The Journal of Foot & Ankle Surgery 56 (2017) 613–617

Contents lists available at ScienceDirect

The Journal of Foot & Ankle Surgery

journal homepage: www.jfas.org

All-Arthroscopic Treatment of Dependent Osteochondral Lesions of the Ankle: Surgical Technique

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ARTICLE INFO

Keywords:
articular cartilage
bone marrow aspirate concentrate
osteochondral lesion
tibial plafond

ABSTRACT

A large number of articular cartilage defect treatments have been described. However, few have discussed the use of biologic agents implanted into the so-called dependent defect arthroscopically. Furthermore, even fewer of these reports have contained a description for treating dependent osteochondral lesions of the tibial plafond. Generally, these lesions have been treated with either microfracture or debridement, and the long-term outcomes have been less than satisfactory. With new interest in biologic treatments for osteochondral defects, we believe that bone marrow aspirate concentrate combined with a biologic scaffold provides the necessary components to provide healing of these so-called dependent lesions. We believe that the combination of bone marrow aspirate concentrate and a biologic scaffold create the perfect viscosity to hold their mold in these dependent osteochondral lesions and provide the perfect scaffold to enhance recovery. We believe that our technique provides a minimally invasive option for the treatment of these osteochondral lesions and eliminates the need for a large arthrotomy.

The treatment of chondral and osteochondral lesions (OCLs) of the knee and ankle remains a challenge for orthopedic surgeons. Various options are available for repair of these lesions, and variable outcomes have been demonstrated using these techniques (1). Regardless of the technique used, repair of these lesions is imperative, because they have been shown to cause joint pain, reduced or disturbed function, impairment of the contact pressures within the joint and progression to a prearthritic state of cartilage breakdown, which eventually leads to osteoarthritis in the affected joint (2–4).

Major advances have been made in the treatment of OCLs in recent years with the advent of tissue engineering and preservation. Several options exist for surgeons to treat these OCLs. Older autologous techniques, such as autologous chondrocyte implantation or osteochondral autograft transfer have shown promising results and are viable options for surgeons in the treatment of these lesions (5–8). However, these 2 modalities are not without drawbacks. Autologous chondrocyte implantation is an extremely expensive, 2-stage procedure. Osteochondral autograft transfer results in donor site morbidity to the knee from the harvest of the osteochondral plugs and recipient morbidity in the ankle because of the need for an osteotomy to access the OCL site most of the time. Newer advances have led to allogeneic cartilage implants that have shown promising preliminary results in the treatment of OCLs (9,10). These advances have made reconstruction of OCLs possible using minimally invasive, single-stage, all-arthroscopic techniques. However, the published data have failed to describe many viable techniques that aim to repair so-called dependent OCLs. These lesions are located on surfaces in the joint such that the surgeon cannot use gravity as an ally to ensure that the defect is covered appropriately by the surgeon's repair of choice, given the position of the patient's lower extremity in the arthroscopic setting. Such lesions include patellar OCLs in the knee and tibial plafond OCLs in the ankle.

The aim of our study was to describe an all-arthroscopic technique used to treat these dependent lesions of the patella and distal tibia. This technique allows for arthroscopic repair of lesions once thought to be only repairable using open techniques owing to the limitations of arthroscopic implantation. The greatest success repairing these lesions arthroscopically has occurred using the cell, scaffold, and growth factor trilogy in the repair strategy (11,12). It is believed that every good repair requires these 3 components to ensure adequate repair and regeneration of the lesion. Different forms of these 3 components can be used, depending on the patient, surgeon preference, and type of repair in question. BioCartilage® (Arthrex, Naples,

Financial Disclosure: None reported.
Conflict of Interest: None reported.
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http://dx.doi.org/10.1053/j.jfas.2017.01.047

FL) is an allogenous cartilage scaffold formed of lyophilized human type II collagen provided in powder form. According to the manufacturer's technical guide, it is reconstituted in the operating room by adding autologous platelet-rich plasma (PRP) to form a doughy paste that would enable arthroscopic implantation after coverage with fibrin glue to seal it. It also has the added benefit of supplementing this acellular collagen II scaffold with chondrogenic growth factors from PRP to potentiate its chondrogenic potential (13). A recent study found that this formula yielded superior repair tissue compared with microfracture (MF) in the equine model (14).

However, it has been the practice of the senior author (A.H.M.) to reconstitute BioCartilage® with autologous iliac crest bone marrow aspirate concentrate (BMAC), because it has the added theoretical benefit of having a concentrated niche of bone marrow-derived mesenchymal stem cells (MSCs) with chondrogenic potential, in addition to growth factors, which might further potentiate the repair process by accomplishing the trilogy of scaffold, cells, and growth factors. It has also been a personal observation that BMAC has a slightly increased viscosity than PRP that renders the BioCartilage®/BMAC paste more malleable in consistency, enabling its adherence to dependent lesions of the patella and tibial plafond without resorting to further stabilization with fibrin glue.

Surgical Technique

The following describes the technique for BioCartilage®/BMAC implantation for tibial plafond OCLs (with or without talar dome kissing lesions). The same technique, tips, and pearls apply for patellar lesions and can be applied in an all-arthroscopic technique and in the knee.

First, bone marrow aspirate (BMA) is retrieved using a Jamshidi bone marrow biopsy needle (CareFusion, San Diego, CA). Because the procedure is performed with the patient in the supine position, bone marrow can be acquired from the anterior iliac crest. The anterior superior iliac spine is palpated, and the inner and outer tables of the iliac crest are held between the thumb and index fingers to help aim the needle to be in line with the iliac wing. The bone marrow aspiration needle (11 to 18 gauge, 100 mm) is inserted percutaneously and gently set into the bone by applying firm forward pressure or gently tapping with a mallet on the needle handle. The needle is advanced 3- to 4-cm deep into the spongy bone, with the needle bevel facing the 12-o'clock position. After a maximum of 5-mL marrow has been aspirated, the surgeon then turns the needle (guided by the direction of the needle handle) 90° clockwise, such that the bevel is facing the 3-o'clock position. Another 5 mL is then aspirated. This procedure is repeated until the needle bevel has moved through the 6- and 9-o'clock positions. On returning to the 12-o'clock position, the surgeon then withdraws the needle 1 cm from within the iliac crest and repeats the previous steps. Another option is to totally withdraw the needle out of the bone (but not the skin) and insert it through another perforation in the iliac crest. With this technique, a maximum of 50 to 60 mL of bone marrow can be extracted from a single iliac wing, without diluting any of the cellular elements (12,15). BMA is then placed in a centrifuge (Arthrex Angel System; Arthrex, Naples, FL) that spins it down to form 2 to 3 cm^3 of BMAC. For 60 cm^3 of BMA at 7% hematocrit, a 2-stage spin cycle is used, which requires a total of 17 minutes. The first cycle should be at 3500 rotations per minute and the second at 3000 rotations per minute. After the bone marrow aspirate has been harvested from the anterior superior iliac spine, we turn our attention to the ankle, which is placed in the ankle arthroscopy distraction system.

Standard ankle arthroscopic portals are created. The scope is then introduced into the anteromedial portal. A probe is introduced into the joint to assess the structural integrity of the ligaments and articular cartilage, and a comprehensive ankle arthroscopic examination is performed (16). Next, attention is turned to the OCL (Fig. 1). When arthroscopically probing an OCL, the overlying articular cartilage will be ballotable, indentable, and/or partially or completely detached compared with stable, healthy articular cartilage. After identifying the boundaries of the lesion or lesions, a curette is introduced into the joint to remove all devitalized cartilage and underlying bone. The bone should be debrided down to the level of healthy, bleeding subchondral bone to prepare a healthy bleeding bed for implantation. Once the lesion has been curetted to a stable cartilaginous rim and healthy bleeding bone, MF is performed in the usual fashion for recruitment of a dilute fibrin/mesenchymal blood clot, which will help further anchorage the BioCartilage®/BMAC implant to the base of the defect and provide a dilute population of bone marrow MSCs (Fig. 2).

Once the MF portion of the procedure has been completed, we establish dry arthroscopy using arthroscopic suction. It is imperative to ensure complete dryness of the joint before definitive implantation, because any residual fluid could interfere with the adhesiveness of the implant. Complete dryness is usually established using an accessory posterolateral portal for suction, especially the residual fluid that tends to trickle posteriorly in the dependent posterior aspects of the joint (Fig. 3).

BMAC is then mixed with the BioCartilage® acellular scaffold. We usually do not add more than 1 mL of BMAC to 1 pack of BioCartilage® (1:1 ratio) to maintain a more malleable and viscous consistency of the implant that would facilitate its adherence to the dependent tibial OCL. Next, the mixture is packed into an extra arthroscopic 4.0-mm sheath in a retrograde fashion (i.e., from the tip of the sheath inward), and a blunt obturator is used to further pack the BioCartilage®/BMAC paste into the arthroscopic sheath.

The sheath is then introduced through the arthroscopic portal closest to the tibial OCL, with the bevel of the sheath facing upward. A small freer elevator is subsequently introduced through the same portal to lie directly underneath the sheath. Once the sheath bevel is opposing the tibial OCL, the BioCartilage®/BMAC paste is pushed using the blunt obturator out of the sheath onto the freer elevator. The sheath is then drawn out, and the freer elevator with the paste is

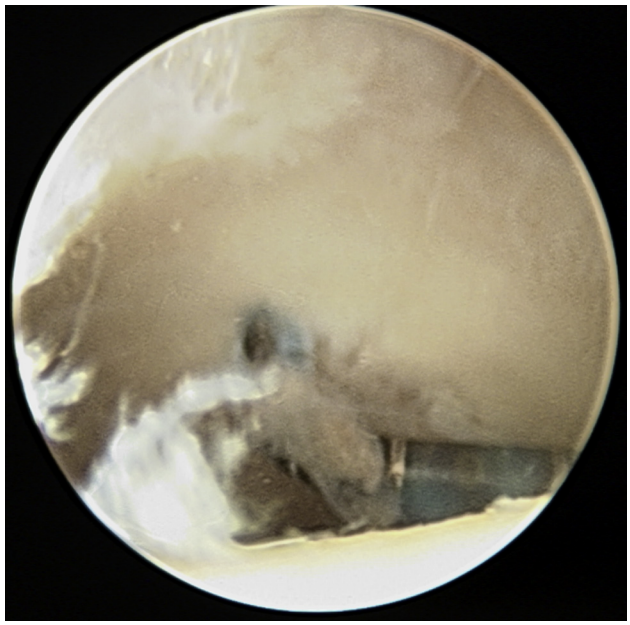

Fig. 1. Arthroscopic view of tibial plafond articular cartilage lesion before intervention.