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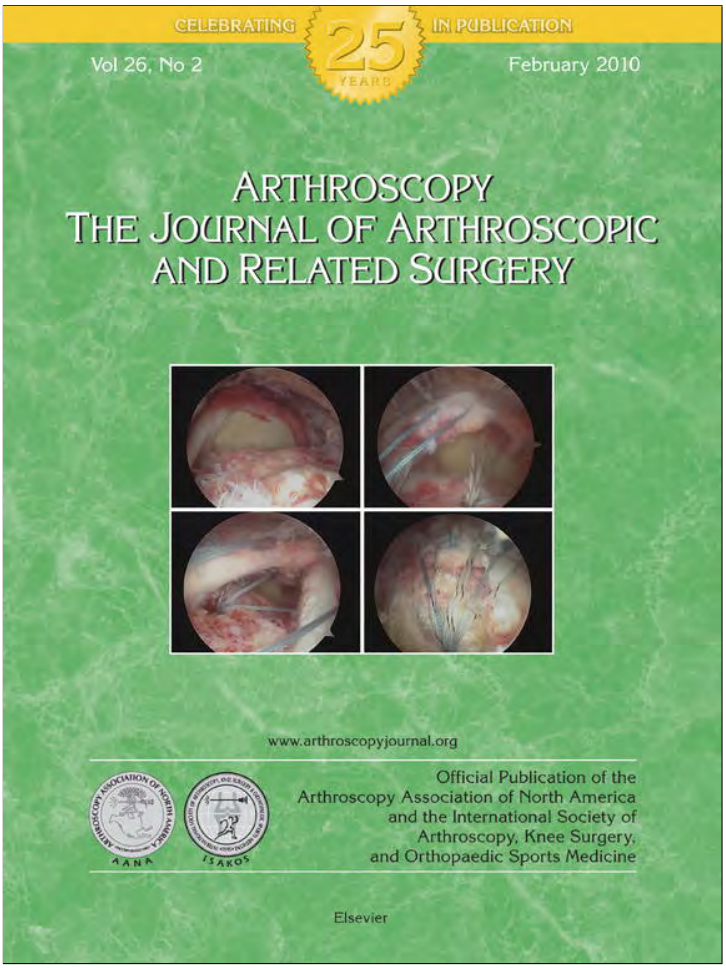

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Technical Note With Video Illustration

Minimally Invasive Bone Grafting of Cysts of the Femoral Head and Acetabulum in Femoroacetabular Impingement: Arthroscopic Technique and Case Presentation

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Abstract: Femoroacetabular impingement (FAI) has been recently established as a risk factor in the development of osteoarthritis of the hip. Intraosseous cysts are commonly seen on imaging of FAI. In most cases these cysts are incidental and do not require specific treatment at the time of surgical treatment of hip impingement. However, in some cases the cysts may mechanically compromise the acetabular rim or femoral neck. We present a technique for treating such cysts with an all-arthroscopic technique using a commercially available bone graft substitute composed of cancellous bone and demineralized bone matrix placed within an arthroscopic cannula for direct delivery into the cysts. This technique may be of benefit to surgeons treating FAI with an all-arthroscopic technique.

For over 50 years, morphologic abnormalities of the hip have been associated with osteoarthritis of the hip.[1,2] However, the recognition of femoroacetabular impingement (FAI) by Ganz and colleagues[3-5] in the 1990s led to a more clear description of the pathogenesis of hip arthritis resulting from these abnormalities. Ganz et al.[3] subclassified FAI into 2 broad categories: the cam and pincer types. In general terms, cam impingement is caused by an excessively large femoral head in a certain dimension, usually the anterolateral aspect. With this type of FAI, the femoral head causes direct chondral injury to the cartilage of the acetabular rim once the larger-diameter segment enters the socket. Because of the damage to the articular cartilage, cam-type FAI has a relatively poor prognosis in terms of ultimate progression to osteoarthritis. Pincer-type FAI results from direct contact between the femoral neck and the acetabular rim. It can occur in the setting of acetabular retroversion[6,7] or an excessively deep acetabulum, known as coxa profunda or protrusio. Despite the differences in the 2 types of impingement, a number of studies have shown that elements of both types of FAI occur in approximately 50% of patients.[8,9] Bone cysts are one of the common findings encountered in imaging of FAI by standard radiographs, computed tomography, and magnetic resonance imaging. Herniation pits were first described by Pitt et al.[10] Their etiology was unknown until the unifying concept of hip impingement indicated that they most likely represent intraosseous ganglia at the head-neck junction of the femoral head. In most cases herniation pits do not require specific treatment and are generally considered an incidental finding in the

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Note: To access the video accompanying this report, visit the February issue of *Arthroscopy* at www.arthroscopyjournal.org.

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TABLE 1. *Steps Involved in Arthroscopic Bone Grafting of Hip Cysts*

1. Determine whether the cyst is appropriate for grafting
   A. Size typically $<3 \times 3$ cm and $>1 \times 1$ cm
   B. Contained
   C. Accessible through arthroscopic portal
2. Remove cyst lining using shavers, burs, and curettes
3. Obtain appropriate bone graft material
   A. Osteoinductive: Capable of inducing or stimulating cells toward osteogenesis
   B. Osteoconductive: Capable of providing a mechanical scaffold for bone growth
   C. Malleable: Capable of being molded or conformed to a given shape
   D. Injectable: Capable of being passed through a small opening with pressure
   E. Self-adherent: Capable of maintaining adhesion to like particles and to avoid random particle separation
4. Place bone graft into the distal end of an arthroscopic cannula
5. Establish cannula access to the cyst
6. Place a switching stick in the cannula
7. Remove the cannula, leaving the switching stick
8. Pass a slotted cannula over the switching stick
9. Remove the switching stick
10. Pass the cannula filled with bone graft over the slotted cannula and place it directly over the opening of the cyst
11. Apply the switching stick into the cannula, slowly pushing bone graft material into the cyst
12. Repeat steps 4-11 if all graft material is passed into the cyst but more space remains unfilled
13. Once bone grafting is completed, slide the cannula over the rim of the cyst to shear off any remaining bone graft attachments into the cannula and to avoid pulling out any bone graft
14. Remove any loose bone graft material with a grasper or shaver

NOTE. Successful arthroscopic bone grafting requires an accurate assessment of cyst characteristics, adequate access, and the appropriate equipment and bone graft materials.

setting of hip impingement.[11] Acetabular ganglion cysts are another common finding noted in pincer-type FAI. These often coincide with severe labral tears and labral ossification.[5,12]

Contemporary treatment of FAI can be classified as open,[8,9,13] arthroscopic,[14-22] or a combination of open and arthroscopic.[23,24] Regardless of the technique, the objective is to remove the damaged and painful tissue and improve the mechanics of the hip by eliminating contact between the femoral neck and the acetabular rim during routine daily activities. Intraosseous cysts commonly occur directly in the area of contact and are often unroofed during the bone recontouring. On the basis of our experience, small cysts often do not require any specific treatment. However, in some cases the cysts can become extremely large and even risk the mechanical integrity of the femoral neck.[25] We present one strategy of grafting such cysts at the conclusion of the arthroscopic acetabuloplasty and/or femoral head osteochondroplasty for FAI. In both cases presented, once the appropriate treatment of FAI had been completed, the respective cysts were treated with an arthroscopic technique by use of a commercially available bone graft substitute composed of cancellous

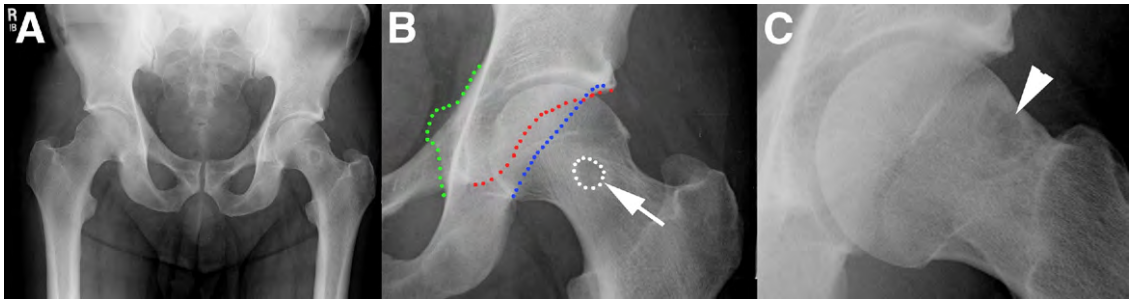

FIGURE 1. (A) Anteroposterior pelvic radiograph in case 1. (B) On the magnified view, a fibrocyst is visible on the anterolateral femoral neck (arrow). Three clinically important outlines can be seen: the anterior acetabular wall (red dots), the posterior acetabular wall (blue dots), and the ischial spine projection into the pelvis (green dots). (C) A preoperative frog lateral radiograph of the hip shows the fibrocyst (arrowhead) in the anterior femoral head-neck junction.

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bone and demineralized bone matrix (Table 1 and Video 1 [available at www.arthroscopyjournal.org]).

CASE 1

A 50-year-old man presented with a history of left hip pain for 3 years. The pain was located in the anterior and lateral hip and groin, and the severity was rated as 7 out of 10. The patient had pain 24 hours per day. Hip range of motion was limited to 120° of hip flexion, 50° of external rotation, and only 5° of internal rotation (compared with 20° on the right side). He had a positive anterior impingement sign.[26] The anteroposterior pelvic radiograph was notable for an aspherical femoral head-neck contour, a fibrocyst in the femoral head-neck junction,[27] acetabular retroversion with a crossover sign,[6,28] and projection of the ischial spine into the pelvis[29] (Fig 1A). The lateral

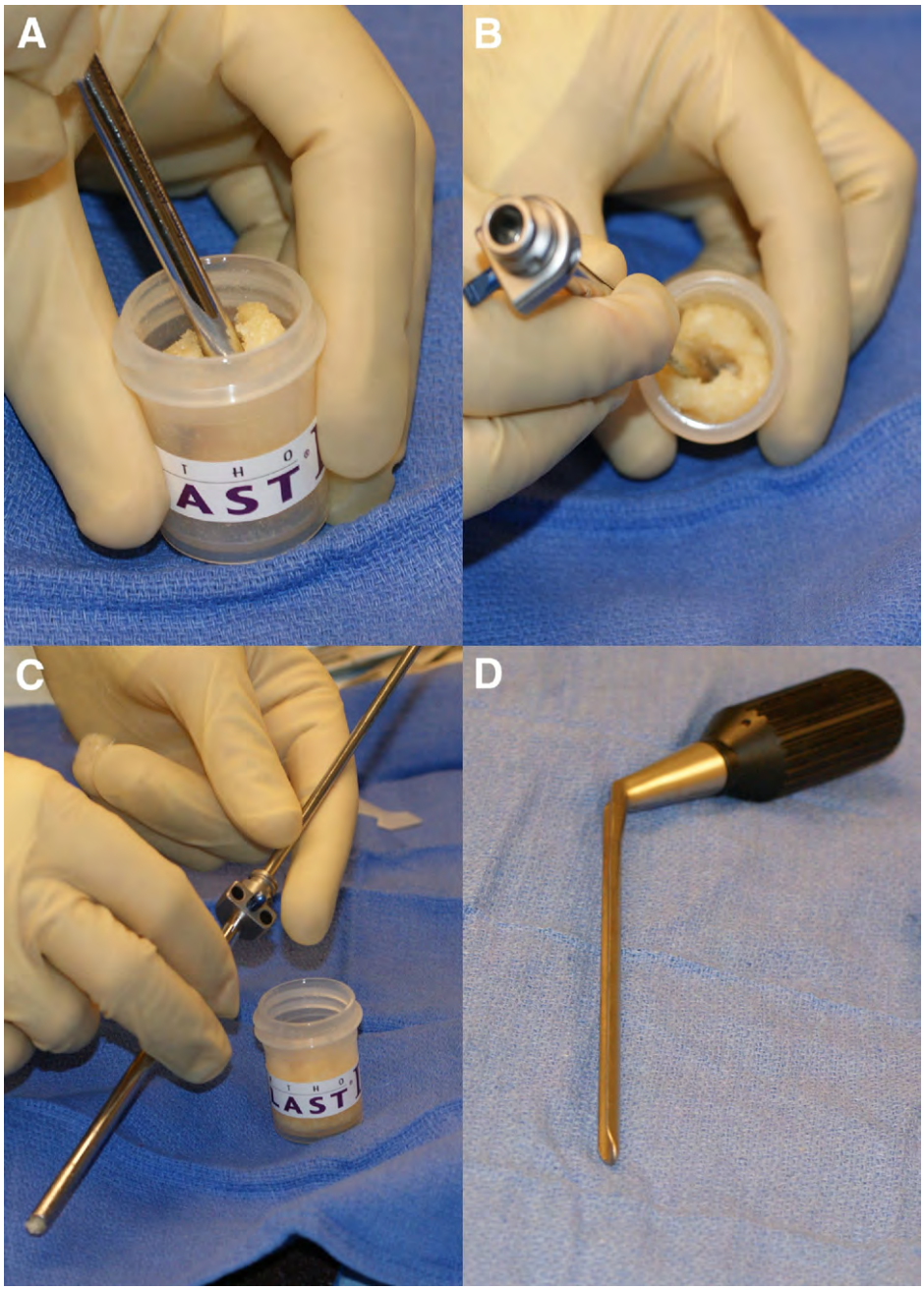

FIGURE 2. (A and B) The technique for arthroscopic bone grafting depends on the use of a metal arthroscopic cannula being passed into the graft material with multiple passes. (C) Subsequently, the graft is compressed into the cannula by use of a switching stick. (D) A slotted cannula can be used to pass the loaded arthroscopic cannula into the joint.

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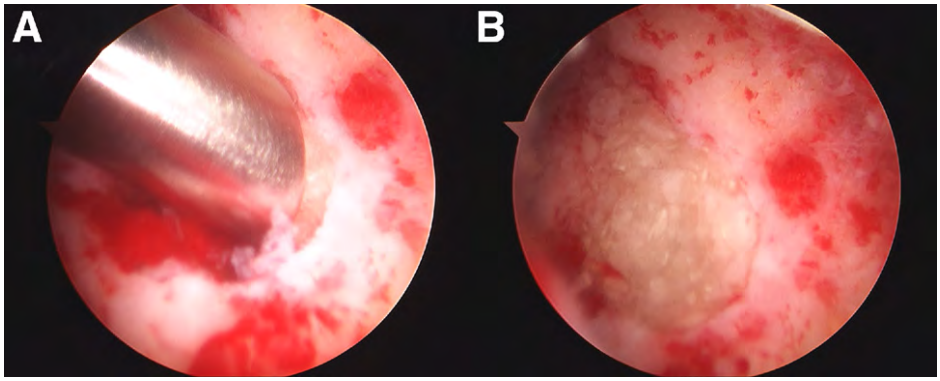

FIGURE 3. The femoral neck cyst of the left hip in case 1 underwent bone grafting through an arthroscopic technique. The patient was in the supine position. (A) The arthroscope was introduced from the anterior paratrochanteric portal, and the bone graft cannula filled with the bone graft material was introduced from the direct anterior portal. (B) After removal of the cannula, the bone graft material can be clearly seen filling the cyst completely.

radiograph showed the fibrocyst and decreased femoral neck offset on the anterior neck[30] (Fig 1B). Magnetic resonance imaging was performed after injection of intra-articular gadolinium (Magnevist; Bayer, Pittsburgh, PA) with the performance of radial sequence imaging.[31] These images were notable for a synovial fibrocyst, an extensive labral tear on the anterolateral acetabulum, and an aspherical femoral head at the anterolateral aspect (Fig 1C). An extensive course of nonsurgical treatment, including rest, activity modification, nonsteroidal anti-inflammatory drugs, and physical therapy, had failed in this patient. He was treated with hip arthroscopy, labral debridement, and femoral head osteochondroplasty through fluoroscopic guidance. During the osteochondroplasty, the opening to the femoral fibrocyst was identified. As the extent of bone removal increased, so did the size of the opening of the cyst, ultimately reaching approximately 14 mm. We elected to arthroscopically graft the cyst at the completion of the osteochondroplasty. In our experience, the optimal bone graft material for this application has osteoconductive and osteoinductive properties, is malleable, and is self-adhesive to prevent fragment release into the joint with the risks of third-body damage. We used one such bone graft material (Orthoblast; Isotis, Irvine, CA) by placing the graft into a 5.0-mm arthroscopic cannula and then placing the cannula over the cyst using a commonly used slotted cannula found in most commercial hip arthroscopy sets (Fig 2). By passing a switching stick into the cannula from the outside, we were able to deliver the bone graft in a controlled fashion directly into the cyst (Fig 3). Any residual graft was then removed with an arthroscopic shaver. Anteroposterior and lateral radiographs obtained at 20 months showed a relatively normal contour for the femoral head along with improved bone density in the region of the cyst (Fig 4).

CASE 2

A 52-year-old woman presented with 2 years of hip pain and limited range of motion. The pain was located in the lateral aspect of the right hip and was aggravated by stair climbing. Hip range of motion was 145° of hip flexion, 45° of external rotation, 20° of internal rotation, and 55° of abduction. The patient had a strongly positive anterior impingement sign.[26]

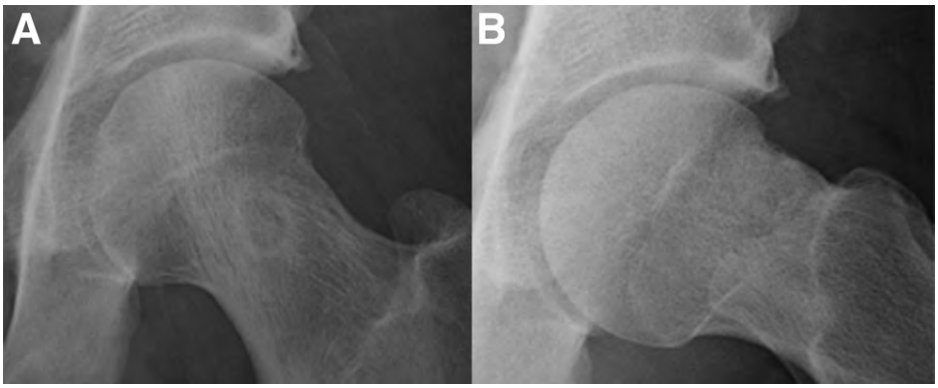

FIGURE 4. At the latest follow-up visit at 20 months, (A) anteroposterior and (B) lateral radiographs of case 1 showed an improved femoral head contour and increased bone density in the femoral head-neck cyst.

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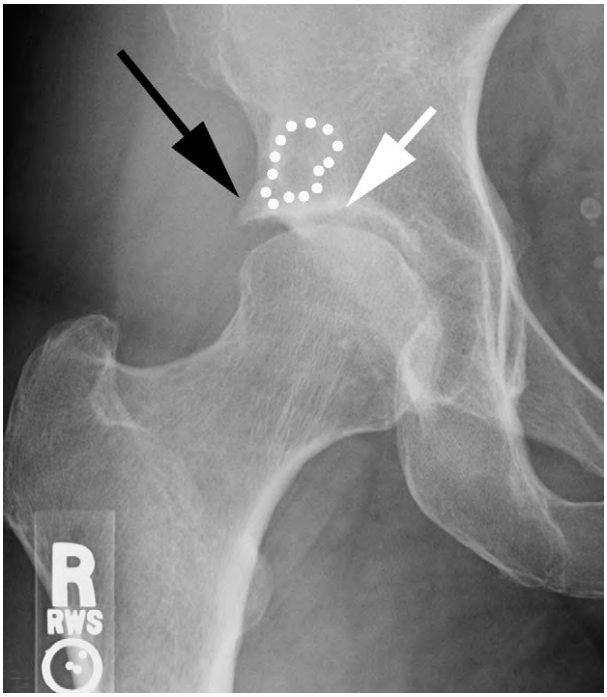

FIGURE 5. Preoperative anteroposterior radiograph in case 2 showing an acetabular bone cyst (dots), ossification of the acetabular labrum (black arrow), and early osteoarthritis with increased bone density in the acetabular roof (white arrow).

The anteroposterior pelvis radiograph showed osseous metaplasia of the acetabular labrum,[32] an intraosseous ganglion cyst of the acetabulum,[33,34] and early osteoarthritis (Fig 5). She was offered hip arthroscopy with concurrent optimization of the offset of the hip emphasizing both a limited osteochondroplasty of the femoral neck and removal of the area of osseous metaplasia on the acetabular labrum. During the recontouring of the acetabular rim, the acetabular cyst was encountered. The opening of the cyst was approximately 5 mm but gradually expanded to approximately 10 to 12 mm with further bone resection under fluoroscopic guidance. We used the technique previously described in case 1 for bone grafting of the acetabular rim cyst (Fig 6). The patient has achieved an excellent clinical result at 6 months' follow-up.

DISCUSSION

A variety of morphologic configurations have been associated with osteoarthritis of the hip including hip dysplasia[2,32] and, more recently, FAI.[3,5,13,35,36] FAI can be defined as painful contact between the femoral head or neck and the acetabular rim during physiologic daily activities. This disease has been subclassified into cam (femoral) and pincer (acetabular) types based on the predominance of the abnormal morphology. Regardless of this classification, approximately 50% of patients have elements of both types of FAI. The radiographic manifestations of FAI include labral damage and ossification as well as sclerosis of the femoral neck and the formation of localized exostoses along the neck. Along with these bony reactive changes, intraosseous cysts are commonly noted. The most common region for these cystic changes is the anterolateral femoral neck. Cysts in this region had been termed "herniation pits" based on their synovial lining, which was thought to have herniated into the bone.[10] Herniation pits were initially described before a clear pathomechanical understanding of FAI had been established. More recently, these cysts have been described as fibrocysts by Leunig et al.,[27] who further hypothesized that the cysts were formed by direct contact between the acetabular rim and the femoral neck. They noted that these cysts were completely absent in a series of 132 hips with hip dysplasia, characterized by inadequate anterior acetabular coverage, whereas they occurred in one third of a series of 117 cases of FAI. This provided evidence that abnormal contact in the setting of FAI could play a causative role in the development of these cysts.

Cysts along the acetabulum have long been associated with labral pathology.[34] A number of reports have documented both intraosseous and extraosseous ganglion cysts in this region.[12,32-34] Haller et al.[33] presented 7 cases with juxta-acetabular ganglionic cysts varying in location around the acetabular rim. They showed histologic evidence of cystic spaces filled with basophilic mucoid material with abundant fibrin-like material and areas of hyaline cartilage indicative of a synovial origin. They proposed a pathomechanical explanation for the occurrence of these cysts resulting from synovial fluid under pressure through damage to the acetabular labrum and adjacent cartilage, with permeation of fluid under this cartilage and a progressive increase in the size of the cysts. On the basis of our current understanding of FAI, this theory appears plausible and similar to that proposed by Leunig et al.[27] for the formation of femoral fibrocysts.

The management of intraosseous cysts of the femoral neck and of the acetabular rim has not been clearly addressed in the literature. In most cases, at the time of either open or arthroscopic recontouring of the femoral head, the cysts are encountered on the neck. However, because of their small size, they rarely require treatment. In contrast, Gunther et al.[25] pub-

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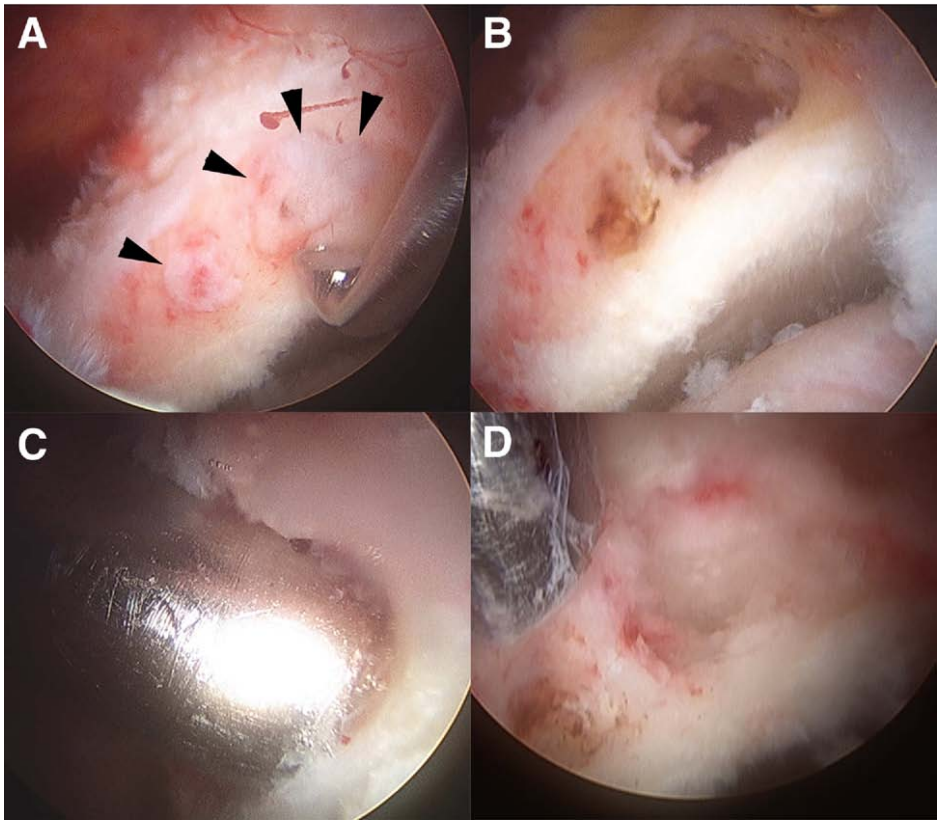

FIGURE 6. Arthroscopic images in case 2 in the supine position as viewed from the direct anterior portal showed (A) an acetabular bone cyst (black arrowheads) with the contents removed with a small curette. (B) After removal of the cyst contents, (C) the metal cannula with the bone graft materials was introduced through the anterior paratrochanteric portal through the slotted cannula. (D) The cyst cavity was filled with the bone graft material.

lished a series of very large cysts of the proximal femur requiring aggressive treatment with decompression, bone grafting, and in some cases stabilization with a screw and side plates. One of the challenges to the arthroscopic management of these cysts lies in the difficulty in accessing the very deep hip joint. Arthroscopic techniques for bone grafting have been widely used in the management of failed anterior cruciate ligament reconstruction including the use of cancellous bone chips and osseous cylinders with various delivery devices such as chest tubes, syringes, and osteochondral autograft instrumentation.[37-40] These techniques can also be used in the hip but would undoubtedly be more technically difficult than in the knee. In this report we discuss the use of a standard metal arthroscopic cannula to deliver a commercially available bone graft substitute consisting of demineralized bone matrix and cancellous chips. The advantage of the technique is that it is performed in an all-arthroscopic manner and by use of standard instruments used for hip arthroscopy. With this technique, the cysts can be effectively filled with graft material and the excess bone graft material can easily be removed to avoid third-body wear of the hip joint.

In summary, arthroscopic bone grafting of femoral and acetabular cysts at the time of the management of FAI may be necessary in selected cases. The arthroscopic technique discussed in this report may be of use to surgeons managing FAI using an all-arthroscopic technique.

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