Return to Sport After Hip Resurfacing Arthroplasty

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Background: Femoroacetabular impingement and degenerative hip osteoarthritis (OA) affect athletes across a wide variety of sports. Hip resurfacing arthroplasty (HRA) has emerged as a surgical treatment for active individuals with end-stage hip OA to provide pain relief and allow return to high-impact activities. Return to professional sports after HRA has not been well characterized.

Purpose/Hypothesis: The aim of this study was to report on a series of elite athletes in a variety of sports who underwent HRA. We hypothesized that professional and elite-level athletes would be able to return to sports after HRA for end-stage hip OA.

Study Design: Case series; Level of evidence, 4.

Methods: A retrospective case series was conducted on professional athletes who underwent HRA at a single institution between 2007 and 2017. All surgeries were performed by a single surgeon using the posterolateral approach. Athletes' return to play and sport-specific performance statistics were obtained using self-reported and publicly available data sources. Athletes were matched to an age- and performance-based cohort to determine changes in performance-based metrics.

Results: Eight professional athletes were identified, including 2 baseball pitchers, 1 ice hockey defenseman, 1 foil fencer, 1 men's doubles tennis player, 1 basketball player, 1 ultramarathoner, and 1 Ironman triathlete. All 8 patients returned to sports; 6 of 8 (75%) patients were able to return for at least 1 full season at a professional level after surgery. There were no significant differences between performance statistics for athletes who returned to play and their preoperative performance measures for the years leading up to surgery or the age- and performance-matched cohort.

Conclusion: HRA remains a surgical alternative for end-stage hip OA in young, high-impact, active patients. While the primary goals of surgery are pain control and quality of life improvement, it is possible to return to elite-level sporting activity after HRA.

Keywords: hip resurfacing arthroplasty; osteoarthritis; elite athlete; return to play

Femoroacetabular impingement (FAI) and the development of hip osteoarthritis (OA) is widely prevalent in the athletic population.[16,17] This condition can have profound detrimental effects on professional athletes' careers, from a decline in performance to a premature retirement. For such athletes, the inability to perform consistently at a professional level without pain is paramount. Career-ending hip pain can have devastating consequences both financially and personally. The traditional surgical treatment for end-stage hip arthritis secondary to FAI is total hip arthroplasty (THA); however, to date, there are no known reports of patients returning to professional sports after THA. In this clinical setting, hip resurfacing arthroplasty (HRA) is an alternative to traditional THA for end-stage arthritis of the hip.

HRA is typically reserved for active, younger male patients with adequate femoral head bone stock and quality. Both HRA and THA involve placement of an acetabular cup; however, unlike THA in which the femoral head and neck are removed and an endoprosthesis is inserted into the femoral canal, HRA involves removing a thin surface layer of femoral head and "capping" it with a prosthesis of a similar size to the native femoral head, which then articulates directly with the acetabular component. In this manner, HRA allows for the utilization of larger femoral head sizes as well as the preservation of more proximal femoral bone. Modern metal-on-metal HRA implants can vary, but they generally consist of a thin metal femoral component, a short stem, and a monoblock press-fit metal acetabular implant. These modern designs have performed extremely well in young, active male patients seeking to maintain or return to high-impact activities.[2,5,7,10]

Regarding return to sports, return to recreational activity after HRA has been well described and reported in the literature.[6,9,13] There are several case reports and series that have recently reported return to high-level activity after HRA, but limited evidence, including news reports, exists regarding return to professional competition. The aim of this

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series was to report on a series of elite athletes in a variety of sports who underwent HRA and successfully returned to professional and high-level competition. We hypothesized that professional and elite athletes would be able to return to professional and high-level competition after HRA.

METHODS

Study Design

A retrospective case series was conducted on professional and elite-level athletes who underwent HRA by the senior author (E.P.S.) between 2007 and 2017. All surgeries were performed at a single orthopaedic specialty hospital. Participants were identified via electronic medical record screening. Then, they were recruited and enrolled at their follow-up visit or were contacted electronically or by telephone to reduce loss at follow-up. All participants gave informed consent, and the study was approved by our institution's review board.

Participants

All patients undergoing HRA between 2007 and 2017 were screened, and patients who participated in professional athletics before undergoing HRA were identified. Professional athletes were defined as those who received payment for their performance or were sponsored by a national federation. Elite athletes were those who competed on the regional and the national level. Patients had to be at least 18 years old. Birmingham HRA (Smith & Nephew Inc) was the implant utilized for all patients in this study, and resurfacing was performed using a posterolateral approach to the hip.

Characteristics, symptoms, and metal ion levels for each athlete were collected retrospectively. Patients were also contacted to confirm both their enrollment and to answer a questionnaire regarding their return to sports. If patients were unable to recall their return to sports date, the data were collected using publicly available sport-specific online databases (eg, www.espn.com, www.fangraphs.com, www.baseball-reference.com, www.hockey-reference.com, www.fie.org, www.wikipedia.org, www.tennisexplorer.com, www.itftennis.com, www.atptour.com, https://calendar.ultrarunning.com, www.jayasports.com) and local news reports.

After identifying eligible participants, publicly available performance data were reviewed to identify a comparison cohort for each athlete who underwent resurfacing. Matching occurred if a player was able to return for greater than one-third of a season. This comparison group was matched on age, number of appearances, and presurgical performance metrics to provide a benchmark for postsurgery performance and to account for age-related performance decline. As most athletes underwent HRA at what would likely be the latter stages of their career, the presurgical performance for the 3 years before HRA was utilized when possible to identify a matched cohort on performance. In addition to professional appearances or competitions played, as applicable, performance metrics were often sport- or even position-specific (eg, earned run average [ERA]). Full details for the search strategy, specific performance metrics used, and cohort characteristics can be found in the online Supplemental Material.

Rehabilitation

All athletes underwent postoperative physical therapy that emphasized early, controlled motion to prevent hip stiffness and to avoid disuse muscle atrophy. While traditional protocols after HRA call for crutches and partial weight-bearing postoperatively, current protocols are more lenient, and the patients in this study did not have strict hip precautions and were able to bear weight as tolerated immediately after their procedure, with crutches used as needed for balance. Criteria-based and patient-specific parameters were used to progress patients through their rehabilitation.

Overall, the physical therapy regimen included 3 phases and both a supervised physical therapy program and a home exercise program. The first phase emphasized protection of the operative limb to avoid femoral neck fractures, and patients were able to bear weight as tolerated, with the use of crutches for support as needed. Goals of the first phase were as follows: establishing pain-free range of motion; normalizing gait; and strengthening core muscle control, balance, and proximal hip muscle. The second phase of rehabilitation began 3 weeks postoperatively, and patients were transitioned to using a cane as needed. The goals of the second phase were as follows: achieving continued improvements in range of motion and hip flexibility, restoring strength, ambulating without an assistive device, and returning to 80% of preoperative function. Typically, after 1 month postoperatively, stretching exercises of the anterior capsule, iliotibial band, and hip flexors were initiated. The third phase began 12 weeks postoperatively, with the goal of achieving a continued restoration of strength and flexibility. Before returning to sports, athletes had to have a full range of motion, have no pain or apprehension during all activities, and have muscle strength (4+/5). For

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Ethical approval for this study was obtained from the Hospital for Special Surgery (study No. 2018-0133).

TABLE 1
Patient Characteristics

Player	Age at Surgery, y	Laterality	Sport	Time Between Surgery and Return to Play, d	Current Status
1	34	Right	Baseball	235	Retired after 3 seasons
2	36	Left	Hockey	274	Retired after 1 season
3	31	Right	Basketball	397	Retired after 1 season
4	25	Left	Olympic fencer	630	Retired after 1 season
5	35	Left	Baseball	626	Returned to World Baseball Classic
6	40	Right	Tennis	166	Active
7	64	Left	Ultramarathon	210	Active
8	50	Right	Ironman Triathlon	356	Active

contact sports (basketball and ice hockey), a period of noncontact, simulated play was undertaken before the game play to ensure that athletes had the movements and the strength required for elite performance. After a simulated play, the athletes participated in scrimmages to restore the timing and the momentum of an actual play. Typically, patients were allowed to return to low-intensity sporting activity at 3 months and higher-impact activities at 6 months postoperatively. The reason for a 6-month interval to return to higher-impact sporting activities was predicated on previous data demonstrating femoral neck bone density increases at 6 months postoperatively.[3]

Statistical Analysis

Independent-samples Mann-Whitney *U* tests were used to compare control groups and patients. The Wilcoxon signed rank test was used to compare metric-based averages before and after surgery. In cases in which an athlete competed for only 1 season after surgery, values were reported as descriptive statistics only, and no statistical comparisons were made. SPSS Version 26 (IBM Corp) was utilized for all statistical comparisons. *P* values $<.05$ were considered statistically significant.

RESULTS

A total of 28 athletes who underwent HRA were identified from a surgical database between 2012 and 2017 at our institution, with 8 male athletes (n = 8 hips) participating in professional or elite competitions and meeting the inclusion criteria. All other screened athletes were excluded, as they did not participate in either professional or elite competition. All 8 patients (100%) subsequently returned in some capacity to elite competition. These included 2 pitchers in Major League Baseball (MLB), 1 player in the National Basketball Association (NBA), 1 player in the National Hockey League (NHL), 1 Olympic fencer (foil fencing), 1 player in the Association of Tennis Professionals (ATP), 1 ultramarathoner, and 1 half Ironman triathlete. An ultramarathon consists of running distances longer than that of the traditional marathon while an Ironman triathlon is a long-distance triathlon consisting of swimming 3.86 kilometers (km), cycling 180.25 km, and finally running a standard 42.20 km marathon with the half triathlon half the distance at each event. The mean return to competition was 361.75 ± 180.54 days after surgery; patient characteristics for this group are reported in Table 1.

After return to competition, there were no revisions, femoral neck fractures, dislocations, or other complications reported in this group of patients following surgery (mean ± SD, 4.3 ± 3.8 years; range, 1-11 years). Of these 8 athletes, 2 did not return to elite competition for at least a full season after surgery and thus were excluded from comparative return to play (RTP) analyses. Thus, of the 8 professional athletes undergoing HRA between 2012 and 2017, 6 (75%) were able to RTP for at least 1 full season at a professional level after HRA. The 2 athletes who did return to competition briefly but not for an entire season were an NBA basketball player and 1 of the 2 MLB baseball pitchers. Reviewing metal ion levels, the mean cobalt (Co) level was 2.0 ± 1.3 μg/L, while the chromium (Cr) level was 2.2 ± 0.7 μg/L at a mean time of 4.3 ± 3.8 years after surgery. Two patients did not have metal ion levels: 1 baseball pitcher and 1 tennis player. At final follow-up, all patients remained asymptomatic in their operative hip (Table 1).

Sport-Specific RTP Analysis

Baseball

One professional baseball pitcher underwent HRA at the age of 32 years after 12 seasons in Major League Baseball (MLB) and subsequently continued to play for 3 more years after surgery. When comparing the patient with age- and performance-matched controls, there were no significant differences in innings played, games played, ERA, walks plus hits per inning pitched, or salary before or after surgery. Similarly, there was no significant difference in the athlete's performance statistics after surgery compared with his preoperative performance in the 3 years leading up to HRA (Table 2).

Hockey

One professional hockey defenseman underwent HRA at the age of 36 years. After 17 seasons in the National Hockey League (NHL), he subsequently returned to the NHL and made 37 appearances the following season before retiring from competition. He was ultimately matched to 9 other NHL defensemen by position, age (within 3 years, inclusive),

TABLE 2
Comparison of Performance Statistics for MLB Players[a]

	Before Surgery				After Surgery			
	Year 1	Year 2	Year 3	Mean ± SD	Year 1	Year 2	Year 3	Mean ± SD
No. of innings played								
Patient	201	200	105	168.7 ± 55.1	170.1	204.2	116.1	163.5 ± 44.4
Controls	194.9	189.7	178.3	187.6 ± 8.5	177.3	198.9	165.9	180.7 ± 16.8
No. of games played								
Patient	32	32	16	26.7 ± 9.2	29	33	19	27 ± 7.2
Controls	29	30	29	29.3 ± 0.6	29	32	29	30 ± 1.7
ERA								
Patient	3.7	4.4	3.4	3.9 ± 0.5	5.4	4.5	3.6	4.5 ± 0.9
Controls	4.3	4.2	3.9	4.1 ± 0.2	4.4	3.8	4.1	4.1 ± 0.3
WHIP								
Patient	1.2	1.2	1.1	1.2 ± 0.1	1.6	1.2	1.1	1.3 ± 0.2
Controls	1.3	1.3	1.2	1.3 ± 0.0	1.3	1.3	1.2	1.3 ± 0.0
Annual salary, $ million								
Patient	1.8	3	3.3	2.7 ± 0.8	2	4	6	4 ± 2
Controls	8.4	10.3	9.7	9.5 ± 1	10.8	11.3	10.8	11 ± 0.3

[a]There were no statistically significant differences in mean values between the patients and controls or between preoperative and postoperative performance ($P > .05$ for both comparisons). ERA, earned run average; MLB, Major League Baseball; WHIP, walks plus hits per inning pitched.

TABLE 3
Performance Statistics for NHL Athlete[a]

		Before Surgery				After Surgery
		Year 1	Year 2	Year 3	Mean ± SD	Year 1
No. of games played	Patient	66	50	66	60.7 ± 9.2	37
	Controls	68.6	72.3	74	71.6 ± 2.8	64.3
Mean time on ice, mins	Patient	21.6	20.5	16.7	19.6 ± 2.6	16.2
	Controls	21.2	21	20.3	20.8 ± 0.5	19.1
DPS/Season	Patient	3	3.4	2.1	2.8 ± 0.7	1.6
	Controls	3.3	3.8	3	3.3 ± 0.4	3.2
CF%	Patient	46.4	48.7	47.8	47.6 ± 1.2	46.7
	Controls	48.9	49.8	48.6	49.1 ± 0.6	48.1
FF%	Patient	46.6	46.6	47.7	47.0 ± 0.6	45.5
	Controls	49.2	50.1	48.2	49.2 ± 1	48.3
Annual salary, $ million	Patient	6	6	4	5.3 ± 1.2	4.3
	Controls	3.5	3.8	3.2	3.5 ± 0.3	3.2

[a]CF%, Corsi for percentage; DPS, defense player score; FF%, Fenwick for percentage; NHL, National Hockey League.

and presurgical performance (composite defense player score [DPS]). As the patient returned only for 1 season, formal statistical comparisons could not be made. Regarding trends in performance, the patient had a reduction in the number of games as well as time on ice and aggregate DPS after surgery; reductions in performance were also seen in age-matched controls. These trends can be seen in Table 3.

Tennis

One men's doubles tennis player underwent HRA at the age of 40 years after 20 seasons as a professional. He subsequently returned and is currently competing in doubles on the Association of Tennis Professionals (ATP) tour >1 year after surgery but subsequently retired following submission of this article. He was matched to 6 doubles players with a similar ATP doubles ranking and age (within 6 years, inclusive) and with no significant injury history (see online Supplemental Material for full details). As the patient similarly has only played 1 season after surgery, thus far, formal statistical comparisons are limited; however, trends in performance show a slight decrease in matches played, win percentage, and prize money in both the patient as well as age-matched controls (Table 4).

Fencing

One Olympic fencer of the foil discipline underwent resurfacing at the age of 25 years after competing in the

TABLE 4
Performance Metrics for Professional Tennis Player[a]

		Before Surgery					After Surgery
		Year 1	Year 2	Year 3	Mean	SD	Year 1
No. of matches played	Patient	60	70	60	63.3	5.8	53
	Controls	62.3	60	62.8	61.7	1.5	53.3
Wins, %	Patient	0.7	0.7	0.7	0.7	0.0	0.7
	Controls	0.7	0.6	0.7	0.7	0.0	0.6
Year-end doubles ranking	Patient	4	5T	3T	4		29
	Controls	15.8	15.8	11.3	14.3	2.6	15.3
Prize money, $	Patient	775,723.00	782,511.00	539,231.00	699,155.00	138,539.83	480,283.00
	Controls	533,438.00	627,549.00	757,112.00	639,366.33	112,304.28	519,840.00

[a]T, tied.

TABLE 5
Performance Metrics for Fencing[a]

		Before Surgery			After Surgery		
		Year 1	Year 2	Mean ± SD	Year 1	Year 2	Mean ± SD
Rank	Patient	15	3	9 ± 8.5	13	29	21 ± 11.3
	Controls	13	8.7	10.9 ± 3	34.5	58.2	46.4 ± 16.8
No. of tournaments played	Patient	8	10	9 ± 1.4	7	10	8.5 ± 2.1
	Controls	9	10	9.5 ± 0.7	9	9	9 ± 0.0
Average tournament ranking points	Patient	11.4	18.2	14.8 ± 4.8	13.3	6.3	9.8 ± 5
	Controls	12.9	13.9	13.4 ± 0.7	6.9	7.6	7.3 ± 0.5
No. of matches played	Patient	65	41	53 ± 17	60	30	45 ± 21.2
	Controls	49.3	45	47.2 ± 3	44.3	54.8	49.6 ± 7.4
Match win, %	Patient	0.7	0.7	0.7 ± 0.1	0.8	0.6	0.7 ± 0.2
	Controls	0.7	0.7	0.7 ± 0.0	0.7	0.7	0.7 ± 0.0

[a]There were no statistically significant differences in mean values between the patient and controls or between preoperative and postoperative performance ($P > .05$ for both comparisons).

International Fencing Federation for 11 years. He subsequently returned to elite fencing competition for 1 season. He was matched to 6 controls on international ranking and age (within 3 years, inclusive) (see online Supplemental Material for details).

When comparing the patient with age- and performance-matched controls (Table 4), there were no significant differences in player ranking, number of tournaments played, average tournament ranking points, number of matches played, or win percentage between the patient and controls ($P > .05$). After surgery, notably, the patient returned to similar performance levels to preoperatively and won an Olympic gold medal in fencing ($P > .05$) (Table 5).

Ultramarathon

One professional ultramarathon athlete underwent HRA at the age of 64 years after competing at an elite-level in ultramarathons for >25 years. After surgery, he returned to ultramarathon competition for 3 more years and remains active at publication of this article. He was matched to 4 male ultramarathoners with similar presurgery appearances data, race times, and age (within 10 years, inclusive). Notably, given the patient's presurgical finish times, the controls were, on average, 9.1 years younger than was the patient.

When comparing the patient with controls, the patient performed better after surgery than did controls in terms of race finish time. Both unadjusted finish times and adjusted finish times were correlated with race day conditions and with each race's top 10 finish times; however, this result was not significant ($P > .05$). Compared with preoperative results, there were no statistical differences after surgery in performance metrics for this high-impact activity professional endurance athlete (Table 6).

Endurance Triathlon

Last, 1 professional Ironman triathlete and a previous first-place finisher who had been competing for 15 years underwent HRA at the age of 50 years. After surgery, he qualified and raced again for a 70.3 Ironman World Championship, a half Ironman, among several other races. Utilizing world championship performance data, he was matched to 10 male triathletes on age, presurgical appearance, and performance data. As the patient only qualified for 1 additional world championship, formal statistical comparisons were limited.

TABLE 6
Performance Metrics for Ultramarathon Runner[a]

		Before Surgery					After Surgery				
		Year 1	Year 2	Year 3	Mean	SD	Year 1	Year 2	Year 3	Mean	SD
Time, h	Patient	6.2	5.8	6.6	6.2	0.4	6.5	6.2	6.2	6.3	0.2
	Controls	6.2	6.4	6.6	6.4	0.2	7.1	7.1	7.1	7.1	0.0
Adjusted time, h	Patient	1.1	1.1	1.3	1.2	0.1	1.1	1.2	1.1	1.2	0.1
	Controls	1.1	1.2	1.2	1.2	0.1	1.3	1.4	1.4	1.3	0.0
T score[b]	Patient	-1.1	-0.9	-0.9	-0.9	0.1	-0.3	-0.4	-0.6	-0.4	0.1
	Controls	-1.1	-0.9	-0.8	-0.9	0.1	-0.6	-0.6	-0.6	-0.6	0.0

[a]There were no statistically significant differences in mean values between the patient and controls or between preoperative and postoperative performance ($P > .05$ for both comparisons).
[b]*T* score: SD compared with race participant mean ± SD.

TABLE 7
Performance Metrics for Triathlete

		Before Surgery						After Surgery
		Triathlon 1	Triathlon 2	Triathlon 3	Triathlon 4	Mean	SD	Triathlon 5
Time, h	Patient	4.8	4.5	4.6	4.7	4.6	0.2	5.6
	Controls	4.6	4.5	4.7	4.8	4.6	0.1	5.2
Adjusted time, h	Patient	1.2	1.2	1.2	1.2	1.2	0.0	1.5
	Controls	1.2	1.2	1.2	1.1	1.2	0.0	1.3
T score[b]	Patient	-0.2	-0.7	-0.2	-0.3	-0.4	0.3	0.4
	Controls	-0.6	-0.6	-0.4	-0.5	-0.5	0.1	-0.3

[b]*T* score: SD compared with race participant mean ± SD..

There was an increase in his compared triathlon time from a mean of 4.64 hours in the 4 triathlons before surgery to 5.63 hours after surgery, but notably this increase also occurred in his age- and performance-matched control group (mean increase, from 4.58 to 5.17 hours) (Table 7).

DISCUSSION

Of the 8 professional athletes in our study, all (100%) were able to return to sports in some capacity, with 6 athletes (75%) returning for at least 1 season and 2 (25%) remaining in active competition at the time of publication. Four athletes (50%) were able to return to their previous or age-matched level of performance. These findings, while unique regarding elite-level performance, are generally in line with previous studies on return to recreational sporting activities after HRA. De Haan et al[4] reported on a 48-year-old man who completed numerous full- and half-Ironman triathlons after HRA, and Girard et al[8] reported a case series of patients returning to endurance triathlon competition. Naal et al[13] surveyed sporting activities of 112 patients before and after HRA and found a significant decrease in high-impact activities, such as jogging, soccer, and tennis. However, they found a small but nonsignificant increase in lower-impact activities, such as exercise walking, Nordic walking, swimming, and fitness/weight training. The authors reported no differences in the frequency or duration of sports participation preoperatively to postoperatively, and sporting activities began approximately 6 months after surgery.[13] Fisher et al[6] reported an 87% return to sporting activities after surgery and included sports, such as football and tennis, with the most frequent sports being swimming, cycling, and golf. Le Duff and Amstutz[12] reported a 90% return rate to recreational sporting activities. In this cohort, there was an increase in high-impact activities postoperatively (from 12.4% to 17.5%) and in the frequency of competitive participation (from 5.5% to 10.1%). Given the increase in the frequency of high-impact activities, the authors postulated that patients may gain confidence in their ability to perform these activities possibly because of implant durability.[12] Girard et al[9] reported an 82% return to high-impact activities after HRA. Additionally, decreases in pain may also make patients more confident with physical activity. The postoperative treatment goals for patients undergoing HRA goals are to reduce pain and improve quality of life, which for many young and active patients includes the resumption of sporting activities. Our data also add to this growing body of literature.

Regarding complications, there were no postoperative femoral neck fractures in our cohort. Bedigrew et al[3] reported longitudinal increases in the bone mineral density after HRA and recommended return to high-impact activity at 6 months. This recommendation is reflected in the postoperative physical therapy regimen utilized by patients in our cohort. While return to high-impact activity began at 6 months, our mean time to RTP in professional competition was 362 days. Notably, RTP was defined as an appearance in a professional-level sporting event, and return to elite-level competition in practice may have been much sooner — this phenomenon could be, in part, explained by the timing of a professional season and that athletes may have elected to have surgery in the offseason for their respective sport. A delayed RTP of roughly 1 year after surgery may also have been due to a greater training requirement to regain the necessary fitness level and dexterity to compete at a high level once patients returned to high-impact activities. Across multiple sports, patients in this study did not show a significant change from their preoperative performance or deviation from an age- and presurgical performance-matched cohort after HRA. All of the sports reported in this case series involve high-impact activity and, given the nature of their performance level, demand regular and repetitive high intensity in both training sessions and competition. Athletes who require greater hip range of motion may also experience increased performance decline. All athletes were able to return to competition in some capacity, with 3 athletes remaining active in professional competitions at the time of publication.

This series describes 6 athletes, 1 baseball pitcher, 1 hockey defenseman, 1 foil fencer, 1 men's doubles tennis player, 1 ultramarathoner, and 1 endurance triathlete competing in the half Ironman, who all returned to regular competition after HRA. The baseball pitcher was able to return for 3 full seasons and maintained similar performance levels to his matched cohort and presurgical performance statistics. The hockey player was able to return and did show a nonsignificant decline in performance and games played. He retired after this season. The fencer returned to competition for 2 years and won a gold medal in the Summer Olympics. The ultramarathoner, and the triathlete are actively competing while the tennis player recently retired. For those who returned for <1 year, we were unable to determine whether it was due to their preoperative injury or overall performance decline, as the athletic demands required for professional sports are high and RTP decisions remain complex and multifactorial to include financial and contractual reasons. Professional athletes who did not return to regular competition after HRA included 1 baseball pitcher and 1 basketball player. It should be noted that the basketball player did not return because of a medical reason other than his operative hip. Additionally, the pitcher who was unable to return for a full season was able to pitch a game at the World Baseball Classic and was actively negotiating his contract for his professional association, but he was not cleared to play because of the presence of a prosthetic hip, further highlighting the multifactorial reasons for RTP decisions. Future studies are required to determine predictors for postoperative RTP. Similarly, it remains unclear how these patients' careers and performances would have been affected had they not had surgery, and the natural history of FAI and OA as well as the timing of surgical intervention remain areas of active study. However, given a high barrier to undergoing any type of arthroplasty procedure, all patients noted an inability to continue participating in their sports and everyday activities and thus presented for HRA, primarily for pain control and quality of life intervention.

We reported mean metal ion levels including a Co level of 2.0 μg/L and a Cr level of 2.2 μg/L. De Haan et al[4] reported similar serum ion concentrations between a highly active triathlete and less active patients and found that after a triathlon, an athlete had a Co level of 1.45 ppb and a Cr level of 2.38 ppb. Although metal ion levels are followed, elevated metal ion levels are not correlated with aseptic lymphocyte-dominant vasculitis-associated lesion severity.[11] There is currently no consensus regarding threshold values for Co and Cr to indicate systemic or local adverse reactions. However, Van Der Straeten[15] noted a mean Co level of 1.3 μg/L and a mean Cr level of 2.1 μg/L in their series.[14] Last, in metal-on-metal articulations that failed, Plummer et al[14] reported a mean Co level of 21.9 ppb and a mean Cr level of 13.24 ppb. Athletes in our series were asymptomatic in their operative hip, and none had signs of aseptic lymphocyte-dominant vasculitis-associated lesion at a mean follow-up of 4.3 ± 3.8 years. Patients who may become symptomatic should undergo evaluation using magnetic resonance imaging and possible aspiration.

There are several limitations to our study. We did not report any radiographic changes after the start of sports participation. Therefore, we were unable to fully comment on implant durability after resumption of these sports. Amstutz and Le Duff[1] also found no association between activity level and implant survivorship. In addition, we did not compare patients who did not complete a full season. While we did compare performance with that of other athletes, these comparisons were challenging given individual skill and previous performance. Additionally, given the small sample size, statistical comparisons with a limited control group may not fully reflect population-based performance means. Also, given the unique performance requirements of professional and elite athletes, comparison with recreational athletes is challenging, especially when assessing performance measures. RTP decisions are complex and multifactorial and may also affect RTP. Furthermore, we did not report patient outcome measures, which can objectively assess patient improvement. Last, we reported on a diversified small group of athletes, and further studies are required to better determine the effects on performance, implant durability, and length of a postoperative career.

CONCLUSION

In summary, we report on a group of professional and elite athletes who sought to undergo HRA for progressive OA or FAI and were able to return to professional and elite-level sporting activities after surgery. While all of the athletes who were reviewed in this series were able to return to their sports in some capacity, only 75% were able to compete for at least 1 season. HRA may be an attractive alternative for professional and elite athletes to allow for a potential return to competition; however, given both the small sample size and the limited follow-up for patients included in this series, further investigations are required to fully evaluate whether HRA can successfully enable athletes to RTP.

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