# Midterm Outcomes of Iliopsoas Fractional Lengthening for Internal Snapping as a Part of Hip Arthroscopy for Femoroacetabular Impingement and Labral Tear: A Matched Control Study

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**Purpose:** To report minimum 5-year outcomes and rate of painful snapping resolution for patients who underwent iliopsoas fractional lengthening (IFL) as a part of hip arthroscopy for femoroacetabular impingement (FAI) and labral tear. In addition, to match this group to a group of patients who underwent hip arthroscopy for FAI and labral tear without internal snapping. **Methods:** Patients were eligible for inclusion if they underwent hip arthroscopy for treatment of FAI and labral tear with concomitant IFL for painful snapping and had preoperative baseline scores for modified Harris Hip Score, Nonarthritic Hip Score, Hip Outcome Score-Sports Subscale, and visual analog scale for pain. The exclusion criteria for this study were preoperative Tönnis grade >0, active workers' compensation claims, or previous ipsilateral hip conditions. These patients were matched to a control group of patients who did not have snapping or undergo IFL but who otherwise satisfied the same inclusion and exclusion criteria. **Results:** There were 57 eligible cases (80.3% follow-up). Mean follow-up time was 69.3 months (from 60.0 to 91.9). All patient-reported outcomes measures demonstrated statistically significant improvements between preoperative and latest follow-up scores for the following measures ($P < .001$): modified Harris Hip Score (from 64.3 to 84.9), Nonarthritic Hip Score (from 61.7 to 85.2), Hip Outcome Score-Sports Subscale (from 47.0 to 75.0), and visual analog scale (from 6.5 to 2.2). Mean satisfaction was 8.1 out of 10. Painful snapping was resolved in 80.7% of cases. Ten hips (17.5%) required secondary arthroscopy at a mean of 30.5 months. Three hips (5.3%) required total hip arthroplasty at a mean of 57.5 months. One case (1.8%) had minor postoperative complications. There were no statistically significant differences between the groups in outcomes, complications, and secondary surgeries. **Conclusions:** IFL as part of hip arthroscopy for treatment of FAI and labral tears demonstrated similar favorable improvement, complication rates, and secondary surgeries, when compared with a control group that did not undergo IFL. **Level of Evidence:** Level III, retrospective comparative study.

*See commentary on page 1441*

The iliacus and psoas major converge to form the iliopsoas tendon (IPT), which inserts onto the lesser trochanter. Internal snapping of the hip is presumed to be caused by the tendon sliding across the femoral head and snapping across the iliopectineal ridge.[1-4] These snapping mechanisms can be audible and can cause pain in the groin as the hip is brought from flexion and external rotation (ER) into extension.

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Untreated snapping iliopsoas can potentially lead to lesions and tearing of the hip labrum.[5,6] Conservative treatment methods include nonsteroidal anti-inflammatory drugs, rest, steroid injections, stretching, and physical therapy.[7-10]

If these measures do not resolve the symptoms, surgical treatment may be warranted. A symptomatic iliopsoas can be treated endoscopically or through an open approach. Varying levels of success have been reported after open release of the tendon,[3,10,11] with a frequent complication being transient or permanent sensory loss in the thigh. Endoscopic release has been described more recently as a minimally invasive solution with favorable short-term outcomes.[12-14] Although most patients have reported adequate alleviation of symptoms with both approaches, complete release has remained controversial due to the significant loss of hip flexion strength observed postoperatively. Endoscopic treatment of iliopsoas snapping as a part of hip arthroscopy for the treatment of other pathologies such as femoroacetabular impingement (FAI) and labral tear has been also reported.[15-19] Those studies showed safe and favorable outcomes as well as outcomes comparable to those patients who had other pathologies and no snapping.

In theory, partially cutting the iliopsoas elongates it and thus alleviates snapping. By cutting only the tendon at the level of the joint in the muscle-tendon junction, the muscle is left intact.[14] This modality aims to preserve the muscle's path, the patient's flexion strength, and the hip's stability. Recent studies have demonstrated favorable short-term outcomes of iliopsoas fractional lengthening (IFL) during hip arthroscopy for the treatment of FAI and labral tears.[6,14,15,20] However, in some cases, the IFL may not adequately lengthen the iliopsoas, which is one possible explanation of recurrent snapping. Although short-term outcomes have been well documented in the current literature, to our knowledge, there have been fewer longer term results reported regarding IFL outcomes. The purpose of our study was to report minimum 5-year outcomes and rate of painful snapping resolution for patients who underwent IFL as a part of hip arthroscopy for FAI and labral tear and in addition, to match this group to a group of patients who underwent hip arthroscopy for FAI and labral tear without internal snapping.

We hypothesized that IFL as a part of hip arthroscopy for the treatment of FAI and labral tear would be safe and would demonstrate favorable midterm outcomes, as well as a high rate of resolution of painful snapping.

## Methods

### Patient Selection

Data were prospectively collected and retrospectively reviewed for all patients who underwent hip arthroscopy at our institution between February 2008 and March 2013. A total of 733 hip arthroscopies were performed during this study period. Patients were eligible for inclusion if they underwent hip arthroscopy for treatment of FAI and labral tear and also had concomitant IFL to treat painful internal snapping of the hip. The exclusion criteria were preoperative Tönnis grade >0, active workers' compensation claims at the time of surgery, and previous ipsilateral hip surgery or conditions, such as dysplasia, Legg-Calve-Perthes disease, avascular necrosis, or slipped capital femoral epiphysis.

Patients were matched in a 1-to-1 ratio to a control group who both did not experience internal snapping and did not undergo IFL but who otherwise satisfied the same exclusion and inclusion criteria. These matches were made according to gender, age at surgery ±10 years, body mass index ±10 kg/m$^2$, acetabular Outerbridge grade (0, 1 vs 2, 3, 4), and capsular treatment (repair vs release).

All patients participated in the American Hip Institute Hip Preservation Registry. While the present study represents a unique analysis, data on some patients in this study may have been reported in other studies. All data collection received Institutional Review Board approval.

### Clinical Evaluation

All patients underwent a comprehensive physical examination preoperatively to identify pathologies, such as FAI, labral tears, and painful snapping of the iliopsoas. All patients were examined and assessed by the senior author (B.G.D.), a board-certified orthopaedic surgeon. Passive range of motion was measured by assessing each hip's flexion, internal rotation (IR), and ER. IR and ER were measured with the patient in the supine position while both the hip and knee were flexed at 90°. Hip impingement tests were performed to diagnose FAI. Anterior impingement was tested in forced flexion and IR, lateral impingement was tested in forced abduction and ER, and posterior impingement was tested in extension and ER.

Patients were also clinically assessed for the presence of painful internal snapping. This physical examination consisted of putting the flexed, abducted, and externally rotated hip into extension and IR.[7] For each patient, it was recorded whether this motion produced a palpable or patient-reported snapping sensation in the groin and, if so, whether or not this snapping was painful.

### Radiographic Evaluation

The anteroposterior pelvis, false profile, Dunn, and cross-table lateral views were taken preoperatively for all patients. The anteroposterior radiograph was used to measure the lateral center-edge angle of Wiberg[21] to quantify acetabular coverage. The false

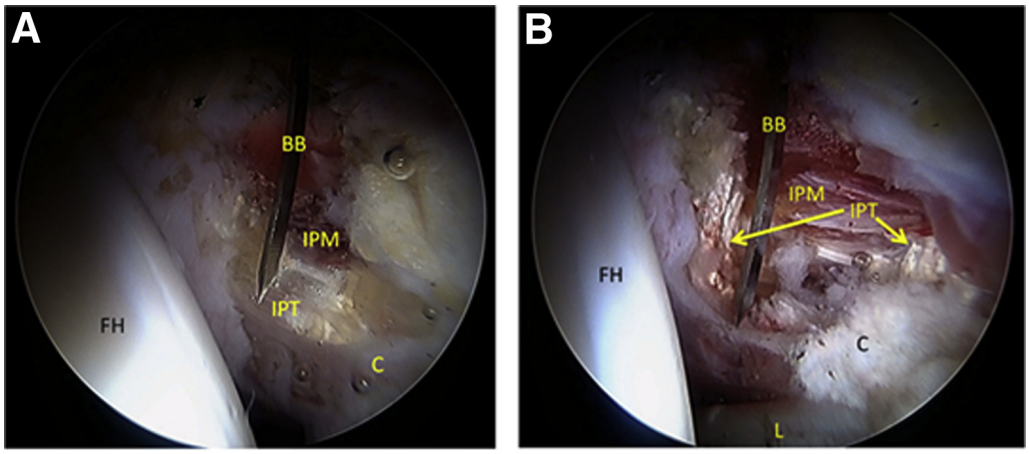


**Fig 1.** An arthroscopic view of the iliopsoas fractional lengthening is depicted in the left hip. (A) To have a clear view of the tendon before the fractional lengthening, the iliopsoas tendon (IPT) is exposed. (B) After cutting the IPT with a beaver blade (BB), it is split into proximal and distal parts. The iliopsoas muscle (IPM) is intact medial to the IPT split. C, capsule; FH, femoral head; L, labrum.

profile radiograph was used to measure the anterior center-edge angle of Lesquesne. The Dunn radiograph was used to measure the alpha angle, with cam lesions defined as an angle $\geq 60°$.[22] Radiographic pincer impingement was identified on standing radiographs by the presence of protrusio acetabuli,[23] coxa profunda,[24] ischial spine sign,[25] crossover sign,[26] lateral center-edge angle $>40°$,[21] or anterior center-edge angle $>40°$. Radiographic measurements were performed using GE Healthcare's Picture Archiving and Communication System (GE-PACS; Fairfield, CT).

## Surgical Technique

All hip arthroscopies were performed by the senior author (B.G.D.). Patients were placed in the modified supine position on a well-padded perineal post. Traction was applied to the operative leg and the nonoperative leg as needed. For each surgery, a minimum of 2 portals were created under fluoroscopic guidance: the midanterior and standard anterolateral accessory portals. After venting the hip, an interportal capsulotomy was performed using an arthroscopic beaver blade to access the joint.

A diagnostic arthroscopy was then performed to evaluate the labrum, intra-articular cartilage, and ligamentum teres. Labral tears were intraoperatively defined using the Seldes classification.[27] Cartilage damage was graded according to the ALAD and Outerbridge classifications.[28,29] Ligamentum teres tears were defined by the Villar and Domb classifications.[30]

Cam and pincer lesions were corrected using an arthroscopic burr under fluoroscopic guidance. Labral tears were repaired or selectively debrided. In cases with irreparable labra, labral reconstruction was performed using a semitendinosus allograft. Ligamentum teres tears were treated with debridement.

For patients experiencing painful internal, IFL was performed with the beaver blade. To have a clear view of the tendon before the fractional lengthening, the IPT was exposed (Fig 1A). The tendinous portion of the iliopsoas was cut using a beaver blade at the level of the joint in the muscle-tendon junction (Fig 1B). This approach partially released the iliopsoas, leaving the muscle intact and preserving its insertion onto the lesser trochanter.

After completion of intra-articular procedures, the capsule was preferentially repaired; however, the capsule was released in cases of stiffness or limited range of motion.

## Rehabilitation

For the first 2 weeks postoperatively, patients used crutches with partial weight-bearing (20 lbs [9 kg]) and a low-profile abduction brace (Donjoy X-Act ROM hip brace; DJO Global, Vista, CA) with extension and flexion limited to 0° and 90°, respectively. Physical therapy began as soon as 1 day postoperatively and continued for a minimum of 3 months to restore strength and range of motion.

## Clinical Outcomes Measures

Outcomes data were collected at clinical visits or through questionnaires delivered by e-mail or telephone. These measurements included modified Harris Hip Score (mHHS),[31] Nonarthritic Hip Score (NAHS),[28] Hip Outcome Score-Sports Subscale (HOS-SSS),[32] visual analog scale (VAS) for pain, patient satisfaction, secondary arthroscopy, and conversions to total hip arthroplasty (THA).[33] As hip arthroscopy is a hip preservation surgery, the patients who converted to THA were considered an end point. We also evaluated the safety of these procedures by reporting patients'

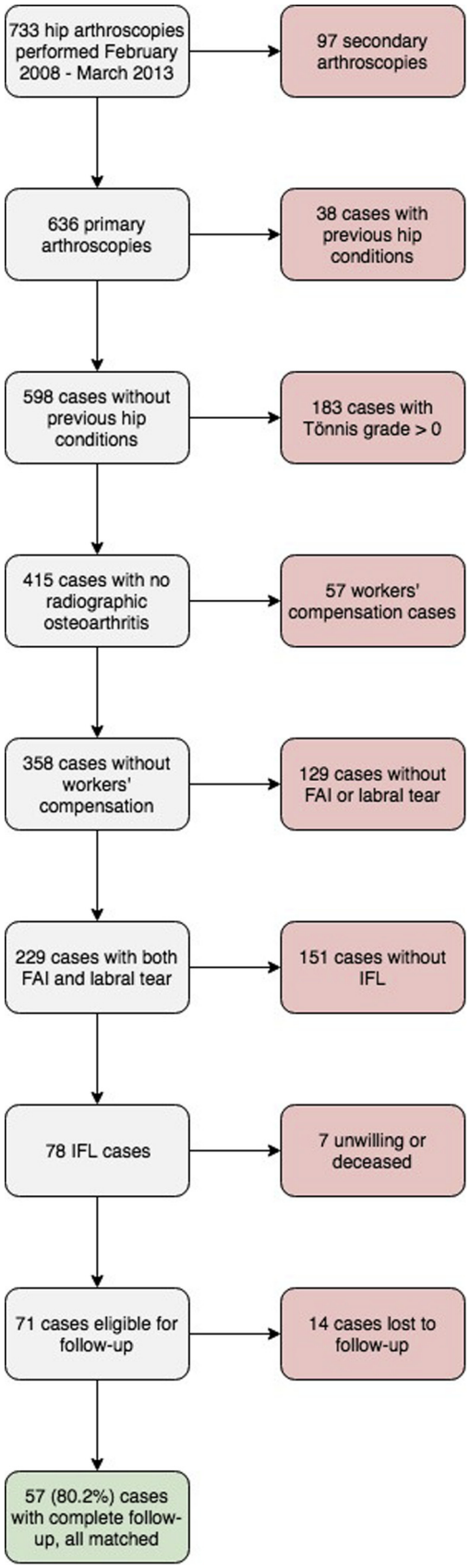


**Fig 2.** Flow chart illustrating the full patient selection process.

postoperative complications at each of these same time intervals. Follow-up was considered complete if all these data points were available at 5 or more years after surgery or if the patient converted to THA end point.

### Statistical Analysis

An a priori power analysis was performed to determine the sample size required to achieve 80% power. Assuming a mean difference of 8 points[34] in mean follow-up mHHS between groups to be clinically significant and using a 1:1 matching ratio, this analysis determined that 26 IFL patients and 26 control patients were needed to demonstrate differences between groups. Microsoft Excel (Microsoft Corporation; Redmond, WA) was used to perform all data analysis, with the threshold for statistical significance set to 0.05. Descriptive statistics were reported for all demographic data, frequency of surgical procedure performance, patient-reported outcome (PRO) scores, and patient satisfaction. Continuous variables were analyzed with the Shapiro-Wilk test for normal distribution and the *F*-test for equal variance, with values >0.05 indicating normality and equal variance, respectively. Normally distributed data with equal variance between arrays were compared using the 2-tailed Student's *t*-test. The Wilcoxon signed-rank test and the Mann-Whitney test were used to assess nonparametric data, depending on the size of the samples. The $\chi^2$ and Fisher's exact tests were performed to test for differences in the proportions of categorical data.

## Results

### Patient Demographics

A total of 71 hip arthroscopy cases met all criteria for inclusion. Of these, 57 patients (80.3%) had minimum 5-year follow-up. A flow chart illustrating the full patient selection process can be found in Figure 2. All 57 were matched to control patients who underwent arthroscopy for FAI and labral tear but did not have painful internal snapping and did not undergo IFL. Matches were made based on gender, age, acetabular cartilage damage, and capsular treatment, and all 57 patients were able to be matched. The demographics of both groups are summarized in Table 1. In the IFL group, the mean follow-up time was 69.3 (range, 60.0-91.9) months, most (87.7%) patients were female, and mean age at surgery was 26.5 years. There were no significant differences between the IFL and control groups in any of these measures. The control group had a significantly ($P = .032$) higher alpha angle compared with the IFL group.

### Intraoperative Findings

The primary findings documented intraoperatively are summarized in Table 2. None of these variables

**Table 1.** Demographics of Patients Undergoing Hip Arthroscopy for the Treatment of Femoroacetabular Impingement and Labral Tear With Concomitant Iliopsoas Fractional Lengthening (IFL) for Painful Internal Snapping of the Hip and a Matched Control Group

| | IFL | Control | *P* Value |
|---|---|---|---|
| Hips included in study, n (%): | | | |
| Left | 24 (42.1) | 24 (42.1) | >.999 |
| Right | 33 (57.9) | 33 (57.9) | |
| Gender, n (%): | | | |
| Male | 7 (12.3) | 7 (12.3) | >.999 |
| Female | 50 (87.7) | 50 (87.7) | |
| Age at surgery, yr, mean ± SD (range) | 26.5 ± 10.7 (14.9-52.1) | 28.0 ± 10.3 (14.9-51.6) | .301 |
| Body mass index, mean ± SD (range) | 23.0 ± 3.9 (17.7-36.6) | 23.1 ± 4.0 (17.6-37.9) | .923 |
| Follow-up time, mo mean ± SD (range) | 69.3 ± 7.8 (60.0-91.9) | 71.7 ± 9.1 (60.0-95.0) | .227 |
| Tönnis grade 0 (%) | 57 (100) | 57 (100) | >.999 |
| Lateral center-edge angle, degrees | 29.5 ± 5.8 | 29.4 ± 7.6 | .582 |
| Anterior center-edge angle, degrees | 34.1 ± 9.1 | 30.5 ± 10.1 | .138 |
| Alpha angle, degrees | 55.9 ± 10.7 | 60.4 ± 10.4 | .032 |

differed between the 2 groups. All of the IFL patients had Seldes-defined labral tears at time of surgery, 32 (56.1%) had ALAD grade ≥2 defects, and 10 (17.5%) had femoral head Outerbridge grade ≥2 defects.

### Intraoperative Procedures

The frequency of the procedures performed are summarized in Table 2. All patients underwent concomitant IFL during arthroscopic treatment of FAI and labral tears. Forty-three cases (75.4%) were treated with repair, 12 (21.2%) with selective debridement, and 2 (3.5%) with reconstruction. Forty-nine (86.0%) of the 57 patients underwent acetabular rim trimming for treatment of pincer morphology, and the capsule was repaired in 40 (70.2%) of the cases. The only significant difference between the IFL and control patients was the frequency of femoroplasty performance. Twenty-six (45.6%) patients in the IFL group underwent this procedure, compared with 39 (68.4%) control patients ($P = .023$).

### PRO Scores

Table 3 depicts all the PROs, VAS, and patient satisfaction scores for the IFL and control groups, measured preoperatively and at least 5 years postoperatively. All measures demonstrated statistically significant improvement from preoperative to latest follow-up ($P < .001$). In the IFL group, for the 54 hips that did not convert to THA, the mean improvement from preoperative to minimum 5-year follow-up was as follows: mHHS (from 64.3 to 85.0), NAHS (from 61.7 to 85.0), HOS-SS (from 47.0 to 74.7), and VAS (from 6.5 to 2.2). Most (80.7%) of the IFL patients had patient-reported resolution of painful internal snapping at latest follow-up. There were no significant differences between the IFL and control patients in satisfaction rating or any of the PROs collected. Preoperatively, the 57-patient IFL group did not differ significantly from the 14 patients who did not have minimum 5-year follow-up in any of the following measures: mHHS ($P = .285$), NAHS ($P = .757$), HOS-SS ($P = .177$), and VAS ($P = .526$).

### Secondary Procedures and Complications

Table 4 indicates the rate of reoperation in patients following their arthroscopic procedures. Ten patients in the IFL group underwent secondary arthroscopies at an average time of 30.5 months after their index surgeries. In only 2 patients (3.5%), secondary arthroscopy was performed for recurrent painful snapping, which was resolved in both cases after a second IFL. Among the 8 other secondary arthroscopies in the IFL group, 4 (7%) were for labral retear, 1 (1.7%) was for heterotopic ossification, 1 (1.7%) was for trochanteric bursitis, 1 (1.7%) was for joint stiffness, and 1 (1.7%) was for joint instability. Neither the rate of ($P > .999$) nor the duration to ($P = .069$) these revision procedures was significantly different from control patients.

Patients who underwent IFL also demonstrated a 5.3% frequency of converting to total hip replacement, with 3 patients undergoing replacement surgeries at an average of 57.5 months later. Again, neither the frequency of end point procedures ($P > .999$) nor the time elapsed from the index surgery ($P = .225$) were not statistically different between the IFL and control patients.

One patient (1.8%) in the IFL group and 5 control patients (8.8%) reported minor postoperative complications ($P = .206$). The IFL patient experienced numbness of the lateral femoral cutaneous nerve, which resolved without need for further treatment. In the control group, 3 patients had lateral femoral cutaneous nerve numbness (5.3%), 1 had stiffness (1.8%), and 1 had a pulmonary embolism (1.8%).

## Discussion

IFL was demonstrated to produce favorable outcomes and high resolution of painful internal snapping at

**Table 2.** Intraoperative Findings and Procedures Documented During Hip Arthroscopy

| | Iliopsoas Fractional Lengthening, n (%) | Control, n (%) | *P* Value |
|---|---|---|---|
| Seldes: | | | |
| I | 21 (36.8) | 32 (56.1) | .060 |
| II | 18 (31.6) | 14 (24.6) | .532 |
| I and II | 18 (31.6) | 11 (19.3) | .197 |
| ALAD: | | | |
| 0 | 7 (12.3) | 9 (15.8) | .788 |
| 1 | 18 (31.6) | 18 (31.6) | >.999 |
| 2 | 21 (36.8) | 19 (33.3) | .845 |
| 3 | 10 (17.5) | 8 (14.0) | .798 |
| 4 | 1 (1.8) | 3 (5.3) | .618 |
| Outerbridge (acetabular): | | | |
| 0 | 8 (14.0) | 6 (10.5) | .776 |
| 1 | 24 (42.1) | 26 (45.6) | .850 |
| 2 | 17 (29.8) | 14 (24.6) | .674 |
| 3 | 6 (10.5) | 6 (10.5) | >.999 |
| 4 | 2 (3.5) | 5 (8.8) | .438 |
| Outerbridge (femoral head): | | | |
| 0 | 46 (80.7) | 51 (89.5) | .293 |
| 1 | 1 (1.8) | 1 (1.8) | >.999 |
| 2 | 1 (1.8) | 2 (3.5) | >.999 |
| 3 | 7 (12.3) | 2 (3.5) | .162 |
| 4 | 2 (3.5) | 1 (1.8) | >.999 |
| LT percentile class (Domb): | | | |
| 0, 0% | 33 (57.9) | 27 (47.4) | .348 |
| 1, 0% to <50% | 11 (19.3) | 19 (33.3) | .126 |
| 2, 50% to <100% | 11 (19.3) | 11 (19.3) | >.999 |
| 3, 100% | 2 (3.5) | 0 (0.0) | .496 |
| LT Villar class: | | | |
| 0, no tear | 33 (57.9) | 27 (47.4) | .348 |
| 1, complete tear | 2 (3.5) | 0 (0.0) | .496 |
| 2, partial tear | 18 (31.6) | 29 (50.9) | .057 |
| 3, degenerative tear | 2 (3.5) | 1 (1.8) | >.999 |
| Labral treatment: | | | |
| Repair | 43 (75.4) | 40 (70.2) | .674 |
| Debridement | 12 (21.1) | 17 (29.8) | .390 |
| Reconstruction | 2 (3.5) | 0 (0.0) | .496 |
| Capsular treatment: | | | |
| Repair | 40 (70.2) | 40 (70.2) | >.999 |
| Release | 17 (29.8) | 17 (29.8) | >.999 |
| Acetabuloplasty | 49 (86.0) | 45 (78.9) | .461 |
| Femoroplasty | 26 (45.6) | 39 (68.4) | .023 |
| Acetabular microfracture | 3 (5.3) | 3 (5.3) | >.999 |
| Femoral head microfracture | 1 (1.8) | 0 (0.0) | >.999 |
| Ligamentum teres debridement | 2 (3.5) | 3 (5.3) | >.999 |

LT, ligamentum teres.

**Table 3.** Patient-Reported Outcome Scores, Visual Analog Score (VAS), and Satisfaction for Patients Who Did Not Convert to Total Hip Replacement

| | Iliopsoas Fractional Lengthening | Control | *P* Value |
|---|---|---|---|
| Modified Harris Hip Score, mean ± SD: | | | |
| Pre | 64.3 ± 13.6 | 61.6 ± 14.4 | .298 |
| Latest | 84.9 ± 15.8 | 85.9 ± 13.5 | .907 |
| Pre-post *P* value | <.001 | <.001 | |
| Delta | 20.2 ± 20.0 | 23.0 ± 18.1 | .445 |
| Nonarthritic Hip Score, mean ± SD: | | | |
| Pre | 61.7 ± 18.2 | 59.1 ± 18.1 | .436 |
| Latest | 85.2 ± 15.7 | 84.8 ± 13.7 | .576 |
| Pre-post *P* value | <.001 | <.001 | |
| Delta | 23.0 ± 23.0 | 24.3 ± 19.4 | .750 |
| Hip Outcome Score-Sports Subscale, mean ± SD: | | | |
| Pre | 47.0 ± 21.6 | 45.9 ± 22.9 | .784 |
| Latest | 75.0 ± 24.0 | 75.9 ± 20.8 | .859 |
| Pre-post *P* value | <.001 | <.001 | |
| Delta | 27.6 ± 30.5 | 29.2 ± 26.1 | .785 |
| VAS, mean ± SD | | | |
| Pre | 6.5 ± 2.1 | 5.8 ± 2.1 | .171 |
| Latest | 2.2 ± 2.0 | 2.3 ± 2.3 | .965 |
| Pre-post *P* value | <.001 | <.001 | |
| Delta | -4.2 ± 2.8 | -3.4 ± 2.8 | .299 |
| IHOT, mean ± SD | 73.8 ± 24.6 | 71.6 ± 22.2 | .425 |
| SF-12 Mental, mean ± SD | 57.1 ± 5.2 | 56.0 ± 7.3 | .791 |
| SF-12 Physical, mean ± SD | 48.2 ± 8.8 | 50.4 ± 9.2 | .070 |
| VR-12 Mental, mean ± SD | 61.5 ± 5.0 | 60.9 ± 6.4 | .935 |
| VR-12 Physical, mean ± SD | 50.5 ± 7.8 | 51.8 ± 8.2 | .198 |
| Patient Satisfaction, mean ± SD | 8.1 ± 1.7 | 8.2 ± 1.6 | .835 |

midterm follow-up. We observed significant improvements in all mean PROs and VAS at latest follow-up ($P < .0001$), as well as high patient satisfaction. Eleven hips (15.5%) required secondary arthroscopy, and 3 hips (4.2%) converted to THA. Importantly, 80.7% of patients experienced resolution of painful internal snapping at latest follow-up.

A number of studies have shown favorable outcomes in terms of PROs and snapping resolution rates. Contreras et al.[13] performed an arthroscopic release in 7 patients at the level of the joint with a 2-year follow-up period. All patients had resolution of snapping postoperatively, which persisted at 2-year follow-up, and improvement was seen in VAS scores and mHHS values. Two patients reported no improvement in pain level, despite resolution of their snapping.

Anderson and Keene[12] reported on 15 athletes (5 competitive and 10 recreational) who underwent endoscopic iliopsoas (IP) release at the level of the lesser trochanter. These individuals were analyzed at minimum 1-year follow-up. The mHHS values showed significant improvement at latest follow-up, all patients had resolution of internal snapping, and all returned to full participation in their sports. However, 6 patients still experienced pain.

Several studies reported the treatment of internal snapping as a part of hip arthroscopy for coexistent hip pathologies, Hwang et al.[15] reported 2-year follow-up outcomes of 25 patients who underwent arthroscopic IPT release with combined hip pathologies. Snapping sounds disappeared in 24 of the 25 patients, and they also showed improvement in Harris Hip Score values. All patients who had presented with loss of flexion strength postoperatively showed recovery of

**Table 4.** Secondary Surgeries

| | Iliopsoas Fractional Lengthening | Control | *P* Value |
|---|---|---|---|
| Secondary arthroscopies, n (%) | 10 (17.5) | 9 (15.8) | >.999 |
| Time to secondary arthroscopy, mo, mean ± SD (range) | 30.5 ± 22.0 (7.1-74.2) | 17.7 ± 17.2 (4.1-57.3) | .069 |
| Total hip replacement, n (%) | 3 (5.3) | 4 (7.0) | >.999 |
| Time to total hip replacement, mo, mean ± SD (range) | 57.5 ± 23.6 (30.4-72.6) | 32.5 ± 18.9 (17.3-53.7) | .225 |

this strength between 6 and 10 weeks after surgery. Mardones et al.[16] reported the outcomes of arthroscopic iliopsoas release in 15 patients with mean follow-up of 4 years. They found statistically significant improvement in patients' functional scores (mHHS and VAIL score). These favorable outcomes are consistent with our results, which demonstrated an 80.7% resolution rate of painful snapping. Our group reported a minimum 2-year outcome and return to sports in 60 competitive athletes who underwent IFL as a part of hip arthroscopy for FAI and compared it to a group of athletes who underwent hip arthroscopy for FAI with no snapping.[19] Some of these patients are also reported in this study. All PROs demonstrated significant improvements at latest follow-up ($P < .001$). Satisfaction was 7.9. Painful snapping was resolved in 91.7% of athletes. Sixty-five percent returned to their sport. No differences were detected in mean magnitudes of improvement or return to sports compared with the control group. In a recent multicenter comparative study that included our group, Maldonado et al.[18] reported a minimum 2-year follow-up of patients that underwent hip arthroscopy for FAI and labral tear with or without IFL. The IFL group consisted of 351 hips, and 392 hips were in the control group. The IFL group showed comparable results to the control group with respect to PRO improvement, minimal clinically important difference, the percentage of patients who achieved patient acceptable symptomatic state, and rates of revision or THA conversion. Those studies, as well as the current study, show safe and favorable outcomes of IFL and combined hip arthroscopy for other hip pathologies. However, to show that the IFL itself is beneficial we would need to compare 2 groups of patients who have internal snapping, one with IFL and the other without. The high rate of resolution of the painful internal snapping helps us point the benefit of the IFL.

Possible causes related to the persistence of painful snapping include the formation of scar tissue at the tenotomy site or in the capsule, tightness of the muscular portion of the IP, and the presence of multiple tendon slips not detected either intraoperatively or on magnetic resonance angiogram. In a cadaveric study by Philippon et al.[35] involving 53 specimens, it was found that the tendon is double banded in 64.4% and triple banded in 7.5% of hips. Ilizaliturri et al.[36] reported on a series of 28 patients with internal snapping hip syndrome treated with endoscopic transcapsular release of the IPT at the central compartment. During these procedures, the surgeon intentionally looked for multiple tendons, which were found in 5 patients (17.9%). None of these 28 patients presented with snapping recurrence. Clinical results in patients with single- and multiple-tendon snapping did show significant differences.

In a prior study by our group, El Bitar et al.[17] reported on a group of 55 patients with minimum 2-year follow-up, who underwent IFL as a part of hip arthroscopy for coexistent pathologies. This study demonstrated statistically significant improvement in all PROs ($P < .001$), 81.8% good/excellent satisfaction ($\geq 7$), and 81.8% resolution of painful snapping. Some of the patients from this study appear in the current study. However, the current study has 2 unique advantages. First, it is a comparative study that uses a control group. Second, it has a longer follow-up time of minimum 5 years compared to minimum 2 years. In terms of snapping resolution, our results were similar to those of short-term studies in the literature. In addition, the similar outcomes at different follow-up times in our studies with overlapping patients may indicate high durability of the results.

Concerns have been raised regarding patients developing hip flexion weakness after release of the iliopsoas. Brandenburg et al.[20] compared 2 groups of 18 patients who did and did not undergo iliopsoas release for symptomatic internal snapping hip. Both groups also underwent surgery for FAI and chondrolabral damage with and without IFL. The groups were evaluated at a mean of 21 months postoperatively. Comparing muscle size on magnetic resonance imaging and flexion strength (to contralateral limbs and between groups) showed that the iliopsoas release resulted in iliopsoas atrophy with a 25% volume loss and a 19% reduction in seated hip flexion strength. However, it is worth noting that a relatively small number of their patients were available for follow-up (25.3% in the release group). This low rate is a potential cause of selection bias, as patients with persistent weakness or pain may be more likely to follow up and to submit to repeat magnetic resonance imaging examinations.

Flanum et al.[37] reported on 6 patients who underwent endoscopic IP release at the level of the lesser trochanter. After surgery, all patients experienced hip flexor weakness, used crutches for 5 weeks, and

reported an average Harris Hip Score of 62 points 6 weeks after surgery. The patients subsequently continued to improve, with their scores averaging 90 and 96 points at 6 and 12 months postoperatively. Additionally, none of these patients experienced recurrence of their snapping or pain. In our study, flexion strength was not specifically examined, though none of our patients complained of weakness during their follow-up clinic visits. In summary, existing data are insufficient to conclude whether hip flexion weakness is a clinical downside of IFL, which warrants further clinical research.

Open approaches for surgical release of the IP have been described with varying degrees of success.[3,10,11,38] These surgical approaches to treat snapping hip have generally been associated with complications, including persistent pain, paresthesia, sensory deficit, weakness with hip flexion, hematoma requiring reexploration, and superficial infection.[2,11,38] A systematic review by Khan et al.[39] of 11 studies involving 248 patients showed a decreased failure rate, fewer complications, and lower postoperative pain with arthroscopic management of internal snapping hip syndrome compared with these open approaches.

Potential advantages of arthroscopic over open surgery include fewer wound complications, shorter hospital stays, and quicker return to function. In addition—and perhaps more importantly—arthroscopy offers the ability to treat concomitant intra-articular pathologies during the procedure, potentially leading to superior outcomes. Variation also exists in the location of the iliopsoas release. Described options include release in the central compartment, in the peripheral compartment, and at the level of the lesser trochanter. Ilizaliturri et al.[40] conducted a randomized controlled trial comparing a group of patients undergoing endoscopic IPT release at the lesser trochanter with a group undergoing endoscopic transcapsular psoas release from the peripheral compartment. Western Ontario MacMaster scores significantly improved for all 19 patients, and no differences were found between the 2 study groups.

In a different study, Ilizaliturri et al.[41] compared 2 groups of patients that underwent iliopsoas release, one treated with endoscopic IPT release at the lesser trochanter and the other treated with release from the central compartment. All patients from both groups showed improvement in their Western Ontario MacMaster scores, and again, no differences were found between the groups. The fractional lengthening technique performed at our institution consisted of cutting only the tendinous tissue at the level of the joint in the muscle-tendon junction. The muscular portion was left intact, with the intention of preserving the muscle's path, flexion strength, and hip stability.[14]

Our study has several strengths. It has a large sample size and a long follow-up time compared with other studies on IFL. Additionally, the inclusion of a matched control group minimized the effect of potential confounders and strengthened the conclusions of our results. Finally, we used 3 different validated measures to assess pre- and postoperative patient outcomes, and because these data were collected prospectively, recall and selection biases were limited.

### Limitations

Our study has several limitations. First, the study group was heterogeneous in that several other intra-articular pathologies besides snapping were treated. However, in all cases, the primary diagnosis was FAI and labral tear. Comparison with a matched control group also helped to minimize the effect of these other variables. Second, we did not have quantitative strength testing to evaluate hip flexion. As discussed previously, this flexion strength has been a point of concern in the field of hip preservation that warrants further research.

## Conclusions

IFL as part of hip arthroscopy for treatment of FAI and labral tears demonstrated similar favorable improvement, complication rates, and secondary surgeries when compared with a control group that did not undergo IFL.

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