Technical Note

Single-Stage Arthroscopic Autologous Matrix–Enhanced Chondral Transplantation (AMECT) in the Hip

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Abstract: Chondral defects of the acetabulum in patients with femoroacetabular impingement syndrome are an increasingly recognized cause of worse outcomes after treatment. Multiple procedures have been described for the treatment of hip cartilage lesions including microfracture, autologous chondrocyte implantation, matrix-induced autologous chondrocyte implantation, and autograft and allograft transplantation. However, many of these techniques have poor long-term outcomes, require multiple surgical procedures, or rely on planned preoperative identification of the chondral lesion. This Technical Note describes our technique of autologous matrix–enhanced chondral transplantation, a single-stage treatment for acetabular cartilage lesions that harvests chondral tissue from the femoral cam deformity and combines it with chondral extracellular matrix, growth factors, and autologous peripheral blood.

Acetabular chondral defects have been associated with worse outcomes after treatment of femoroacetabular impingement syndrome.[1] Lesions in the weight-bearing area, as well as those measuring greater than 300 mm,[2] have been associated with a higher rate of conversion to total hip arthroplasty.[3] If left untreated, patients with femoroacetabular impingement syndrome continue to experience repetitive trauma leading to further cartilage delamination and full-thickness chondral defects. The remaining cartilage sees elevated tensile strains, shearing forces, and contract stresses, which may lead to the eventual development of osteoarthritic changes of the hip.[4,5]

Hip microfracture has shown good short-term outcomes, but these results appear to decline with longer-term follow-up.[6-10] Autologous matrix–induced chondrogenesis techniques using various collagen scaffolds have also shown improved short-term follow-up.[8,11-13] Moreover, treatment of chondral defects with arthroscopic autologous chondrocyte implantation (ACI) and matrix-induced autologous chondrocyte implantation (MACI) has been shown to improve short-term outcomes.[12,14]

A technique of ACI harvest from the cam region of the femur in patients undergoing osteoplasty has shown a sufficient and heterogeneous composition of cells when chondrogenic potential and histology were examined.[15] This makes cartilage harvest from the cam lesion an intriguing possibility.

We perform a technique to harvest the articular cartilage from the femoral head-neck junction and cam lesion prior to femoral osteochondroplasty using an arthroscopic shaver and attached suction retrieval device (GraftNet; Arthrex, Naples, FL). The retrieval device allows for the sterile collection of cartilage, with data showing maintained viability and activity of the harvested cartilage.[16] The harvested cartilage may then be combined with sterile extracellular matrix, growth factors, or other biological materials prior to implantation.[17] This combination results in autologous matrix–enhanced chondral transplantation (AMECT) in a single stage. In this Technical Note, we review our technique of arthroscopic single-stage AMECT to treat acetabular chondral lesions with a chondral donation from the femoral cam lesion combined with chondral

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The authors report the following potential conflicts of interest or sources of funding: T.G.M. is a paid speaker for Arthrex and receives research support from Zimmer Biomet. Full ICMJE author disclosure forms are available for this article online, as supplementary material.

Received October 8, 2019; accepted November 17, 2019.

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2212-6287/191235

https://doi.org/10.1016/j.eats.2019.11.007

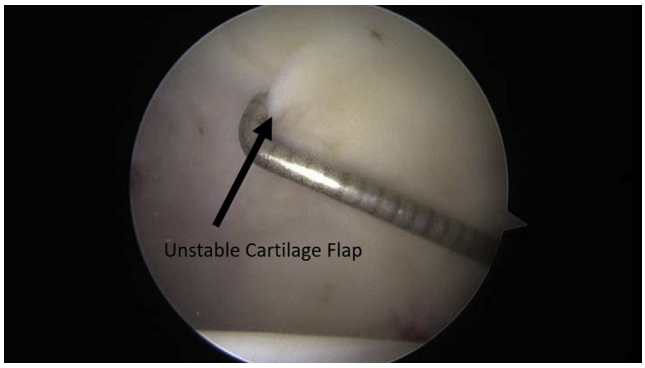

Fig 1. Chondral delamination defect covered by a cartilage flap that was incompletely characterized on preoperative magnetic resonance imaging (view of left hip through midanterior portal).

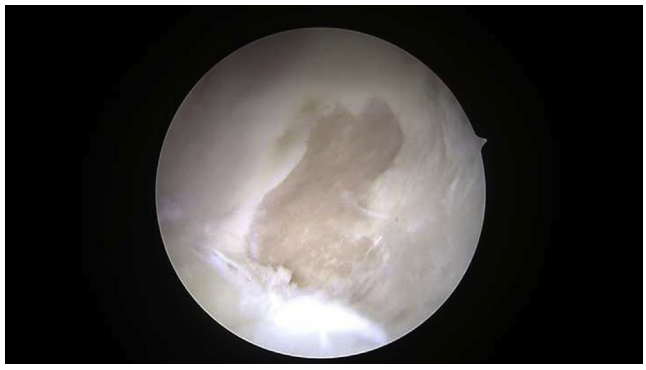

Fig 3. Grade 4a chondral defect after debridement of unstable flap (view of left hip through midanterior portal). The lesion measured 24 mm × 28 mm and extended from the chondrolabral junction centrally.

extracellular matrix, growth factors, and autologous peripheral blood.

Surgical Technique

The patient is positioned supine on a traction table. Traction is applied, and fluoroscopy is used to confirm adequate distraction of the joint. An anterolateral portal is established, followed by the creation of a midanterior portal. Under direct visualization, an interportal capsulotomy is then performed (Video 1). A diagnostic arthroscopy is performed with evaluation of the chondrolabral junction (Fig 1) and specific quantification of the size, depth, and severity of the chondral lesion and any other pathology (Fig 2). Acetabular osseous pathology and unstable labral pathology are then addressed in a standard fashion. Chondral flaps are debrided to a stable edge using a curved ring curette to generate a stable contained lesion bordered by cartilage and labrum circumferentially (Fig 3) and to completely remove the calcified cartilage layer in preparation for transplantation (Fig 4).

After this, traction is released, and the peripheral compartment is entered and evaluated. In this case, a T-capsulotomy is made in the interval between the gluteus minimus and iliocapsularis. Flaps are raised medially and laterally to gain adequate exposure of the head-neck junction. Medial and lateral retinacular vessels are identified and protected throughout the procedure.

Attention is then directed to the chondral harvest. A 4.0 mm shaver is used with an attached chondral fragment capture device (GraftNet) to harvest the chondral surface from the area of the femoral cam deformity prior to femoral osteochondroplasty. The harvested chondral fragments are then combined with 1 mL of chondral extracellular matrix and growth factors (Biocartilage; Arthrex) as well as peripheral blood obtained through a previously placed intravenous catheter to produce an adequate transplant consistency and optimize chondral proliferation and transplantation (Fig 5). A 5.5-mm burr is used to complete the femoral osteochondroplasty.

Attention is now directed to the single-stage acetabular AMECT. Traction is reapplied to gain exposure of the acetabular chondral defect. The ring curette may

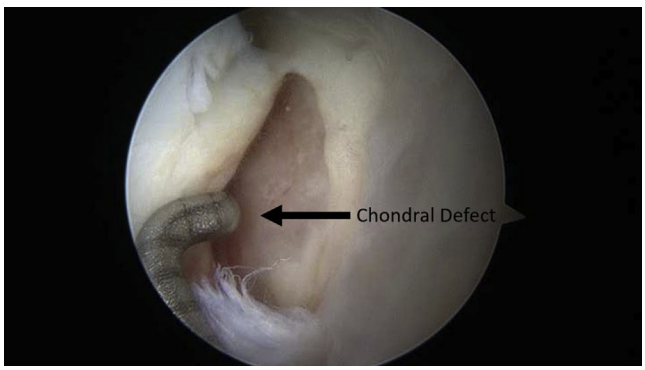

Fig 2. Probing of the chondral lesion showed a grade 4a chondral defect with an unstable flap (view of left hip through midanterior portal with probing through anterolateral portal).

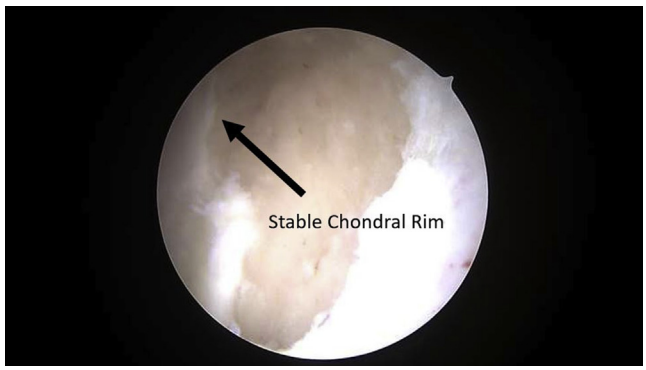

Fig 4. A ring curette is used to debride the lesion until a stable chondral rim circumferentially, including the labral interface, is established (view of left hip through midanterior portal with instrumentation through anterolateral portal).

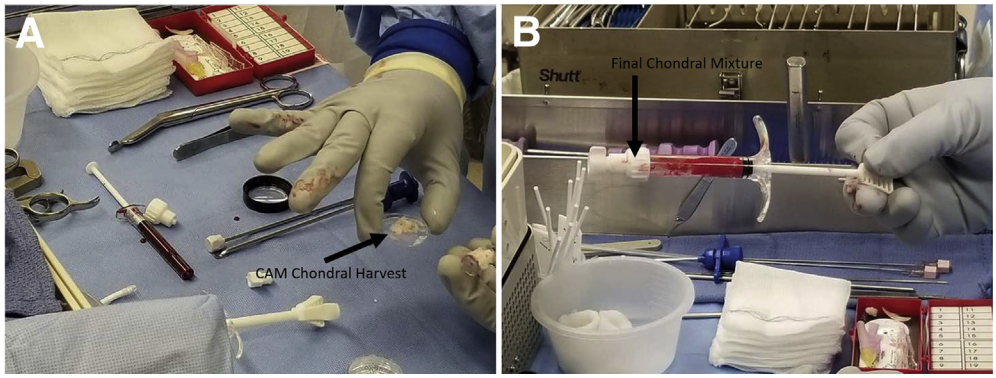

Fig 5. (A) Peripheral blood, minced cartilage from the cam lesion obtained with the chondral fragment capture device (GraftNet), and 1 mL of chondral extracellular matrix and growth factors (Biocartilage) are combined. (B) After preparation, the final chondral mixture is transferred to a syringe for injection into the lesion.

again be used to confirm complete lesion preparation until minimal punctate bleeding from the subchondral bone is established, thereby confirming complete removal of the calcified cartilage layer (Fig 6). At this point, the fluid is extravasated from the hip joint and the bone is carefully dried using arthroscopic gauze and a suction catheter placed in the base of the joint adjacent to the ligamentum teres. Placement of the catheter assists in consistent maintenance of a dry joint for optimal implantation. A Foley catheter can be attached to suction tubing for this purpose.

Once the recipient site is adequately prepared and dried, the autologous enhanced chondral transplant product is introduced arthroscopically using the same instrumentation provided for isolated extracellular matrix transplantation (Fig 7). The chondral fragments are sufficiently small (<0.5 to 1 mm) that the mixture can be injected through the provided metal catheter. Once the mixture is introduced into the joint, it is carefully contoured into the defect to confirm anatomic fill without convexity (Fig 8). A freer or Penfield dissector is specifically useful during this contouring process. Fibrin glue is then used to seal the graft in the acetabular defect. A 14-gauge hip-length spinal needle can be attached to the fibrin glue syringe to assist in optimal delivery of the fibrin glue to affix the transplant to the defect. The fibrin glue is allowed to set, at which time traction is removed from the hip to stabilize the graft. Once this is achieved, the interportal capsulotomy and T-capsulotomy are repaired, followed by closure of the portal sites.

Postoperatively, the patient is maintained on crutches with toe-touch weight bearing for 4 weeks, followed by a transition to weight bearing as tolerated by 6 weeks. Hip range of motion is limited to neutral extension and 90° of hip flexion. At 6 weeks, motion is advanced, ambulation is allowed as tolerated, and lower-extremity closed-chain strengthening is initiated. Jogging and running are allowed at 3 months postoperatively, with a transition to return to full activity from 4 to 6 months after surgery.

Discussion

This Technical Note presents our preferred method of single-stage AMECT in the hip using the femoral cam

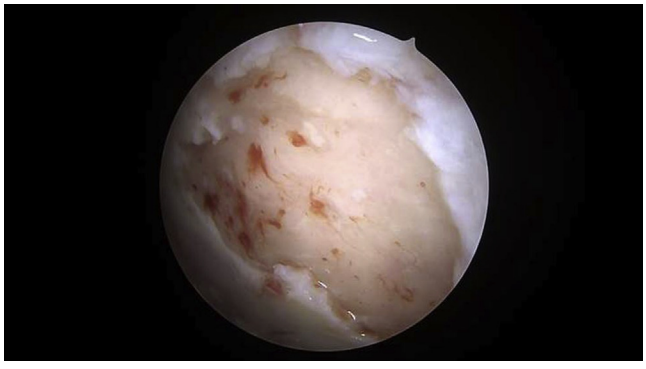

Fig 6. A ring curette is used to remove the calcified cartilage layer and debride the subchondral bone until punctate bleeding is confirmed (view of left hip through midanterior portal with instrumentation through anterolateral portal).

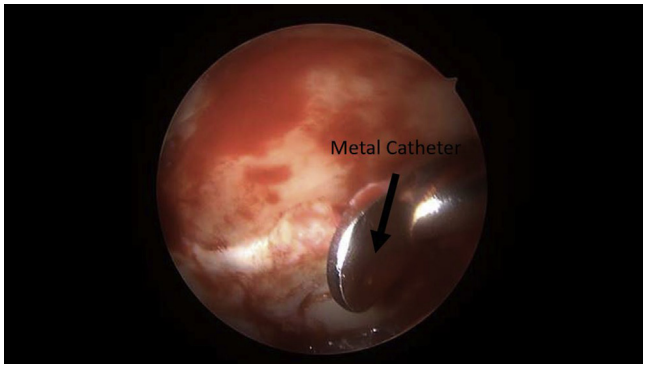

Fig 7. Fluid is extravasated from the hip joint, and gauze is used to carefully dry the chondral lesion (view of left hip through midanterior portal with instrumentation through anterolateral portal). The autologous matrix–enhanced chondral transplant is introduced arthroscopically using the metal catheter provided for isolated extracellular matrix transplantation.

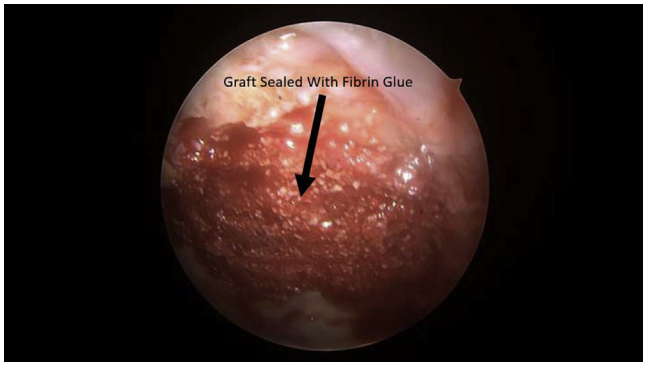

Fig 8. The chondral transplant product is carefully contoured to fill the chondral defect (view of left hip through mid-anterior portal with instrumentation through anterolateral portal). A freer or Penfield dissector is specifically useful during this contouring process. Fibrin glue is used to seal the graft in the defect.

donor site for the treatment of full-thickness chondral defects of the acetabulum. The advantages of our technique include the ability to address the acetabular defect at the time of the initial operation. One difficulty in preoperative planning for chondral lesions is that magnetic resonance imaging has been shown to have a sensitivity and specificity of only 25% to 90% and 50% to 90%, respectively.[18-21] Concomitant acetabular chondral lesions are a common finding in patients with femoroacetabular impingement undergoing hip arthroscopy, with rates ranging from 80% to 100% of patients.[22-25] This discrepancy between imaging and arthroscopy reduces our ability to have appropriate preoperative discussions with patients about their pathology and treatment options. It also limits our ability to have the appropriate chondral transplantation equipment available.

Open techniques for chondral transplantation in the hip joint have included mosaicplasty with various autograft and allograft options. Although these have shown good results, they require a surgical dislocation of the hip, which results in significant morbidity. Arthroscopic techniques such as ACI and MACI have also shown encouraging results, but they require a 2-stage implantation, which necessitates cutting the capsule twice, increasing the potential for capsular insufficiency and instability.[26] Single-stage allogeneic minced chondral transplantation has also been used for the treatment of focal acetabular chondral defects with good early data.[27] However, this procedure requires preoperative knowledge of the defect to ensure that the allogeneic chondral transplant is available, and it is expensive and often not covered by insurance. AMECT offers the advantages of requiring a single surgical procedure and being available to all patients.

Table 1. Advantages and Disadvantages of AMECT of Hip

Advantages
AMECT can be performed during a single surgical procedure with minimal increase in morbidity.
Specialized chondral transplantation equipment is not required.
The procedure can be performed even when a chondral lesion is not identified preoperatively.
Disadvantages
Limited short- and long-term outcome data
Technically challenging
Increased operative time

AMECT, autologous matrix–enhanced chondral transplantation.

Table 2. Pearls and Pitfalls of AMECT of Hip

Pearls
The chondral lesion should be appropriately prepared with debridement to create stable edges and to completely remove the calcified cartilage layer.
The chondral surface of the cam deformity should be harvested using a chondral fragment capture device.
Prior to implantation of the chondral product, the surgeon should ensure the recipient site is adequately prepared and dried.
Careful contouring of the chondral product into the defect site to confirm anatomic fill without convexity is critical.
Pitfalls
Failure to appropriately prepare the chondral defect may prevent adequate incorporation of the chondral product.
Failure to wait for the fibrin glue to adequately dry may result in loss of anatomic contouring of the defect.

AMECT, autologous matrix–enhanced chondral transplantation.

Our technique allows for the harvesting of autograft chondral tissue with minimal morbidity to the patient at the time of the index procedure even when a chondral defect is not visible on preoperative imaging. We are able to augment this autograft tissue with chondral extracellular matrix (Biocartilage). Performing AMECT without microfracture should minimize the subchondral sclerosis seen after standard microfracture techniques. By harvesting cartilage from the cam lesion site, we are able to obtain high-quality chondral autograft without significantly increasing the operative time or donor-site morbidity.

Advantages and disadvantages of our technique can be found in Table 1. Although our early results have been promising, short- and long-term outcome data on this technique are lacking. The risks of this technique include the increased operative time and failure of the graft to incorporate, necessitating a second cartilage operation. Additional pearls and pitfalls of our technique can be found in Table 2.

In conclusion, our early experiences with hip AMECT have shown it to be safe, to be technically reasonable, and to lead to improved outcomes. Future studies are needed to focus on short- and long-term outcomes, as well as reproducibility in a larger population, and to compare the results with other cartilage restoration procedures of the hip.

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