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Case Report

# MRI findings of subchondroplasty of the knee: a two-case report

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ABSTRACT

Bone marrow lesions observed in magnetic resonance imaging (MRI) have been recognized as a source of knee pain. Subchondroplasty was developed to treat these lesions with a percutaneous injection of calcium phosphate bone substitute into the bone. As subchondroplasty may potentially become a more common procedure in the treatment of knee osteoarthritis, it is important for radiologists to recognize the typical MRI findings and not to confuse them with other pathology. Here we report the MRI findings for two patients following subchondroplasty.



## 1. Introduction

Osteoarthritis (OA) of the knee is a very common disease and it is estimated that almost 50% of United States citizens will have painful knee OA in their lifetime leading to significant socioeconomic impact [1]. Knee OA is typically described by the narrowing of the joint space and loss of articular cartilage, but is has been shown that the degree of joint space narrowing poorly correlates with the incidence and severity of the pain [2,3]. Bone marrow lesions (BMLs), which are a common but nonspecific finding in magnetic resonance imaging (MRI), on the contrary, have been well documented to correlate with pain in OA [4–9]. The association of BML with overlying cartilage damage in OA has also been shown [5,10]. Felson et al. [11] showed in a longitudinal study that an increase in the size of BMLs correlated with increased pain. Furthermore, Moisio et al. [12] demonstrated that the amount of denuded subchondral bone and the volume of the BMLs were strongly correlated with the severity of reported pain. However, regression or even complete resolution of subchondral BMLs has been also reported, so therefore, the utmost clinical relevance of changing BML size remains controversial [7].

The treatment of early- and mid-stage knee OA is somewhat disputable, since injections of viscosupplements and arthroscopic debridement or lavage have been associated with inconsistent results [13,14]; consequently, it has been stated that the evidence to support their use is inconclusive [15,16]. In the end, for patients with severe pain associated with OA, surgical interventions such as high tibial osteotomy, unicompartmental knee arthroplasty, or total knee arthroplasty (TKA) are often recommended [17]. Subchondroplasty was first described in 2007 as a minimally invasive procedure to treat pain in knee OA patients with MRI identified BMLs [18]. Because subchondroplasty is increasingly used to treat painful BMLs [19], it is essential to distinguish postprocedure changes from other marrow pathology on MRI. To our knowledge, the MRI findings of knee subchondroplasty have never been described in the radiological literature. The purpose of this study is to describe the characteristic findings of knee subchondroplasty seen on MRI. We present two cases of subchondroplasty with clinical follow-up information.

## 2. Case reports

### 2.1. Case 1

A 42-year-old man [body mass index (BMI) 40.2 kg/m$^2$] who had persistent right knee medial pain for 8 months was treated conservatively with physical therapy, anti-inflammatory medicine, cortisone and hyaluronic acid injection without significant pain relief. Initial MRI showed a medial meniscal tear, patellofemoral chondrosis, and BML at medial tibial plateau. In the follow-up MRI, the size of the BML was shown to increase. Eventually, a decision for arthroscopy and subchondroplasty for the medial tibial plateau lesion was made. Arthroscopy showed loose bodies at suprapatellar pouch in lateral gutter, medial femoral condyle and medial tibial plateau chondrosis, and medial meniscus radial flap tear at posterior horn junction. Consequently, partial meniscectomy and chondroplasty at medial tibial plateau was performed. Then, subchondroplasty was performed and a

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**Fig. 1.** A 42-year-old man with subchondroplasty performed on the medial tibial plateau of his right knee. The postprocedure MRI after 4 months shows low signal (arrows) representing calcium phosphate injectate on coronal T1-weighted (a), coronal T2-weighted fat suppressed (b) and sagittal T2-weighted fat suppressed (c) images. Note that high T2 signal rim (arrowheads) on fluid sensitive sequences (b and c). Some residual marrow edema (black arrows) is observed at the medial femoral condyle (b and c).

total of 5 ml of Zimmer Knee Creations (West Chester, PA, USA) Accufil calcium phosphate was injected into the medial tibial plateau under fluoroscopy without complications. At the 6-week follow-up visit, the knee pain had decreased. However, at 3-month follow-up visit, the patient complained of significant pain in the right knee. The pain persisted and the follow-up MRI after 4 months from subchondroplasty showed typical postprocedure findings with low signal representing the injected calcium phosphate (Fig. 1). In the radiographs obtained 6 months after the procedure, focal density could be seen in the medial tibial plateau (Fig. 2). Subsequently, the patient was evaluated for knee arthroplasty, which was not performed due to the patient's morbid obesity and young age.

### *2.2. Case 2*

A 58-year-old man (BMI 29.7 kg/m$^2$) suffered from left knee pain for 3 years after twisting his knee. Arthroscopy with partial medial meniscectomy was performed a year after the injury. Conservative treatment with hyaluronic acid injections was also performed to relieve symptoms. Radiographs showed mild OA, and MRI showed BML at the medial tibial plateau (Fig. 3a). Consequently, a decision to perform subchondroplasty without arthroscopy was made. A standard subchondroplasty was performed to the medial tibial plateau without complications. The follow-up MRI exams were performed after 9 and 14 months and showed postprocedure findings with low signal surrounded by a T2 hyperintense rim (Fig. 3b, c). Eventually, the patient developed extensive arthritis in lateral compartment and in patellofemoral compartment, and TKA was performed 17 months after subchondroplasty.

## 3. Discussion

Since the beginning of the 21th century, the vast increase in the use of MRI for patients with knee pain has led to interest in the role of BMLs in knee OA. Consequently, subchondral BMLs and cartilage loss are thought to be the hallmark of knee OA on MRI [7]. BMLs can be seen in conjunction with trauma, chronic cartilage damage and OA, as an idiopathic entity or as a concomitant feature of other pathologies such as subchondral fracture, osteonecrosis, inflammation or tumor [17]. The majority of BMLs fluctuate in size over time and are potentially reversible [7,20]. However, the understanding of the pathophysiology of BMLs is still limited [9]. In the knee OA, the clinical significance of subchondral BMLs for structural progression, as well as explaining the pain, has been well recognized in multiple studies [4–9]. Ultimately, knee OA patients with BMLs are at substantially increased risk of subchondral bone attrition, subchondral bone plate collapse and need for TKA.

Treatment of early- and mid-stage knee OA is conservative, and invasive procedures including arthroscopy have been deemed to give less long-term pain relief [15,16]. Ultimately, for painful end-stage

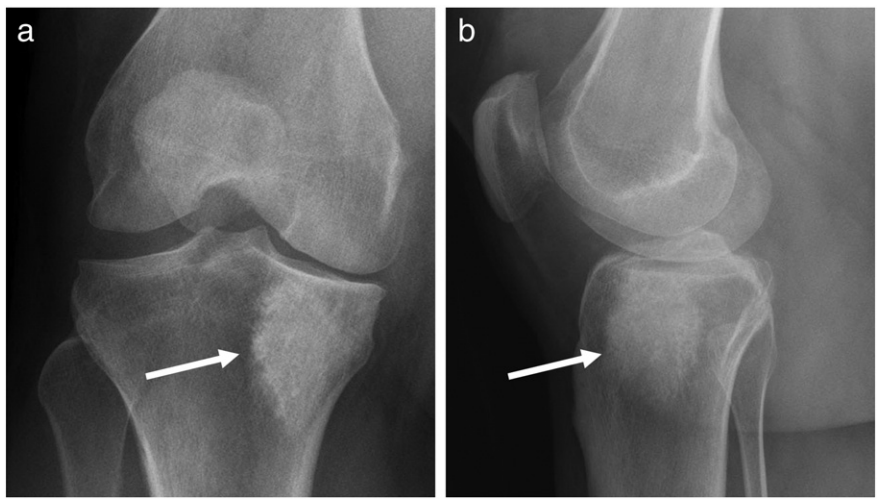


**Fig. 2.** Anteroposterior (a) and lateral (b) radiographs of a 42-year-old man (same patient as Fig. 1) 6 months after subchondroplasty demonstrate a focus of density (arrows) in the medial tibial plateau representing the injected material.


**Fig. 3.** Subchondroplasty was performed on a 58-year-old man with preprocedure and postprocedure MRI exams acquired; T2-weighted fat suppressed images of three exams are displayed. Preprocedure MRI (a) shows bone marrow edema (arrow) at the medial tibial plateau. On the first follow-up MRI 9 months after subchondroplasty (b), typical changes are seen with low signal surrounded by a T2 hyperintense rim (arrow). The second follow-up MRI 14 months after subchondroplasty (c) shows some regression of the hyperintense rim (arrow).

knee OA, TKA is the only feasible option being the leading indication with more than 600,000 TKAs performed in 2008 in the United States [1]. However, an average 20% dissatisfaction rate (range 10% to 34%) from TKA has been reported [21], and in addition, the postoperative rehabilitation, surgical morbidity and complication rates have rendered both osteotomy and TKA less popular with middle-aged or active patients [22]. Furthermore, younger patients who undergo TKA are subject to requiring revision surgery as bearing surfaces wear with increasing activity [23].

Accordingly, a minimally invasive method to treat painful BMLs related to knee OA titled subchondroplasty was introduced in 2007 [18]. It is based on familiar and accepted internal fixation and bone stimulating techniques for treating nonhealing bone injuries by injecting calcium phosphate bone substitute into the BML under fluoroscopic guidance. In a small clinical study, it was shown that only 12/22 (55%) had good or excellent results after the knee subchondroplasty [19]. Treated patients were found to have statistically significant improvement in both Knee injury and Osteoarthritis Outcome Score and Tegner/Lysholm scores (both $P<.001$). However, due to short follow-up and large number of patients lost to follow-up, the authors concluded that they were not able to confirm the long-term efficacy of subchondroplasty for advanced knee OA [19]. More recently, two of the authors of this present study have performed a retrospective study on 66 patients undergoing subchondroplasty with arthroscopy with advanced OA and BMLs with a minimum of 2-year follow-up. These results revealed significant improvements in pain and function after subchondroplasty with only a 30% conversion to arthroplasty (article submitted for publication).

In this article, we have described imaging findings of two patients with subchondroplasty of the knee. Radiographically, the injected calcium phosphate bone substitute is seen as focal radiodensity analogous to that observed following vertebroplasty. MRI shows low signal on T1-weighted and T2-weighted corresponding to the injectate, with a rim of T2 hyperintensity. Patient history is essential when such findings are observed on radiographs or MRI to avoid misdiagnosis as infarction, infection, or neoplasm. Anecdotally, we have observed some evidence that the injected material and hyperintense rim can regress over time. The same finding has been reported in a case report by Sharkey et al. [17] in 31-month follow-up. However, natural history of the appearance of the injected material would require more study.

In conclusion, subchondroplasty is novel method to treat painful BMLs in knee OA. Findings on postprocedure radiographs and MRI should not be confused with infarction or other pathology.

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