Frontal plane knee moments in golf: Effect of target side foot position at address

Scott K. Lynn and Guillermo J. Noffal
California State University, Department of Kinesiology, Fullerton, CA, USA

Abstract
Golf has the potential to keep people active well into their later years. Injuries to the target side knee have been reported in golfers, yet no mechanisms for these injuries have been proposed. The loads on the knee during the golf swing may be insufficient to cause acute injury, yet they may be a factor in the progression of osteo/degenerative conditions; therefore, research developing swing modifications that may alter loading of the knee is warranted. It has been suggested that the proper golf set-up position has the target-side foot externally rotated but no reasoning for this modification has been provided. Frontal plane knee moments have been implicated in many knee pathologies. Therefore, this study used a 3-dimensional limb segment model to quantify the frontal plane knee moments during the golf swing in a straight (STR) and externally rotated (EXT) target-side foot position. Subjects were 7 collegiate golfers and knee moments were compared between conditions using repeated measures T-tests. The golf swing knee moment magnitudes were also descriptively compared to those reported for two athletic maneuvers (drop jump landing, side-clip cutting) and activities of daily living (gait, stair ascent). The EXT condition decreased the peak knee adduction moment as compared to the STR condition; however, foot position had no effect on the peak knee abduction moment. Also, the magnitude of the knee adduction moments during the two activities of daily living were 9-33% smaller than those experienced during the two different gait conditions. The drop jump landing and golf swing knee moment magnitudes were of similar magnitude (STR = 5%, EXT = 5%); however, the moments associated with side-step cutting were 50-71% larger than those on the target-side knee during the golf swing. The loading of the target side knee during the golf swing may be a factor in the development and progression of knee pathologies and further research should examine ways of attenuating these loads through exercise and swing modifications.

Keywords: Golf, ACL injury, biomechanics, knee abduction (valgus) moment/torque, knee adduction (varus) moment/torque, knee osteoarthrits.

Introduction
Current public health messages are consistent in their emphasis of the value of an active lifestyle across all ages. The game of golf has great potential in keeping people active as it has been called a “lifeline” sport that allows for participation from early childhood until well into our older adult years. With the estimated 53 million golfers world-wide (Farrell et al., 2003), the potential of this game for keeping a large number of individuals active is enormous. Therefore, research aimed at ensuring that golfers can avoid musculoskeletal injury/degenerative disease and remain active much longer is warranted. Traditionally, golf has been considered a docile and non-tremulous sport; however, recent evidence has shown that there is considerable strain on the musculoskeletal system during the golf swing. Although not as common as injuries to the upper extremity (wrist, shoulder, elbow) as well as the lower back, there is evidence that lower body injuries account for anywhere from 15-18% of the total injuries reported by golfers (McCarroll, 1996). The prevalence of upper body and lower back injuries are high for both amateur and professional golfers; however, the prevalence of some lower extremity injuries has been shown to differ between these two groups. One difference is that in the professional golfer, the left knee was found to be injured about as frequently (7%) as the left hand (7.1%) and left shoulder (7.1%), and was also injured more commonly than several upper limb joints (left elbow – 3.8%, right wrist – 3.1%, right elbow – 2.8%) (McCarroll, 1996). In amateurs, the knee was not injured as commonly (9.3%) as any of the upper limb joints – elbow (33%), hand and wrist (25%), shoulder (11.9%) (McCarroll, 1996). The subjects in the McCarroll (1996) study were exclusively right handed golfers and their left leg is the target side leg upon which the golfer stands following the shot. These different injury rates would suggest that the loads experienced by the joints during the golf swing differ between professional and amateur golfers.

Although the prevalence of target side knee injury is much more common in the professional golfer relative to injuries of other joints, it has been found that there is no difference in the knee joint kinematics between skilled and unskilled golfers (Gott et al., 1998). If it is assumed that on average a group of professional golfers would be more skilled than a group of amateurs, it may be hypothesized that the different target side knee injury rates in these two groups of golfers are due to the cumulative loading of the knee, as professionals would most likely be performing this motion much more often. Becker et al. (1995) also tested the EMG activity of various muscles during the golf swing in extremely skilled golfers (handicaps less than 5), and findings indicated that the activity in these target-side leg muscles reached up to 83% of peak muscle contraction. Therefore, the combination of these muscular contractions and the external forces resulting from the powerful transfer of the entire body mass onto the target side leg during the swing could place large loads on the knee joint.

Since abnormal loading of the knee joint can be detrimental to many of the soft tissues in the joint (Hewett et al. 2005; Lynn et al., 2007), it is important to attempt to quantify these loads during golf in order to determine the relative risk for acute/chronic injury and/or degenerative disease.