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Treatment of Hip Microinstability with Arthroscopic Capsular Plication: A Retrospective Case Series

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Purpose: Hip microinstability is defined as hip pain with a snapping and/or blocking sensation accompanied by fine anatomical anomalies. Arthroscopic capsular plication has been proposed as a treatment modality for patients without major anatomic anomalies and after failure of properly administered conservative treatment. The purpose of this study was to determine the efficacy of this procedure and to evaluate potential predictors of poor outcome.

Materials and Methods: A review of 26 capsular plications in 25 patients was conducted. The mean postoperative follow-up period for the remaining patients was 29 months. Analysis of data included demographic, radiological, and interventional data. Calculation of pre- and postoperative WOMAC (Western Ontario and McMaster Universities Osteoarthritis) index was performed. Pre- and postoperative sports activities and satisfaction were also documented. A $P<0.05$ was considered significant.

Results: No major complications were identified in this series. The mean pre- and postoperative WOMAC scores were 62.6 and 24.2, respectively. The WOMAC index showed statistically significant postoperative improvement ($P=0.0009$). The mean satisfaction rate was 7.7/10. Four patients with persistent pain underwent a periacetabular osteotomy. A lateral center edge angle $\leq 21^{\circ}$ was detected in all hips at presentation. We were not able to demonstrate any difference in postoperative evolution with regard to the presence of hip dysplasia ($P>0.05$), probably because the sample size was too small.

Conclusion: Capsular plication can result in significant clinical and functional improvement in carefully selected cases of hip microinstability.

Key Words: Hip, Arthroscopy, Joint instability, Joint capsule

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INTRODUCTION

The introduction of hip arthroscopy enabled improved comprehension of this joint and its various pathologies[1-3]. Interest in hip stability has increased as a result of the increase in indications and number of arthroscopies performed[2]. Hip stability is dependent upon osseous congruity, the labral suction seal, and the integrity of the hip capsule-ligamentous complex, as well as dynamic muscular forces[2]. The biomechanics of the native hip can be influenced by an abnormality of one of these anatomical structures[2]. Microinstability of the hip comprises hip pain accompanied by fine anatomical anomalies[4]. A subtle supra-physiological increased translation of the femoral head occurs in the acetabulum during mobilization of the hip, which can disrupt normal kinematics of the hip, causing symptoms such as hip pain, as well as snapping and/or blocking sensations[2,5]. These symptoms are associated with repetitive movements of rotation and axial loading[4]. Finally, this type of instability can lead to changes in hip biomechanics, resulting in development of lesions affecting other anatomical structures such as the labrum, capsule, and cartilage[4]. Reported causes of hip microinstability[6] include bone anomalies (hip dysplasia and femoro-acetabular impingement), soft tissue pathologies (hyperlaxity, connective tissue disorders) and lesions, trauma, and iatrogenic causes[6,7].

In cases where conservative treatment has failed, surgical management can be considered for treatment of intra-articular lesions as well as eventual associated structural anomalies and to improve hip stability[6,8]. In cases where patients do not present with significant osseous anomalies such as severe hip dysplasia, surgical treatment focusing on the capsule-ligamentous complex of the hip has been proposed[8].

According to our hypothesis, use of arthroscopic capsular plication might result in improvement of short-term clinical and functional outcomes in patients presenting with hip microinstability without gross osseous anomalies. An analysis of operative indications was performed in order to identify the most common presentations of hip microinstability. We also attempted to determine factors that might have a negative influence on postoperative results. Our review of all arthroscopic capsular plication procedures performed at a specialized center was conducted as a preliminary series.

MATERIALS AND METHODS

1. Study Design

This study was conducted with the agreement of the designated French ethical committee of Poissy-Saint-Germain-en-Laye Hospital (No. 2017-A01900-53), and the written informed consent was obtained from all patients.

A retrospective study of 25 patients who underwent 26 arthroscopic capsular plication procedures for treatment of symptomatic hip microinstability between September 2012 and January 2018 at Clinique du Sport was conducted. All patients underwent surgery performed by the senior author (F.L.). The patients included in the study presented with symptomatic hip microinstability resulting from hip dysplasia, general hyperlaxity, traumatic events, or iatrogenic causes without gross osseous anomalies requiring arthroscopic capsular plication after failure of properly administered conservative treatment for at least six months. A minimum postoperative follow-up period of 12 months was required for the end point analysis. The mean postoperative follow-up period was 29 months for the remaining 26 hips.

Exclusion criteria were as follows: measurement of hip dysplasia with a lateral center edge angle (CEA) less than 17°, sequelae of Legg–Calvé–Perthes disease, severe osteoarthritis on preoperative X-rays, and age 50 years or older at the time of intervention. None of the patients were excluded based on these exclusion criteria.

Collected data included demographic data (age, sex, complaints, and preoperative work-up), interventional data (length of the procedure, traction time, operative gestures performed, and complications), and postoperative data.

The preoperative work-up included calculation of the WOMAC (Western Ontario and McMaster Universities Osteoarthritis) index, a validated French version[9], and radiographic evaluation with conventional X-rays, scanner arthrography and magnetic resonance imaging. All X-rays were assessed for the presence of osteoarthritis and classified according to the Tönnis classification[10]. The angle of the lateral center edge, the Tönnis angle, and the femoro-epiphyseal acetabular roof (FEAR) index were determined using anteroposterior standing pelvic incidences[11]. The alpha angle was calculated on a modified Dunn view.

Patients received a standard questionnaire consisting of different sections pertaining to pain, joint stiffness, and function in order to determine a final postoperative WOMAC (Western Ontario and McMaster Universities Osteoarthritis)

index. Evaluation of satisfaction was performed using a scale from 1 (0% satisfaction) to 5 (100% satisfaction). Preoperative sports practice was documented and evaluation of the quality of the return to sports was performed using a scale divided into four categories (Table 1). Responses were collected through email or phone. Unfortunately, only 21 patients (22 hips) responded, thus four patients (four hips) were lost to follow-up.

The end point of this study was defined as the date of the response to the standard questionnaire sent to the patients or the date of revision surgery in cases where the intervention was ineffective.

2. Operative Technique

All patients were placed in supine position on an orthopedic traction table. All procedures were performed using the outside-in technique, starting from the peripheral compartment.

The first entrance point was the antero-lateral portal, placed with the hip in slight flexion and abduction and the knee extended. After confirming a good position by palpation of the femoral neck, the hip was flexed and internally rotated relaxing the ilio-femoral ligament.

After positioning the second entry point, the anterior portal under arthroscopic guidance, debriding of precapsular fat was performed, avoiding damage to the circumflex vessels. A T-shaped capsulotomy starting along the axis of the femoral neck and ending circumferential to the anterior labrum was performed. After capsulotomy, gentle traction was applied for inspection of the central compartment and for treatment of eventual intra-articular lesions. Treatment of labral lesions was based on feasibility; some lesions were debrided and reinsertion was performed when possible. When a reparable labral lesion associated with a wave sign was detected, the wave was tensioned with the anchor of the labral repair at the same time. After treatment of all lesions located in the central compartment, traction was released and the peripheral compartment was addressed.

Capsular plication was performed last (Fig. 1). The first and most important suture point to be placed was the point at the level of the zona orbicularis. A second suture was placed proximal with or without a bone anchor depending on technical feasibility (Fig. 2). A third suture was placed between the first two points if possible. Wide placement of sutures enabled a real imbrication of the two parts of the hip capsule in order to obtain a hip capsule that is tighter in external rotation. Following placement of all sutures, tightening was performed under arthroscopic guidance.

Postoperatively, maintenance of slight hip flexion and walking with high heels for six weeks was recommended for all patients; protected weight bearing was recommended for four weeks and immediate use of training bikes was recommended after the intervention in order to avoid capsular adhesions.

Table 1. Categories of Quality of Return to Sports

Have you resumed your sports activities after the intervention?
1 Yes, on the same level as before the appearance of the symptoms.
2 Yes, but less intensively because of my hip.
3 No, because of my hip.
4 No, for another reason that does not concern my hip.

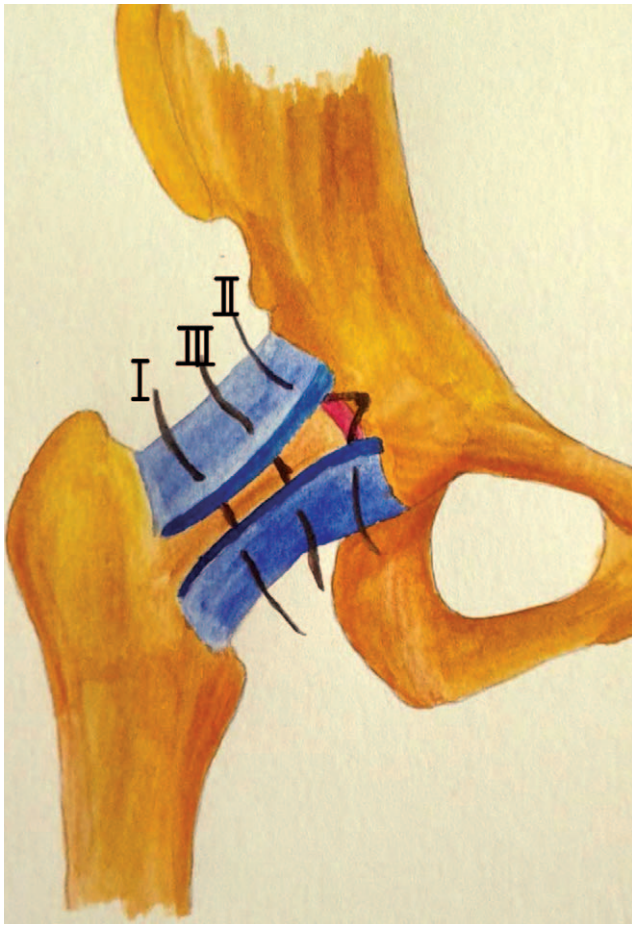

Fig. 1. Front view of a right hip representing the sutures of the capsular plication along the borders of the previously performed longitudinal capsulotomy.

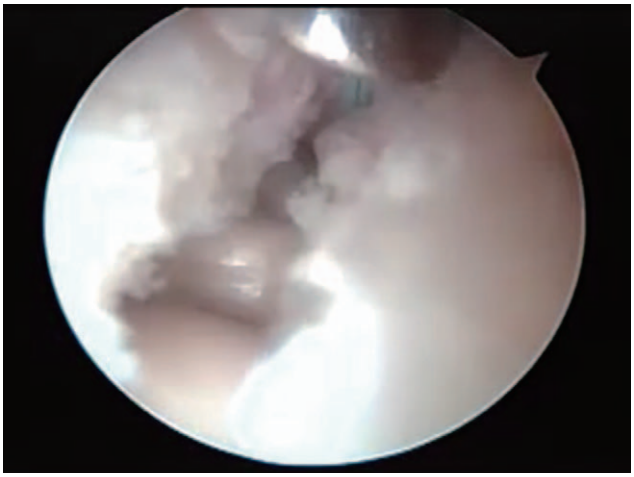

Fig. 2. Arthroscopic view of anchor placement for proximal suture point.

3. Statistical Analysis

All statistical analyses were performed using Systat v 5.0 for DOS (Systat Software, Chicago, IL, USA). Analysis of differences in pre- and postoperative WOMAC scores was performed using a Wilcoxon matched-pairs signed rank test. Two-way analysis of variance for repeated measures was performed for evaluation of the influence of variable parameters on the postoperative evolution. A *P*-value <0.05 was considered significant.

RESULTS

1. Patient Demographics

The mean follow-up period for the remaining 26 hips was 29 months (range, 14-70 months). None these hips presented with a lateral CEA of less than 17° or with sequelae of Legg–Calvé–Perthes disease.

All patients who underwent a capsular plication were female (Table 2). The mean age of patients was 28.3 years (range, 16-47 years). Surgery was performed in 19 right hips and in seven left hips.

All patients described a major complaint of hip pain during mobilization or sports activities. Eight patients also presented with painful blocking and snapping of the affected hip. Two patients ascribed their symptoms to minor traumatic events and two other patients had benefitted previously from an arthroscopic intervention (one case of a labral lesion and one case of femoroacetabular impingement).

As a result of clinical examination, seven patients showed signs of general hyperlaxity according to the Beighton score ≥4[12]. Of these patients, one received a postoperative diagnosis of Ehlers–Danlos syndrome. The mean preoperative WOMAC score for the 26 included patients was 60.8 (range, 33-88). After extracting the patients who were lost to follow-up, the mean preoperative WOMAC score was 62.6±16.6.

Table 2. Patient's Demographics

Variable	Value
Mean age (yr)	28.3 (16-47)
Sex	
Female	26
Male	0
Mean BMI (kg/m²)	21.4 (18.4-27.4)
Side involved	
Right	19
Left	7
Microinstability attributed to	
Dysplasia (LCEA <20°)	5
Borderline dysplasia (LCEA <26°)	7
General hyperlaxity (Beighton score ≥4)	7
Iatrogenic	2
Labral lesion	2
Traumatic event	2
FAI	1

Values are presented as mean (range) or number of hips only.
BMI: body mass index, LCEA: lateral center edge angle, FAI: femoroacetabular impingement.

2. Radiological Analysis

The mean lateral CEA was 25° (range, 17° to 37°). Seven patients presented with borderline hip dysplasia defined as measurement of a lateral CEA between 20° and 25°. Five patients presented with a more severe hip dysplasia defined as measurement of a lateral CEA between 17° and 19°. The mean Tönnis angle was 6.4° (range, 3° to 19°). Ten hips presented with a Tönnis angle >10° suggesting dysplastic morphology. No hips presented with a cross-over sign.

The mean alpha angle was 48° (range, 36° to 63°). Five hips presented with an alpha angle >50°. In five cases measurement of the alpha angle could not be performed due to lack of an adequate X-ray view.

Five hips showed a positive FEAR index[11]. All of these hips presented with a lateral CEA ≤20°. Four of these five hips also presented with a Tönnis angle >10°.

Eleven hips presented with early signs of osteoarthritis, a Tönnis grade 1 osteoarthritis. The other 15 hips presented with a Tönnis grade 0 (absence of osteoarthritis) on X-

rays. Preoperative work-up showed that 17 of the 24 hips that benefitted from a capsular plication as primary intervention (excluding the two revision cases) presented with labral tears.

3. Surgical Data

Prior to application of traction on the traction table, it was discovered that one hip was already open and accessible without application of traction. Two hips were easily distracted. The mean intervention time was 52.4 minutes (range, 26-76 minutes). The mean traction time was 15.7 minutes (range, 5-30 minutes) (Table 3).

Only 22 hips benefitted from the required minimum of two sutures for capsular plication. Four patients benefitted from only one suture point in the zona orbicularis due to technical difficulties.

No major complications were identified in this series. Only one minor complication was identified: a painful edema of the vulva that resolved spontaneously.

Table 3. Resume of the Surgical Data

Variable	Value
Surgical data	
Intervention time (min)	52.4±15.0
Traction time (min)	15.7±6.7
CP (n=26)	
1 suture in the ZO	4
≥2 sutures	22
Labral tears (n=18)	
Debridement	7
Repair	11
FP (minimal)	14
Acetabular cartilage lesions (n=10)	
Debridement	3
Tensioning of the wave deformity with an anchor	7

Values are presented as mean±standard deviation or number only.
CP: capsular plication, ZO: zona orbicularis, FP: minimal femoroplasty of head-neck junction.

4. Postoperative Results

Four hips were lost to follow-up. Four of the 26 hips required a revision surgery with periacetabular osteotomy for management of failed arthroscopic treatment. The mean time to conversion was 19 months (range, 5-33 months). Three patients presented with hip dysplasia (CEA ≤20˚) and one patient with borderline dysplasia (CEA 21˚). The four patients who benefitted from a periacetabular osteotomy were also not included for the end point analyses described below.

The mean pre- and postoperative WOMAC scores were 62.6±16.6 and 24.2±20.8, respectively (Fig. 3). The WOMAC score showed statistically significant postoperative improvement (P=0.0009). According to our observations, the presence of borderline hip dysplasia or early osteoarthritis or the type of operative procedure performed

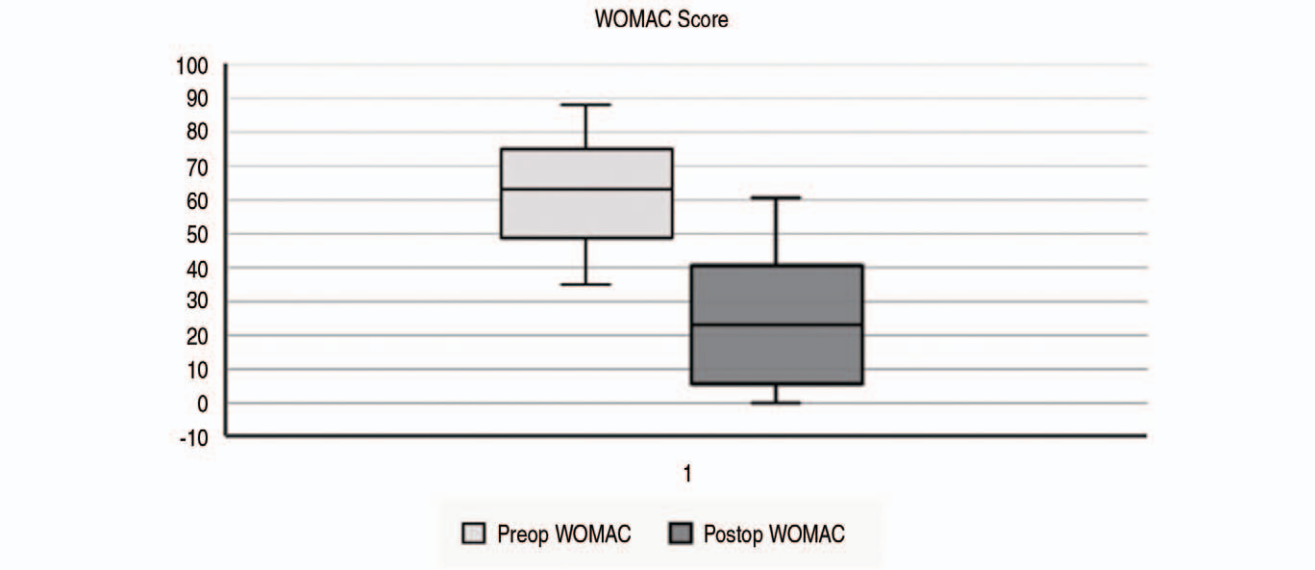

Fig. 3. Box plot representation of the pre- and postoperative WOMAC scores.
Preop: preoperative, Postop: postoperative, WOMAC: Western Ontario and McMaster Universities Osteoarthritis.

Table 4. Postoperative Improvement in WOMAC Scores

	Preop WOMAC	Postop WOMAC	*P*-value
Efficacy of the intervention: improvement of the WOMAC score			
Mean WOMAC score	62.6±16.6	24.2±20.8	0.0009
Effect of different variables on postoperative improvement			
Hip dysplasia			
Dysplastic hips (n=6)	58.3±12.2	21.0±24.9	0.921
Non dysplastic hips (n=11)	64.9±18.6	26.0±19.2	
Osteoarthritis			
Tönnis grade 0 (n=10)	63.6±13.7	23.9±18.9	0.831
Tönnis grade 1 (n=7)	61.1±21.1	24.7±24.7	
Labral tear			
Debridement (n=5)	60.8±24.1	7.8±9.2	0.293
Repair (n=8)	61.5±13.2	27.5±19.6	
Other			
CP (n=7)	61.4±19.3	36.0±19.2	0.137
CP+FP (n=10)	63.4±15.4	16.0±19.3	

This table shows the postoperative improvement of the WOMAC score in general (first part of the table). In the second part of this table, improvement regarding the WOMAC score is analyzed depending on some variable parameters.
Values are presented as mean±standard deviation.
Preop: preoperative, Postop: postoperative, WOMAC: Western Ontario and McMaster Universities Osteoarthritis, CP: capsular plication, FP: minimal femoroplasty of head-neck junction.

(Table 4) had no influence on the postoperative improvement of the patients (P>0.05).

The mean satisfaction score increased to 7.7/10. High scores for satisfaction of ≥8/10 were observed for 65% of patients. Two patients presented with a score for satisfaction ≤4/10.

Estimation of the failure rate of this intervention was based on combining the patients who required revision surgery with periacetabular osteotomy for treatment of failed capsular plication and patients who were not satisfied with the intervention. Thus, the failure rate of this intervention was estimated at 23.1%.

Thirteen patients were non-professional sportswomen who were active in at least one sports activity prior to development of symptoms. Sports activities varied, ranging from combat sports to dance, cycling, running, and fitness. The rate of return to sports was 46.1% and only one patient was able to return to sports at the same level as before development of symptoms. Reduced intensity was required for all other patients who resumed sports activities due to persistent hip symptoms. Of these 13 sportswomen, seven were not able to resume their preferred sporting activities because of persistent hip symptoms.

DISCUSSION

Hip microinstability is a clinical entity that presents as an increased supra-physiological translation of the femoral head in the acetabulum, leading to development of hip symptoms in association with repetitive movements of rotation and axial loading of the hip joint[2,4,5]. This condition has been associated with different entities, including hip dysplasia, femoro-acetabular impingement, lesions of intra-articular structures, generalized articular laxity, connective tissue disorders, and trauma[6,7]. Diagnosing this pathology is difficult and relies essentially on a high index of suspicion based on medical history, as well as findings from clinical and radiological examinations[4-7]. According to the demographic data from our series, hip microinstability appears to be encountered more frequently in female patients presenting with generalized hyperlaxity or borderline hip dysplasia.

All subjects included in our series were female; however, the predisposition of the female sex for this pathology was not only observed in our series, but has also been reported in other series. All patients who underwent treatment in a series of 31 patients were female[8]. In a second series 81% of patients who underwent treatment were female[13]. Another recently published series reported that 90% of patients were female[14]. Some authors have reported that acquired articular hyperlaxity is more common in females[7,15], which could partially account for the female predominance in patients suffering from hip microinstability. In our series seven patients showed signs of generalized hyperlaxity at

the initial clinical work-up of which one patient was postoperatively diagnosed with Ehlers–Danlos syndrome. Ehlers–Danlos syndrome might be clinically suspected in patients with a Beighton score ≥5/9 accompanied by elastic skin and some minor criteria such as chronic articular pain[16]. In this regard, the Beighton score is an effective, easy-to-use tool for use in the preoperative work-up in cases where hip microinstability is suspected.

An association of hip dysplasia with hip microinstability has also been reported[5-7]. The original study reported by Wiberg[17] describes hips with a CEA <20˚ as pathological and hips with a CEA >25˚ as normal. Hips with CEA between 20˚ and 25˚ were considered 'uncertain'[17]. Currently, in the literature on hip arthroscopy, hips presenting with a CEA from 16˚ to 28˚ are described as mild or borderline dysplastic, which might cause some confusion[18]. Interventions involving periacetabular osteotomy or other acetabular reorientation procedures for treatment of more severe dysplastic hips presenting with a CEA <17˚ have been associated with high per- and postoperative morbidity[14,18]. Some authors have reported that the critical limitation in treatment of dysplastic hips with hip arthroscopy is the fact that underlying osseous structural anomalies cannot be corrected[19]. Some findings have suggested the importance of soft tissues in maintenance of hip stability in patients with borderline hip dysplasia, thus arthroscopic capsular plication was introduced as part of the surgical management[8,14]. A recent series reported on the results of capsular plication in 21 patients with borderline hip dysplasia with a follow-up period of five years[14]. The results showed significant improvement of all functional scores, which was maintained at five years of follow-up and 19% of patients required a revision hip arthroscopy. Another series published in 2017 evaluating capsular plication in 31 hips reported that no significant difference in postoperative improvement was observed between borderline dysplastic hips and non-dysplastic hips[8]. Another series comparing the effects of capsular plication between patients presenting with borderline hip dysplasia and patients presenting with ligamentous hyperlaxity also reported that there was no significant difference[13]. The results of our series, which also compared postoperative improvement of functional scores between patients with dysplastic hips and those with non-dysplastic hips, showed no significant difference (P>0.05). However, in our analysis of the failure rate of this intervention (23.1% or six patients), which included patients who benefitted from a periacetabular osteotomy and those who were not satisfied, we observed that five of these six patients also presented with a lateral CEA ≤25˚. In addition, it should be noted that the four patients who benefitted from a revision with a periacetabular osteotomy were not included for this end point analysis at final follow-up, thus weakening the significance of these results.

A study describing the femoro-epiphyseal acetabular roof or FEAR index was recently published[11]. This index is represented by an angle between the mid-third of the epiphyseal line of the femoral head and the acetabular roof. An angle directed medially is negative and considered stable while an angle with an external direction is positive representing external directed forces favoring translation of the femoral head. Using this index, in cases of borderline dysplasia, identification of stable hips from unstable hips with a sensitivity of 80% and a specificity of 78% was reported[11]. According to our findings, five hips presented with a positive FEAR index. All of these hips presented with a lateral CEA ≤21˚. Of these five hips, four hips benefitted from a periacetabular osteotomy to address failed arthroscopic management of hip microinstability. Of the two remaining patients, one patient was lost to follow-up and one patient had a follow-up period of less than 12 months and therefore was not included for the final evaluation. Because our series included only a small number of hips, we can only suggest that the FEAR index should be utilized in larger series in order to confirm its role in identifying borderline dysplastic hips that might not benefit from arthroscopic treatment.

Although maintenance of significant improvement in functional scores has been demonstrated in all series reported in the literature[8,13,14,16], sports activities appear to be of less importance. Two series evaluating the Hip Outcome Score – Sport Specific Subscale reported significant improvement of this score after arthroscopic capsular plication[13,14]. However, there are no detailed reports with regard to sports activities and rates of return to participation in sports. In our opinion these details are of uttermost importance in this young and active population. Our series showed good results with significant improvement in WOMAC scores with mean improvement of 47.2 points and mean patient satisfaction of 7.7/10. However, only 46% of recreational sportive patients actually returned to their preferred sporting activities and only one patient was able to perform at the same level as before the development of symptoms, downgrading these 'good results'.

We acknowledge that because the technique of capsular plication has not yet been standardized and is dependent upon the capsulotomy technique performed when accessing the hip during arthroscopy, comparison between differ-

ent series is difficult[20]. In addition, evaluating the effect of the plication itself is also difficult since management of hip microinstability must include treatment of all associated lesions[8,13,14].

The limitations of this study must be considered due to its retrospective design and small case series. Because only 26 hips were included for evaluation at final follow-up, demonstrating any difference in postoperative evolution between groups is difficult due to lack of power. The WOMAC score was used in our study because we only had a preoperative WOMAC score and the WOMAC score has been validated for use in survey evaluation. However, in our opinion this tool might not represent the best outcome score for evaluation of young and active patients.

CONCLUSION

Microinstability of the hip remains a continuously evolving and complex pathology. Management of this pathology with arthroscopic capsular plication results in short-term improvement of pain and functional scores in carefully selected patients. Conduct of further study will be required in order to evaluate the role of new parameters, including the FEAR index, in the surgical decision-making process. Conduct of long-term studies will be required in order to clarify the role of capsular plication in the arthroscopic management of hip microinstability.

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CONFLICT OF INTEREST

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

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