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Research article

Clinical presentation of intra-articular osteoid osteoma of the hip and preliminary outcomes after arthroscopic resection: a case series

Andrea M. Spiker[1]*, Ben-Zion Rotter[2], Brenda Chang[2], Douglas N. Mintz[3] and Bryan T. Kelly[2]

[1]Department of Orthopedic Surgery, Sports Medicine and Hip Preservation, University of Wisconsin-Madison, Madison, WI, USA,
[2]Department of Orthopaedic Surgery, Hospital for Special Surgery, 535 E. 70th St, New York, NY 10021, USA and
[3]Department of Radiology, Hospital for Special Surgery, 535 E. 70th St, New York, NY 10021, USA
*Correspondence to: A. M. Spiker. E-mail: spiker@ortho.wisc.edu
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ABSTRACT

Intra-articular osteoid osteoma (IAOO) of the hip is a relatively rare diagnosis, but one that can closely mimic symptomatic presentation of femoroacetabular impingement (FAI). Although there are multiple case reports of osteoid osteoma (OO) in the hip, we present the largest case series of hip IAOO treated with hip arthroscopy and discuss limited patient-reported outcomes after treatment with hip arthroscopy. We retrospectively identified patients diagnosed with IAOO of the hip with confirmatory computed tomography, magnetic resonance imaging or biopsy diagnoses of OO. We analyzed lesion location, main presenting symptoms, symptom duration and treatment undertaken. For the patients who underwent hip arthroscopy for treatment of their IAOO, we reviewed patient-reported outcome scores when available.

Forty patients with confirmed IAOO were identified. Thirteen underwent excision with hip arthroscopy. The most common presenting symptom was groin pain. In limited patients who had pre- and post-operative outcome scores, we found significant improvements in modified Harris Hip Score (mHHS), Hip Outcome Score-Activity of Daily Living (HOS-ADL) and international Hip Outcomes Tool (iHot33) scores. Compared with patients undergoing hip arthroscopy for FAI alone, baseline mHHS, HOS-ADL, Hip Outcome Score–Sport-Specific Subscale and iHot33 scores were almost identical. We found that the presenting symptoms of hip IAOO closely mimic symptomatic FAI, including groin pain and anterior hip pain, so it is important to keep IAOO of the hip in the differential diagnosis of hip pain. Based on our experience, arthroscopy can be an effective treatment option for excision of intra-articular OO and is especially effective in patients with concomitant FAI in treating both pathologies.

INTRODUCTION

Osteoid osteomas (OOs) represent approximately 10% of benign bone tumors and were first identified as a separate entity by Jaffe [1]. OOs are most commonly found in the femur, the tibia and the spine, but can be found throughout the body [2]. Approximately 1–3% of OOs are localized to the pelvic region [3, 4] and approximately 20% of all OOs are located in the proximal femur [5]. Five to 12% of OOs have an intra-articular location [1], and approximately 13% of intra-articular osteoid osteoma (IAOO) lesions occur at the hip joint [6]. While IAOO at the hip is a relatively rare diagnosis, its presentation can mimic many other hip pathologies, so is an important entity to keep in the differential diagnosis.

The typical presentation of an extra-articular OO is severe pain, often including night pain in 80% of patients [2], which is relieved with administration of aspirin or non-steroidal anti-inflammatory drugs (NSAIDs) [7]. The proximal femur, along with the proximal humerus, the proximal radius and the distal fibula, is unique in that the metaphysis is partially intracapsular. It has been reported that IAOOs can present with atypical symptoms, but there

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has not been a clear consensus on the hip IAOOs presentation. Hip IAOOs have been reported as presenting with synovitis, joint effusion, decreased ROM, muscle atrophy in the affected leg or abductor muscles [8], limb length discrepancy [3] or even hip contractures [9]. In the acetabular OO lesions specifically, patients have presented with chronic pain [10], chronic synovitis [9, 11], normal hip mobility [10] and partial pain relief with NSAIDs [10]. Hip IAOOs have also been associated with growth disturbances of the hip [12], rapid development of osteoarthritis (OA) [13], severe radicular pain, progressive and diffuse muscular atrophy and weakness in the affected limb, and diminished deep tendon reflexes [14, 15]. These sometimes subtle and non-specific presentations can be a diagnostic challenge. The lag in diagnosis of patients with general IAOO has been reported to be up to three times longer (26.6 months) than those with more classic extra-articular lesions (8.5 months) [6].

Treatment of OO can be non-surgical. Prolonged administration of oral salicylates and NSAIDs has been reported to take 2–15 years for the OO pain to resolve [16]. Surgical treatment of OO lesions in the acetabulum has included open surgical hip dislocation [9], percutaneous radiofrequency ablation (RFA), hip arthroscopy [17], the use of an intra-articular laser with en block excision [18], burring the lesion [17, 19] or using a curette to excise the lesion [20], arthroscopically assisted RFA [21], or intraoperative percutaneous RFA [22]. Surgical treatment of femoral neck OOs has included excision with the arthroscopic burr and electrosurgical instruments [11, 19], a modified core decompression technique [8], excisional biopsy or intralesional curettage through an anterior hip approach [23], with internal fixation or cast immobilization [23], and a lateral approach and en bloc excision through the greater trochanter [24]. The standard treatment most often reported for acetabular OOs has been an open surgical procedure to access the cartilage surface [25, 26]. RFA is also commonly used to treat OOs in all locations, and has a reported overall success rate of up to 90% in permanently treating OOs [10, 27]. However, complications of RFA include infections, skin burns, bleeding, nerve injury, tendonitis or thrombosis. There has also been a report of long-term (10 years) femur fracture after RFA of a proximal femur lesion [28], and mid-term (1 year after procedure) symptomatic articular damage has been reported after treatment with RFA [10]. RFA is contraindicated when in close proximity to the spinal cord or peripheral nerves adjacent to disrupted cortical bone [10]. If the entire lesion is not ablated with RFA, recurrence can occur [29].

While multiple case reports have described IAOOs in the acetabulum [9, 10, 17, 19–21, 30–44] and femoral neck [11, 12, 19, 23, 30, 33–35, 37, 45–49], as well as the femoral head [35–37, 50, 51] (Table I), we report the largest case series of OOs of the intra-articular region of the hip treated with hip arthroscopy. We share limited pre- and post-surgical outcome scores after treatment with hip arthroscopy. We also discuss the presentation (symptom location and duration) and imaging findings in patients with IAOO of the hip.

MATERIALS AND METHODS

Study population

We retrospectively identified all patients in our institution's hip preservation group who had been given a diagnosis of OO of the hip (acetabulum or intra-articular proximal femur). We reviewed available radiographic, computed tomography (CT) and magnetic resonance imaging (MRI) of the lesions to describe lesion location. We excluded any patient who did not have a confirmed diagnosis of OO (either biopsy confirmed or definitive diagnosis made from either CT or MRI imaging by a fellowship trained musculoskeletal radiologist. If MRI was not pathognomonic and CT was not available, we excluded the patient).

Of these patients, we further selected those who were enrolled in our institutional review board–approved hip registry of prospectively collected data on over 1800 procedures in 1600 patients since 2010. Patients are enrolled after providing informed consent, and data collected include pre-, intra-, and post-operative findings, patient-reported outcomes pre- and post-operatively, and radiographic reports. From these patients, we were able to analyse patient-reported outcome scores.

Outcome measures

Patient-reported outcome scores were tabulated when available. The hip registry includes scores for the modified Harris Hip Score (mHHS), the international Hip Outcomes Tool (iHot33), the Hip Outcome Score-Activity of Daily Living (HOS-ADL) and the Hip Outcome Score–Sport-Specific Subscale (HOS-SSS). These scores are routinely obtained pre-operatively, at 6 months, 1 year and yearly thereafter through final follow-up.

Statistical analysis

Descriptive statistics were reported in terms of means and standard deviations for continuous demographic variables, and in terms of total number and percentage of patients for discrete variables. Descriptive statistics were similarly reported for clinical characteristics in terms of total

Table I. Review of the literature—previous reports of IAOO of the hip

Citation	*Year*	*Number of patients with hip IAOO*	*Age/ average age*	*Location of lesion*	*Treatment*	*Follow-up (months)*	*Outcome scores?*
Agrawal *et al.* [14]	2009	1	11	Proximal femoral shaft	NR	NR	No
Ahlfeld *et al.* [23]	1990	5	15	Femoral neck	Open excision	48	No
Alvarez *et al.* [18]	2001	1	16	Acetabulum	Arthroscopy	1	No
Asik *et al.* [20]	2014	1	7	Acetabulum	Arthroscopy +RFA	8	No
Banga *et al.* [52]	2014	1	52	Femoral neck	Non-op	7	No
Barnhard *et al.* [31]	2011	1	20	Acetabulum	Arthroscopy	NR	No
Bettelli *et al.* [3]	1989	2	NR	Acetabulum	Open excision	37	No
Bosschaert *et al.* [10]	2010	1	17	Acetabulum	RFA	12	No
Callaghan *et al.* [25]	1998	6		Five acetabulum, 1 femoral neck	Open excision	NR	No
Carter *et al.* [8]	1990	1	17	Femoral neck	Open excision	24	No
Cassar-Pullicino *et al.* [56]	1992	2	23	Femoral neck, acetabulum	Open excision	36	No
Chang *et al.* [32]	2010	1	29	Acetabulum	Arthroscopy	12	No
de los Santos *et al.* [26]	2013	1	12	Acetabulum	Open excision	36	No
Dunlap *et al.* [50]	1985	1	14	Aemoral head	Non-op	NR	No
Foeldvari *et al.* [13]	1998	1	14	Femoral neck	Open excision	5	No
Gille *et al.* [9]	1990	2	14	Acetabulum	Open excision	3	No
Giustra *et al.* [12]	1970	2	14	One femoral neck, 1 proximal femoral shaft	Open excision	NR	No
Goldberg *et al.* [33]	1975	31	NR (range 2-16)	Femoral neck, acetabulum	Twenty-nine open excision, 2 non-op	NR	No
Herget *et al.* [11]	2012	1	21	Femoral neck	Arthroscopy	NR	No
Kang *et al.* [61]	2014	1	24	Femoral neck	CT-guided excision	43	No
Karray *et al.* [44]	2010	1	16	Acetabulum	Open excision	NR	No
Kattapuram *et al.* [54]	1983	11	NR	Seven femoral neck, 2 acetabulum, 2 NR	NR	NR	No

(continued)

Table I. Continued

Citation	*Year*	*Number of patients with hip IAOO*	*Age/ average age*	*Location of lesion*	*Treatment*	*Follow-up (months)*	*Outcome scores?*
Khapchik *et al.* [19]	2001	2	26	One acetabulum, 1 femoral neck	Arthroscopy	21	No
Lee *et al.* [34]	2009	2	11	One acetabulum, 1 femoral neck	Arthroscopy	19	No
Marwan *et al.* [17]	2015	1	31	Acetabulum	Arthroscopy	44	No
Muscolo *et al.* [35]	1994	4	19	Three femoral neck, 1 femoral head	CT-guided excision	27	No
Nehme *et al.* [30]	2012	2	27	One femoral neck, 1 acetabulum	Arthroscopy	24	No
Ninomiya *et al.* [36]	1989	2	12	One acetabulum, 1 femoral head	Open excision	14 and NR	No
Papagelopoulos *et al.* [37]	2006	16	NR	Eight femoral head, 6 femoral neck, 2 acetabulum	RFA	30	No
Parlier-Cuau *et al.* [38]	1999	3	20	Acetabulum	CT-guided excision	36	No
Pianta *et al.* [46]	2012	1	16	Femoral neck	RFA	12	No
Raux *et al.* [47]	2014	26	NR	Femoral neck	CT-guided excision	NR	No
Raux *et al.* [39]	2013	5	17	Acetabulum	CT-guided excision	18	No
Ricci *et al.* [21]	2013	1	47	Acetabulum	Arthroscopy + RFA	22	No
Richardson *et al.* [48]	2009	1	18	Femoral neck	CT-guided excision	NR	No
Scalici *et al.* [51]	2011	1	24	Femoral head	Open excision	60	No
Sestan *et al.* [49]	2005	1	11	Femoral neck	Non-op	60	No
Shoji *et al.* [40]	2014	1	12	Acetabulum	Arthroscopy	16	No
Szendroi *et al.* [6]	2004	9	20	Three acetabulum, 6 femoral neck	Two open excision, 7 curettage	29	No
Tamam *et al.* [41]	2014	1	23	Acetabulum	Arthroscopy	NR	No
Tokis *et al.* [29]	2013	1	19	Acetabulum	Arthroscopy	12	No
Tsuruomto *et al.* [42]	2005	1	15	Acetabulum	Open excision	96	No
Xiao *et al.* [62]	2011	1	9	Femoral neck	Open excision	12	No

number of procedures. Paired *t*-tests were used to compare the latest post-operative scores at 6 months or greater to pre-operative scores. Frequency and percentage of patients achieving a minimal clinically important difference for arthroscopic treatment of femoroacetabular impingement (FAI) were calculated.

A comparison group of all patients undergoing hip arthroscopy for isolated cam- or rim-impingement was

included for demographic and baseline outcome score comparison in a non-matched case–control design. These included unilateral or bilateral scopes between 10 July 2007 and 14 April 2016 with completed survey scores at baseline.

All analyses were conducted using SAS version 9.3 (SAS Inc., Cary, NC, USA).

RESULTS

Forty patients from the hip preservation group database were identified as having a hip IAOO between 2000 and 2015. Ten lesions were located in the acetabulum, 29 in the femoral neck and 1 in the femoral head. Twenty-four patients were male and 16 female, with the average age of 24.5 years (range 11–57).

Thirty of the 40 patients underwent intervention for their OO at our institution. Ten patients were either lost to follow-up or were treated non-operatively (Table II). Of those who sought treatment, 16 underwent RFA, 13 underwent hip arthroscopy and 1 underwent open excision. Of the patients who were treated with RFA, 13 of the lesions were located in the femoral neck and 3 in the acetabulum. Of the patients treated with hip arthroscopy, nine lesions were in the femoral neck, three were in the acetabulum and one was in the inferior femoral head. The one patient who underwent open excision had a lesion in the acetabulum. Of the 13 patients who had arthroscopic excision of the OO, the concomitant arthroscopic procedures performed were as follows: 8 had labral repair, 7 had rim decompression, 9 had cam decompression, 1 had subspine decompression, 2 had iliopsoas release and 4 had labral debridement. All 13 patients who underwent arthroscopic excision of the OO had the lesion confirmed by pathology.

The main presenting symptom for each patient was documented (Table III). The duration of symptoms at the time of initial evaluation at our institution was also noted (Table IV), as was the prevalence of night pain and pain relief with NSAIDs (Table V).

We reviewed the CT imaging available on our IAOO patients (13 of 40). The average alpha angle in these patients was 64.6° (±13.1°), coronal center edge angle 30.2° (±3.8°), femoral neck shaft angle 133.2° (±4.9°), acetabular version at 1 o'clock 3° (±6.9°), 2 o'clock 8.8° (±8.3°) and 3 o'clock 16° (±5.4°). On MRI review, 65% (26 of 40) of the patients had edema surrounding the OO lesions.

Of the 13 patients treated with hip arthroscopy, 5 had both pre- and post-operative mHHS and HOS-ADL. Four had both pre- and post-op iHot33 scores, and three had both pre- and post-op HOS-SSS scores. The mean pre-op mHHS in these patients was 58.1, HOS-ADL 65.3, HOS-SSS 41.7, iHot33 37.5. At final follow-up, the mean scores

Table II. Treatment course of patients who did not undergo treatment at our institution (10 of 40 patients)

Patients treated non-operatively or lost to follow-up	*Number of patients*
Initiated PT—lost to follow-up	3
Lost to follow-up	2
Pain level manageable—patient opted for conservative management	1
Recommended RFA—patient refused	1
Recommended arthroscopy—patient refused	1
Recommended RFA—lost to follow-up	1
Intra-articular injection + initiated PT —lost to follow-up	1

Table III. Main presenting symptoms of patients with confirmed IAOO of the hip

Main presenting symptom	*Number of patients*	*% of patients*
Groin pain	9	23
Anterior hip pain	6	15
Groin pain w/anterior hip pain	4	10
Lateral hip pain	4	10
Generalized hip pain	4	10
Groin pain w/radiation to leg	1	3
Groin pain w/lateral hip pain	1	3
Groin pain w/anterior and posterior hip pain	1	3
Groin pain w/anterior and lateral hip pain	1	3
Buttock pain w/radiation to groin and leg	1	3
Anterior hip pain w/posterior pain	1	3
Pelvic pain	1	3
Not recorded	6	15

were mHHS 93.9 (Δ35.9, $P = 0.002$), HOS-ADL 98.2 (Δ33.0, $P = 0.006$), HOS-SSS 90.7 (Δ49.1, $P = 0.06$) and iHot33 80.0 (Δ42.5, $P = 0.006$). We had no reported surgical complications and no recurrences of the lesion at the time of last follow-up (average 27 months, range 3–105 months).

Table IV. Duration of symptoms upon initial evaluation at our institution

Duration of symptoms	*Number of patients*	*% of patients*
0–6 months	10	25
6 months to 1 year	9	23
1–2 years	6	15
>2 years	8	20
Not recorded	7	18

Table V. Presence of night pain and pain relief with NSAIDs

Presence of night pain	*Number of patients*	*% of patients*
Night pain	15	38
No night pain	3	8
Not recorded	22	55
Pain relief with NSAIDs	*Number of patients*	*% of patients*
Pain relief with NSAIDs	23	58
No pain relief with NSAIDs	10	25
Not recorded	13	33

A comparison group of all patients undergoing hip arthroscopy for isolated cam- or rim-impingement was included. There were no statistically significant differences in gender or age between these groups (Table VI), nor were there any statistically significant differences between baseline pre-operative scores (mHHS, HOS-ADL, HOS-SSS and iHot33) (Table VII). Given the small number of hip IAOO patients with post-operative outcome scores, we were not able to directly compare post-operative scores between our study group and the group of FAI patients undergoing hip arthroscopy.

DISCUSSION

IAOO of the hip may be a confounding diagnosis in patients presenting with hip pain and symptoms consistent with FAI. Diagnosis of this rare but treatable benign bone tumor is often delayed due to its atypical presentation [6], and based on our findings, its similarity with symptomatic presentation of FAI. Case reports in the literature have previously reported of the coexistence of OO and FAI [52] and described multiple treatment options, including hip arthroscopy [11, 17, 19]. We report the largest case series of hip IAOO treated with hip arthroscopy (13 patients), and discuss the clinical presentation of a total of 40 patients with confirmed diagnosis of IAOO of the hip.

Males are more commonly affected by OO than females, at a rate of 2:1 [2] to 3:1 [27]. In our series of hip IAOO, 24 patients were male and 16 were female, a male to female ratio of 1.5:1. The location of the IAOO lesions was on both sides of the hip joint; however, there was almost a 3:1 ratio of lesions in the femoral neck compared with the acetabulum (29 IAOO in the femoral neck, 10 IAOO in the acetabulum and 1 in the inferior femoral head). OO with intra-articular location has been reported to present with

Table VI. Demographic comparison of patients undergoing hip arthroscopy for FAI only and patients undergoing hip arthroscopy with IAOO in a non-matched case–control design

	Patients with IAOO		*Patients with FAI only*			
	N	*%*	N	*%*	*Odds ratios (95% CI)*	P-*value*
Total number of patients	14		153			
Female	6	42.9	106	69.3	0.3 (0.1 to 1.0)	0.39
Bilateral	3	21.4	16	10.5	2.3 (0.6 to 9.3)	0.14
Revision	1	7.1	9	5.9	1.2 (0.1 to 10.5)	0.39
	Mean	*SD*	*Mean*	*SD*	*Difference in means (95% CI)*	*P-value*
Age (years)	23.7	8.4	29.2	10.6	5 (–6 to 10)	0.064

Table VII. Comparison of preoperative scores for patients undergoing hip arthroscopy for FAI only and patients undergoing hip arthroscopy for IAOO

Preoperative survey score (N= # IAOO, N = # FAI)	*Patients with IAOO (N = 14)*		*Patients with FAI only (N = 153)*		*Unadjusted difference (95% CI)*	P-*value*	*Adjusted difference*[a] *(95% CI)*	P-*value*
mHHS (mean ± SD)	62	15	60	13	−2 (−9 to 7)	0.63	1 (−6 to 9)	0.70
(*N* = 13, *N* = 153)								
HOS ADL (mean ± SD)	74	21	72	17	−1 (−13 to 10)	0.80	1 (−9 to 11)	0.77
(*N* = 13, *N* = 153)								
HOS Sport (mean ± SD)	61	24	49	24	−12 (−26 to 1)	0.099	−6 (−21 to 8)	0.40
(*N* = 11, *N* = 153)								
iHot33 (mean ± SD)	41	24	38	19	−3 (−17 to 11)	0.64	5 (−7 to 18)	0.41
(*N* = 9, *N* = 153)								

[a]Differences in means are adjusted for age, sex, bilaterality and revision status

atypical and varied symptoms, different from the classic night pain relieved by NSAIDs found with extra-articular OO [3, 8–15]. Our patients had a wide range of presentations consistent with previous reports of IAOO, but the most common presenting symptom was groin pain (Table III). Groin pain is also the most common presenting symptom of FAI [53]. This overlap in symptoms of IAOO and more common causes of hip pathology, such as FAI, can be part of the reason IAOO of the hip is misdiagnosed or missed. Previous reports have emphasized the delay in diagnosis of OO of the proximal femur, which have been reported to range between 12 months and 2 years after pain onset [23]. In our series, patients presented with a more evenly distributed duration of symptoms between acute, sub-acute and chronic (Table IV).

Radiographic features of hip IAOO may differ from extra-articular lesions. The IAOO may not be evident on plain radiograph (Figs 1A and 4A), as the nidus of OO is not visible on plain radiographs until the lesion is greater than 4 mm in size [54]. Additionally, in a majority of subchondral or subperiosteal intra-articular lesions, there is no surrounding sclerosis on plain radiograph [6]. CT is the gold standard for diagnosing OO [23] as it is the most useful imaging modality to identify the OO nidus [6], which classically appears as a central calcification and surrounding sclerosis (Figs 1F and 4C). When the OO is near a joint, CT may demonstrate changes on both sides of the joint, including osteophyte formation, a localized soft-tissue mass, reduced bone density or increased bone density in the subchondral bone of the abutting joint surface [55]. Additional intra-articular imaging findings include joint effusion (Fig. 3), periarticular osteoporosis and periosteal reaction [54]. Varying amounts of tumor mineralization may be present, with more calcification often correlated with more mature lesions [56]. While lesions located in the bone cortex may present with large periosteal reaction, the lack of adjacent periosteum in intra-articular lesions often results in only a mild osteoblastic response [56].

MRI appearance of OO is often more aggressive than the lesion actually is, with extensive bone marrow edema and even adjacent soft tissue signal changes can be seen [56, 57] (Figs 2, 3 and 4B). MRI can demonstrate variable signal intensity and juxta-lesional edema of the OO depending on the amount of calcification present, the vascularity and age of the lesion [58]. Chondral hypertrophy has also been described with intra-articular hip OO lesions [56], which could be identified on MRI. Sixty-five percent of the MRI reports in our series (26 of 40) describe significant edema. This is consistent with previous findings, where 63% of OOs on MRI (12 of 19) showed perinidal bone marrow edema and inflammation [59]. While MRI is often the imaging modality used to assess hip and groin pain, the diagnostic accuracy of MRI in detecting OO is not as reliable as with CT [58, 59]. MRI fails to identify 21% of intra-articular OOs and only poorly identifies them in an additional 29% [58].

Multiple treatment options exist for treatment of symptomatic OO, including open excision, RFA or arthroscopic excision. The gold standard treatment for OO in all locations is RFA [10, 27]. Patients in our series were referred RFA if the lesion was a safe distance from the articular

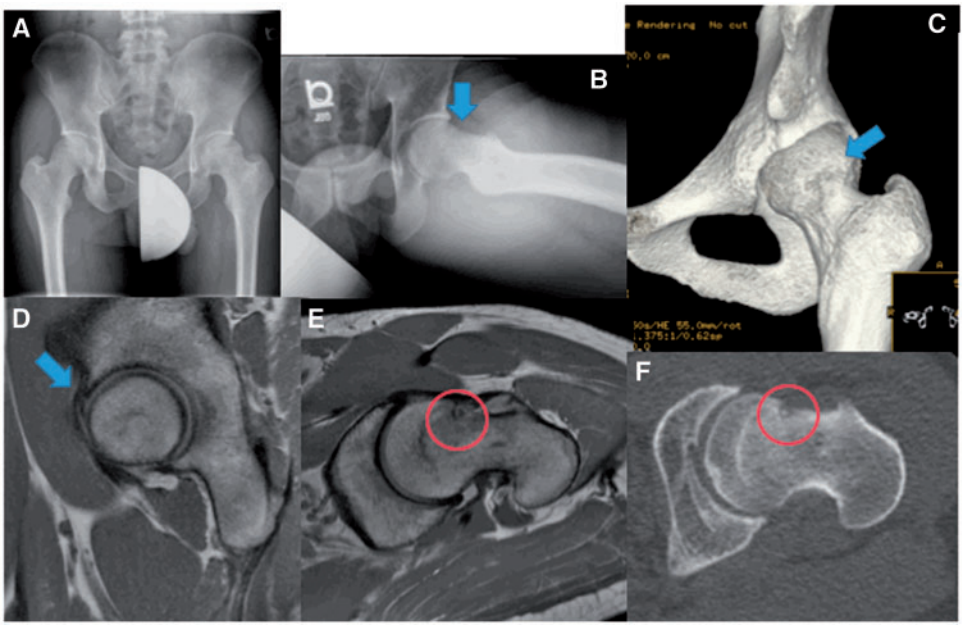

Fig. 1. The radiographic imaging of one patient in our series with IAOO of the hip who presented with left groin pain. (**A**) AP pelvis. (**B**) Lateral radiograph demonstrates loss of femoral head neck offset with a small cortical irregularity at the head-neck junction. (**C**) 3D CT scan demonstrates large cam lesion. (**D**) MRI demonstrates superior labral tear. (**E**) MRI shows OO lesion. (**F**) CT shows characteristic appearance of OO.

cartilage, and they had no evidence of other intra-articular pathology that could be addressed with hip arthroscopy.

The decision to proceed with arthroscopic excision of the hip IAOO in our patient population was based on (i) lesion accessibility with hip arthroscopy instrumentation, (ii) the presence of additional pathology which could be addressed with hip arthroscopy and (iii) in depth discussion with the patient about available options and the patient's treatment preference.

Marwan *et al.* [17] recently published a systematic review of all acetabular IAOO treated with hip arthroscopy. From this review of 11 cases, they reported a success rate of greater than 90% in treating acetabular OOs with hip arthroscopy and noted no recurrences of the lesion at last follow-up ranging between 6 months and 2 years, and one study not reporting follow-up duration [17]. Similarly, in our case series, none of our patients treated with hip arthroscopy had recurrence of the lesion after our treatment at an average 27-months follow-up (range 3–105 months). There were, however, three patients who presented to our institution after previous intervention for their IAOO, and at the time of our initial evaluation, had either persistent or recurrent IAOO. All three patients had previously undergone RFA: one patient proceeded with no further treatment, another patient underwent subsequent hip arthroscopy and the third patient had a repeat CT-guided RFA.

Norman *et al.* [60] looked at a series of 182 OOs over 24 years and found 30 of which were intra-articular at the hip joint. Of these 30 lesions, 50% were associated with the development of OA [60]. Rapid development of OA has also been described as beginning as early as 5 months after OO lesion excision [13]. None of our patients with IAOO had concomitant diagnoses of OA; however, we would require longer and more complete follow-up to determine the incidence of degenerative changes related to the IAOO. This strong correlation of OA with IAOO does, however, give us incentive to identify these lesions early, and treat symptomatic IAOO more aggressively to prevent the theoretical sequela of early hip OA.

There have been multiple case reports and a number of case series of hip IAOO (Table I). Our case series is the largest of hip IAOO of the hip treated by hip arthroscopy (Fig. 5). While we had a very small number of patients who had both pre- and post-operative outcome scores after treatment with hip arthroscopy, this is the first report of patient-reported outcomes in this subset of patients. We noted a significant improvement in mHHS, HOS-ADL and iHot33 scores. Our comparison group of patients (Tables VI and VII), included patients undergoing hip arthroscopy for FAI only, as this was the closest group of patients to a control group who had taken the pre-operative patient-reported outcome surveys. The FAI only and IAOO patients were

matched in age, gender and unilaterality/bilaterality of surgery as well as revision status. When comparing baseline, pre-operative patient-reported outcome scores, the FAI-only hip arthroscopy patient scores were not statistically different from the scores of those patients with hip IAOO undergoing hip arthroscopy. This emphasizes that patients with hip IAOO can present almost identically to patients with FAI. The physician should be extra vigilant to keep the diagnosis of hip IAOO in the differential.

Limitations

Given that the diagnosis of IAOO is relatively rare, we have limited numbers of patients who had this diagnosis and were treated with hip arthroscopy. This case series includes only a small number of patients who had long-term follow-up. We excluded patients who had OA, although it is possible that older patients who had advanced OA once had an OO, especially given the high incidence of OA associated with hip IAOO [60]. If IAOO was in the differential based on hip MRI, but the patient did not have a confirmatory CT scan,

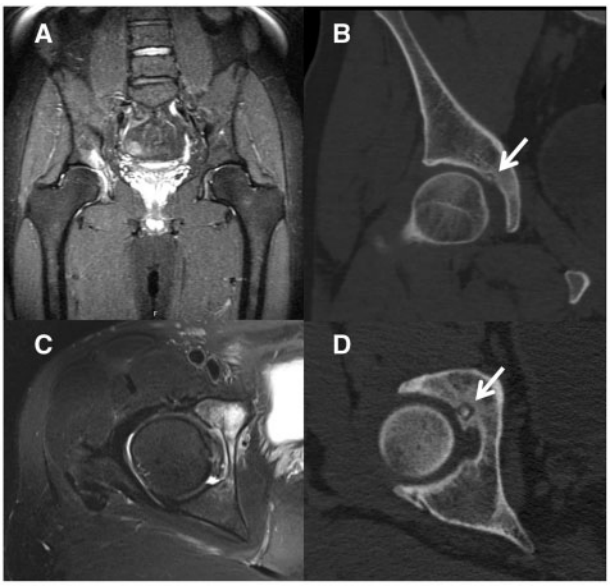

Fig. 2. (**A**) Coronal STIR MRI demonstrating edema of the right acetabulum surrounding the OO lesion. (**B**) Coronal CT demonstrating OO lesion (arrow). (**C**) Axial T2 FSE fat saturated MRI again demonstrating bone marrow edema. (**D**) Axial CT of OO (arrow).

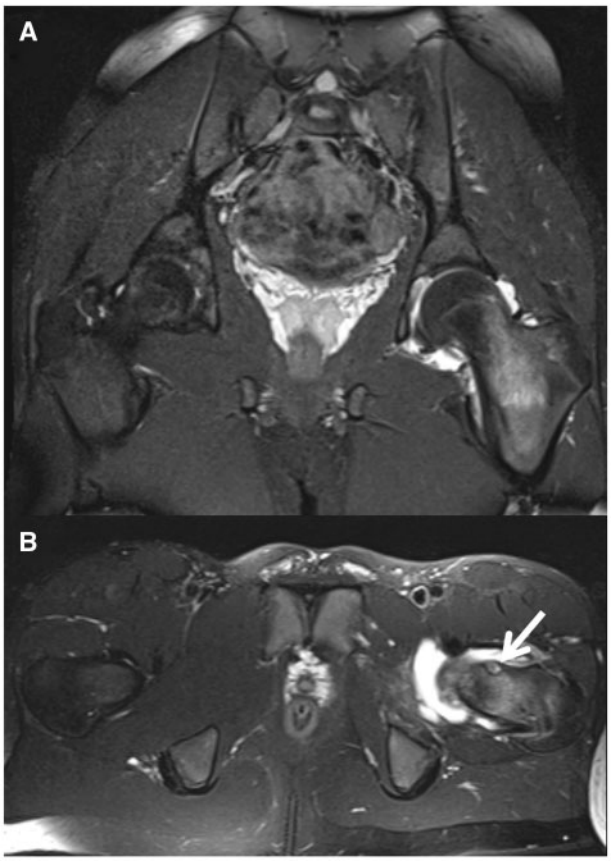

Fig. 3. (**A**) STIR coronal MRI demonstrating bone marrow edema of the left femoral neck surrounding the OO lesion and left hip joint effusion. (**B**) T2 Axial MRI fat-saturated sequence demonstrating OO (arrow) at left anteromedial femoral neck.

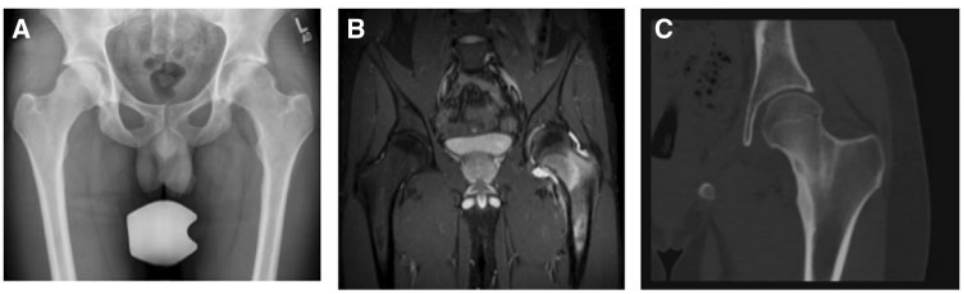

Fig. 4. (**A**) Pre-operative AP Pelvis of a left inferior femoral neck IAOO. (**B**) Pre-operative MRI demonstrating significant edema in the femoral neck surrounding the OO lesion. (**C**) Pre-operative CT scan of characteristic CT findings of OO, demonstrating a nidus with surrounding sclerotic bone.

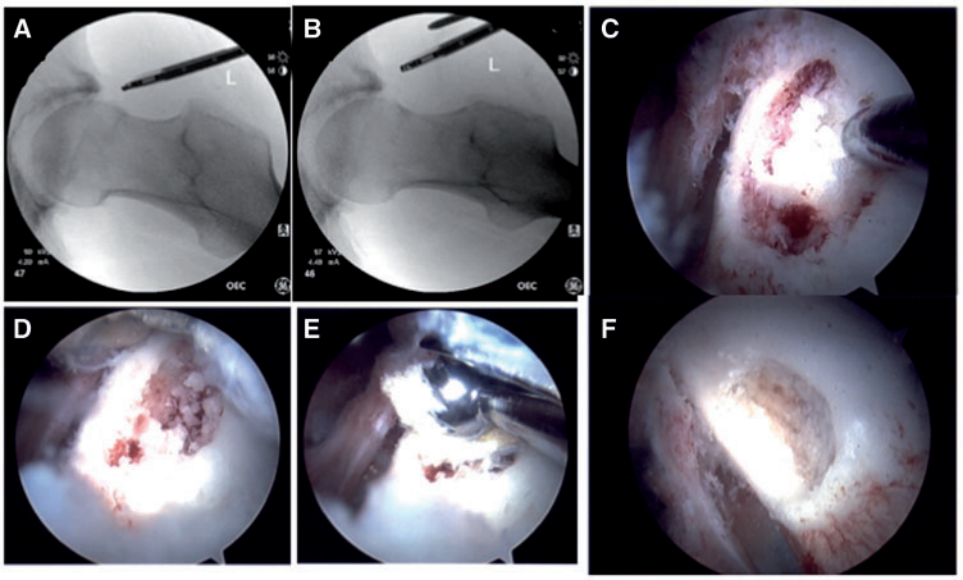

Fig. 5. In this left hip with femoral neck OO, intraoperative radiographic image demonstrating the contour of the femoral head-neck junction prior to (**A**) and after (**B**) CAM decompression and OO excision. Intraoperative arthroscopic image showing OO of the femoral neck prior to (**C, D**), during (**E**) and after (**F**) excision with a curette an arthroscopic burr.

they were also excluded. Given the limitations of MRI to definitively identify OO [58], it is possible we missed OO lesions that would have been present on CT scan if the patient had undergone CT. While all excised IAOO were confirmed by histology, we did not obtain post-operative CT to evaluate the lesion (as this practice is not standard of care). Additionally, many of our patients had multiple procedures in addition to the arthroscopic excision and ablation of the IAOO. This does confound the post-surgical PROs, as there is no way to delineate what benefit the patients received from IAOO excision versus treatment of other intra-articular pathology. Another significant limitation to this study was that we did not have patient-reported outcome scores or long-term follow-up on those patients who underwent RFA, as our registry only collects data on post-operative patients and those that follow for non-operative treatment of hip pain. Those patients who underwent RFA had post-procedure follow-up outside of our practice. A comparison between patients who underwent IAOO with RFA versus hip arthroscopy would be clinically useful, but in our series patients were indicated for hip arthroscopy over the gold standard RFA if they met a number of criteria. We favored hip arthroscopy in patients who had a lesion close to the articular cartilage where there was concern for the potential detrimental effects of RFA to the cartilage; or if they had concomitant intra-pathology that could be addressed with hip arthroscopy.

CONCLUSIONS

Our series presents 13 patients with IAOO of the hip treated with hip arthroscopy and the clinical presentation of 40 patients with confirmed diagnosis of hip IAOO. While OO in the intra-articular hip location is a relatively rare diagnosis, our findings highlight the importance of keeping IAOO in the differential diagnosis of patients with hip pain. If an IAOO is diagnosed in the hip joint, we propose the following treatment algorithm: If there is no coexistence of FAI or other intra-articular pathology, RFA remains a viable option with a proven success rate if the lesion is far enough away from the articular cartilage to minimize concern for cartilaginous injury. If FAI or intra-articular pathology is also present, RFA of the IAOO with a staged treatment of the FAI is also an option, especially if it is unclear which pathology is the predominant etiology of the patient's symptoms. If the OO is in the setting of, or exacerbating, symptomatic FAI, we believe that hip arthroscopy is the preferred treatment method to address all of the patient's hip pathology during one intervention, and has the added benefit of obtaining tissue for a definitive diagnosis of the OO lesion.

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CONFLICT OF INTEREST STATEMENT

None declared.

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