Review Article

Joint-preserving Surgical Options for Management of Chondral Injuries of the Hip

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Abstract

Management of injuries to the articular cartilage is complex and challenging; it becomes especially problematic in weight-bearing joints such as the hip. Several causes of articular cartilage damage have been described, including trauma, labral tears, and femoroacetabular impingement, among others. Because articular cartilage has little capacity for healing, nonsurgical management options are limited. Surgical options include total hip arthroplasty, microfracture, articular cartilage repair, autologous chondrocyte implantation, mosaicplasty, and osteochondral allograft transplantation. Advances in hip arthroscopy have broadened the spectrum of tools available for diagnosis and management of chondral damage. However, the literature is still not sufficiently robust to draw firm conclusions regarding best practices for chondral defects. Additional research is needed to expand our knowledge of and develop guidelines for management of chondral injuries of the hip.

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Dr. Domb or an immediate family member is a member of a speakers' bureau or has made paid presentations on behalf of Arthrex; serves as a paid consultant to Arthrex and Mako Surgical; has received research or institutional support from Arthrex, Mako Surgical, MedWest Associates, and Adventist Hinsdale Hospital; and serves as a board member, owner, officer, or committee member of the American Hip Institute and the Arthroscopy Association of North America. None of the following authors or any immediate family member has received anything of value from or has stock or stock options held in a commercial company or institution related directly or indirectly to the subject of this article: Dr. El Bitar, Dr. Lindner, and Dr. Jackson.

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Management of chondral injuries is challenging and complex, especially when weight-bearing joints such as the knee or the hip are involved.[1] Nonsurgical methods of alleviating pain are temporizing measures; they do not solve the underlying problem. Chondral damage in the hip is more prevalent in the setting of other intra-articular pathologies.[2] McCarthy and Lee[2] reported on arthroscopic evaluation of 457 hips performed over 6 years. They found that most chondral injuries in the hip joint were associated with labral tears and were located in the anterior quadrant of the acetabulum (59%).

Several causative factors have been implicated, including trauma,[3,4] labral tears,[4,5] femoroacetabular impingement (FAI),[4,6] arthritis,[2] osteonecrosis, and dysplasia.[7] Although total hip arthroplasty (THA) is typically used for management of advanced osteoarthritis (OA), early detection and management of focal chondral injuries may preempt degeneration of the entire joint. Thus, hip-preserving strategies are particularly applicable in the younger patient (age ≤50 years).

Patients with chondral injuries of the hip typically have a history of hip catching or locking and present with pain in the groin area that occasionally radiates to the buttock or thigh. Other pathologies (eg, labral tears) can present with similar symptoms.[4,8] Physical examination should be thorough, focusing on intra-articular and extra-articular causes of pain. Plain radiography can be used to detect joint space narrowing but not focal

Table 1

Radiographic Classifications for Hip Osteoarthritis

Classification	Grade	Description
Tönnis	0	No signs of OA
	1	Mild OA: Increased sclerosis, minimal JS narrowing, no or minimal loss of head sphericity
	2	Moderate OA: Small cysts, moderate JS narrowing, moderate loss of head sphericity
	3	Severe OA: Large cysts, severe JS narrowing, severe deformity of the head
Kellgren-Lawrence	0	No signs of OA
	1	Doubtful JS narrowing, possible osteophyte formation
	2	Possible JS narrowing, definite osteophytes
	3	Definite JS narrowing, moderate multiple osteophytes, some sclerosis, and possible deformity of bone contour
	4	Marked JS narrowing, large osteophytes, severe sclerosis, and definite deformity of bone contour

JS = joint space, OA = osteoarthritis

Table 2

Chondral Damage Classifications

Classification	Grade	Description
Outerbridge	0	Macroscopically normal cartilage
	1	Cartilage softening and swelling
	2	Fragmentation and fissuring involving area <1.5 cm in diameter
	3	Fragmentation and fissuring involving area >1.5 cm in diameter
	4	Loss of cartilage and exposed subchondral bone
Beck	0	Macroscopically normal cartilage
	1	Malacia: Roughening of surface, fibrillation
	2	Pitting malacia: Roughening, partially thinning and full-thickness defects or deep fissuring to bone
	3	Debonding: Loss of fixation to subchondral bone, macroscopically sound cartilage (carpet phenomenon)
	4	Cleavage: Loss of fixation to subchondral bone, frayed edges, thinning of cartilage
	5	Defect: Full-thickness defect
ALAD	0	Macroscopically normal cartilage
	1	Cartilage softening
	2	Early peel back of cartilage
	3	Large flap of cartilage or delamination
	4	Complete loss of cartilage and exposed subchondral bone

ALAD = Acetabular Labrum Articular Disruption

chondral defects. MRI offers improved visualization of soft tissues about the hip.[4,8] However, it is suboptimal for visualization of labral or chondral injuries. MRI arthrography has improved the detection rate of acetabular labral tears and chondral defects at the expense of a higher rate of false-negative results.[4,8]

Several radiographic classification systems for OA of the hip have been described. The most widely used are the Tönnis[9] and Kellgren-Lawrence[10] (Table 1). Classification systems also have been developed to grade the intraoperative extent of articular cartilage damage. The Outerbridge, Beck,[11] and Acetabular Labrum Articular Disruption[12] classifications can be used to guide management (Table 2).

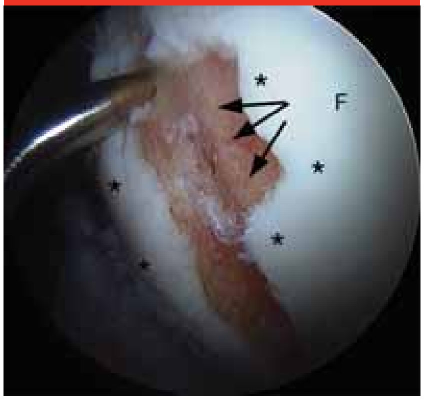
In addition to hip arthroplasty, management options for injury to the articular cartilage include microfracture,[3,13-17] articular cartilage repair,[1,18,19] autologous chondrocyte implantation (ACI),[20,21] mosaicplasty[22-25] and osteochondral allograft transplantation (OAT).[26-28] The use of these modalities in the knee has been well described, with favorable outcomes reported. However, much less evidence exists regarding the effectiveness of these techniques for chondral injuries of the hip.

Management

Microfracture

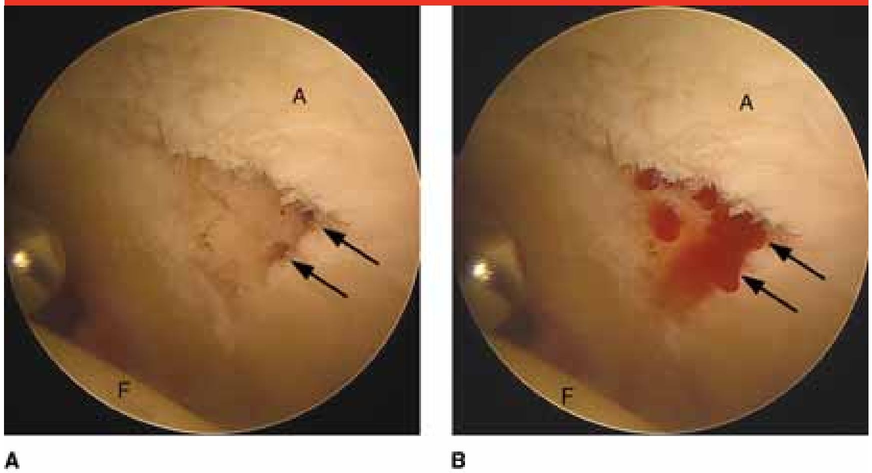
Management of chondral defects of the knee with microfracture is well established, and favorable outcomes have been reported.[29-31] Data on the efficacy of this modality for chondral defects of the hip remain limited. Indications for microfracture in the hip (eg, minimal OA, a focal, contained lesion measuring <4 cm^2 in size) have been extrapolated from literature on the knee.[3,16,29-31]

Figure 1



Intraoperative arthroscopic image demonstrating preparation of a full-thickness chondral lesion of the femoral head for microfracture. Intact cartilage with a healthy appearance (asterisks) surrounds the chondral defect. The arrows indicate the intact subchondral bone layer. F = femoral head

Figure 2



Intraoperative arthroscopic images demonstrating a full-thickness chondral lesion of the acetabulum treated with microfracture. The surface of the acetabulum before (**A**) and after (**B**) bleeding at the sites of microfracture (arrows). Holes were created in the subchondral bone layer using a microfracture awl. A = acetabulum, F = femoral head

The procedure begins with débridement of the cartilage lesion. The friable parts are resected using a shaver, and the bed and edges are freshened using ringed curets to create a well-contained lesion with a perpendicular edge of healthy, well-attached cartilage. An awl is then used to create several 3- to 4-mm deep perpendicular holes in the subchondral bone until bleeding is visualized. The holes should be spaced 3 to 4 mm apart to preserve a subchondral bone bridge between the holes. The goal is to bring marrow cells and growth factors from the underlying bone marrow into the chondral defect area (Figure 1). The pluripotent marrow cells that emerge from these holes can form new fibrocartilage to fill the defect (Figure 2).

Karthikeyan et al[16] reported on a series of 20 patients with FAI and acetabular chondral defects who underwent hip arthroscopy and microfracture followed by a second-look arthroscopy. None of the patients had diffuse OA. The average size of the defect was 1.54 cm^2. The mean time interval between the primary and second-look surgeries was 17 ± 11 months. The mean percent fill at second-look arthroscopy was 93% ± 17%, with good-quality cartilage macroscopically. The Nonarthritic Hip Score was 55 points before the initial procedure and 54 points before second-look arthroscopy. After the second arthroscopy, the score improved to 78 points at a mean follow-up of 21 months.[16] Byrd and Jones[17] reported on arthroscopic management of cam-type FAI in 207 hips. Microfracture was performed in 58 hips with a grade 4 chondral defect, an intact subchondral plate, and healthy surrounding cartilage. The modified Harris hip score (MHHS) improved from 65 preoperatively to 85 at 2-year follow-up.

Philippon et al[3] reported on a series of nine patients who underwent revision hip arthroscopy for a variety of reasons after prior microfracture for acetabular chondral defects.[3] The mean-percent fill was 91%, with good-quality cartilage. However, no outcome measures were reported. Haviv et al[13] reported on results of arthroscopic femoral osteoplasty performed in patients with cam lesions and isolated acetabular chondral injuries. Twenty-nine of 135 patients with grade 2 or 3 chondral lesions underwent microfracture when the lesion was <3 cm^2 in size, and the remaining patients underwent chondroplasty. The Nonarthritic Hip Score results were substantially higher in patients treated with microfracture than in those treated with chondroplasty.[13] However, the authors did not report the average size of the defect in patients who underwent chondroplasty. In a study of nine patients with hip OA, Byrd and Jones[14] reported that the possible cause was an inverted labrum. All nine patients had grade 4 acetabular chondral lesions. Three patients had well-circumscribed lesions and underwent microfracture. At 2-year follow-up, those three patients were the only ones who returned to a sporting level of activity.[14]

Microfracture seems to be a simple and effective modality for manage-

Table 3

Comparison of Management Techniques for Chondral Injury of the Hip

	Technique					
Factor	**Microfracture**	**ACI**	**MACI**	**Repair**	**Mosaicplasty**	**OAT**
Technical difficulty	Minimal	Moderate	Moderate	Minimal	Significant	Significant
Acetabular lesion size	<6 cm^2	2–8 cm^2	2–8 cm^2	<2 cm^2	Investigational	Investigational
Femoral lesion size	<2 cm^2	2–8 cm^2	2–8 cm^2	N/A	<2 cm^2	2–8 cm^2
Type of defect	Full-thickness	Full-thickness	Full-thickness	Delaminated cartilage	Full-thickness	Full-thickness
Subchondral layer	Intact	Intact	Intact	Intact	Intact or breached	Intact or breached
Number of surgeries	1	2	2	1	1	1
Surgical approach	Arthroscopy	Open surgical dislocation	Arthroscopy	Arthroscopy	Open surgical dislocation	Open surgical dislocation
Donor site morbidity	None	Minimal	Minimal	None	Moderate	None
Repair tissue	Fibrocartilage	Hyaline/ fibrocartilage	Hyaline/ fibrocartilage	Hyaline cartilage	Hyaline cartilage	Hyaline cartilage
Risk of disease transmission	None	None	None	None	None	Minimal
Graft viability	N/A	Minimal	Minimal	N/A	Significant	Moderate
Cost	Minimal	Moderate	Significant	Minimal	Minimal	Significant
Available in the United States	Yes	Yes	No	Yes (but fibrin glue not approved for this purpose)	Yes	Yes

ACI = autologous chondrocyte implantation, MACI = matrix-assisted autologous chondrocyte implantation, N/A = not applicable, OAT = osteochondral allograft transplantation

ment of chondral defects that involve the hip in patients with little or no evidence of arthritis.[13,16] However, clinical results of microfracture in the setting of advanced arthritis are less encouraging.[15] Horisberger et al[32] reported on 20 patients with FAI who underwent hip arthroscopy. All patients had Outerbridge grade 3 or 4 lesions of the acetabulum. Three patients had Outerbridge grade 4 lesions of the femoral head. At an average follow-up of 3 years, 50% of the patients had undergone or were scheduled for THA. The authors concluded that hip arthroscopy for FAI is contraindicated in patients with Tönnis grade 3 OA.[32]

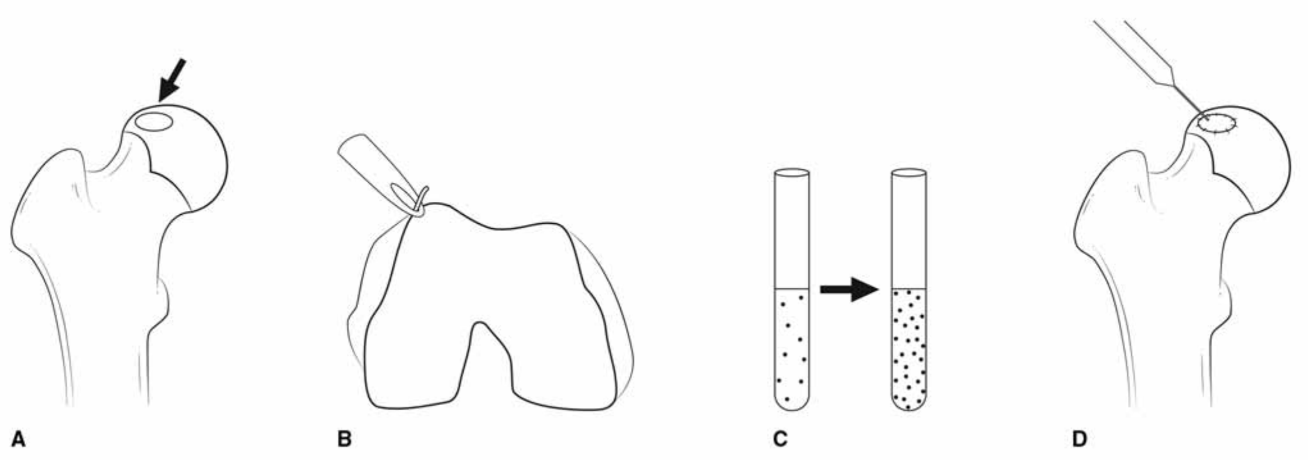
Microfracture is cost effective and relatively easy to perform, with the entire surface of the acetabulum and femoral head accessible (Table 3). Clinical outcomes of microfracture in the hip have been favorable in the absence of OA, with no significant complications reported.[3,13,14,16,17] However, sample sizes were small, and none of these studies compared the outcomes of patients treated with microfracture with those of a control group.[3,13,14,16,17,32] Long-term outcome studies are needed to better judge the effectiveness of microfracture for management of chondral injuries of the hip.

Autologous Chondrocyte Implantation

Similar to those of microfracture, favorable outcomes have been reported with ACI for chondral lesions in the knee.[31,33] Indications for ACI in the knee (ie, solitary chondral lesions and no signs of OA) have been applied to the hip. The defects should be full thickness and well contained, with intact subchondral bone. Lesions typically range in size from 3 to 10 cm^2.[31,33-36]

The procedure is performed in a staged manner. During the first stage, chondrocytes are harvested from one of the patient's joints and then sent

Figure 3



Illustrations demonstrating autologous chondrocyte implantation. **A,** A chondral defect (arrow) is shown on the femoral head. **B,** Chondrocytes are harvested from the lateral aspect of the femoral trochlea. **C,** The harvested chondrocytes are cultivated to increase their numbers. **D,** Autologous chondrocytes are implanted under the patch that covers the chondral defect.

to specialized facilities for cultivation. The second stage is the implantation of cultivated chondrocytes into the defect. Earlier ACI techniques in the knee used a patch (periosteal or synthetic) to cover the defect, which acted as a seal, allowing containment of chondrocytes within the targeted defect area.[31,33,35,36] The solution containing the cultivated chondrocytes was then injected into the defect under the patch (Figure 3). Matrix-assisted ACI (MACI) is a newer technique that is based on the use of biodegradable scaffolds for chondrocyte delivery, which eliminates the need for patches and injectable solutions.[21,34-36] This procedure has been performed in the knee using both open and arthroscopic techniques.[34-36]

Fontana et al[21] compared the effectiveness of simple débridement versus MACI for management of hip chondral defects in 30 patients with Outerbridge grade 3 or 4 lesions. The area of involvement was >2 cm^2 in size and all patients had radiographic evidence of Tönnis grade 2 OA. Both stages of the MACI procedure were performed arthroscopically. In both treatment groups, the mean size of the defect was 2.6 cm^2 and the mean follow-up was approximately 74 months. The preoperative Harris hip score (HHS) was comparable in both groups, with 48.3 in the MACI group and 46 in the débridement group (P = 0.428). The authors reported better clinical outcomes with MACI than with simple chondroplasty, with an average HHS of 87.4 in the MACI group and an average score of 56.3 in the débridement group (P < 0.05) at final follow-up.

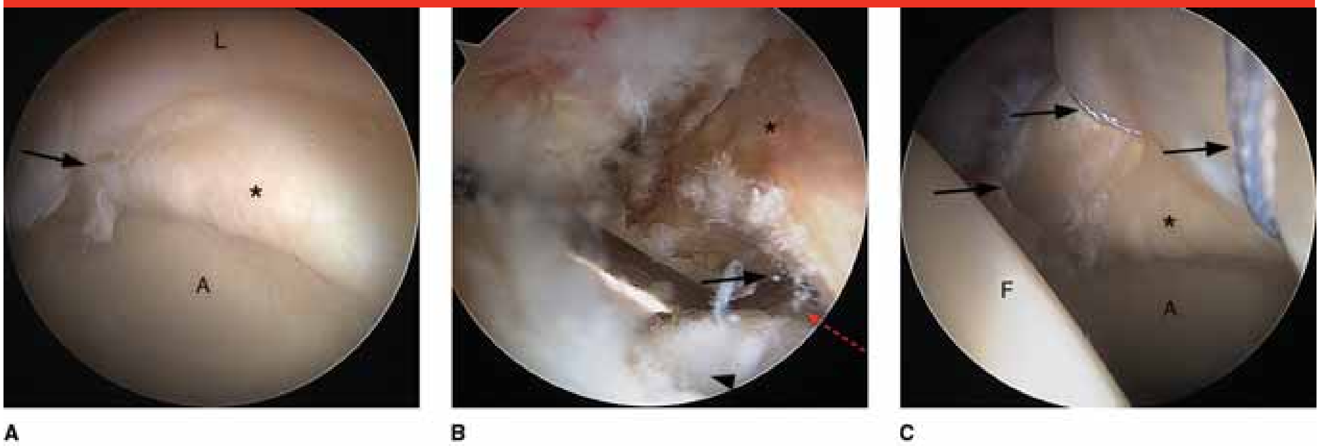
Akimau et al[20] reported on a case of ACI in a young patient with osteonecrosis of the femoral head following a traumatic fracture-dislocation of the hip that was initially treated with open reduction and internal fixation. Chondrocytes were harvested arthroscopically from the ipsilateral knee. The hip was dislocated and the defects of the femoral head were filled with bone graft from the trochanter. The entire femoral head was covered with a synthetic collagen patch under which chondrocytes were injected. The HHS was 52 preoperatively and improved to 76 at final follow-up. Second-look arthroscopy with biopsy showed 2-mm thick fibrocartilage. Follow-up CT revealed evidence of cystic and sclerotic changes to the femoral head and joint space narrowing.[20]

ACI or MACI of the hip is challenging because the joint is deep, with surrounding bulky muscles, and certain areas are difficult to access. The first step of this complex surgery, harvesting of chondrocytes, carries the risk of infection and other potential comorbidities to the donor site. In addition, the second stage of ACI surgery can be performed only via surgical dislocation, which carries the risk of development of osteonecrosis in the femoral head.[21] In contrast to ACI, MACI can be performed arthroscopically, obviating the need for open surgical dislocation. MACI is currently used in Europe but is still not approved for use in the United States (Table 3).

Articular Cartilage Repair

Delaminated articular cartilage is a full-thickness separation of the artic-

Figure 4



Intraoperative arthroscopic images demonstrating management of a delaminated cartilage lesion of the acetabulum with the suture repair technique. **A,** The lesion (asterisk) is visible on the acetabulum (A). A tear (arrow) of the labrum (L) can be seen, as well. **B,** Part of the acetabular rim (asterisk) is trimmed for the repair of the labrum and delaminated cartilage lesion. A microfracture awl is used to create a hole (black arrow) in the subchondral bone. The labrum (arrowhead) is detached from the acetabular rim to perform the repair. The undersurface of the delaminated area of cartilage is visible (red arrow). **C,** Completed suture repair of the labral tear (arrows) and delaminated cartilage (asterisk). F = femoral head

ular cartilage from the underlying subchondral bone. The delaminated cartilage may break off and become a loose body in the joint, leaving behind a substantial defect.[1] In the hip, delamination injuries are commonly associated with FAI as well as anterior superior labral tears.[6] Managing such injuries can be a challenge. The delaminated cartilage can be resected, resulting in exposure of the underlying subchondral bone. This exposed surface can then be managed using microfracture, as long as the lesion is <3 cm^2.[1] If the delaminated cartilage lesion is >3 cm^2, management of the defect after débridement becomes more complex. A cartilage flap that appears to be healthy macroscopically may be salvageable; some authors have attempted repair of unstable healthy-looking delaminated cartilage with sutures[1] or fibrin adhesive[18,19] (Figure 4).

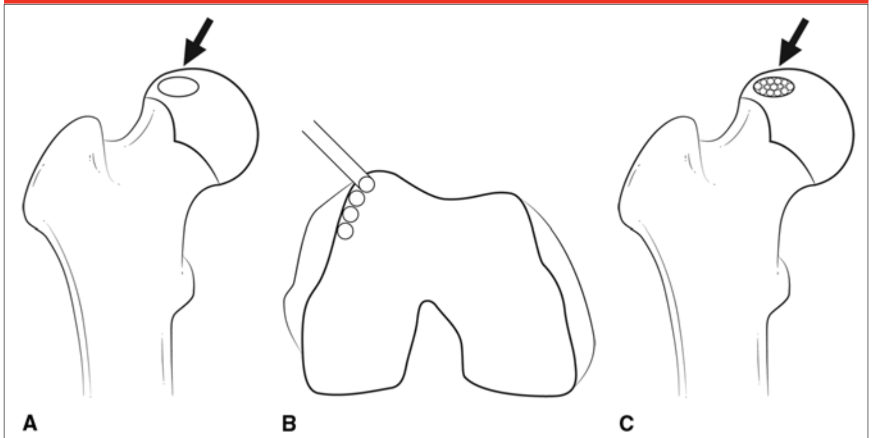
Sekiya et al[1] reported on a case of chondral delamination in a 17-year-old male athlete with FAI, an anterosuperior labral tear, and an adjacent area of delaminated acetabular articular cartilage that measured 1 cm^2. This area was found to be unstable but looked healthy enough for salvage. Microfracture was performed under the flap, and the flap was sutured with absorbable polydioxanone monofilament. At 2-year follow-up, the patient reported feeling 95% normal, scoring 96 points on the MHHS scale, 93 points on the Hip Outcome Score Activities of Daily Living subscale, and 81 points on the Hip Outcome Score Sports subscale.[1]

In a study of 19 patients with chondral delamination injuries of acetabular cartilage, Tzaveas and Villar[19] managed chondral delamination lesions of the hip arthoscopically with fibrin adhesive. Nineteen patients underwent hip arthroscopy for labral tears (15 cases) and cam-type impingement (18 cases). The overall cartilage structure was intact in all patients. The authors performed microfracture of the underlying subchondral bone and then injected fibrin adhesive under the flap, pressing down until the adhesive had set. Five patients underwent revision hip arthroscopy for multiple reasons, and the repaired chondral lesion was found to be stable in all patients. At 1-year follow-up, the mean MHHS improved from 53.3 to 80.3, and the mean pain score improved from 15.7 to 28.9.[19]

In the largest study on articular cartilage repair of the hip, Stafford et al[18] used fibrin adhesive to treat 43 patients with delaminated articular cartilage. The average follow-up was 28 months. The authors reported significant improvement in the MHHS pain subscale, with an average score of 21.8 preoperatively and an average score of 35.8 postoperatively (P < 0.0001). The MHHS function subscale also improved significantly, from an average of 40.0 preoperatively to an average of 43.6 postoperatively (P = 0.0006).

Articular cartilage repair is appropriate only for small lesions of delaminated cartilage. Limited evidence exists to support the use of this technique in the hip despite the relatively favorable outcomes reported.[1,18,19]

Figure 5



Illustrations demonstrating mosaicplasty. **A,** A chondral defect (arrow) is shown on the femoral head. **B,** Osteochondral autograft is harvested from the lateral aspect of the femoral trochlea. **C,** The defect (arrow) is filled with the harvested osteochondral autograft.

The fibrin adhesive used in this technique is available only in Europe and is not approved for use in the United States[18,19] (Table 3). The suture repair technique described by Sekiya et al[1] is limited to a single case report.

Mosaicplasty

Mosaicplasty (autologous osteochondral graft transplantation) involves the use of autologous osteochondral cylindrical grafts to fill chondral or osteochondral defects in an affected joint. The procedure has been performed in the knee, with favorable clinical outcomes reported.[30,37] Indications for this procedure in the knee include patient age <45 years, no signs of OA, and a focal, full-thickness lesion that is contained and <3 cm^2 in size.[30,37]

The first step in mosaicplasty is measurement and preparation of the defect area. The friable edges of the lesion are débrided to obtain stable, healthy cartilage edges. The number of drill holes created in the lesion depends on its size. The holes penetrate subchondral bone, leaving a stable subchondral bone bridge between them. Osteochondral graft is then harvested from the lateral trochlea and implanted into the previously created holes (Figure 5). This technique has been used in the hip for management of lesions that affect the femoral head.[22-25] Osteochondral grafts are harvested from the knee[24,25] or from the inferolateral aspect of the femoral head in the involved hip.[22,23,25]

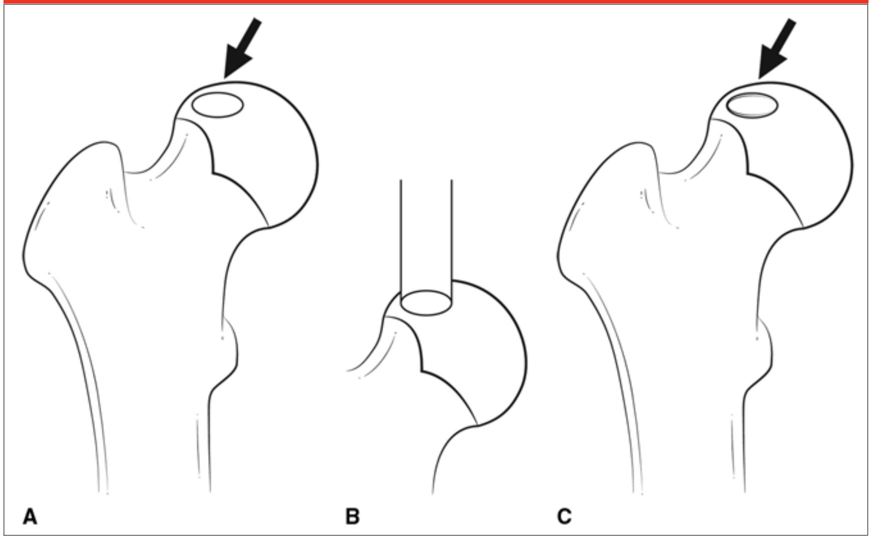
Hip mosaicplasty involves open surgical dislocation for management of femoral head lesions.[22-25] Girard et al[23] used this procedure to treat femoral head defects in 10 patients (average age, 18 years) with a variety of congenital hip diseases. Average lesion size was 4.8 cm^2 and the average follow-up was 29.2 months. The Merle d'Aubigné and Postel score improved from an average of 10.5 preoperatively to an average of 15.5 postoperatively. The HHS also improved from 52.8 preoperatively to 79.5 postoperatively. At 6 months postoperatively, CT arthrograms showed excellent graft incorporation with intact cartilage in all patients. At final follow-up, none of the patients required THA.

Hart et al[24] reported on a case in which mosaicplasty of the femoral head was performed following failure of open reduction and internal fixation for an acetabular fracture associated with posterior hip dislocation. The HHS score improved from 69 to 100 postoperatively, and the patient had full hip range of motion with no pain.[24] Sotereanos et al[22] described the use of mosaicplasty in a young patient with osteonecrosis of the femoral head that affected both hips, which were previously treated with free fibular grafts. The patient was scheduled for THA secondary to continued pain in both hips. At the time of surgery, the femoral head cartilage was found to be in good condition except for one well-defined area of cartilage softening. Mosaicplasty was performed in an attempt to salvage the hip, using grafts from the inferolateral aspect of the femoral head. The pain score decreased from 90 to 9.[22]

Nam et al[25] reported on two cases of osteochondral injuries to the femoral head that were treated acutely with mosaicplasty. One patient sustained posterior hip dislocation with an associated cartilage defect on the femoral head. The other patient sustained posterior hip dislocation with associated femoral head fracture and a full-thickness chondral defect. The fracture was treated with screw fixation, and the chondral defect of the femoral head was treated with mosaicplasty. MRI showed graft incorporation in both patients, and they returned to their baseline activity level.[25]

Mosaicplasty seems to be a good option for management of osteochondral lesions of the femoral head. Advantages include elimination of the need for a second procedure (as in ACI), replacement of chondral lesions with grafts containing hyaline cartilage, which has mechanical properties superior to those of fibrocartilage, and immediate or near-immediate weight bearing after surgery (Table 3). However, the

Figure 6



Illustrations demonstrating osteochondral allograft transplantation. **A,** A chondral defect (arrow) is shown on the femoral head. **B,** The osteochondral allograft is harvested from a donor femoral head using a harvesting cylinder. **C,** The defect (arrow) is filled with the harvested osteochondral allograft.

procedure is performed via open dislocation of the hip, which adds further risk of osteonecrosis in the already compromised joint. Donor site morbidity is also an issue, especially when the grafts are harvested from a normal joint.

Osteochondral Allograft Transplantation

OAT is another option for management of osteochondral defects of the hip. Similar to the previously described techniques, indications for OAT in the hip are extrapolated from those for OAT in the knee. Patients are typically aged ≤50 years and have no evidence of OA.[38] This technique is appropriate to use when the defect is large (ie, >2.5 cm^2) or in the setting of substantial loss of subchondral bone.[27,38] Preparation of the lesion starts with débridement of the friable edges to obtain healthy, stable cartilage. The lesion is then drilled to accept the allograft. The size of the drilled hole is measured, and an allograft of similar dimensions is harvested from a cadaver donor. The allograft is then inserted in a press-fit manner into its recipient location (Figure 6).

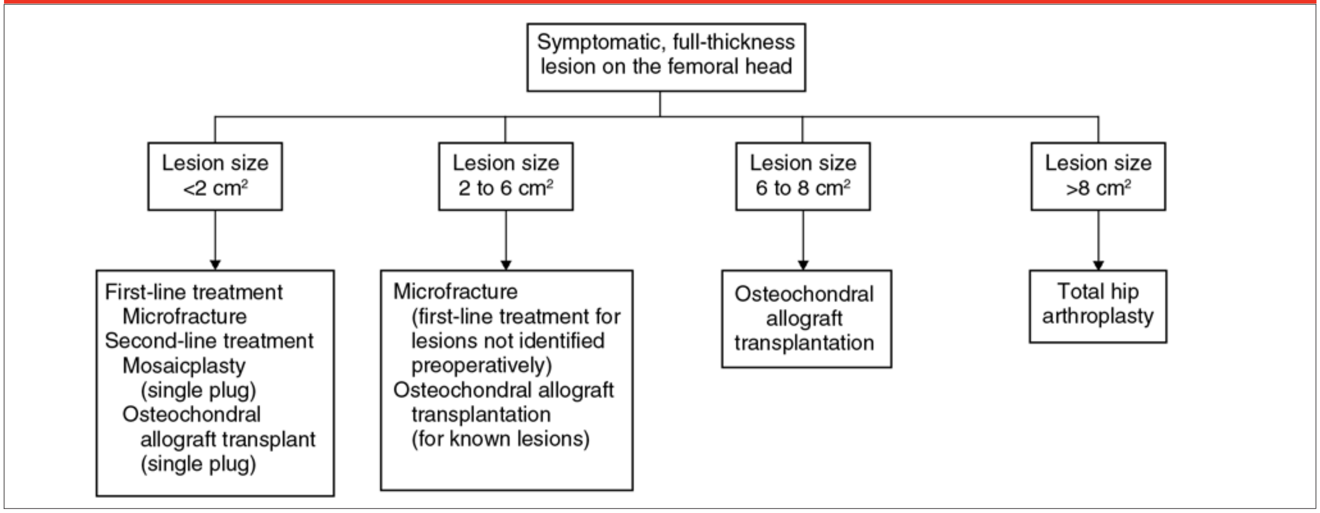
In 1985, Meyers[28] published one of the earliest reports on the use of osteochondral allografts in the hip. He used this technique in 20 patients with osteonecrosis of the femoral head and segmental collapse and in one patient with a fracture-dislocation of the femoral head (25 hips total). In 5 of 10 hips (50%) with steroid-induced osteonecrosis, the procedure failed; however, the success rate was 80% in 15 hips with nonsteroid-induced osteonecrosis.[28] Evans and Providence[26] described the use of osteochondral allograft in a patient with posttraumatic osteochondritis dissecans of the femoral head. The HHS improved from 69 preoperatively to 94 at 1-year follow-up, and the patient had full, painless hip range of motion.[26]

Krych et al[27] reported on management of osteochondral defects of the acetabulum in two patients. One patient had a periacetabular cyst in the superior acetabular dome as well as a failed arthroscopic osteoplasty of the femoral neck. The allograft was taken from an acetabular donor. The MHHS improved from 75 preoperatively to 97 at 2-year follow-up. The second patient had fibrous dysplasia of the acetabulum that was treated with curettage and grafting of the lesion with cement. The allograft in this case was taken from a medial tibial plateau donor for congruity matching. The MHHS improved from 79 preoperatively to 100 at 3-year follow-up. MRIs (obtained at 1-year follow-up in the first patient and at 18-month follow-up in the second) showed graft incorporation and hip joint congruity in both patients.[27]

In the few cases reported in the literature, good clinical results have been achieved with OAT in the hip joint.[26-28] This technique eliminates donor site morbidity, immediately providing a mechanically functioning joint surface.[27,38] Larger lesions that are otherwise hard to manage using other techniques can be managed with OAT. Additionally, this technique provides a hyaline cartilage replacement, which has superior mechanical properties, compared with fibrocartilage, for hyaline cartilage defects.[38]

Drawbacks of OAT include the risk of disease transmission, the relative paucity of donor tissue, and the need for complex graft handling and procurement procedures.[27] Viability of the chondrocytes from graft procurement to implantation is affected by the length of storage time after graft procurement. Some reports suggest that there is a substantial reduction in graft viability after 28 days of storage[39] (Table 3). Both mosaicplasty and OAT are appropriate for managing "apple-bite" lesions that occur at the junction of the femoral head-neck secondary to over-resection of femoral cam deformities.

Figure 7

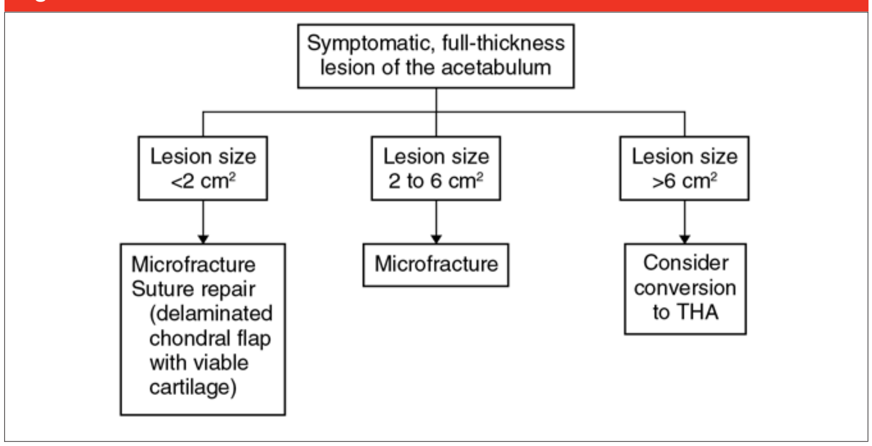


Authors' treatment algorithm for joint-preserving management of chondral injuries of the femoral head. This algorithm can be used in patients who meet the following criteria: (1) age ranging from skeletal maturity to 50 years; (2) minimal (Tönnis grade ≤1) or no sign of osteoarthritis on radiography; (3) no inflammatory arthritis; (4) one or more full-thickness defects, but no bipolar lesions; (5) a well-contained lesion; (6) ability to perform rigorous postoperative physical therapy regimen.

Authors' Algorithms

We propose algorithms for the management of chondral injuries of the hip in patients who meet specific criteria for joint-preserving surgery (Figures 7 and 8). The algorithms outline a simplified approach for joint-preserving management of articular cartilage lesions of the femoral head and the acetabulum, respectively.

Figure 8



Authors' treatment algorithm for acetabular lesions. This algorithm can be used in patients who meet the following criteria: (1) age ranging from skeletal maturity to 50 years; (2) minimal (Tönnis grade ≤1) or no sign of osteoarthritis on radiography; (3) no inflammatory arthritis; (4) one or more full-thickness defects, but no bipolar lesions; (5) a well-contained lesion; (6) ability to perform rigorous postoperative physical therapy regimen. THA = total hip arthroplasty

Summary

Preserving the hip joint in young, active patients with chondral injuries remains an important goal for the orthopaedic surgeon. The use of microfracture, ACI, articular cartilage repair, mosaicplasty, and OAT in the hip joint has been described, with relative success reported. However, the literature is limited to small case series and case reports, with no long-term studies. In addition, the available studies lack control groups, making comparison of different treatment modalities difficult. Therefore, further investigation of these treatment modalities as they apply to the hip is required to formulate best- treatment practices and provide appropriate recommendations for management of chondral injuries of the hip.

References

Evidence-based Medicine: Levels of evidence are described in the table of contents. In this article, references 30, 33, and 35 are level I studies. References 31 and 36 are level II studies. Reference 21 is a level III study. References 3, 5-7, 11, 13-19, 23, 28, 29, 32, 37, and 38 are level IV studies. References 1, 20, 22, 24-27, and 34 are level V expert opinion.

References printed in **bold type** are those published within the past 5 years.

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