during impact the ball now has a clockwise spin causing the flight of the ball to veer right [16]. Specifically, the idea of swing-plane first

originated when Ben Hogan introduced the idea of a plane of glass extending from top of the shoulders to the ball [17].

Hogan [17] writes that the golfer should perform the backswing that should keep the left arm below the imaginary glass plane during the entire backswing preventing over-the-top motion at the start of the downswing. Fig. 1. shows Hogan's swing angle is measureable at start of downswing from lines created at: (1) the top of the left shoulder to ball and; (2) line the straight left arm makes over or under imaginary glass plane line .The specific aims of this study were to attempt to answer the following three questions: (1) does the seven key golf swing principles improve the ability of the novice golfer to hit a straighter ball; (2) does starting the downswing by rotating your legs and hips counterclockwise and just letting your straight left arm track to the ball reduce the over-the-top swing; and (3) before golf lessons, what is the mean Hogan's angle created by novice players starting the downswing over-the-top or under-the-top of Hogan's imaginary glass plane line?

II. METHODS

1. Participants : Participants were students drawn from The Clubs of Kingwood Country Club in Texas. This four-year study occurred in the years of 2012-2016. The ninety-five right-handed students all took lessons from the Golf Advantage School, which is operated by Kingwood Country Club.

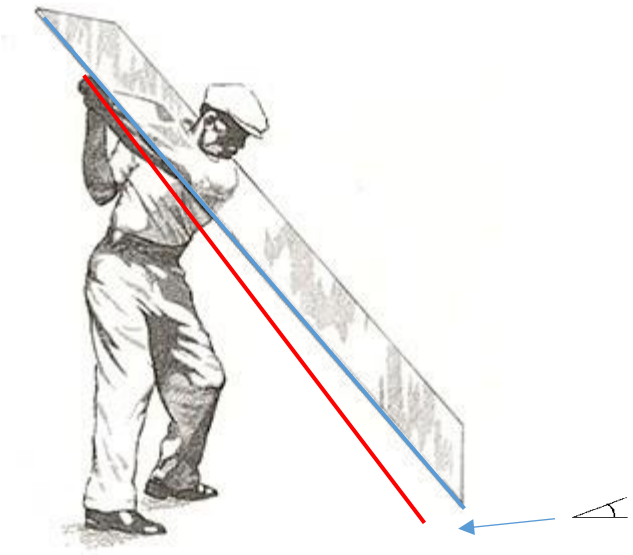

Figure 1.

Hogan's swing angle is measured from the blue line created from top of the left shoulder to ball and red line drawn from the straight left arm. If the player swings over-the-top, the red line is superior to the blue line creating a positive angle. Figure copied from (Hogan & Ravielli, 1990).

The state-of-the-art Golf Advantage School has indoor and outdoor driving ranges. All the students were instructed by the same Professional Golfers' Association (PGA) certified instructor. Men between the ages of 25-45 years comprised 80% of students, and the rest of the students were adolescent (15% boys and 5% girls). All students were novice or near novice and taking lessons to improve their golf game-swing. Data was recorded before the intent of writing this manuscript. No Ethics Committee approved the protocol and the consent procedure, however this study was conducted in accordance with the ethical standards. Participants were not given their written informed consent prior to taking part. However, all students' names will be kept permanently anonymous. Golf Advantage School, which is operated by Kingwood Country Club approved this method of study.

2. First Research Question : The seven key golf swing principles were instructed to all 95 students starting from their first lessons. All students were recorded every lesson to ascertain if improvements of hitting a straighter ball occurred during their period of lessons.
Students were recorded from their right lateral view using an Apple iPad2 tablet as given in Fig. 1. Hudl Technique Software was downloaded to the iPad2 for video editing to examine student's swing in super slow motion, frame by frame, and zoom and pan. The software was also used for its drawing resources for calculating Hogan's angle. All students were recorded using the same type club (driver of varying lengths) while swinging at the outdoor driving range. The ball was hit from a tee either from an artificial mat or from earth. Using direct observation, the PGA instructor logged ball trajectories for each student and recorded if any improvements were made from first day of lesson to future lessons. The total number lessons given per student varied, however, each student had at least three lessons to qualify for this study.

3. Second Research Question V1 Pro Software HD was used to determine if starting the downswing by rotating legs and hips counterclockwise and just letting the straight left arm track to the ball reduce the over-the-top swing. Twenty-five of the 95 participants that naturally swung from over-the-top were chosen at random for this determination. These 25 students were recorded indoors using V1 Pro cameras connected to a personal computer before their first lesson. V1 Pro Software HD was used for video editing to examine swing biomechanics in super slow motion, frame by frame, and zoom and pan. The software was also used for its drawing tool resources, which can automatically calculate Hogan's angle after connecting the two lines of need. For every swing, both the camera and software package can help determine if correct swing principles occurred by viewing recordings.

4. Third Research Question : Hudl Technique Software and the iPad2 were used to determine Hogan's mean angle created if the novice student starts the downswing over-the-top imaginary glass plane line. While all 95 students were recorded every outdoor lesson to ascertain if improvements of hitting a straighter ball occurred during their period of lessons, Hogan's angle was also calculated by using software drawing tools. The instructor can draw the two lines and Hudl Technique Software displays degree angle of need. *Statistical Analysis* All statistics used in this study were performed by StatView for Windows Version 5.0.1 software. This included descriptive statistics, histogram figure drawing, and utilizing paired t-tests for calculating significant differences.

III. RESULTS

5. First Research Question : iPad2 camera and Hudl Technique Software were used during the first lesson day before any instructions. Recordings indicated 81 of the students swung from over-the-top, creating a positive angle (M = 6.3, SD = 4.4), and 14 were at Hogan's line or under, creating a negative angle (M = -5.8, SD = 4.4). Through direct observation, all of the over-the-top students either pushed the ball to their right, faded, or worse sliced on a consistent basis. At times, 14 of the students that were under Hogan's line, still pushed or curved the ball to their right. However, after at least three lesson periods and learning the seven key golf swing principles, from instructor observation, 90.5% of the students started to hit a straighter ball with improvements in driver-ball contact. It appeared these students were contacting the ball more squarely. From video reply, 86 of students were now at or under Hogan's line (M = -6.3, SD = 4.5) due to starting their downswing by rotating legs and hips counterclockwise and just letting their arms track to the ball (not "arm swinging"). There was a significant difference, $t(2.13) = 80$, $p = .036$, with the before and after groups indicating that adding at least three lessons significantly reduced student's over-the-top swing. Determining clubface being open at ball impact nor ball clockwise rotation could not be determined in this study, for which both are also known to cause a slice (Harmon, Harmon, & Chwasky, 2014).

6. Second Research Question : Before their first lesson, 25 students were chosen at random and were recorded indoors using V1 Pro cameras connected to a personal computer. The data from V1 Pro Software HD indicated the mean Hogan's angle was (M = 7.6, SD = 4.4) degrees over-the-top. After their third lesson, the students learned to start the downswing by rotating legs and hips counterclockwise and just letting their straight left arm track to the ball. Students were recorded again after their third lesson and data showed a mean Hogan's angle of (M = -5.9, SD = 4.4). This data indicated by not "arm swinging", students significantly reduced Hogan's angle by 13.5 degrees by swinging less from over-the-top. There was a significant difference, $t(10.27) = 24$, $p < .001$, with the before and after groups indicating that adding at least three lessons significantly reduced these 25 student's over-the-top swing.

7. Third Research Question During the first lesson day before any instructions from the Golf Advantage School, 81 out of 95 students swung their driver from over-the-top, which created the positive Hogan's angle as previously noted. Before their first official lesson, the 95 students were recorded from the outdoor driving range using iPad2 video camera. Using Hudl Technique Software, the 95 student's mean Hogan's angle was calculated at a positive (M = 4.5, SD = 6.2) degrees over-the-top (Fig. 2).

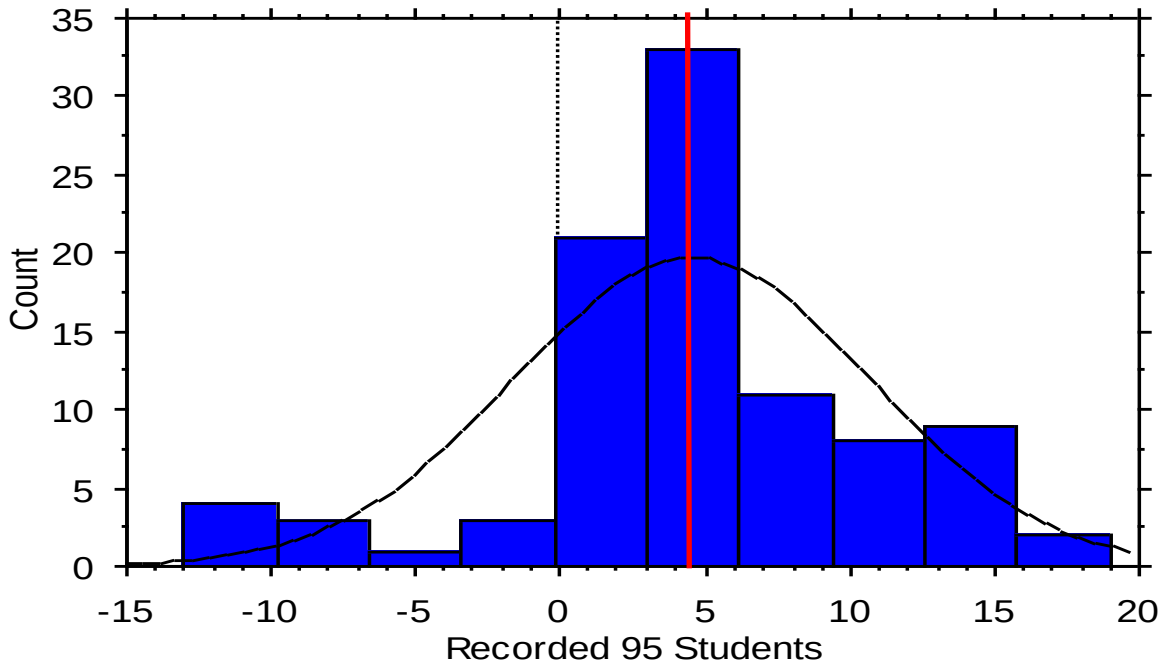

Figure 2.

Using Hudl Technique Software, 95 student's mean Hogan's angle was calculated at a positive degrees over-the-top (M = 4.5, SD = 6.2).

IV. DISCUSSION

This study was designed to provide basic information in order to investigate golf swing-specific factors associated with producing a straighter ball flight. Study results indicate with just three golf lessons with a PGA certified instructor novice golfers can significantly improve their golf game by not slicing. According to Golf Digest 50 Best Teacher Hank Haney, no player ever gets better slicing the ball [4]. Data from this study indicated the most important factor in swinging a driver correctly is to change the route the driver takes to the ball, from over- the-top to a better inside path. Before any lessons, results indicate that 85% of novice golfers have a first natural tendency to swing with their arms which is the main cause of a positive Hogan's angle [4, 5]. Once students were able to start the downswing by first rotating lower body to target, which helps bring the club down along a proper inside-out path, the golf ball was struck more solidly with a straighter flight. In order to hit a straight shot, the ball has to be struck with a square clubface and with minimal ball spin [16]. It is almost impossible to hit a straight ball with a driver coming over-the-top at the start of the downswing [5], and it is certainly easier to slice a long driver than a short nine iron. Hank Haney even suggests on the downswing making an intentional inside outside arc with the club head and try to square the clubface at impact which can create a little draw [4]. The only swing technique needed to stop slicing according to this study's data was just start the downswing with the lower body instead of arms.

The second most important golf principle noted in this study was to stare at the ball at moment of impact. During the first day of lessons most of the students had the habit of peeking at ball flight too early. The student's head needs to be motionless during the entire swing and also must start behind the ball with eyes fixated on the

ball all the way through impact [12]. Marking several red dots on balls really seemed to help students with watching the ball at impact.

In several studies, a bright red color seems to attract the human eye the most [13]. The third most important golf principle observed in this study was keeping the left arm straight from start of the swing through impact. Once the students learned the straight arm technique, most told the instructor it aided them to stop "arm swinging" and thus helped reduce Hogan's angle by + 6.3 to -6.3 degrees.

V. CONCLUSION

This study should help future PGA certified professional instructors teach the proper biomechanics of the golf swing. This study's results indicated that Ben Hogan was right when he wrote in 1957, the downswing cannot be from over-the-top unless the golfer wants to slice the ball [17] (Hogan & Ravielli, 1990). You can live with a fade but not a slice because slicing the golf ball costs the player too much loss of distance with the driver [4] (Rudy, 2016). With proper swing mechanics, as observed in this study, any player can contact the ball with a square clubface and without the ball spinning clockwise during flight.

VI. ACKNOWLEDGMENTS

I want to thank The Clubs of Kingwood Country Club and Golf Advantage School for the use of their facility and equipment. This club has five 18-hole courses in the heart of Kingwood Texas with all new TifEagle Bermuda grass and all reworked sand traps for 2016. I especially want to thank Russell W. Pollock for his contribution to this study. He is a retired chemical engineer that worked for Chevron (Houston & San Francisco) for 35 years. Now he is a PGA Certified Professional Instructor working for Kingwood Country Club. It was his data that was used in this golf swing analyses study. His videos and exceptional bookkeeping for four years was critical to this research.

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