Influence of Modified Driver Properties on Golfer Movement Patterns

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Summary

Golfers can modify the mass and moment of inertia (MoI) of their driver. The influence of these changes on golfers' unique centre of pressure and centre of gravity movement patterns were investigated. The patterns between the control and High Mass condition showed small differences to the High MoI and combined high MoI/Mass condition which may be similar to results seen in running footwear literature with substantial changes to shoe characteristics.

Introduction

In golf, the mass and moment of inertia (MoI) of a driver can be modified by golfers using lead tape or interchangeable masses sold commercially with clubs. It is assumed that the modification to mass or MoI are made to suit their preferred swing. The influence of modifications to a club on the outcome of the shot and golfers' movement patterns are likely to be individual [1] which is of interest to club manufacturers, club fitters, coaches and physicians for developing personalised equipment. Individual features in golfers centre of pressure (e.g. front and back foot COP style) and centre of gravity have been found and linked to determinants of driving distance such as clubhead velocity [2]. The aim of this study was to identify differences in golfers' centre of pressure and centre of gravity when modifications were made to the MoI and mass of a driver.

Methods

Whole body kinematics were recorded for eight low handicap golfers (Mean ± SD, age: 32.9 ± 10.3 years; height: 179.4 ± 6.4 cm; mass: 84.3 ± 12.9 kg; handicap: 3.4 ± 3.3 strokes) using a 13 camera Vicon Nexus motion analysis system (500 Hz). Two Kistler force plates synchronised with Vicon collected ground reaction force data (1000 Hz). Whole body COG was the estimated weighted sum of individual body segment and golf club COG positions. The resultant COP was calculated from combining both force plates. The COP and COG were normalised as a percentage of the medial-lateral distance between front (0%) and back (100%) foot at set-up (%COP). Each swing was temporally aligned between swing events, takeaway, top of the backswing, impact and mid-follow through. Golfers hit ten drives for each condition in a randomised order towards a predefined target. Five trials were then analysed. Four drivers (control, high mass, high MoI, combo) with the same shaft and clubhead were modified using metallic rods placed in the golf shaft. Shaft stiffness, total club mass and total club MOI were measured (Table 1). Club and ball impact parameters were measured using GOM.

Results and Discussion

Across all golfers, clubhead velocity results (Table 1) supported previous findings that impact velocity of a swung sporting implement is indirectly proportional to the MoI and remains approximately constant for an increase in mass [3].. For a front foot COP style golfer, driver modifications seemed to show small differences in golfers COG and COP movement patterns. Notably COG patterns were similar for the High MoI and Combo condition and showed an approximate 2% shift in COG position to the front foot near impact compared to the Control and High Mass condition.

Table 1: Shaft stiffness (cycles per minute (cpm)), mass and moment of inertia measurements for each club condition. Clubhead velocity are the mean ± std across all golfers.

Club	Stiffness (cpm)	Mass (g)	MoI ($kg.cm^2$)	Clubhead Velocity ($m.s^{-1}$)
Control	222	389.9	2877.5	103.9 ± 8.2
Hi Mass	221	484.7	2888.1	104.0 ±7.5
Hi MoI	215	392.7	3267.2	101.0 ± 7.0
Combo	221	483.8	3298.3	99.8 ± 7.9

For this golfer, the greatest difference in COP position (approximately 5%) occurred between the high MoI and combination and the control and high mass club condition (Figure 1). In running, the preferred movement path is less maintained when the changes to shoe characteristics are substantial which may also be suggested through the results for this golfer [4].

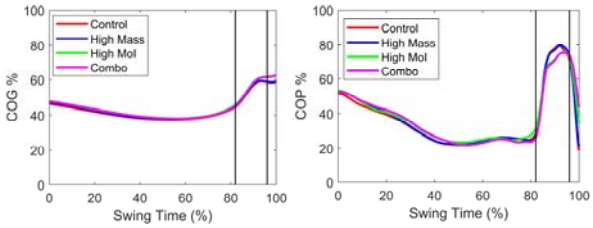

Figure 1: Mean ± SD medial-lateral COP and COG movement patterns for an example front foot style golfer with four different drivers. Vertical lines represent top of the backswing and impact..

Conclusions

As with running footwear literature, the preferred movement path may also try to be maintained by golfers when club mass or moment of inertia are modified. Future analysis will explore results of other golfers and investigate the relationship between the biomechanics, subjective and impact parameters when using the different modified drivers.

References

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