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Comparison of club kinematic parameters between elite and amateur golfers during swing

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ABSTRACT

A key focus of most golfers is to acquire better driving performance. The mechanics of swing has been long described as the most important for optimal golf performance. This study was conducted to compare the club kinematics between elite and amateur golfers during swing. It was hypothesized that elite golfers would perform better than amateur athletes during the swing. The following parameters were studied: the movement time, displacement, arc, velocity and acceleration of the club. In a cross-sectional study, two groups of elite and amateur golfers (n=72) aged 18 to 40 years old were recruited upon written consent. The participants were asked to perform swing and two-dimensional motion analysis system was used to capture swing in sagittal and frontal planes. The statistical analysis revealed that the maximum displacement of the club was higher for the elite than the amateurs, but it was not statistically different (3.91 m and 2.17 m, respectively; P = 0.123). The swing time was similar in both elites and amateurs (3.32 s and 1.9 s, respectively; P = 0.365). The club trajectory showed that both groups had comparable arc angle backswing, while the arc radius arc was significantly different in forward swing. The elite participants showed significantly higher mean linear accelerations (199.94 vs. 146.97 m/s², P = 0.001) and angular accelerations (-169.63 vs. 291.22 m/s², P = 0.001) than the amateurs. The mean linear and angular velocities of the club were also significantly different between the elite and amateur golfers (0.94 vs. -0.58 m/s; P = 0.001). In short, the elite golfers performed more efficiently than the amateur golfers and showed improved timing of the movement path in comparison to the amateur group. It can be concluded that timing should be more emphasized in the training for beginners.

Keywords: amateur golfers, elite golfers, kinematic analysis

Introduction

The main goal of golf players is to use the golf club to finish the game with the lowest number of strokes. The swing is a very speedy, multifaceted movement so that it is challenging for the golfers to identify the swing. Primary focus of most golfers is to achieve better driving performance. The swing mechanics has been studied for optimal golf driving performance (Adlington, 1996). Amateur golfers are trained on the best tactic to move the body and club during the swing, in order to maximally increase the driving distance. Previous research indicates that during the swing, the players should have a straight back, slightly bent forward and at right angle to the ground. During the backswing, the body mass should move towards the trailing foot (that is the left foot for a left-handed golfer) and then back towards the leading foot (that is the right foot for a right-handed golfer) at the end of the follow-through position. Moreover, from the ground up, the drive of body segments should be consecutive (Adlington, 1996).

The golf swing motion has been investigated with the aim of providing valuable information to improve the swing and score. Some mathematical models have been also used to explain the swing (Penner, 2000). The motion capture system was employed as a scientific approach to golf training to measure the kinematics and kinetics of golfers. It is a common approach to identify the features that distinguish good golfers from others. In a study by Cooper and Mather (1994), it was found that professional golfers increased angular velocity of club head at ball impact, high-handicap players peaked in early downslope, while low-handicap players peaked exactly before the impact. Another finding indicated that less-skilled players released and speeded the club too early (Robinson, 1994).
Professional golfers showed sequential trunk rotation and the trunk rotation was slower in amateurs than professionals (Robinson, 1994). High-handicap golfers adopt less and slower body mass shift back towards the trailing foot in the backswing and then shift forward towards the leading foot in the downswing.

**Purpose of the study**

Regardless of extensive motion analysis studies, there is limited research that on the importance of biomechanics of club swing and its role in optimizing the driving performance. The current study aimed to evaluate multiple variables throughout the golf swing to determine the key factors among them. This study was conducted to compare the club kinematics between elite and amateur golfers during swing. It was hypothesized that elite golfers would perform better than amateur athletes during the swing.

**Methodology**

In a cross-sectional study, the sample was selected from elite and amateur golfers. Total of 72 golfers (36 elites and 36 amateurs) participated in this study. The inclusion criteria was being free of injury and no significant history of joint injury at the testing time. The amateurs had undergone 1-day training. All the participants signed an informed consent as required by the institution’s ethics board. The golf swing kinematic data were obtained in two locations; in the laboratory and in the driving range using high-speed camera working at 250 Hz. The golfers were asked to wear black clothes and 9 reflective markers were attached to the upper limb on the acromion, lateral epicondyle of the humerus, wrist, metacarpals and the club head. The markers trajectories were tracked by the camera and filtered by a cut-off frequency. The participants did typical warm-up prior to data collection and the following procedure was performed. The camera was positioned 5 m from the participant. Each participant was asked to hit 5 shots off the artificial turf tee box using Iron 7 club, and 2D motion capture was performed with sagittal and frontal planes. The following parameters were extracted from the data: the movement time, displacement, arc, velocity and acceleration of the club. The shot with highest distance was selected for the data analysis, which was performed using the Labview 7.1 and Visual Basic software. Statistical analyses were performed using the SPSS 16.0. Normality of the data was checked with the Kolmogorov–Smirnov test and the independent t tests were used to make comparisons between the elite and amateur golfers.

**Results**

The mean age, height and weight of the participants were 35.2±10.3 years, 1.67±0.54 m, 76.5±17.0 kg. Table 1 presents group means and standard deviations of variables. Figure 1 shows the velocity and acceleration values compared between the elite and amateur golfers.

![Figure 1. Comparison of maximum velocity and acceleration between the elite and amateur golfers.](image-url)
Table 1. Mean, standard deviation and $P$ values of variables between the elite and amateur golfers.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Elites Mean</th>
<th>Elites SD</th>
<th>Amateurs Mean</th>
<th>Amateurs SD</th>
<th>$P$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>2.3</td>
<td>0.3</td>
<td>1.9</td>
<td>0.5</td>
<td>0.385</td>
</tr>
<tr>
<td>Displacement (m)</td>
<td>3.91</td>
<td>1.06</td>
<td>2.17</td>
<td>0.91</td>
<td>0.123</td>
</tr>
<tr>
<td>Arc (deg)</td>
<td>206.72</td>
<td>73.76</td>
<td>194.61</td>
<td>98.09</td>
<td>0.001</td>
</tr>
<tr>
<td>Angular Velocity (rad/s)</td>
<td>-16.94</td>
<td>74.48</td>
<td>-50.38</td>
<td>78.92</td>
<td>0.001</td>
</tr>
<tr>
<td>Linear Velocity (m/s)</td>
<td>6.13</td>
<td>1.36</td>
<td>9.60</td>
<td>-0.60</td>
<td>0.001</td>
</tr>
<tr>
<td>Angular Acceleration (rad/s$^2$)</td>
<td>291.22</td>
<td>81.00</td>
<td>-169.63</td>
<td>57.30</td>
<td>0.001</td>
</tr>
<tr>
<td>Linear Acceleration (m/s$^2$)</td>
<td>199.94</td>
<td>18.18</td>
<td>146.97</td>
<td>7.38</td>
<td>0.001</td>
</tr>
</tbody>
</table>

**Discussion & Conclusion**

This study aimed to examine the differences between elite and amateur golfers in terms of club swing parameters. The statistical analysis revealed that the swing time was similar in both elites and amateurs ($P = 0.385$). All other parameters showed significant difference between the two groups. The velocity and acceleration of club head was significantly higher for elite golfers in comparison to the amateurs. This is consistent with the findings of Williams & Sih (2002) and Cheetham et al. (2008). On the other hand, there was no significant difference in the swing time between the two groups. These results might indicate that elite golfers were able to have improved control over the club by managing the time to achieve higher performance. Moreover, the club trajectory showed that both groups had comparable arc in backswing, while the arc radius arc was significantly different in forward swing. In conclusion, the elite golfers showed better timing of the swing compared with the amateurs. Optimal swing is resulted from the performance of all the upper limb joints as well as the club movement. Therefore, the upper limb trajectories should be also investigated through motion analysis. From the findings of this study, it is implied that more emphasis should be on timing in the training for amateurs.

**References**


