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Research article

Role of arthroscopy for the diagnosis and management of post-traumatic hip pain: a prospective study

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ABSTRACT

The current published literature regarding the role of hip arthroscopy in the diagnosis and management of post-traumatic hip pain is still limited. Therefore, we conducted the present prospective study to determine the value of hip arthroscopy in the diagnosis and management of various causes of hip pain after traumatic conditions. The present study included a prospective cohort of 17 patients with symptomatic post-traumatic hip pain. It was conducted between July 2013 and May 2018. The mean age was 22 (19–29) years and the mean follow-up was 24 (*r*: 7–36) months. Prior to surgery, every eligible patient underwent assessment of functional status using the Modified Harris Hip Score, Oxford hip score (OHS) and Western Ontario and McMaster Universities Arthritis Index (WOMAC) score. All patients underwent arthroscopic management for their diagnosed pathologies. The most commonly encountered diagnosis was labral tear (58.8%), followed by ligamentum teres tear (35.3%) and loose intra-articular fragments (29.4%). In addition, 52.9% of the patients had associated CAM lesion and 11.8% had associated Pincer lesion. The mHSS, OHS and WOMAC score showed significant improvement in the post-operative period ($P < 0.001$), all the 17 patients had 100% Patient Acceptable Symptomatic State; only one patient did not achieve minimal clinical importance difference. One case underwent labral debridement for failed labral repair (5.8%), another patient developed maralgia paraesthetica (5.8%). In conclusion, hip arthroscopy is a useful and effective minimally invasive procedure for the diagnosis and management of selected patients with post-traumatic hip pain. Moreover, hip arthroscopy was safe technique with no reported serious adverse events.

INTRODUCTION

Hip pain is uncommon in adolescent and young adults with a reported annual incidence rate of 0.44% [1]. However, the onset of hip pain in young adults usually reflects clinically significant pathological disorders which can dramatically affect work and other daily activities of those patients, with subsequent impairment in their quality of life [2]. The onset of hip pain in young adults has a wide range of differential diagnosis that includes extra-articular (such as sciatica, core muscle injury or athletic pubalgia) and intra-articuprogramlar conditions. Post-traumatic hip injuries are known causes of hip pain and can include labral tears, loose bodies, chondral injuries, ligamentum teres tears and capsular tears; such injuries can be sometimes associated with non-arthritic disorders as femoroacetabular impingement (FAI) syndrome [3]. Also, several authors have suggested a correlation between untreated loose fragments and the development of arthritis in a joint [4].

However, the diagnosis of post-traumatic hip pain can be challenging in young adults, especially when they present with non-specific symptoms and ill-defined physical findings. Moreover, it was reported that initial imaging studies can miss hip injuries in 2–10% of the patients [5]. On the other hand, the utility of conservative management can be ineffective in the management of post-traumatic hip pain and open surgical procedures might be associated with higher risk of intra or post-operative complications [6]. Therefore, hip arthroscopy has emerged as an alternative modality for the diagnosis and management of post-traumatic hip pain.

Previous reports showed that hip arthroscopy can effectively diagnose and manage various intra-articular pathologies such as loose bodies after hip fracture [7], ligamentum teres injury [8] and labral injuries [9]. Moreover, hip arthroscopy exhibited long-term improvement in clinical outcomes and satisfaction among patients with different types of hip pathologies [10] Nevertheless, the current published literature regarding the role of hip arthroscopy in the diagnosis and management of post-traumatic hip pain is still limited by the small number of published retrospective studies included small number of patients. The purpose of this study was to assess the efficacy and safety of the use of hip arthroscopy in the diagnosis and management of post-traumatic hip pain.

MATERIALS AND METHODS

The study protocol was approved by the local ethics and research committee. An informed consent was obtained from every eligible patient prior to study enrolment.

Study design and patients

This was a prospective study which was conducted at the orthopaedic department of our university hospital between July 2013 and May 2018. Adult patients with symptomatic post-traumatic hip pain due to a pathological condition (e.g. Traumatic labral tears, post-traumatic loose bodies, etc.) were included in the present study. The pre-operative diagnoses which indicated surgeries were summarized in Table I. All patients had to have history of sudden onset hip pain after single traumatic event with absence of pre-trauma hip symptoms. Patients with pathological fracture, infection, advanced osteoarthritis or ankylosed joint were excluded from the study. The mechanism of trauma included was either motor vehicle accidents or sport-related (football or handball) injuries in all patients.

Pre-operative assessment

Prior to surgery, every eligible patient underwent careful history taking and assessment of functional status using Modified Harris Hip Score (mHHS) [10], Oxford hip score (OHS) [11] and Western Ontario and McMaster Universities Arthritis Index (WOMAC) score [12]. In addition, relevant clinical examination was performed and plain radiographs of the hip (anteroposterior and lateral) were obtained for all patients. All patients had pre-operative cross-sectional imaging of the hip (computed tomography [CT] scan and/or MR arthrogram). Routine pre-operative investigations were conducted in all patients.

Table I. Pre-operative diagnoses

Diagnosis	*Patients* (N = *17*)
Loose intra-articular fragments	4 (23.5)
Pipkin fracture	1 (5.8)
Traumatic labral tear	10 (58.8)
Haemarthrosis and ligamentum teres tear	2 (11.8)
Associated CAM lesion	9 (52.9)
Associated Pincer lesion	2 (11.8)

The present study included 17 patients with a mean (interquartile range [IQR]) age of 22 (19–29) years old. The majority of patients were males (52.9%), and 47.1% of the affected hips were on the left side. The mean duration from injury to surgery was 6 months (*r*: 1 week to 10.5 months) and the mean duration of follow-up was 24 (7–36) months. The baseline and clinical characteristics of the included patients are listed in Table II. All patients were examined and evaluated by the authors and operated by two surgeons (A.H.A. and A.E.B.) experienced in hip arthroscopy surgery.

Surgical technique

General anaesthesia was used in all patients and prophylactic antibiotics were administered intravenously at the time of induction of anaesthesia. The patient was positioned supine on the fracture table, lower extremity holders were applied to a standard operating table, and large well-padded perineal post was used and positioned laterally against the medial thigh of the operative leg. Then a slight countertraction was applied to the non-operative limb and 10–20 kg traction was applied to the operative limb. The contralateral hip was kept in abduction of about 20°, neutral rotation and 0° of extension. Once traction was placed on the operative leg, central arthroscopy was performed first.

The anterolateral portal was established first under fluoroscopic guidance with a 6-inch, 17-gauge, spinal needle to distend the joint with approximately 40 ml fluid. A stab wound is made through the skin at the needle, the

Table II. Characteristics of the included patients

Variables	*Patients (N = 17)*
Age (years), median (IQR)	22 (19–29)
Males, *N* (%)	9 (52.9)
Side, *N* (%)	
Left	8 (47.1)
Right	9 (52.9)
Duration from injury to surgery (months), median (IQR)	6 (0.25–10.5)
Follow-up period (months), median (IQR)	24 (7–36)

guidewire was placed through the needle and the needle was removed. Then, the cannulated obturator with the 5.0-mm arthroscopy cannula was passed over the wire into the joint; while the mid-anterior portal was established under arthroscopic guidance and placed distal and lateral to the anterior portal which is located at the intersecting point of the vertical line (drawn from the ASIS) and the horizontal line (drawn from the greater trochanter). Then traction was released and the peripheral compartment was accessed, the leg was allowed to remain dynamically flexible to allow for various amounts of rotation and abduction to optimize visualization of various points of the peripheral compartment. With this technique, the hip and knee can be flexed up to 90° abducted to about 30° and rotated 20° internally and externally.

Arthroscopic procedures

In case of labral tear, the torn part was cut using a banana knife if the tear is degenerated and unrepairable. A monopolar flexible probe was used for focal delineation in debridement, then shaver was used to complete the debridement. If the labral tear could be repaired, a 2.9-mm PushLock (Arthrex) knotless bio-absorbable suture anchor was used to repair the labrum if it is detached from the bone (Fig. 1). If it is an intra-substance labral tear, a bio-absorbable suture was inserted around the split using suture lasso, then the suture was tied to reapproximate the edges of the tear. Cases with post-traumatic intra-articular loose fragments, we had to access the peripheral compartment as long as the central compartment as loose fragments is sometimes being located in the peripheral compartment (Fig. 2). In case of partial-thickness chondral defects, chondroplasty was done to debride the damaged cartilage to create a smooth surface. For full-thickness defects, microfracture was done, ligamentum teres tears underwent debridement using the motorized shaver and the radio frequency probe (Fig. 3). In addition, Pipkin fracture assisted arthroscopic fixation was done for a 28-year-old female patient with femoral head fracture who sustained right hip dislocation following motor vehicle accident. This patient underwent immediate reduction in the emergency department, there was 1-week duration between the date of injury and the date of surgery, the fracture was fixed with 4 mm partially threaded cannulated screw (Fig. 4). If osteochondroplasty was required for impingement, partial synovectomy was performed to allow for the adequate visualization of the anterior, lateral and posterior femoral head and the extra-articular acetabular rim. The hip then was flexed, adducted and rotated to demonstrate the impingement arthroscopically. With the use of a motorized burr, the femoral head–neck offset was restored after removal of the excessive bone. The surgery was tailored to the patients' pathology.

Post-operatively, a neurovascular examination was done to ensure that no neurovascular compromise had occurred. Patients who underwent labral debridement, labral repair, ligamentum teres debridement, intra-articular fragments removal, Cam or Pincer excision were discharged on the same or the following day while the patient with femoral head fracture (Pipkin I) fixation was discharged on the third post-operative day. A standard rehabilitation programme was started as early as the first day in the form of early partial weight-bearing and range of motion (ROM) exercises, emphasis was placed on hip rotation and flexion to prevent formation of adhesions between the labrum and the joint capsule. Strengthening exercises were initiated by the sixth week post-operative for lumbar-pelvic region (core stability) and extensor and abductor strengthening. Precautions and limitations regarding ROM and weight-bearing during post-operative rehabilitation were determined by which arthroscopic procedures were performed.

Study outcomes

The primary outcome of this study was to assess the patients' clinical improvement after the use of the hip arthroscopy by comparing the post-operative mHHS and other patients reported outcome measures (PROMs; OHS and WOMAC) to their pre-operative ones as well as calculating the minimal clinical importance difference (MCID) and patient acceptable symptomatic state (PASS). The secondary outcome was to determine the safety of the use of hip arthroscopy in this cohort by assessing the rate of associated intra and post-operative complications.

Statistical analysis

Data entry, processing and statistical analysis were carried out using IBM SPSS (Statistical Package for the

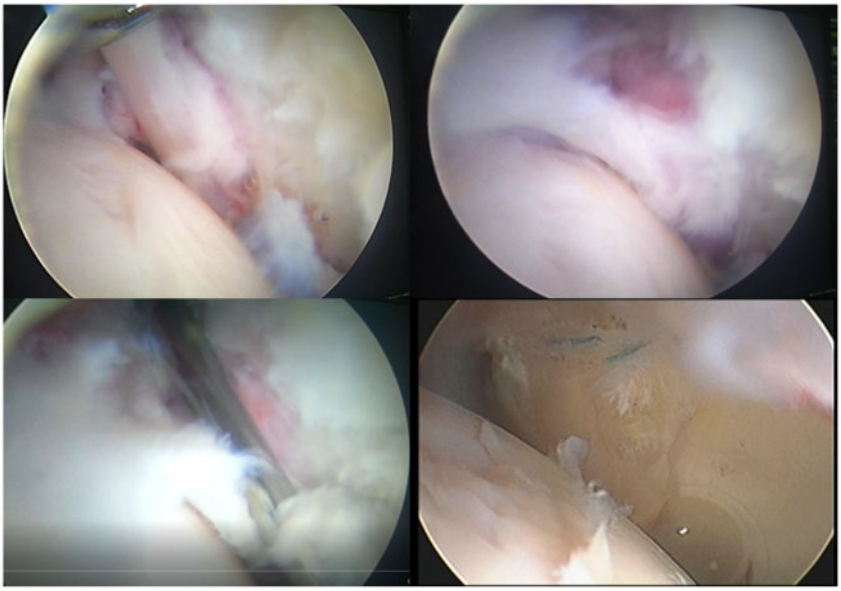

Fig. 1. Arthroscopic photos of post-traumatic bucket handle labral tear and repair with suture anchor.

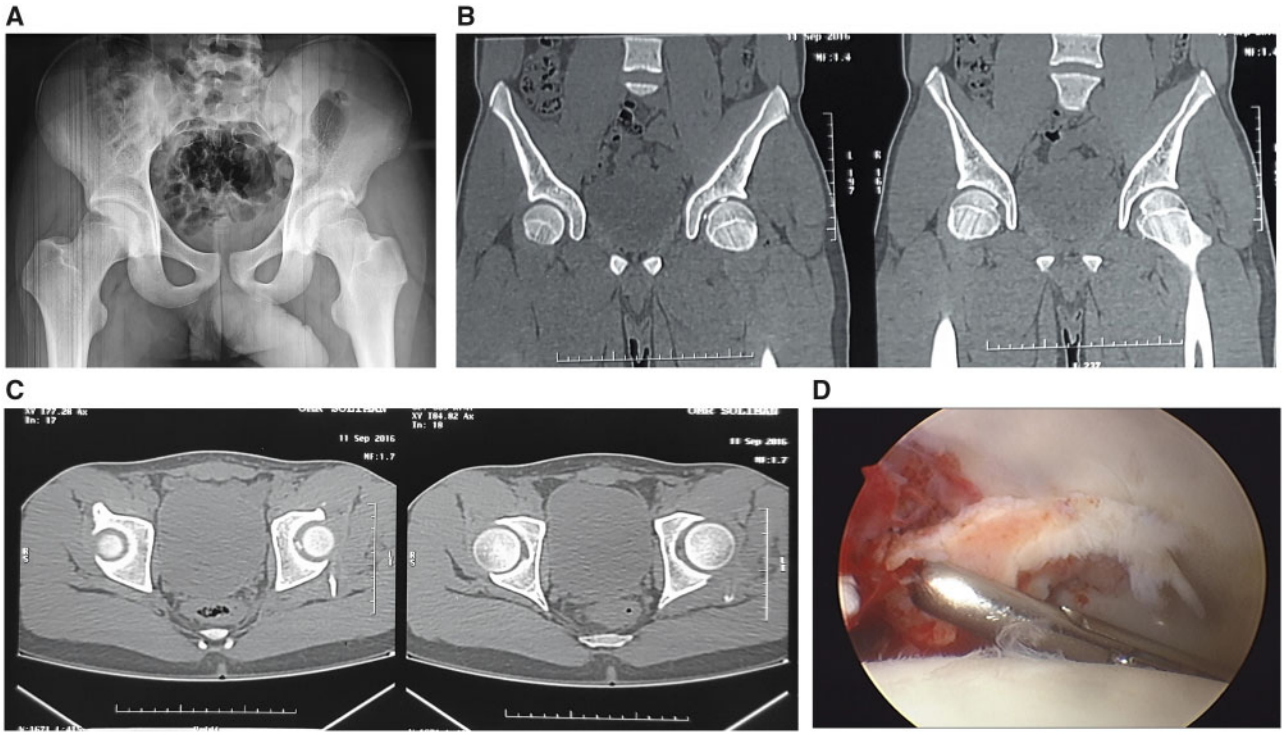

Fig. 2. (**A**) X-ray of posterior wall intra-articular fragment of left hip joint. (**B** and **C**) CT scan of posterior wall intra-articular fragment of left hip joint. (**D**) Intra-operative arthroscopic photo of posterior wall intra-articular fragment of left hip joint removed arthroscopically.

Social Science; IBM Corp, Armonk, NY, USA) release 22 for Microsoft Windows. Frequency tables with percentages were used for categorical variables and descriptive statistics (median and IQR) were used for numerical variables. Non-parametric Wilcoxon rank test was used to assess the changes in post-operative scores.

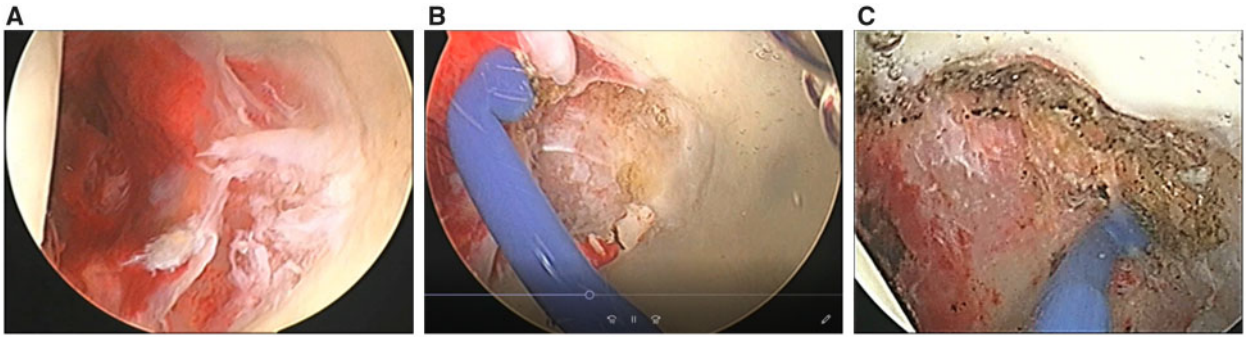

Fig. 3. (**A**) Arthroscopic photo showing avulsion injury of the ligamentum teres. (**B** and **C**) Photos showing arthroscopic debridement of the ligamentum teres avulsion injury.

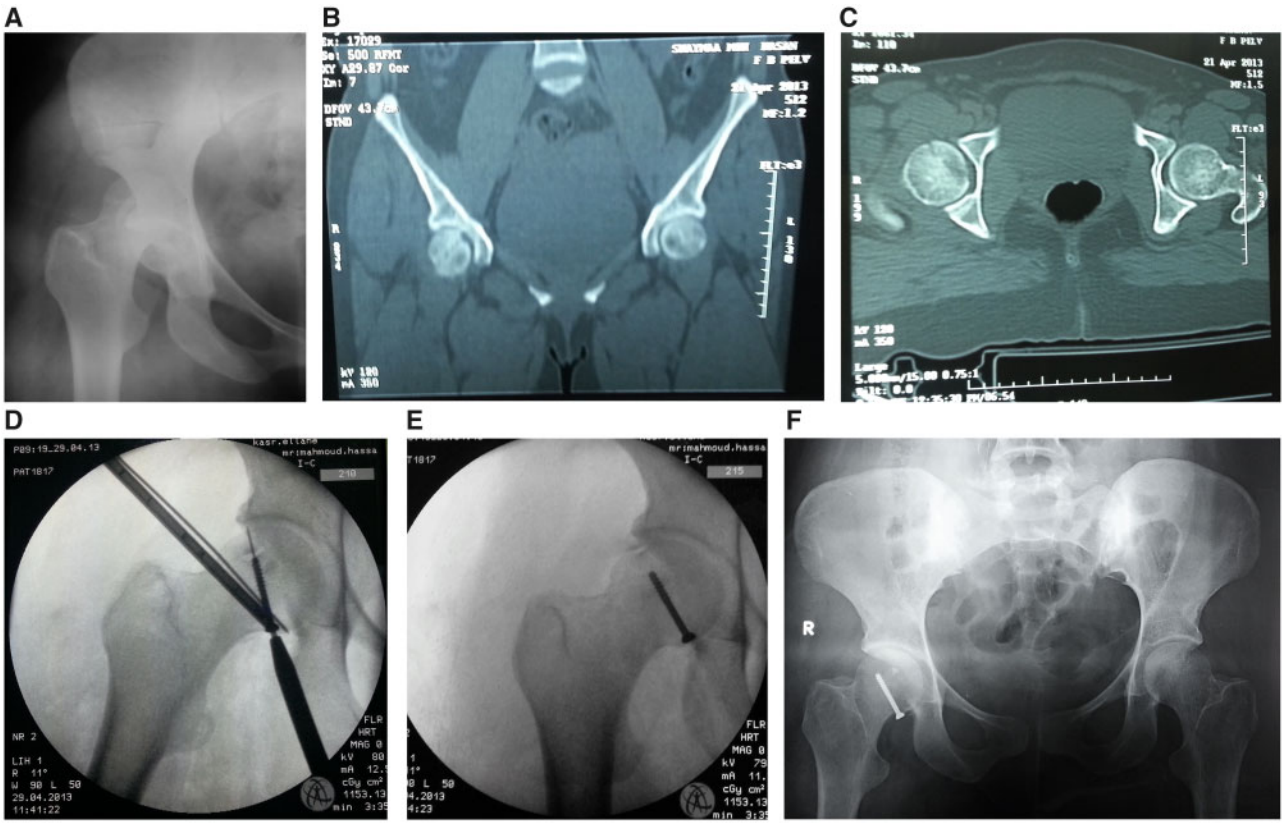

Fig. 4. (**A**) X-ray of femoral head fracture of dislocated right hip joint. (**B** and **C**) CT scan of the femoral head fracture (Pipkin Type 1) of the right hip joint. (**D** and **E**) Intra-operative image of the femoral head fracture of the right hip joint fixed arthroscopic assisted using cannulated screw. (**F**) One year of follow-up X-ray of the femoral head fracture of the right hip joint fixed arthroscopic assisted using cannulated screw.

A *P* values of <0.05 was considered statistically significant.

RESULTS

The most commonly encountered diagnosis was traumatic labral tear (58.8%), followed by ligamentum teres tear (35.3%) and loose intra-articular fragments (23.5%). One patient with Pipkin I fracture who underwent arthroscopic assisted fixation. She was followed up for a period of 2 years with radiographic evidence of healing of the fracture at the end of follow-up plain radiographs, no evidence of avascular necrosis and good functional score. In addition, 52.9% of the patients had associated CAM lesion and 11.8% had associated Pincer lesion. Regarding the

Table III. Arthroscopic diagnoses and management of hip conditions

Variables	*Patients (N = 17)*
Diagnosis	
Loose intra-articular fragments	4 (23.5)
Pipkin fracture	1 (5.8)
Traumatic labral tear	10 (58.8)
Ligamentum teres tear	6 (35.3)
Associated CAM lesion	9 (52.9)
Associated Pincer lesion	2 (11.8)
Management	
Removal of loose fragments	4 (23.5)
Arthroscopic assisted fixation of Pipkin fracture	1 (5.8)
Labral repair	5 (29.4)
Labral debridement	5 (29.4)
Ligamentum teres debridement	6 (35.3)
CAM excision	9 (52.9)
Pincer excision	2 (11.8)

arthroscopic management of labral tears, half of the patients with labral tear underwent labral repair and the rest of them underwent labral debridement (Table III).

Patients reported outcome measures

The mean mHSS, OHS and WOMAC score showed significant improvement in the post-operative period ($P < 0.001$) (Table IV). We assessed PASS (post-operative mHHS is 75/100 points or more) [13] MCID (eight points improvement of the post-operative mHHS compared to pre-operative mHHS) [13, 14] for all our patients. All patients achieved PASS score and only one patient did not achieve MCID.

Post-operative plain radiographs

The plain X-rays did not show any signs of progression degenerative changes in any of the patients. Full fracture union was noticed in one patient with Pipkin fracture with no signs of avascular necrosis. There was no residual loose bone fragment denoting complete surgical retrieval.

Table IV. Pre-operative and post-operative values of mHSS, Oxford hip score and WOMAC score

Score, median (IQR)	*Pre-score*	*Post-score*	P-*value*
mHHS	71.2 (61.15–73)	89.4 (86–98)	<0.001
Oxford hip score	39 (34–40.5)	46 (46–47.5)	<0.001
WOMAC score	79.7 (73.65–83)	93.15 (95–98.5)	<0.001

Associated complications

Regarding encountered complications, one case underwent labral debridement for failed labral repair (5.8%), another case developed maralgia paraesthetica (5.8%) which recovered fully within 2 months from the operation.

DISCUSSION

Recently, a growing body of evidence has demonstrated a beneficial role of hip arthroscopy as the minimally invasive procedure of choice for the diagnosis and management of post-traumatic hip pain in young adults [4, 6, 10]. In the present study, the most commonly encountered arthroscopic diagnoses of hip pain were a traumatic labral tear, ligamentum teres tear and loose intra-articular fragments. Hip arthroscopy with treatment of the injured structures led to significant improvement in post-operative functional outcomes in this cohort of patients with post-traumatic hip pain.

Mechanical hip pain is a common cause of functional disability and impaired quality of life. Traumatic labral tears are common cause of hip pain in young adults [15]; additionally, subtle pathological abnormalities of the FAI syndrome are common findings during arthroscopic diagnosis of hip pain [15]. In our cohort, traumatic labral and ligamentum teres tears were the most commonly encountered causes of post-traumatic hip pain, while associated CAM and Pincer lesions were observed in 52% and 12% of the patients, respectively. In concordance with our findings, Khanna *et al.* [16] reported that labral tears were identified by arthroscopy in 93% of 29 adults' patients with post-traumatic hip pain; and loose bodies in 59% of the patients. Another case series of 17 patients by Ilizaliturri *et al.* [17] found that arthroscopy identified labral tears in the vast majority of the patients, followed by loose intra-articular fragments. These findings are in line with a recent systematic review that included 31 studies and reported a high prevalence of labral tears and loose intra-articular bodies, which were diagnosed by hip arthroscopy [18]. This was also in agreement with what was reported by Philippon *et al.* [19] on 14 professional athletes who sustained

traumatic hip dislocation. The latter study showed that traumatic hip dislocations were accompanied by a variety of intra-articular hip joint pathologies, the most common being labral and chondral injuries followed by intra-articular loose fragments and disruption of the ligamentum teres. On the other hand, Wylie *et al.* [20] reported on more patients with loose bone fragments (8 of 12 patients—66%) compared to those with traumatic labral tears. Their cohort involved adolescent and young adult patients with previous traumatic hip dislocation. The authors have explained this by the fact that their younger patient population appear to be more prone to hip dislocations after less energy trauma compared to adult patients exposed to the same amount of traumatic energy.

Hip arthroscopy is an option to manage selected cases of femoral head fractures. We had a successful outcome of one case Pipkin I fracture who had arthroscopic assisted fixation in this series. This was also previously described by Park *et al.* [21] who used hip arthroscopy to perform reduction and internal fixation of a displaced femoral head fracture Pipkin type I. They reported good patient's recovery and satisfactory outcome. This was similarly described by Kekatpure *et al.* [22] who did arthoscopic reduction and internal fixation of a case of Pipkin Type I femoral head fracture. This revealed that hip arthroscopy can provide the benefits of anatomical reduction as well as the advantages of minimal soft tissue injury and early patients' rehabilitation.

Currently, there are different PROMs for the assessment of functional activities and hip pain, mHHS is a 10-item, joint specific score that exhibited high validity and reliability for the evaluation of hip functional outcomes [10]. Similarly, the OHS [11] is a valid measure for assessment of disability of the joint. While, and WOMAC score [12] can reflect the condition of osteoarthritis in post-traumatic patients. In the present study, hip arthroscopy improved the post-operative mHSS, OHS and WOMAC scores; which reflects a notable improvement of the functional outcome of the patients. In agreement with our findings, Hwang *et al.* [23] reported a significant improvement in the mHHS and hip ROM in a cohort of patients who underwent arthroscopic treatment for painful hip after major trauma. Another case series on 23 patients with traumatic ligamentum teres showed significant improvement in mHHS 1 year after undergoing hip arthroscopy [24]. The beneficial role of arthroscopy in the management of post-traumatic hip pain appears to extend beyond the short-term post-operative period, as Domb *et al.* [25] reported that arthroscopy significantly led to maintained improvement in patient-reported outcomes, including mHHS and patient satisfaction, for at least 5 years post-operatively.

Strengths and limitations

This is a single-centre study which was conducted prospectively with no loss of follow-up. Although this study has included relatively small number of patients, post-traumatic hip pain is considered less common indication for hip arthroscopy compared to other indications such as FAI. Some of the PROMS (OHS and WOMAC), we used in this study are designed to assess patients with osteoarthritis and are not commonly used for young population with non-arthritic symptoms. However, with the prospective design of this study, we were expecting that a proportion of our patients might develop post-traumatic osteoarthritis and therefore it can be useful to have those PROMS as baseline scores. Also, the calculated PASS and MCID scores for this cohort was performed according to previously published work for patients undergoing hip arthroscopy for FAI and have not been validated for patients with post-traumatic hip pain. We also acknowledge being a single-centre trial; it may affect the generalizability of our findings. Moreover, patients were not followed for a long duration to assess the long-term outcomes of the hip arthroscopy and the development of post-traumatic osteoarthritis.

CONCLUSION

In conclusion, hip arthroscopy is a useful and effective minimally invasive procedure for the diagnosis and management of selected patients with post-traumatic hip pain. Moreover, hip arthroscopy was safe technique with no reported serious adverse events.

CONFLICT OF INTEREST STATEMENT

All authors confirm no financial or personal relationship with a third party whose interests could be positively or negatively influenced by the article's content.

REFERENCES

1. Röling MA, Mathijssen NMC, Bloem RM. Incidence of symptomatic femoroacetabular impingement in the general population: a prospective registration study. *J Hip Preserv Surg* 2016; **3**: 203.
2. Diaz-Ledezma C, Lichstein PM, Maltenfort M *et al.* Pattern of impact of femoroacetabular impingement upon healthrelated quality of life: the determinant role of extra-articular factors. *Qual Life Res* 2013; **22**: 2323.
3. Poultsides LA, Bedi A, Kelly BT. An algorithmic approach to mechanical hip pain. *HSS J* 2012; **8**: 213–24.
4. Begly JP, Robins B, Youm T. Arthroscopic treatment of traumatic hip dislocation. *J Am Acad Orthop Surg* 2016; **24**: 309–17.
5. Lubovsky O, Liebergall M, Mattan Y *et al.* Early diagnosis of occult hip fractures: MRI versus CT scan. *Injury* 2005; **36**: 788–92.

6. Schoenecker PL, Clohisy JC, Millis MB, Wenger DR. Surgical management of the problematic hip in adolescent and young adult patients. *J Am Acad Orthop Surg* 2011; **19**: 275–86.
7. Byrd JW. Hip arthroscopy for posttraumatic loose fragments in the young active adult: three case reports. *Clin J Sport Med* 1996; **6**: 129–33.
8. Haviv B, O'Donnell J. Arthroscopic debridement of the isolated Ligamentum Teres rupture. *Knee Surg Sport Traumatol Arthrosc* 2011; **19**: 1510–3.
9. Philippon MJ, Briggs KK, Hay CJ *et al*. Arthroscopic labral reconstruction in the hip using iliotibial band autograft: technique and early outcomes. *Arthroscopy* 2010; **26**: 750–6.
10. Byrd JWT, Jones KS. Prospective analysis of hip arthroscopy with 10-year followup. *Clin Orthop Relat Res* 2010; **468**: 741.
11. Wylde VV, Learmonth ID, Cavendish VJ. The Oxford hip score: the patient's perspective. *Health Qual Life Outcomes* 2005; **3**: 66.
12. Theiler R, Spielberger J, Bischoff HA *et al*. Clinical evaluation of the WOMAC 3.0 OA index in numeric rating scale format using a computerized touch screen version. *Osteoarthr Cartil* 2002; **10**: 479–81.
13. Chahal J, Van Thiel GS, Mather RC 3rd *et al*. The patient acceptable symptomatic state for the modified Harris hip score and hip outcome score among patients undergoing surgical treatment for femoroacetabular impingement. *Am J Sports Med* 2015; **43**: 1844.
14. Cvetanovich GL, Weber AE, Kuhns BD *et al*. Clinically meaningful improvements after hip arthroscopy for femoroacetabular impingement in adolescent and young adult patients regardless of gender. *J Pediatr Orthop* 2018; **38**: 465–70.
15. Ward D, Parvizi J. Management of hip pain in young adults. *Orthop Clin North Am* 2016; **47**: 485.
16. Khanna V, Harris A, Farrokhyar F *et al*. Hip arthroscopy: prevalence of intra-articular pathologic findings after traumatic injury of the hip. *Arthroscopy* 2014; **30**: 299–304.
17. Ilizaliturri VM, Gonzalez-Gutierrez B, Gonzalez-Ugalde H, Camacho-Galindo J. Hip arthroscopy after traumatic hip dislocation. *Am J Sports Med* 2011; **39**: 50.
18. Mandell JC, Marshall RA, Banffy MB *et al*. Arthroscopy after traumatic hip dislocation: a systematic review of intra-articular findings, correlation with magnetic resonance imaging and computed tomography, treatments, and outcomes. *Arthroscopy* 2018; **34**: 917–27.
19. Philippon MJ, Kuppersmith DA, Wolff AB, Briggs KK. Arthroscopic findings following traumatic hip dislocation in 14 professional athletes. *Arthroscopy* 2009; **25**: 169–74.
20. Wylie JD, Abtahi AM, Beckmann JT *et al*. Arthroscopic and imaging findings after traumatic hip dislocation in patients younger than 25 years of age. *J Hip Preserv Surg* 2015; **2**: 303.
21. Park MS, Her IS, Cho HM, Chung YY. Internal fixation of femoral head fractures (Pipkin I) using hip arthroscopy. *Knee Surg Sports Traumatol Arthrosc* 2014; **22**: 898.
22. Kekatpure A, Ahn T, Lee SJ *et al*. Arthroscopic reduction and internal fixation for Pipkin type I femoral head fracture: technical note. *Arthrosc Tech* 2016; **5**: e997–e1000.
23. Hwang JT, Lee WY, Kang C *et al*. Usefulness of arthroscopic treatment of painful hip after acetabular fracture or hip dislocation. *Clin Orthop Surg* 2015; **7**: 443.
24. Byrd JWT, Jones KS. Traumatic rupture of the ligamentum teres as a source of hip pain. *Arthroscopy* 2004; **20**: 385–91.
25. Domb BG, Yuen LC, Ortiz-Declet V *et al*. Arthroscopic labral base repair in the hip: 5-year minimum clinical outcomes. *Am J Sports Med* 2017; **45**: 2882.