CLINICAL ARTICLE

Utility of Ultrasound-Guided Anesthetic Intra-articular Injection to Estimate the Outcome of Hip Arthroscopy in Patients with Femoroacetabular Impingement Syndrome

Shoupeng Li, BA[1], Chunbao Li, MD[2], Huanfang Wang, BA[1], Yukun Luo, MD[1], Haipeng Li, MD[2], Mingbo Zhang, MD[1]

[1]Department of Ultrasound, The First Medical Center, General Hospital of Chinese PLA and [2]Department of Orthopedics, The Fourth Medical Center, General Hospital of Chinese PLA, Beijing, China

Objective: To investigate the effectiveness of ultrasound (US) guided intra-hip joint injection to estimate the outcome of hip arthroscopy in patients with femoroacetabular impingement (FAI) syndrome.

Methods: Patients with FAI syndrome (n = 60) were prospectively enrolled in our study. Before hip arthroscopy, a mix of 4 mL 2% lidocaine and 4 mL 1% ropivacaine were injected into the hip joint under the guidance of US. The clinical efficacy of the intra-articular injection was evaluated by comparing the visual analog scale (VAS) and international hip outcome tool 12 (iHOT-12) results before and after the injection. The outcome of hip arthroscopy was evaluated by iHOT-12, the modified Harris hip score (MHHS), and the patient's satisfaction 12 months after the operation. The outcome of intra-articular injection and hip arthroscopy were compared. Factors related to the outcomes of hip arthroscopy were evaluated. The correlation between the efficacy of intra-hip joint injection and arthroscopy was evaluated.

Results: The VAS of patients decreased from 11.3 ± 7.7 to 3.3 ± 4.5, and the iHOT-12 increased from 52.1 ± 23.2 to 84.1 ± 18.1 after intra-articular injection (all $P < 0.001$). The iHOT-12 score increased from 52.1 ± 23.2 to 78.9 ± 19.2, and the MHHS increased from 66.5 ± 6.8 to 81.6 ± 8.1 after hip arthroscopy (all $P < 0.001$). The satisfaction rate of arthroscopy, including very satisfied and effective patients, was 93.3%. Multi-variable logistic regression showed that only iHOT-12 improved value after injection was included in the regression formula of satisfaction, with the β of −0.154, standard error of 0.071, Wald value of 4.720, and OR of 0.857 (95%CI 0.746–0.985) ($P = 0.03$). Significant correlation was detected between iHOT-12 scores after intra-articular anesthesia and at 12 months after arthroscopy ($r = 0.784$, $P < 0.001$). So was the iHOT-12 improved value ($r = 0.781$, $P < 0.001$) and the iHOT-12 improved ratio ($r = 0.848$, $P < 0.001$). If we had performed arthroscopy only on patients with post-injection iHOT-12 score improvement ≥10, the satisfaction rate of arthroscopy would have increased to 96.6%.

Conclusions: US-guided intra-hip joint injection may provide a feasible way to estimate the outcome of hip arthroscopy in patients with FAI syndrome, and could be used as a method for indication selection of hip arthroscopy.

Key words: Arthroscopy; Femoroacetabular impingement syndrome; Hip; Outcome; Ultrasound

Address for correspondence Mingbo Zhang, MD, Department of Ultrasound, The First Medical Center, General Hospital of Chinese PLA, No. 28 Fuxing Road, Haidian District, Beijing, China 100853 Tel: +86 13552744805; Fax: +86 010 66937394; Email: owsifanduizhe@126.com, Haipeng Li, MD, Department of Orthopedics, The Fourth Medical Center, General Hospital of Chinese PLA. No. 28 Fuxing Road, Haidian District, Beijing, China 100853 Tel: +86 13811635940; Fax: +86 010 66939533; Email: doctorlhp@163.com
Address for reprints: Same as the corresponding author address.

Shoupeng Li and Chunbao Li authors contributed equally to this work and should be considered co-first authors.
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Introduction

Femoroacetabular impingement (FAI), also known as hip impingement syndrome, was officially proposed by Ganz *et al.*[1], as a condition of abnormal contact that may arise as a result of anatomic variations in the femur and acetabulum. FAI can cause injury of the hip labrum cartilage and other structures, leading to hip pain and dysfunction, and is considered the early stage of primary hip osteoarthritis[2].

FAI is prevalent in asymptomatic general and athletic populations[3], as well as in symptomatic patients[4]. The prevalence of cam type and pincer type FAI were 4.2% and 20.3% in Asian population older than 50 years old[5]. The diagnosis of FAI relies on the presence of symptoms, clinical signs and imaging findings[6]. However, because of the deep position of the hip joint, abundant surrounding muscle tissue, slow onset of symptoms, and a lack of characteristic pain manifestations, it is often misdiagnosed as "osteoarthritis" or "femoral head necrosis," leading to poor curative effect.

Treatments of FAI include non-operative treatment, hip arthroscopy[1], and open surgery. Non-operative treatments have limited benefit for FAI patients[7]. Both arthroscopy and open surgery provide excellent and equivalent patient outcomes. However, arthroscopy has the benefit of minimal trauma, rapid recovery, lower complication rate, higher quality of life, and higher probability of returning to play for athletes[8–11]. Hip arthroscopy has recently gained importance in hip joint surgery[12] and, with rapidly increasing numbers[13–15], has become the mainstream treatment for FAI[16]. However, because of the complexity of the FAI diagnosis, it is a challenge for orthopaedic surgeons to identify the indications of hip arthroscopy and to predict its outcome. Studies have suggested that many factors are associated with outcome of hip arthroscopy: patients older than 50 years may require conversion to total hip arthroplasty within 5 years of the hip arthroscopy[17]; longer duration of symptoms, and worse preoperative pain and functional scores are associated with poor outcomes of FAI[18]; greater age at the index operation, worse preoperative modified Harris hip score (MHHS), and over 1.5-year duration of symptoms preoperatively were associated with poor outcomes[18]; patients with symptoms due to residual cam- or pincer-type deformity may affect the outcome, which are related with the technique of the surgeon[19]. However, identifying the origin of hip pain is the key to detect the hip joint pathology, to ensure the reasonable indication of the hip arthroscopy, and to improve its outcome, which is often difficult for surgeons.

To avoid such situations, pain relief after intra-articular local anesthesia injection can be used to support the diagnosis of FAI syndrome[20–22] and then to predict the outcome of hip arthroscopy. The hypothesis of this approach is to block the pain caused by the internal hip lesion with local anesthesia, simulating the effectiveness of hip arthroscopy. If the patient's pain is significantly reduced, the disease is likely to come from the hip joint; otherwise it is considered that the lesion originates from other positions. In addition, the degree of pain reduction is similar to that which can be achieved after arthroscopy. And with imaging guidance, this process can be more accurate. Ultrasound (US) is a convenient imaging method with no radiation. Therefore, it can be used to guide intra-articular injection[6,23–25].

The purpose of our study is: (i) to explore the use of US-guided intra-articular injection to predict the therapeutic effect of hip arthroscopy on FAI; (ii) to provide a more accurate indication for the treatment of hip arthroscopy on FAI patients; and (iii) to improve the life quality of the FAI patients.

Patients and Methods

Inclusion and Exclusion Criteria

From January 2018 to February 2019, 60 consecutive patients in our hospital (27 males and 33 females) with an average age of 38.6 ± 14.9 years (range: 14 to 69 years) were enrolled in our study. Institutional approval was obtained by the ethics committee of our hospital. Written informed consent was obtained from each participant.

Inclusion criteria were: (i) clinically diagnosed as FAI; (ii) no remission after conservative treatment for 6 months; (iii) all patients underwent US-guided intra-articular injection within 2 weeks before hip arthroscopy and rehabilitation after hip arthroscopy; and (iv) the outcome of US-guided intra-articular injection and hip arthroscopy were evaluated and compared.

Exclusion criteria were: (i) acetabular dysplasia, center-edge angle <25°; (ii) hip osteoarthritis with Tonnis grade 3 or above; (iii) history of peri-hip fracture or surgical operation; (iv) local or global pincer deformities, including acetabular retroversion, acetabular inversion, and acetabular floor protrusion; (v) lumbar spine disease, ankylosing spondylitis, or sacroiliac joint lesions; (vi) rheumatic diseases or femoral head necrosis; or (vii) arthroscopy proved FAI not present.

General information, including gender, age, height, weight, body mass index, duration of disease, and the affected side of the patient, was collected for each patient.

US-guided Intra-articular Injection

A Mylab Twice US system (Esaote SpA, Geneva, Italy) with CA541 convex transducer (frequency, 1-8MHz) was used in this study.

The patient lay supine with the lower extremity of the affected hip in neutral rotation. A US-guided intra-articular injection was performed by a doctor with more than 4 years' experience in interventional US and musculoskeletal US.

The intra-articular injection involved three steps. First, a survey scan of the hip joint was performed, allowing visualization of the anterior rim of the acetabulum, femoral head, femoral neck, and the anterior recess (Fig. 1).

Second, sterilization was performed in the patient's anterior hip and groin area. The longitudinal section of femoral neck was displayed. A 21-gauge 200 mm length core needle (Hakko Company, Chikuma-Shi, Nagano, Japan) was punctured by intra-plane technique from head to foot along the articular capsule to the anterior recess of the hip joint,

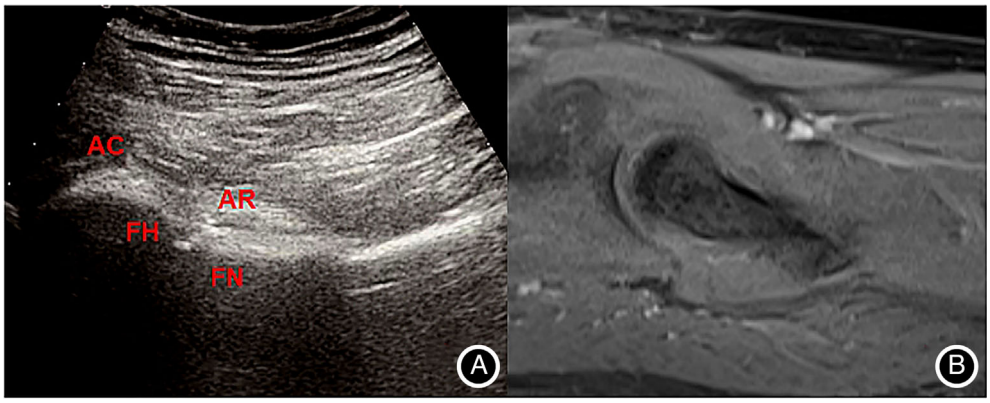

Fig 1 Ultrasound (left) and MRI (right) images of the oblique sagittal section at femoral acetabular junction. FH, Femoral head; FN, Femoral neck; AR, Anterior recess; AC, Acetabulum.

avoiding the femoral artery, femoral vein, femoral nerve, and lateral circumflex femoral artery (Fig. 2).

Third, an anesthetic mixture of 4 mL 2% lidocaine (5 mL:0.1 g, Suicheng Pharmaceutical Company, Xinzheng, Henan, China) and 4 mL 1% ropivacaine (100 mg/10 mL, AstraZeneca AB, Södertälje, Sweden) were injected through the needle. Any effusion present in the hip joint cavity was extracted before injection. A small amount of liquid was injected first. If there was no resistance, the rest was injected into the joint cavity. If there was resistance, the direction of the needle tip was adjusted until no resistance was felt during injection and the liquid was then injected (Fig. 3).

Hip Arthroscopy

Hip arthroscopy was performed by one surgeon (L. C. B.) with more than 5 years of experience in hip arthroscopy.

All procedures were performed under general anesthesia with the patient in the supine position on a standard traction table. Anterolateral, mid-anterior, and distal anterolateral accessory portals were established to provide visualization of the central and peripheral compartments.

Procedures including labial repair or partial debridement, acetabular rim trimming, femoral osteo-chondroplasty, and limited synovectomy were performed. After verification of hip function with a dynamic examination, the capsule was sutured at the end of the procedure.

Rehabilitation

All patients underwent a rehabilitation protocol. The surgical leg was restricted to 30% foot-flat weight bearing and the hip joint allowed to flex to 90° passively the day after the operation. At week 4, patients could wean off crutches if they were able to tolerate ambulation without significant pain. At week 6, patients were allowed to use the elliptical machine. Patients could progress to sport-specific activities at week 24.

Outcome Measures of Intra-articular Injection

The Visual Analog Scale (VAS) Score of Hip Physical Examinations

The patient's pain intensity was self-assessed before and 30 min after intra-articular injection. The doctor who performed the injection for the patients carried out hip physical examination for the patient, including rolling test, internal rotation, external rotation, hyperflexion, flexion internal rotation, and 4-character test. The visual analog scale (VAS) was evaluated in each physical examination position. A 100-mm VAS was employed, and patients could rate pain intensity from no pain (0 mm) to unbearable pain (100 mm). The sum of VAS scores in each position before and after US-guided intra-articular injection were calculated, and it was used to evaluate the clinical efficacy of local anesthesia before and after injection.

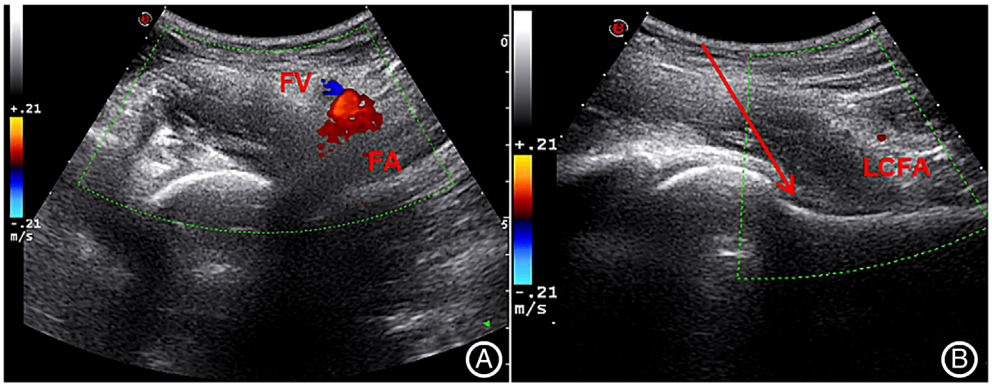

Fig 2 Ultrasound-guided intra-articular injection to avoid important vessels. FA, femoral arteries; FV, For Review Only femoral veins; LCFA, Lateral circumflex femoral artery. The red arrow indicates puncture direction.

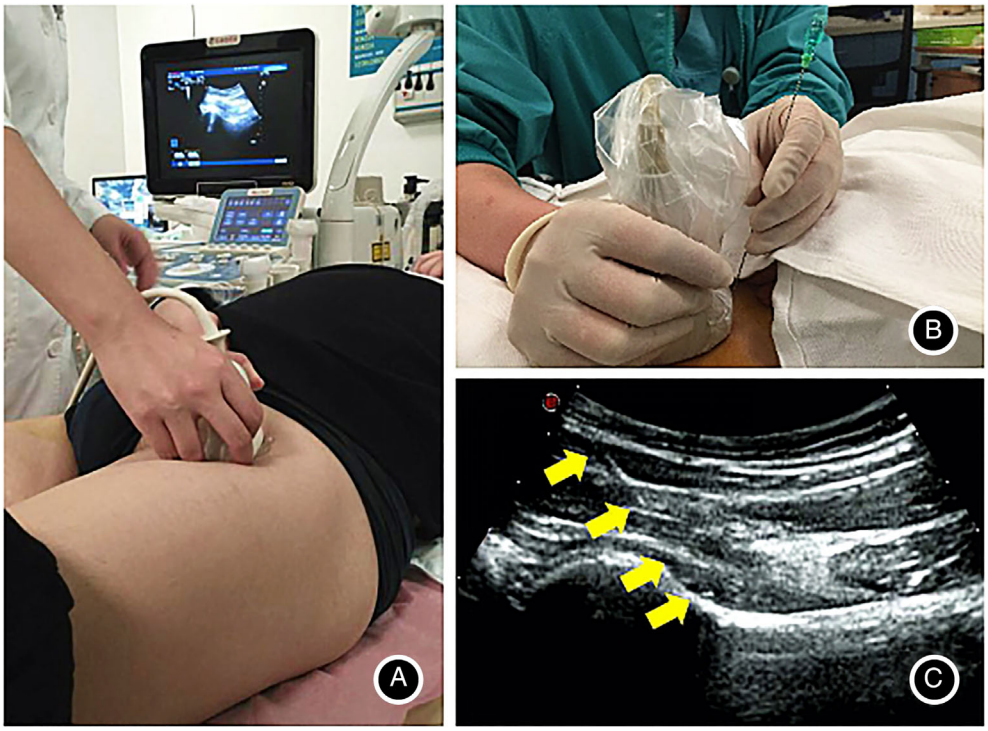

Fig 3 Ultrasound (US)-guided intra-articular injection. (A) A survey scan of the hip joint before injection; (B) US-guided in-plane puncture technique. (C) The US image during puncture; yellow arrows indicate the 21-gauge fine needle.

The International Hip Outcome Tool 12 (iHOT-12) Score

Two iHOT-12 tables were distributed to each patient. One of them was filled before intra-articular injection and the other was filled 30 min after the injection. The total iHOT-12 scores in each patient before and after intra-articular injection was calculated and they were used to evaluate the hip function before and after injection.

Outcome Measures of Hip Arthroscopy

Patients' Satisfaction

At 12 months after arthroscopy, another doctor who was not involved in the hip arthroscopy or US-guided intra-articular injection followed the patient's satisfaction by telephone. The satisfaction of the patients was divided into three grades (very satisfied, effective, and fail) according to the patient's own description. It was used to evaluate the subjective feelings of patients after arthroscopy.

The iHOT-12 and MHHS Scores

Firstly, the iHOT-12 and MHHS tables were filled by each patient within 1 week before hip arthroscopy. Twelve months after arthroscopy, another doctor who was not involved in the hip arthroscopy or US-guided intra-articular injection followed the patients by telephone and filled the iHOT-12 and MHHS tables according to their own description. They were used to evaluate the quality of life of patients after arthroscopy.

Statistical Analysis

All statistical analysis was performed using IBM SPSS for Windows, version 24.0 (IBM Corp., Armonk, NY, USA). Clinical information including age, height, weight, body mass index, symptom duration, VAS, iHOT-12, and MHHS scores are all quantitative variables and are described as mean ± SD (range). The gender is a qualitative variable and is described as number (ratio). The gender is compared by chi-square test. The VAS and iHOT-12 scores before and after intra-hip injection of local anesthesia and the iHOT-12 and MHHS scores before and after hip arthroscopy were compared by Wilcoxon Signed Ranks Test. The subgroup analysis was performed for the improved value and ratio of MHHS and iHOT-12 after hip arthroscopy, and the factors related to the satisfactory outcomes of hip arthroscopy were analyzed. Normal distribution variables were compared by T test and non-normal distribution variables were compared by Mann–Whitney U Test. Factors related to the satisfactory outcomes of hip arthroscopy were evaluated by uni-variate analysis first and followed by logistic multi-variate regression. Bivariate correlation analysis was used to evaluate the correlation between the change of iHOT-12 after anesthesia injection and after operation. A P-value <0.05 was considered to indicate a statistically significant difference.

Results

General Results

The study included 27 male and 33 female patients, with an average age of 38.6 ± 14.9 years (range: 14 to 69 years).

Average height, weight, and body mass index (BMI) of patients were 167.4 ± 9.4 cm (148–185 cm), 66.1 ± 11.9 kg (48 to 90 kg), and 23.5 ± 3.6 kg/m^2 (17.1 to 29.4 kg/m^2), respectively. Their average course of disease was 19.9 ± 21.5 months (6 to 120 months). All patients were confirmed to be in accordance with the diagnosis of FAI syndrome and acetabular labrum injury by intraoperative arthroscopy. All incisions healed without serious complications.

The Outcome of Intra-articular Injection

Ultrasound (US)-guided injection images of three different cases were shown in Fig. 4. By 20 min after intra-articular injection, the VAS score of patients decreased from 11.3 ± 7.7 to 3.3 ± 4.5, and the iHOT-12 score increased from 52.1 ± 23.2 to 84.1 ± 18.1 (all $P < 0.001$). The score improved value was 8.0 ± 5.2 for VAS and 32.0 ± 17.6 for iHOT-12; and the score improvement ratio was 0.71 ± 0.27 for VAS and 0.91 ± 0.88 for iHOT-12 (all $P < 0.001$, Table 1).

The Outcome of Hip Arthroscopy

iHOT-12

At 12 months after arthroscopy, the iHOT-12 score increased from 52.1 ± 23.2 to 78.9 ± 19.2 ($P < 0.001$). The score improved value was 26.8 ± 18.6 for iHOT-12; and the score improvement ratio was 0.78 ± 0.84 for iHOT-12 (all $P < 0.001$, Table 2). Subgroup comparisons of the iHOT-12 improvement after the hip arthroscopy showed that no significant difference was detected among the subgroups of age, gender, and symptom duration (Table 3).

MHHS

At 12 months after arthroscopy, the MHHS increased from 66.5 ± 6.8 to 81.6 ± 8.1 ($P < 0.001$). The score improved value was 15.1 ± 7.0 for iHOT-12; and the score improvement ratio was 0.23 ± 0.12 for iHOT-12 (all $P < 0.001$, Table 2). Subgroup comparisons of the MHHS improvement after the hip arthroscopy showed that no significant difference was detected among the subgroups of age, gender, and symptom duration (Table 3).

Patients' Satisfaction

For the patients' satisfaction, 36 were very satisfied, 20 were effective, and four considered that the operation failed. The satisfaction rate of arthroscopy, including very satisfied and effective patients, was 93.3%. Factors related to the satisfactory outcomes of hip arthroscopy showed that the gender, age, iHOT-12 improved value and ratio after hip arthroscopy and after injection showed significant difference between satisfactory and unsatisfactory groups (Table 4). After logistic regression, only iHOT-12 improved value after injection was included in the regression formula, with the β of −0.154,

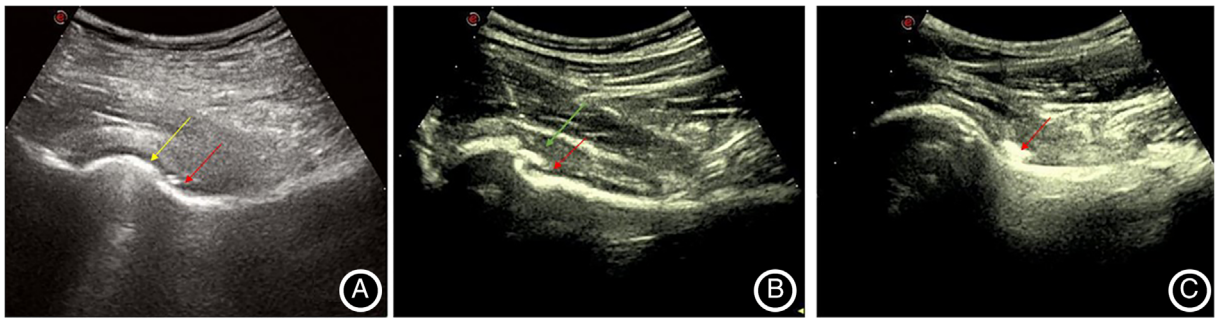

Fig 4 Ultrasound (US)-guided injection images of three different cases (red arrow indicated the needle tip). (A) A 52-year-old lady with small amount of effusion in hip joint cavity (yellow arrow), which showed a thin layer of anechoic area; (B) A 24-year-old man with obvious thickened hip capsular (green arrow), which showed a layer of thickened iso-echoic area around the hip; (C) A 21-year-old man with no US abnormality in the anterior part of hip joint.

TABLE 1 Comparisons of VAS and iHOT-12 score before and after intra-articular injection*

	Score before injection	Score after injection	*P*-value	Z value	Score improvement	
					Value	Ratio
VAS	11.3 ± 7.7	3.3 ± 4.5	<0.001	6.349	8.0 ± 5.2	0.71 ± 0.27
iHOT-12	52.1 ± 23.2	84.1 ± 18.1	<0.001	6.511	32.0 ± 17.6	0.91 ± 0.88

*VAS, visual analog scale; iHOT-12, international hip outcome tool 12. Ratio, the ratio of the score improvement value after injection to the score before injection. VAS and iHOT-12 score before and after intra-articular injection are described as mean ± SD.

TABLE 2 Comparison of iHOT-12 and MHHS scores before and after hip arthroscopy*

	Score before operation	Score after operation	*P*-value	Z value	Score improvement	
					Value	Ratio*
iHOT-12	52.1 ± 23.2	78.9 ± 19.2	<0.001	6.516	26.8 ± 18.6	0.78 ± 0.84
MHHS	66.5 ± 6.8	81.6 ± 8.1	<0.001	6.512	15.1 ± 7.0	0.23 ± 0.12

* iHOT-12, international hip outcome tool 12; MHHS, modified Harris hip score. Ratio, the ratio of the score improvement after hip arthroscopy to the score before operation. iHOT-12 and MHHS score before and after hip arthroscopy are described as mean ± SD.

TABLE 3 Subgroup comparisons of the iHOT-12 and MHHS improvement after the hip arthroscopy*

	iHOT-12 improvement						MHHS improvement					
	Value	*P*-value	Z value	Ratio*	*P*-value	Z value	Value	*P*-value	Z value	Ratio*	*P*-value	Z value
Gender												
Male (27/60)	25.1 ± 17.3	0.547	0.603	0.62 ± 0.58	0.319	0.996	15.4 ± 8.9	0.852	0.187	0.24 ± 0.15	0.634	0.476
Female (33/60)	28.2 ± 19.7			0.91 ± 1.00			14.8 ± 5.1			0.22 ± 0.09		
Age												
<50y (46/60)	25.3 ± 18.4	0.261	1.123	0.74 ± 0.89	0.259	1.129	15.8 ± 6.9	0.085	1.722	0.24 ± 0.12	0.214	1.242
≥50 y (14/60)	31.6 ± 19.1			0.90 ± 0.65			12.6 ± 6.8			0.19 ± 0.11		
Symptom duration												
<24 m (37/60)	26.5 ± 18.8	0.915	0.107	0.82 ± 0.95	0.891	0.137	14.6 ± 6.6	0.743	0.328	0.22 ± 0.11	0.897	0.129
≥24 m (23/60)	27.3 ± 18.6			0.71 ± 0.64			15.8 ± 7.6			0.24 ± 0.13		

* iHOT-12, international hip outcome tool 12; MHHS, modified Harris hip score. Ratio, the ratio of the score improvement after hip arthroscopy to the score before operation. iHOT-12 and MHHS score improvement after hip arthroscopy are described as mean ± SD.

TABLE 4 Factors related to the satisfactory outcomes of hip arthroscopy*

	Satisfactory outcome (n = 40)	Unsatisfactory Outcome (n = 20)	*P*	Statistic Value†
Gender				
Male	23 (85.2%)	4 (14.8%)	0.036	5.238
Female	33 (100%)	0		
Age (year)	39.5 ± 15.0	25.8 ± 2.9	0.023	2.228
Height (cm)	167.1 ± 9.6	171.3 ± 5.9	0.365	0.936
Weight (kg)	65.8 ± 12.2	69.5 ± 6.4	0.519	0.669
BMI (kg/m^2)	23.5 ± 3.7	23.8 ± 2.8	0.875	0.178
Symptom duration(month)	19.7 ± 21.9	22.3 ± 16.1	0.483	0.749
iHOT-12 improved value after hip arthroscopy				
Value	28.1 ± 18.5	7.5 ± 2.6	0.003	2.716
Difference ratio	0.83 ± 0.85	0.12 ± 0.07	0.012	2.401
MHSS improved value after hip arthroscopy				
Value	15.4 ± 7.0	10.0 ± 4.5	0.089	1.726
Difference ratio	0.24 ± 0.11	0.14 ± 0.07	0.058	1.883
iHOT-12 improved value after injection				
Value	33.4 ± 17.1	12.3 ± 11.6	0.011	2.418
Difference ratio	0.96 ± 0.89	0.22 ± 0.23	0.019	2.268
VAS improved value after injection				
Value	8.2 ± 5.3	5.3 ± 3.8	0.265	1.149
Difference ratio	0.71 ± 0.27	0.72 ± 0.21	0.764	0.313

* BMI, body mass index; iHOT-12, international hip outcome tool 12; MHHS, modified Harris hip score; VAS, visual analog scale. Age, height, weight, body mass index, symptom duration, VAS, iHOT-12 and MHHS scores are described as mean ± SD. The gender is described as number (ratio).; † Chi-square value is used to describe the chi-square test of the gender comparison between two groups. T value is used to describe the T test of the comparison of the normal distribution variables. Z value is used to describe the Mann–Whitney U Test of the comparison of the non-normal distribution variables.

TABLE 5 The correlation of iHOT-12 score between intra-articular injection and arthroscopy

The correlation of iHOT-12 score after injection and arthroscopy	Correlation coefficient	*P*
iHOT-12 score	0.784	<0.001
iHOT-12 improved value	0.781	<0.001
iHOT12 improved ratio	0.848	<0.001

standard error of 0.071, Wald value of 4.720, and OR of 0.857 (95% CI 0.746–0.985) ($P = 0.03$).

And all patients that considered the operation "effective" or "very successful" had an iHOT-12 score improvement ≥10. If we had performed arthroscopy only on patients with post-injection iHOT-12 score improvement ≥10, the satisfaction rate of arthroscopy would have increased to 96.6%.

The Correlation of iHOT-12 Score Between Intra-articular Injection and Arthroscopy

Significantly correlation was detected between iHOT-12 scores after intra-articular anesthesia and at 12 months after arthroscopy ($r = 0.784$, $P < 0.001$). So were the iHOT-12 improved value ($r = 0.781$, $P < 0.001$) and the iHOT-12 improved ratio ($r = 0.848$, $P < 0.001$) (Table 5).

Complications

All patients recovered well without serious complications. Two patients developed pain in the inguinal region after intra-articular injection, which resolved 3 days later without treatment.

Discussion

The Outcome of Intra-articular Injection in FAI Patients

FAI has high prevalence in clinical practice. The complexity of FAI diagnosis creates challenges for orthopaedists when identifying the indications of hip arthroscopy and predicting its outcome. Pain relief after intra-articular injection may indicate whether the pain comes from the hip or another region, and can be used to support the diagnosis of FAI[20]. Thus, our study aimed to explore whether US-guided intra-articular injection can be used to predict the efficacy of hip arthroscopy. In our study, VAS scores were significantly reduced and iHOT-12 scores significantly improved after intra-articular injection. The results confirmed not only the origin of the pain, but also the accuracy of the injection.

The Outcome of Hip Arthroscopy and the Influencing Factors in FAI Patients

In our study, the iHOT-12 and MHHS scores were significantly improved 12 months after hip arthroscopy, and the satisfaction rate of arthroscopy was 93.3%, indicating the efficacy of hip arthroscopy in our study.

Many other factors affect FAI response to treatment. Patients over age 50 may require conversion to total hip arthroplasty[17]. Severe cartilage damage (cartilage thickness less than 2 mm), advanced osteoarthritis, higher age at surgery, and longer duration of symptoms are all strong predictors for failure[18]. However, in our study, subgroup comparisons of the iHOT-12 and MHHS improvement after the hip arthroscopy showed that no significant difference was detected among the subgroups of age, gender, and symptom duration, which may be affected by limited cased. Incomplete bony resection of the cam or pincer lesion may also necessitate revision operations[19], which did not happen in our patients.

Intra-hip joint Injection as a Way to Predict the Outcome of Arthroscopy in FAI Patients

Multi-variable logistic regression showed that only iHOT-12 improved value after injection was included in the regression formula of satisfaction, which suggested that intra-articular injection may provide a feasible way to predict the outcome of hip arthroscopy in patients with FAI syndrome.

Significant correlation was detected between iHOT-12 scores after intra-articular anesthesia and at 12 months after arthroscopy. The results suggest that intra-hip articular injection may allow patients to have a more direct perception of the surgery effect, which can be used to establish confidence of surgery and to promote a better communication between doctors and patients.

Intra-hip joint Injection for Patients Selection of Arthroscopy in FAI Patients

In our study, the satisfaction rate of arthroscopy was 93.3%. If we had performed arthroscopy only on patients with post-injection iHOT-12 score improvement≥10, the satisfaction rate of arthroscopy would have increase to 96.6%.

US-Guided Intra-articular Injection: Technique and Precautions

In 2004, Byrd and Jones[23] first reported on the diagnostic value of an intra-articular injection in patients undergoing arthroscopy. Image guidance makes the injection more accurate, safe, and effective. US is widely used since it demonstrates superiority over fluoroscopy based on patient satisfaction and convenience, and it has excellent reliability and a minimal learning curve for mastery of the technique[25,26].

In our study, the injection position was the anterior recess of the hip joint, which is a hypo-echoic area in the femoral head neck junction. The needle insertion path was from head to foot, which differed from other studies[25,26], and its efficacy was confirmed in our results. The advantages of this path are as follows: (i) the lateral circumflex femoral artery can be better avoided to avoid vascular injury; (ii) most patients have no hydrocele in the hip joint cavity. The volume of the anterior recess is small. This insertion path allows the needle tip to be located in the long axis of the anterior recess, making it easier for the needle tip to

enter the joint capsule; and (iii) the needle path is shorter, which causes less damage to the patient.

However, this method has a steeper needle path, which leads to certain requirements for the freehand US-guided technique. In our study, we used 21-gauge fine needle to minimize damage to surrounding tissue. The needle tip does not show up well in the intersection area of adipose layer and fascia, but it is displayed clearly in the muscular layer. Thus, we adjusted the position of the needle tip in the muscular layer, using slight vibration of the needle tip. When the needle tip reached the femoral surface, the assistant helped to inject local anesthetics. If there was resistance to injection, the injection was stopped, since forced injection can lead to exosmosis and pain, and adjusted the angle and position of the needle tip. We then re-tried the injection. If there was effusion in the hip joint cavity, we first extracted the effusion to avoid dilution of the anesthetics by the joint cavity effusion, which might reduce the anesthetic effect.

The dosage of anesthetics in our study was 4 mm 2% lidocaine and 4 mm 1% ropivacaine, which is close to the recommendation in Nashivelle Sound[24]. The evaluation of patients was performed at >20 min after injection to ensure best anesthetic efficacy.

Complications

In our study, two patients had their symptoms relieved immediately after anesthetic injection, but experienced pain at the puncture point in the first day of injection that was gradually relieved after 3 days. This may have been caused by injection into the articular capsule and the attachment ligament in the joint capsule. Another possibility is that the ligament, periosteum, or joint capsule formed blunt separation during the attempt to inject anesthetics, resulting in puncture point pain. Thus, careful adjustment of the needle tip into the capsule space is necessary as soon as we encounter resistance to insure we inject into the hip joint cavity.

Limitations

Our research has limitations. First, our study does not consider the repeatability of intra-articular injections effects when directed by different ultrasound doctors. Second, the sample size is still limited in this study. In the future, we need to do more work in these areas.

In conclusion, US-guided intra-articular injection is a useful method to estimate the outcome and to identify the indications of hip arthroscopy. Its application may improve the outcome and the satisfaction of hip arthroscopy in FAI patients.

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