Return to Golf After Arthroscopic Management of Femoroacetabular Impingement Syndrome

Brian R. Waterman, M.D., Gift Ukwuani, M.D., Ian Clapp, B.A., Philip Malloy, M.S., P.T., William H. Neal, B.S., and Shane J. Nho, M.D., M.S.

Purpose: To investigate if patients who reported playing golf before arthroscopic hip surgery for femoroacetabular impingement syndrome were able to return to playing golf postoperatively. **Methods:** The study was a retrospective analysis of all consecutive patients undergoing hip arthroscopy for femoroacetabular impingement syndrome between 2012 and 2014. Inclusion criteria required that a patient (1) reported playing golf before the surgery, (2) had a minimum 2-year follow-up, and (3) completed patient-reported outcome measures. An electronic postoperative return to golf questionnaire was completed by patients who reported golf as an activity. To evaluate patients' ability to return to golf after surgery, the following variables were analyzed with paired samples *t* test and χ-square tests: handedness, holes played, modified-Harris Hip Score, and Hip Outcome Score Activity of Daily Living and Sports-Specific Subscale. **Results:** A total of 29 patients (22 men; age, 36.0 $\pm$ 11.9 years) with a minimum of 24 months of follow-up who self-reported playing golf preoperatively were included in the analysis. Preoperatively, 23 patients (79%) had discontinued golfing owing to activity-related hip complaints. At the final follow-up, all patients had significant improvements in the Hip Outcome Score Activity of Daily Living (preoperatively, 65.9 $\pm$ 19.9; postoperatively, 91.5 $\pm$ 12.8; $P < .0001$), the Hip Outcome Score Sports-Specific Subscale (38.2 $\pm$ 23.5, 79.7 $\pm$ 28.8; $P = .0002$), and modified-Harris Hip Score (54.8 $\pm$ 15.6; 84.2 $\pm$ 15.8; $P < .0001$). Additionally, there was a decrease in pain from 7.34 $\pm$ 1.63 to 1.71 $\pm$ 2.3 postoperatively ($P < .0001$), and 97% of patients returned to golf at an average of 7.2 months postoperatively. Postoperatively, 55% of patients (n = 16) noted improved golfing performance, 41% (n = 11) returned to their preinjury level, 1 patient (3%) returned at a lower level owing to non–hip-related problems, and 1 (3%) did not return to golf owing to fear of reinjury. **Conclusions:** Arthroscopic treatment of femoroacetabular impingement syndrome in patients who reported playing golf before surgery resulted in significant improvements in hip function and predictably high rates of patient satisfaction, with 97% returning to golfing activity and 55% noting improvement from preinjury sporting performance. **Level of Evidence:** Level IV, retrospective case series.

From Rush University Medical Center, Chicago, Illinois, U.S.A.

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Address correspondence to Brian R. Waterman, M.D., Rush University Medical Center, 1611 W Harrison St, Ste 400, Chicago, IL 60612, U.S.A. E-mail: brian.r.waterman.mil@mail.mil

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Femoroacetabular impingement syndrome (FAIS) represents the premature symptomatic contact that occurs between the femur and acetabulum during normal ranges of hip motion secondary to aberrant hip joint morphology. FAIS can lead to acetabular labral tears and articular cartilage injury, and has been implicated in secondary hip osteoarthritis.[1] FAIS has been reported in multiple athletic populations and often contributes to diminished sports performance.[2] The arthroscopic management of FAIS has evolved over the past 2 decades and demonstrates good to excellent outcomes in athletes.[3,4] Although there are ample data on an athlete's ability to return to sports after hip arthroscopy, little is known specifically about the ability to return to golf. Recently, Newman et al.[5] reported that Professional Golf Association tour-level golfers were able to return to the same skill level after hip arthroscopy and demonstrated improved performance

as evidenced by an overall increase in driving distance after arthroscopic hip surgery.[5]

Although golf is considered a low-impact sport,[6] the hip joint is subject to high amounts of force transmission combined with near end-range of hip internal rotation motion during follow-through of the golf swing.[7-10] Sports that require a high degree of hip rotation, such as golf, may place athletes at greater risk symptom development in the presence of FAIS morphology.[7,10] Limitation of hip internal rotation is a common clinical sign of FAIS; therefore, it is not surprising that golf participation may be limited in persons with FAIS. As such, evaluating the outcomes of hip arthroscopy in people who play golf can be used to help inform clinical decision making regarding return to play. Additionally, this information can be used preoperatively to assist with setting realistic postoperative expectations for patients in terms of return to preinjury levels of golf.

The purpose of this retrospective case series was to investigate if patients who reported playing golf before arthroscopic hip surgery for FAIS were able to return to playing golf postoperatively. Additionally, we sought to determine if hip range of motion was associated with improvement in patient-reported outcomes and golf-specific metrics. Owing to its relatively lower impact nature, we hypothesize that nearly all patients would be able to return to golf and most would experience improvements in their performance.

Methods

Patient Selection

Approval was granted by the local university's institutional review board to enroll all consecutive patients who underwent hip arthroscopy for the surgical treatment for FAIS between January 1, 2012, and April 17, 2014. All patients were assessed and operated on by a single, fellowship-trained orthopedic surgeon (S.J.N.) at a high-volume hip center (Figure 1). All clinical data were recorded and stored in a secure electronic repository. Patients were diagnosed with FAIS based on positive radiographic (lateral center edge angle $>30°$, alpha angle $>50°$) and positive physical examination (pain on flexion adduction and internal rotation, positive flexion abduction and external rotation) evidence of FAIS. For the current study, a retrospective query was made to identify all patients who reported golfing in their clinical history and had a 2-year minimum clinical follow-up duration after hip arthroscopic surgery. Patients were excluded if their history included rheumatologic disease, dysplasia, a prior history of pediatric deformities (congenital hip dislocation, slipped capital femoral epiphysis, or Perthes disease), osteoarthritis, or any joint space narrowing (Tönnis grade >1).

Study Participants

Patients diagnosed with FAIS who reported a history of golfing in the preoperative period were included in the study and completed a postoperative return to golf questionnaire (Appendix 1) on November 29, 2016.

Patient-Reported Outcomes and Physical Examination Data

The Hip Outcome Score and modified Harris Hip Score surveys were assessed preoperatively and postoperatively at 6 months, 12 months, and 24 months. Postoperatively, a return-to-golfing questionnaire was sent to patients to complete by e-mail. Complications after surgery were assessed by review of patient electronic records. Preoperative and postoperative hip internal and external rotation ranges of motion were collected because these movements are of prime importance for the golf swing.[8,9]

Diagnostic Imaging for FAIS Morphology

All patients received preoperative and postoperative anteroposterior pelvis and 45° Dunn lateral radiographs. The lateral center-edge angle of Wiberg was obtained on preoperative and postoperative anteroposterior radiographs to assess acetabular undercoverage/overcoverage and was defined as an angle $>30°$. The alpha angle was measured preoperatively and postoperatively on 45° Dunn lateral radiographs according to the method previously defined by Notzli et al.[11] Hip joint space width was measured at the superolateral, apical, and superomedial positions as described by Lequesne et al.[12]

Operative Technique

All patients were treated with the same arthroscopic technique performed under general anesthesia in the supine position on a standard traction table.[13-15] The central compartment was accessed via the anterolateral and midanterior portals; procedures included but were not limited to acetabular rim trimming for correction of pincer deformities, labral refixation or labral debridement, selective synovectomy, capsular repair, and loose body removal. After work in the central compartment was complete, traction was then released and the peripheral compartment was accessed. All patients underwent T-capsulotomy through the distal anterolateral accessory portal to assist with arthroscopic visualization in the peripheral compartment. A comprehensive femoral osteochondroplasty was performed in the peripheral compartment to address cam pathology, and dynamic examination confirmed that there was no evidence of impingement. At the conclusion of each

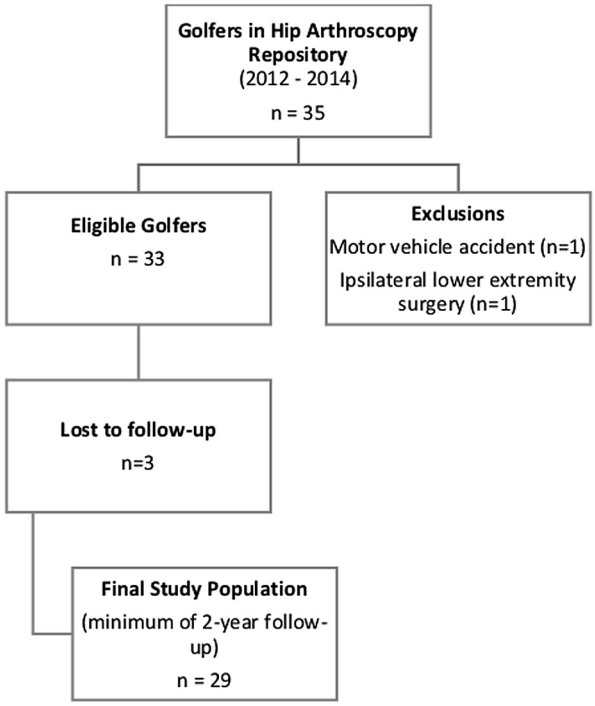

Fig 1. Flowchart for patient inclusion.

case, a capsular repair was performed to ensure proper soft tissue tension and to prevent the chance of postoperative instability. For this technique, 3 high-strength nonabsorbable sutures are passed through the vertical limb of the capsulotomy to reconstitute the iliofemoral ligament, then the interportal capsulotomy is closed with 2 or 3 sutures to close the interportal capsulotomy.

Postoperative Rehabilitation

All patients participated in 16 to 20 weeks of a 4-phased postoperative rehabilitation program. The rehabilitation program addressed hip joint mobility, muscle performance and stability, and neuromuscular control.[16] The first phase of rehabilitation consisted of initial joint protection. The goal of joint protection was to minimize pain and inflammation during the first postoperative week and make the patient independent using an assistive device for restricted weight bearing. Treatments such as nonsteroidal anti-inflammatory medication and cryotherapy were used during this initial phase. Additionally, joint protection education was given to minimize joint strain with daily activities during the first postoperative week.[16] The goal of the second phase of rehabilitation was to restore normal joint mobility and a normal gait pattern for community ambulation. This phase involved progressive range-of-motion exercises, hip muscle strengthening, and neuromuscular control exercises for the trunk and pelvis to improve mobility and motor control for function. The goal of the third phase of rehabilitation was to restore the patient to unrestricted activity except for return to sport. This phase involved advanced strengthening and neuromuscular control exercises to restore normal daily pain-free function. Advanced-level strength training and neuromuscular control exercises are emphasized during this phase

Table 1. Swing Progression on a Golf Mat or Artificial Turf Surface

Week	Day 1	Day 2	Day 3
1	20 putt	20 putt	30 putt
	20 chip	30 chip	40 chip
2	10 putt	10 putt	10 putt
	40 chip	40 chip	40 chip
	10 short iron	20 short iron	30 short iron
3			10 chip
	20 chip	20 chip	30 short iron
	30 short iron	30 short iron	30 mid iron
	10 mid iron	20 mid iron	5 long iron/hybrid
			5 woods

NOTE. Type of swing is the putt using a putter on either artificial turf or a practice green surface. The chip swing type uses a pitching or lob wedge of an artificial surface. Type of clubs: a short iron is a wedge, 9-iron, or 8-iron; mid irons are the 7-iron, 6-iron, and 5-iron; long irons/hybrid are the 4-iron, 3-iron, and 2-iron; woods are the 3-wood and 5-wood; and a driver is a driver. The club definitions and sample progression are adapted from Reinold et al.[31]

Table 2. Natural Turf Golf Swing and Return to Play Progression

Week	Day 1	Day 2	Day 3
4			10 chip
	20 chip	20 chip	20 short iron
	30 short iron	30 short iron	30 mid iron
	10 mid iron	20 mid iron	5 long iron/hybrid
			5 wood
5	30 short iron	30 short iron	20 short iron
	30 mid iron	30 mid iron	30 mid iron
	10 long iron/hybrid	10 long iron/hybrid	20 long iron/hybrid
	10 wood	10 wood	5 wood
			5 driver
6	20 short iron	20 short iron	Play 9 holes
	20 mid iron	20 mid iron	
	20 long iron/hybrid	30 long iron/hybrid	
	15 wood	20 wood	
	8 driver	10 driver	
7	Play 9 holes	Play 9 holes	Play 18 holes

NOTE. Type of swing is the putt using a putter on either artificial turf or a practice green surface. The chip swing type uses a pitching or lob wedge of an artificial surface. Type of clubs: a short iron is a wedge, 9-iron, or 8-iron; mid irons are the 7-iron, 6-iron, and 5-iron; long irons/hybrid are the 4-iron, 3-iron, and 2-iron; woods are the 3-wood and 5-wood; and a driver is a driver. The club definitions and sample progression are adapted from Reinold et al.[31]

Table 3. Patient Demographic Information

Demographics	
Gender (male)	23 (79%)
Age (yr)	36.0 ± 11.9
Body mass index	25.2 ± 2.4

Table 4. Radiographic Measures for Golfers With FAIS

Radiographic Parameters	Preoperative	Postoperative	*P* Value
Alpha angle, °	67.42 ± 12.48	40.98 ± 3.69	**<.0001**
LCEA, °	34.07 ± 7.09	27.65 ± 4.89	**.0002**
Superolateral JSW, mm	3.82 ± 0.64	3.77 ± 0.65	.7657
Apical JSW, mm	4.17 ± 0.80	4.11 ± 0.76	.7991
Superomedial JSW, mm	4.28 ± 0.80	4.23 ± 0.86	.7991
Average JSW, mm	4.09 ± 0.80	4.09 ± 0.80	.6642
Tönnis 0	27	–	–
Tönnis 1	2	–	–

NOTE. Bold entries indicate statistical significance at $\alpha = .05$.
AIS, femoroacetabular impingement syndrome; JSW, joint space width; LCEA, lateral center edge angles.

to provide an appropriate foundation for the fourth phase of rehabilitation, which is focused on return to sport. Phase 4 hip arthroscopy rehabilitation involves a progressive return to sport-specific training and reintegration to sport specific activities. Most commonly, this phase is performed under the supervision of coaches and trainers, with input from the rehabilitation specialists who were involved in the earlier phases of rehabilitation.

Specifically, patients who desire to return to golf perform a 2-part swing progression that is initiated in phase 4 as part of the return to sports progression. The first part must be performed on a golf mat or artificial turf surface to prevent taking a divot, which could impart a significant torque across the hip joint (Table 1). The second part of the swing is performed on a natural turf such that taking a divot can simulate a more natural swing environment (Table 2). Ultimately, the second part of the swing progression leads to return to play beginning with 9 holes and progresses to full 18-hole rounds.

Statistical Analysis

All data were analyzed using the SPSS Statistics for Windows, Version 22.0. (IBM, Armonk, NY). Descriptive statistics summarizing patient demographics were presented as means and standard deviations or percentages where appropriate. Responses on the return to golf questionnaire were averaged to provide continuous data for the number of holes played per week by the golfer, length of time that golfing was decreased or discontinued preoperatively, and time to return to golfing postoperatively. Parametric and nonparametric tests were used to compare continuous and categorical data, respectively, and paired samples *t* tests and χ-square analysis determined statistical significance. For the current study, a P value $< .05$ was deemed statistically significant.

Table 5. Surgical Information for Golfers Who Underwent Hip Arthroscopic Surgery for Femoroacetabular Impingement Syndrome

Surgical Procedures Performed	No. of Patients	Percentage (%)
Labral repair	29	100
Acetabular rim trimming	28	97
Femoral osteochondroplasty	29	100
Capsule closure	28	97
Femoral microfracture	3	10

Results

Patients who underwent hip arthroscopy in the current study ranged in age from 14 to 72 years (Table 3). Twenty-two patients (75.9%) underwent hip arthroscopy on the left lower extremity, and 7 patients (24.1%) had surgery on the right lower extremity. Additionally, 2 patients (6.9%) underwent bilateral hip arthroscopic surgery, and their reported outcomes reflected their most recent surgery. The average time to surgery for the contralateral limb in the bilateral patients was 4.5 months.

Radiographic Parameters

For 25 patients (86%), 45° Dunn lateral radiographs revealed evidence of a cam morphology. Anteroposterior pelvis radiographs revealed that 5 patients (16%) demonstrated a pincer-type morphology. No patient demonstrated joint space width measures <2.5 mm on any radiographic measurement (Table 4).

Table 6. Patient-Reported Outcome and Hip Passive Range of Motion Data

Patient-Reported Outcomes	Preoperative	Postoperative	*P* Value
HOS-ADL	65.9 ± 19.9	91.5 ± 12.8	**.0001**
HOS-SS	38.2 ± 23.5	79.7 ± 28.8	**.0002**
mHHS	54.8 ± 15.6	84.2 ± 15.8	**.0001**
VAS pain	7.3 ± 1.6	1.7 ± 2.3	**.0001**
VAS satisfaction	–	85.1 ± 22.3	
Range of motion, °			
Flexion	110.3 ± 11.4	117.1 ± 8.4	**.01**
External rotation	39.2 ± 8.5	40.5 ± 11.1	.608
Internal rotation	12.6 ± 9.9	21.0 ± 9.6	**.0001**

NOTE. Bold entries indicate statistical significance at $\alpha = .05$.
HOS-ADL, Hip Outcome Score Activity of Daily Living subscale; HOS-SS, Hip Outcome Score Sports subscale; mHHS, modified Harris Hip Score; VAS, visual analog scale.

Table 7. Pearson Correlation Coefficients (r) for Changes in Hip ROM Patient-Reported Outcomes

	HOS-ADL		HOS-SS		mHHS	
	r	P Value	r	P Value	r	P Value
Δ Flexion, °	0.140	.451	0.137	.464	0.148	.436
Δ Internal rotation, °	0.014	.941	−0.063	.735	−0.017	.928
Δ External rotation, °	0.107	.566	0.127	.497	0.217	.248

NOTE. Δ indicates postoperative change in range of motion, preoperative ROM − postoperative ROM.
HOS-ADL, Hip Outcome Activity of Daily Living subscale; HOS-SS, Hip Outcome Score Sports subscale; mHHS, modified Harris Hip Score; ROM, range of motion.

A significant reduction in the alpha angle and lateral center edge angles was found postoperatively (Table 4).

Surgical Pathology and Arthroscopic Procedures

All patients demonstrated evidence of FAIS deformity with acetabular labral tear, and subsequent hip arthroscopy consisted of a repair of acetabular labrum and femoral osteochondroplasty (Table 5). Additional concomitant procedures included acetabular rim trimming, capsular closure, and microfracture (Table 5). There were no surgical complications, and none of the patients required revision hip arthroscopy or converted to total hip arthroplasty within the follow-up period.

Clinical and Patient-Reported Outcomes

A significant improvement in patient-reported outcome scores, hip flexion, and hip internal rotation range of motion was found in golfers postoperatively (Table 6). There were no significant correlations between patient-reported outcome scores and improvement in hip range of motion postoperatively (Table 7).

Return to Golf Activity

Of the 29 patients included, 23 (79%) had to discontinue golfing at an average time of 8.3 ± 6.4 months before surgery. Preoperatively, patients played an average of 49.2 ± 36.8 holes per week. A total of 26 patients (90%) were right handed, and the remaining patients (n = 3) were left handed. Within the postoperative follow-up period, 28 patients (97%) resumed golfing with minimal pain at an average time of 7.2 ± 2.07 months postoperatively. One patient was unable to return to golfing within 2 years after surgery owing to fear of reinjury. There was no significant difference in the number of holes played postoperatively when compared with how many holes were played preoperatively (preoperative, 49.2 ± 36.8 holes per week; postoperative, 45.9 ± 38.8 holes per week). Sixteen patients (55%) reported that they felt they returned to golf at a better level since their onset of symptoms, whereas 12 patients (41%) reported returning to the same level before the onset of hip symptoms. Only 1 patient (3%) reported returning to a lower level, and 1 patient (3%) did not return to golf since the onset of symptoms.

Discussion

In the current series, 97% of patients successfully returned to golfing activity at an average of 7.2 months postoperatively. Despite nearly 80% discontinuing golf before the surgery owing to pain, most of the patients reported either improved perception of their play (55%) or an equivalent level of play compared with preinjury (41%). Only 1 patient noted diminished golfing function postoperatively, and 1 patient elected not to return to athletic activity owing to concerns for reinjury. Furthermore, all individuals noted significant subjective improvement in patient-reported outcome measures, including the Hip Outcome Score Activity of Daily Living, Hip Outcome Score Sports-Specific Subscale, modified Harris Hip Score, and average visual analog scale patient satisfaction. Additionally, hip flexion and internal rotation range of motion improved significantly by a mean of 6.8° and 8.4°, respectively.

Golf remains one of the most popular sports worldwide, with approximately 57 million participants across a broad demographic population. Despite its relatively low-impact nature, the prevalence of golf-related hip injuries can vary between 2.0% and 19.3%[6,9,17] versus 3% to 4% in the general adult population.[18] Given the nature of an efficient golf swing reaching peak rotational velocities of 228° per second,[19] this rate of hip injury is not surprising, particularly when considering torque generated by the lower extremities in a closed kinetic chain.[17,20,21] With repetitive motions, increasing levels of competition, and underlying morphologic abnormalities such as with FAIS, the hip may be predisposed to acetabular labral tear, specifically in the anterosuperior aspect in the leading leg.[5,9,22] With an acetabular labral tear and loss of the physiologic suction seal of the native hip joint, increased joint translation can lead to worsening chondral delamination and intra-articular pathology that is further exacerbated during the follow-through phase.

The current series confirms the prevalence and morbidity of FAIS in the lead hip of right-handed golfers, which accounts for >90% of the patients in our study. Dickenson et al.[22] showed some similar trends among professional golfers. In their review of 109 men, the median International Hip Outcome Tool

12 scores and pain scores were significantly worse among individuals with lead hip involvement, whereas increasing the alpha angle and advancing chronological age further predicted hip-related quality of life. Given the angular velocity and increased peak forces >4 times the body weight during driving,[23] repetitive exposure to a golf swing may have more deleterious effects on the leading lower extremity and increase the likelihood for worsening injury in the face of FAIS.

Clinical outcomes after hip surgery have varied significantly according to the nature of athletic involvement and level of competition, as well as the degree of articular cartilage involvement.[6,24,25] Initial series documented the results after total hip arthroplasty for end-stage osteoarthritis.[26-32] Arbuthnot et al.[26] demonstrated that only 1 of 66 patients was not able to return to golfing activity after total hip arthroplasty; 54% reported overall improvement, and 42% noted no changes. Furthermore, patients noted a significant increase in their average handicap of approximately 10 strokes at the 3- to 6-month postoperative timepoint, whereas Mallon and Callaghan[26,27] noted only an increase of 1.1 strokes at the mean 6.5-year follow-up. Among a series of 20 professional golfers, all athletes returned to competition at an average 4.7 months with significant increases in drive distance at 1, 2, and 5 years postoperatively.[5] Of our patients, 97% were able to return to golf participation, with 55% noting an improvement in overall performance. However, 1 of the current patients exhibited fear of reinjury after hip arthroscopy.

Limitations

Although this investigation features many strengths, we must acknowledge certain limitations. The current patients were consistently involved in golfing activity preoperatively and postoperatively, but no golf performance metrics, such as handicap, greens in regulation, or average score, were evaluated. Contrary to prior studies with high-grade chondral involvement,[5,10,33] only 10% of existing patients underwent marrow stimulation for focal chondral disease, and no individuals had early arthritic disease. This factor may contribute to an increased likelihood of success after surgery, because individuals with early joint space narrowing or articular cartilage defects are more likely to fail arthroscopic interventions and require subsequent arthroplasty procedures.[4] Additionally, the patients surveyed for this study self-reported their global golfing performance, which may introduce recall and measurement bias. Finally, the questionnaire used to evaluate golf was not validated but served as more of a general questionnaire inquiring if patients were able to return to playing golf after surgery.

Conclusions

Arthroscopic treatment of FAIS in golfers resulted in significant improvements in hip function and predictably high rates of patient satisfaction, with 97% returning to golfing activity and 55% noting improvement from preinjury sporting performance.

References

1. Bedi A, Kelly BT. Femoroacetabular impingement. *J Bone Joint Surg Am* 2013;95:82-92.
2. Farrally MR, Cochran AJ, Crews DJ, et al. Golf science research at the beginning of the twenty-first century. *J Sports Sci* 2003;21:753-765.
3. Byrd JW, Jones KS. Hip arthroscopy in athletes. *Clin Sports Med* 2001;20:749-761.
4. Byrd JW, Jones KS. Hip arthroscopy in athletes: 10-year follow-up. *Am J Sports Med* 2009;37:2140-2143.
5. Newman JT, Saroki AJ, Briggs KK, Philippon MJ. Return to elite level of play and performance in professional golfers after arthroscopic hip surgery. *Orthop J Sports Med* 2016;4:2325967116643532.
6. Domb BG, Stake CE, Finch NA, Cramer TL. Return to sport after hip arthroscopy: Aggregate recommendations from high-volume hip arthroscopy centers. *Orthopedics* 2014;37:e902-e905.
7. Chu Y, Sell TC, Lephart SM. The relationship between biomechanical variables and driving performance during the golf swing. *J Sports Sci* 2010;28:1251-1259.
8. Fradkin AJ, Cameron PA, Gabbe BJ. Golf injuries—-Common and potentially avoidable. *J Sci Med Sport* 2005;8:163-170.
9. Hume PA, Keogh J, Reid D. The role of biomechanics in maximising distance and accuracy of golf shots. *Sports Med* 2005;35:429-449.
10. Meister DW, Ladd AL, Butler EE, et al. Rotational biomechanics of the elite golf swing: Benchmarks for amateurs. *J Appl Biomech* 2011;27:242-251.
11. Notzli HP, Wyss TF, Stoecklin CH, Schmid MR, Treiber K, Hodler J. The contour of the femoral head-neck junction as a predictor for the risk of anterior impingement. *J Bone Joint Surg Br* 2002;84:556-560.
12. Lequesne M, Malghem J, Dion E. The normal hip joint space: Variations in width, shape, and architecture on 223 pelvic radiographs. *Ann Rheum Dis* 2004;63:1145-1151.
13. Frank RM, Lee S, Bush-Joseph CA, Kelly BT, Salata MJ, Nho SJ. Improved outcomes after hip arthroscopic surgery in patients undergoing T-capsulotomy with complete repair versus partial repair for femoroacetabular impingement: A comparative matched-pair analysis. *Am J Sports Med* 2014;42:2634-2642.
14. Harris JD, Slikker W 3rd, Gupta AK, McCormick FM, Nho SJ. Routine complete capsular closure during hip arthroscopy. *Arthrosc Tech* 2013;2:e89-e94.
15. Nho SJ, Magennis EM, Singh CK, Kelly BT. Outcomes after the arthroscopic treatment of femoroacetabular impingement in a mixed group of high-level athletes. *Am J Sports Med* 2011;39:14S-19S (suppl).

16. Malloy P, Gray K, Wolff AB. Rehabilitation after hip arthroscopy: A movement control-based perspective. *Clin Sports Med* 2016;35:503-521.
17. Nesbit SM, Serrano M. Work and power analysis of the golf swing. *J Sports Sci Med* 2005;4:520-533.
18. Urwin M, Symmons D, Allison T, et al. Estimating the burden of musculoskeletal disorders in the community: The comparative prevalence of symptoms at different anatomical sites, and the relation to social deprivation. *Ann Rheum Dis* 1998;57:649-655.
19. Nesbit SM. A three dimensional kinematic and kinetic study of the golf swing. *J Sports Sci Med* 2005;4: 499-519.
20. Gulgin H, Armstrong C, Gribble P. Hip rotational velocities during the full golf swing. *J Sports Sci Med* 2009;8:296-299.
21. Murray E, Birley E, Twycross-Lewis R, Morrissey D. The relationship between hip rotation range of movement and low back pain prevalence in amateur golfers: An observational study. *Phys Ther Sport* 2009;10:131-135.
22. Dickenson E, O'Connor P, Robinson P, et al. Hip morphology in elite golfers: Asymmetry between lead and trail hips. *Br J Sports Med* 2016;50:1081-1086.
23. D'Lima DD, Steklov N, Patil S, Colwell CW Jr. The Mark Coventry Award: In vivo knee forces during recreation and exercise after knee arthroplasty. *Clin Orthop Relat Res* 2008;466:2605-2611.
24. Seyler TM, Mont MA, Ragland PS, Kachwala MM, Delanois RE. Sports activity after total hip and knee arthroplasty: Specific recommendations concerning tennis. *Sports Med* 2006;36:571-583.
25. Swanson EA, Schmalzried TP, Dorey FJ. Activity recommendations after total hip and knee arthroplasty: A survey of the American Association for Hip and Knee Surgeons. *J Arthroplasty* 2009;24:120-126.
26. Arbuthnot JE, McNicholas MJ, Dashti H, Hadden WA. Total hip arthroplasty and the golfer: A study of participation and performance before and after surgery for osteoarthritis. *J Arthroplasty* 2007;22:549-552.
27. Mallon WJ, Callaghan JJ. Total hip arthroplasty in active golfers. *J Arthroplasty* 1992;7:339-346 (suppl).
28. Mallon WJ, Callaghan JJ. Total joint replacement in active golfers. *J South Orthop Assoc* 1994;3:295-298.
29. Mallon WJ, Liebelt RA, Mason JB. Total joint replacement and golf. *Clin Sports Med* 1996;15:179-190.
30. Papaliodis DN, Photopoulos CD, Mehran N, Banffy MB, Tibone JE. Return to golfing activity after joint arthroplasty. *Am J Sports Med* 2017;45:243-249.
31. Reinold MM, Wilk KE, Reed J, Crenshaw K, Andrews JR. Interval sport programs: Guidelines for baseball, tennis, and golf. *J Orthop Sports Phys Ther* 2002;32:293-298.
32. Wylde V, Blom A, Dieppe P, Hewlett S, Learmonth I. Return to sport after joint replacement. *J Bone Joint Surg Br* 2008;90:920-923.
33. McDonald JE, Herzog MM, Philippon MJ. Return to play after hip arthroscopy with microfracture in elite athletes. *Arthroscopy* 2013;29:330-335.

Appendix 1

RETURN TO GOLF QUESTIONNAIRE

Have you had any other hip surgery since Dr. Nho's on your hip? If yes, when?

[Short answer]

If you have had surgery since then, is it

A) Same side
B) Other side
C) Free answer

Did you golf prior to surgery? (Yes/No)

Handedness (Right/Left)

How many holes per week?

[Free answer]

Could you golf at your usual pace immediately prior to surgery?

A) Yes, there was no change in my capability
B) No, I had to decrease golfing
C) I stopped completely
D) [Free answer]

If you could not golf at your usual pace, why?

A) Pain
B) Lack of interest
C) Availability
D) [Free answer]

If you decreased/discontinued golfing, for how long prior to surgery (in months)?

[Free answer]

After your hip surgery, did you return to golfing? (Yes/No)

How long (in months) did it take before you could golf with minimal pain after surgery?

A) I have not returned to golfing
B) 3-6 months
C) 6-9 months
D) 9-12 months
E) [Free answer]

What ability level have you returned to currently?

A) Same
B) Better
C) Worse

How many holes do you currently play?

[Free answer]

If you have either not returned to golf or have decreased the hours, please rank the following from 1 (not at all a factor) to 10 (extremely important factor) as to why you changed your golfing habits (you may type in the reasons too)

[Free answer]

- Pain or discomfort (1-10)
- Fear of reinjury (1-10)
- Loss of interest (1-10)
- Other physical limitation (injury or decreased conditioning (1-10)
- Availability of resources (1-10)

On a scale of 0-10, can you say your quality of life has improved since surgery?

0 = No improvement at all

10 = Excellent improvement

On a scale of 0-10, since surgery can you say your presurgery expectations were met?

0 = Not at all

10 = My expectations were met

Since surgery, have you accomplished as much as you would like in terms of participating in your hobbies?

A) Yes
B) No
C) I am okay with my activity level
D) [Free answer]

On a scale of 0-10, rate your satisfaction with your surgery

0 = Not satisfied at all

10 = Very satisfied