

Lower Body Joint Moments During the Golf Swing: Comparison to other Activities of Daily Living

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Introduction

The National Golf Foundation estimates that the total US Golf Participation rates are up more than 17% over the last five years, with the current estimate being there are 37.5 million people over the age of 6 years old participating in a golfing activity¹. With this large increase in golf participation, clinicians need better guidelines in advising golfers when it is safe to return to golfing following injury or surgery. Several studies have quantified the loading of the large lower extremity joints during the golf swing^{2,3,4}, but no studies have compared these loads to other activities of daily living in the same population. Therefore, this study will compare the knee and hip joint loading during the golf swing with loading during gait and sit-to-stand tasks.

Methods

Twenty-two healthy males participated in the study (age: 62±8 years, height: 1.8±0.1m, mass 89.1±10.9kg). All participants signed an informed consent document approved by the university. Participants were outfit with motion tracking markers to collect kinematics data (Vicon, Oxford, UK), and stood with each foot on a separate force plate (AMTI) for golf swing trials. Marker data were collected at 100 Hz, force plate data were collected at 1000 Hz. After appropriate warm-up/practice swings, eight 6-iron shots were recorded for analysis. A Trackman (Vedbæk, Denmark) radar launch monitor collected club head speed (CHS). Two more tasks were also performed: gait and sit-to-stand (STS) testing. For gait trials, subjects walked on 10-meter walkway at their preferred pace. Three successful trials (subject's foot landed entirely on the force plate without targeting it) were used to analysis. For STS testing, subjects sat on a standard height chair (46 cm) with each foot on a separate force plate. They were instructed to continuously stand up and sit down as many times as possible for 30 seconds with their arms extended in front of them. Three consecutive repetitions of STS in the middle of the 30 second trial which had the most consistent peak sternal marker velocities were selected for analysis. Knee and hip joint moments in the sagittal and frontal planes were calculated in all tasks using custom MATLAB code. Peak net joint moments during each movement were then extracted from the curves and normalized to body mass. A repeated measures ANOVA was then used to determine differences in peak moments between the three movements (golf – lead and trail leg, gait, STS). Significance level was set at p<0.05.

Results and Discussion

The mean 6-iron CHS for the group was 33.5 ± 4.3 m/s. Mean net joint moment data are shown in Table 1. Golf joint loads are significantly different than gait/STS for the internal hip extension, hip adduction (both legs) and knee flexion (trail leg) moments, as well as for the external valgus knee moment (lead leg). The internal moment differences reinforce previous work examining muscular activations during the golf swing⁵. The external valgus moment on the lead knee during golf support the abnormally large load on the ACL & lateral compartment of this knee in golf².

Significance

Clinicians should focus on improving the functioning of the hip extensors & adductors, as well as the trail side hamstring to ensure a safe return to golf after injury/surgery. Those with lateral side knee joint or ACL pathologies in the lead knee should also take extra precautions when returning to golf as the swing can place abnormally large loads on these tissues.

References

(1)National Golf Foundation, 2021; (2) Lynn & Noffal, 2010; (3)Gatt et al., 1998; (4) Kanwar et al., 2021; (5) Marta et al., 2015.

Table 1. Mean joint moments for the different movements. All are internal moments except for the frontal plane knee moments.

	Gait	STS	Golf Lead Leg	Golf Trail Leg
Varus Knee	0.395(0.134)	0.125(0.058) ^a	0.527(0.212)	0.517(0.133)
Valgus Knee	-0.165(0.146)	-0.117(0.969)	-0.552(0.359) ^a	-0.271(0.270)
Knee Extension	0.445(0.166)	0.898(0.275) ^a	0.595(0.275)	0.465(0.259)
Knee Flexion	-0.334(0.141) ^a	-0.098(0.078) ^b	-0.410(0.339) ^a	-0.682(0.192) ^c
Hip Abduction	0.728(0.141)	0.294(0.091) ^a	0.696(0.302)	0.794(0.240)
Hip Adduction	-0.124(0.83) ^a	-0.110(0.142) ^a	-0.878(0.541) ^b	-0.436(0.308) ^c
Hip Extension	0.411(0.187) ^a	0.783(0.169) ^b	1.16(0.385) ^c	1.458(0.254) ^d
Hip Flexion	-0.683(0.162) ^a	-0.219(0.234)	-0.269(0.147)	-0.405(0.285)

- Moments presented as Mean (SD) in Nm/kg. Different superscript letters = statistical differences at p<0.05.