Technical Note

Autograft Cartilage Transfer Augmented With Bone Marrow Concentrate and Allograft Cartilage Extracellular Matrix

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Abstract: The use of biologics in sports medicine is increasing rapidly. An osteochondral defect in a young active patient remains a difficult issue to treat. Autograft cartilage has tremendous advantages for the treatment of full-thickness defects, but harvesting and preparation have been difficult in the past. Disadvantages have included donor-site morbidity and the need for further surgery. With the recent development of the GraftNet device (Arthrex, Naples, FL), harvesting and delivery of autograft have become easier and can be performed arthroscopically in a single surgical procedure. Bone marrow concentrate has recently increased in popularity owing to the presence of mesenchymal stem cells. These stem cells combined with autograft cartilage and BioCartilage (Arthrex) could lead to better incorporation and healing. In this article, we show how this unique biological composite is obtained and then added in the cartilage defect during a single-stage arthroscopic procedure.

Articular cartilage defects of the knee are a common cause of knee pain and dysfunction in adults. Although the exact etiology is unknown, a number of causes have been proposed, including trauma, vascular insults, genetics, and endocrinopathies.[1] Of these mechanisms, repetitive trauma has been thought to be the primary cause because of its primary location on the lateral aspect of the medial femoral condyle, which may encounter a hypertrophic tibial spine.[2] In the past few decades, advances in arthroscopy and magnetic resonance imaging (MRI) have led to an increased rate of detection of articular defects of the knee.[3] The exact prevalence of osteochondral lesions is unknown; studies have reported rates of 15 to 29 cases per 100,000 persons.[4] Because of the poor healing potential of hyaline cartilage, articular defects may lead to premature osteoarthritis with significant impairment in function and quality of life. Initial imaging consists of plain radiographs including anteroposterior, tunnel, lateral, and Merchant views. Plain radiographs help to localize lesions, determine the size, and evaluate the status of the distal femoral physis in adolescents. MRI is often the imaging modality of choice because of its ability to show lesions that are not evident on plain radiographs.[1]

Initial treatment options include nonoperative management with activity modification, nonsteroidal anti-inflammatory drugs, and intra-articular corticosteroids. However, osteochondral lesions in adults typically have an unremitting course with progressive dysfunction and impairment. Surgical options for unstable lesions and those in which conservative measures fail include arthroscopic drilling, debridement and bone grafting, internal fixation, microfracture, autologous chondrocyte implantation (ACI), and osteochondral autograft and allograft. Of these techniques, ACI—which involves regeneration of hyaline cartilage through a 2-stage procedure—has been used to treat large articular defects with minimal donor-site morbidity. To circumvent the 2-stage ACI, newer techniques aim to achieve the clinical results of ACI with a 1-step process.

We present a technique for a single-stage autologous chondrocyte transplantation procedure using the GraftNet tissue collector (Arthrex, Naples, FL). This is a

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1-step surgical approach that combines bone marrow concentrate, healthy autologous hyaline tissue, and allograft BioCartilage (Arthrex) as a scaffold to treat articular defects of the knee.

Surgical Technique

Figures 1 through 10 and Video 1 show the surgical techniques.

Patient Setup

The patient is placed supine in a standard knee arthroscopy position. The operative extremity is placed into a leg holder with a tourniquet applied to the thigh, and the nonoperative extremity is placed in a well-padded leg pillow.

Bone Marrow Aspiration

Before the tourniquet is inflated, a small stab incision is made just lateral to the tibial tubercle. An aspiration needle and central sharp trocar are inserted proximally at approximately a 10° angle. A mark is made on the needle at 30 mm to avoid over-insertion. Then, 60 mL of bone marrow is aspirated into heparinized syringes. This aspirated material is concentrated using the Arthrex Angel System to 5 mL of bone marrow concentrate.

Autograft Cartilage Transfer Technique

Lesion Preparation. The tourniquet is inflated, and a standard diagnostic arthroscopy reveals the large osteochondral defect in the lateral femoral condyle (Figs 1 and 2). The lesion is prepared and debrided using a shaver and then a small curette. After the lesion has been prepared, a standard microfracture technique is performed with a small drilling device (PowerPick; Arthrex). Circumferential perforations are created first, followed by central perforations to a bleeding base (Figs 3 and 4).

Osteochondral Autograft Harvesting. With viewing from the lateral portal and the knee in full extension, a shaver with the GraftNet device applied is placed through the medial portal. Prior to harvesting, it is important to debride as much synovium as possible

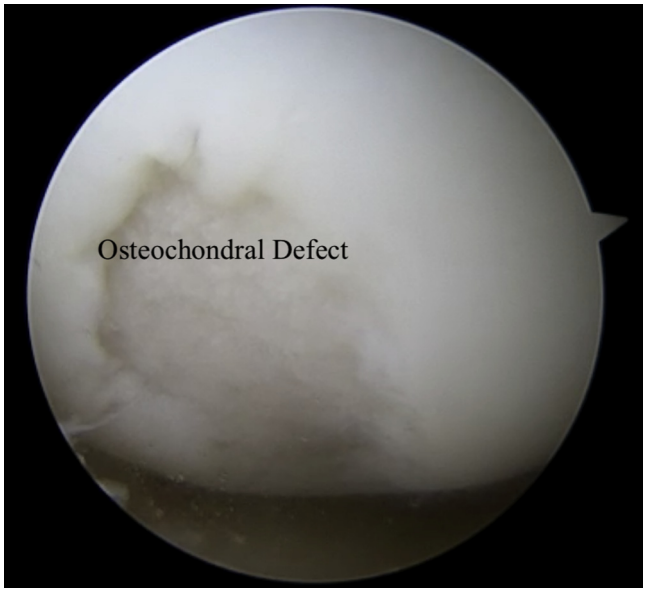

Fig 1. With the patient supine, the right knee in 90° of flexion, and the arthroscope placed through the medial portal, the large osteochondral lesion on the lateral femoral condyle can be seen.

Fig 2. With the patient supine, the right knee in 90° of flexion, and the arthroscope placed through the medial portal, a standard probe is applied to the large osteochondral lesion on the lateral femoral condyle.

Fig 3. With the patient supine, the right knee in 90° of flexion, and the arthroscope placed through the medial portal, a curette is used to prepare the large osteochondral lesion on the lateral femoral condyle.

Fig 4. With the patient supine, the right knee in 90° of flexion, and the arthroscope placed through the medial portal, the large osteochondral lesion on the lateral femoral condyle has been prepared; a microfracture is seen on the lesion surface.

from the areas of harvesting to increase the amount of pure cartilage harvested. The shaver is then used to harvest the nonarticulating portion of cartilage from the medial femur (Figs 5 and 6). The shaver and arthroscope are switched, and in similar fashion,

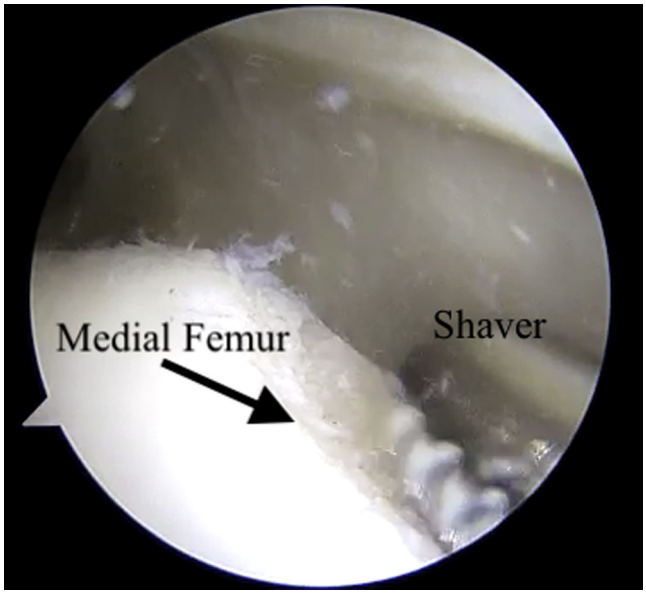

Fig 5. The patient is supine with the right knee in full extension, with viewing from the lateral portal with the 30° arthroscope. The shaver is shown obtaining medial femur nonarticulating cartilage, with the GraftNet device applied to the shaver.

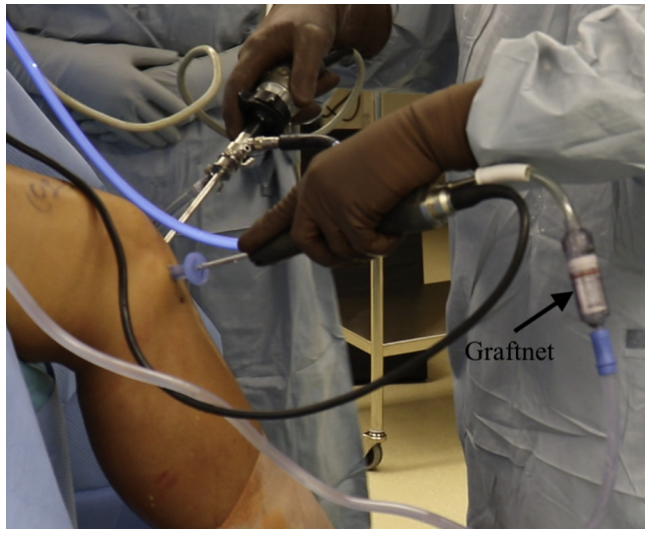

Fig 6. With the right knee in 90° of flexion, the patient supine, and the 30° arthroscope placed through the medial portal, the shaver can be seen in the lateral portal, with the GraftNet device applied. The shaver harvests the lateral nonarticulating cartilage.

autograft cartilage is harvested from the lateral nonarticulating cartilage of the femur. This autograft cartilage is then removed from the GraftNet device on the back table (Fig 7).

Mixing of Composite Graft. One milliliter of BioCartilage is added to the BioCartilage mixing cannula with the autograft cartilage. One milliliter of bone marrow concentrate is also added and mixed with the graft until a toothpaste consistency is obtained. The delivery cannula is then applied to the mixing cannula and placed on the back table.

Composite Graft Delivery. It may be helpful to establish an inferior accessory portal to aid in suctioning during graft delivery. The arthroscopy fluid is turned off at this

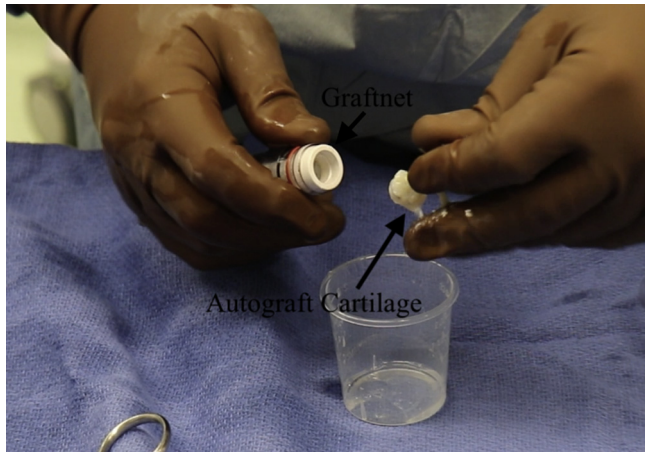

Fig 7. The GraftNet device has been disassembled, and autograft cartilage is removed from the collector.

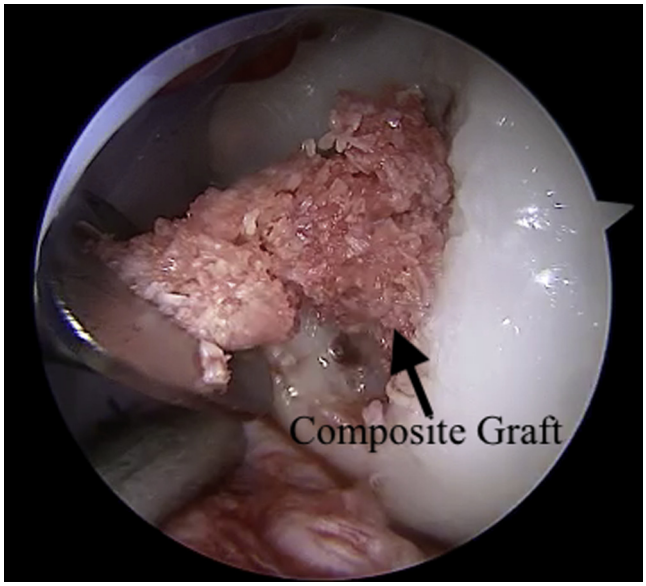

Fig 8. With the patient supine, the right knee in 90° of flexion, and the 30° arthroscope placed through the medial portal, the composite graft is delivered through the lateral portal into the large osteochondral lesion on the lateral femoral condyle.

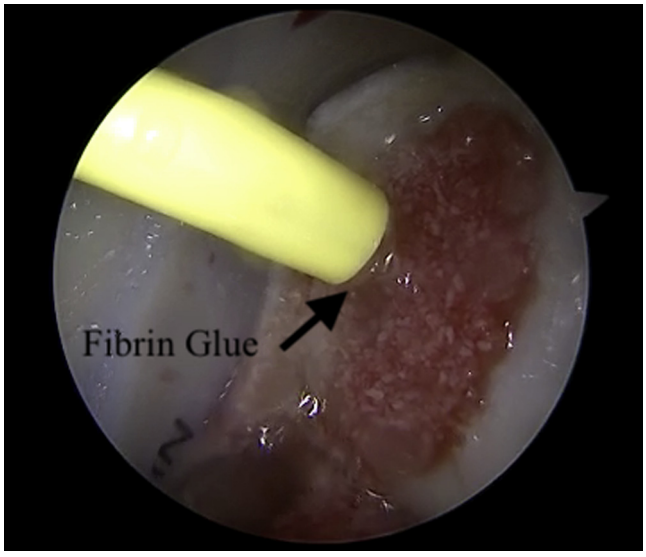

Fig 10. With the patient supine, the right knee in 90° of flexion, and the arthroscope placed through the medial portal, fibrin glue is placed through the lateral portal from superior to inferior onto the graft in the large osteochondral lesion on the lateral femoral condyle.

point, and sponges can be used through the lateral portal to dry the lesion. The composite graft is then carefully delivered through the lateral portal, and a small bone tamp can be used to impact the graft in place (Figs 8 and 9). Two key points are to make sure the graft is not prominent and to avoid delivering too much graft. After the graft is properly placed into the lesion, Evicel glue (Ethicon, Blue Ash, OH) is delivered onto the graft. It is important to start application of the glue superiorly because it will run inferiorly (Fig 10). Care is taken not to deliver too much glue, and suction can be used to remove excess (Table 1). The glue will need at least 7 to 8 minutes to set up and fix the graft in place.

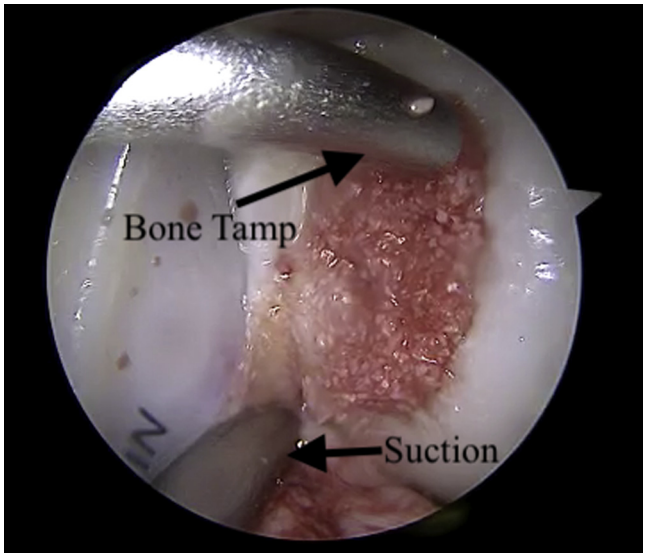

Fig 9. With the patient supine, the right knee in 90° of flexion, and the arthroscope placed through the medial portal, a bone tamp has been placed through the lateral portal and is evening out the composite graft in the large osteochondral lesion on the lateral femoral condyle. A suction device has been placed through the inferior accessory portal.

Discussion

Treatment of articular defects is difficult because of the avascular nature of hyaline cartilage. Most authors believe that treatment of osteochondral lesions should be based on skeletal maturity and lesion stability.[5] Osteochondral lesions in adults typically have an unremitting course and rarely respond to conservative measures. De Smet et al.[6] reported only an 11% rate of good clinical outcomes in 9 knees after a mean follow-up period of 3.6 years. Operative treatment should be considered in skeletally immature patients with detached or unstable lesions and those in which conservative measures have failed, as well as all lesions in adults, because the clinical course is deleterious,

Table 1. Pearls and Pitfalls of Autograft Cartilage Transfer

Pearls
During harvesting of autograft cartilage, care shoulder be taken to avoid articulating areas.
The joint needs to be dry for insertion of the graft, and it may be useful to apply sponges.
Pitfalls
Too much glue can cause displacement of the graft.

Table 2. Advantages and Disadvantages of Autograft Cartilage Transfer

Advantages
No arthrotomy required
Autologous chondrocytes
Single-step procedure
No need for second surgical field to obtain BMC
Disadvantages
Technically difficult
No long-term data
Potential donor-site morbidity

BMC, bone marrow concentrate.

necessitating early aggressive intervention.[4] Drilling has been reported to be an effective technique in stable juvenile osteochondritis dissecans lesions. Aglietti et al.[7] noted healing on radiographs after drilling in 16 knees in 14 patients, and all patients were asymptomatic at a mean follow-up of 4 years.

Unstable lesions should be treated operatively regardless of age. They should be further classified as salvageable or unsalvageable. Salvageable lesions are those with the potential for healing to the remainder of the subchondral bone with a congruent articular surface. Unsalvageable lesions are fragmented and cannot form a congruent articular surface with fixation because of excessive gapping. In cases of unsalvageable lesions and cases in which significant concern exists for the development of premature osteoarthritis, newer techniques have been developed to combat this problem. These include reparative techniques and restorative techniques. Reparative techniques such as microfracture and ACI aim to create fibrocartilaginous fill by addressing chondral lesions without subchondral bone loss. Restorative techniques such as osteochondral grafting allow for chondral as well as bony defects to be addressed.

Microfracture is used to create small perforations in subchondral bone, which release pluripotent cells from the marrow to create a fibrocartilage cap. ACI is a 2-stage procedure in which a small amount of hyaline cartilage is harvested arthroscopically and cultivated in the laboratory. The second stage of the procedure involves subsequent reimplantation of graft into the defect.

In an attempt to bypass the need for multiple procedure, as well as decrease donor-site morbidity, recent techniques have focused on single-stage procedures with transplantation of autologous hyaline cartilage fortified with bone marrow concentrate or plasma-rich protein. Buda et al.[8] conducted a 1-step procedure in 20 patients with bone marrow–derived mesenchymal stem cells and platelet-rich fibrin. The results of immunohistochemical analysis of biopsy specimens obtained from 2 patients showed type II cartilage, and MRI showed satisfactory filling of the articular defects. Cugat et al.[9] presented 2 cases of patients treated with autologous mixed platelet-rich plasma and platelet-poor plasma with hyaline chips and intra-articular injection of platelet-rich plasma. They noted a return to the preinjury level of play in both patients, with excellent defect filling on MRI (both patients) and arthroscopy (1 patient). Salzmann et al.[10] presented a single-step surgical technique of autologous minced cartilage implantation with fibrin glue. However, an open arthrotomy was used in this technique.

In our technique, we perform a single-stage arthroscopic autologous chondrocyte transplantation using the GraftNet tissue collector. Advantages of this technique include the minimally invasive nature and the fact that it is performed in a single stage (Table 2). A disadvantage is that there are limited data on the viability of the cartilage cells obtained with the GraftNet device and their incorporation. Moreover, an obvious risk or disadvantage is that donor-site morbidity, although decreased, is still present. Our technique circumvents the major drawbacks of previous techniques; however, further studies with long-term follow-up are needed to assess the effectiveness of the procedure.

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