

PROCEDURE 17

c0017 Subchondroplasty

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[AU3]

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p0010 Subchondroplasty is a procedure developed to treat subchondral defects known as bone marrow lesions (BMLs) or bone marrow edema (BMEs) by injecting a calcium phosphate bone substitute under fluoroscopic guidance.

s0010 INDICATIONS

- u0010 • Failed conservative management
- u0015 • Intact subchondral bone
- u0020 • OA with BMLs
- u0025 • Symptoms matching location of subchondral edema
- u0030 • Stable knee
- u0035 • Not acute (<3 months onset)

s0015 Examination/Imaging

- u0065 • History: mechanism of injury, duration and severity of symptoms.
- u0070 • Examination: full clinical examination including ROM and ligamentous stability, palpations of the bony prominences (i.e., anteromedial tibia) with a particular focus on the area of the bone marrow lesion being evaluated.
- u0075 • Imaging:
- u0080 • standard weight-bearing anteroposterior (AP) (at 0° and 30° of flexion), sunrise, and lateral knee radiographs are used to evaluate the level of arthritis or presence of osteochondritis dissecans lesions (Fig. 17.1)
- u0085 • preoperative magnetic resonance imaging (MRI) is used to confirm the presence of and evaluate the area of subchondral signal (Fig. 17.2).

s0020 SURGICAL ANATOMY

- u0130 • Subchondral bone refers to the epiphyseal bone directly underneath the area of articular cartilage.
- u0135 • Note that as it relates to viewing on the lateral fluoroscopic image of the knee, the lateral tibial plateau resides more superiorly and is more convex, while the medial tibial plateau is more inferior and concave in appearance.
- u0140 • Be mindful of the course of the common peroneal nerve, saphenous nerve, and popliteal artery about the knee, to avoid injury to these structures with placement of the subchondroplasty guide and cannula.

s0025 POSITIONING

- u0145 • Patient should be positioned supine with a sterile thigh tourniquet.

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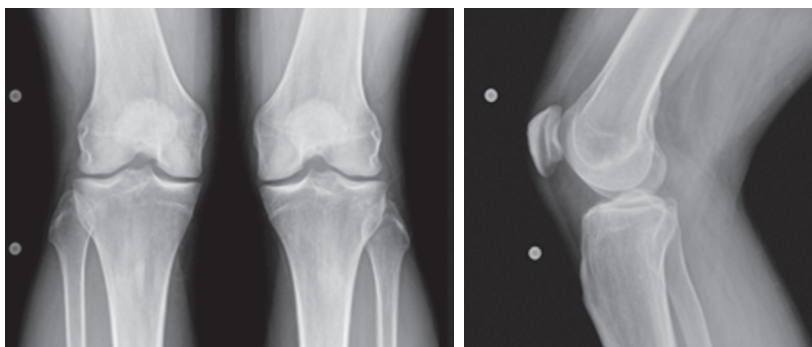


FIG. 17.1

INDICATIONS PITFALLS

- These osseous defects are unrecognized by standard radiographs, but in fat-suppressed MRI sequences they appear as diffuse water-consistent signals in the marrow space.

INDICATIONS CONTROVERSIES

- Advanced osteoarthritis
- Osteochondritis dissecans
- Patellofemoral osteoarthritis
- Avascular necrosis

TREATMENT OPTIONS

- Some bone marrow lesions may respond to a course of conservative measures, and these options should be recommended prior to proceeding with surgical intervention.
- Conservative
 - Rest, oral nonsteroidal anti-inflammatory drugs, physical therapy, low impact activity, and weight loss.
 - Unloader bracing can be particularly helpful as these lesions may calm down with decreased load across the joint.
- Minimally Invasive
 - Injections of corticosteroids and viscosupplementation.
- Surgical
 - Arthroscopy, subchondroplasty, débridement, osteotomy, unicompartmental/total knee arthroplasty.

POSITIONING PEARLS

- Perform a thorough examination under anesthesia at the conclusion of positioning and document range of motion and ligamentous stability.
- A true lateral fluoroscopic image is obtained when the posterior and distal femoral condyles are collinear with one another, and the medial and lateral aspects of the tibial plateau are aligned – a bigger bump can be used if the nonoperative leg remains in view, and the leg adducted or abducted to improve the lateral fluoroscopic image.
- The trochlear groove is visible as a separate line from the lateral and medial facet margins with a true lateral fluoroscopic image.
- A true lateral fluoroscopic image of the patella will include two parallel lines, with one more posterior (the median ridge) and one more anterior (lateral facet margin).

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POSITIONING PITFALLS

- Make sure that the positioning of the nonoperative leg does not impede fluoroscopic imaging of the operative leg.

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POSITIONING EQUIPMENT

- Standard arthroscopy equipment
- Fluoroscopy
- Subchondroplasty kit
- A lateral post can be used for assistance with valgus stress during the arthroscopic portion of the procedure

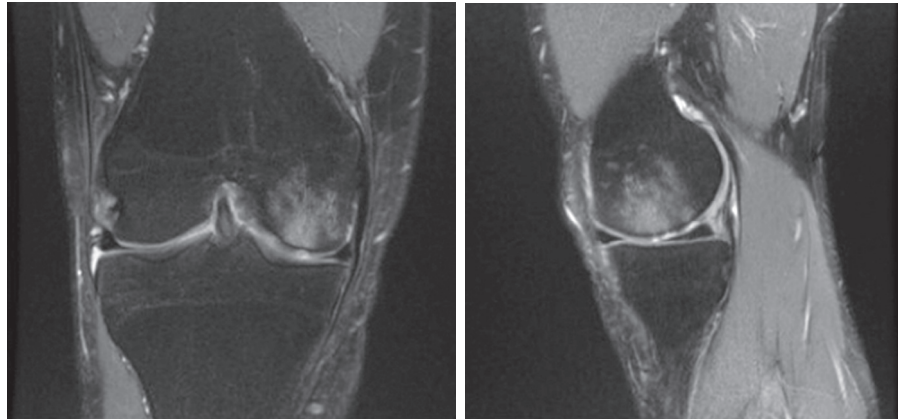


FIG. 17.2

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PORTALS/EXPOSURES PEARLS

- The portal creation at the time of diagnostic arthroscopy is not likely to hinder the access needed for subchondroplasty.

- Patient should be positioned on a flat radiolucent operating table. u0150
- The nonoperative knee should be well padded and placed flat on the operating table. u0155
- Once diagnostic arthroscopy is completed, the operative leg can be placed on a bump or basin to get the nonoperative leg out of the way so a proper lateral fluoroscopic view is obtainable. u0160

b0045

STEP 1 PEARLS

- Take note of chondral grading based on the Outerbridge and International Cartilage Repair Society scales.
- Assess the anterior cruciate and posterior cruciate ligaments with probing for stability.

PORTALS/EXPOSURES

- Standard infralateral and inframedial portal sites alongside the patellar tendon are utilized in the course of the diagnostic arthroscopy performed before and at the conclusion of the subchondroplasty procedure. s0030 u0210
- The site of the subchondroplasty injection is accessed percutaneously by fluoroscopic guidance, and thus does not require an open exposure otherwise. However, care should be taken to visualize any extravasation if present. u0215

b0050

STEP 1 PITFALLS

- Failure to address the underlying etiology of the bone marrow lesion prior to subchondroplasty is expected to lead to inferior results (in the setting of treatment for trochlear or patellar lesions, this is typically due to patellofemoral malalignment).

PROCEDURE

s0035

Step 1: Diagnostic Arthroscopy

- After establishing the standard arthroscopic portals, a standard systematic evaluation of all three compartments (medial, lateral, and patellofemoral) should be performed. s0040 u0225
- Thorough inspection for cartilage damage should ensue, and débridement chondroplasty should be performed as necessary to address loose chondral flaps. u0230
- Probe the medial and lateral meniscus and perform débridement as necessary. u0235
- Remove any loose bodies or chondral debris. u0240

b0055

STEP 1 INSTRUMENTATION/IMPLANTATION

- Débridement chondroplasty is completed with a rotary arthroscopic shaver
- Meniscal débridement can be completed with either a rotary arthroscopic shaver or an arthroscopic basket forceps

Step 2: Navigation Guide and Cannula Placement

- Obtain a proper lateral fluoroscopic view of the operative knee. s0045 u0275
- For tibial lesions: u0280
 - mark the medial and lateral joint lines and patellar tendon on the skin with a skin marker u0285
 - the navigation guide is placed on the anterior knee so that the access portals on the guide are placed over the subchondral bone of the tibia (Fig. 17.3) u0290
 - the guide should delineate the posterior tibia and tibial plateau u0295
 - with the guide in place, the trajectory determined preoperatively from the mapping guide and MRI images facilitates placement of the fenestrated cannula into the region of the subchondral bone marrow lesion u0300
 - proper cannula placement should be confirmed first with the lateral fluoroscopic view, and subsequently with an AP fluoroscopic view and oblique view. u0305
- For femoral lesions: u0310
 - mark the femoral condyles on the skin with a skin marker u0315
 - the navigation guide is placed on the anterior knee so that the access portals on the guide are placed over the subchondral bone of the femur u0320
 - the guide should delineate the articular surface of the condyles u0325

b0060

STEP 1 CONTROVERSIES

- Some may agree to perform concomitant extra-articular procedures at this time prior to the subchondroplasty procedure, including those procedures which correct underlying malalignment (osteotomy of the tibia or femur, or tibial tubercle osteotomy).



FIG. 17.3

STEP 2 PEARLS

- A Kocher can be placed against the skin during fluoroscopic imaging to help localize the joint lines by imaging.
- The level of the subchondral bone is 5 mm to 10 mm below the articular surface at the knee.
- For treatment of a tibial lesion, the tibial tubercle can act as a stabilizer for the navigation frame.
- Fluoroscopic views should be performed at orthogonal (90°) angles to confirm exact location of the fenestrated cannula.
- Preoperative review of the femoral and patellar anatomy is suggested – specifically for treatment of trochlear or patellar lesions – to best understand how it relates to the appearance on fluoroscopic imaging.
- The MRI should frequently be compared with the obtained intraoperative fluoroscopic images to ensure proper identification of the site of bone marrow lesion.
- Prior to placement of the navigation guide cannula, a 25-gauge needle can be used to help triangulate the location on the skin medial or lateral to the lesion from which the cannula guide must enter to access the bone marrow lesion site.
- When placing the cannula into the patella to address a bone marrow lesion in this location, it is helpful to keep the cannula more superficial at the anterior cortex in order to prevent intra-articular breach of the cannula.

STEP 2 PITFALLS

- Improper MRI sequences or imaging, or utilization of images greater than 3 months old, can affect the proper location of cannula placement.
- Improper fluoroscopic images (obtaining that which are not true AP or lateral views) can significantly affect placement of the bone marrow substitute.
- Do not make multiple passes with the cannula drill as this can lead to greater risk for extravasation of cement into the joint.

STEP 2 INSTRUMENTATION/IMPLANTATION

- Large C-arm fluoroscopy is necessary

STEP 2 CONTROVERSIES

- Patients in whom gross knee instability or intra-articular pathology is noted may still be considered appropriate to exclude from further performance of the subchondroplasty procedure.

STEP 3 PEARLS

- Proper speed of injection of the synthetic bone substitute is achieved by applying steady digital pressure on the syringe.
- Turn the fenestrated cannula so that the fenestrations face the articular surface to facilitate injection of the bone substitute.
- Judiciously inject the bone substitute into the lesion.
- Leave the cannula in its place for 1 minute to 3 minutes after injection of the bone marrow substitute to allow it to cure prior to cannula removal.

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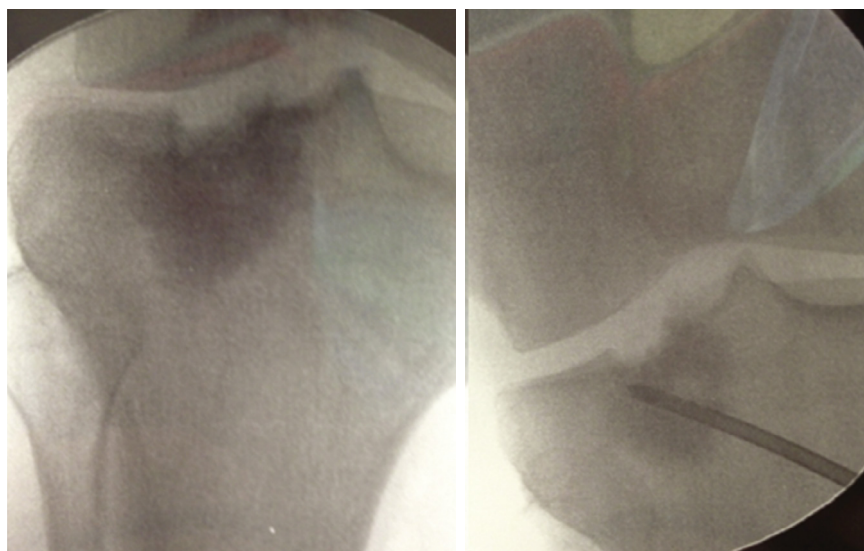


FIG. 17.4

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- u0330 • with the guide in place, the trajectory determined preoperatively from the mapping guide and MRI images facilitate placement of the fenestrated cannula into the region of the subchondral bone marrow lesion so a portal to the bone defect is made
- u0335 • proper cannula placement should be confirmed first with the lateral fluoroscopic view, and subsequently with an AP fluoroscopic view and oblique view.
- u0340 • For patellar lesions:
 - u0345 • navigation guide placement steps should proceed as above
 - u0350 • an assistant should stabilize the patella during drilling of the cannula so that it does not mobilize and cause incorrect placement
 - u0355 • lesions are typically more easily accessed from the medial side of the patella.

s0050 Step 3: Injection of Synthetic Bone Substitute

- u0425 • After confirmation of proper cannula placement into the existing bone marrow lesion, the trocar is removed from the cannula.
- u0430 • The injectable synthetic bone substitute syringe is luer-locked onto the cannula.
- u0435 • Inject the bone substitute into the subchondral bone marrow lesion site.
- u0440 • Continue injection of the synthetic bone substitute under fluoroscopic guidance until the darkened bluish hue of the filler mimics the preoperative MRI image of the bone marrow lesion (Fig. 17.4).

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STEP 3 PITFALLS

- Injection of synthetic bone substitute too forcefully or of too much volume through the fenestrated cannula can cause extravasation into the knee joint.
- Do not over pressurize the bone substitute upon insertion.
- Failure to fill the entirety of the area of the bone marrow lesion with bone substitute may lead to inferior results.
- Carefully assess all fluoroscopic images at the levels of the soft tissues to be certain that no synthetic bone marrow substitute has traveled into the peri-knee soft tissues.

b0095

STEP 3 INSTRUMENTATION/IMPLANTATION

- The synthetic bone substitute (calcium phosphate) must be injectable, endothermic, flowable, structurally similar to cancellous bone, and able to be resorbed over time so that the lesion location can be replaced with healthy bone.

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STEP 4 PEARLS

- Since the injectable synthetic bone substitute (calcium phosphate) is hydrophilic, lavage of the joint will flush any extravasated material out of the joint, along with suction from the shaver.

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STEP 4 INSTRUMENTATION/IMPLANTATION

- Diagnostic arthroscopy equipment

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POSTOPERATIVE PEARLS

- Significant pain may be reported in the first 72 hours postoperatively which is beyond what is normally encountered with standard arthroscopy.
- Most patients require between 4 weeks and 8 weeks of physical therapy for proper rehabilitation after surgery.
- The full effects of the procedure in terms of pain reduction and functional improvements can be expected by about 3 months after surgery.

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POSTOPERATIVE PITFALLS

- Failure of the procedure may result in conversion to total or unicompartmental knee arthroplasty.

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POSTOPERATIVE INSTRUMENTATION/IMPLANTATION

- Those patients who utilized an unloader brace preoperatively can continue to utilize this brace for up to 8 weeks postoperatively during rehabilitation

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POSTOPERATIVE CONTROVERSIES

- There is no current evidence to suggest that subchondroplasty affects future performance of a total joint arthroplasty should conversion to replacement options be necessary.

Step 4: Confirmatory Arthroscopy

- The arthroscopic camera is placed to confirm proper placement of the bone substitute and to be certain that the synthetic bone substitute has not extravasated into the knee joint while the substitute is being injected. s0055
u0490
- Lavage the joint with arthroscopic fluid and suction through a standard shaver. u0495

Complications

- No significant medical complications or reactions related to the synthetic bone substitute injection have been encountered to date. s0060
u0510
- Extravasation of the bone substitute into the joint can occur, but can be ameliorated with the secondary arthroscopic viewing through lavage. u0515
- Synthetic bone substitute which extravasates into the soft tissue and hardens can be palpable and tender; this has occurred in a few documented patient cases. u0520
- As the bone marrow lesion is considered to potentially act as part of a more systemic degenerative disease, new lesions can occur in previously uninvolved compartments. u0525

POSTOPERATIVE CARE AND EXPECTED OUTCOMES

- Patients are typically treated in an outpatient (same-day) surgical setting, but overnight stay can be necessary for pain control reasons. s0065
u0530
- Pain will often be most significant for the first 48 hours to 72 hours following subchondroplasty, when analgesic medication (narcotics or anti-inflammatories) consumption will be most necessary. u0535
- Postoperative regional nerve blocks can provide adequate analgesia. u0540
- Patients remain weight-bearing as tolerated with crutches for assistance during the first 1 week to 2 weeks after surgery if needed. u0545
- Patients are seen within 7 days to 10 days after surgery for surgical site evaluation and suture removal. u0550
- At 2 weeks postoperatively, crutch use can be discontinued, and formal physical therapy is initiated. u0555
- Return to full and unrestricted activities is allowed between 4 weeks and 8 weeks postoperatively, pending patient symptoms. u0560

EVIDENCE

Abrahams GD, Alentorn-Geli E, Harris JD, Cole BJ: Treatment of a lateral tibial plateau osteochondritis dissecans lesion with subchondral injection of calcium phosphate, *Arthrosc Tech* 2:e271–e274, 2013.

Chatterjee D, McGee A, Strauss E, Houm T, Jazrawi L: Subchondral calcium phosphate is ineffective for bone marrow edema lesions in adults with advanced osteoarthritis, *Clin Orthop Relat Res*. 473:2334–2342, 2015.

The authors, reported on 22 of 33 patients treated with subchondroplasty by four surgeons. The median age was 53.5 years (range, 38–70 years). Lesions were predominantly tibial (15 of 22), and all had grade III to grade IV chondral lesions. At a median follow-up of 12 months (range, 6–24 months), Knee Injury and Osteoarthritis Outcome Score (KOOS) scores significantly improved from a mean 39.5 to 71.3, with 15 patients (68% of cohort) with more than 20 points of improvement, indicating highly clinically significant findings. Tegner-Lysholm scores significantly improved from 48 to 77.5, with 18 patients (82% of cohort) with more than 10 points of improvement, indicating clinically significant findings. Ultimately, the authors reported a 55% success rate at the median 12 month final follow-up, suggesting that the 10 patients (7 with poor results, 3 with fair results) were considered ‘failures’. However, several of these “failure” patients actually had significant improvements recorded in outcome scores despite the authors of this study suggesting their findings were unsatisfactory – yet, the authors recommended against use of this procedure for the designated patient demographic which seems to contradict their results.

Cohen SB, Sharkey PF: Surgical treatment of osteoarthritis pain related to subchondral bone defects or bone marrow lesions: subchondroplasty, *Tech Knee Surg* 11:170–175, 2012.

Cohen SB, Sharkey PF: Subchondroplasty for treating bone marrow lesions, *J Knee Surg*, 2015. [Epub ahead of print]. s0070
[AU5]

Data were prospectively collected and retrospectively reviewed from 66 patients who presented to the authors between May 2008 and May 2012 with indications for knee arthroplasty (i.e., unsatisfactory response to nonoperative and moderate/severe symptoms >2 months) who underwent subchondroplasty combined with arthroscopy at a single center by one surgeon. These patients all presented bone marrow lesions on MRI in a weight-bearing region of the femoral condyle or tibial plateau. Patients were predominantly female (34 of 66, 52%), average age was 55.9 years (range,

35.0–76.0 years) and the average body mass index was 30.1 kg/m² (range, 20.3–53.2 kg/ m²). Ninety-six percent of patients had grade 3 or 4 changes in the subchondroplasty-treated compartment. Statistically and clinically significant improvements in both pain and function were seen following subchondroplasty with arthroscopic débridement as per International Knee Documentation Committee (IKDC) Subjective Knee Evaluation and visual analog scale (VAS) pain measurements through 2 years of postoperative follow-up. Joint preservation survivorship (nonarthroplasty conversion) was 70% (42 of 60) for study patients at 2 years postoperative. Younger patients with a shorter duration of symptoms were less likely to convert to knee arthroplasty. These findings suggest the treatment of osteoarthritis with bone marrow lesions by subchondroplasty may be a promising approach.

Colon DA, Yoon BJ, Russell TA, Cammisa FP, Abjornson C: Assessment of the injection behavior of commercially available bone BSMS for subchondroplasty procedure, *The Knee* 22:597–603, 2015. This mechanical testing protocol was performed to assess the behavior of injectable calcium phosphate bone substituting materials (BSMs) in small microarchitecture environments using a standardized polyurethane block material model that behaves similarly to the trabecular bone of the knee. Simplex, AccuFill, and StrucSure materials were successfully injected, and AccuFill was the only material able to inject in a closed model with adequate implantation of BSM into the simulated trabecular bone. This in vitro study gives credence to the injectability of BSMS as clinically relevant options for such minimally invasive injection procedures as with subchondroplasty.

David A, Byrd J, Zenner J, DeMeo P, Frank D, Akhavan S: Short-term outcomes of the subchondroplasty procedure for the treatment of bone marrow edema lesions in patients with knee osteoarthritis, *AOSSM*, 2015. Poster #28.

The authors reported a retrospective chart review of 50 patients with bone marrow lesions diagnosed on MRI who underwent subchondroplasty after failure of conservative treatment options. Patients were a mean 55 years of age, and had a mean final follow-up of 14.6 months (12.9–25.1 months). At final follow-up, mean VAS improvement was 4.7 points, with 88% experiencing improvement in pain and 72% experiencing improvement in pain-free walking distance. Patient satisfaction was a mean 7.8 out of 10; seventy-eight percent (78%) would undergo the subchondroplasty procedure again, and 86% would recommend the procedure to someone else. Forty-eight percent underwent additional interventions, including 18 injections, two with serial aspirations, and four (8%) who converted to total knee arthroplasty. They concluded that short-term outcomes with subchondroplasty demonstrate its efficacy in the management of patients with knee osteoarthritis and bone marrow lesions.

Farr II J, Cohen SB: Expanding applications of the subchondroplasty procedure for the treatment of bone marrow lesions observed on magnetic resonance imaging, *Oper Tech Sports Med* 21:142–147, 2013.

The authors provide their preliminary results on the patient population reported by Cohen et al in 2015. This early report included 59 patients at an average age of 55.6 years with predominantly medial tibial bone marrow lesions. At mean follow-up of 14.7 months, fifteen patients (25%) had continued pain and converted to knee arthroplasty (total or unicompartmental) at a mean 10.1 months after subchondroplasty procedure (range, 4.2–22 months). IKDC and Short Form (SF)-12 scores significantly improved at final follow-up. Pain scores were improved substantially in the immediate postoperative period, with maintenance or continued improvement thereafter. None of the assessed patient demographics or preoperative variables were predictive of failure (conversion to total or unicompartmental knee arthroplasty).

Miller JR, Dunn KW: Subchondroplasty of the ankle: a novel technique, *Foot Ankle Online J* 8:7–13, 2015.

These authors reported the first two cases of use for the subchondroplasty procedure in the ankle and foot for chronic subchondral bone marrow edema to the talar dome. At 10-month follow-up, both patients reported just minimal pain in the ankle joint. Both patients had returned to sporting activities, and state that they would elect to have the procedures performed again.