A COMPARISON BETWEEN THE MODERN AND THE LOWER BODY GOLF SWING TECHNIQUES– PILOT STUDY WITH IMPLICATIONS FOR LOWER BACK INJURY RISK

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The purpose of this study was to compare the biomechanical characteristics of the lower body swing to modern swing techniques, with a focus on lower back injury risk. Fifteen male individuals free from lower back injury participated in this study. Nine participants utilized the modern swing (age = 48.0 ± 13.6 years; height = 176.8 ± 4.4 cm; mass = 82.1 ± 5.3 kg) while six utilized the lower body swing (age = 53.9 ±12.1 years; height = 182.9 ± 6.1 cm; mass = 92.5 ± 14.8 kg). Whole body kinematics were recorded with a ten-camera motion analysis system while individuals performed 5 shots with a driver for maximum distance. Continuous waveform and discrete point analysis was used to explore the differences between these two techniques. The lower body swing demonstrated favourable kinematics in the majority of variables related to lower back pain and lumbar load.

KEYWORDS: kinematics, motion analysis, lumbar, spine, biomechanics

INTRODUCTION: Abnormal swing biomechanics have been highlighted as a major cause of golf injury (Gluck, Bendo & Spivak 2008; Lindsay and Vandervoort, 2014; McHardy, Pollard & Luo 2007). The majority of these injuries occurred at ball impact or follow through of the golf swing (McHardy et al., 2007), likely due to the large forces during these phases (Lim, Chow & Chae 2012). Modifications to swing technique may reduce spinal load/ injury risk, however limited empirical evidence supports this claim (Cole and Grimshaw, 2015).

While the modern swing technique has been developed and adopted for improving performance (e.g., Hume, Keogh & Reid 2005; Myers et al., 2008), these characteristics may also contribute to increased risk for low back injury (i.e., greater X-factor, lateral bend or crunch factor, follow-through hyperextension, forward tilt, etc.). Numerous, theoretical and clinical commentaries have suggested that the classic style swing has advantages over the modern swing due to the potentially decreased spinal motion and loading (Cole and Grimshaw, 2014; Cole and Grimshaw, 2015; Gluck et al., 2008). To date, only one study has compared the classic vs modern swing (Ashish, Shweta & Singh 2008), however, only electromyography (EMG) data of the oblique's and erector spinae was captured. Results revealed greater erector spinae activation in the modern swing with greater oblique activation in the classic swing. This limited evidence and methodological shortcomings (e.g., EMG data only, no performance evaluation, large variability, order effects, iron use, and lack of technical verification/quality) warrants further investigation comparing various swing techniques.

One potential method that could ameliorate spinal loads while maintaining or even improving performance could be to increase lower body motions to produce the necessary rotational characteristics while minimizing spinal forces. This 'lower body' style swing has the potential to produce similar spinal loading characteristics to that of the 'classic' style but performance benefits seen from the 'modern' style. The lower body style has been documented in coaching texts (Weedon and Harris, 2015) but has yet to be empirically investigated for its potential protective and performance benefits. Therefore, the purpose of this study was to analyse biomechanical characteristics between two different golf swing techniques - the modern and the lower body swing.

METHODS: Fifteen male golfers free from musculoskeletal injury took part in the study. Ethical approval was granted by the ethics committee of the Leeds Beckett University, and all participants provided informed consent. Participants were divided into a modern (n = 9) and lower body (n = 6) swing group based on their preferred swing technique (see Fig 1).

Figure 1: Lower body (top) and modern (bottom) swing techniques.

Participants performed five shots for maximum distance and 3D kinematics were recorded using a ten-camera (Vantage V5, Vicon, UK) motion analysis system (250 Hz). A set of 62 reflective markers (1.4 cm diameter) were attached to the participants using double sided tape, at bony landmarks on the lower limbs, pelvis and trunk per the Vicon Plug-in-Gait markerset, in combination with marker clusters on fore and upper arm as well as the thigh and shank. Vicon Nexus 2.3 was used to analyse the motion data, which was filtered using a fourth-order Butterworth filter (cut-off frequency of 15Hz (Kristianslund, Krosshaug & van den Bogert 2012)). Segment and joint angles were calculated as described in Winter, 2009. The swing movement was time normalized to 303 frames (three phases) and landmark registered to the following key events (address, top of back swing, ball impact and end of follow through) (Ramsey, 2006). Subsequently to the landmark registration, all trials of a subject were averaged to generate a representable mean. The aim of this pilot investigation was to provide initial data for the feasibility of further investigations exploring the benefits of the lower body swing in reducing lower back injuries. Thus, variables of interest were: the thorax (in relation to pelvis and global) angles, angular velocity and angular acceleration as well as the crunch factor (product of trunk abduction angle and trunk rotational velocity). This exploratory analysis utilized continuous waveform analysis of the various kinematic variables and discrete point analysis of potential velocity and acceleration variables that are likely related to lower back pain and joint loading (Grimshaw and Burden, 2000; Lindsay and Horton, 2002; Cole and Grimshaw, 2014). To identify differences in examined kinematic measures between the groups, Cohens *d* effect size was calculated in a point-by-point manner to determine relevance of a difference ($d > 0.5$ = moderate; $d > 0.8$ = large) (Cohen, 1988). However, since the main goal was exploratory in nature and due to the small sample size, statistical analyses should be interpreted with caution. All data processing and statistical analyses were performed using MATLAB (R2015a, MathWorks Inc., USA).

RESULTS: Participants in the lower body swing group were aged 53.9 (±12.1 SD) years old, 182.9 (±6.1 SD) cm tall and 92.5 (±14.8 SD) kg. Participants in the modern swing group aged 48.0 (±13.6 SD), 176.8 (±4.4 SD) cm tall and 82.1 (±5.3 SD) kg. The average handicap for the lower body swing group in this study was 15.8 (±6.3 SD) and for the modern swing group 9.1 (±5.1 SD). On average, the participants in the lower body swing group had been playing golf for 17.6 (±11.9 SD) years, while the participants who performed the modern swing had been playing for 23.4 (±15.3 SD) years. Lower body swing participants averaged 2.3 (±2.7 SD) rounds per week, while the modern swing participants averaged 3.0 (±1.9 SD) rounds per week.

Table 1: Kinematic differences between the lower body and modern swing.

	Lower Body		Modern			
	Mean	SD	Mean	SD	*p* value	*d*
Thorax-Pelvis Rotation Velocity (°/sec)	356.19	49.46	436.98	82.33	0.066	1.05
Thorax-Pelvis Rotation Acceleration (°/sec^2)	6253.68	2429.78	9008.15	1514.03	0.040	1.14
Thorax-Pelvis Abduction Velocity (°/sec)	97.48	24.44	155.91	33.79	0.006	1.41
Thorax-Pelvis Abduction Acceleration (°/sec^2)	4347.38	2146.03	5904.96	1096.05	0.144	0.86
Thorax Flexion Velocity (°/sec)	95.41	34.72	131.08	31.11	0.094	0.97

Thorax to pelvis rotation separation angle (X-factor) was substantially lower in the lower body compared to modern swing technique at the top of the backswing and during ball impact (see Fig 3-A). Thorax to pelvis abduction (side bending) angle was lower in the lower body compared to modern swing prior to ball impact (see Fig 3-B). Trunk flexion to pelvis angle was slightly lower in the lower body compared to the modern swing prior to impact (see Fig 3-C). Near ball impact, maximum thorax to pelvis rotational angular velocity and acceleration were lower in the lower body compared to the modern swing (see Table 1). Thorax to pelvis abduction velocity and acceleration were also lower prior to and near ball impact. Maximum thorax to pelvis flexion velocity was substantially lower prior to ball impact in the lower body compared to the modern swing. Finally, the crunch factor appeared to be slightly lower in the lower body compared the modern swing near ball impact (see Fig 3-D).

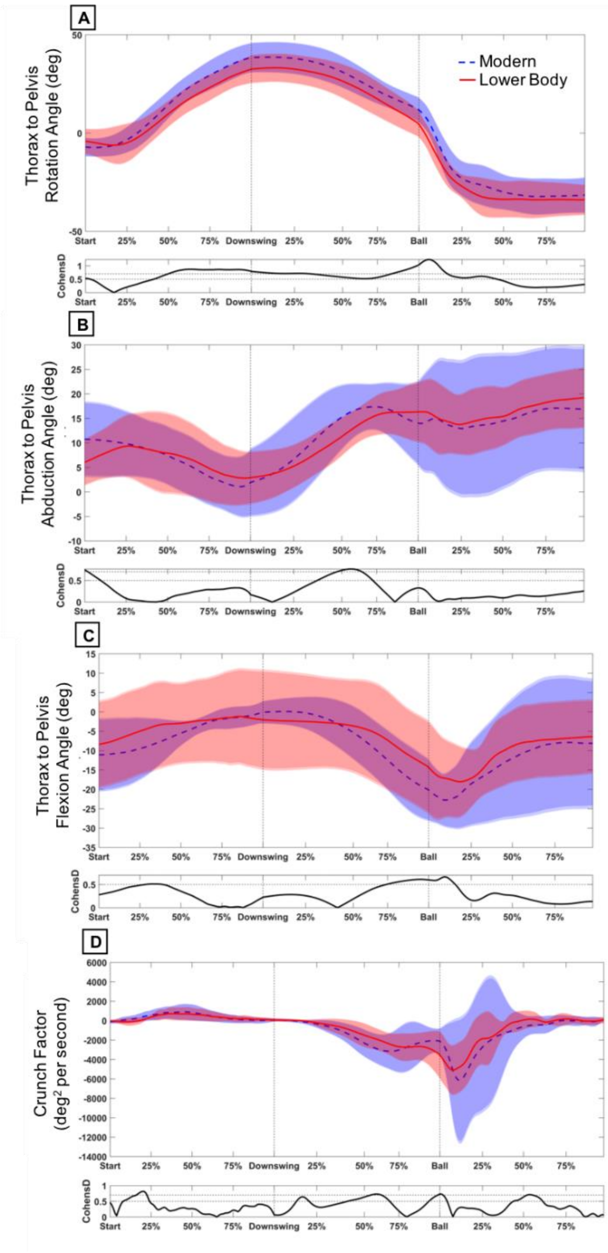

Figure 2: Kinematic difference between the modern and lower body swing techniques.

DISCUSSION: Large differences were found in the thorax to pelvis separation angle (X-factor) between the two groups at the top of the backswing and at impact. These findings suggest that during the lower body swing, the rotational and compressive load acting on the spine may be reduced at these time points (Cole and Grimshaw, 2014). Decreasing hip/shoulder separation angle has also been shown to be a positive adaptation following a coaching intervention with an individual with low back pain (Grimshaw and Burden, 2000), as well as following a shortened back swing (Bulbulian, Ball & Seaman 2001). In addition, differences in spinal rotation have been found between individuals with and without low back pain (Lindsay and Horton, 2002). While it is clear that other spinal motions besides rotation occur during a golf swing, aggressive axial twisting has been identified as a significant risk factor for LBP (Lindsay and Vandervoort, 2014). On the contrary, increased torso – pelvis separation angle and rotational velocity has been shown to be related to improved golf performance (Myers et al., 2008). Thus, there seems to be a performance-injury risk trade off that may influence an individual's desire to modify their swing technique (Cole and Grimshaw, 2015), if the notion that this increased stretch is contributing to injury risk. However, it is unlikely that the stretch (e.g., during the backswing), is contributing to excessive spinal loads as the downswing and impact phase is likely the phases in which most stress and injuries occur (Cole and Grimshaw, 2014; Hosea, 1990; Lim et al., 2012).

CONCLUSION: While very few studies have compared various swing techniques or modifications thereof, abnormal swing biomechanics have been highlighted as a major cause of injury. The current pilot investigation provides preliminary data for the feasibility of further research investigating the lower body swing and its potential to reduce lower back injury risk. The kinematic characteristics of the lower body swing has the potential to reduce lower back loading, however further higher-powered, prospective or longitudinal studies should be conducted to evaluate the benefits of this novel technique.

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