FRONTAL PLANE KNEE JOINT MOMENTS DIFFER BETWEEN CLUBS AND GENDERS IN THE GOLF SWING

Luke Adams[1,2*], Aaron Trunt[1,2], and Lisa N. MacFadden[1,2]
[1]Sanford Sports Science Institute
[2]Sanford Research
email: luke.adams@sanfordhealth.org

Introduction

Knee injuries are some of the most frequently experienced by golfers, with prevalence comparable to that seen in some high-impact sports. While the literature regarding loading of the knee joint and related injury risk in golfers is inconclusive, it is theorized that the complex set of conditions occurring in the knee during the swing, and cumulative load placed on the joint, may contribute to acute injuries as well as degenerative processes with resulting injury. Given the paucity of research investigating joint loading in golfers and its relation to injury risk, it is valuable to investigate what factors affect knee joint loading during the golf swing in order to inform technique and return to sport criteria. Previous studies have investigated the knee joint load experienced during the swing and how different stances affect loading. However, many of these studies have small sample sizes or limit their investigation to study participants of a single sex or the use of one club. Using a database collected on both 6-iron and driver swings from golfers of all ages, skill levels and both sexes, this study investigates how knee joint loads differ between sexes and when using different clubs. We hypothesized that swings with a driver would result in significantly greater knee joint loads than swings with an iron, and that there would be no difference in knee joint loads between males and females after controlling for golfer mass.

Methods

The Sanford Health Institutional Review Board approved this study and all golfers consented to their participation in the study. Fifty-seven healthy golfers (26.7 ± 12.5 yrs, 1.75 ± 0.10 m, 75.5 ± 15.8 kg, 29 males/28 females, 54 right-handed/3 left-handed) ranging in skill level from recreational to professional completed up to 15 6-iron swings followed by up to 10 driver swings for assessment in a biomechanics laboratory. 3-D kinematic data was collected from 10 optical motion capture cameras recording at 300 Hz (Qualisys AB, Gothenburg, Sweden) with the Qualisys Golf Performance markerset, while force plate data was collected simultaneously at 1200 Hz (Bertec Corp. USA). A Trackman 4 launch monitor was used to collect club speed data, and the five fastest swings from both the iron shots and driver shots were used for analysis. Peak frontal plane knee joint moments normalized to bodyweight for the lead leg were calculated in Visual 3D for each swing, averaged across the five shots for iron and driver, and exported for analysis. Paired T-tests were used to determine differences in knee joint moments between clubs, and unpaired T-tests were used to determine differences in knee joint moments between males and females. Significance was determined *a priori* to be 0.05.

Results and Discussion

Results across all golfers showed that while the peak lead knee abduction moment with the driver was significantly greater than with the 6-iron, the peak lead knee adduction moment with the iron was significantly greater than when using the driver. This pattern held when the groups were stratified by sex. While our hypothesis was partially correct in that abduction moment with the driver was greater than when using the 6-iron, the peak abduction moments as a group were considerably smaller in magnitude across all golfers and with both clubs than peak adduction moments, and thus may be of less practical significance regarding injury risk and prevention. After controlling for golfer mass, males had significantly greater peak lead knee abduction and adduction moments when using both drivers and 6-irons.

Significance

The use of shorter clubs is commonly recommended to reduce swing intensity, joint loading, and injury risk. However, when participants in this study used a shorter club, while their lead knee abduction moment did decrease, they actually experienced an increase in the adduction moment. Furthermore, the finding that males experience greater peak knee moments than females was in contrast to our hypothesis, and suggests that factors other than increased body mass, such as technique or swing speed, may contribute to the load experienced in the knee during the golf swing. These findings suggest that a golfer's sex and the type of club used affect knee joint loads experienced during the swing, and should therefore be considered when assessing injury risk and when designing return to sport programs for golfers following a knee injury. Additionally, the laterality of knee pathology should be considered in golfers with chronic injuries or when returning to sport, as different clubs were found to affect medial-lateral knee loading differently.

Table 1. Frontal plane joint moments for each club in the entire sample (n = 57; Mean ± SD)

Variable	6-Iron	Driver	P-value
Peak Lead Knee Abduction Moment (Nm/kg)	0.317 ± 0.141	0.360 ± 0.157	**<0.001**
Peak Lead Knee Adduction Moment (Nm/kg)	-0.906 ± 0.323	-0.762 ± 0.276	**<0.001**

Table 2. Frontal plane joint moments between males and females (Mean ± SD)

	6-Iron			Driver		
Variable	Males (n = 29)	Females (n = 28)	P-value	Males (n = 29)	Females (n = 28)	P-value
Peak Lead Knee Abduction Moment (Nm/kg)	0.376 ± 0.135	0.255 ± 0.122	**<0.001**	0.436 ± 0.142	0.280 ± 0.130	**<0.001**
Peak Lead Knee Adduction Moment (Nm/kg)	-1.019 ± 0.333	-0.789 ± 0.270	**0.006**	-0.848 ± 0.288	-0.673 ± 0.235	**0.015**