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Changing MRI after subchondroplasty with partial meniscectomy for knee osteoarthritis☆

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ABSTRACT

A 54-year old woman with primary osteoarthritis and a tibial bone marrow lesion underwent subchondroplasty with injectable calcium phosphate. Post-operatively, the patient's symptoms worsened, and she lost the ability to bear weight. Follow-up MRI revealed previously absent, diffuse STIR hyperintensity in the tibia extending far beyond the surgical site. Twelve months post-operatively, symptoms spontaneously resolved. As the prevalence of subchondroplasty grows it will be important to recognize potential complications. To the authors' best knowledge this is the first report of significantly worsening pain and difficulty bearing weight corresponding with diffuse hyperintense T2 signal in the tibia after a calcium phosphate subchondroplasty.

1. Introduction

Osteoarthritis (OA) of the knee is a well-recognized cause of disability among the American adult population [1,2]. Although OA is most often defined by loss of articular cartilage and joint space narrowing, significant evidence has shown bone marrow lesions (BMLs) are both indicative and predictive of worsening OA [3–8]. BMLs are thought to result from subchondral remodeling when changing focal forces or reduced healing capacity cause an arthritic joint to fail [9]. Histological study has shown these areas represent chronic non-healing stress fractures [10]. These pathologic areas are not present on plain radiography although they can be identified with fat saturated MRI sequencing [11,12].

Presence of a BML in patients with knee OA strongly predicts conversion to total knee arthroplasty [13]. One study found that patients with BMLs of the knee are nine times more likely to undergo TKA within a three-year period than a cohort of matched arthritic patients without BMLs [8]. Although TKA portends reliable outcomes for treatment of OA it is an invasive procedure with potentially serious complications, therefore joint-preserving strategies are often sought. Injection of calcium phosphate into BMLs has been theorized to provide structural stability to these pathologic areas and potentially allow for re-vascularization and healing [14]. This procedure was first described in 2007 and has since been referred to as subchondroplasty [15]. It is performed under fluoroscopy and often concomitantly with arthroscopy to correct intra-articular pathologies such as loose bodies, meniscal tears, or chondral flaps [16]. Several studies have reported promising improvement in outcomes, at both short-term and mid-term follow-up, of pain and patient-reported outcome measures (PROMs), such as the International Knee Documentation Committee (IKDC) form and SF-12 [9,16]. However, a retrospective study did not fully support the use of subchondroplasty, especially in those with advanced OA, as a significant proportion of optimal candidates experienced clinical failure despite improvement in KOOS and Tegner-Lysholm scores [17].

To the authors' knowledge, there is a lack of literature exploring variant subchondroplasty findings on MRI with correlation to clinical findings. Thus, we present a case report examining a patient's adverse effects status post subchondroplasty, with concomitant abnormal diffuse extension of injected calcium phosphate throughout the tibia beyond the surgical site.

2. Case Report

A 54-year old female with a BMI of 31.2 kg/m^2 presented to the senior author's clinic two months after undergoing a subchondroplasty and meniscectomy at an outside institution. The procedure had been preceded by failure of NSAIDs, intra-articular cortisone injection, and physical therapy, to adequately control symptoms of non-traumatic osteoarthritis. At the time of first presentation, the patient was experiencing medial joint line tenderness and pain/stiffness with activity but was bearing weight on the limb and ambulating without any assistive device. Pre-operative x-rays showed medial compartment joint

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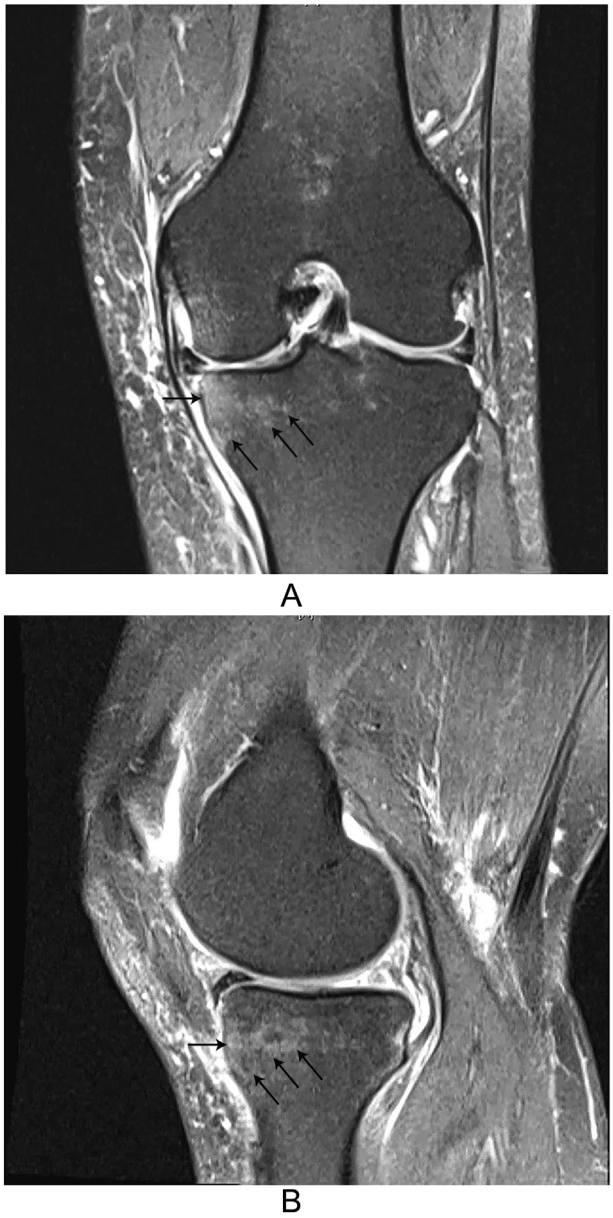

Fig. 1. A 54-year old female underwent medial meniscectomy and subchondroplasty of the medial tibial plateau of the left knee. The preoperative MRI obtained 3-weeks before the procedure shows mild hyperintensity consist with a focal bone marrow edema *(black arrows)* and medial compartment cartilage thinning, indicative of a bone marrow lesion. (a) coronal T2-weighted PD fat saturated MRI of the left knee and (b) sagittal T2-weighted PD fat saturated MRI of the left knee.

space narrowing. Pre-operative MRI, obtained three weeks prior to surgery, showed medial compartment cartilage thinning and focal bone marrow edema in the medial tibial plateau, consistent with a BML. (Fig. 1) At the time of subchondroplasty, a diagnostic arthroscopy revealed diffuse cartilage fibrillation consistent with OA in the medial and lateral compartments without discrete cartilage defects. Degenerative changes to both menisci were also appreciated with minimal horizontal tears of both menisci.

Post-operatively, the patient experienced a three days period of symptom relief followed by increasing pain beyond the magnitude and characteristics of original, presenting symptoms. Five weeks post-operatively, physical exam revealed tenderness of the medial tibial plateau. At that time, CBC and ESR were within normal range, with CRP mildly elevated at 0.9. Post-operative care consisted to two weeks of

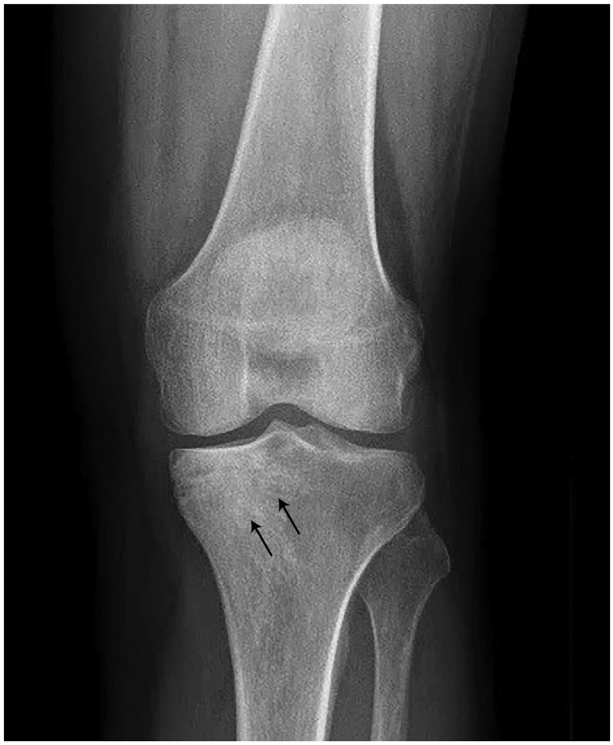

Fig. 2. Postoperative anteroposterior (AP) plain radiograph demonstrate the typical findings 5-weeks status-post subchondroplasty with a focal density *(black arrows)* under the medial tibial plateau at the site of injection.

toe-touch weight bearing with crutches and subsequent attempt to progress to full weight-bearing while undergoing physical therapy for range of motion.

A postoperative anteroposterior radiograph obtained at 5-weeks status post subchondroplasty shows a focal density under the medial tibial plateau, corresponding to the injection site, where bone marrow edema was seen preoperatively on MRI. (Fig. 2) An MRI obtained at six weeks post-operatively showed focal hypointense area in the region previously occupied by the BML with a clear trochar insertion site, consistent with expected postoperative imaging of Accufill (calcium phosphate) placement. (Zimmer Biomet, Warsaw, Indiana) (Fig. 3) Additionally, the remainder of the tibial epiphysis, metaphysis, and proximal diaphysis showed diffuse STIR hyperintensity extending far beyond the surgical site. (Fig. 3) Corticosteroid injection administered by the operating surgeon provided no symptomatic relief. The patient had a previous unremarkable workup for rheumatoid arthritis but had never been evaluated for bone density. At the time of presentation to the senior author's clinic the patient reported 10/10 pain on the visual analog scale (VAS) score resulting in dependence on crutches and unable to fully bear weight on the left leg, a significant decline from her preoperative state. Passive range of motion was intact. Pain and tenderness were located diffusely in the proximal and mid-tibia. Twelve months post-operatively, symptoms resolved spontaneously, with diffuse proximal tibia pain decreased to 4/10 VAS score with the patient able to fully weight bear and achieve full active range of motion. At two-year follow-up, the patient was reached by phone and reported continued knee pain at a 3/10 VAS score and active weight bearing status.

3. Discussion

Subchondroplasty is emerging as a potential joint-preserving alternative to TKA in patients with knee osteoarthritis, as a large patient population stands to benefit from joint preservation in the setting of

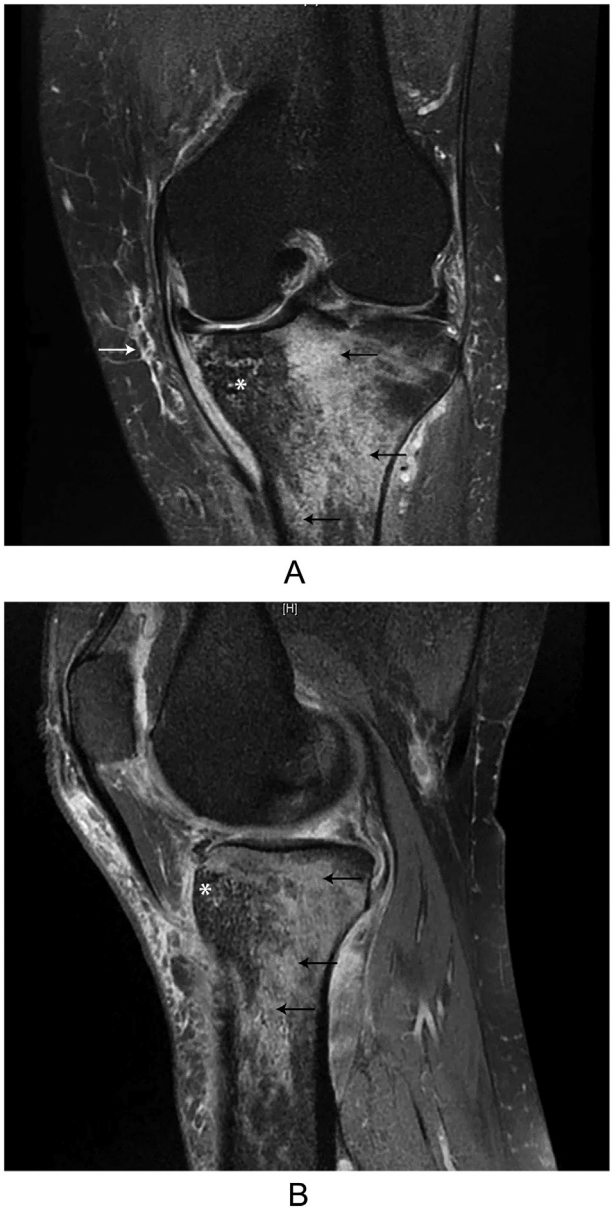

Fig. 3. Postoperatively MRI obtained 6-weeks after subchondroplasty showing a clear trocar insertion site *(white arrow)* and focal hypointensity in the area of injection *(white asterisk*), where focal bone marrow edema was seen pre-operatively, in addition there is the typical slight rim of hyperintensity, which usually resolves after 6 months. Additionally, the remainder of the tibial epiphysis, metaphysis, and proximal diaphysis showed diffuse STIR hyperintensity extending far beyond the surgical site. *(black arrows)* (a) coronal T2-weighted PD fat saturated MRI of the left knee and (b) sagittal T2-weighted PD fat saturated MRI of the left knee.

knee OA. As the prevalence of this procedure grows, it will be important to recognize potential complications. Nevalainan et al. analyzed typical MRI findings for patients who underwent subchondroplasty and made careful distinction from pathologic findings [18]. Similarly, Agten et al. reported described pre- and post-operative imaging findings of a small case series for patients undergoing subchondroplasty [19]. Both studies demonstrated the typical appearance of subchondroplasty post-operatively on MRI is a T1-weighted and T2-weighted hypointense area with a fine rim of hyperintense signal on fluid sensitive sequences [19]. Several studies have corroborated resolution of the T2 hyperintense rim at mid-term follow-up imaging [8,18,19]. However, the diffuse hyperintensity seen post-operatively on T2 MRI in our patient has not been traditionally reported. To the authors' best knowledge, this is the first report of diffuse hyperintense T2 signal in the tibia after calcium phosphate subchondroplasty corresponding with significantly worsening pain and difficulty bearing weight.

The diffuse hyperintensity seen postoperatively in this patient is of an unknown etiology and although the patient's physical exam seems to correspond with imaging, the two are not necessarily related. The authors hypothesize that the extended hyperintensity beyond the surgical site could be the result of micro-cracks throughout the tibia, potentially below the detectability of radiographic or magnetic resonance imaging [8]. Histological biopsy and analysis would be required to confirm this hypothesis. The presence of micro-cracks could have obfuscated the focal healing potential of the subchondroplasty. MRI changes could also represent an allergic reaction to the Accufill or a stress fracture from changing biomechanical forces in the tibia. The literature on subchondroplasty has not demonstrated a traditional sequence of pain post-operatively to explain the patient's clinical findings. The unexplained relationship between persistent pain and extension of the subchondroplasty throughout the tibia indicates the need for further investigation of the underlying etiology, as this may help to refine prognostic characteristics for this procedure.

The limited body of research on subchondroplasty outcomes has conflicting reports that contest significant improvements in pain and functional outcome measures after subchondroplasty. Cohen et al. reported significant improvements in VAS pain score and IKDC score at 2-year follow-up in a cohort of 66 patients who chose subchondroplasty over arthroplasty [14]. Byrd et al. have reported a high satisfaction rate and a decrease in pain in patients at minimum 2-year follow-up among 133 patients who underwent subchondroplasty, but did not use PROMs or statistical tests of significance in their analysis [17]. While Chatterjee et al., reporting on a cohort of 22 patients that received subchondroplasty with a minimum of 6-month follow-up, found that 7 patients had poor results based on the Tegner-Lysholm score. However, the clinical picture is complex, with 18 of 22 patients also received a concomitant partial meniscectomy [16].

This patient represents a clinical failure after subchondroplasty with regards to pain and function, and more literature is needed to examine the radiographic and MRI findings of patients treated with subchondroplasty to determine contraindications and complications of this procedure. The authors recommend further research into the development of diffuse infiltration of subchondroplasty throughout the tibia and associated pain in other patients as identified by post-operative MRI examination.

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IRB Statement

No IRB approval necessary, Case Report:

“Statement of Informed Consent: The patient was informed that data concerning their case would be published and informed consent was obtained.”

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