# RESULTS OF BIOMECHANICAL STUDIES OF TWO WAYS TO EXECUTE THE GOLF SWING

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The purpose of this study was to identify the biomechanical distinctions of two different ways to learn the Golf Swing. We compared the classical method with a new method we call “carving-golf”. The study compared the dynamic analyses of 12 carving-golf swings and 32 classic swings. The horizontal and vertical forces of the persons standing on a Kistler platform were analysed. We found significant differences in impact and time parameters. While “carving-golf” teaches not to start with a countermovement the evaluation of the horizontal forces showed that a countermovement took place. The mean value of this impact was only 25% of the mean value the classic swing shows. There was no significant change in the forward impact but the velocity the whole system generated towards the target course was diminished by 33%.

**KEY WORDS:** carving golf; forces; learning; motor skills.

**INTRODUCTION:** The Golf Swing is a complex movement. There are rotation and translation and we have to handle a tool that should be moved precisely to a specific point. This movement requires coordinated muscle activation. The more complex it is the more difficult it is to learn (McHardy and Pollard 2005). We also know, that movements with less complexity are more easy to remember if they get close to the function of everyday movements (Dijkstra, K.; MacMahon, C.; Misirlisoy, M, 2008).

To make the movement of the swing easier carving golf forced only to balance the weight to the front foot, not to do any active rotation and not to do a translation in the way of a countermovement. The registered ground reaction forces of the golfers who dominate this movement have been compared with ground reaction forces of golfers who play the classic technique.

**METHOD: Data Collection:** The ground reaction forces of 42 Golf Players were measured by Kistler force platform (type 9287A and Type 9286B). Analogue Data was collected with 1000 Hz by a 12bit AD-converter and a range of ±5V. The average handicap of 32 players playing the classic style was 10 and 12 players were beginners who learned to play “carving golf”.

After a warm up each person has to do 5 swings with their feet on the force platform. The golf ball was placed for the personal needs on an artificial turf mat. The ball was beaten with iron 7. The turf mat was also placed on a force platform, so that we controlled a fast change in the force when the ball was hit.
We analyzed the horizontal ground reaction forces of the last five seconds before impact.

**Data Analysis:** Figure 1 shows the horizontal force of a classic swing for the line direction of the ball. It also gives us the information how the collected data was calculated. It is:

- $t_1$ – time when movement starts;
- $t_2$ – time when horizontal force turned algebraic sign first time;
- $t_3$ – time when horizontal impulse comes to zero;
- $t_4$ – time when horizontal force turned algebraic sign second time;
- $t_5$ – moment of impact to the golf ball.

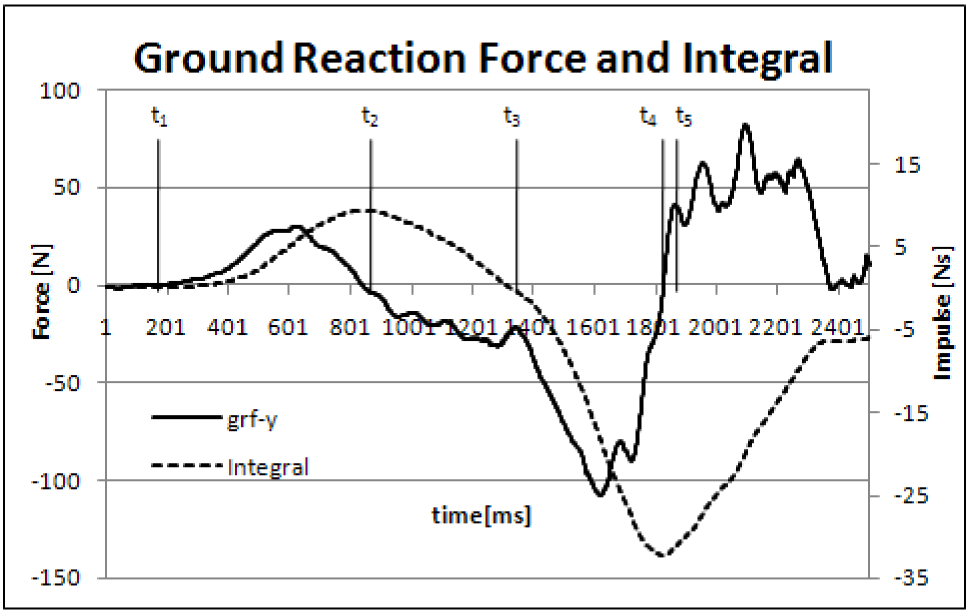


**Figure 1: Horizontal ground reaction force in line direction of the golf ball and its integral with the recorded points of time**

These time markers represent the following periods:

- $t_{minus} = t_2 – t_1$; the time period the force vector shows in countermovement direction;
- $t_{amort} = t_3 – t_{2,}$ the time period the maximum velocity in countermovement direction comes to zero;
- $t_{produce} = t_4 – t_3$ as the time period the maximum impulse of the whole system in the line direction of the golf ball is generated;
- $t_{lack} = t_5 – t_4$ as the time period from maximum impulse of the whole system and the impact to the golf ball.

Additional we calculated:

- $p_1$: the maximum impulse of the whole system in countermovement direction;
- $p_2$: the maximum impulse of the whole system in line direction of the golf ball;
- $v_1$: the velocity of the centre of gravity in countermovement direction;
- $v_2$: the velocity of the centre of gravity in line direction of the ball.

To calculate the velocities we had to register the mass of our test persons.

The computed data were statistically tested by t-test for independent samples.

**RESULTS:** Table 1 shows the mean values of the parameters and significant differences. The duration when force in countermovement direction is produced is significant lower while playing carving golf. Classic golf players produce 3.8 times the impulse of carving golfers in countermovement direction and even more velocity in the same direction. The time to stop this movement shows no significant difference. The period classic golfers produce impulse in the line of the direction of the golf ball is significant shorter than carving golfers needed. Nevertheless is the impulse in the line of the direction of the golf ball for the classic players more than 25% higher than for the carving golfers and even more is the velocity. The mean value of the time period between the maximum impulse and the moment of impact is significant shorter for the carving golfers.

**Table 1 Mean values of the parameters**

| Variable | Type | N | Mean | SD | Significance |
|---|---|---|---|---|---|
| $t_{minus}$[s] | Classic | 32 | .593 | .154 | p<0.05 |
| | Carving | 12 | .441 | .199 | |
| $p_1$[kg*m/s] | Classic | 32 | 11.09 | 4.60 | p<0.05 |
| | Carving | 12 | 2.92 | 1.44 | |
| $t_{amort}$[s] | Classic | 32 | .338 | .106 | p>0.05 |
| | Carving | 12 | .308 | .163 | |
| $t_{produce}$[s] | Classic | 32 | .53 | .144 | p<0.05 |
| | Carving | 12 | .657 | .237 | |
| $p_2$[kg*m/s] | Classic | 32 | -34.66 | 9.02 | p<0.05 |
| | Carving | 12 | -25.46 | 3.49 | |
| $t_{lack}$[s] | Classic | 32 | .0469 | .0571 | p<0.05 |
| | Carving | 12 | .00892 | .0181 | |
| $v_1$[m/s] | Classic | 32 | .142 | .0608 | p<0.05 |
| | Carving | 12 | .0344 | .0154 | |
| $v_2$[m/s] | Classic | 32 | -.437 | .105 | p<0.05 |
| | Carving | 12 | -.294 | .0384 | |

**DISCUSSION:** Figure 2 shows the force time curve that was expected if you teach a player to do the first move in line direction of the golf ball. Under the condition that there was no move when we start to record the force values we realize that there is no countermovement. Our results depending on a larger number of players show such a movement with about 25% of the impulse classic golf players have. The perception of the carving golfers and the instruction to the golf players is different. Guadagnoli M et al. (2002) prove the necessity of video or verbal instruction to support the teaching of the golf swing. The analysis of ground reaction forces are additional information on the causes of a movement

To produce impulse in the line direction of the ball the classic group needed less time and induce a higher impulse. That is only possible with higher forces. The carving golf method was invented to avoid these higher forces. Higher forces are often the reason for a lack of accuracy. There is a lack of research literature regarding this coherence for golf game. Articles are focussing on putting when dealing with accuracy or they look for higher forces to motivate longer distance for the shot (Hume et al. (2005); Fletcher and Hartwell (2004); Doan et al. (2006)).
Assuming that the best performance for the length of the shot is given when the highest impulse is produced, it looks like that the carving golfers have advantages over the classic golf players. The delay between maximum velocity of the whole system and the impact to the golf ball is significantly shorter regarding the carving golfer opposite the classic golfer. However, we did not measure the speed of the club. Maybe there is a necessity for a larger delay between maximum horizontal impulse and impact to the golf ball to generate a higher performance.

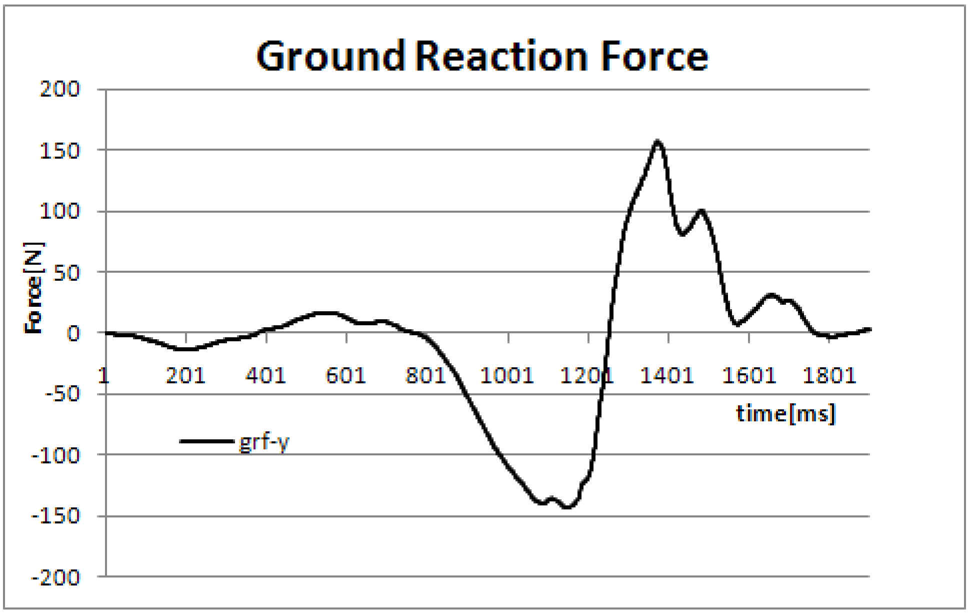


**Figure 2: The expected horizontal ground reaction force in line direction of the golf ball when doing a carving golf movement.**

**CONCLUSION:** This study identified mechanical parameters evoked by 2 different possibilities to realize a golf shot. It shows that even if a special movement is forced the player starts with a countermovement. This countermovement is not realized by the players.

Using the techniques of force platforms it is possible to distinguish between different kinds of movements while the golf swing. It provides with fundamental basics for moving techniques in golf. It also can assist to evaluate the quality of a golf swing movement.
Carving golf is based on a young training method to teach the golf swing. Controlling the procedure of learning by using biomechanical measurements can help us to improve our knowledge about the complexity of learning and playing golf.

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