

Intra-Abdominal Fluid Extravasation During Hip Arthroscopy: A Survey of the MAHORN Group

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Purpose: The purpose of this study was to survey experts in the field of hip arthroscopy from the Multicenter Arthroscopy of the Hip Outcomes Research Network (MAHORN) group to determine the frequency of symptomatic intra-abdominal fluid extravasation (IAFE) after arthroscopic hip procedures, identify potential risk factors, and develop preventative measures and treatment strategies in the event of symptomatic IAFE. **Methods:** A survey was sent to all members of the MAHORN group. Surveys collected data on general hip arthroscopy settings, including pump pressure and frequency of different hip arthroscopies performed, as well as details on cases of symptomatic IAFE. Responses to the survey were documented and analyzed. **Results:** Fifteen hip arthroscopists from the MAHORN group were surveyed. A total of 25,648 hip arthroscopies between 1984 and 2010 were reviewed. Arthroscopic procedures included capsulotomies, labral reattachment after acetabuloplasty, peripheral compartment arthroscopy, and osteoplasty of the femoral head-neck junction. Of the arthroscopists, 7 (47%) had 1 or more cases of IAFE (40 cases reported). The prevalence of IAFE in this study was 0.16% (40 of 25,650). Significant risk factors associated with IAFE were higher arthroscopic fluid pump pressure ($P = .004$) and concomitant iliopsoas tenotomy ($P < .001$). In all 40 cases, the condition was successfully treated without long-term sequelae. Treatment options included observation, intravenous furosemide, and Foley catheter placement, as well as 1 case of laparotomy. **Conclusions:** Symptomatic IAFE after hip arthroscopy is a rare occurrence, with an approximate prevalence of 0.16%. Prevention of IAFE should include close intra-operative and postoperative monitoring of abdominal distention, core body temperature, and hemodynamic stability. Concomitant iliopsoas tenotomy and high pump pressures may be risk factors leading to symptomatic IAFE. **Level of Evidence:** Level IV, therapeutic case series.

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Note: To access the MAHORN survey (Fig 1) accompanying this report, visit the November issue of *Arthroscopy* at www.arthroscopyjournal.org.

Hip arthroscopy has become an established procedure for the treatment of a variety of pathologic hip conditions, including labral tears, loose bodies, and femoroacetabular impingement. The number of hip arthroscopies has increased over the past 2 decades with advancements in specialized instruments and education within the orthopaedic community.¹ The reported prevalence of complications during hip arthroscopy has been estimated between 1% and 13%.²⁻⁶ The most common complications include traction-related injuries, peripheral nerve injuries, trochanteric bursitis, portal hematoma, and instrument breakage. Several recent case reports have detailed both intraoperative and postoperative complications as a result of intra-abdominal fluid extravasation (IAFE) during arthroscopy of the hip.^{1,7-12}

The purpose of this study was to survey experts in the field of hip arthroscopy from the Multicenter Arthroscopy of the Hip Outcomes Research Network (MAHORN) group to determine the frequency of symptomatic IAFE during arthroscopic hip procedures. Secondary goals included the identification of risk factors leading to such a complication and the development of preventative measures and treatment strategies in the event of such a complication. The hypothesis of this study is that IAFE is a rare but potentially serious complication of hip arthroscopy.

METHODS

A standardized survey (Fig 1, available at www.arthroscopyjournal.org) was sent to each member of the MAHORN group to retrospectively recollect general data on their performed hip arthroscopies. In addition, surgeons reviewed the medical records for any symptomatic IAFE cases that they might have encountered to complete the second part of the questionnaire for each case.

The MAHORN group is a study group composed of clinicians from around the world with a large experience in hip arthroscopy. Although there is 1 member who is a physical therapist, the rest of the members perform a high volume of hip arthroscopies. Members were asked to complete the survey and anonymously document each individual case of IAFE that they encountered.

Out of a total of 17 MAHORN members, 15 arthroscopists (88%) responded to the survey. Responses were collected by the senior author, and all data were aggregated and analyzed.

RESULTS

Survey Results

Fifteen arthroscopists returned our questionnaire, with an overall number of 25,648 arthroscopies performed. The mean number of arthroscopies performed per surgeon in our group was 1,768.4 (range, 300 to 5,200). All participants except 1 (93%) used a fluid pump in more than 75% of their arthroscopies, and 1 (7%) used it in less than 25% of cases. Of the surgeons, 12 (80%) reported their typical fluid pump pressure setting.

Among the different types of arthroscopic procedures currently performed, capsulotomy, labral reattachment after acetabuloplasty, peripheral compartment arthroscopy, and osteoplasty of the femoral head-neck junction were commonly reported by most participants. Iliopsoas tenotomy constituted less than 25% of all arthroscopies as reported by 14 (93%) of the participants (Table 1).

Osteoplasty of the femoral head-neck junction was the most frequently performed procedure in our group, followed by acetabuloplasty and labral repairs.

Of the 15 arthroscopists who responded to our survey, 7 (47%) had at least 1 case of IAFE. The 3 surgeons with the highest numbers of IAFE cases were also those with the largest number of procedures overall. There was no significant correlation between the number of procedures and the incidence of IAFE per surgeon. Overall, 40 cases of IAFE were reported, with a range per arthroscopist of 1 to 13, as shown in Fig 2.

Pump pressure in cases of fluid extravasation was reported in 26 of 40 cases (65%), with a mean of 69.42 mm Hg (range, 45 to 90 mm Hg) as compared with a reported mean of 55.62 mm Hg in all arthroscopies. The mean operative time in the fluid-extravasated patients was 120.2 minutes (range, 45 to 319 minutes). The volume of extravasated fluid was reported in 14 of the 40 cases (35%), with a mean of 1.4 L (range, 0.70 to 4.00 L). The volume of fluid extravasated was measured only in 35% of fluid extravasation cases, mainly those patients who had a Foley catheter or ultrasound, in addition to 1 patient treated with a laparotomy.

Within the 40 cases of abdominal fluid extravasation, 25 (63%) had an iliopsoas tenotomy, 11 (44%) of which occurred at the beginning of the arthroscopy compared with 1 (4%) performed in the middle portion of the case. There were 13 iliopsoas tenotomies (52%) performed at unreported times during the case. A capsulotomy was performed in 31 patients (78%), and 38 patients (95%) had a peripheral compartment arthroscopy.

TABLE 1. Percentage of Different Arthroscopic Procedures Performed by Participants

	No. of Providers	%
Capsulotomy		
Never	0	0
<25%	1	6.7
25%-50%	1	6.7
51%-75%	1	6.7
>75%	12	80
Iliopsoas release		
Never	1	6.7
<25%	14	93.3
25%-50%	0	0
51%-75%	0	0
>75%	0	0
Peripheral compartment arthroscopy		
Never	0	0
<25%	0	0
25%-50%	1	6.7
51%-75%	3	20.0
>75%	11	73.3
Labral repair		
Never	0	0
<25%	6	40.0
25%-50%	1	6.7
51%-75%	5	33.3
>75%	3	20.0
Osteoplasty of femoral head-neck junction		
Never	0	0
<25%	0	0
25%-50%	3	20.0
51%-75%	4	26.7
>75%	8	53.3
Acetabuloplasty		
Never	0	0
<25%	5	33.3
25%-50%	4	26.7
51%-75%	2	13.3
>75%	4	26.7
Arthroscopy on acute hip dislocation without fracture		
Never	6	40
<25%	9	60
25%-50%	0	0
51%-75%	0	0
>75%	0	0
Arthroscopy on acute acetabular fracture with or without dislocation		
Never	8	53.3
<25%	7	46.7
25%-50%	0	0
51%-75%	0	0
>75%	0	0

Of the patients, 3 (8%) presented with postoperative dyspnea, 2 (5%) had a drop in core body temperature postoperatively, and 1 (3%) presented with hemody-

namic instability. Abdominal fluid extravasation was detected in the recovery room postoperatively in 20 cases (50%) versus intraoperatively in the other 20 cases (50%). For 16 of the 20 cases (40%) with fluid extravasation intraoperatively, it was noted at the end of the procedure, whereas 4 cases (10%) were identified midway through the procedure. Intraoperative and/or postoperative symptoms were reported in 39 patients (98%).

The location of the extravasated fluid was reported for 39 patients (97.5%). Of the patients, 22 (57%) had intra-abdominal extravasation in which the exact location was uncertain, 14 (35%) had retroperitoneal extravasation, and 3 (8%) had intraperitoneal fluid accumulation. The location of the extravasated fluid was detected through a computed tomography (CT) scan and/or ultrasound in 24 patients (60%) and through abdominal palpitation in 16 (40%).

Treatment for IAFE varied among participants. Among the 39 patients (98%) who received treatment, 14 (36%) received intravenous furosemide and Foley catheter placement, 12 (30%) were treated with furosemide alone, and 12 (30%) were admitted and observed overnight. An emergent laparotomy was performed in 1 patient (3%). This patient had respiratory distress, a tense abdomen, and decreased venous return circulation from the lower extremities. Four liters of intraperitoneal fluid was released, and he had no sequelae. One patient (3%) did not receive any treatment other than observation. All 40 patients (100%) had complete resolution of symptoms and were discharged on postoperative day 1. There were no reported long-term sequelae from this complication.

In 13 cases (33%) the surveyed specialists could not identify risk factors associated with the extravasation. The remaining 27 cases (68%) were attributed to elevated pump pressure, early iliopsoas tenotomy, or a combination thereof.

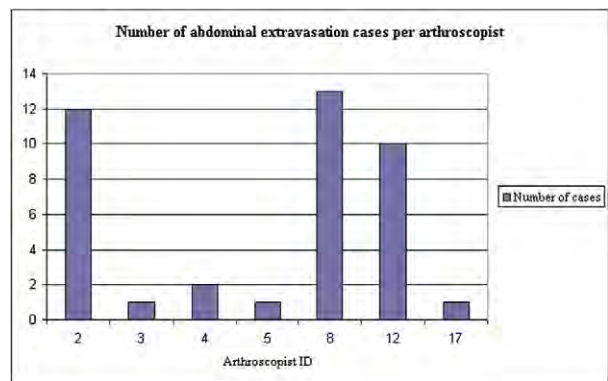


FIGURE 2. Number of cases per surveyed arthroscopist.

TABLE 2. Summary of Literature on IAFE for Reported Symptoms, Treatments Used, and Authors' Recommendation for Detection and/or Treatment

Study Title	Year	IAFE Presentation	Treatment	Study Recommendations/ Conclusions
Complications in hip arthroscopy ⁸	1996	Abdominal pain	Close observation	Careful fluid management, tight control of pump pressure, and application of general anesthesia
Cardiac arrest as a result of intra-abdominal extravasation of fluid during arthroscopic removal of a loose body from the hip joint of a patient with an acetabular fracture ¹⁰	1998	Intra-abdominal compartment syndrome and cardiopulmonary arrest	Exploratory laparotomy	Do not advocate hip arthroscopic procedures for acute or healing acetabular fractures
Complications of hip arthroscopy ³	2001	Not reported	Laparoscopy and CT-guided paracentesis	Careful attention to pump mechanics and pump pressure and strict attention to outflow
Intra- and retroperitoneal irrigation liquid after arthroscopy of the hip joint ¹¹	2008	Core body temperature drop with abdominal pain	Close observation	Close monitoring of body temperature
Abdominal compartment syndrome during hip arthroscopy ⁹	2009	Hypotension, patient becoming unresponsive, and intubation	Emergent mini-laparotomy	Close monitoring of fluid pump settings, frequent evaluation of abdomen, and tight hemodynamic control by anesthesia
Abdominal fluid extravasation during hip arthroscopy ¹	2010	Abdominal distension	Furosemide and bedside paracentesis	Maintenance of core body temperature, frequent abdominal examinations, pH and cardiac monitoring, use of diuretics, paracentesis, and a low threshold for a general surgical consultation, as well as exploratory laparotomy if abdominal compartment syndrome is suspected
Intrathoracic fluid extravasation after hip arthroscopy ¹²	2010	Shortness of breath	Close observation	Five warning signs of arthroscopic fluid extravasation: (1) inability to distend joint, (2) increased fluid requirement to maintain distension, (3) frequent cutoff of pump irrigation systems, (4) abdominal and thigh distension, and (5) acute hypothermia
Abdominal compartment syndrome after hip arthroscopy ⁷	2010	Abdominal distension and elevated bladder and peak inspiratory pressures	Emergent exploratory laparotomy	Emergent laparotomy and abdominal decompression with delayed closure in suspected cases

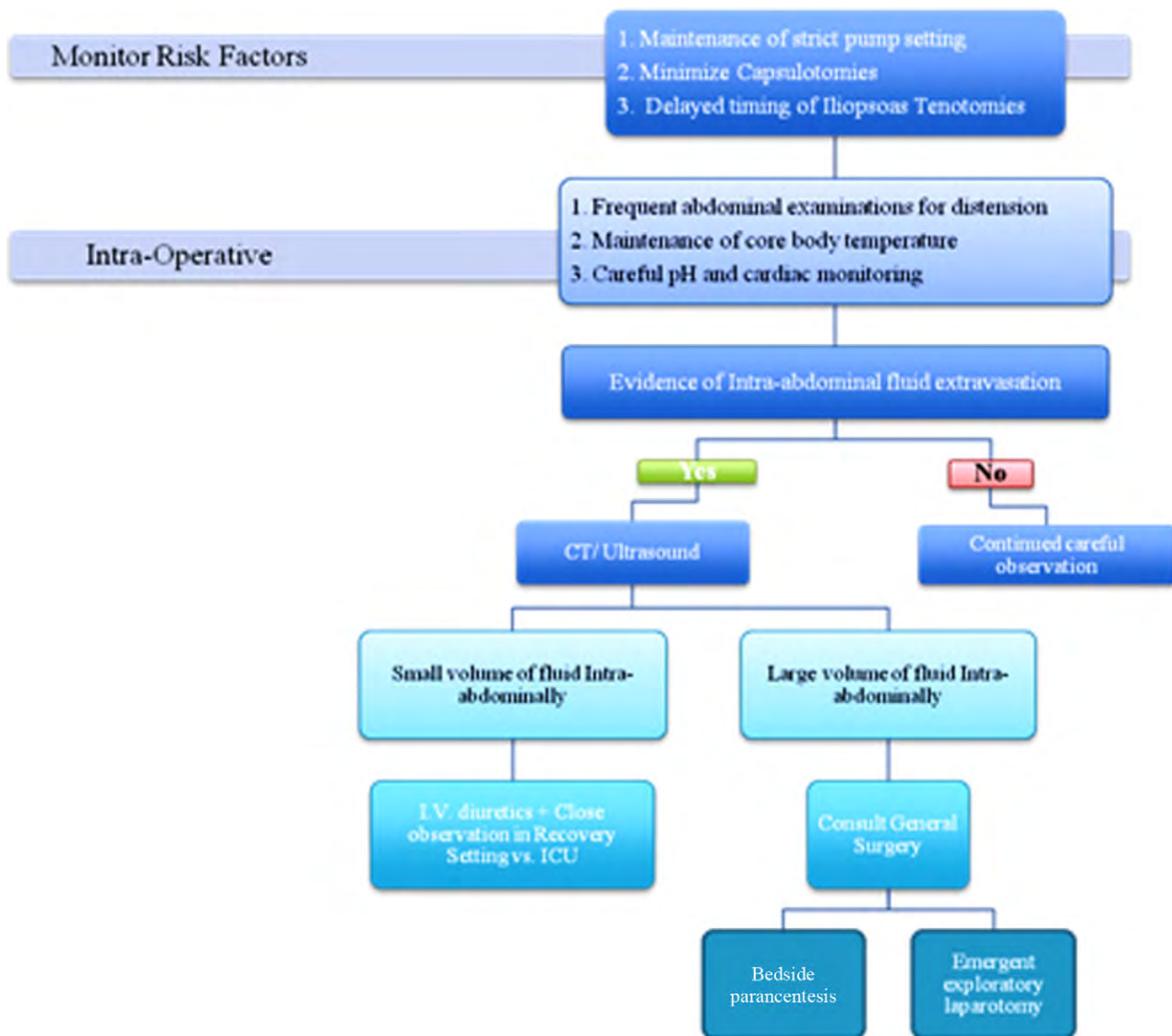


FIGURE 3. Our proposed treatment algorithm once intra-abdominal and/or retroperitoneal fluid extravasation has been established after hip arthroscopy. (ICU, intensive care unit; IV, intravenous.)

Different preventative measures were suggested by the MAHORN members. In 13 cases (33%) lowering the pump settings to prevent fluid extravasation was recommended. In 10 cases (25%) a combination of lowered pump settings and delaying iliopsoas tenotomy to the end of the case was suggested. The remaining complications were attributed to extended capsulotomies, prolonged operative times, and other unknown factors. The surveyed arthroscopists suggested different monitoring measures intraoperatively and postoperatively to account for possible IAFE. In 25 cases (63%) periodic monitoring of abdominal

distension intraoperatively was suggested. Other recommendations included strict control of pump settings, careful hemodynamic monitoring and body temperature monitoring by anesthesia, and finally, recording of bladder pressures to identify early fluid extravasation.

Risk Analysis

The mean pump pressure in reported cases of symptomatic IAFE (69.42 mm Hg; range, 45 to 90 mm Hg) was significantly higher than the general pump pressure setting reported by all 15 surveyed participants

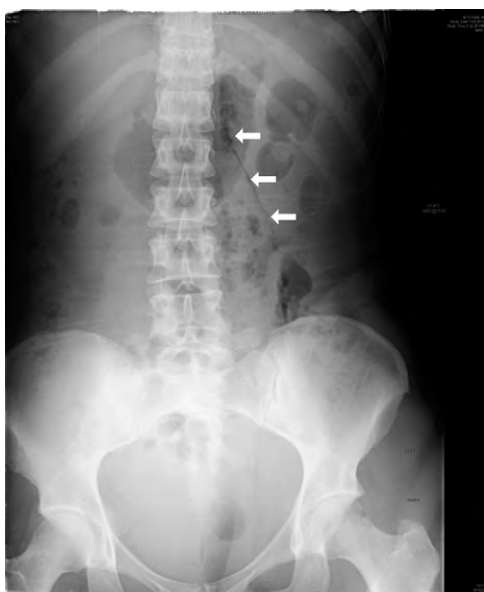


FIGURE 4. Fluid tracking (arrows) up iliopsoas sheath after left hip arthroscopy.

(55.62 mm Hg; range, 30 to 80 mm Hg) ($P = .004$, t test).

Although most surveyed participants (14 surgeons [93.3%]) performed an iliopsoas tenotomy on less than 25% of their patients, 25 of the 40 extravasation cases (63%) had an iliopsoas tenotomy performed. On the basis of the contingency table for the association of this variable (dichotomized as yes or no) with the incidence of symptomatic IAFE, there was a strong association between concomitant iliopsoas tenotomy and fluid extravasation ($\chi^2 = 6.54$, $P < .001$, Fisher exact test). Using contingency tables, we did not find any strong associations between symptomatic IAFE incidence and performing a capsulotomy ($P = .715$) or peripheral compartment arthroscopy ($P = .153$).

DISCUSSION

Hip arthroscopy is being performed more frequently for the treatment of a variety of pathologic hip conditions. Complications of hip arthroscopy are infrequent.²⁻⁶ IAFE is a serious and potentially life-threatening complication of hip arthroscopy. In the last 2 decades, several cases of IAFE have been reported, and these are summarized in Table 2.^{1,3,7-12}

In this survey of 15 expert hip arthroscopists, 40 cases of intra-abdominal and/or retroperitoneal fluid extravasation occurred among approximately 25,650 hip arthroscopies. The prevalence of symptomatic

IAFE was 0.16%. Risk factors associated with fluid extravasation included elevated pump pressures and concomitant iliopsoas tenotomy.

In this study the most common symptoms of IAFE were abdominal pain and distension. Others included hypothermia, hemodynamic instability, and shortness of breath. All patients were diagnosed either intraoperatively or in the recovery room. The diagnosis was made based on physical examination of the abdomen with supporting imaging studies, including ultrasound or CT scan. Treatment varied, including observation and intravenous furosemide, as well as an emergent laparotomy for a patient with hemodynamic instability.

Prevention of IAFE includes periodic intraoperative abdominal examination underneath the surgical drapes and careful monitoring of hemodynamic status and body temperature. Excessively high pump pressures should be avoided. Iliopsoas tenotomy should be performed toward the end of the procedure.

Treatment for IAFE (Fig 3) includes frequent abdominal examinations and hemodynamic monitoring. There should be a low threshold to obtain an ultrasound and/or CT scan to establish the volume of fluid within the abdominal and retroperitoneal cavities. Small volumes of fluid (<500 mL) can be managed with intravenous diuretics (e.g., furosemide) and careful observation. Larger volumes may require a general surgery consultation with consideration for either paracentesis in the patient in stable condition or lap-

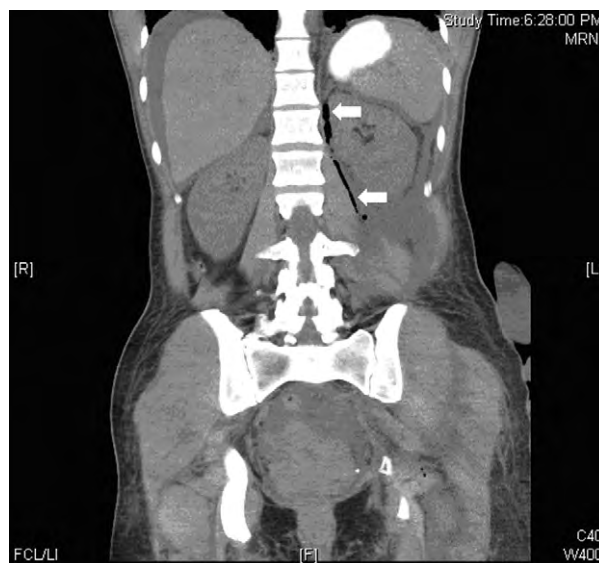


FIGURE 5. CT scan showing fluid tracking (arrows) along iliopsoas sheath after left hip arthroscopy.

arotomy and fluid evacuation in the patient with abdominal compartment syndrome. Having the patient lie on his or her left side may help reduce pressure on the inferior vena cava during evaluation and initial treatment.

The pathoanatomy behind this complication is a result of fluid tracking either along the iliopsoas sheath from an iliopsoas tenotomy (Figs 4 and 5) or directly intra-abdominally from an extended hip capsulotomy in the face of prolonged operative times and higher pump settings. A small- to moderate-sized accumulation will typically present with abdominal pain and distension, as well as hypothermia from the cool irrigation fluid. However, a larger collection can develop into abdominal compartment syndrome and hemodynamic instability. Excess pressure in the abdomen from the fluid collection can compress the inferior vena cava, causing decreased venous return to the heart and resultant paradoxical bradycardia and, ultimately, cardiopulmonary arrest.^{10,13,14} Renal and splanchnic circulation can also be compromised both from developing abdominal compartment syndrome and epinephrine within the irrigation fluid potentially resulting in end-organ failure.⁹

Strengths of this study include a large volume of hip arthroscopies reviewed, all of which were performed by experienced hip arthroscopists who routinely track patient and surgical outcomes. Limitations of this study include its retrospective nature and lack of uniform technique for evaluating and defining this particular complication. Although the medical records of patients with IAFE were reviewed for data collection pertaining to this study, the reported data for the first part of the questionnaire were based on surgeons' experiences overall, with potential recall bias. This study reported cases of symptomatic IAFE. Asymptomatic cases were potentially not detected, and hence the overall rate of this complication could be higher than reported. Finally, this study evaluated the prevalence of IAFE among a collection of very experienced hip arthroscopists. Therefore the data may not accurately apply to surgeons with less experience and lower volumes of hip arthroscopies. Future studies should include prospective collection of data or registries to better understand the incidence of this complication and associated risk factors.

CONCLUSIONS

Symptomatic IAFE after hip arthroscopy is a rare occurrence, with an approximate prevalence of 0.16%. Prevention of IAFE should include close intraoperative and postoperative monitoring of abdominal distention, core body temperature, and hemodynamic stability. Concomitant iliopsoas tenotomy and high pump pressures may be risk factors leading to symptomatic IAFE.

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**Complications of Intra-Abdominal Fluid Extravasation During Hip Arthroscopy:
A Survey of the MAHORN Group**

<i>For Office Use Only</i>
Participant ID: _____
Date questionnaire mailed: ____/____/____

INSTRUCTIONS: The following questions deal with complications of intra-abdominal fluid extravasation during hip arthroscopy. The goal of this questionnaire is to determine the frequency of intra-abdominal fluid extravasation and to identify risk factors leading to such a complication.
For each question, please check only one box. If the directions ask you to skip a question please do so.

1. How many hip arthroscopies have you performed (total) to date?

1a. Please specify during what time period you performed these arthroscopies (ex. 1996-present):

2. What percentage of your hip arthroscopies do you?

2a. USE A FLUID PUMP

₁ NEVER ₂ <25% ₃ [26-50%] ₄ [51-75%] ₅ >75%

2a1. Please list your typical fluid pump setting (in mm Hg):

2b. PERFORM A CAPSULOTOMY

₁ NEVER ₂ <25% ₃ [26-50%] ₄ [51-75%] ₅ >75%

2c. PERFORM AN ILIOPSOAS RELEASE

₁ NEVER ₂ <25% ₃ [26-50%] ₄ [51-75%] ₅ >75%

2d. PERFORM A PERIPHERAL COMPARTMENT ARTHROSCOPY

₁ NEVER ₂ <25% ₃ [26-50%] ₄ [51-75%] ₅ >75%

2e. PERFORM A LABRAL REPAIR

₁ NEVER ₂ <25% ₃ [26-50%] ₄ [51-75%] ₅ >75%

2e.1 When did you start performing **Labral Repairs** (MM/ YYYY)? _____

2e.2 How many **Labral Repairs** do you perform (On average) per year? _____

2f. PERFORM AN OSTEOPLASTY OF THE FEMORAL HEAD NECK JUNCTION (OFHNJ)

₁ NEVER ₂ <25% ₃ [26-50%] ₄ [51-75%] ₅ >75%

2f.1 When did you start performing **OFHNJ** surgery (MM/ YYYY)?

2f.2 How many **OFHNJ** surgeries do you perform (On average) annually?

2g. PERFORM AN ACETABULOPLASTY

₁ NEVER ₂ <25% ₃ [26-50%] ₄ [51-75%] ₅ >75%

2g.1 When did you start performing **Acetabuloplasties** (MM/ YYYY)?

2g.2 How many **Acetabuloplasties** do you perform (On average) per year?

2h. PERFORM AN ARTHROSCOPY ON AN ACUTE (< 3 WEEK) HIP DISLOCATION (WITHOUT FRACTURE)

₁ NEVER ₂ <25% ₃ [26-50%] ₄ [51-75%] ₅ >75%

2h.1 When did you start performing this surgery (MM/ YYYY)?

2h.2 How many **Arthroscopies on an acute hip dislocation** do you perform (On average) per year?

2i. PERFORM AN ARTHROSCOPY ON AN ACUTE (< 3 WEEK) HIP FRACTURE (W/ OR W/O DISLOCATION)

₁ NEVER ₂ <25% ₃ [26-50%] ₄ [51-75%] ₅ >75%

2i.1 When did you start performing this surgery (MM/ YYYY)? _____

2i.2 How many **Arthroscopies on an acute hip fracture** do you perform (On average) per year? _____

3. Have you had any cases of intra-abdominal fluid extravasation during or after hip arthroscopy?

₁ YES (Please Proceed to Annex I on the next page)

₀ NO

FIGURE 1. Survey sent to arthroscopists. (A) Set of questions regarding arthroscopists' general experience. (B) Survey pertaining exclusively to cases of IAFE.

Complications of Intra-Abdominal Fluid Extravasation During Hip Arthroscopy:
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ANNEX I

For each of your hip arthroscopy cases complicated by intra-abdominal fluid extravasation please complete ONE set of the following details specific to that particular case (Please duplicate per need)

Participant ID: _____
 Patient Number: **01**

1. WAS A FLUID PUMP USED

₁ YES, PLEASE SPECIFY THE HIGHEST PRESSURE SETTING USED DURING THE SURGERY: _____ ₀ NO

2. WAS AN ILIOPSOAS TENOTOMY PERFORMED

₁ YES, PLEASE SPECIFY AT WHAT POINT IN THE CASE IT WAS CARRIED OUT: _____ ₀ NO

3. WAS A CAPSULOTOMY PERFORMED?

₁ YES ₀ NO

4. WAS A PERIPHERAL COMPARTMENT ARTHROSCOPY PERFORMED?

₁ YES ₀ NO

5. WAS THERE A DROP IN THE PATIENT'S BODY TEMPERATURE?

₁ YES ₀ NO

6. WAS THERE ANY EVIDENCE OF HEMODYNAMIC INSTABILITY?

₁ YES ₀ NO

7. DID THE PATIENT EXPERIENCE ANY SHORTNESS OF BREATH POST-OPERATIVELY?

₁ YES ₀ NO

8. PLEASE DESCRIBE ANY OTHER PRESENTING SYMPTOMS EITHER INTRA- OR POST-OPERATIVELY

9. PLEASE SPECIFY THE LENGTH OF THE CASE (in minutes):

10. PLEASE SPECIFY WHEN (In minutes after start of case) AND HOW WAS THE IAFE DETECTED:

11. WAS A TREATMENT UNDERTAKEN ONCE THE EXTRAVASATION WAS DETECTED?

₁ YES ₀ NO

IF YES, PLEASE SPECIFY THE TYPE OF TREATMENT USED: _____

12. DO YOU HAVE ANY IMAGING OF THE EXTRAVASATION?

₁ YES (If yes, please provide a copy) ₀ NO

12a. PLEASE SPECIFY THE LOCATION OF THE EXTRAVASATION:

12b. PLEASE SPECIFY THE VOLUME (In liters) OF EXTRAVASATED FLUID:

12c. PLEASE LIST ANY OTHER FINDINGS YOU HAD:

13. PLEASE DESCRIBE THE FINAL OUTCOME OF THE COMPLICATION:

14. WHAT FACTORS DO YOU ASSOCIATE WITH THE EXTRAVASATION?

15. WHAT FACTORS DO YOU THINK MAY HAVE PREVENTED THIS COMPLICATION?

16. WHAT ADDITIONAL MEASURES CAN BE TAKEN TO MONITOR FOR THIS COMPLICATION EITHER INTRA-OPERATIVELY OR POST-OPERATIVELY?

17. WAS A HIP FRACTURE PRESENT?

₁ YES ₀ NO