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Playing Surface Influences Limb Accelerations During the Golf Swing

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• Biomechanics and Physiology

Although golf is not considered a strenuous sport, it is well documented that injuries occur. Over one-third of recreational golfers sustain a golfing injury each year, and this number more than doubles in professional golfers. Findings from sports such as tennis, gridiron, hockey, and soccer have shown that surface plays a large role in injury risk, yet there have been no studies investigating the effect surface may have on injury risk in golf.

Purpose: To analyze and compare accelerations exerted on both the arms and legs during a golf swing on three commonly used surfaces in golf: natural grass (G), sand (S), and artificial turf (T). Also, to determine the phases of the golf swing that resulted in the largest acceleration differences across surfaces.

Methods: Thirty golfers with a registered handicap completed a standardized warm-up routine prior to hitting a golf wiffle ball outdoors three times on each surface using a 5-iron club in a randomly assigned order. Four Microstrain G-link wireless accelerometers were attached to an elastic resistance band with Velcro, and this band was wrapped around the participant's limbs and also secured with Velcro. One accelerometer was placed on each of the golfer's left and right forearms, as well as one on each of the left and right tibial surfaces. As the golf swing has considerable rotational movement associated with it, the orientation of the accelerometers was constantly changing throughout the swing. Therefore, resultant accelerations were calculated to quantify total acceleration experienced by each segment. Video of the golfers' swings were synched to the accelerometer output so that the phases of golf swing (backswing, downswing, impact, and follow-through) could be more easily identified. A repeated-measures MANOVA was performed to determine within-subjects effects, and a univariate ANOVA was undertaken to determine surface differences for each body location. Further examination using pair-wise comparisons were performed to determine acceleration differences for each surface.

Results: The overall reliability and precision data on each surface and body location were high (ICC range: 0.72 – 0.96), with only two exceptions: the lead leg on T (0.48) and the trail leg on S (0.27). Accelerations in the lead arm and lead leg were significantly higher on G compared to T ($p = 0.016$, and $p = 0.009$, respectively), and G compared to S ($p = 0.025$, and $p = 0.002$, respectively). Accelerations in the trail leg were also significantly higher on G compared to S ($p = 0.031$), and although not significant, accelerations in the trail arm were higher on G compared to T ($p = 0.061$). Resultant accelerations were

also significantly smaller in the legs compared to the arms across all conditions ($p \leq 0.001$). When investigating surface differences via swing phases, significant differences were seen in the arms during all phases on G compared to both S and T (all $p \leq 0.01$), and in the legs during the downswing and follow-through on G compared to both S and T (all $p \leq 0.01$).

Discussion: Natural grass consistently produced the greatest total accelerations, suggesting that body segments may be subjected to greater forces on this surface which may increase the risk of injury, or re-injury. The acceleration variations between the arms and legs are likely due to the roles of these limbs throughout the golf swing. The arms have a much greater role as they help generate force throughout the swing, and control accuracy of club head at impact, whereas the legs primarily act as stabilizers and contribute to consistency. Accelerations were significantly greater on the lead side compared to the trail side which is expected as the lead side is more involved throughout the golf swing, however, this is a major concern as the lead side sustains significantly more injuries than the trail side. The high degree of reliability shown suggests that all golfers had consistent swings and conditions, thus, the swings were not the limiting factor, so it is likely that the stability of the surface was. The surface may have caused the legs to become less stable, which in turn may have affected the accelerations of both the arms and legs. These data suggest further research should be performed to examine how playing and practice surfaces relate to golf injuries.

Practical Application / Clinical Relevance: Variations in acceleration in any phase of the golf swing increase the potential for injury to occur. These results suggest that the amount of golf play and / or practice on natural grass should be limited, especially in golfers recovering from, or those pre-disposed to, injury.

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