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Multi-Site Insufficiency Pelvic Fracture Following Total Hip Arthroplasty

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Data Collection B
Statistical Analysis C
Data Interpretation D
Manuscript Preparation E
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Funds Collection G

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Conflict of interest: None declared

Patient: Female, 47-year-old
Final Diagnosis: Pelvic fracture
Symptoms: Hip pain
Medication: —
Clinical Procedure: —
Specialty: Orthopedics and Traumatology

Objective: Challenging differential diagnosis

Background: The indication of total hip arthroplasty (THA) has been increasing among older and more frail patients who possibly have suboptimal bone quality. Pelvic insufficiency fractures (PIF) are rarely observed after THA. The appropriate diagnosis of fracture location is crucial, but its symptoms are non-specific and radiographic abnormality is often subtle; thus, diagnosis can be challenging, particularly in case of concomitant fractures at multiple locations.

Case Report: A 47-year-old woman with rheumatoid arthritis and ongoing long-term oral corticosteroid therapy had groin pain in her left hip, which gradually developed without traumatic events 2.5 years after THA. Follow-up radiographs revealed an ipsilateral inferior pubic ramus fracture and a contralateral ischium fracture. The acetabular component of THA was slightly shifted upward, but further diagnostic examination was not conducted at that time. The pain was improved temporarily, but subsequently worsened and made her return to the clinic 6 months later, and radiographs revealed a medial wall fracture and superomedial migration of the acetabular component. She required a 2-stage revision procedure with massive allograft. At 1 year after these procedures, the patient is able to walk without a walking aid and does not report groin pain or present signs of dislocation, and radiographs show no loosening of the implant.

Conclusions: This case highlights that medial wall post-THA PIF can occur along with pubic/ischial fractures, which mask the symptoms of the medial wall fracture. We also reviewed the current literature and discussed the diagnostic strategy to be applied when suspecting this rare injury.

MeSH Keywords: Arthritis, Rheumatoid • Arthroplasty, Replacement, Hip • Fractures, Stress • Osteoporosis

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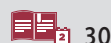
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Background

Total hip arthroplasty (THA) is an effective procedure to achieve pain relief and provide functional improvement for patients with various hip pathologies [1]. Because of the growing elderly population, the indication of THA has been increasing among older and more frail patients who possibly have sub-optimal bone quality [2,3]. Early postoperative acute hip pain following THA is rare if the implant is properly placed; however, it suggests a serious problem requiring immediate medical attention or reoperation. Common causes of post-THA hip pain include dislocation, infection, and periprosthetic fracture [4].

In the case of periprosthetic fractures, periprosthetic acetabular fractures are less common than periprosthetic femoral fractures [5–8]. However, complications around the acetabular component can have serious consequences in such patients. Acetabular over-reaming has been suggested as a risk factor for periprosthetic acetabular fractures [9].

Insufficiency fractures are a type of stress fracture that are defined as fractures caused by relatively low but repetitive stress on fragile bones [10]. Various classifications of PIF following THA based on their locations in the pelvis have been described [11–15]. These fractures commonly occur in the superior and inferior pubic ramus, the ischiopubic rami, or the ischium around the obturator foramen, which are usually treated nonoperatively. However, fractures around the acetabular component can lead to late loosening, which can have serious consequences and may require revision surgery if left untreated [10].

This article reports a case in which the acetabular medial wall was fractured due to excessive intraoperative reaming and in which bilateral pubic rami and ischiatic PIF occurred at the same time after THA. In this case, the acetabular medial wall fracture was initially missed due to concomitant fractures in the pelvis, eventually resulting in a complex revision surgery. We also present a review of the current literature and discuss the diagnostic strategy to be implemented when suspecting this rare injury combination.

Case Report

A 47-year-old woman with a 13-year history of mutilans-type rheumatoid arthritis and ongoing long-term oral corticosteroid and disease-modifying antirheumatic drug therapy presented at our institution. After being diagnosed with rheumatoid arthritis, she had taken vitamin D for the prevention of glucocorticoid-induced osteoporosis. Her lumbar spine bone mineral density was 0.998 g/cm², which corresponded to a T-score of >-1 SD. In addition, the patient had previously undergone



Figure 1. Radiography of anteroposterior pelvis revealing a narrow joint space at the bilateral hip joint.

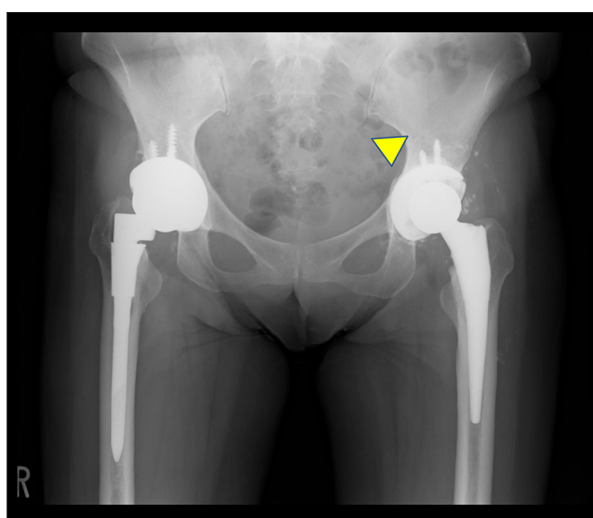


Figure 2. Anteroposterior pelvis following primary total hip arthroplasty. The acetabulum component was located medially due to over-reaming.

right wrist arthroplasty and bilateral total knee arthroplasties for joint lesions due to rheumatoid arthritis. Furthermore, she complained of gradually worsening bilateral groin pain (Figure 1). Right THA [PINNACLE (52 mm), DELTA (36 mm), S-ROM system (DePuy Orthopedics, Inc., Warsaw, IN, USA)] was performed, followed by left THA [R3/Reflection cup system (52 mm), Oxinium (32 mm), Anthology (Smith & Nephew, Memphis, TN, USA)] 5.5 years later, using the direct lateral approach by a well-experienced hip surgeon with 25 years' experience. During the second operation, no pelvic discontinuity was observed; however, on postoperative radiographs, the acetabular component was noted to be excessively medialized past the teardrop, likely secondary to over-reaming intraoperatively (Figure 2).

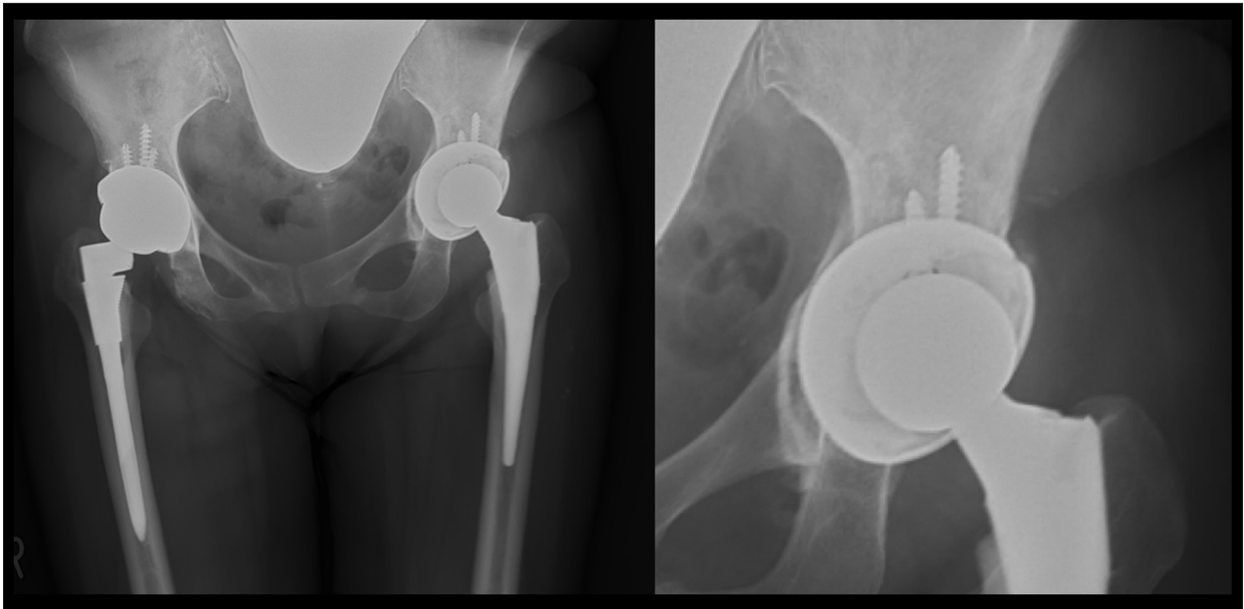


Figure 3. Anteroposterior pelvis after the onset of acute pain, showing mild superomedial migration.

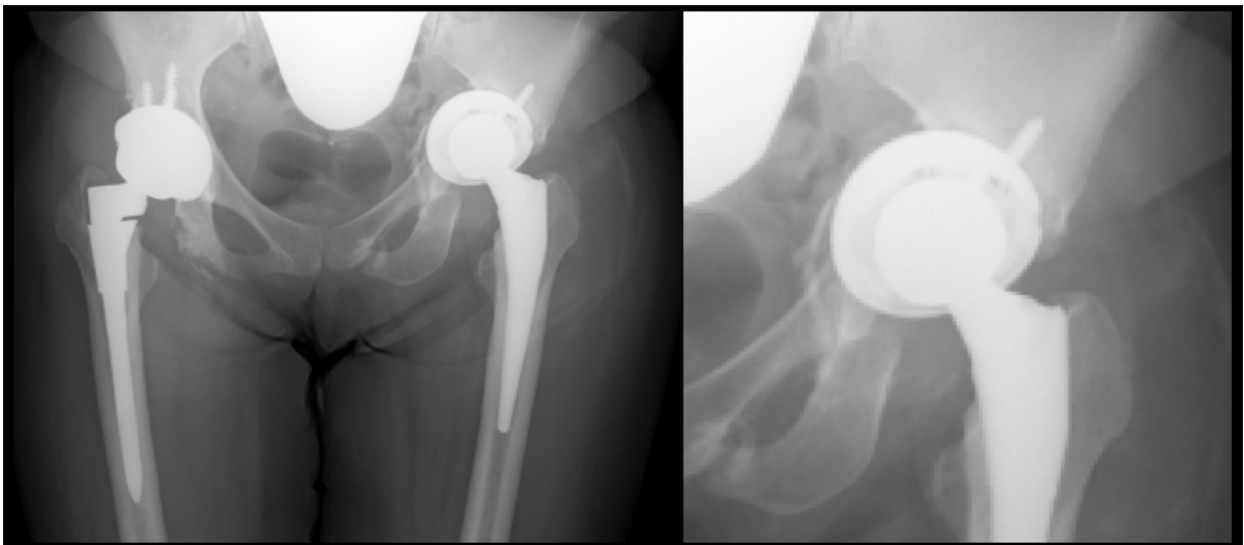


Figure 4. Radiography revealing a medial wall fracture and superomedial migration of the acetabular component.

According to our institutional protocol, the radiographs were taken at 1, 3, and 6 months postoperatively, and every 6 months thereafter. After being asymptomatic and with no radiological abnormality for 2.5 years after the second operation, the patient began to experience left groin pain. Follow-up radiography revealed a right ischium fracture and left inferior pubic ramus fracture. The left hip acetabular component showed proximal medial migration (Figure 3); however, this finding was missed, and no further diagnostic examination was conducted at that time. After 6 months, radiography revealed acetabular medial wall discontinuity, superomedial migration of the acetabular component, and circular hyperlucent image around the left hip joint, which was not observed 6 months

prior (Figure 4). Computed tomography (CT) at this time also revealed migration of the acetabular component and a well-circumscribed circular soft-tissue mass around the greater trochanter (Figures 5, 6). Magnetic resonance imaging (MRI) revealed a T1 low-/T2 high-intensity lesion. We suspected that the patient had complications from adverse reactions to metal debris (ARMD) (Figure 7). Blood test results revealed only a slight increase in erythrocyte sedimentation rate, and all other laboratory data were within the normal ranges.

She subsequently underwent 2-stage revision surgery with an 8-week interval between the stages because the cause of implant loosening was not confirmed at the time and concomitant

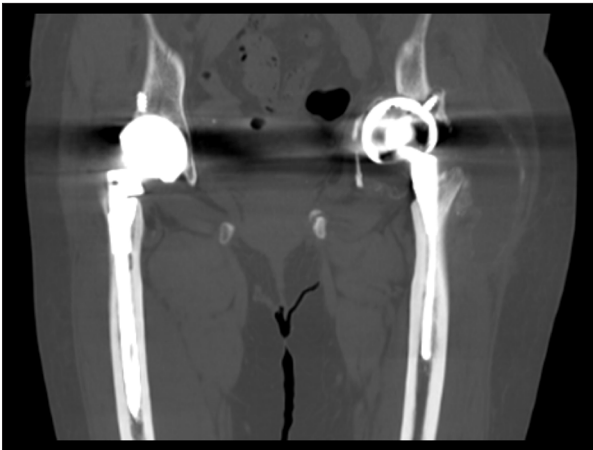


Figure 5. Coronal CT scan revealing destruction of medial wall with attendant superomedial component migration.

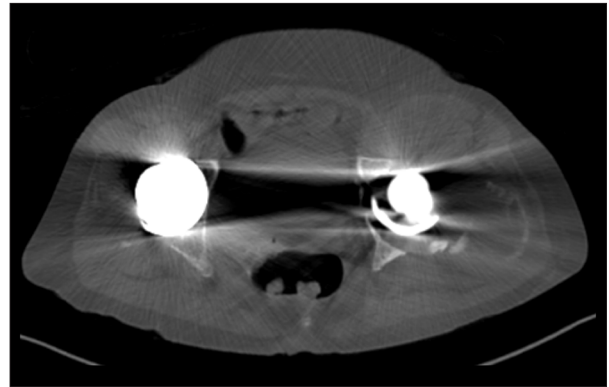


Figure 6. Axial CT revealing relative preservation of native medial wall.

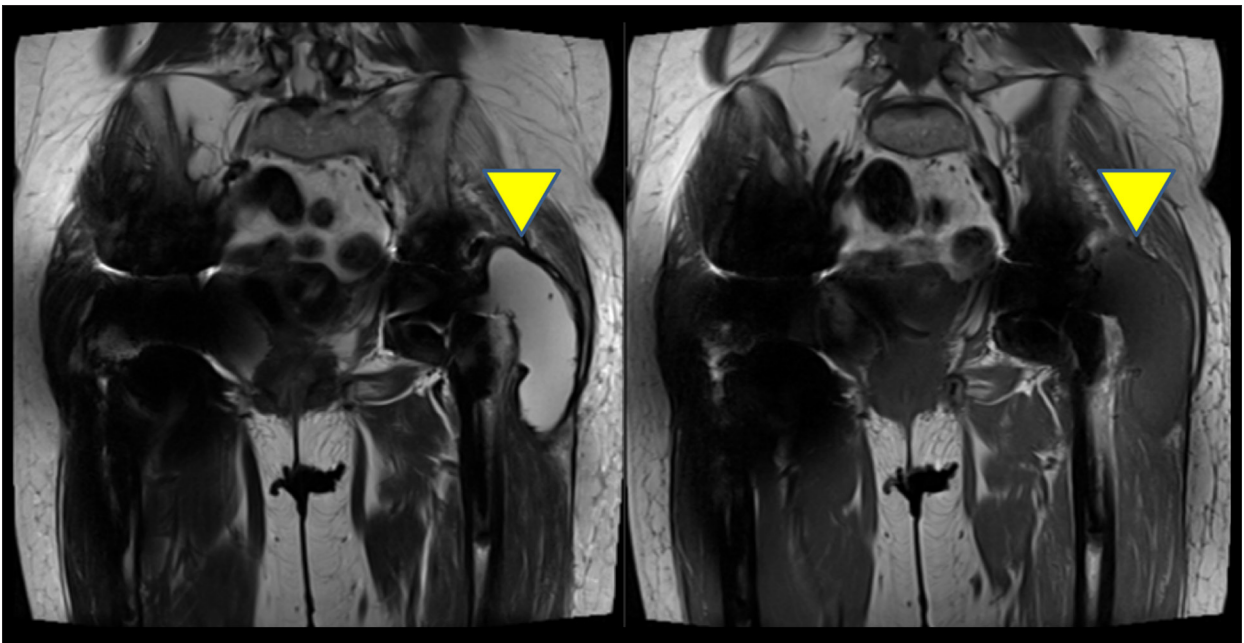


Figure 7. MRI revealing T1 low-/T2 high-intensity lesion around the left greater trochanter.

infection was not definitively excluded. Furthermore, owing to impaired bone status, there was a concern that implanting an acetabular cup on the fractured bone before obtaining enough stability might lead to a secondary displacement of the fixed fracture site. First, we removed the implant and performed internal fixation with a 3.5-mm reconstruction plate. Artificial bone grafts with antibiotics (amikacin) was implanted in the left hip joint (Figure 8). The acetabulum demonstrated American Academy of Orthopedic Surgeons (AAOS) type IV pelvic discontinuity [16]. The distal insertion of the gluteus medius and gluteus minimus was eroded away because of ARMD, and the femoral component had wear/damage at the base of the neck because of neck-cup impingement (Figure 9). Microbiological examinations of multiple tissue samples from the first procedure were

all negative. Furthermore, we performed the second stage of revision THA 8 weeks later [Modulus system, (Lima Corporate, Villanova di San Daniele del Friuli, Italy)] with Kerboul-type plate (KT plate, Kyocera Medical Corporation, Osaka, Japan) and a massive allograft using the posterior approach. Antibiotic (amikacin)-loaded acrylic cement was used for the acetabular reconstruction, and prophylactic cerclage cabling was performed on the femur. Microbiological examinations of all tissue samples and joint fluid obtained during this second stage were all negative. The patient started full weight bearing from 6 weeks after revision THA and was discharged home with a cane. At 1 year after these procedures, the patient is able to walk without use of a walking aid and does not report groin pain or present signs of dislocation (Figure 10).

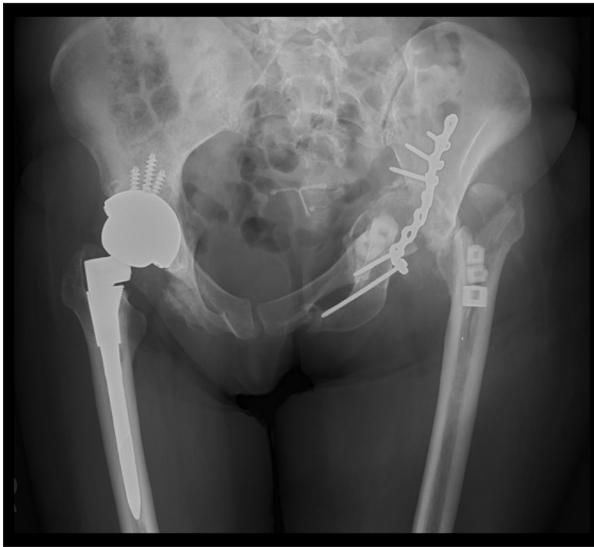


Figure 8. Anteroposterior pelvis after we removed the implant and performed internal fixation with a 3.5-mm reconstruction plate.

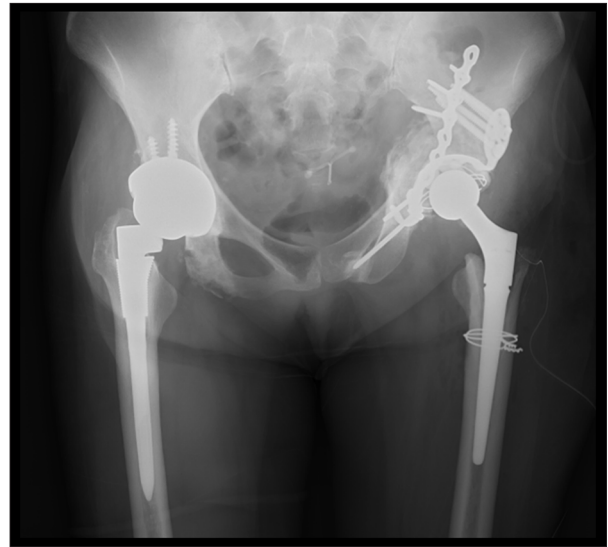


Figure 10. Radiography after revision surgery.

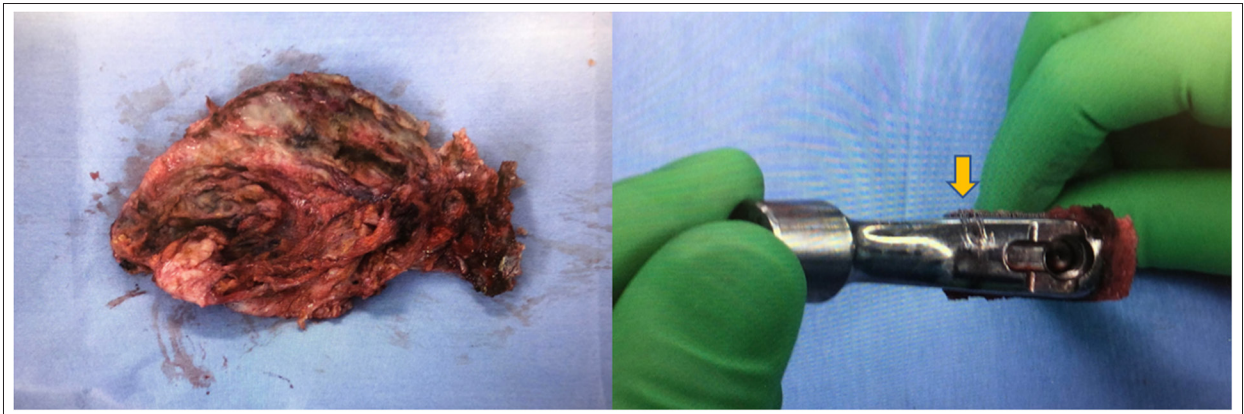


Figure 9. Pseudotumor removed during surgery. The neck of the femoral component displayed wear/damage.

Discussion

We speculated that the sequence of clinical events in this case was as follows: (1) the acetabulum was over-reamed, and the component was placed excessively medial during the primary THA; (2) a subsequent periprosthetic insufficiency fracture occurred concomitantly with other PIFs; (3) the diagnosis of the medial wall fracture was missed because of distraction by other fractures; and (4) the pelvic discontinuity was aggravated secondarily by ARMD because of the untreated instability of the acetabular component.

Regarding over-reaming, Takigami et al. [7] reported that inappropriate acetabular reaming causes pelvic “discontinuity.” The term “pelvic discontinuity” is associated with multiple causes and has been used in various ways. It is used to describe an intraoperative acute complication as the result of reaming or

component removal. It is also used for acute and chronic post-operative complications, such as acute periprosthetic fracture, as well as chronic conditions, such as debris-induced osteolysis, infection, or late migration of the socket. The AAOS classification is the most frequently used radiological classification for acetabular defects, defined by D’Antonio [16]. This AAOS classification is a descriptive classification of the severity and location of bone loss, and the AAOS type IV is considered the most severe type of pelvic discontinuity, in which the superior hemipelvis is completely disconnected from the inferior one. The possible causes of type IV discontinuity include periprosthetic acetabular fracture, bone loss, and a combination of both. In our patient, pelvic discontinuity possibly occurred due to a medial wall fracture predisposed by over-reaming.

Desai et al. [17] have reported 2 cases of early postoperative acetabular discontinuity following THA, which were similar to our

Table 1. Seven cases of acetabular medial wall fracture after total hip arthroplasty (THA).

Author	Age (years)	Sex	Underlining condition	Side	Time after index arthroplasty	Osteolysis	Loosening	Acetabular component	Revision surgery
Akinbo O (2017) [15]	72	M	Rheumatoid arthritis	Right	1 month	–	–	Uncemented	+
Kanaji A (2007) [14]	70	F	Osteoarthritis	Right	3 months	–	–	Cemented	–
	72	F	Osteoarthritis	Left	11 years	+	+	Cemented	+
	69	F	Osteoarthritis	Left	11 years	+	+	Cemented	+
Mahoney CR (2002) [19]	67	F	Osteoarthritis	Left	9 months	–	+	Uncemented	+
Andrews P (2002) [13]	70	F	Revision operation aseptic loosening of the femoral/acetabular component of previous THA	Left	1.5 months	–	+	Uncemented	–
Chato M (1998) [12]	75	F	Osteoarthritis	Right	12 years	+	+	Cemented	+

case. Both the cases described elderly women with osteoporosis who underwent THA (cementless acetabulum component). In 1 case, the acetabulum was reamed medially to the floor of the acetabulum, and a small defect in the medial wall was identified during surgery. Two weeks following THA, the patient experienced severe hip pain. Radiography revealed acetabular discontinuity with intrapelvic protrusion of the cup. Therefore, it is always important to avoid excessive medialized reaming during initial THA, and patients with excessively medialized cups should be closely monitored even if they are asymptomatic after the surgery or no discontinuity is observed during the primary surgery, given the risk of late fracture or aggravation.

Insufficiency fractures are usually a concern in the elderly population. Osteoporosis is the most significant predisposing factor for insufficiency fracture in general; however, advanced rheumatoid arthritis, radiation therapy, certain types of reconstructive surgeries, and metabolic diseases have also been reported as risk factors [18]. In our case, the diagnosis of insufficiency fracture was made on the basis of the history of illness, in which the fracture occurred without trauma in a female patient with rheumatoid arthritis and suspected bone fragility, which was most likely caused by long-term oral corticosteroid therapy. Insufficiency fractures also occur following THA and are more common in the pelvis than in the femur. Post-THA PIFs include various types of fractures at different locations. Such fractures are frequently observed in the superior and inferior pubic ramus, the ischiopubic rami, or the ischium around the obturator foramen. Although iatrogenic cases occur, such as our patient, post-THA PIFs in the medial wall of the acetabulum are rare.

Only 7 cases of insufficiency fracture in the medial wall of the acetabulum following THA have been reported in the literature (Table 1) [12–15,19]. In our case, excessive medialization at the initial THA was thought to have contributed to the fracture of the medial wall. However, the fragility of the medial wall due to osteoporosis might also have been a contributing factor for the insufficiency fracture. Based on treatment for periprosthetic acetabulum fracture, treatment choice depends on fracture site and implant stability. Fractures with a stable acetabular component can be treated nonoperatively. However, there is a very high possibility that these fractures will require operative treatment [5,20]. In fact, according to reports (Table 1), 71% (5/7) of cases needed revision surgery. Thus, prompt diagnosis is critically important. A delay in diagnosis can lead to severe destruction of arthroplasty components, followed by loss of bone and soft-tissue mass around the hip joint, which eventually requires extensive surgery because of ARMD [21–23]. The metal concentrations in the blood and/or local tissue are commonly used as a supplemental tool for ARMD diagnosis as well as monitoring systemic toxicity. However, we did not test the levels of metal in the blood samples and in the local tissue in this case since the testing is not our routine procedure for all revision cases due to resource utilization issues. The direct lateral approach in primary THA might have partially influenced the gluteus medius and minimus muscle disruption. However, during the revision surgery, the tendons of these muscles were disrupted much more extensively, and there was a large pseudotumor around the gluteus medius muscle that was discolored by metal debris; therefore, we considered that the ARMD was the main cause of the muscle disruption [24].

In our case, the symptoms of the medial wall acetabular fracture were masked by concomitant ramus/ischium fractures. In previous studies, CT and MRI were reportedly useful for identifying fracture lines that were not visible on radiography [18,25,26]. Mandell et al. [27] reported that in the clinical setting of suspected occult fracture, the sensitivity of clinical CT results for detecting pelvic fractures was 88%, the specificity was 98%, and the negative predictive value was 94%. Ross et al. [28] reported that MRI could detect pelvic fractures with a sensitivity of 92% and specificity of 98%. A retrospective comparison of MRI and CT in detecting PIFs showed that 128 (99%) of 129 fractures were identified using MRI and 89 (69%) of 129 were identified using CT [29]. However, it may be difficult to identify fractures by MRI due to the halation of the implant in post-THA cases [30]. Thus, along with a high index of suspicion and careful physical examination, frequent radiographic and clinical follow-up might be required for post-THA PIF cases, even if the fractures appear benign.

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Conclusions

In summary, this case illustrates that missed diagnosis of the medial wall fracture possibly caused the instability of the fracture, and early diagnosis and subsequent treatment could have avoided the following invasive surgery. As demonstrated in the present case, surgeons should have a high index of suspicion for PIFs in any patient with atraumatic groin pain after hip replacement, especially if predisposing factors such as osteoporosis/osteopenia or medialized acetabular components are present, even if obvious fractures are observed in other pelvic regions. In such suspected cases, CT and/or MRI, as well as frequent follow-up examinations, are suggested to obtain the correct diagnosis before serious complications occur.

Conflicts of interest

None.