Treatment of a Lateral Tibial Plateau Osteochondritis Dissecans Lesion With Subchondral Injection of Calcium Phosphate

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Abstract: Osteochondritis dissecans lesions occur frequently in children and adolescents. Treatment can be challenging and depends on the status of the articular cartilage and subchondral bone. Injection of calcium phosphate bone substitute into the area of subchondral bone edema (Subchondroplasty; Knee Creations, West Chester, PA) may be an option. We present a case of a lateral tibial plateau osteochondritis dissecans lesion treated with subchondral injection of nanocrystalline calcium phosphate. Preoperative magnetic resonance imaging is used to determine the area of subchondral edema, and intraoperative fluoroscopy is used to localize this area with the injection cannula. Calcium phosphate is injected by use of a series of syringes until the appropriate fill is obtained. Treatment of concomitant cartilage defects may also be carried out at this time.

Osteochondritis dissecans (OCD) is a relatively common disease in children and adolescents.[1] Although the etiology is not clearly understood, OCD is characterized by avascular subchondral bone with or without separation and instability of the overlying articular cartilage.[2,3] OCD may affect any joint, but the knee is the most common location, with most lesions affecting the medial femoral condyle,[3] although lateral condyle[4] and patellar lesions[5] have also been reported.

The management of OCD depends on physeal status (open or closed) and fragment stability.[2,6,7] A number of investigations have shown successful nonoperative management for lesions of the femoral condyle, particularly in skeletally immature patients.[8-10] However, in patients in whom conservative management has failed, surgical techniques include defect debridement and loose body removal,[11] transchondral and retrograde drilling,[12] in situ fixation,[13] microfracture,[14] autologous chondrocyte implantation,[15] and osteochondral grafting.[16,17] A new method, which is the focus of our technical note and video, is the use of an osteoconductive bone substitute (calcium phosphate) injected into the subchondral bone region. This technique is appropriate when the subchondral bone is intact (not unstable) and when patient symptoms match the location of subchondral edema noted on magnetic resonance imaging (MRI). We describe the use of this technique in an unusual case of a lateral tibial plateau OCD lesion in a skeletally immature female patient.

Surgical Technique

The patient is positioned supine on the operating room table with the foot of the bed up and a lateral post in place. A radiolucent table is not required but may be used. After induction of anesthesia, a tourniquet is placed but is not routinely inflated. When a radiolucent table is not used, the patient is positioned toward the edge of the table on the surgical side so that the leg can be abducted to obtain appropriate fluoroscopic images (Table 1). The leg is then prepared and draped in the usual sterile fashion.

Diagnostic arthroscopy is performed to evaluate the status of the articular cartilage within the knee (Video 1). If no articular cartilage abnormalities are seen or the status of the cartilage does not require intervention, then the arthroscopic portion of the case can be terminated and the external portion may begin. Should the defect be deemed to require treatment, standard articular cartilage treatment methods are performed with or without adjunct marrow stimulation.

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Table 1. Helpful Tips and Potential Pitfall Areas for Surgeons Performing Subchondral Injection of Calcium Phosphate Bone Cement for Treatment of OCD Lesions

Preoperative	Ensure that a high-quality MRI scan is obtained to enable the surgeon to determine the exact area of subchondral bone edema and assess the structural integrity of the bone.
Intraoperative	Lateralize the patient on the table to ensure that fluoroscopic images of the joint can be easily obtained without interference.
	Injection of the calcium phosphate should be carried out so that it completely fills the area of subchondral bone edema recognized on preoperative MRI.
	After injection of the last syringe of calcium phosphate, use the supplied trocar to push the remaining calcium phosphate out of the fenestrated pin and leave the trocar in place until the bone cement has cured. Removing the trocar and/or pin before this may cause the calcium phosphate to leak back out through the fenestrated pin track. The typical curing time is approximately 4 to 5 min.

Once the arthroscopic portion has been completed, the side post is lowered so that the leg can be abducted. A mini-fluoroscopy unit (Flouroscan InSight; Hologic, Bedford, MA) is placed so that appropriate anteroposterior and lateral views of the knee can be obtained. By use of an 11 × 120—mm fenestrated cannula (AccuPort Subchondroplasty; Knee Creations, West Chester, PA), the appropriate starting site is identified and a small incision is made in the skin. A power drill with attached adaptor chuck is used, and the tip of the fenestrated cannula is inserted to the location of maximal T2 signal intensity based on the preoperative MRI scan (Fig 1). Appropriate placement of the cannula is confirmed with anteroposterior and lateral fluoroscopic images (Fig 2). A fluoroscopic template and guide are available to assist in targeting the area of subchondral edema, if desired.

Fig 1. Intraoperative image of the right knee shows insertion of the fenestrated cannula using a power drill and adaptor chuck. After insertion, the tip of the fenestrated cannula should rest at the desired location for the injection of calcium phosphate cement.

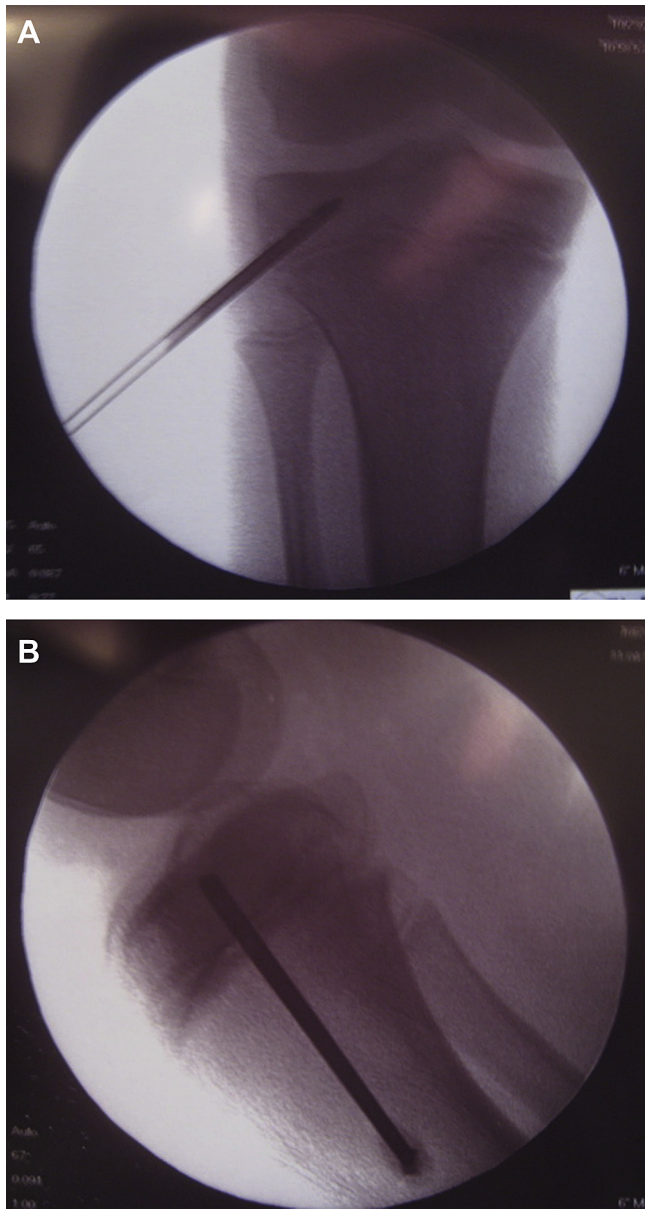

Fig 2. Anteroposterior (A) and lateral (B) fluoroscopic images show placement of the tip of the fenestrated cannula at the location of maximal T2 signal intensity based on preoperative MRI after insertion of the cannula with the power drill and adaptor chuck.

The power drill and adaptor chuck are removed, leaving only the fenestrated cannula in place. Next, the calcium phosphate bone substitute (AccuFill; Knee Creations) is mixed by standard techniques. An inserter syringe is manually filled, followed by filling of the injector syringes, which couple with the fenestrated cannula for injection into the designated area (Fig 3).

Fig 3. Intraoperative image shows attachment of the injection syringe onto the fenestrated cannula. The adaptor chuck and power drill have been removed after insertion of the fenestrated cannula to allow attachment of the syringe.

After injection of the appropriate amount of calcium phosphate (based on fill as visualized during intraoperative fluoroscopy), a stylus may be placed through the fenestrated cannula so that the remaining calcium phosphate in the cannula may be injected into the region of interest. The calcium phosphate is allowed to cure for 5 minutes before removal of the trocar (Table 1).

Final fluoroscopic images are obtained to confirm the appropriate location of the calcium phosphate (Fig 4). If a marrow-stimulation procedure has been performed, the arthroscope can be reinserted into the knee to debride the calcium phosphate that may have extravasated through the microfracture holes. Intra-articular visualization of the calcium phosphate also confirms that the extra-articular injection was performed in the correct location.

Fig 4. Anteroposterior fluoroscopic image of the right knee shows a relatively radiopaque area within the lateral epiphysis correlating to the location of calcium phosphate placement.

Postoperatively, the patient is allowed partial (20-lb) weight bearing with crutches for 2 weeks and then slowly progresses to full weight bearing. There is no restriction of knee range of motion, and patients are prescribed physical therapy to help achieve full motion of the extremity. Full weight bearing may be initiated approximately 2 weeks after the operation as symptoms allow.

Discussion

The treatment of an OCD lesion depends on the age of the patient and the status of the subchondral bone and overlying articular cartilage.[2,3] Options range from debridement of the lesion with or without marrow stimulation, antegrade or retrograde drilling, fixation of the fragment, autologous chondrocyte implantation, or autograft/allograft replacement.[1,2] Should the subchondral bone be intact with only edema noted on a fluid-sensitive MRI scan, injection of calcium phosphate into the subchondral bone underlying the lesion may be appropriate and is a relatively new technique. This procedure is believed to stabilize the mechanical insufficiency in the subchondral bone, leading to pain relief during reconstitution of the subchondral region.

In addition, the senior author has used this procedure for bone marrow edema (BME) associated with osteoarthritis (OA), as well as spontaneous osteonecrosis of the knee, in adults in whom conservative treatment has failed. Felson et al.[18,19] were the first authors to show a correlation between BME and symptomatic OA because patients with painful knee OA were 2.5 times more likely to have BME on MRI. Although there is no current literature relating to treatment of OCD lesions by use of this technique, Sharkey et al.[20] recently reported its use in the treatment of BME associated with OA in a 51-year-old woman. At 31 months' follow-up, the patient had improvement in knee pain and required no further treatment.

Advantages of the described technique include its relative simplicity, low morbidity potential, and minimal postoperative restrictions. There are no major neurovascular structures in the anterior portion of the knee, and no soft-tissue dissection is required for cannula insertion. Although the senior author's postoperative protocol involves toe-touch weight bearing, patients quickly regain normal ambulatory status after cessation of crutch use. Potential challenges in using this technique are accurate localization of the lesion intraoperatively. Fluoroscopy is often not able to show the lesion at the time of the procedure. Because of this, we regularly have the preoperative MRI scan available in the operating room for reference to be able to properly match the location of the cannula with the area of maximal T2 signal intensity based on the MRI scan. In addition, when this technique is used in skeletally immature individuals, there is the potential for physeal injury because of the

proximity of the calcium phosphate. However, as shown in this case, the cannula can be directed to not violate the physis.

In summary, we present a unique option for treatment of an OCD lesion of the tibial plateau with subchondral injection of calcium phosphate. We believe that this technique is a viable treatment option for patients with intact OCD lesions who have not responded to nonoperative management.

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