REVIEW ARTICLE

The Application of Arthroscopic Techniques in the Diagnosis and Treatment of Hip-Related Conditions in China

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The hip joint is the largest weight-bearing joint in the body and is surrounded by dense capsules and thick muscles. Hip arthroscopic techniques are suitable for the treatment of hip-related conditions. These minimally invasive techniques have rapidly developed in China since 2007. Moreover, they have been used in the treatment of gluteal muscle contracture, snapping hip syndrome, femoral acetabular impingement, acetabular labral injury, hip labral calcification, synovial chondroma, osteoid osteoma, synovitis, osteonecrosis of the femoral head, and developmental dysplasia of the hip. This technique has showed its advantage in the total debridement of lesions, precision treatment, and less trauma. However, we lack understanding of the overall development of arthroscopic techniques in China. This review illustrates the recent development of hip arthroscopic techniques in China and related research progress.

Key words: Acetabular labrum; China; Hip arthroscopy; Hip joint

Introduction

Endoscopic surgery is estimated to have a less than 200-year-old history[1]. This technique is minimally invasive and relieves pain[2]. The hip joint is the largest weight-bearing joint in the body which is surrounded by dense capsules and thick muscles. Hip joint exposure in an open surgery can likely cause iatrogenic injury to the surrounding muscles and tissues. In 1931, Michael Burman[3] first performed an arthroscopy examination on a cadaver hip. He found that it was impossible for the arthroscope to enter the hip joint without the use of traction. In 1984, Jim Glick endeavored to use a hip arthroscopy to remove a loose body in the hip joint of a moderately obese female patient; however, the arthroscope failed to enter the hip joint owing to the very thick surrounding soft tissues. Thereafter, Jim Glick and Thomas Sampson proposed a lateral position arthroscopic surgery technique, including traction and long instruments[4]. Thomas Byrd was the first surgeon to perform hip arthroscopic surgery in the supine position[5]. Hip arthroscopic technology has rapidly developed since the 1980s, spreading from North America to the rest of the world.

In China, the hip arthroscopic surgery technique developed relatively late. Before 2007, there were only a few medical institutions performed this technique. The main indications for this type of technique were hip joint exploration, loose body removal, and gluteal muscle contracture (GMC) release surgery[6]. The hip arthroscopic technique rapidly advanced following an increased understanding of the femoral acetabular impingement (FAI) and acetabular labral injuries. After a decade of development in China, the hip arthroscopic technique has become widely used in the treatment of GMC, snapping hip syndrome (SHS), FAI, acetabular labral injury, hip labral calcification, synovial chondroma,

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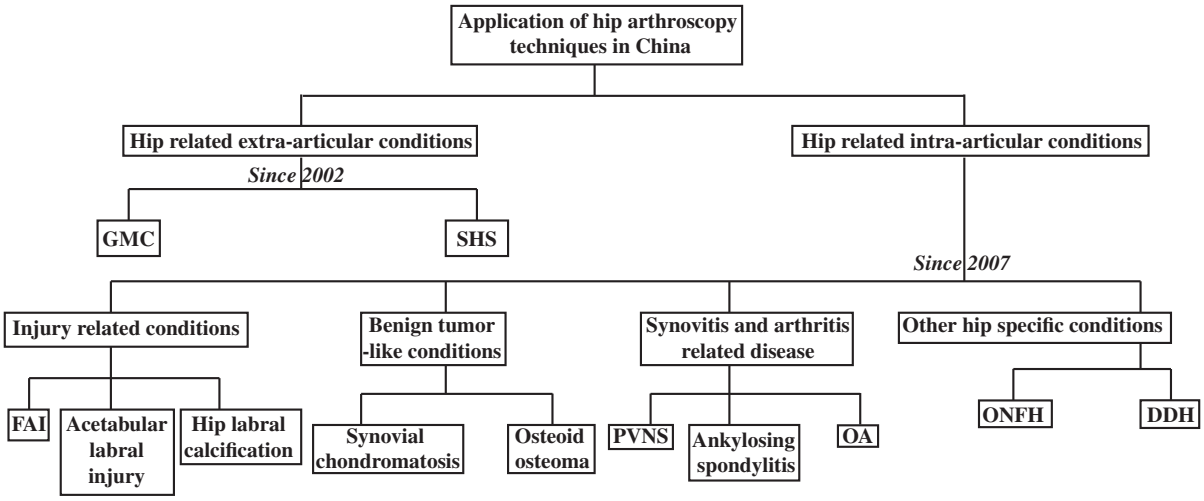

Fig 1 Flowchart showing the application of hip arthroscopy techniques in China. GMC: gluteal muscle contracture; SHS: snapping hip syndrome; FAI: femoral acetabular impingement; PVNS: pigmented villonodular synovitis; OA: osteoarthritis; ONFH: osteonecrosis of the femoral head; DDH: developmental dysplasia of the hip.

osteoid osteoma, synovitis, osteonecrosis of the femoral head (ONFH), and developmental dysplasia of the hip (DDH)[7] (Fig. 1). This technique has showed its advantage in the total debridement of lesions, precision treatment, and less trauma[8,9] (Table 1). However, we lack understanding of the overall development of arthroscopic technology in China.

In this review article, we will introduce the recent hip arthroscopic development in China and its related research progress. Chinese surgeons initially used it in the treatment of GMC and related SHS. Recently, this technique has been more used in the treatment of FAI and related acetabular labral tears. Until now, this is the first review for hip arthroscopic techniques conducted in China. We hope that it will enable readers to better understand the recent progress of hip arthroscopic techniques in China.

Gluteal Muscle Contracture (GMC) and Related Snapping Hip Syndrome (SHS)

Clinical Manifestations

SHS is a syndrome in which an audible or palpable snap occurs in the hip joint during flexion and walking, with or without local pain. It is typically divided into three types: intra-articular SHS, internal SHS, and external SHS (abbreviated as ESH). The latter is the common type and frequently occurs with hip flexion and extension during exercise, when the GMC tissues or the thick and taut posterior border of the iliotibial band (ITB) moves over the greater trochanter[10]. GMC is the degeneration and contracture of the hip muscles and their fascia, which is the most common cause of ESH[11]. Besides hip snapping, the classical symptoms of GMC also include gait abnormality and difficulties in adducting the hip or squatting with the knees together. The Chinese population has been reported to have a higher prevalence of GMC than the American and European populations[12]. This is believed to be a result of the rampant use of benzyl alcohol as a solvent for penicillin in China in the 1970s and 1980s[13]. Additionally, a recent study[14] illustrated that a repeated high-intensity load training for the hip joint can also lead to ITB thickening, which might lead to ESH.

Treatment Methods

A recent experimental study[15] demonstrated that contracture tissues of both the gluteal muscle and ITB have similar histology and molecular pathology. In contrast with dense normal tissues, the contracture tissues were loose and inconsistent. More type III collagen and tissue repair genes were found in the contracture tissues, showing that the pathological changes in this condition include degeneration, fibrosis, and regeneration. The first choice in the treatment of ESH and GMC is conservative management. This includes rest, avoiding snapping-provoking movements, stretching exercises, non-steroidal anti-inflammatory medication, and steroid injection. When the conservative management is ineffective, ITB surgical release is necessary. For some time, open surgery has been the main method of treating these conditions. The goal of surgery is to release the contracture tissues, thickened fascia, and scarred contracture bands. However, open surgery has a high rate of complications, such as extensive scar, postoperative adhesions, and sciatic nerve injury, which decrease overall patient satisfaction[16]. Liu *et al.*[17] and Zhang *et al.*[18] firstly introduced the arthroscopic release technique for GMC in 2002. It has since then become the gold standard treatment for GMC.

TABLE 1 Hip-related conditions and corresponding hip arthroscopy methods

Hip-related conditions		Symptoms	Arthroscopic surgery	Prognosis
Hip related intra-articular conditions	GMC/SHS	Hip snapping/gait abnormality/pain/adduction limited	Release of the contracture tissues under arthroscopy	Fewer complications compared with open surgery[16,19]
Injury-related conditions	FAI	Hip or groin pain/limited hip mobility	Reshape the hip joint	Higher NAHS score and lower reoperation rates compared with open surgery[32]
	Acetabular labral injury	Hip or groin pain/locking of hip joint/snapping	Labral debridement, labral repair, or labral reconstruction	Satisfactory clinical results for medium- and long-term follow-up[41]
	Hip labral calcification	Hip or groin pain	Remove the calcification lesions	Pain syndrome was well-relieved[46]
Benign tumor-like conditions	Synovial chondromatosis	Locking of hip joint/hip pain	Remove loose body under arthroscopy	Functional scores were significantly improved[54]
	Osteoid osteoma	Hip or groin pain	Remove the tumor under arthroscopy	Effectively eliminate pain[56]
Synovitis and arthritis-related disease	PVNS	Discomfort in the hip	Complete synovectomy under arthroscopy	Lower recurrence rates compared with open surgery[59,60]
	Ankylosing spondylitis	Limited joint movement	Synovial resection under hip arthroscopy	ROM could be effectively restored[63]
	Degenerative OA	Hip or groin pain/limited hip mobility	Arthroscopic debridement and synovial resection	Only be effective for slight and moderate[61,64]
Hip-specific conditions	ONFH	Hip or groin pain/limited hip mobility	Small diameter, multi-porous drilling decompression under hip arthroscopy	Higher surgery effective rate compared with traditional drilling alone method[74,75]
	DDH	Hip joint instability/hip pain/limited hip mobility	Arthroscopy-assisted closed reduction surgery for children/Arthroscopic debridement for adults	Reliable clinical symptom relief[79,84]

Abbreviations: GMC, gluteal muscle contracture; DDH, developmental dysplasia of the hip; FAI, femoral acetabular impingement; OA, osteoarthritis; ONFH, osteonecrosis of the femoral head; PVNS, pigmented villonodular synovitis; ROM, range of motion; SHS, snapping hip syndrome.

Comparison between Open Surgery and Arthroscopic Release Technique

Compared with open surgery, the arthroscopic release technique for GMC has the advantage of being minimally invasive and having a wider surgical field, fewer complications, more rapid recovery, and greater satisfaction. Rai *et al.*[16] compared the clinical outcomes of contracture release using arthroscopic *vs* open surgical approaches in these patients. Although no statistically significant differences were observed in hip outcome scores, the conventional open surgery group had significantly more complications than the arthroscopic surgery group. Moreover, the arthroscopy group had a 100% satisfaction rate, whereas the open surgery group had only 71%. Furthermore, when primary open GMC surgeries failed, the three-step arthroscopic release procedure showed effectiveness and improved postoperative function and patient satisfaction regardless of which primary procedure was performed. The overall satisfaction rate of the revision operations was 90.4%[19].

Concerns Considered for Surgery

Insufficient release of fibrous connective tissues is the most common reason for the failure of hip arthroscopic operation in the treatment of GMC and related SHS. Xiao *et al.*[20] compared the surgical efficacy between local infiltration anesthesia and spinal anesthesia for the arthroscopic-assisted surgical treatment of SHS. The results showed that arthroscopic release operation under local infiltration anesthesia has a shorter operative time and a better surgical outcome. Local infiltration anesthesia allows patients to actively move the affected hip joint in each direction, assists surgeons to easily observe the contracture fiber bundle, and determines the degree of release and postoperative efficacy.

Another issue we should consider is whether arthroscopic release of gluteal muscle contracture using radiofrequency energy is effective to relieve the contracture tissues without causing complications. Liu *et al.*[13] retrospectively followed 108 patients with bilateral gluteal muscle contractures for a minimum of 7 months. At last follow-up timepoint, the adduction and flexion arrangments of the hip were $45.3^\circ \pm 8.7^\circ$ and $110.2^\circ \pm 11.9^\circ$, compared with $10.4^\circ \pm 7.2^\circ$ and $44.8^\circ \pm 14.1^\circ$ before surgery. No operation-related complications were found in this study. They believed the application of radiofrequency energy in arthroscopic release surgeries makes the procedures easier and safer. This minimally invasive surgery leads to less trauma, shorter operative time, and less intraoperative bleeding as well as promotes earlier rehabilitation of patients[21].

Also, arthroscopic release cannot only resolve symptoms but can also greatly improve accompanying patellofemoral instability. Huang *et al.*[22] followed 54 patients who were diagnosed with GMC and underwent arthroscopic release surgery. The mean follow-up time was 12.2 months. The average Lysholm scores increased significantly from 58.3 ± 9.9 to 76.9 ± 5.7 ($P < 0.05$) after surgery. The CT scan results showed that the average patellar tilt angle (PTA), patellofemoral index (PFI), and lateral patellar displacement (LPD) were obviously decreased ($P < 0.05$) after the release surgery. Based on this, they suggested that the arthroscopic release of GMC can reduce the tilt and lateral shift of the patella, further enhancing patellar stability.

Future Technique Prospects

The arthroscopic release of contractures has been the main treatment method for GMC and the related ESH in China. This minimally invasive technique showed better clinical outcomes than the traditional open surgery, although large sample comparison studies are rare, and the role of arthroscopy in exploring the mechanisms of this condition has not yet been fully elucidated.

Femoral Acetabular Impingement (FAI)

Clinical Manifestations

FAI has recently been defined as an abnormal femoral acetabular contact that occurs within the normal range of motion (ROM) caused by acetabular and/or femoral head or neck alterations[23,24]. There are two patterns of FAI: cam FAI and pincer FAI. Cam FAI is generally caused by morphological factors of the proximal femur, whereas pincer FAI is due to either localized or generalized acetabular over-coverage. For both FAI types, the goal of surgery is to eliminate the anatomical factors that cause the impingement. With the development of hip arthroscopic technology in China in the last 10 years, this minimally invasive technique has been widely used in the treatment of FAI.

Clinical Effectiveness of Hip Arthroscopy Surgery

Hip arthroscopy surgery aims to reshape the hip joint to prevent impingement. During operation, labral tears can also be resected, repaired, or reconstructed. Some recent retrospective clinical studies in China have indicated that arthroscopic labral repair and osteoplasty provide effective and safe management for FAI in the medium term[24,25]. This technique is also effective for middle-aged and older adult patients. In a therapeutic case series study[26], a total of 27 FAI patients over the age of 50 years were being followed up for at least 2 years. Imaging results and clinical follow-up results showed that hip arthroscopy significantly improved hip symptoms and functions in Chinese FAI patients over 50 years without severe radiographic osteoarthritis (OA). In addition, a low complication rate and a low rate of conversion to total hip arthroplasty (THA) were observed.

Special Circumstances Requiring Attention for Surgery

Despite the low complication rate of hip arthroscopy[27], there are some concerns which need attention during the procedure. One of the most important concerns is residual impingement lesions[28]. Zhuo *et al.*[29] used three-dimensional computed tomography (CT) to determine the clinical characteristics of residual bony impingement lesions after the arthroscopic treatment of pincer FAI and found a 63.3%

incidence. Patients with residual rates >20% exhibited significantly lower clinical scores and satisfaction rates. Gao *et al.*[30] retrospectively analyzed 22 patients who underwent arthroscopic hip revision surgery and found that residual FAI and extra-articular impingement were the common reasons for arthroscopic hip revision surgery. Another concern to be considered is heterotopic ossification (HO) after surgery. Gao *et al.*[31], in a retrospective clinical study, found that 5.4% of the patients had imaging evidence of HO after hip arthroscopy for FAI; however, in the majority of cases, this had no effect on clinical symptoms. They believed that oral NSAID treatment was helpful in the prevention of HO after primary hip arthroscopy.

Comparison Between Different Surgical Methods

Some Chinese meta-review studies attempted to resolve controversial issues related to hip arthroscopic surgery in FAI. Zhang *et al.*[32] performed a systematic review and meta-analysis comparing hip arthroscopy and open surgical dislocation in the treatment of FAI. This study indicated that hip arthroscopy resulted in higher non-arthritic hip scores (NAHS) and lower reoperation rates, although it results in less improvement in the alpha angle in patients with cam osteoplasty than in those with open surgical dislocation. Wu *et al.*[33] performed a meta-analysis comparing the arthroscopic labral debridement *vs* labral repair in patients with FAI and found that labral repair demonstrated a better clinical efficacy than labral debridement.

Future Technique Prospects

In conclusion, we believe that the hip arthroscopic technique shows good early- and medium-term clinical efficacy for FAI in China. However, as this technology has only been recently applied in the treatment of FAI, future studies should focus on a long-term (5-year) clinical effect of hip arthroscopy in the treatment of FAI.

Acetabular Labral Injury

Clinical Manifestations

The acetabular labrum is a triangular fibrocartilaginous structure attached to the acetabular rim. It surrounds most of the bony rim of the acetabulum, except for the transverse acetabular ligament in a ring shape to stabilize the joint[34]. An anatomical study illustrated that the acetabular labrum has abundant free nerve endings[35]. If the acetabular labrum is injured or becomes mechanically unstable, it can cause obvious pain, restricted movement, or even interlocking, which affects the patient's daily life. The main factors responsible for acetabular labral injury include injury, degeneration, dysplasia, and FAI. Most patients with acetabular labral injury should first try appropriate rest, local restraint, anti-inflammatory drugs, physical therapy, and other conservative treatments to relieve the symptoms. However, patients with recurrent pain or mechanical interlocking of joints should be actively treated with surgery. The application of arthroscopic technology can determine the location and type of labral injury under direct visualization, and the lesions can be treated simultaneously, making it the gold standard for the diagnosis of labral injury and the preferred surgical treatment method[36]. In recent years, this arthroscopic technique has been widely applied in the treatment of acetabular labral injury in China.

Three Surgical Methods for Acetabular Labral Injury

There are three surgical methods for acetabular labral injury: labral debridement, labral repair, and reconstruction[37,38]. Chen *et al.*[39] performed limited acetabular labral debridement, in which only the damaged labral structure was cleaned up during the surgery, and the labral integrity and sealing function were preserved as much as possible. In this study, 101 patients were followed for at least 5 years, of which four underwent secondary hip arthroscopic revision surgery, and 14 underwent THA due to the development of OA. The Modified Harris Hip Score (mHHS), Hip Outcome Score (HOS), and patient satisfaction were not significantly different compared with those of the acetabular labral repair group.

However, other studies have shown that labral repair was better for the reconstruction of the whole structure and that the biological function of the acetabular labrum was improved. A meta-analysis study comparing arthroscopic labral debridement to the labral repair in patients with FAI showed better clinical results with labral repair[33]. Although most parts of the acetabular labrum are without blood supply, the base part that connects the acetabulum contains a periacetabular periosteal vascular ring formed by the branches of the superior and inferior gluteal arteries. The anatomical integrity of the acetabular labrum can be reconstructed by repair with threaded anchor sutures provided that the labrum is not severely injured or the labral injury is located at the junction of the labrum and cartilage[40]. Li *et al.*[41] retrospectively followed 106 patients who underwent arthroscopic labral repair operation. Among them, 91 patients finished a follow-up of no less than 2 years, with an average of 26.0 ± 2.0 months (24–32 months) and 64 completed a follow-up more than 5 years, with an average of 62.9 ± 3.1 month (60–70 months). Results showed that there was a significant improvement in the hip functional scores at 2-years postoperatively and 5-years postoperatively compared with preoperatively. There was no significant difference in hip functional scores and patient satisfaction at 5-years postoperatively compared with 2-years postoperatively. Based on the above results they concluded that labral repair in the patients with labral tears shows satisfied clinical results at the medium- and long-term follow-up.

When the acetabular labrum is severely damaged, labral reconstruction surgery is a better choice for rebuilding the structure and preserving the function. There are several options for graft repair, including autograft (ITB, gracilis and semitendinosus, quadriceps tendon, rectus femoris tendon, joint capsule) and allograft (peroneus brevis, tensor fascia

lata). These grafts can restore the labral structures and hip movement[42]. Shi *et al.*[43] reconstructed the acetabular labrum of pigs with an autologous mesogluteus tendon. Histological assessment and gene expression analysis showed that the autologous tendon tissue for the acetabular labral reconstruction can fully or partially fill labral defects and will finally convert to fibrocartilage. Furthermore, Shi *et al.*[44] presented that labral reconstruction using autografts greatly reduced the progression to OA compared with labral resection. The autologous implants used for reconstruction effectively restored the biomechanical and histological features of the labrum, contributing to hip joint homeostasis.

Future Technique Prospects

In conclusion, hip arthroscopy is an effective method for the treatment of acetabular labral tears. Hip arthroscopy surgeons should choose the correct way to restore the structure and function of the acetabular labrum. However, hip labral reconstruction surgery is still in its early stages of clinical application. More basic research and clinic research about hip labral reconstruction should be done. Also, more clinical research should be conducted to compare clinical results between labral repair and labral reconstruction to guide the selection of surgical procedures.

Hip Labral Calcification

With the rapid development of imaging examination technology, researchers have discovered some rare hip labral lesions, such as calcification. Hip labral calcification refers to calcium salt and hydroxyapatite deposition on the acetabular labrum[45]. The main clinical manifestation is hip pain, which most frequently occurs in the groin area. A previous study illustrated that the labral calcification occurs secondary to FAI or acetabular labral injury[46]. This kind of calcification lesion is typically very small, with a diameter < 3 mm. Recently, Chinese researchers Ju *et al.*[47] reported five cases of isolated hip labral calcification. These patients had other hip joint lesions, the calcification lesions of 9.5–13.2 mm in diameter. Under hip arthroscopy, the calcification lesions were removed using a shaver. Postoperatively, the pain syndrome was relieved, and the visual analog scale (VAS) decreased from 5.8 ± 1.6 to 1.1 ± 0.3 ($P < 0.01$). They believed that the calcification debridement surgery under arthroscopy is a good way to treat hip labral calcification.

Synovial Chondromatosis

Clinical Manifestations

Synovial chondro-matosis (SC), also known as synovial chondro-metaplasia, is a rare and benign condition that has a predilection for major joints, and most often occurs in the knee joint, followed by the hip joint. The etiology of SC is unknown; however, it typically originates from the synovial membrane, bursa, or tendon sheath. Synovial hyperplasia of the involved large joints results in several pedicled projections. The cells on the free end undergo metaplasia into chondrocytes, and a loose body in the articular cavity is formed after exfoliation. Late cartilage nodules may calcify or ossify. Milgram divided the disease into three stages according to its course. Stages II and III are characterized by loose bodies[48].

Arthroscopic Treatment for Synovial Chondromatosis

Loose body removal and joint debridement are the main objectives of surgical treatment for synovial chondromatosis[49]. This relieves the patient's symptoms of joint interlocking and pain. Traditional open surgery is highly invasive, and the complete removal of the loose body requires the treatment of hip joint dislocation, which is associated with the risk of avascular necrosis of the femoral head, several postoperative complications, and a long recovery time[50]. Arthroscopic surgery has the advantages of less trauma and pain as well as fewer complications[51]. Additionally, the postoperative recovery of patients is fast, and the recurrence rate is low[52]. Yu *et al.* also reported that, compared to open surgery, arthroscopy resulted in a more rapid recovery and lower recurrence incidence than open surgery. However, they also pointed out that insufficient observation and inadequate debridement were unavoidable drawbacks of arthroscopy, with resultant higher recurrence rates especially when the posteroinferior approach was used[52].

In an attempt to address this challenge, Li *et al.* recommended that the intraoperative release of traction after flexion, extension, and rotation of the hip joint may release some of the hidden free loose bodies[53]. The loose bodies stick in the acetabular fossa because they are squeezed by the femoral head and are relatively difficult to observe and clean, especially in the medial area of the hip joint where they are most likely to accumulate. Surgeons need to exercise patience and appropriately expand the entrance of the arthroscopic approach and increase its mobile range. Special instruments, such as 30° or 70° arthroscopy, scrapers, arc-shaped plane knives, and flexible radiofrequency, can be used for processing; changing the approach of arthroscopy and surgical instruments can avoid missing loose bodies. Gao *et al.*[54] reported that the relapse of SC was a significant reason for hip revision surgery, and arthroscopic hip revision surgery could provide good clinical outcomes, with statistically significant improvement in mHHS and VAS.

Future Technique Prospects

The postoperative recurrence rates of SC treated by hip arthroscopy are inconsistent between studies. The existing literature is scant, with a relatively short follow-up period. A multicenter clinical trial with a long-term follow-up period is necessary to address this limitation.

Osteoid Osteoma

Osteoid osteoma is a benign bone tumor that occurs in young adults between 10 and 30 years of age. The male-to-female incidence ratio is 2:1–3:1. According to previous

statistics, it accounts for 11.23% of all benign bone tumors[55]. Mei *et al.*[56] resected the hip osteoid osteoma under hip arthroscopy. All patients underwent a preoperative CT scan to identify the location of the lesion. Intraoperatively, the affected limb was fixed in a position of 15° hip flexion, 20° abduction, and mild internal rotation. The ankle joint was firmly fixed, and traction was applied to establish a hip joint operation gap. They first established an anterolateral approach under the C-arm. Then, an additional anterolateral approach was established under anterolateral approach monitoring. After the tumor lesion was found, the tip of the thin guide wire was inserted and attached to the surface of the lesion. It was then repositioned with the C-arm and compared with the position on the CT image. After confirming that the position was correct, they used a narrow bone knife and drill to remove the tumor until the complete wound surface showed normal cancellous bone. The clinical results showed that nocturnal pain disappeared 24 h after resection, and the average VAS scores decreased from 7.3 ± 1.4 preoperatively to 1.1 ± 0.8 postoperatively. Based on these findings, we believe that the arthroscopic resection of osteoid osteoma is a minimally invasive and safe technique that can effectively eliminate pain and help in the early recovery of hip function.

Synovitis and Arthritis

Common Types of Hip Synovitis and Arthritis

Hip arthroscopic technology is suitable for use in the treatment of early degenerative changes of the hip joint and other types of synovitis and arthritis. Zhou *et al.*[57] performed a retrospective clinical study to investigate the efficacy of arthroscopic surgery in hip synovitis and arthritis. Among the 36 cases, 17, 11, and eight were of ankylosing spondylitis, rheumatoid arthritis, and psoriatic arthritis, respectively. The joints were irrigated, and the inflamed tissues were debrided with arthroscopy. According to the Harris Hip Score (HHS), the results were classified as excellent, good, fair, and poor in eight, 17, eight, and three cases, respectively. They concluded that arthroscopy-assisted joint debridement and synovial resection was an effective procedure for hip lesions in inflammatory arthritis.

Pigmented Villonodular Synovitis (PVNS)

Pigmented villonodular synovitis (PVNS) is a rare, benign condition with a potential to be locally aggressive and recurrent. It is characterized by synovial hyperplasia and pigment deposition (hemosiderin) inside the joints, tendon sheaths, and bursae. This disorder most commonly occurs in the knee (73.84%) and hip (18.14%) joints[58]. Complete synovectomy has been the standard treatment for this invasive disease. Since a hip arthroscopic technique is minimally invasive and local lesions can be amplified for observation, it has unique advantages in the complete synovectomy. Chen *et al.*[59] used arthroscopy to treat 27 hips with synovitis-like lesions (nine PVNS hips). After an average follow-up of 22 months (6–60) months the HHS had significantly improved (49 points preoperatively and 85 points postoperatively) and there was a relief of pain in 74% and an improved joint mobility in 85% of cases. In a retrospective multicenter study of 237 PVNS cases conducted by Xie *et al.*[60], 108 and 129 were treated by open surgery and arthroscopy, respectively. The recurrence rates were 20.93% and 19.44% for the open surgery and arthroscopy groups, respectively. We believe that the hip arthroscopy technique is a good method for the treatment of PVNS.

Ankylosing Spondylitis (AS)

Ankylosing spondylitis (AS) is a chronic progressive inflammation that often involves the sacroiliac joints, spine, and hip joints. Synovial debridement under hip arthroscopy is a good method for the relief of symptom in AS patients[61]. Zhang *et al.*[62] performed hip arthroscopy surgery in eight patients with early AS who had hip joint involvement. Three months postoperatively, the HHS had increased from 62.3 ± 6.7 to 86.5 ± 18.8. Therefore, synovial resection under hip arthroscopy was asserted to be effective in the treatment of early stage AS. Moreover, in a retrospective clinical study, Li *et al.*[63] showed that manipulation release combined with arthroscopic debridement and synovial resection under general anesthesia could effectively restore ROM in patients with AS. This will significantly improve the patients' quality of life.

Degenerative Osteoarthritis (OA)

Degenerative OA and hip synovitis are often secondary to other diseases, such as hip joint fracture, DDH, and hip dislocation. However, arthroscopic debridement and synovial resection can only be effective for slight and moderate inflammatory hip arthritis cases[61,64]. Liu *et al.*[65] reported on 23 hip OA cases treated by hip arthroscopy. The average follow-up time was 25 months. The clinical results showed that after debridement, the pain in most patients was relieved and the range of joint movement was restored. Besides for degenerative OA, debridement under hip arthroscopy has also been used in the treatment of hip tuberculosis[66], hip cysts[67], and hip ligamentum teres cysts[68] in China. Hip arthroscopy provides a minimally invasive procedure in the debridement surgery.

Future Technique Prospects

In conclusion, the hip arthroscopic technique has an advantage over debridement of synovitis or arthritic lesions owing to better visualization and minimal invasiveness. Future studies should be conducted to determine its long-term clinical effectiveness.

Osteonecrosis of Femeral Head (ONFH)

ONFH typically affects relatively young, active patients in the third or fourth decade of their lives. The condition is the result of irreversible anoxia of the affected subchondral bone, resulting in both marrow-cell and osteocyte necrosis[69]. Core decompression is a common procedure for the early stage of ONFH. Hip arthroscopy can assist fluoroscopic-

assisted retrograde drilling by guiding the accurate placement of the drill tip into the area of chondral lesions of the femoral head[70]. Liu *et al.*[71] and Li *et al.*[72] initially introduced a novel technique of small diameter, multi-porous drilling decompression under hip arthroscopy that showed good early clinical outcomes. Then Wang *et al.*[73] further investigated the clinical effects of this novel method in a larger sample size. A total of 164 patients were followed up for 35 (3–60) months. The HHSs increased from 68 points preoperatively to 79 points postoperatively. Excellent results were found in 198 of the 383 patients. Li *et al.*[74, 75] compared this multiple small-diameter drilling decompression combined with the hip arthroscopy debridement method to the traditional drilling alone method. The patients were followed up for an average of 57.6 months. They showed that the HHS at the final follow-up was higher for patients who underwent the combined arthroscopic debridement surgery. The total surgery effective rate was also higher for this novel surgical method. Based on the above results, we conclude that multiple small-diameter drilling decompression combined with hip arthroscopy is a better way for the treatment of patients with early ONFH.

Developmental Dysplasia of the Hip (DDH)

Clinical Manifestations

DDH, also known as congenital dislocation of the hip (CDH), refers to the joint instability caused by the structural deformity of the acetabulum, proximal femur, and articular capsule. Early detection and treatment are key to a good prognosis. At present, from birth to 6 months is the universally accepted golden stage for the treatment of DDH, and the Pavlik harness is the first choice of treatment. For children aged 7–18 months, the effect of sling treatment is significantly reduced, and closed reduction and plaster fixation in the human position are recommended. If the closed reduction fails or the safe angle range is <20°, arthroscopic debridement can be used. The risk of ONFH is low because the arthroscopic approach is distinct from the internal and external femoral circumflex arteries and thus less likely to damage them[76].

Arthroscopic treatment in children with developmental dysplasia of the hip syndrome (DDH)

In 2019, Feng *et al.* reported that they performed a single-approach arthroscopy-assisted closed reduction in 12 children, with good clinical outcomes at a 2-year follow-up; there was one case of femoral head avascular necrosis (AVN) and two cases of residual acetabular dysplasia postoperatively[77]. The same research team published another article in 2020 using double operative approaches (anterolateral and lateral) and an ordinary traction table with the assistance of arthroscopy to treat five patients with DDH. They obtained satisfactory curative effects[78]. These studies confirmed the short-term efficacy of hip arthroscopy in the treatment of DDH, and the study by Tian *et al.* confirmed its medium-term effects[79]. They included 18 patients (24 hips) and followed up for an average of 6.5 years. Postoperatively, all patients achieved normal gait and hip ROM, restored Shenton line continuity, and an improved average acetabular index. During the follow-up period, only one case had secondary acetabular dysplasia[79]. Tian *et al.* concluded that arthroscopy treated the pathological structure more comprehensively with less trauma, and they suggested removing the fibrous adipose tissue of the acetabulum in the final step to reduce bleeding, maintain a clear field, and shorten the operative time[79]. Yan *et al.* proposed that owing to the magnifying effect of arthroscopy, the intraoperative field of vision in the joint capsule was clear, less soft tissue was removed, and the postoperative recovery was faster. Theoretically, the incidence of AVN and postoperative joint dysfunction was lower[80]. Furthermore, they described the disadvantages of arthroscopy, as the tissue outside the capsule not being completely released, joint reconstruction not being able to be performed, the reduction effect being difficult to ensure, and the possibility of secondary surgery and re-dislocation being increased[80].

Arthroscopic Treatment of Adult DDH-Related Conditions

The hip arthroscopic technique can also be used in the treatment of mild adult DDH-related labral tears and OA[81,82]. Liu *et al.*[83] reported 32 mild adult DDH patients with OA debrided under arthroscopy. They removed the osteophyma, loose body, hyperplastic synovia, and degenerated cartilage. The results showed that the HHS increased from 58.8 ± 6.2 to 89.6 ± 11.3 postoperatively. The rate of excellent and good results was up to 85.7%. Ju *et al.*[84] investigated the clinical efficacy of treating the mild adult DDH using hip arthroscopy. This study included 27 cases, and the mean preoperative lateral central-edge angle was 19.8° ± 6.2° (13.1°–27.7°). During the arthroscopic surgery, the labral injury lesion was sutured or debrided, and the cartilage injury was also treated. The results showed that the HHS increased from 66.9 ± 12.2 to 90.1 ± 5.1, and the surgical satisfaction rate reached 92.6%. Based on these findings, we conclude that hip arthroscopy is a safe and effective treatment for mild adult DDH with minimally invasive trauma. It can obviously improve clinical symptoms and functions, and delay the development of OA.

In conclusion, the application of hip arthroscopy in the treatment of DDH is still in the exploratory stage, with few cases and a short follow-up period.

Conclusion

Hip arthroscopic techniques have rapidly developed in China in the last few decades. Chinese surgeons initially used it in the treatment of GMC and related SHS. Recently, this technique has been used more in the treatment of FAI and related acetabular labral tears. To better understand the effectiveness of this minimally invasive technique, more clinical research should be performed to determine the long-term clinical outcomes of this novel technique in the treatment of hip-related conditions.

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