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Relationship Between the Dominant Leg in Producing Ground Loading in a Vertical Jump and Ground Loading Patterns During the Golf Swing

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Introduction: The goals of coaching programs are to improve accuracy and distance, and lower scores. Although it is commonly agreed upon that there is no specific swing for every golfer, current research and instruction need to account for differences between individuals. Traditionally, golf instruction and research has focused on kinematics to describe proper swing mechanics (Lynn et al., 2013, Tinmark et al., 2010). Specifically, the kinematic sequence has been heavily examined as it relates to maximizing distance and accuracy (Cheetham et al., 2008, Callaway et al., 2012). Additionally, there have been some studies examining the kinetic connection between the golfer's feet and the ground, which provided insight into how forces can be used to create or respond to the motions of the golf swing (Lynn et al., 2012, Barrentine et al., 1994). However, each of these studies examined the difference between golfers of different skill levels without accounting for individual differences between players. One factor that could affect how golfers load the ground during the swing is whether there is the presence of a dominant leg or not. Leg dominance has been defined from self-kicking leg or from measuring a single leg countermovement jump (CMJ) to denote a stronger or weaker leg (Hewett et al., 2012, Fort-Vanmeerhaeghe et al., 2012). To our knowledge, no previous research has investigated individual differences such leg dominance and how this affects ground-loading patterns.

Purpose: Therefore, the purpose of this study was to examine the correlations between the lead leg/trail leg vertical force production during a maximal CMJ and the lead leg/trail leg loading ratios during the golf swing. It can be hypothesized that identifying a dominant leg could be useful to properly individualize ground loading patterns in the golf swing.

Methods: 17 golfers (Age=23.18±4.65yrs, height=1.79±.08m, mass= 79.40±14.48kg, handicap=12.71 ±12.09) were recruited for this study. Countermovement jump and 3-dimensional golf swing data were collected using a 9 camera Qualisys Motion Capture system (Goteborg, Sweden) and 2 AMTI force plates (Watertown, MA). Peak vertical GRF and average rate of force development (RFD) during the concentric phase of a CMJ in each leg were calculated using a custom written LabVIEW program (National Instruments, Austin, Texas). These variables from the golfer's lead and trail legs during golf were then divided by each other to create a ratio (Lead leg/Trail Leg). Golf swing variables calculated using Visual 3D (C-Motion, Germantown, MD) were club head speed at impact (CSI), peak anterior-posterior (AP) ground reaction force (GRF) during the downswing (DS), peak medial-lateral (ML) GRF, ML braking GRF, peak vertical GRF during the downswing, and peak free moment during the backswing (BS) and downswing. Pearson correlation was used to assess the relationship between the vertical jump force ratios, GRF ratios, and CSI in the golf swing.

Results: Descriptive data and dependent variables are shown in table 1, while correlation data is shown in table 2. Peak GRF and RFD ratios during the CMJ were not related to any GRF ratios in the golf swing.

Discussion: Lead leg/Trail leg ratios of force production in the countermovement jump were not related to any GRF variables in the golf swing. Based on these results, we can reason that this sample of golfers may not be appropriately using their dominant legs during the swing. It can be hypothesized that if golfers are taught a technique where the contributions of each leg in the countermovement jump are matched during the golf swing, there may be increases club head speed. Additionally, CMJ testing only evaluates a participant's ability to produce vertical GRF's and may not comprehensively evaluate a person's dominant leg. As such, CMJ testing may not be a valid test to assess leg dominance in this population or activity. Therefore, additional tests should be developed to assess linear and rotational force production in order to properly determine leg dominance. This may prove more beneficial to fully evaluate individual leg dominance and its relationship to loading characteristics during the golf swing.

Practical Application/ Clinical Relevance: Identifying individual characteristics in force production may prove beneficial when developing individual coaching programs. The goal in instruction programs is to maximize performance and therefore, must take into account individual differences in order to effectively maximize this goal. These differences can be attributed to multiple factors that may develop across an individual's lifespan. Future research should focus on identifying tests that can comprehensively evaluate force production capabilities of each leg in multiple planes to determine if emphasizing the use of the dominant leg could have beneficial effects during the golf swing.

Table 1: Golf Swing Dependent Variables

Vertical Jump Variables	Mean	Std. Dev.
Peak GRF Ratio (Lead Foot/Trail Foot)	0.99	0.05
RFD Ratio (Lead Foot/Trail Foot)	1.08	0.18
Golf Swing Variables	**Mean**	**Std. Dev.**
CSI (MPH)	87.67	6.53
AP GRF Ratio	1.24	0.64
Peak ML GRF Ratio	0.32	0.38
ML Braking GRF Ratio	1.67	9.64
Peak Vertical GRF DS Ratio	1.63	0.78
Free Moment BS Ratio	0.49	0.50
Free Moment DS Ratio	7.31	6.70

Table 2: Correlations Coefficients between Golf Swing and Vertical Jump Variables

		AP GRF	Peak ML GRF	Peak ML Braking GRF	Vertical GRF	Free Moment BS Ratio	Free Moment DS Ratio
Peak GRF Ratio	Pearson Correlation	-0.072	0.085	0.284	0.201	.040	.122
	Sig.	0.784	0.745	0.269	0.439	.879	.640
RFD Ratio	Pearson Correlation	0.046	0.224	0.031	0.239	.158	.040
	Sig.	0.861	0.388	0.907	0.355	.544	.880
CSI	Pearson Correlation	0.069	0.390	0.219	0.313	-.002	.372
	Sig.	0.791	0.121	0.399	0.221	.995	.156

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