# High Rate of Return to Swimming After Hip Arthroscopy for Femoroacetabular Impingement

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**Purpose:** To evaluate patients' ability to return to swimming after hip arthroscopy for femoroacetabular impingement syndrome (FAIS) with capsular closure. **Methods:** Consecutive FAIS patients who had undergone hip arthroscopy for the treatment of FAIS by a single fellowship-trained surgeon were reviewed. The inclusion criteria included patients with a diagnosis of FAIS who self-reported being swimming athletes with a minimum clinical follow-up duration of 2 years. For all patients, we assessed demographic data; preoperative physical examination findings, imaging findings, and patient-reported outcome (PRO) scores including the modified Harris Hip Score, Hip Outcome Score—Activities of Daily Living subscale, Hip Outcome Score—Sports-Specific subscale, and visual analog scale for pain; and postoperative examination findings and PROs at a minimum of 2 years after surgery, including a swimming-specific questionnaire. **Results:** The study included 26 patients (62% female patients; average age, 31.3 ± 7.2 years; average body mass index, 24.2 ± 2.7 kg/m$^2$). Preoperatively, 24 patients (92%) were unable to swim at their preinjury level, and swimming was either decreased or discontinued entirely at an average of 6.0 ± 4.0 months before surgery. All 26 patients (100%) returned to swimming at an average of 3.4 ± 1.7 months after surgery, including 14 (54%) who returned at a higher level of performance than their preoperative state, 10 (38%) who returned to the same level, and 2 (7%) who returned at a lower level. The ability to return at a higher level of performance was not associated with age ($P = .81$), sex ($P = .62$), or body mass index ($P = .16$). At an average of 31.2 ± 4.95 months' follow-up, postoperative PRO scores improved significantly from preoperative values (Hip Outcome Score—Activities of Daily Living subscale from 68.5 ± 19.9 to 93.9 ± 5.7, $P < .0001$; Hip Outcome Score—Sports-Specific subscale from 44.0 ± 21.0 to 85.2 ± 16, $P < .0001$; and modified Harris Hip Score from 59.5 ± 12.1 to 94 ± 8.6, $P < .0001$). The average patient satisfaction level was 93% ± 9%. **Conclusions:** Recreational and amateur swimmers return to swimming 100% of the time after hip arthroscopy for FAIS, with just over half returning at a higher level, and most of these patients return within 4 months after surgery. This information is critical in counseling patients on their expectations with respect to returning to swimming after hip arthroscopy for FAIS. **Level of Evidence:** Level IV, case series.

*See commentary on page 1478*

Femoroacetabular impingement syndrome (FAIS) is becoming increasingly recognized and diagnosed in the young, athletic patient population, particularly in athletes who perform activities that require repetitive hip flexion and rotational load. Although in some cases, hip impingement can be successfully managed with physical therapy, in higher-demand patient populations, including athletes who participate in activities that require repetitive rotation and/or loading to the hip, hip arthroscopy is required. In general, hip arthroscopic surgery for FAIS is a reliable operation with respect to reducing pain and improving function, resulting in good to excellent outcomes with low complication rates.[1-7] Given the increasing volume of hip arthroscopy procedures being performed in athletes, data describing the ability of athletes to return to sport (RTS) after hip arthroscopy have become more readily available.[1,5,6,8-33] This information is critical, particularly for counseling patients, parents, and coaches on the expected outcomes after hip arthroscopy.

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Swimming is an activity that involves repetitive flexion and rotational motions about the hip, particularly with the breaststroke and butterfly stroke. Repetitive flexion movements are performed during freestyle, the backstroke, and the butterfly stroke, whereas repetitive rotation movements are required during the breaststroke. In 2004 Grote et al.[34] assessed a survey of 296 amateur swimmers and determined that breaststroke swimmers were significantly more likely to complain of groin pain when compared with individual medley swimmers and, furthermore, were significantly more likely to have required time off of training because of groin-related injuries. Given the rising popularity of swimming as a recreational and amateur activity, both as a stand-alone sport and through its role in triathlons, a better understanding of expected outcomes after hip arthroscopy in this patient population is warranted. Therefore, the purpose of this study was to evaluate patients' ability to return to swimming after hip arthroscopy for FAIS with capsular closure. We hypothesized that there would be a high rate of return to swimming after hip arthroscopy with capsular closure, with most patients returning to the same level or a higher level of activity.

## Methods

Our university's institutional review board approved this study. Parental or guardian consent, as well as minor assent, was obtained for all patients younger than 18 years. A query of an institutional surgical registry showed patients who reported swimming on intake forms and had undergone hip arthroscopy for FAIS by a single fellowship-trained surgeon (S.J.N.) between February 2012 and June 2014. FAIS incorporates a spectrum of diagnoses related to an abnormal contact area between the femoral head-neck junction and acetabulum. The indications for hip arthroscopy were based on clinical history, physical examination findings, and radiographic findings of FAIS (alpha angle >50°, lateral center-edge angle [LCEA] >25°). The inclusion criteria included patients with a diagnosis of FAIS who self-reported being swimming athletes with a minimum clinical follow-up duration of 2 years. The exclusion criteria included patients with a history of rheumatologic disease, a Tönnis grade greater than 1, hip dysplasia (LCEA <20°), a history of congenital hip dislocation, Perthes disease, slipped capital femoral epiphysis, neurologic disorders, and/or concomitant orthopaedic conditions (ipsilateral limb injuries, scoliosis, or sacroiliac joint dysfunction).

### Operative Technique

All arthroscopic procedures were performed with the patient under general anesthesia in the supine position on a standard traction table as previously described by Frank et al.[3] After diagnostic arthroscopy, rim trimming, and labral repair, traction was released and femoral osteochondroplasty was performed through a T-capsulotomy. The traction time ranged from 30 to 45 minutes on average, and the traction magnitude was approximately 10 mm after capsulotomy. All patients underwent complete capsular closure, with some patients undergoing additional capsular plication once all peripheral-compartment work was completed. The preferred techniques of the senior author (S.J.N.) for the central and peripheral compartments, as well as for capsular closure and plication, have been previously described in detail.[3]

### Rehabilitation

All patients underwent a 4-phase rehabilitation protocol lasting an average of 32 weeks (Table 1). Initially, the surgical leg was restricted to 20-lb foot-flat weight bearing. At week 3, patients were weaned off crutches if they were able to tolerate ambulation without significant pain or compensatory gait movements. By 6 weeks, patients were permitted to use an elliptical machine. By 12 weeks, running on an antigravity treadmill was allowed, with progression to sport-specific activities at week 16.

Patients progressed with their rehabilitation to be able to return to swimming when they (1) were determined to be pain free in the hip complex and (2) had regained full range of motion and muscular strength. The initial phase in returning to swimming focused on stroke technique drills, with progression in yardage advancement. Precautions were taken to avoid technique maladaptation and make sure appropriate stroke drills were followed. This phase was not focused on addressing an individual swimmer's specialty (i.e., sprint or distance) but rather on conditioning and improving endurance. The next phase concentrated on returning to swimming specialty with interval training (interval work, kicks, and drills).

### Clinical Outcomes

Clinical outcomes were assessed at baseline and at a minimum of 2 years after surgery, including physical examination with range-of-motion assessment and patient-reported outcomes (PROs) including the modified Harris Hip Score, Hip Outcome Score—Activities of Daily Living subscale, Hip Outcome Score—Sports-Specific subscale, and visual analog scale for pain. Data on overall pain and patient satisfaction were recorded. Complications and reoperations were analyzed for all patients. Failure was defined by persistent pain, revision arthroscopy, or conversion to hip arthroplasty during the study period. A customized return-to-swimming questionnaire was sent to patients to complete by e-mail (Appendix Fig 1, available at www.arthroscopyjournal.org). Swimmers were classified as either recreational or amateur, with amateur athletes defined as high school, intercollegiate, or amateur swimmers.

**Table 1.** Rehabilitation Regimen for Returning to Activity and/or Sports After Hip Arthroscopy

| Phase | Goal | Restrictions | Techniques and Treatment Strategies |
|---|---|---|---|
| 1 | Protect joint and repaired tissues | 20 lb at 3 wk<br>50% WB for 1 wk followed by WBAT<br>Limit flexion, abduction, and extension at 3 wk<br>No active sitting >30 min at 3 wk | Soft-tissue mobilization<br>Isometrics<br>Deep-water aqua-jogging with flotation belt<br>Swimming with pull buoy (cardio) |
| 2 | Appropriate gait progression | Avoid hip flexor and adductor irritation<br>Aim to avoid compensatory or Trendelenburg gait | Aquatic therapy<br>Joint mobilization<br>Deep-water aqua-jogging with flotation belt<br>Swimming with pull buoy<br>Squats and lunges in waist-deep water at week 6<br>Muscular and cardiovascular conditioning |
| 3 | Return to preinjury function | Avoid agility drills until week 10<br>Avoid hip rotational activities until week 10 | Single-leg squat<br>Soft-tissue and joint mobilization for prolonged stiffness<br>Double-leg strengthening<br>Swimming without pull buoy<br>Breaststroke |
| 4 | Return to swimming | Ensure adequate functional strength and proximal control before advancing | Multiplanar agility training<br>Stroke technique drills: recovery, pull through<br>Gradual advancement in yardage<br>Interval work, kicks, and drills |

WB, weight bearing; WBAT, weight bearing as tolerated.

### Imaging Outcomes

Anteroposterior (AP) and Dunn lateral radiographs were obtained for all patients both preoperatively and postoperatively. Preoperative and postoperative alpha angles were measured on Dunn lateral radiographs, whereas the LCEA of Wiberg was measured on AP radiographs. Additional characterization of hip arthritis was performed by measuring hip joint space width in the superolateral, apical, and superomedial positions. Magnetic resonance imaging of all patients was also performed to assess for labral pathology, articular cartilage pathology, and other intra-articular hip pathology, as well as peri-hip extra-articular pathology, if present.

### Statistical Analysis

Patient data were analyzed with SPSS statistical software (IBM, Armonk, NY). Patient demographic data were presented as means and standard deviations or percentages. Continuous variables were compared using bivariate regression, whereas categorical data were compared using the Pearson $\chi^2$ test. One-way analysis of variance was used to compare continuous variables against categorical variables. Preoperative and postoperative scores were compared by use of *t* tests. Return-to-swimming variables were reported as continuous data for miles spent swimming weekly before and after surgery, length of time patients discontinued or decreased swimming preoperatively, and time to return to swimming postoperatively. An $\alpha$ value of $P < .05$ denoted statistical significance.

## Results

### Demographic Characteristics

The query of the surgical repository contained 30 patients (32 hips) who indicated participation in swimming either recreationally or at the amateur level before hip arthroscopy. We excluded 3 patients because of concomitant orthopaedic pathologies including contralateral lower-extremity surgery (n = 1) and spine pathology (n = 2). The remaining 27 patients (29 hips) met the inclusion criteria, and 26 of these patients (28 hips) completed the return-to-swimming survey and PROs at a minimum of 2 years after surgery, as well as returned to the clinic for a follow-up physical examination, for an overall follow-up of 96%.

Study participants (26 patients) included 16 female patients (62%) and 10 male patients (38%) with an average age of 31.3 ± 7.2 years (range, 12-42 years) and an average body mass index (BMI) of 24.2 ± 2.7 kg/m$^2$ (Table 2). Bilateral hip arthroscopy was performed in 2 patients (7%)—their PROs are reflective of their most recent surgical procedure, with an average of 4.5 months between operations in these 2 bilaterally treated patients. A labral tear was recorded in all 26 patients (100%). The chronicity of symptoms was reported by 20 participants (77%), and 6 (23%) had acute symptoms before surgery. Patients completed an average of 0.4 ± 0.8 miles of swimming per week before surgery (range, 0.2-1.02 miles). Of the 26 patients, 20 (77%) were predominantly freestyle swimmers, 5 (19%) were butterfly stroke swimmers, and 4 (15%) were

**Table 2.** Demographic Characteristics

| | Data |
|---|---|
| Sex, n | 16 female and 10 male patients |
| Age, mean ± SD, yr | 31.3 ± 7.2 |
| BMI, mean ± SD, kg/m$^2$ | 24.2 ± 2.7 |
| Surgical side, n | 15 left and 13 right |
| Bilateral surgery, n | 2 (6%) |
| Competition level, n | |
| Amateur | 6 (23%) |
| Recreational | 20 (77%) |
| Swimming type, n | |
| Freestyle | 20 (77%) |
| Butterfly stroke | 5 (19%) |
| Breaststroke | 4 (15%) |

BMI, body mass index; SD, standard deviation.

breaststroke swimmers. No swimmers reported the backstroke as their stroke of choice. When divided by competition level, there were 6 amateur swimmers (23%) and 20 recreational swimmers (77%). Of the patients, 24 (92%) had to decrease or discontinue swimming entirely at an average of 6.0 ± 4.0 months before surgery because of hip-related pain.

## Intraoperative Data

Hip arthroscopic procedures performed (Table 3) consisted of acetabular labral repair and femoral osteochondroplasty, acetabular rim trimming, and capsular closure. No surgical complications were recorded.

## Clinical Outcomes

All patients showed significant improvements in all patient-reported outcome scores ($P < .05$ for all) and in pain scores after surgery at an average of 31.2 ± 4.95 months (range, 24-48 months) after surgery (Table 4). The average patient satisfaction level with surgery was 93% ± 8.5%. Within the follow-up period, none of the patients required revision hip arthroscopy or conversion to hip arthroplasty. After surgery, there were no significant differences in hip range of motion compared with preoperative values, including forward flexion ($P = .9$), internal rotation ($P > .99$), and external rotation ($P = .6$).

**Table 3.** Intraoperative Findings and Procedures Performed

| Intraoperative Findings | n (Hips) |
|---|---|
| Cam deformity | 26 (100%) |
| Pincer deformity | 23 (88%) |
| Mixed FAIS | 23 (88%) |
| Labral tear | 26 (100%) |
| Cartilage delamination | 9 (35%) |
| Surgical procedures | |
| Labral repair | 26 (100%) |
| Acetabular rim trimming | 26 (100%) |
| Femoral osteochondroplasty | 26 (100%) |
| Capsular closure | 26 (100%) |

FAIS, femoroacetabular impingement syndrome.

**Table 4.** Clinical Outcomes

| | Preoperative | Postoperative | *P* Value |
|---|---|---|---|
| HOS-ADL | 68.5 ± 19.9 | 93.9 ± 5.7 | <.0001 |
| HOS-SS | 44 ± 21 | 85.2 ± 16 | <.0001 |
| mHHS score | 59.5 ± 12.1 | 94.1 ± 8.6 | <.0001 |
| VAS score for pain | 7.7 ± 1.1 | 0.7 ± 1.2 | <.0001 |
| VAS score for satisfaction | | 90.7 ± 12 | |
| Forward flexion, ° | 118.5 ± 24.3 | 118.1 ± 10.0 | .9 |
| Internal rotation, ° | 16.0 ± 15.4 | 21.3 ± 5.0 | .16 |
| External rotation, ° | 43.3 ± 6.8 | 45.8 ± 8.3 | .6 |

NOTE. Data are presented as mean ± standard deviation.

HOS-ADL, Hip Outcome Score—Activities of Daily Living; HOS-SS, Hip Outcome Score—Sports-Specific subscale; mHHS, modified Harris Hip Score; VAS, visual analog scale.

## Return-to-Swimming Results

All 26 patients (100%) returned to swimming at an average of 3.4 ± 1.7 months after hip arthroscopy for FAIS (Table 5). Of the patients, 14 (54%) returned to swimming at a subjectively higher level of performance compared with their preinjury level whereas 10 (38%) returned to the same level before injury and 2 (7%) returned at a lower level. Thirteen patients who returned to a higher level of performance were recreational swimmers, and one was an amateur swimmer. On linear regression analysis, the ability to return at a higher level of performance was not associated with age ($P = .81$), sex ($P = .62$), or BMI ($P = .16$). There was no significant difference in preoperative and postoperative miles per week (0.4 ± 0.79 miles preoperatively vs 0.36 ± 0.74 miles postoperatively, $P = .86$). There was no association between when preoperative swimming was stopped because of hip symptoms and when patients were able to return to swimming ($r^2 = 0.08$, $P = .24$).

## Imaging Outcomes

Alpha angles were measured on standard AP and Dunn lateral radiographs (Table 5). All 26 patients (100%) had evidence of cam deformity as defined by an alpha angle greater than 50°. AP pelvis radiographs showed that 23 patients (88%) had pincer-type

**Table 5.** Summary of Return-to-Swimming Outcomes

| | Data |
|---|---|
| Patients able to return to swimming, n | 26 (100%) |
| Preoperative miles per week | 0.4 ± 0.79 |
| Postoperative miles per week | 0.36 ± 0.74 |
| Length of time swimming was discontinued before surgery, mo | 6.0 ± 4.0 |
| Length of time to return to swimming with minimal pain, mo | 3.4 ± 1.7 |

NOTE. Data are presented as mean ± standard deviation unless otherwise indicated. The reasons for discontinued swimming were ranked on a scale from 1 to 10 according to pain, fear of reinjury, loss of interest, other physical limitation (injury, concomitant comorbidities, or decreased conditioning), and availability of resources.

**Table 6.** Radiographic Outcomes

| Outcome | Preoperative | Postoperative | *P* Value |
|---|---|---|---|
| Alpha angle, ° | 59.91 ± 11.08 | 38.91 ± 4.37 | <.0001 |
| LCEA, ° | 29.91 ± 4.81 | 25.10 ± 4.63 | .0002 |
| Superolateral JSW, mm | 4.47 ± 0.90 | 4.54 ± 0.86 | .18 |
| Apical JSW, mm | 3.83 ± 0.69 | 4.00 ± 0.3 | .8 |
| Superomedial JSW, mm | 4.47 ± 0.90 | 4.7 ± 0.84 | .6 |
| Average JSW, mm | 4.30 ± 1.54 | 4.49 ± 0.94 | .3 |

NOTE. Data are presented as mean ± standard deviation.
JSW, joint space width; LCEA, lateral center-edge angle.

deformity of the femur, which was defined by an LCEA greater than 40° or the presence of the crossover sign. No patient showed joint space width measures of less than 2.5 mm on any radiographic measurement. Postoperative assessment of radiographs obtained after surgery showed significant reduction in both alpha angle and LCEA when compared with preoperative values (Table 6).

## Discussion

The principal findings of this study show that (1) there is a high rate of return to recreational and amateur swimming after hip arthroscopy for FAIS at an average of 3.4 months after surgery, (2) there is no association between when preoperative swimming is stopped because of hip symptoms and when patients are able to return to swimming, and (3) most patients are able to return to the same level or a higher level of swimming after surgery. Taken together, the data provide information on expected outcomes and RTS rates in patients undergoing hip arthroscopy who specifically participate in swimming, an activity that places high demands on the core and hips. This information will be helpful for counseling patients on appropriate expectations with respect to returning to swimming after hip arthroscopy for FAIS.

As noted by a variety of authors, RTS rates in athletes after hip arthroscopy for FAIS at short- and medium-term follow-up are exceedingly high. In general, RTS rates have been reported to be greater than 85% to 95% in the vast majority of available studies, across a wide variety of sports and across a wide variety of athletic abilities, including recreational, amateur, and professional.[12,19,20,24,33] Specifically, the reported RTS rate is 82% to 100% in professional hockey players,[21,29] 87% in professional football players,[22] 96% in Australian football players,[31] 100% in professional soccer players,[8] 100% in professional golfers,[25] 88% in competitive baseball players,[13] and 94% in runners.[18] Notably, rowers have a substantially lower RTS rate after hip arthroscopy for femoroacetabular impingement, with Boykin et al.[10] reporting an RTS rate of 56% at an average of 8 months after surgery. It is important to note that professional athletes may have other motivating factors influencing their RTS rates, and thus the data described in studies on professional and elite and/or sponsored athletes may not be translatable to the typical weekend warrior with FAIS.

In our study the return-to-swimming rate was 100%, with 92% of patients returning to the same level (38%) or a higher level (54%) of participation at an average of 3.4 months after surgery. Given the overall low occurrence of an inability to RTS (0%), no statistical association between preoperative cessation of swimming and rate of return to swimming was able to be determined. Although these data are encouraging, it is important to note that there was no clinically meaningful or statistically significant difference between the patients' preoperative and postoperative number of miles swam per week. It is likely that a combination of decreased pain with improved overall function as evidenced by improvements in all PROs allowed the patients to participate more fully in swimming after surgery when compared with their preoperative swimming sessions, resulting in over half of the participants self-reporting a return at a higher level of participation after surgery. Notably, patient age, sex, and BMI were not independently associated with PROs or RTS rates.

Athletes participating in swimming are at particular risk of pain attributable to hip impingement because of the repetitive and extreme range of motion required by many of the strokes, particularly freestyle (repetitive flexion), the breaststroke (rotational loading),[35,36] and the butterfly stroke (repetitive flexion).[37] Unfortunately, in the literature, no other studies describing the prevalence of FAIS in swimming athletes—or the outcomes of hip arthroscopy for FAIS in swimmers—are available for comparison with our study. In 2017 Girard et al.[38] assessed the RTS rate in long-distance triathletes after hip resurfacing. In their study of 48 patients, they reported an overall RTS rate of 94%, including rates of return of 79% for swimming, 85% for cycling, and 69% for running. It is important to note that the rate of return to competition-level triathlons was only 58%, likely attributable to the substantial physical demands of long-distance triathlons. Certainly, hip resurfacing is a more invasive procedure relative to hip arthroscopy, and it is difficult to compare the return-to-swimming rate of 79% reported by Girard et al. with the RTS rate of 100% in our study. In a study specifically looking at runners, Levy et al.[18] reported a 94% return-to-running rate at a mean of 8.5 months after surgery. Compared with our study, with a similarly high RTS rate, the demands placed on the hip for running likely require a prolonged period of recovery and rehabilitation in runners before fully returning to sport.

### Limitations

This study has several limitations, including its retrospective nature, small sample size (particularly

with respect to competitive-level swimmers), relatively short-term follow-up, and use of survey data (potential for recall bias) as the primary outcome of interest. Furthermore, there was no control group of patients participating in swimming undergoing a similar rehabilitation protocol (but without surgery), which would strengthen the study. In addition, the PROs used in this study, although commonly used in the hip-preservation literature, have not been specifically validated for this patient population.[39-42] Another limitation is unknown mechanism of injury in terms of whether swimming or another activity was the offending mechanism causing the pathology in patients who participated in activities in addition to swimming. Finally, although one of the study's strengths is the consistency of the surgical procedures performed by a single, high-volume, fellowship-trained surgeon, the overall outcomes may not be generalizable.

## Conclusions

Recreational and amateur swimmers return to swimming 100% of the time after hip arthroscopy for FAIS, with just over half returning at a higher level, and most of these patients return within 4 months after surgery. This information is critical in counseling patients on their expectations with respect to returning to swimming after hip arthroscopy for FAIS.

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