CASE REPORT

Subchondral Insufficiency Fracture of the Femoral Head treated with Core Decompression and Bone Void Filler Support

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Abstract

Subchondral insufficiency fracture of the femoral head (SIFFH) is characterized by acute onset hip pain without overt trauma. It appears as a low intensity band with bone marrow edema on T1-weighted MRI. The most common course of treatment is protected weight bearing for a period of several weeks. Total hip arthroplasty (THA) has been commonly used if the patient does not respond to the initial protected weight bearing treatment. We present a case of a 48-year-old male with SIFFH who was treated with core hip decompression and bone void filler as a hip-preserving alternative to THA. The patient has an excellent clinical and radiographic result at final follow up. Core hip decompression with bone void filler is a less invasive alternative to THA, and may be a preferred initial treatment strategy for SIFFH in the young and active patient who has failed conservative measures.

Keywords: Bone void filler, Hip core decompression, Hip preservation, Subchondral insufficiency fracture femoral head, Total hip arthroplasty

Introduction

Subchondral insufficiency fracture of the femoral head (SIFFH) is characterized by acute onset hip pain, without overt trauma, that often progressively worsens over time (1). The insufficiency fracture occurs under physiologic stress conditions, more commonly affects elderly patients, and typically presents with unilateral involvement (2). SIFFH sometimes resolves with non-weight bearing treatment; however, if conservative therapy is ineffective, then total hip arthroplasty (THA) is often required (3).

SIFFH may be associated with joint space narrowing, either at the onset in the setting of an arthritic hip, or with progressive subchondral collapse related to the fracture insult. The degree of joint space narrowing is associated with a higher failure rate of conservative, non-weight bearing treatment (3). There are often no apparent lesions to the femoral head on plain radiography. Diagnosis with T1-weighted magnetic resonance image (MRI) is made by identification of an irregularly shaped, low-intensity band parallel to the subchondral bone, often with associated bone marrow edema (1).

We present the management of an active male patient who presented with worsening groin pain without trauma. The patient was diagnosed with SIFFH and treated with hip core decompression and injection of bone void filler to support the affected subchondral bone.

Case Report

The patient, a 48-year-old male, presented with a six-month history of worsening left groin pain, resulting in greatly decreased levels of activity. The patient reported the acute onset of pain with no overt antecedent trauma. He reported the pain to be 7 out of 10 at its worst and exacerbated by walking, running, deep hip flexion, and hip rotational maneuvers. The patient had undergone a several month trial of protected weight-bearing with no resolution in his symptoms, and an outside orthopedic surgeon had recommended THA.

On plain radiographs at our clinic, no fracture of the left hip was identified, and there was no collapse of the femoral head or narrowing of the joint space [Figure 1A, 1B]. T1-weighted MRI sequences showed a linear subchondral low intensity signal with surrounding edema involving the anterior superior weight-bearing portion of the femoral head, consistent with SIFFH [Figure 1C-F].

Management options that were discussed included

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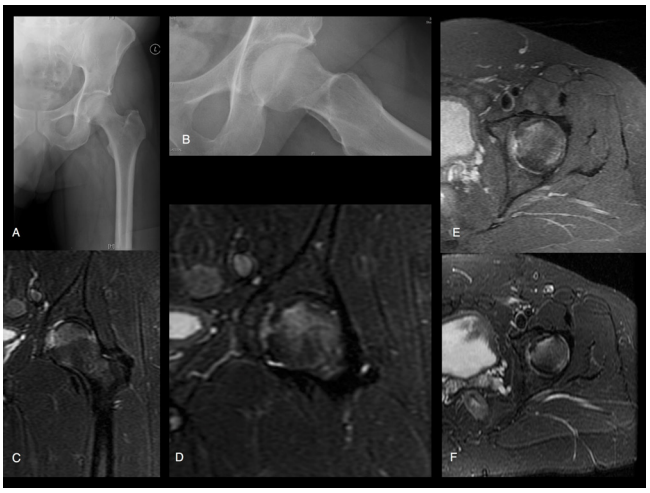

Figure 1. Pre-operative anterior-posterior (A) and frog lateral (B) hip radiographs demonstrating preservation of the joint space, with no discrete insufficiency fracture noted. Pre-operative coronal STIR (C, D), axial proton-density fat-saturated (E), and axial STIR (F) magnetic resonance images highlighting a femoral head insufficiency fracture with characteristic signal intensity changes.

another trial of protected-weight bearing, observation without surgical intervention at this time, hip arthroplasty, and hip core decompression with subchondral bone support injection. The patient elected to undergo the hip core decompression with subchondral bone support injection as a first-line treatment, rather than continued non-weight bearing or THA. A hip preservation strategy was chosen in an attempt to maintain the patient's native cartilage.

At the time of surgery, the patient was positioned supine and placed under general anesthesia. Specialized decompression instruments were malleted through the lateral femoral cortex and into the femoral neck;

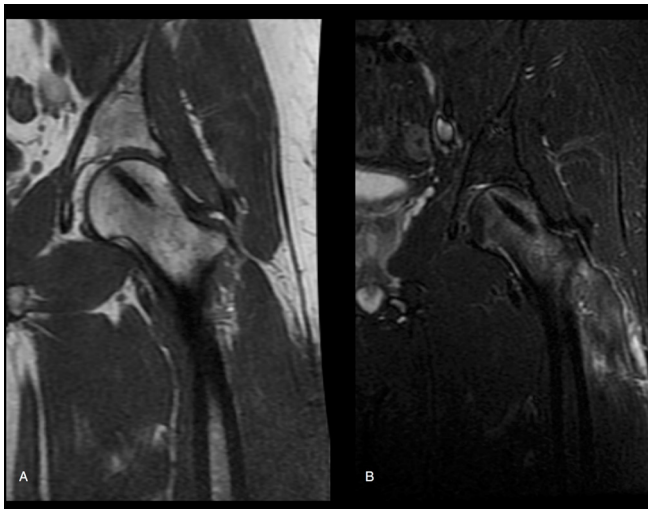

Figure 3. Post-operative coronal T1-weighted (A) and coronal STIR (B) magnetic resonance images at follow-up demonstrating resolution of the fracture and associated bone marrow edema. Evidence of prior decompression tract and bone cementation is still visible.

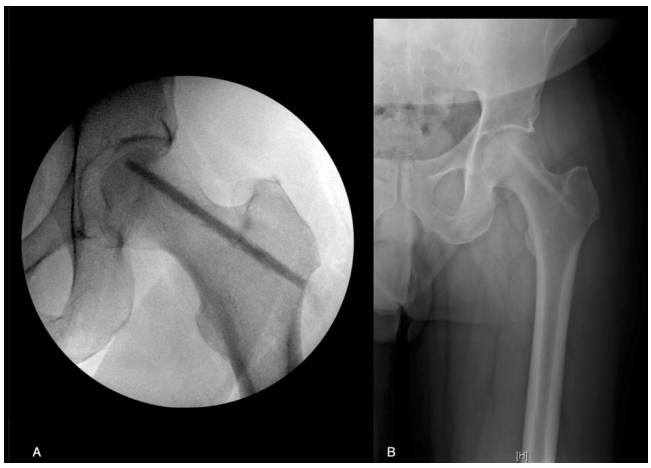

Figure 2. Intra-operative fluoroscopic anterior-posterior view (A) showing the core tract ending just below the area of insufficiency, in order to decompress the femoral head edema and to provide a subchondral raft of bone cement. An immediate post-operative anterior posterior plain radiograph (B) of the hip shows maintenance of the joint space and no immediate complication.

the precise location was guided by pre-operative three-dimensional advanced imaging studies and intra-operative fluoroscopic guidance. No power was used in order to avoid thermal necrosis to the bone. The technique and philosophy behind this treatment comes from management of osteonecrosis lesions using the PerFuse system (Biomet, Inc., Warsaw, IN). This involves the use of specialized 6 mm trochars which are malleted into the lesions using a manual technique to minimize any thermal damage associated with a high-speed drilling mechanism. This technique has been published widely for the treatment of osteonecrosis. The same trochars were used by the author to inject bone void filler substance into the area of subchondral insufficiency fracture. The mechanism of treatment is therefore subchondral support of the compromised bone to allow for adequate healing.

The instruments were then passed just inferior to the insufficiency fracture, leaving sufficient room so as to not violate the fracture zone. The instruments were confirmed to be in a subchondral rafting position using intra-operative fluoroscopy in multiple planes. A long needle was then used to inject 10cc of calcium sulfate and hydroxyapatite bone void filler (Cerament, Biomet, Inc., Warsaw, IN) into the core decompression path [Figure 2]. There was no evidence of femoral neck fracture or violation of the femoral head on intra-operative fluoroscopy.

Post-operative management

The patient was protected with 10kg-weight-bearing for four weeks post-operatively. At six weeks post-operative follow-up, the patient reported significantly improved left groin pain. Mild trochanteric bursitis had resolved by eight weeks post-operatively. Repeat T1-weighted MRI showed resolution of the low intensity band and no surrounding bone marrow edema [Figure 3]. The patient was allowed weight bearing without

Table 1. Summary of the SIFFH cases reported in the literature.

First Author	Year	N	Percent Male	Average Age (Range)	Clinical Presentation	Imaging Features	Conservative Treatment Failure Rate	Secondary Intervention for Failure
Bangil	1996	2	0%	74 (72-76)	*	Low intensity band on T1-weighted MRI with surrounding bone marrow edema	0/2 (0%)	n/a
Buttaro	2003	4	0%	70 (64-74)	*	Low intensity band on T1-weighted MRI with surrounding bone marrow edema	3/4 (75%)	THA
Fukui	2014	1	0%	71	*	Round cyst-like finding on T1-MRI	1/1 (100%)	THA
Iwasaki	2012	25	32%	57 (19-88)	*	Low intensity band on T1-weighted MRI with surrounding bone marrow edema	n/a	n/a
Miyanishi	2010	27	19%	72 (51-85)	*	Low intensity band on T1-weighted MRI with surrounding bone marrow edema	13/27 (48%)	THA
Yamamoto	2010	5	60%	23 (16-29)	*	Low intensity band on T1-weighted MRI	4/5 (80%)	Anterior trochanteric rotational osteotomy
Yamamoto	2014	39	36%	58 (16-84)	*	Low intensity band on T1-weighted MRI	15/39 (38%)	THA
Yoon	2014	31	16%	69 (53-90)	*	Low intensity band on T1-weighted MRI with surrounding bone marrow edema	15/31 (48%)	THA

* = Acute onset groin pain with no antecedent trauma
n/a = not available
THA = total hip arthroplasty

restrictions at eight weeks post-operatively based on no clinical symptoms. He had returned to full-duty work by twelve weeks post-operatively. At the latest follow-up of one and a half years, the patient had no pain in the left hip, and he had returned to all his prior recreational activities, including running, weight-lifting, and swimming.

Discussion

Femoral head insufficiency fracture was first closely described in 1996 as a condition usually secondary to osteoporosis or osteopenia without the presence of osteonecrosis (2,4). A review of the literature [Table 1] indicates that SIFFH usually manifests clinically as acute onset groin pain with no antecedent trauma, and with a characteristic low intensity band and bone marrow edema on T1-weighted MRI (1-5, 6-11). A recent study with over 7000 femoral heads showed that the incidence of SIFFH is 6.5% in patients with osteoporosis or osteopenia who had undergone THA. The average age for patients with SIFFH was 68 years, though there were many cases of much younger patients in their twenties (5). In addition, there have been several cases of SIFFH in patients after transplantation, suggesting a possible link (12).

SIFFH is clinically similar in presentation to transient

osteoporosis and osteonecrosis of the hip (13). Transient osteoporosis is a self-limiting condition affecting young patients (6). SIFFH usually presents with an irregular lesion convex to the articular surface on T1-weighted MRI, while osteonecrosis presents as a smooth lesion concave to the articular surface. On updated MRI imaging at our clinic prior to surgery, a subchondral fracture line was visible, without the other typical features of osteonecrosis. Therefore, the orthopedic and radiologist interpretation pre-operatively at our clinic was that of SIFFH. Additionally, patients with neither high corticosteroid intake nor excessive alcohol intake, such as the patient in this study, have an odds ratio of 56 for SIFFH compared to osteonecrosis (7).

The first treatment option for SIFFH is typically protected weight bearing therapy for an average of eight weeks. If this conservative treatment fails, the most commonly reported treatment option is THA [Table 1] (8). In most cases THA is effective in reducing pain (9). While this procedure may reduce joint pain and improve function, it necessitates removal of a sometimes otherwise unaffected joint, especially in the young patient without overt arthritis, in addition, this procedure increases the risk of blood loss and operative time (10). For young, active patients with preserved hip cartilage, less invasive procedures that preserve the natural hip joint would be welcome alternatives if proven effective.

In this case we used a core hip decompression and bone void filler technique to successfully treat a case of SIFFH in a young male. This procedure is less invasive than more common treatment methods such as THA and preserves the hip joint. In patient with no joint space narrowing and healthy articular cartilage, this novel technique may be a compelling treatment option.

Another alternative to THA proposed in the literature is an anterior trochanteric rotational osteotomy. This procedure rotates the femur to shift the weight bearing surface of the femoral head and to allow for healing of the insufficiency fracture. Four patients reported to have received this treatment improved from an average Harris Hip Score of 71 pre-operatively to 97 post-operatively (11). While we would consider trochanteric rotational osteotomy as perhaps another effective hip-preserving alternative to THA, osteotomy is a more invasive than the core decompression technique presented in this report.

The primary limitation of this paper is the single case presentation at short-term follow-up (1.5 years) with no direct comparison to other techniques, other than a trial of protected weight-bearing pre-operatively. Since this case was submitted for publication, other patients have been treated successfully with this technique. As with this index case, no patient was taken for surgical treatment unless they had failed an extensive course of non-surgical measures, including protected weight-bearing and rest. The subchondral insufficiency injuries had not healed with this non-surgical approach, and all patients had continued pain and dysfunction until this surgical treatment method was used to support the subchondral area of insufficiency. Moreover, a biopsy at the time of surgery might have informed more clearly a diagnosis of SIFFH, which as discussed previously may have an overlapping presentation with osteonecrosis. We submit that the ability to perform an adequate biopsy through the percutaneous incisions would be difficult, and might risk destabilizing the insufficient subchondral surface. We did not perform a biopsy at the time of the surgery for these reasons, and performed the retrograde backfilling of the lesion to provide mechanical support to the lesion under the presumed diagnosis of SIFFH. The differential diagnosis for this type of lesion certainly includes osteonecrosis. However, the patient had undergone multiple imaging studies prior to referral to our center. The imaging, including MRI studies, suggested more of an insufficiency pattern rather than an avascular lesion. The patient had no known risk factors for osteonecrosis. Between the patient's first MRI and the latest preoperative MRI study, there was clear definition of the subchondral insufficiency fracture injury to the femoral head with resolution of the initial femoral head edema. The area of subchondral insufficiency has healed on subsequent imaging, and the patient has no radiographic stigmata of osteonecrosis on any follow up examination.

SIFFH is an important clinical condition, and hip decompression with bone void filler rafting support is a novel, minimally invasive treatment that may be effective for young, active patients with preserved articular cartilage who do not respond to protected weight bearing regimens. It represents a possible joint-preserving alternative to THA in the carefully selected patient, and more data will elucidate the utility of this novel subchondral support technique.

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