Comprehensive Review of Advancements in Hip Arthroscopy

Deuk-Soo Hwang, MD, PhD, Chang-Kyun Noh, MD

Department of Orthopaedic Surgery, Chungnam National University School of Medicine, Daejeon, Korea

Hip arthroscopy is currently being leveraged in the diagnosis and treatment of a wide range of hip joint problems. In fact, great advancements in hip arthroscopy have resulted in an ever-expanding number of indications to which it is being applied. Minimally invasive hip arthroscopy allows for quicker initiation of rehabilitation and has attracted much attention as the field becomes increasingly focused on surgeries designed to preserve joints. This review aims to summarize the recent advances, applications, and impact of hip arthroscopy.

Key Words: Hip arthroscopy, Endoscopy, Advancement, Hip joint, Review

INTRODUCTION

Hip arthroscopy was first described in 1931 by Burman[1] who used it to view the inside of a joint in his cadaver studies; the first clinical description was made in 1939 by Takagi[2]. Despite the early clinical applications of hip arthroscopy, the procedure did not gain popularity until the 1970s. Since 1977, when Gross[3] first introduced hip arthroscopy as treatment for congenital dislocation of the hip, Johnson[4], Eriksson et al.[5], and others have further applied the technique to the diagnosis, management, and surgical intervention of other hip joint ailments. Subsequently, the procedure became well established by Glick et al.[6],

Sampson[7], and Villar[8]. who contributed to significant advances in surgical approaches and anatomical aspects. Conventionally, hip arthroscopy has been applied to i) helping to diagnose the cause of hip pain, ii) diagnosis and treatment of labral tears, iii) removal of loose bodies, and iv) management of degenerative arthritis, cartilage damage, synovial lesions, avascular necrosis of the femoral head, pyogenic arthritis and other conditions[9-13]. As femoroacetabular impingement has emerged as a major cause of hip pain[14,15], arthroscopy has become even more widely used[16-18]. Recent advancements in hip arthroscopy focus on maximizing joint preservation and range of motion following surgeries designed to treat: i) extra-articular lesions and ii) intra-articular lesions. Examples of extra-articular injuries being treated with hip arthroscopy include: i) subspinal impingement, ii) internal and external snapping hip, iii) greater trochanteric pain syndrome, and iv) deep gluteal syndrome. Examples of intra-articular injuries being treated with hip arthroscopy include: i) arthroscopic-assisted reduction and internal fixation for hip joint fracture; ii) labral repair, refixation, and reconstruction; and iii) reconstruction of damaged ligament teres. Given the frequency and significance of updates occurring within the field, the aim of this review is to outline and discuss an ever-increasing number of new indications and therapeutic applications of hip arthroscopy.

MAIN SUBJECTS

1. Extra-articular Lesions (e.g., Antero-medial, Lateral, Posterior)

1) Antero-medial area

(1) Anterior inferior iliac spine (AIIS) impingement (subspinal impingement)

Femoroacetabular impingement syndrome is recognized as a major cause of hip pain and acetabular labral tears in young adults. Although a number of authors have documented improvements in hip joint range of motion and clinical symptoms after arthroscopic surgery[16-21], this is not always the case. There are some reports in the literature describing unsatisfactory improvements in hip joint range of motion and clinical symptoms, most often as a result of impingement remaining due to inappropriate decompression and arthroplasty after surgery[22,23]. Recent studies have reported that hip impingement syndrome may be caused by extra-articular impingement, in particular, AIIS impingement, in patients without improvement in symptoms after surgery[24-26]. AIIS impingement is categorized into three morphological variants according to the AIIS classification system proposed by Hetsroni et al.[25] (Table 1). Patients with AIIS impingement during hip flexion experienced pain in the distal end during flexion and internal rotation of the hip. These symptoms improved with bump resection in the AIIS[24-26]. Previously, open reduction using the Smith-Peterson approach was used; however, a minimally invasive approach can now be attempted using advanced hip arthroscopy techniques[27]. The authors presented a case showing symptom improvement following arthroscopic decompression (Fig. 1). It is important to note, however, that a number of precautions are recommended when performing arthroscopic resection of the AIIS. For instance, since the AIIS is the origin of the direct head of rectus femoris, excessive excision during arthroscopic decompression may lead to rectus femoris injuries and a decrease in knee extension strength. Interestingly, Hapa et al.[28] suggested

Table 1. Type of the Anterior Inferior Iliac Spines (AIIS)

Type	Description
I	Smooth ilium wall without bony prominences between the caudal level of the AIIS and the acetabular rim
II	Bony prominences on the ilium wall extending from the caudal area of the AIIS to the acetabular rim
III	Bony prominences extends distally to the anterosuperior acetabular rim
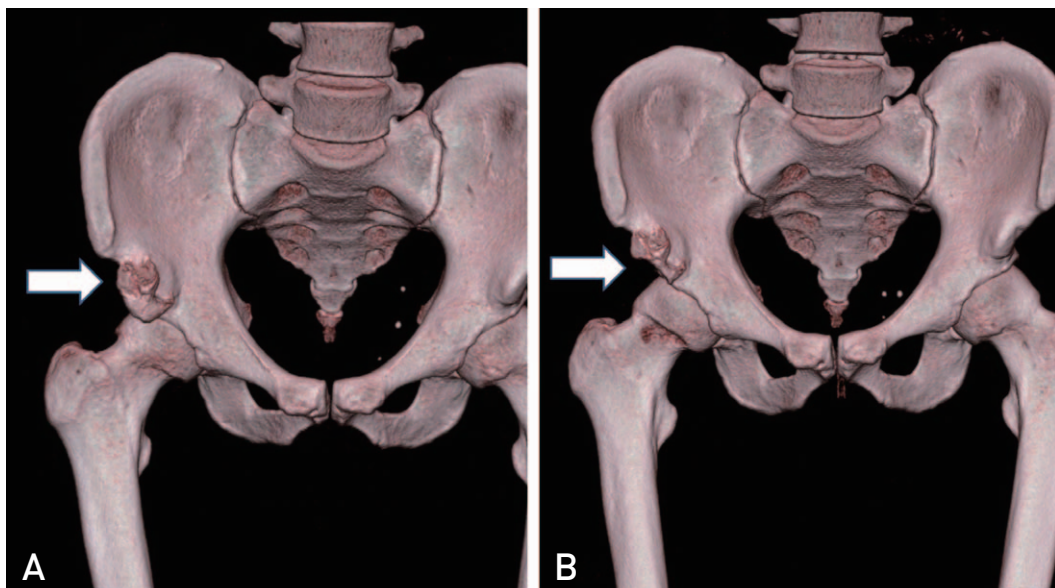
Fig. 1. A 23-year-old man complained pain on flexion and limited range of motion in the right hip joint. (**A**) Preoperative axial computed tomography (CT) scan shows anterior inferior iliac spine (AIIS) extends distally to the acetabular rim. (**B**) Postoperative CT scan shows resected AIIS prominence.

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that: i) these risks are lower because the rectus femoris does not attach to the anteromedial AIIS, and ii) injuries significant enough to induce a decrease in hip flexion strength are less likely to occur because the rectus femoris attaches to the AIIS extensively when an additional incision is made at the proximal and lateral aspects. Regardless of the variances in the perceived risk of this approach, surgeons should be cautious about proceeding with surgery.

(2) Internal snapping hip

Snapping hip syndrome may be due to external or internal causes and is thus characterized as either "internal" or "external" snapping hip. Internal snapping hip is associated with pain and an audible snapping sound as a thickened iliopsoas muscle travels across the anterior aspect of the femoral head, joint capsule of the hip, or iliopectineal eminence. In hip arthroscopy, the anterior, anterolateral, and posterolateral portals are considered standard options. After insertion of the arthroscope through the anterolateral portal, the iliopsoas tendon can be exposed through incision over the anterior joint capsule via the anterior portal. Iliopsoas tendon release can be done arthroscopically. During this procedure, care must be taken to avoid injury to adjacent neurovascular structures. Internal snapping hip may also

Fig. 2. A 33-year-old man who had anterior groin pain and limitation of flexion after total hip arthroplasty with a diagnosis of avascular necrosis of femoral head. After arthroscopic iliopsoas release (asterisk), his symptom was improved.

result from the protrusion of an acetabular cup, formation of abnormal angle of the iliopsoas tendon, and excessvie femoral anteversion after total hip arthroplasty[29-31]. We achieved satisfactory results in improving the symptoms of internal snapping hip by performing arthroscopic iliopsoas release in a patient who complained of persisting pain at the anterior aspect of the hip after receiving total hip arthroplasty due to avascular necrosis (Fig. 2).

2) Lateral area

(1) External snapping hip

External snapping hip is accompanied by a snapping noise associated with a thickening of the iliotibial band as the iliotibial band slides over/catches on the greater trochanter during hip extension from a flexed position. This syndrome is often associated with inflammation and tenderness in the greater trochanteric bursa. Asymptomatic snapping hip resolves spontaneously and when accompanied with pain typically resolves with conservative treatment. Surgical management is implemented only when conservative treatment fails[32]. Resection of the greater trochanteric bursa and iliotibial band release can be attempted with an open procedure[33,34], and favorable outcomes have been reported using an arthroscopic procedure[35,36]. Arthroscopic removal of the bursa can be performed to manage greater trochanteric pain syndrome accompanying chronic inflammation in the greater trochanteric bursa. A 30° angled arthroscope was placed in the inferior portal (viewing portal) by making portals 3 cm distal and 3 cm proximal to the tip of the greater trochanter, and the iliotibial band was released by inserting radiofrequency probes via the superior portal (working portal) (Fig. 3).

3) Posterior area

(1) Deep gluteal syndrome

Deep gluteal syndrome describes the presence of sciatica arising from non-discogenic and extrapelvic entrapment of the sciatic nerve[37]. Structures involved in sciatic nerve entrapment within the gluteal space include the piriformis muscle[38,39], fibrous bands containing blood vessels and gluteal muscles[40], hamstring muscles[41,42], the gemelli-obturator internus complex[43,44] and others. Recently, the term 'deep gluteal syndrome' is preferred over 'piriformis syndrome'. Differential diagnosis of deep gluteal pain is essential to discriminate from hip pain arising from the vertebral column. For this reason, history taking and physical examination are crucial. Patients should be assessed for: i) radiating pain to the lower limbs, ii) abnormal nerve
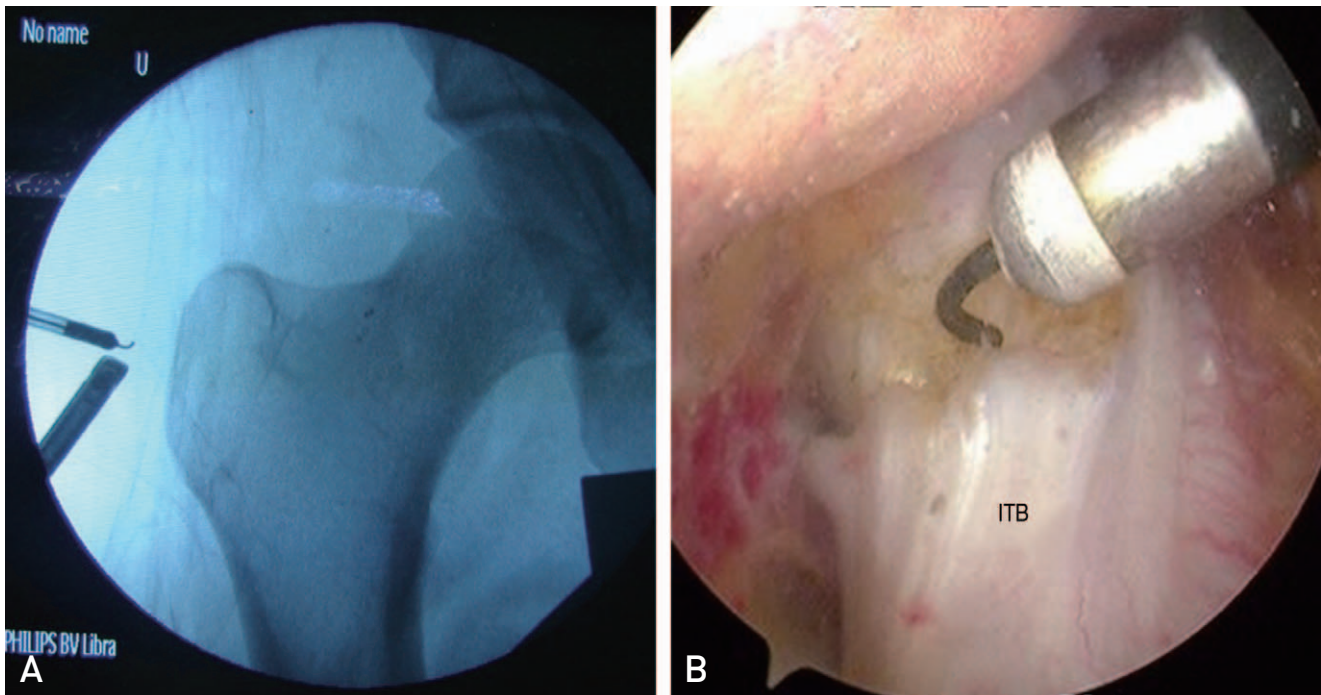
Fig. 3. Endoscopic iliotibial band releases in external snapping hip. (**A**) Triangulation under the fluoroscopy; Radiofrequency device in superior portal and 30° arthroscope in inferior portal. (**B**) Arthroscopic iliotibial band (ITB) release.

sensations, and iii) abnormal nerve reflex and muscle weakness in the sciatic nerve; importantly, taking a sitting position in a chair is often reported to be associated with sciatic nerve entrapment in piriformis muscle[40,45,46]. Upon physical examination, active piriformis test and seated piriformis test can be carried out. Injection of local anesthetics and steroids has been described to be effective and physical therapy can be performed[39]. Surgical measures can be implemented when the condition does not improve with conservative treatment, and open procedure or arthroscopic surgery can be considered. Martin et al.[40] and Dezawa et al.[47] documented symptom improvement following sciatic nerve decompression using arthroscopy in patients with deep gluteal syndrome, and we ourselves have reported symptom improvement following arthroscopic decompression in a patient with this syndrome caused by cysts surrounding the sciatic nerve[48]. Therefore, radiological diagnosis (e.g., magnetic resonance imaging and other imaging tests) is required to examine soft tissues along the sciatic nerve in cases of persistent nondiscogenic sciatica of unknown genesis. Intra-articular abnormalities should be checked because paralabral cysts resemble the clinical manifestations of perineural cysts as increased intra-articular pressure is placed on the sciatic nerve (articular synovial theory)[49]. The authors used triangulation based on fluoroscopy-guided radiographs by creating additional portals along the upper part of, and 5 cm distal to, the posterior greater trochanter and by placing patients in a semiprone position. Cystostomy was conducted using basket forceps after confirming the sciatic nerve and adjacent cysts with unaided eyes, and symptoms improved in all cases (Fig. 4).

2. Intra-articular Lesions

1) Hip fracture and dislocation

Multiple case reports have been published describing symptom improvements in patients with persistent pain caused by intra-articular loose bodies resulting from hip fracture and dislocation when these loose bodies are removed arthroscopically[50-52]. In addition to mechanical actions of giant loose bodies and incongruency of the joint, Evans et al.[53] showed, using an experimental model, that the etiology of traumatic arthritis seems to result from increased activity of chondrolytic enzymes by free cartilaginous particles remaining after a traumatic event. This provides a theoretical foundation for performing arthroscopy after hip fracture and dislocation. Hip fracture and dislocation are frequently associated with a tear of the anterior labrum which may generate post-injury joint pain and instability. For this reason, labral repair can be done using minimally invasive arthroscopic surgery when patients with labral tear complain of persisting pain after primary internal

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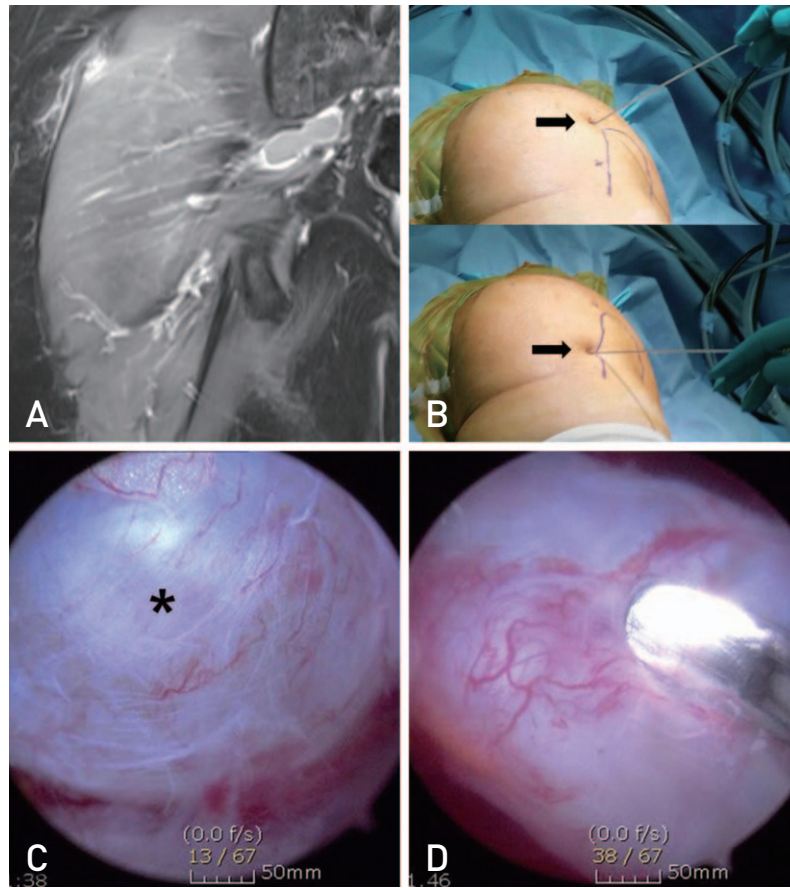
Fig. 4. Entrapment neuropathy of the sciatic nerve caused by perineural cyst. (**A**) Magnetic resonance imaging of perineural cyst. (**B**) Two portals are utilized; the posterolateral portal and the distal accessary portal (arrows). (**C**) Intraoperative arthroscopic images; the perineural cyst (asterisk). (**D**) Decompression with cystostomy of the perineural cyst.
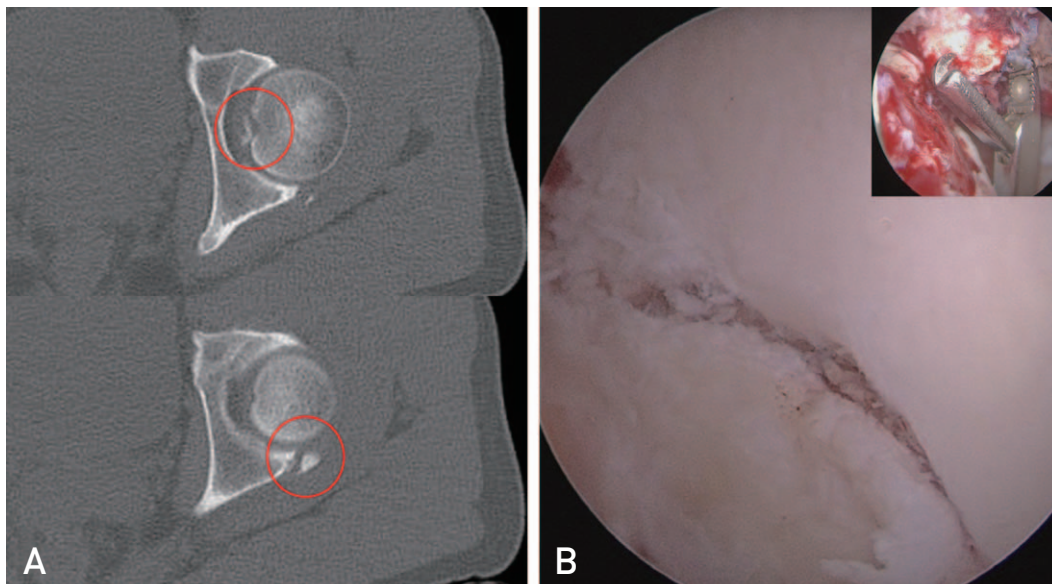
Fig. 5. A 35-year-old man with traumatic hip fracture and islocation caused by pedestrian traffic accident. The dislocated hip was reduced in other hospital. (**A**) Preoperative axial computed tomography scan shows loose body in joint and posterior acetabular fracture (red circles). (**B**) Loose body removal (inset) and percutaneous screw fixation under arthroscopic guide.

fixation in fractures[54,55]. In recent years, direct reduction of fractures has been attempted using an arthroscope. Matsuda[56] reported arthroscopic fixation of an isolated femoral head fracture, and Yang et al.[57] and Kim et al.[58] described case reports on the use of percutaneous screw fixation via an arthroscope for management of an acetabular fracture. Arthroscopic reduction of fractures allows surgeons to visualize the fractured joint surface and simultaneously enables arthroscopic treatment of intra-articular lesions (labral tear, removal of loose bodies) (Fig. 5).

2) Ligamentum teres injury

The ligamentum teres was once considered to have no role in the stabilization of the hip joint; however, it is now recognized to contribute to the distribution of synovial fluid within the hip joint and internal stability. Importantly, it has also been shown to play a critical role in the flaccid joint capsule[59,60]. According to Leunig et al.[61], ligamentum teres injuries have shown to contribute to hip joint pain since this structure consists of free nerve endings involved in the production of pain, pressure, and deep sensation. Haviv and O'Donnell[62] documented improvement in

clinical symptoms after arthroscopic treatment for isolated ligamentum teres tears. Furthermore, using a cadaveric study, Kivlan et al.[63] highlighted the key roles that the ligamentum teres plays including: i) stabilizing the hip joint during multi-plane movements involving flexion and abduction and ii) contributing to stability by providing tensile strength during flexion and abduction motions. Until recent years, ligamentum teres tears were commonly treated by debridement and shrinkage with either shavers or radiofrequency probes. However, a number of authors have recently investigated reconstruction of the ligamentum teres. Although Philippon et al.[64] obtained favorable outcomes in a few patients, additional follow-up studies are warranted[64-67] (Fig. 6).

3) Labral injury

The labrum plays a significant role in increasing joint stability by trapping synovial fluid and sealing the central compartment[68,69]. It has been suggested that labral injuries are a potential contributor to the early development of arthritis of the hip[70]. Thus, because of important functions of the labrum, sutures were used to repair labrum tears using an arthroscope. However, there are examples in which the structure was not preserved, (e.g., cases of severe injuries

Fig. 6. A 47-year-old female had large size of anterior capsular defect and acetabular labral tear. Despite of conservative treatement and arthroscopic labral repair, she had hip instability by recurrent anterior dislocation. After reconstruction of ligamentum teres (asterisk), she had no experience of hip dislocation.
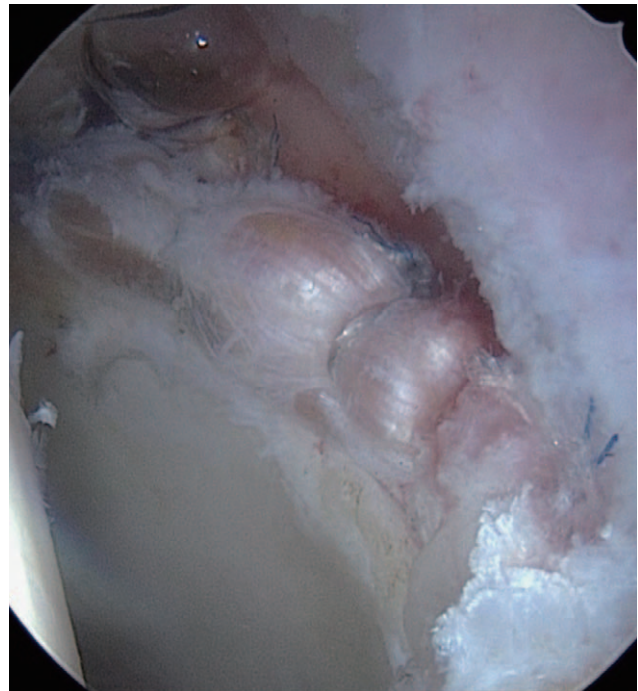
Fig. 7. Arthroscopic reconstruction of acetabular labrum using autogenous iliotibial band. The patient had a persistent groin pain with a history of previous arthroscopic debridement surgery.

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or defects to the labrum where it was not possible to use a suture because of significant degenerative changes). In these cases, debridement was performed following arthroscopic surgery. Recent studies have reported satisfactory results based on short-term follow-up by performing reconstruction of the iliotibial band, gracilis, ligamentum teres, and other structures where the native labrum cannot be preserved in patients of younger age[71,72] (Fig. 7).

CONCLUSION

Minimally invasive arthroscopy is widely used to diagnose and treat various hip joint problems. A variety of previously undetected diseases are being diagnosed as the anatomic characteristics and mechanisms of the hip joint are better understood and with recent advances in diagnostic imaging technology. Clinical applications of hip arthroscopy have expanded as a result of advancements in portal location, traction technique, surgical equipment, surgeons' accumulated experience in arthroscopic surgery and others. Surgery of intra-articular lesions has shifted from joint-reconstructive procedure using joint-replacement surgery to joint-preserving procedures in order to maintain clinical functions as much as possible and improve mid- and long-term quality of life. Minimally invasive surgical procedures are also increasingly preferred to treat extra-articular lesions. With these recent trends and minimally invasive surgical characteristics, hip arthroscopy is projected to be a safer and more effective treatment modality in diagnosing and treating extra- and intra-articular injuries of the hip.

CONFLICT OF INTEREST

The authors declare that there is no potential conflict of interest relevant to this article.

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