Imaging the Previously Operated Hip

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Introduction

The volume of arthroscopic surgery of the hip has increased dramatically over the past decade for multiple hip disorders, including labral tears, chondral damage, femoroacetabular impingement (FAI), synovial chondromatosis, loose bodies, foreign body removal, and crystalline hip arthropathy [1, 2]. For primary hip arthroscopies, in the absence of joint arthritic changes, patients generally have excellent outcomes with return to active lifestyles. Numerous papers have shown 90–93 % good to excellent results [3–6] with resolution of mechanical symptoms and improved modified Harris hip scores [7, 8]. Still, there are patients who never fully experience relief following surgery, or develop recurrent symptoms of hip pathology. This may be from a new injury or due to an inadequate surgical procedure. Further, studies have shown that patients with degenerative arthritis (more specifically Grade 3–4 cartilage wear on the Outerbridge classification) have significantly worse outcomes than those with isolated labral tears and/or only mild chondral pathology [9–11].

Long-term studies have demonstrated the condition of articular cartilage to be the most important factor related to long-term outcome [4]. Several studies have correlated the findings of magnetic resonance arthrography (MRA) with primary hip arthroscopy, demonstrating sensitivity of 71–100 % [12–17] and specificity of 44–100 % [15, 18, 19]. Byrd and colleagues demonstrated an improved sensitivity of MRA compared to MRI using arthroscopic hip findings as the gold standard, improving the rate of false-negative results from 42 % with MRI to 8 % with MRA [20]. Further, for other orthopedic diagnoses, studies have evaluated the utility of MRA compared to surgical findings at revision knee arthroscopy (evaluating menisci and chondral damage/repair) [21–24] and revision shoulder arthroscopy [25, 26] (evaluating rotator cuff and labral pathology), but there is limited data on the prognostic value of MRA before revision hip arthroscopy.

There have been some recent studies that evaluated the utility of MRA in the diagnosis and treatment of ongoing or recurrent symptoms in patients who have had a prior hip arthroscopy. There have also been some recent studies that evaluated the use of 3D Cat Scans (CT) and delayed gadolinium-enhanced magnetic resonance imaging of cartilage (dGEMRIC) scans for an attempt at more precise evaluation of bone and cartilage defects of the hip [27, 28]. This chapter will review this data and how it can be used to better care for hip arthroscopy patients.

Data from Imaging Studies

Following a thorough patient history and examination, standard AP and frog-lateral radiographs should be the initial evaluation of any patient who has recurrent or ongoing symptoms of hip pain after hip arthroscopy. At times a false profile view to assess anterior femoral head coverage can be useful. This is taken standing, with the affected hip against the cassette, the ipsilateral foot parallel to the cassette, and the pelvis rotated 65° from the plane of the cassette. Ideally, these images should be compared to any radiographs taken prior to the original hip arthroscopy to assess for any change. If there has been a substantial progression of degenerative joint disease, with narrowing of the joint space, osteophytes, or subchondral cysts, then no further imaging may be necessary. In these patients with worsening cartilage wear, it is at times

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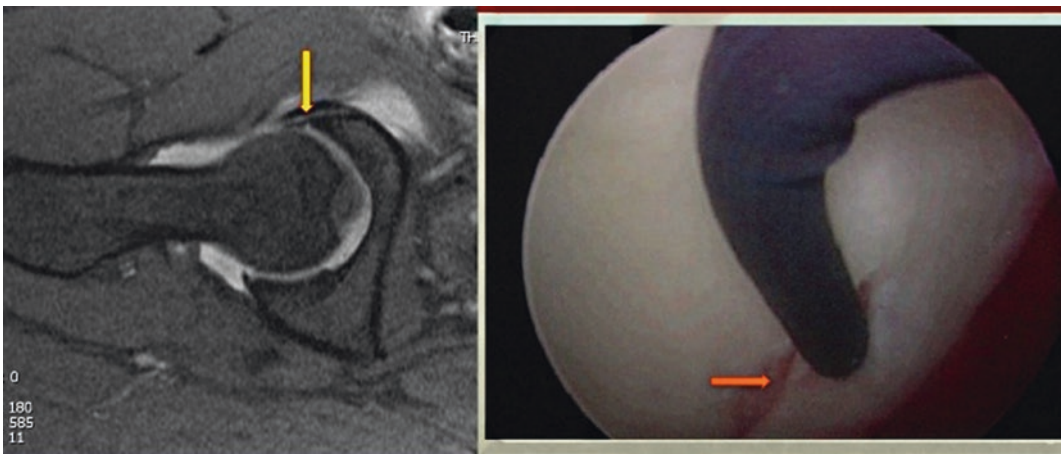

Fig. 25.1 An axial oblique T1 MRA image showing an anteromedial labral tear (*yellow arrow*), confirmed at the time of arthroscopy (*orange arrow*)

best to manage them with anti-inflammatory medications, exercises, activity modification, and injections with a discussion of a future total hip arthroplasty (THA) as an option. Further, it is always necessary to evaluate the patient for other sources of pain that could be hindering their recovery, such as the knee or spine, or at times an inguinal hernia [29]. When there is no apparent referred source of pain, and no obvious change on basic radiographs, then advanced imaging is necessary.

As noted earlier, plain MRI can be used for evaluation of the painful hip, but studies have shown MRA to increase sensitivity to assess labral and chondral injuries in patients who have not had prior hip surgery. An MRI can show basic muscle pathology in patients with suspected extra-articular pathology or to assess the bone in those patients where there is a concern for avascular necrosis (AVN) of the femoral head [30, 31]. If there is more of a clinical concern for intra-articular pathology, then MRA should be considered.

The standard MRA imaging protocol involves injecting a 15 cm^3 mixture of 0.9 % normal saline, Marcaine 0.5 % with epinephrine, and contrast (i.e., Isovue 300 and Prohance) into the hip joint space, followed by imaging with a 1.5 T, or higher, MR scanner. The following sequences are performed: coronal T1, coronal T1 with fat suppression, coronal T2 with fat suppression, coronal STIR, sagittal oblique T1 with fat suppression, axial proton density with fat suppression, and axial oblique T1 with fat suppression.

There are two recent studies that have assessed the utility of MRA to evaluate labral injury in patients who have had prior hip arthroscopy, and one of these also addressed chondral pathology. The study by Aprato et al. retrospectively reviewed the data on 60 patients who had undergone revision hip arthroscopy at a single center [32]. Patients were split into two groups: Group 1 was 40 patients who had undergone labral debridement or repair at the time of the index procedure; Group 2 was 20 patients (who served as the control) who did not have labral surgery at the time of the index procedure. They sought to determine the accuracy of MRA to identify labral tears at revision hip arthroscopy in Group 1. In regard to identifying labral pathology, they found that the sensitivity was only 53 % in Group 1 as compared to 71 % in Group 2 and that the specificity was 50 % for Group 1 and 92 % for Group 2. The positive predictive value (PPV) was quite similar in both groups, 81 % and 83 %, respectively. However, they found that the negative predictive value (NPV) was only 21 % for Group 1 versus 86 % for Group 2 and that the accuracy was also inferior in Group 1 (53 % as compared to 85 % for Group 2). They concluded that MRA was not a reliable tool for accurate diagnosis of new or recurrent labral tears in patients who have prior labral surgery. This was supported by the fact that of 21 patients who had an MRA read as a labral tear, 17 of these did truly have a labral tear at revision surgery, as compared to the 19 patients who had an MRA read as normal labrum, in which only 4 were actually intact at the time of surgery. In other words, of the 32 patients who had labral tears at the revision surgery, 19 (53 %) were read as normal labrum on MRA (Fig. 25.1).

In a similar study by Glassner and McCarthy, a retrospective review of 70 revision hip arthroscopies (62 patients) was performed to correlate MRA and intraoperative findings in regard to labral and chondral pathology at revision surgery [33]. The labral tears were identified based on location and the cartilage injuries based on location and Outerbridge grade [34]. In regard to labral pathology, the comparison of MRA and intraoperative findings revealed a sensitivity of 82 %, a specificity of 70 %, a PPV of 94 %, and an NPV of 39 %.

This study did show better sensitivity and specificity than the study by Aprato et al., but the positive, and more specifically the negative, predictive values were similar. The similarity in the NPV was demonstrated by 11 patients with an MRA interpretation of a normal labrum, who were all found to have a labral tear intraoperatively. This low NPV is con-

sistent with studies on primary hip arthroscopy, with an NPV of only 13 % in a study by Keeney et al. [35], as compared to 21 and 39 % in the above studies. The reason for the low NPV in the studies of patients who had prior surgery may be due to the patient population of these studies; i.e. patients with a prolonged course of pain and prior hip surgery have a higher likelihood of having intra-articular pathology than the general population, making a true negative MRA result less likely.

In comparing the sensitivities and specificities between these two studies, the study by Aprato showed a sensitivity of only 53 % versus 82 % in the study by Glassner and a specificity of 50 % versus 70 %. The second study is comparable to past studies in evaluating the labrum at primary hip arthroscopy, which have shown a 71–100 % sensitivity [12–17]. Specificity has had a much broader range in prior studies, from 44 to 100 %, making the data comparable for both studies [15, 18, 19]. The reason for the difference in sensitivity is unclear, but could be related to different experience levels of the interpreting radiologists or simply the size and location of the tears, as larger tears would be easier to identify than small tears, and the size of the tear was not addressed in the studies.

In regard to the location of labral pathology, the second study was consistent with findings at primary hip arthroscopy, with 97 % of tears being located anterior versus 52–92 % in prior studies of primary hip arthroscopy [12, 15, 35–38]. Interestingly, they found that 53 % of these tears were more specifically anteromedial, a location that is difficult to assess with MRA and difficult to access arthroscopically. The authors felt that the discrepancy regarding the anteromedial lesions is that currently MRA cannot adequately distinguish a postsurgical change from a new injury. This is in agreement with the conclusion made by Aprato, but in contrast, largely due to the better sensitivity, the authors felt that MRA is a useful tool in the evaluation of patients with prior hip surgery.

In the evaluation of MRA to detect chondral pathology, they found a sensitivity of 65 %, specificity of 90 %, PPV of 94 %, and NPV of 50 %. Seventeen patients had an MRA read of normal articular cartilage, who in fact had chondral damage in at least one location at the time of arthroscopy.

This data is consistent with previous studies for primary hip arthroscopy. One of these, by Keeney et al., demonstrated the sensitivity, specificity, PPV, and NPV to be 47 %, 89 %, 84 %, and 59 %, respectively [35]. Another, by Schmid et al., found some variability between two interpreting radiologists, with specificities of 79 and 50 %, sensitivities of 77 and 84 %, PPV of 73 and 71 %, and NPV of 83 and 68 %, but overall similar results [39].

The study by Glassner et al. also found that MRA was more accurate in detection of chondral damage of the femoral head (20/21) and then in detection of acetabular chondral damage (36/65). Further, MRA was superior at detecting Grade III and IV acetabular chondral injuries (18/22) as compared to Grade I and II injuries (15/31, i.e., 52 % of these early lesions were not identified). The prior mentioned study by Keeney, on primary hip arthroscopies, also demonstrated the difficulty of MRA at detecting Grade I and II lesions, in which 22.8 % of these injuries were not identified.

In respect to the location of chondral injuries, they found that 78 % of acetabular chondral injuries were found in the anterior acetabulum at the time of surgery. This was similar to a prior study by McCarthy et al. of 457 primary hip arthroscopies, which showed chondral injuries in the anterior acetabulum in 59 % of the cases [40]. The authors concluded that there was utility for MRA before revision hip arthroscopy in regard to cartilage lesions, but with the abovementioned limitations.

These limitations have led other researchers to search for a superior imaging study for evaluating cartilage injuries. In one such study with a goal of improving the detection of cartilage lesions, the researchers added a cartilage-sensitive three-dimensional spoiled gradient-recalled echo (SPGR) sequence with iterative decomposition of water and fat with echo asymmetry and least-squares estimation (IDEAL) fat-water separation to the hip MR arthrography studies [41]. The study included 67 patients who underwent standard MRA followed by MRA with the additional IDEAL-SPGR sequence and subsequently had hip arthroscopy. They found that the IDEAL-SPGR had a similar sensitivity to traditional MRA, 74 % versus 70 %, but a lower specificity, 77 % versus 84 %. Importantly, the IDEAL-SPGR was more accurate at grading cartilage lesions, leading them to conclude that it could be a useful adjunct to traditional MRA. This could prove to be of benefit for patients who have had a prior hip arthroscopy, due to the limitations in identifying cartilage injuries previously mentioned.

Future studies, for more accurate detection of early chondral damage, could also include the use of dGEMRIC scans (which measure the biochemical integrity of cartilage by detecting changes in glycosaminoglycans). Recent studies have shown that a mean dGEMRIC index in morphologically normal hips is 570 ± 90 ms and that levels less than this correlated with pain in the hip [28]. There is also data on dGEMRIC scans in patients with hip dysplasia and pre-radiographic osteoarthritis that found that age (>30) and presence of a labral tear were independent risk factors for developing osteoarthritis, as these patients had significantly lower dGEMRIC index [42]. For patients who have had a prior hip arthroscopy, and have ongoing pain, but have had an MRA that did not detect a cartilage lesion, dGEMRIC scans may prove to be useful in identifying early cartilage lesions (Fig. 25.2).

Interest in improved imaging studies can be expected, as the number of clinical studies focusing on reasons for failure of hip arthroscopy is increasing. Separate studies by Heyworth, Philippon, and Aprato all focused on the reasons

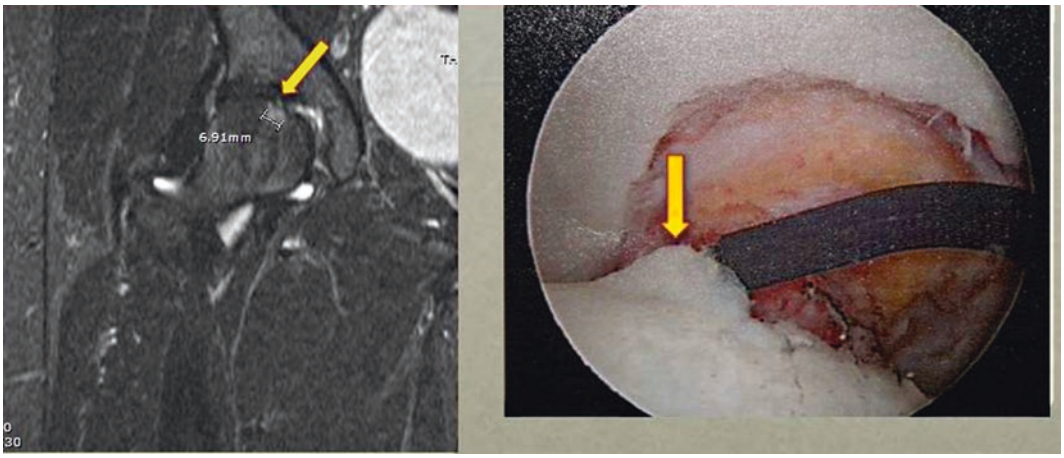

Fig. 25.2 A coronal STIR MRA image showing a superior femoral head cartilage lesion (*yellow arrow*), with underlying bone marrow edema (*cursor*), correlating with intraoperative findings of a chondral flap lesion of the superior femoral head (*orange arrow*) with Grade 2–3 wear

for revision, citing labral lesions and FAI that were not addressed, or inadequately addressed, at the initial surgery [43–45]. Recurrent symptoms from FAI ranged from 31 to 95 %, and recurrent symptoms from a persistent, or possibly new, labral tear were found in up to 92 % of cases. While the majority of patients in these studies had preoperative MRA or MRI, the authors did not specifically evaluate the accuracy of the imaging studies in these revision operations.

Conclusion

The evaluation of patients who have had a prior hip arthroscopy should start with a thorough clinical assessment, to determine if imaging of the hip is the next appropriate step. If so, one should begin with plain radiographs and progress to advanced imaging, such as MRA for further evaluation of the cartilage and labrum. The data on MRA of these patients is preliminary, but does show promise. Studies thus far have shown that MRA is superior at ruling in, rather than ruling out, a diagnosis, with PPV up to 94 % for labral and chondral pathology and an NPV of 21–39 % for labral tears, and 50 % for chondral damage. More conclusive data with larger sample sizes should become available as the number of primary and revision hip arthroscopies continue to increase. This, combined with innovative imaging techniques, should lead to a clearer understanding of the underlying pathology and aid surgeons in the diagnosis and treatment of these challenging and complex patients.

References

1. McCarthy JC, Lee J. Arthroscopic intervention in early hip disease. Clin Orthop Relat Res. 2004;429:157–62.
2. Yusaf MA, Hame SL. Arthroscopy of the hip. Curr Sports Med Rep. 2008;7(5):269–74.
3. Beaule PE, O'Neill M, Rakhra K. Current concepts review: acetabular labral tears. J Bone Joint Surg Am. 2009;91:701–10.
4. Byrd JW, Jones KS. Prospective analysis of hip arthroscopy with 2-year follow-up. Arthroscopy. 2000;16:578–87.
5. McCarthy J, Barsoum W, Puri L, et al. The role of hip arthroscopy in the elite athlete. Clin Orthop Relat Res. 2003;406:71–4.
6. Shindle MK, Voos JE, Nho SJ, et al. Arthroscopic management of labral tears in the hip. J Bone Joint Surg Am. 2008;90 Suppl 4:2–19.
7. O'Leary JA, Berend K, Vail TP. The relationship between diagnosis and outcome in arthroscopy of the hip. Arthroscopy. 2001;17:181–8.
8. Potter BK, Freedman BA, Andersen RC, et al. Correlation of short form-36 and disability status with outcomes of arthroscopic acetabular labral debridement. Am J Sports Med. 2005;33:864–70.
9. Farjo LA, Glick JM, Sampson TG. Hip arthroscopy for degenerative joint disease. Arthroscopy. 1998;14:435.
10. Margheritini F, Villar RN. The efficacy of arthroscopy in the treatment of hip osteoarthritis. Chir Organi Mov. 1999;84:257–61.
11. Walton NP, Jahromi I, Lewis PL. Chondral degeneration and therapeutic hip arthroscopy. Int Orthop. 2004;28:354–6.
12. Burnett RS, Della Rocca GJ, Prather H, et al. Clinical presentation of patients with tears of the acetabular labrum. J Bone Joint Surg Am. 2006;88:1448–57.
13. Chan YS, Lien LC, Hsu HL, et al. Evaluating hip labral tears using magnetic resonance arthrography: a prospective study comparing hip arthroscopy and magnetic resonance arthrography diagnosis. Arthroscopy. 2005;21:1250.
14. Czerny C, Hofmann S, Neuhold A, et al. Lesions of the acetabular labrum: accuracy of MR imaging and MR arthrography in detection and staging. Radiology. 1996;200:225–30.
15. Freedman BA, Potter BK, Dinauer PA, Giuliani JR, Kuklo TR, Murphy KP. Prognostic value of magnetic resonance arthrography for Czerny stage II and III acetabular labral tears. Arthroscopy. 2006;22:742–7.
16. Toomayan GA, Holman WR, Major NM, Kozlowicz SM, Vail TP. Sensitivity of MR arthrography in the evaluation of acetabular labral tears. AJR Am J Roentgenol. 2006;186:449–53.
17. Zeigert AJ, Blankenbaker DG, De Smet AA, et al. Comparison of standard hip MR arthrographic imaging planes and sequences for detection of arthroscopically proven labral tear. AJR Am J Roentgenol. 2009;192:1397–400.

18. Leunig M, Werlen S, Ungersböck A, et al. Evaluation of the acetabular labrum by MR arthrography. J Bone Joint Surg Br. 1997;79:230–4.
19. Mitchell B, McCrory P, Brukner P, et al. Hip joint pathology: clinical presentation and correlation between magnetic resonance arthrography, ultrasound, and arthroscopic findings in 25 consecutive cases. Clin J Sport Med. 2003;13(3):152–6.
20. Byrd JW, Jones KS. Diagnostic accuracy of clinical assessment, magnetic resonance imaging, magnetic resonance arthrography, and intra-articular injection in hip arthroscopy patients. Am J Sports Med. 2004;32:1668–74.
21. Cardello P, Gigli C, Ricci C, et al. Retears of postoperative knee meniscus: findings on magnetic resonance imaging (MRI) and magnetic resonance arthrography (MRA) by using low and high field magnets. Skeletal Radiol. 2009;38:149–56.
22. Gobbi A, Kon E, Berruto M, et al. Patellofemoral full-thickness chondral defects treated with hyalograft-C: a clinical, arthroscopic, and histologic review. Am J Sports Med. 2006;34:1763–73.
23. Magee T, Shapiro M, Rodriguez J, et al. MR arthrography of postoperative knee: for which patients is it useful? Radiology. 2003;229:159–63.
24. Makino A, Muscolo DL, Puigdevall M, et al. Arthroscopic fixation of osteochondritis dissecans of the knee: clinical, magnetic resonance imaging, and arthroscopic follow-up. Am J Sports Med. 2005;33:1499–504.
25. Magee TH, Gaenslen ES, et al. MR imaging of the shoulder after surgery. Am J Roentgenol. 1997;168(4):925–8.
26. Probyn L, White L, Salonen D, et al. Recurrent symptoms after shoulder instability repair: direct MR arthrographic assessment-correlation with second-look surgical evaluation. Radiology. 2007;245(3):814–23.
27. Heyworth BE, Dolan MM, Nguyen JT, et al. Preoperative three-dimensional CT predicts intraoperative findings in hip arthroscopy. Clin Orthop Relat Res. 2013;470:1950–7.
28. Kim YJ, Jaramillo D, Millis MB, et al. Assessment of early osteoarthritis in hip dysplasia with delayed gadolinium-enhanced magnetic resonance imaging of cartilage. J Bone Joint Surg Am. 2003;85:1987–92.
29. Tibor L, Sekiya J. Current concepts: differential diagnosis of pain around the hip joint. Arthroscopy. 2008;24(12):1407–21.
30. Jacobson JA, Bedi A, Sekiya JK, et al. Evaluation of the painful athletic hip: imaging options and imaging-guided injections. AJR Am J Roentgenol. 2012;199:516–24.
31. Robinson HJ, Hartleben PD, Lund G, et al. Evaluation of magnetic resonance imaging in the diagnosis of osteonecrosis of the femoral head. Accuracy compared with radiographs, core biopsy, and intraosseous pressure measurements. J Bone Joint Surg Am. 1989;71:650–63.
32. Aprato A, Jayasekera N, Villar RN. The accuracy of magnetic resonance arthrography in hip arthroscopic labral revision surgery. Hip Int. 2013;23(1):99–103.
33. Glassner PJ, Marchie A, Lee JA, McCarthy JC. MR imaging in patients with prior surgery: what are the limitations? In: 42nd annual Harvard arthroplasty course, Boston, MA; 2012.
34. Outerbridge R. The etiology of chondromalacia patellae. J Bone Joint Surg. 1961;43B:752–4.
35. Keeney J, Peele M, Jackson J, et al. Magnetic resonance arthrography versus arthroscopy in the evaluation of articular hip pathology. Clin Orthop Relat Res. 2004;429:163–9.
36. Fitzgerald Jr RH. Acetabular labrum tears: diagnosis and treatment. Clin Orthop Relat Res. 1995;31:60–8.
37. Lage LA, Patel JV, Villar RN. The acetabular labral tear: an arthroscopic classification. Arthroscopy. 1996;12:269–72.
38. McCarthy JC, Busconi B. The role of hip arthroscopy in the diagnosis and treatment of hip disease. Orthopedics. 1995;18:753–6.
39. Schmid M, Notzli H, Zanetti M, et al. Cartilage lesions in the hip: diagnostic effectiveness of MR. Arthrography. 2003;226(2):382–6.
40. McCarthy JC, Noble PC, Schuck MR, et al. The Otto E. Aufranc Award: the role of labral lesions to development of early degenerative hip disease. Clin Orthop Relat Res. 2001;393:25–37.
41. Blankenbaker DG, Ullrick SR, Kijowski R, et al. MR arthrography of the hip: comparison of IDEAL-SPGR volume sequence to standard MR sequences in the detection and grading of cartilage lesions. Radiology. 2011;261:863–71.
42. Jessel RH, Zurakowksi D, Zilkens C, et al. Radiographic and patient factors associated with pre-radiographic osteoarthritis in hip dysplasia. J Bone Joint Surg Am. 2009;91:1120–9.
43. Aprato A, Jayasekera N, Villar RN. Revision hip arthroscopic surgery: outcome at three years. Knee Surg Sports Traumatol Arthrosc. 2014;22(4):932–7.
44. Heyworth BE, Shindle MK, Voos JE, et al. Radiologic and intraoperative findings in revision hip arthroscopy. Arthroscopy. 2007;23:1295–302.
45. Philippon MJ, Schenker ML, Briggs KK, et al. Revision hip arthroscopy. Am J Sports Med. 2007;35:1918–21.