CLINICAL ARTICLE

Arthroscopic Treatment of Acetabular Rim Fracture after Traumatic Posterior Hip Dislocation: A Case Series Study

Mingjin Zhong, MD, Huanyu Xie, MD, Zicai Fu, MD, Wei Lu, PhD, MD, Weimin Zhu, PhD, MD, Kan Ouyang, MD

Department of Sports Medicine, The First Affiliated Hospital of Shenzhen University, Health Science Center; Shenzhen Second People's Hospital, Shenzhen, China

Objective: To investigate the clinical and radiographic short-term results of arthroscopic treatment for posterior labrum tears with an attached bony fragment after traumatic posterior hip dislocation.

Methods: Between July 2014 and May 2019, a consecutive series of nine patients diagnosed with a posterior labrum tear with an attached bony fragment after traumatic posterior hip dislocation were treated by hip arthroscopic techniques. The patients had been injured in traffic accidents ($n = 6$) or high falls ($n = 3$). All patients were provided primary treatment at the emergency department of our institution, and then were transferred to our department for arthroscopy. Demographic data (e.g. gender, age, etc), intraoperative findings, the preoperative and postoperative multiple clinical scores and radiological results were subsequently assessed. Visual analogue scale for pain (VAS) and modified Harris hip scores (mHHSs) were measured and compared before surgery, and at the last follow-up.

Results: A total of nine patients were enrolled, all of them were male, with a mean age at surgery of 32.2 ± 5.6 years (range, 22–65 years). The patients were followed-up for an average of 26.5 ± 4.1 (range, 24 to 50 years). During the arthroscopic surgery, all patients had labral tears with posterior acetabular rim fracture. All patients had loose osteochondral fragments. Five had partial or complete tears of ligamentum teres. Two patients had osteochondral damage. Two had capsular rupture. Postoperative X-ray films and three dimension computed tomography (3D-CT) showed satisfactory reduction of posterior acetabular wall fractures. The mHHS before surgery and at 1 year and 2 years after surgery were 51.8 ± 4.3, 81.8 ± 2.0 and 87.5 ± 1.9 respectively; VAS scores were 5.6 ± 0.5, 1.3 ± 0.3 and 0.7 ± 0.3 respectively. As compared with the condition before surgery, there was a significant improvement in the mHHS and VAS scores at 1 year and 2 years after surgery ($P < 0.01$). There was no significant improvement in the mHHS and VAS scores between 1 year and 2 years after surgery ($P < 0.05$). At the final follow-up, all patients had regained full range of motion (ROM) and were satisfied with the results. None of the patients showed signs of heterotopic ossification, avascular necrosis or progression of osteoarthritis of the hip joint.

Conclusion: Traumatic dislocation is accompanied by a variety of intra-articular hip joint pathologies. Managing posterior acetabular rim fracture after traumatic posterior hip dislocation using arthroscopic reduction and fixation with anchors is a safe and minimally invasive option and delays the progression of traumatic osteoarthritis.

Key words: Hip; Hip arthroscopy; Posterior hip dislocation

Address for correspondence: Kan Ouyang, Department of Sports Medicine, The First Affiliated Hospital of Shenzhen University, Health Science Center; Shenzhen Second People's Hospital, 3002 Sungang West Road, Futian District, Shenzhen, China 518000; Tel: +86-0755-83366388; Fax: +86-0755-83366388; Email: 510296924@qq.com

Grant Sources: This study is supported by the Clinical research Project of Shenzhen Second People's Hospital (20193357019).

Disclosure: No conflict of interest exits in this manuscript.

Received 13 January 2021; accepted 17 May 2021

Introduction

Traumatic dislocation of the hip joint is an orthopedic emergency trauma typically observed in young adults after high-energy trauma (e.g., motor vehicle accidents)[1,2]. Among them, posterior hip dislocation is most common. Posterior hip dislocation is often associated with various intra-articular lesions. The most common intra-articular pathologies reported after hip dislocation are ligamentum teres injury, loose body, cartilage injury, labral tear, and acetabular fracture, all of which could result in painful hip and joint no-concentric reductions[2–4]. Among these pathologies, acetabular and femoral head fractures are the most severe injuries involving articular surfaces that threaten hip function and can result in significant long-term disability, with avascular necrosis and post-traumatic osteoarthritis as the most common complications[5,6]. The rate of post-traumatic arthritis following a traumatic posterior hip dislocation has been shown to be as high as 88% for complex dislocations, those that involve acetabular fractures, and up to 24% for simple dislocations, that occur without an associated fracture[1]. Timely reduction may be essential to preserve the femoral head and reduce the risk of osteonecrosis[1,7]. All fractures involving articular surfaces should be surgically treated to restore joint congruency, achieve stable fixation, and minimize surgical damage. Historically, nonconcentric hip reduction or intra-articular pathologies have been addressed through an arthrotomy. However, open reduction and treatment can result in great damage to the joint, and complications following the surgery of femoral head fractures have been reported to lead to heterotopic ossification, avascular necrosis, and long-term rehabilitation[1,8].

As arthroscopic techniques have been refined. Increases in the experience of hip arthroscopy surgeons and novel developments in technology have expanded the use of hip arthroscopy to aid the diagnosis and treatment of intra-articular pathologies of the hip joint[1]. The arthroscopic treatment described may offer advantages over open approaches. Arthroscopy can be performed without need to wait a predetermined period for stabilization of hematoma, and with less expected blood loss. Previously, the application of hip arthroscopy to post-trauma of the hip is described but remains very limited. Usually, hip arthroscopy is typically performed as a subsequent procedure after the hip has been reduced and the patient stabilized of associated injuries. In recent years, there has been an emerging role of arthroscopy in the treatment of hip trauma for a number of indications including treatment of persistent pain and removal of intra-articular fragments. Several case reports and case series have described arthroscopy after hip dislocation, with a wide spectrum of intra-articular injuries reported.

However, literature discussing the usefulness of arthroscopy for the treatment of posterior acetabular rim fracture after traumatic posterior hip dislocation is scarce[9]. It is well known that glenoid rim fractures are recognized as a risk factor for recurrent instability after anterior shoulder dislocation and several arthroscopic techniques of fixation and reconstruction recently have been described. Due to fractures of the posterior rim of the acetabulum are also important factors in hip instability. Therefore, posterior acetabular rim fracture after traumatic posterior hip dislocation should also be repaired. The purpose of the present study is to: (i) to demonstrate the feasibility of arthroscopy in hip trauma; (ii) to investigate the clinical and radiographic results of arthroscopic treatment for posterior labrum tears with an attached bony fragment after traumatic posterior hip dislocation; (iii) to evaluate the occurrence of other intra-articular pathologies. We hypothesized that arthroscopic treatment of posterior labrum tears with an attached bony fragment after traumatic posterior hip dislocation is a safe and effective technique with low morbidity and complication rates.

Methods

Inclusion and Exclusion Criteria

Inclusion Criteria

Patients inclusion criteria were as follows: (i) patients aged >18 years old, hip with posterior dislocation due to a major trauma; (ii) completed radiographic examinations such as anteroposterior X-ray of the pelvis and CT scan of the hip joints after reduction; (iii) all the patients were under hip arthroscopic treatment.

Exclusion Criteria

The exclusion criteria was as follows: (i) developmental dysplasia of the hip, with insufficient acetabular coverage upon X-ray and lateral center-edge (LCE) angle ≤25°; (ii) Tonnis grade 2 or above; (iii) a history of hip surgery or hip pathology such as Perthes disease, slipped upper femoral epiphysis, avascular necrosis, or previous hip injury; (iv) neuromuscular diseases; (v) body mass index (BMI) greater than 30; (vi) lumbar spine lesions, ankylosing spondylitis or sacroiliac joint diseases; and (vii) refuse to surgery or contraindictions to surgery due to other underlying diseases or cardiopulmonary dysfunction.

General Characteristics of Participants

Approval from the Institutional Review Board was obtained before performing retrospective chart review and attempting to contact patients. Patients over 18 years old who presented at our institution between July 2014 and May 2019 and underwent hip arthroscopy for traumatic dislocation were identified by Current Procedural terminology codes. Clinic notes, operative reports, radiographic images, and arthroscopic photographs were reviewed. The patients' records were examined for presenting features, pathology, treatment, and subsequent clinical course. We also attempted to contact patients by telephone and Wechat to administer the hip outcome questionnaire after application of the exclusion criteria, a total of nine patients were eligible for review. A prospective

analysis was performed on these patients. Arthroscopy was carried out by one of the senior surgeons (kan Ouyang) in all cases.

Surgical Procedures for Hip Arthroscopy

Anesthesia and Surgical Position

Each patient was administered general anesthesia and placed in a supine position. The hip joint was abducted by 10°–15°, and the lower extremity was placed in a neutral position and fixed to the fracture table. The perineal post was oversized (diameter, >15 cm) and lateralized against the medial thigh to protect the pudendal nerve and provide a lateralization vector to the traction force. The foot was well padded to prevent compression injury. Traction was considered adequate when an 8–10 mm joint space between the lateral rim of the acetabulum and the femoral head was documented using fluoroscopy.

Arthroscopic Techniques

An anterolateral portal was established for joint inspection with a 30- or 70-degree arthroscope. The second portal established was the direct anterior portal. Three portals, namely, anterior, anterolateral, and posterolateral, were made, mainly using a 70-degree arthroscope.

After the intra-articular pathologies were identified subsequent to appropriate anterolateral capsulotomy, loose fragments were removed using a grasper. Labral tears were partially resected or repaired depending on the case (repair was indicated for labral detachments from the acetabular rim, partial resection for free margin, or complex tears). Ligamentum teres tears were partially debrided using a shaver or shrunk by the radiofrequency (Smith & Nephew, Andover, MA, USA) unstable chondral flaps were removed, and exposed subchondral bone areas were microfractured.

Posterior acetabular fracture fragment reduction was performed with the grasper, and two 2.9 mm anchors (Smith & Nephew, Andover, Massachusetts, USA) were placed on the acetabular rim. The suture was passed through the bone fragment and tied firmly. The acetabular surface was restored (Fig. 1). The lesions in the central compartment were treated, the instruments were taken out of the joint, the traction was released, and the hip periphery was examined without traction. The capsule was repaired before the wound was closed. Other portals were established when necessary during the surgery.

Postoperative Care

Continuous passive motion and passive pendulum exercise were started after the procedure to avoid postoperative capsular adhesion. The gluteus medius, the lumbar back, and the quadriceps muscles were strengthened gradually through strength training. Hyperflexion of the hip over 90° was forbidden for 4 weeks. Partial weight-bearing with crutches was permitted for 6 weeks. Patients were restricted to touch-down weight-bearing 8 weeks after their surgery.

Radiological and Clinical Evaluation

X ray and 3D-CT images obtained after closed reduction at the emergency department of our institution showed displaced acetabular wall fractures. All cases underwent 3D-CT on the second postoperative day to check the state of the acetabular fracture and removal of loose bodies. We identified the degree of osteoarthritis postoperatively based on the Tönnis classification at the final follow-up. The patients were assessed clinically at intervals of 1, 3, 6, and 12 months after discharge. Then each patient was required to be re-examined each year in the outpatient department. The hip joint function scores before surgery and at 1 year and 2 years after surgery were also assessed.

Hip Function Evaluation Indicators

Visual Analogue Scale

The degree of hip joint pain was evaluated using a visual analogue scale (VAS) score. The degree of hip joint pain was evaluated in all patients using a visual analogue graduated scale. The patient was asked to mark the appropriate position on the graduated scale representing the degree of pain. The score was evaluated according to the patient's mark. The score criteria were as follows: no pain: 0; mild pain, tolerable, not affecting sleep: 1 to 3; mode rate pain, mild affecting sleep, still tolerable: 4 to 6; severe pain, unbearable pain, pain resulting in inability to sleep or waking up from sleep: 7 to 10.

Modified Harris Hip Score

The modified version of the original Harris hip score contains only the patient reported portion. It comprises three domains with eight quest ions. The domains include pain, function in gait, and function in activities. The total score has a maximum of 91 and is multiplied by 1.1 to give a score out of 100. The modified Harris hip score (mHHS) is scored from 0 (indicating the worst functional outcomes and the maximum amount of pain) to 100 (the best functional outcome and the minimum amount of pain). The interpretation of these scores is as follows: <70 (poor result), 70 to 79 (fair result), 80 to 89 (good result), and ≥90 (excellent result). The mHHS has been widely used in hip arthroscopy.

Statistical Analysis

The paired *t*-tests were performed to assess the difference in clinical outcomes before surgery and at the time of the final follow-up. The IBM SPSS version 13.0 (IBM, Armonk, NY, USA) was used for all statistical analyses. The threshold of statistical significance was set to 0.05.

Results

Patient Demographic Data

The average age of the nine patients in this study was 32 ± 5.6 years (range, 22–55 years). All the patients were male. Four left hips and five right hips. The major causes of injury were traffic accident (n = 6) and high falls (n = 3) (Table TABLE 1).

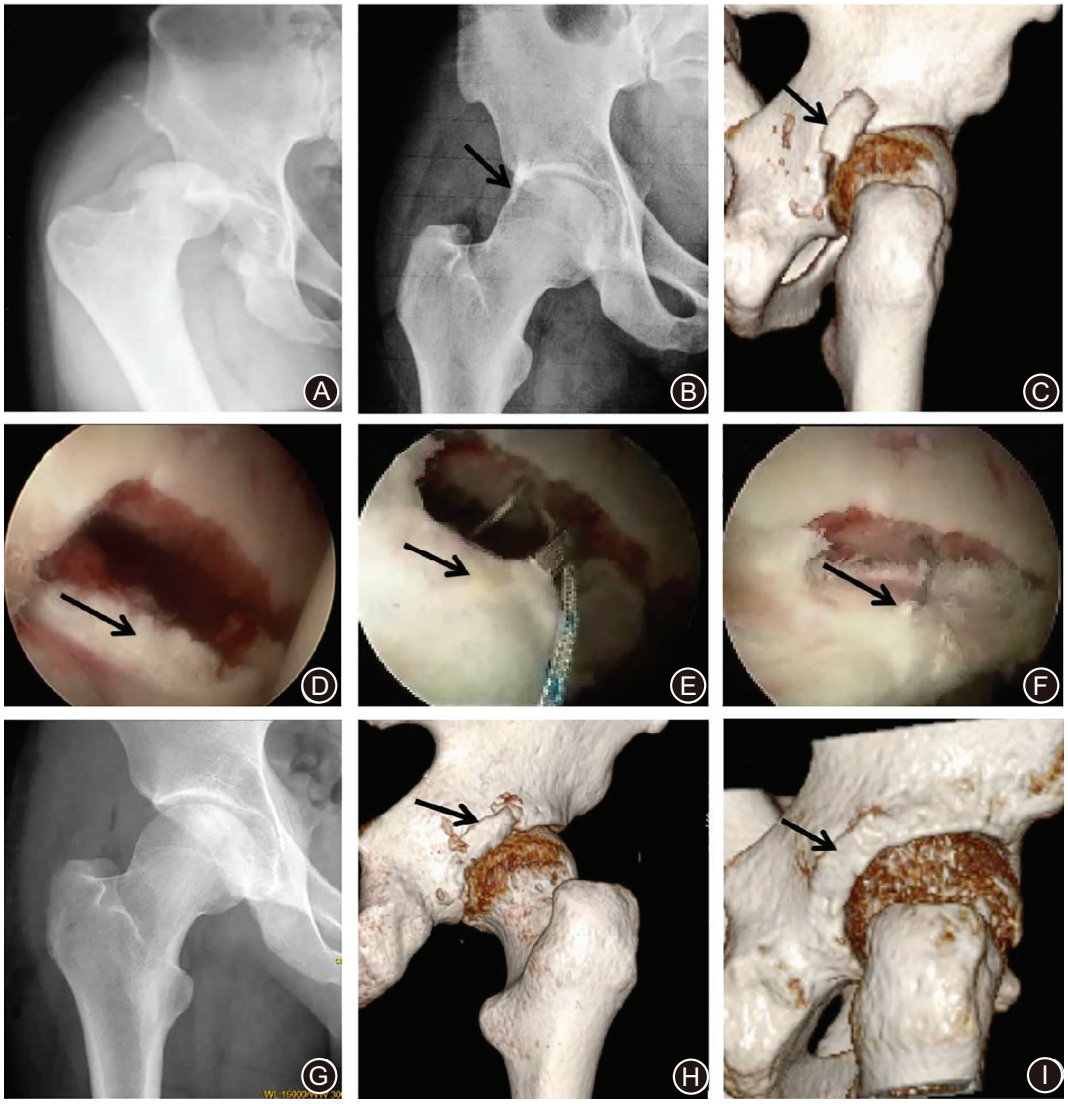

Fig 1 A-22-years old male underwent arthroscopic treatment for acetabular rim fracture caused by posterior hip dislocation. A: X-ray showed posterior hip dislocation; X-ray (B) and 3D-CT (C) showed posterior acetabular rim fracture after hip reduction; D: Arthroscopic view of acetabular fracture; E: The fracture fragment was fixed with anchor; F: Arthroscopic view of acetabular fracture after reduction. X-ray (G) and 3D-CT (H) on the second postoperative day showed well reduction; I: 3D-CT on the 3-month postoperative day showed the complete fracture union.

Intraoperative Findings and Treatment

During the arthroscopic surgery, all patients had labral tears with posterior acetabular rim fracture. The bony fracture fragments with labrum were fixed with anchors. Intra-articular loose osteochondral fragments were observed at the acetabular fossa in all patients. All the loose bodies were removed from the inside of the joint. Actabular chondral damage was observed in two patients, and one was managed by resection of unstable cartilage without the need of for microfracture and one was treated by resection of unstable cartilage and microfracture. Five patients had partial or complete tears of ligamentum teres. In all cases, the torn ligamentum teres tissue was debrided and a stable portion of ligamentum teres was preserved. Two patients had capsular rupture. No fragments were detected at examination of the hip periphery (Table TABLE 1).

Radiological and Clinical outcomes

Radiological Results

The acetabular fracture fragments were well fixed and loose bodies were completely removed. The posterior acetabular fracture fragments healed at 3 months post-operation from 3D-CT scans images. None of the patients exhibited progression of osteoarthritis of the hip at the final follow-up.

TABLE 1 Demographic dates and arthroscopic findings

Variable	Value
No. of patients	9
Sex (male: female)	9:0
Right: left	5:4
Age at surgery, mean, range (years)	32.2 ± 5.6 (22–55)
Follow-up mean, range (month)	26.5 ± 4.1 (24–50)
Arthroscopic findings	
Posterior acetabular rim fracture	9
Loose body	9
Osetochondral damage	2
Ligamentum teres injury	5
Capsular rupture	2

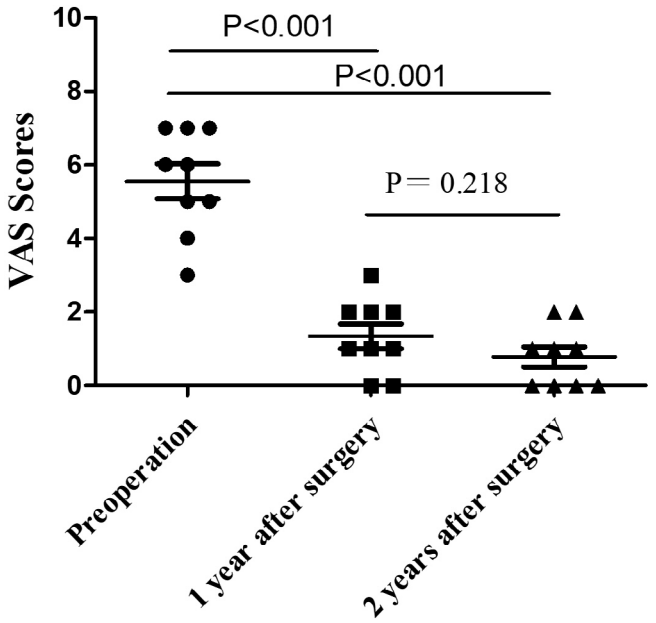

Fig 2 VAS scores before and after surgery.

Clinical Scores and Results

Visual Analogue Scale Scores

The mean VAS score changed from 5.6 ± 0.5 preoperatively to 1.3 ± 0.3 at 1 year postoperatively (VAS score decreased 76.0%). The mean VAS score changed from 5.6 ± 0.5 preoperatively to 0.7 ± 0.3 at final follow-up time postoperatively (VAS score decreased 85.6%). The differences were of statistical significance ($P < 0.01$). There was no significant difference in the mean VAS score between 1 year and final follow-up time after the operation ($P = 0.218$) (Fig. 2). The results showed that the pain of the patients was significantly relieved after arthroscopic surgery.

Modified Harris Hip Scores

The mean mHHS changed from 51.8 ± 4.3 preoperatively to 81.8 ± 2.0 at 1 year postoperatively (mHHS score increased 57.6%). The mean mHHS changed from 51.8 ± 4.3 preoperatively to 87.5 ± 1.9 at final follow-up time

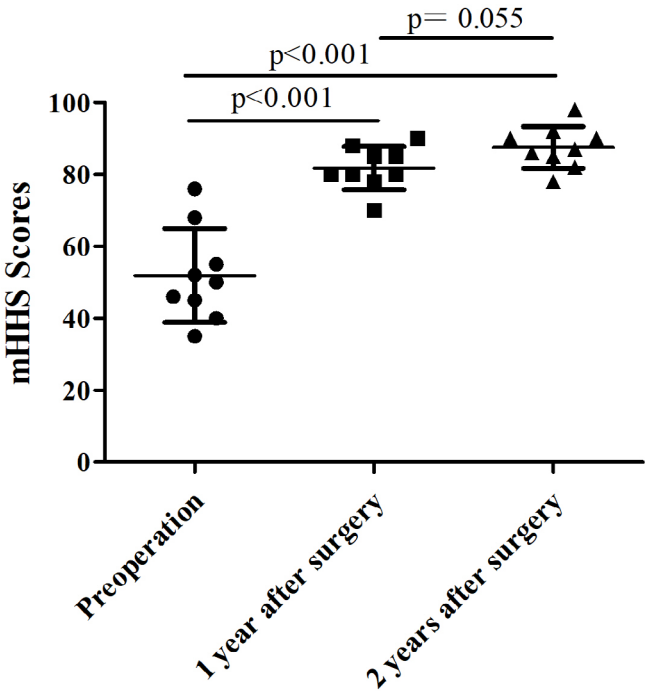

Fig 3 mHHS scores before and after surgery.

postoperatively (mHHS score increased 68.7%). The differences were of statistical significance ($P < 0.01$). At the final follow-up time after surgery, the mean mHHS improved further still as compared with the condition at 1 year after surgery, and the difference was not significant ($P > 0.05$) (Fig. 3). The results showed that the hip function of the patients was significantly improved after arthroscopic surgery.

Complications

During the preoperative and follow-up period, none of the patients developed complications such as wound infection, intra-abdominal fluid extravasation vascular and nerve damage, phlebitis of lower extremities, deep vein thrombosis, or osteonecrosis of the femoral head.

Discussion

Intra-articular fractures require anatomical reduction and stable fixation of the articular surfaces to retain the normal function of the hip joint. In the present study, hip arthroscopy treatment for posterior acetabular wall fractures achieved promising short-term functional results. 3D-CT scan also demonstrated that fracture displacements were firmly fixed by the installation of anchors during hip arthroscopy surgery.

The application of hip arthroscopy to post-trauma of the hip has become increasingly popular in recent years. Foulk and Mullis reported the indications for hip arthroscopy after a hip dislocation as follows: (i) as an alternative to an open arthrotomy for a non-concentric reduction; (ii) to address a dislocation associated

with a stable acetabular fracture not requiring open reduction and internal fixation; and (iii) to evaluate for residual loose bodies or a labral tear when suspicion for these lesions exist[8,10]. The most common intra-articular pathologies occurring in athletes after hip dislocation are labral tears, cartilage injury, loose bodies, and ligamentum teres injury. Many reports regarding the use of hip arthroscopy to treat intra-articular lesions after posterior hip dislocation are available in the peer-reviewed literature[11]. Svoboda *et al.*[12] reported that arthroscopic removal of the loose body in patients with posterior dislocation of the hip is safe and effective. In 2003, Yamamoto *et al.*[13] reported that nine out of 11 patients with fracture and/or dislocation of the hip joint who underwent arthroscopic treatment were successfully treated with loose body removal, which safely prevented posttraumatic arthritis even after 5 years. In 2009, Philippon *et al.*[11] published a series of reports on 14 professional athletes who presented with a traumatic hip dislocation during active competition. All patients had labral and chondral damage, and partial debridement of ligamentum teres tears was performed in 12 cases. The authors found that 11 patients had loose bodies, which were removed arthroscopically. The authors concluded that intra-articular lesions, the most common of which include labral lesions, chondral damage, intra-articular loose bodies, and ligamentum teres tears, are very common after traumatic hip dislocations.

Because the hip is a constrained joint, hip dislocation most commonly occurs following a high-energy injury. In the general population, hip dislocation is commonly associated with acetabular and femoral head fractures[4,14]. Hsu *et al.*[5] followed-up a consecutive series of seven patients with femoral head fracture dislocation treated by scope-assisted percutaneous headless screw fixation and concluded that hip scope-assisted internal fixation may be a safe way to achieve good short-term outcomes and excellent range of motion (ROM) in the hip joint. Like shoulder anterior dislocation, posterior labrum with or without an attached bony fragment may occur after posterior hip dislocation[4]. In our study, we report nine patients with a posterior labrum with an attached bony fragment from the posterior wall of the acetabulum. During surgery, the fracture fragment bearing the labrum was fixed with anchors. Small and thin fracture fragments cannot be fixed using screws[9]. We also found that other intra-articular lesions are very common after traumatic hip dislocations; the most common of these lesions include intra-articular loose bodies, labral lesions, chondral damage, and ligamentum teres tears. We believe that ligamentum teres tears contribute to posttraumatic pain and that arthroscopic intervention serves as an adequate form of treatment for this condition. The fractures of all nine cases in our study healed within 3 months without fragment resorption. No complications, such as wound infection or compartmental syndrome related to arthroscopy, were found. The VAS pain and mHHS scores improved remarkably at the final follow-up after surgery. Moreover, osteoarthritis did not progress at the final follow-up.

The timing of hip arthroscopy surgery is important. In general, when indicated, hip arthroscopy should be accomplished 3 weeks after the initial event to allow for the capsule to stabilize, avoid fluid extravasation and excessive swelling, and optimize visualization from the optimal fluid containment. In 1998, Bartlett *et al.*[15] reported a devastating complication of hip arthroscopy to remove loose bodies after a prior ilioinguinal approach and internal fixation of a both-column acetabular fracture. Fluid extravasation through the fracture site resulted in intra-abdominal compartment syndrome, which presented as cardiopulmonary arrest. The patient recovered after an emergent laparotomy. Many other complications may occur following the application of hip arthroscopy to trauma-related indications. Thus, surgeons must be cognizant of the traditional complications of hip arthroscopy, as well as the additional risks associated with a trauma patient[1].

This study was limited by several factors. First, the number of patients was insufficient to generate significant results. Second, because we could not design a prospective comparative study, further studies comparing this technique with simple excision or open surgery are needed. Finally, we could not achieve anatomical reduction within the limited space of the hip joint, especially in the rotation orientation.

In conclusion, arthroscopic treatment for acetabulra rim fracture after traumatic posterior hip dislocation could result in satisfactory outcomes, including relief of symptoms and prevention of the progression of traumatic arthritis. Concomitant intra-articular hip lesions secondary to traumatic hip dislocation can also be treated using this approach. Future studies seeking to observe mid- and long-term results in more patients are necessary to provide detailed insights into this area of study.

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