Professional golfers' hips: prevalence and predictors of hip pain with clinical and MR examinations

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ABSTRACT

Aims This study aimed to determine the prevalence of hip pain in professional golfers, comparing the lead (left hip in right-handed golfer) and trail hips, and to establish what player characteristics predicted hip symptoms.

Methods Male elite professional golf players were invited to complete questionnaires and undergo clinical and MR examinations while attending the Scottish Hydro Challenge 2015. Questionnaires determined player demographics, self-reported hip pain and an International Hip Outcome Tool 12 (iHOT12) score (hip-related quality of life). Clinical examinations determined hip range of motion and the presence of a positive impingement test. MR scans determined the presence of labral pathology and player hip morphology with measures of α angle (cam), acetabular depth (pincer) and femoral neck antetorsion.

Results A total of 109 (70% of tournament field) of players completed questionnaires, 73 (47%) underwent clinical examination and 55 (35%) underwent MR examination. 19.3% of players reported of hip pain. 11.9% of lead and 9.1% of trail hips were painful ($p=0.378$), iHOT12 scores were lower in the lead (94.1) compared to the trail hip (95.3) ($p=0.007$). Stepwise multiple linear regression modelling was able to predict 20.7% of the variance in iHOT12 scores with mean α angles between 12 and 3 o'clock, and increasing age-significant variables ($R^2=0.207$, $p<0.001$; $\beta=-0.502$, $p<0.001$ and $\beta=-0.399$, $p=0.031$, respectively).

Conclusions 19.3% of male professional golfers reported hip pain. The presence of an increasing α angle and increasing age were significant predictors of reduced hip-related quality of life.

INTRODUCTION

Golf is one of the most popular global sports with an estimated 57 million participants worldwide and 4 million in the UK.[1] Regular participation in golf has been shown to be beneficial to an individual's health, with a mean increased life expectancy of 5 years among players regardless of gender, age and socioeconomic groups.[2] Golf likely confers the physical, mental and economic benefits associated with regular physical activity. However, participation comes with the risk of injury.

In an efficient golf swing, hip rotation is an essential part of the kinetic chain in generating power with the lead hip (left hip in a right-handed player) moving rapidly from external to maximal internal rotation, and the trail hip (right hip in a right-handed player) moving from internal to external rotation. The internal rotational velocities in the lead hip have been measured to peak at 228/s, and in the trail hip an external rotational velocity of 145/s.[3] Professional golfers typically hit 200 balls in practice and play four rounds of 18 holes a week channelling large joint torque forces in a repetitive fashion.[4] In a closed kinetic chain these repetitive asymmetrical forces risk injuries to the hip such as labral tears.[3] An increasingly recognised cause of labral tears is the presence of subtle hip shape abnormalities such as the cam and pincer morphologies associated with femoroacetabular impingement (FAI).[5 6] FAI is frequently proposed as a cause of hip pain in different groups of professional athletes including golfers.[7–9 10]

Within the general population, 3–4% of adults aged 16–44 report hip pain.[11] A recent systematic review demonstrated the wide range in the reported prevalence of hip injuries in golfers from 2% to 18%.[12] However, none of the papers included in this review highlight predictors of hip pain in golfers, or established whether there were differences in the prevalence of hip pain between the lead and trail hips.

This study aims to determine the prevalence of hip pain in professional golfers, comparing lead and trail hips, and to establish what demographic, clinical and morphological characteristics predict hip pain.

METHODS

This study is a prospective cross-sectional clinical and MRI study of the hips in elite golfers.

After institutional ethical approval, a group of researchers attended the Scottish Hydro Challenge, Aviemore 2015, where a European Challenge Tour (the second-tier men's professional golf tour in Europe) tournament was being held.

When registering for the event, all professional golfers were invited to take part in the study completing questionnaires, undergoing clinical examination and having MRI of both their hips.

Questionnaires

Questionnaires determined player demographics including age, height, mass, years playing golf, hours of practice per week and any history of hip injuries. The presence of hip pain was determined by asking players: 'In the past month have you had any pain in the hip or groin lasting 1 day or longer?'. Where players answered 'yes' they were asked which hip was affected. Players' hip-related function was determined for each hip, using the International Hip Outcomes Tool 12 (iHOT12) score, a hip-related quality-of-life survey validated for use in assessing young adult hips.[13 14] The iHOT12 provides a score from 0 to 100 and does not show a ceiling effect. Participants requiring surgery for a range of hip pathologies have been shown to have a mean score of 66 (±19.3).[13]

Clinical examination

Standardised clinical examinations were undertaken by the first, second and third authors (orthopaedic surgeons). Passive hip flexion and abduction were measured, with the players supine, using a handheld, long-arm goniometer, with the end point determined as the point at which movement ceased or the pelvis moved.[15] Hip internal rotation at 90° of flexion (IR90) was determined with the players seated using an electronic goniometer aligned to the medial aspect of the tibial crest using the technique described by Reichenbach *et al*.[16] This technique uses weights and pulleys to apply a consistent force moving the joint into internal rotation, and has been demonstrated to have an improved interobserver reliability compared to conventional methods of assessing the range of internal rotation.[16] Flexion adduction internal rotation (FADIR) and flexion abduction external rotation (FABER) impingement tests were also undertaken.[15]

MR examination

A portable 1.5 T MR scanner (Siemens, Erlangen, Germany) was used to assess players' hip morphology. All players who completed questionnaires and clinical examinations were invited to undergo an MR scan. Players who agreed to undergo MR examination were allocated appointment times on a first come basis, with the researchers blinded to the results of their questionnaires and clinical examinations. MRI was conducted with participants supine and feet held together in neutral rotation with ties. The following MR sequences used were: an axial fast spoiled gradient echo fat saturated three-dimensional (3D) sequence from the anterior superior iliac spine to the lesser trochanters to assess hip morphology (field of view 34 cm, echo time (TE) 2.7 ms, relaxation time (TR) 7.9 ms, slice thickness 2 mm, flip angle 0), coronal and sagittal proton density fat saturated (TE 44.4, TR 2000, slice thickness 3 mm) sequences of each hip were additionally used to assess intra-articular pathology. In order to assess femoral antetorsion, the axis of the femoral condyles was determined using a localiser sequence (TE 1.3, TR 4.9, slice thickness 3 mm).

MR 3D volume sequences were subsequently reconstructed using Osirix DICOM viewer (V.6.0.1 32 bit) to assess hip morphology.[17] Femoral neck antetorsion was measured on axial slices of the hip, using slices through the posterior condyles of the knee as a reference.[18] Femoral neck morphology was assessed by measuring α angles around the axis of the femoral neck at 30 intervals, with 12 o'clock being superior (relative to long axis of femur), and 3 o'clock representing the anterior neck.[19] Acetabular morphology was assessed by measuring the acetabular depth as described by Pfirrman *et al*.[20] α angles, acetabular depth and femoral neck antetorsion measures were made by the first author, with repeated measurements made on 20 randomly selected cases independently by the fifth author (consultant radiologist).

A hip with an α angle >55 at 3 o'clock (anterior) was considered to have a cam deformity,[19 21 22] a negative acetabular depth was considered to represent pincer morphology,[20] and femoral neck antetorsion of <0 was considered retrotorsion and pathological.[23] Hips were referred to as lead (left hip in a right-handed or right hip in a left-handed golfer) and trail (right hip in right-handed golfer, or left hip in a left-handed golfer).

Three experienced musculoskeletal radiologists, each with more than 15 years experience, blind double scored all MR scan for signs of acetabular labral tears or degeneration/deformity. Where there was disagreement, the third observer blind scored the abnormality with the majority score, then taken as the consensus score.

Statistical analysis

Summary statistics were used to describe baseline player demographics and differences in player-reported pain, iHOT12 scores, hip range of motion, α angles, acetabular depth and femoral neck antetorsion between the lead and trail hips. Differences in the presence of pain between the lead and trail hips were assessed with a χ^2 test. Interclass correlation coefficients (ICC) were calculated to determine inter-rater reliability for measures of α angle, femoral neck antetrosion and acetabular depth using a two-way fixed-effects model for absolute agreement. Wilcoxon signed rank test and paired t tests were used to assess differences between lead and trail hips for parametric and non-parametric data, respectively, with an α value of 0.05. As 12 separate measures of α angle were made on each hip, a Bonferroni correction was applied giving an α value of 0.004.[24] A stepwise multiple linear regression was used to assess the relationship between iHOT12 scores and the mean α angles between 12 and 3 o'clock (positions where cam morphology is identified[25]), femoral antetorsion, acetabular depth, presence of a labral tear, body mass index (BMI), age and practice time. Statistical analysis was conducted using SPSS statistics V.22 (IBM, Armonk, USA).

RESULTS

The Scottish Hydro Challenge was attended by 156 professional male golfers, 109 competitors (70% of the field) completed questionnaires, 73 (47% of the field) underwent clinical examination and 55 (35% of the field) underwent MR examination (see figure 1). Six players were left handed (right hip lead hip) while 103 were right handed (left hip lead hip). Player demographics are described in table 1.

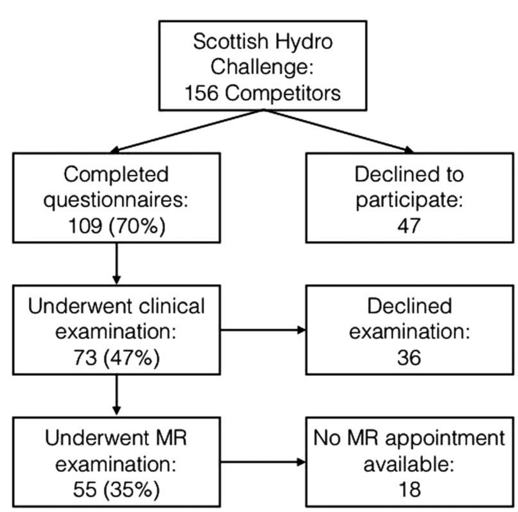

Figure 1 Included and excluded players.

Questionnaires

Twenty-one players (19.3%) reported of hip pain lasting 1 day or longer over the preceding month. The lead hip was painful in 14 (11.9%) and the trail hip in 9 players (9.1%) (p=0.378). The median iHOT12 scores for the lead hip was significantly lower 94 (IQR 86–98) compared to the trail hip 95 (IQR 90–99) (p=0.007), meaning the hip-related quality of life was statistically lower for the lead hip compared to the trail. The first of the iHOT12 questions relates to hip pain (overall, how much pain do you have in your hip/groin?) pain scores were statistically lower in the lead hip compared to the trail with median scores of 97 (IQR 86–100) versus 98 (IQR 93–100) (p=0.039), meaning golfers reported more pain in their lead hips.

Clinical examinations

FADIR testing was positive in 22 players (30%; 9 lead, 8 trail, 5 bilateral hips affected). FABER impingement testing was positive in 12 players (16%; 7 lead, 3 trail, 2 bilateral hips affected). The mean IR90 was 32 (±8.5) in lead and 31 (±6.5) in the trail hip. The mean passive hip flexion was 101 (±6.5) for the lead and 101 (±6.8) for the trail hip.

MR examinations

α Angles around the femoral neck were significantly higher in the trail compared to lead hips (p=0.001), meaning lead hips had greater head neck offset. The greatest differences between lead and trail hip α angles were between 12 and 3 o'clock (see table 2). Mean femoral neck antetorsion was significantly greater for lead hips at 16.7° (±7.5) compared to 13.0° (±7.2) in trail hips (p<0.001). Acetabular depth was 11.6 mm (±4.0) in the lead hips and 11.5 mm (±3.9) in the trail hips (p=0.81).

ICC were 0.92 (0.85–0.96), 0.85 (0.64–0.94) and 0.85 (0.64–0.94) for α angles, femoral neck antetorsion and acetabular depth measurements, respectively.

Cam morphology was present in 11 players (20%); the lead hip was affected in 1 player, the trail hip in 5 players and both hips in 5 players. Femoral retrotorsion was present in two players (3.6%) with the trail hip affected in isolation in both cases. No player had pincer morphology. Labral tears were identified in 21 players (39%) with 9 (16%) lead hips and 20 (37%) trail hips affected (paired t test p=0.022).

A stepwise multiple linear regression was used to predict the relationship between iHOT12 scores and the mean α angles between 12 and 3 o'clock, femoral antetorsion, acetabular depth, presence of a labral tear, BMI, age and practice time. Preliminary analysis was conducted to ensure there was no violation of the assumption of normality, linearity, multicollinearity and homoscedasticity.

Table 1 Player demographics

Players	109
Mean age years	29 (±5.6)
Mean years playing golf	19 (±6.6)
Mean hours of practice (week)	38 (±12.0)
Height (cm)	182 (±6)
Mass (kg)	82 (±10)
Mean body mass index	24.6 (±2.6)

Table 2 Proximal femoral morphology

	α Angle (°)											
Position on femoral neck (o'clock)	12	1	2	3	4	5	6	7	8	9	10	11
Trail hip median (IQR)	45 (42–49)	66 (55–80)	56 (48–68)	45 (40–52)	40 (37–44)	42 (40–44)	43 (41–45)	38 (36–41)	36 (36–38)	39 (36–42)	42 (39–45)	41 (39–42)
Lead hip median (IQR)	46 (44–48)	62 (52–73)	51 (46–57)	41 (38–46)	39 (37–43)	43 (40–45)	44 (42–46)	39 (37–43)	37 (35–40)	39 (36–42)	40 (38–43)	39 (38–42)
p Value	0.661	0.053	<0.001*	0.001*	0.885	0.094	0.006	0.069	0.027	0.584	0.016	0.075

*p Values that reached statistical significance.

A multivariate regression model revealed an R^2 of 0.207 ($p<0.001$) for a mean α angle between 12 and 3 o'clock ($\beta=-0.502$, $p<0.001$) and for age ($\beta=-0.399$, $p=001$) to be significant predictors for hip quality of life (see table 3). This model is able to predict 21% of the variance in iHOT12 scores.

Femoral neck antetorsion ($\beta=0.02$, $p=0.83$), BMI ($\beta=0.33$, $p=0.74$), practice time ($\beta=0.007$, $p=0.942$), acetabular depth ($\beta=-0.033$, $p=0.73$) and the presence of a labral tear ($\beta=0.087$, $p=0.38$) were not significant predictors.

DISCUSSION

This is the first study to describe the prevalence of hip pain and predictors of a lower hip-related quality of life in professional golfers. Hip pain (defined as pain lasting for 1 day or longer in the preceding month) was found to be present in 19.3% of professional golfers. Pain was reported more frequently in the lead hip (11.9% vs 9.1% of hips), although this was not statistically significant. However, the lead hip iHOT12 scores (hip-related quality of life) were statistically lower for the lead compared to the trail hip (median 94 vs 95). Twenty-one per cent of the variance in hip-related quality-of-life (iHOT12) scores could be predicted by an increasing α angle between 12 and 3 o'clock (the anteriosuperior portion of femoral head neck junction) and increasing age.

A previous systematic review by Cabri *et al*[12] assessing golfing injuries reported that the prevalence of hip injuries was between 2% and 18%. However, it is unclear from this review how hip injuries were defined, and if the included studies were homogeneous. In professional tennis, where rapid hip rotation is also required, hip pain is reported in 8–27% of players compared to 19.3% of golfers in this study.[26] Our study has specifically assessed self-reported hip pain lasting 1 day or longer at any time in the preceding month, and not the point prevalence of diagnosed hip injuries. Although golfers' iHOT12 scores were statistically lower in the lead hips (94 vs 95), this is of uncertain clinical significance given the iHOT12 has a minimal clinically important difference of 6.1.[13] It would not be surprising if there was a greater degree of hip pain in the lead hip given the greater rotational velocities experienced and the cumulative load (200 swings and 4 rounds of 18 holes a week), which might be expected to result in exceeding the soft tissue tolerance to injury.[3 4] However, as well as understanding the difference in biomechanics of the lead and trail hips, we must also appreciate the difference between lead and trail hip morphology (see Hip morphology in elite golfers: a new finding of asymmetry between lead and trail hips, Dickenson *et al* (also submitted for IOC edition of *BJSM*)) the morphology of the lead hip, which is advantageous to internal rotation, may reduce the possibility of injury despite greater rotational velocities.

Table 3 Multiple linear regression model of International Hip Outcome Tool 12 scores

Predictor	β Coefficient	95% CI	p Value
Mean α angle 12–3 o'clock	−0.502	−0.740 to −0.265	0.001*
Age	−0.399	−0.761 to −0.038	0.031*
Femoral neck antetorsion	0.02	n/a	0.83
Acetabular depth	−0.033	n/a	0.73
Practice time	0.007	n/a	0.942
Body mass index	0.33	n/a	0.74
Presence of labral tears	0.087	n/a	0.38

*Significant values.
n/a, not applicable.

The results of this study have allowed us to predict 21% of the variance of iHOT12 hip-related quality-of-life scores in golfers, with increasing mean α angles between 12 and 3 o'clock, and increasing age proving significant predictors. The association of an increasing α angle predicts a lower iHOT12 score may be the result of premature contact of the femoral neck and acetabulum, as described in FAI.[6] This premature contact risks labral tears and cartilage delamination.[3 5] Given this finding, clinicians could consider appropriate conservative care for FAI in a golfer reporting hip pain.[27] The presence of cam morphology was also found to predict groin pain in capoeira competitors.[10] Although not assessed in this study, the presence of hip morphologies that limit internal rotation such as cam, pincer and retrotorsion, may also contribute to pain elsewhere in the kinematic chain. For example, where limited lead hip rotation is observed in golfers with lower back pain, this may be due to them adapting a compensatory swing that increases the likelihood of injury elsewhere in the kinematic chain.[28]

Increasing age was also found to be a predictor of a lower iHOT12 score, with every additional year lowering the iHOT12 by 0.4. This change may reflect the cumulative load that is placed on an athlete over the duration of his/her career, eventually reaching a critical threshold resulting in injury and pain.[4 12] This pattern may be a reflection of the increased probability of athletes, including professional golfers, developing hip osteoarthritis compared to non-athletes, even in the absence of a specific hip injury.[29]

Strengths and limitations

The strengths of this study are that it includes a large group of professional golfers in which clinical and radiological measures were collected. The response rate to questionnaires was high with 70% of the field completing them. Limitations occurred due to the practicalities of undertaking the study at a professional golf tournament, include a suboptimal uptake in terms of consent to examination (47%), and the limited number of MR appointments meaning only 35% of eligible players could be imaged. As described in the Methods section the authors attempted to limit bias in those assessed with questionnaires, clinical and MR examinations, so that those imaged were broadly representative of the golfers who attended this event and across the Challenge Tour. The Challenge Tour is a male only professional event and, therefore, the results are not applicable to female golfers and golfers of other abilities.

Further studies that delineate the precise diagnosis in players who report pain and the time loss due to hip injuries would add to the understanding of hip pathology in professional golfers.

CONCLUSION

Hip pain affects 19% of professional golfers, with the lead hip more frequently affected than the trail. Variability in a players' hip-related quality of life can be partially predicted by an increasing α angle between 12 and 3 o'clock (anteriosuperior aspect of the head neck junction) and increasing age.

What are the findings?

- A 19.3% of professional golfers report hip pain.
- Despite greater rotational velocities in the lead hip, there was no clinically important difference in hip-related quality of life between lead and trail hips.
- Twenty-one per cent of the variance in hip-related quality of life can be predicted by the presence of an increasing α angle (a measure of cam morphology) and increasing age.

How might it impact on clinical practice in the future?

- Understanding the epidemiology of hip pain in golfers can help to guide prevention and treatment programmes.
- Raising awareness that hip pain is present in one-fifth of professional golfers will promote identification of pathology.

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Competing interests None declared.

Patient consent Obtained.

Ethics approval Ethical approval was granted by the University of Warwick Biomedical and Scientific Research Ethics Committee REGO-2015-1570.

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