Technical Note

Nanoscopic Single-Incision Autograft Cartilage Transfer (ACT)

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Abstract: Osteochondral defects in the young active patient remain a difficult issue to treat. Autograft cartilage implantation is a procedure that was originally devised as a difficult 2-stage process, with disadvantages including donor-site morbidity and the need for multiple procedures. Recently, a technique for a single stage autograft cartilage transfer, also known as AutoCart using the GraftNet device for autograft harvest and BioCartilage in addition to bone marrow concentrate to aid in graft incorporation and healing, has been described. In this article, we discuss a modification of this autograft cartilage transfer procedure using a minimally invasive single incision for lesion preparation, microfracture, graft harvest, and graft delivery using visualization from the NanoScope.

Recently, a technique for a single-stage autograft cartilage transfer. also known as AutoCart using the GraftNet device (Arthrex, Naples, FL) for autograft harvest and BioCartilage (Arthrex) in addition to bone marrow concentrate to aid in graft incorporation and healing, has been described to treat osteochondral defects of the knee.[1] Osteochondral defects of the knee are a common cause of knee pain and dysfunction in adults. Several etiologies for the cause of these lesions has been proposed, including trauma, vascular insults, genetics, and endocrinopathies; however, the true etiology is unknown.[2] Of these, repetitive microtrauma is agreed to likely be the primary cause, as most lesions are located on the lateral aspect of the medial femoral condyle, which may encounter a hypertrophic tibial spine.[3] Advances in knee arthroscopy and magnetic resonance imaging (MRI) have led to an increased rate of detection of articular cartilage defects of the knee.[4] Previous studies have reported a prevalence of osteochondral lesions in the population to be 15 to 29 cases per 100,000.[5] In adults, symptomatic osteochondral lesions often are treated surgically to prevent further progression and to improve function and quality of life. Surgical options for unstable lesions, as demonstrated on MRI, and those who are unresponsive to conservative measures, such as nonsteroidal anti-inflammatory drugs and activity modification, 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 streamline the 2-stage ACI, newer techniques aim to achieve the clinical results of ACI with a 1-step process. Our technique is a modification of the aforementioned technique described by Lavender et al. using only a single small incision for lesion debridement, preparation, autograft harvest, and graft delivery with the NanoScope (Arthrex) used for visualization.

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Surgical Technique (With Video Illustration)

Video 1 and Figures 1-10 detail the surgical technique.

Patient Positioning

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 on 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 cc of bone marrow is aspirated into heparinized syringes. This aspiration is the concentrated using the Arthrex Angel System to 5 cc of bone marrow concentrate.

NanoScope (Arthrex) Insertion

The leg is exsanguinated, and a tourniquet is placed to 250 mm Hg. With the operative knee in flexion, a spinal needle is placed in the standard anterolateral portal location. A nitinol wire is inserted through the spinal needle and the needle is removed. Next, the 3.4-mm high-flow NanoScope cannula (Arthrex) is inserted and the NanoScope (Arthrex) is inserted into the cannula after flow is attached. A standard diagnostic arthroscopy is then performed with the NanoScope.

Autograft Cartilage Transfer Technique

Lesion Preparation

The lesion on the medial femoral condyle is then identified. A spinal needle is used to establish a standard portal at the location of the medial lesion (Fig 1). The lesion is prepared and debrided with a shaver and then using a small curet. After the lesion has been prepared, a standard microfracture technique is performed with a small drilling device (PowerPick; Arthrex) (Fig 2). First, circumferential perforations are created and then central perforations to a bleeding base.

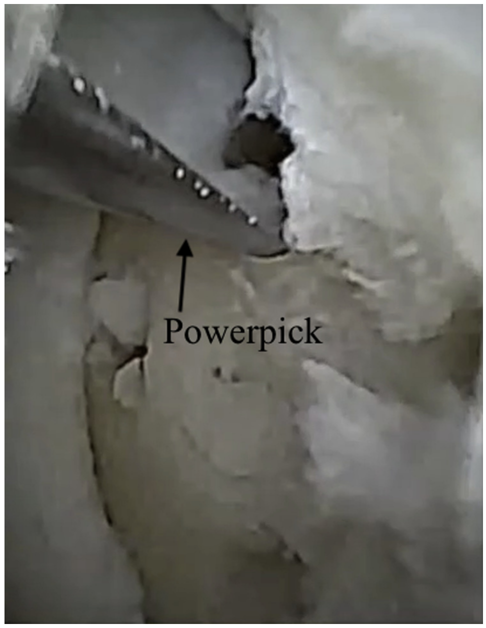

Fig 2. Viewing the left knee in flexion with the NanoScope (Arthrex) 0° from anterolaterally. You can see the lesion medially and the PowerPick (Arthrex) performing the microfracture.

Osteochondral Autograft Harvesting

While viewing from the lateral portal with the NanoScope (Arthrex) and with the knee in full extension, a shaver with the GraftNet (Arthrex) applied is placed through the medial portal. It is important to debride as much synovium from the areas of harvesting before harvesting to increase the amount of pure cartilage harvested (Figs 3 and 4) This shaver then is used to harvest the nonarticulating portion of cartilage from the medial femur. The shaver and NanoScope

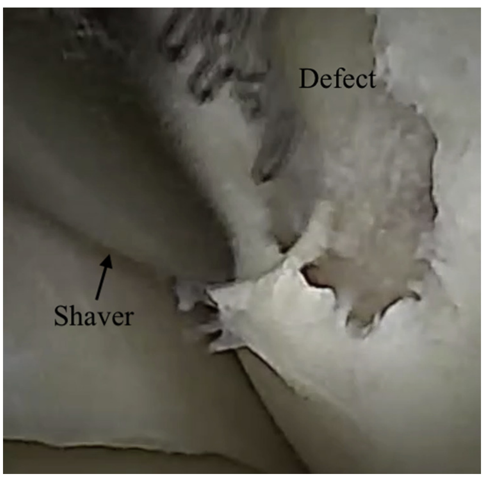

Fig 1. Viewing the left knee in flexion with the NanoScope (Arthrex) 0° from anterolaterally. The medial femoral defect is seen being prepared by the shaver which is placed through the anteromedial portal.

Fig 3. Viewing the left knee in extension with the NanoScope (Arthrex) 0° from anterolaterally. The shaver with the GraftNet (Arthrex) placed through the medial portal is harvesting autograft cartilage from the nonarticulating cartilage of the medial trochlea.

Fig 4. Histology of the autograft cartilage obtained with hematoxylin and eosin staining at 40× power.

(Arthrex) are switched and in similar fashion autograft cartilage is harvested from the lateral nonarticulating cartilage of the femur. This autograft cartilage is then removed from the graft net on the back table.

Mixing Composite Graft

Then, 1 cc of BioCartilage (Arthrex) is then added to the BioCartilage mixing cannula with the autograft cartilage. In addition, 1 cc of bone marrow concentrate is added and mixed with the graft until a toothpaste consistency is obtained (Figs 5-7). The delivery cannula is then applied to the mixing cannula and this is 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 point and sponges can be used through the lateral portal to dry the lesion (Fig 8). 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. Two key points are to make sure the graft isn't prominent and to not deliver too much graft. After the graft is properly placed into the lesion, EVICEL glue (Ethicon, Blue Ash, OH) is

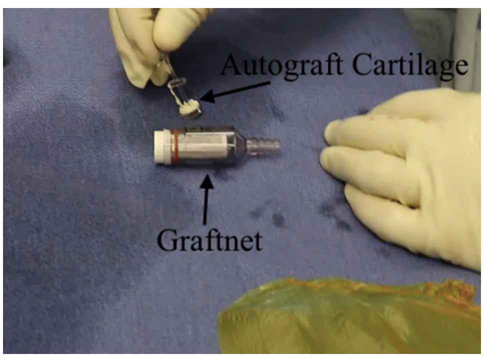

Fig 5. View showing the autograft obtained and the GraftNet (Arthrex).

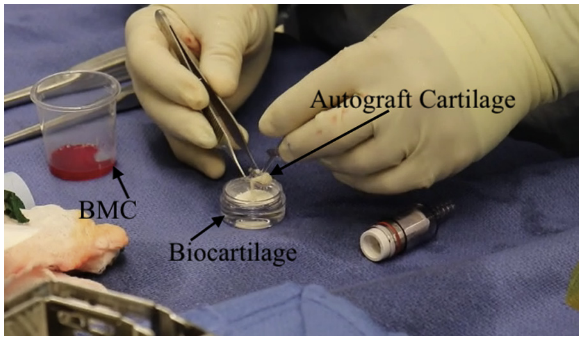

Fig 6. View from the table showing mixing of the BioCartilage (Arthrex), BMC, and the autograft cartilage. (BMC, bone marrow concentrate.)

delivered onto the graft. It is important to start the glue superiorly as it will run inferiorly (Figs 9 and 10). Care is taken to not deliver too much glue, and suction can be used to remove excess. The glue will need at least 7 to 8 minutes to set up and fix the graft in place.

Rehabilitation

The patient is placed in a hinged knee brace postoperatively locked in full extension. We keep the patient non—weight-bearing on that extremity for 8 weeks. Passive range of motion is started with a continuous passive motion device if available for 6 to 8 hours per day. If not, the patient begins physical therapy for passive flexion with a goal of 90° by 2 weeks and full motion by 6 weeks. At 8 weeks, the brace is discontinued and weight-bearing is begun with active strengthening exercises started. The patient progresses to full activity by 9 to 12 months depending on the size of the lesion.

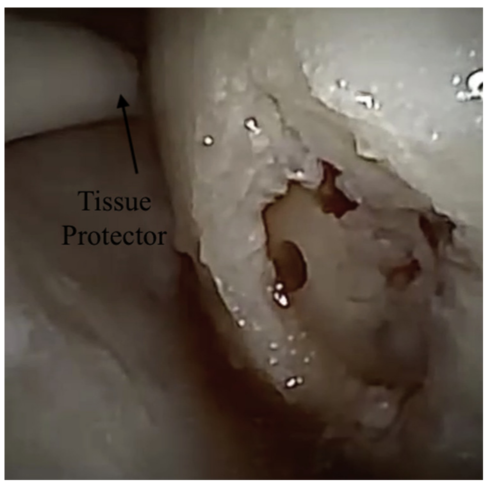

Fig 7. Viewing the left knee in flexion with the NanoScope (Arthrex) 0° from anterolaterally. You can see the prepared lesion and a tissue protector being used to help keep the lesion dry.

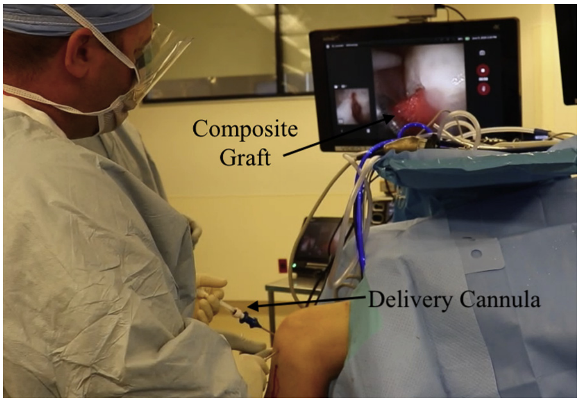

Fig 8. Viewing from outside the joint. You can see the composite graft being injected on the screen and the delivery cannula is placed into the anteromedial portal.

Discussion

ACI aims to create fibrocartilaginous fill by addressing chondral lesions without subchondral bone loss. Recent systematic reviews of the literature have demonstrated favorable outcomes of ACI in patients and show that ACI can achieve equal or improved outcomes when compared with microfracture alone for treatment of osteochondral defects.[6,7] Initially, ACI was developed as a 2-stage procedure where a small amount of hyaline cartilage is harvested arthroscopically and cultivated in laboratory. The second stage of the procedure involve subsequent reimplantation of graft into the defect. To bypass the need for multiple procedure and 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 one-step procedure on 20 patients with bone marrow—derived mesenchymal stem cells and platelet rich fibrin. Results of immunohistochemical analysis in biopsies obtained from 2 patients showed type II cartilage and MRI showed satisfactory filling of the articular defects. Cugat et al.[9] present 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 preinjury return to play in both patients with excellent defect filling on MRI and arthroscopy. Salzmann et al.[10] presented a single-step surgical technique of autologous minced cartilages implantation with fibrin glue. However, an open arthrotomy was used in this technique. As previously described, we use a single-stage arthroscopic autologous chondrocyte transplantation using the Arthrex GraftNet tissue collector. This cartilage added with BioCartilage (Arthrex) has distinct advantages to the standard ACI procedures. We have now modified this technique and use a Arthrex NanoScope, which creates single-incision autograft cartilage transfer procedure.

Fig 9. Viewing the left knee in flexion with the NanoScope (Arthrex) 0° from anterolaterally. The lesion is seen on the medial femur and the EVICEL glue (Ethicon) is being delivered onto the lesion.

Fig 10. Viewing the left knee in flexion with the NanoScope (Arthrex) 0° from anterolaterally the final lesion is seen.

This technique has several advantages and should lead to less pain and morbidity, as only one incision needs to be made for lesion visualization, debridement, microfracture, graft harvest, and graft delivery. Less fluid flow from the Arthrex NanoScope allows for a

Table 1. Advantages and Disadvantages of the Nanoscopic ACT Procedure

Advantages
Only a single incision needed
Less fluid and swelling should lead to improved outcomes
Disadvantages
Cost of the NanoScope
Technically difficult

ACT, autograft cartilage transfer.

Table 2. Pearls and Pitfalls of The Nanoscopic ACT Procedure

Pearls
May need to move NanoScope more in line with lesion for visualization
Use the high flow sheath
Pitfalls
Small margin of error with viewing portal
Difficult to glue lesion if there isn't a dry environment

ACT, autograft cartilage transfer.

drier joint space to aid in graft delivery (Table 1). The Arthrex NanoScope also allows for easier visualization of the lesion and can be moved to multiple sites about the knee without the need for further incisions. Using the NanoScope (Arthrex), however, can be technically demanding. If you don't have a direct view of the lesion, it can be more difficult to see. There are several pearls of the technique, which include using the high-flow sheath, possibly moving your viewing portal to a more direct view, and keeping the joint as dry as possible (Table 2). This technique addresses 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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