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Easily missed nondisplaced fractures accompanying complete fractures in the lower extremity and pelvis: a narrative review

Young-Chang Park, MD

Department of Orthopedic Surgery, Severance Hospital, Yonsei University College of Medicine, Seoul, Korea

Nondisplaced fractures accompanying complete fractures are often difficult to detect on plain radiographs or computed tomography scans, posing a diagnostic challenge. The diagnosis of these frequently overlooked injuries can be delayed, potentially leading to suboptimal patient outcomes. This review discusses four commonly missed fracture patterns in the lower extremity and pelvis, including posterior involvement in fragility fractures of the pelvis, intertrochanteric extensions in isolated greater trochanter fractures, ipsilateral femoral neck fractures in high energy femoral shaft fractures, and posterior malleolar fractures in distal spiral tibial shaft fractures. An accurate diagnosis of these accompanying nondisplaced fractures is critical for optimizing surgical outcomes. Surgeons should incorporate thorough preoperative evaluations into their clinical practice to facilitate early detection and appropriate treatment strategies. Prompt identification and comprehensive management remain essential for improving patient outcomes.

Keywords: Bone fractures; Pelvis; Lower extremity; Diagnostic imaging; Magnetic resonance imaging

Review Article

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Correspondence to:
Young-Chang Park, MD
Department of Orthopedic Surgery, Severance Hospital, Yonsei University College of Medicine, 50-1 Yonsei-ro, Seodaemun-gu, Seoul 03722, Korea
Tel: +82-2-2228-2189
Email: yc4508@yuhs.ac

Introduction

The successful management of fractures relies on multiple factors, with accurate diagnosis and thorough evaluation forming the cornerstone of effective treatment planning. The diagnostic process typically includes a detailed patient history, physical examination, plain radiographs, and computed tomography (CT) scans of the affected area. Despite these assessments, missed diagnoses remain a significant challenge in clinical practice, particularly in the case of nondisplaced fractures accompanying complete fractures.

Nondisplaced or occult fractures present unique diagnostic challenges, as incomplete fracture lines can be difficult to identify, even with CT imaging. Advanced imaging modalities, such as magnetic resonance imaging (MRI) or bone scintigraphy, are generally more effective in detecting these fractures, making their inclusion an important consideration in selected cases. The presence of an accompanying nondisplaced fracture alongside a complete fracture adds complexity to clinical evaluations and increases the risk of misdiagnosis. Delayed recognition of these fractures can significantly affect postoperative outcomes.

This review highlights four commonly overlooked fracture patterns in the lower extremity and pelvis, emphasizing the diagnostic challenges and discussing strategies for optimal management.

Fragility Fracture of the Pelvis Type I: Posterior Involvement

Fragility fractures of the pelvis (FFP) are commonly associated with low energy trauma in older adults, and their incidence continues to rise with the aging population [1,2]. In 2013, Rommens and Hofmann [1] introduced a comprehensive classification system for FFP, which remains widely utilized. This system categorizes FFP into four types: type I involves anterior lesions only; type II includes nondisplaced posterior lesions; type III involves displaced posterior lesions; and type IV features bilateral displaced posterior lesions. Typically, type I and type II fractures are managed nonsurgically, whereas type III and IV fractures require surgical intervention, provided the patient's overall condition permits [2-4].

Among the subtypes, FFP type II fractures are the most prevalent and are generally considered stable fractures [1]. These fractures are often successfully treated with conservative measures, including pain management and physiotherapy, allowing weight bearing as tolerated. However, surgical intervention should be considered if patients experience significant pain that prevents ambulation within several days [5]. Recent studies suggest that early surgical intervention, particularly percutaneous fixation, can alleviate pain, promote early mobilization, and enhance overall outcomes in type II fractures [3,5-8]. However, postoperative complications should also be carefully considered in elderly patients [9-12].

Radiographic assessment of FFP typically involves plain radiographs and CT imaging. However, nondisplaced sacral fractures, often involving osteoporotic cancellous bone, are difficult to identify with these modalities and are frequently overlooked [3,13]. Fractures initially classified as type I (anterior lesions only) are often reclassified as type II upon further evaluation with advanced imaging techniques such as MRI (Fig. 1). At our institution, MRI is considered for cases involving ambiguous sacral buckling, localized posterior pain during mobility, or significant difficulty walking due to pain after approximately 1 week of weight bearing as tolerated with a walker. Scheyerer et al. [14] reported that 96.8% of elderly patients with pubic rami fractures also had posterior lesions. Subtle findings, such as sacral buckling, may be more clearly visible on coronal CT images, aiding in diagnosis (Fig. 2). However, in patients with severe degenerative changes, bony spurs can mimic subtle buckling, complicating differentiation. Bilateral comparison of imaging findings can assist in resolving such ambiguities.

Given the structural integrity of the pelvic ring, anterior fractures, such as ramus fracture, often suggest the possibility of associated injuries to the posterior pelvic lesion. Therefore, clinicians should maintain a high index of suspicion for posterior pelvic lesions, particularly in FFP type I cases. Close monitoring and further evaluation, when warranted, are essential for accurate diagnosis and optimal management.

Isolated Greater Trochanteric Fracture: Intertrochanteric Extension

Isolated greater trochanteric (GT) fractures are among

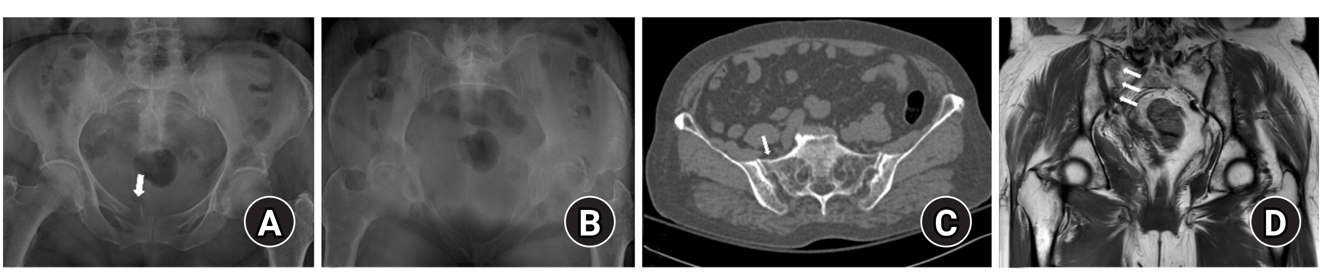

Fig. 1. A 78-year-old female patient with a fragility fracture of the pelvis due to a slip down injury. (A, B) Plain radiographs (anteroposterior and outlet views) show fractures of the right superior and inferior rami (arrow). (C) According to the Rommens classification, the fracture is categorized as type I based on a computed tomography evaluation, as no definite posterior involvement is observed; however, there is a suggestion of subtle buckling in the right sacral ala (arrow). (D) T1-weighted axial magnetic resonance imaging reveals posterior involvement (arrows), reclassifying the fracture from type I to type II.

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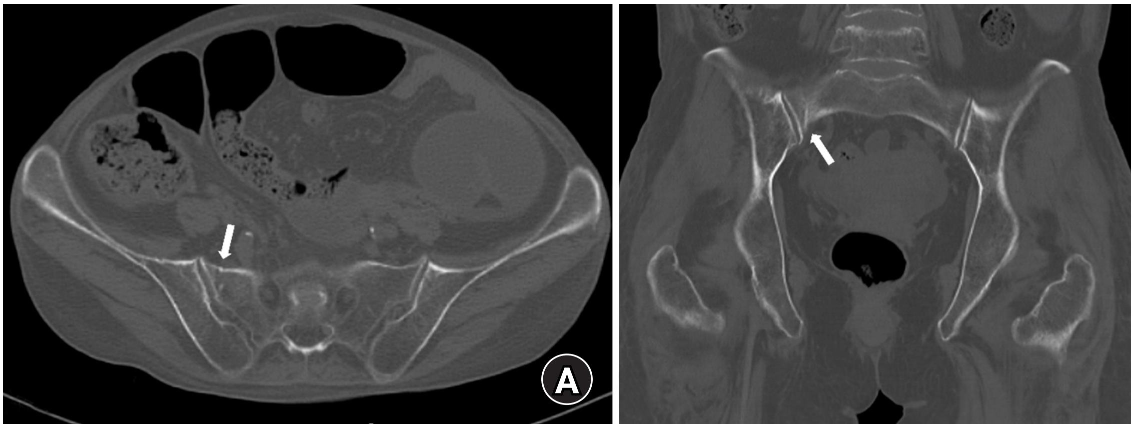

Fig. 2. Subtle buckling of the sacral ala. (A, B) Subtle buckling (arrows) is more clearly detected on coronal computed tomography images than on axial images.

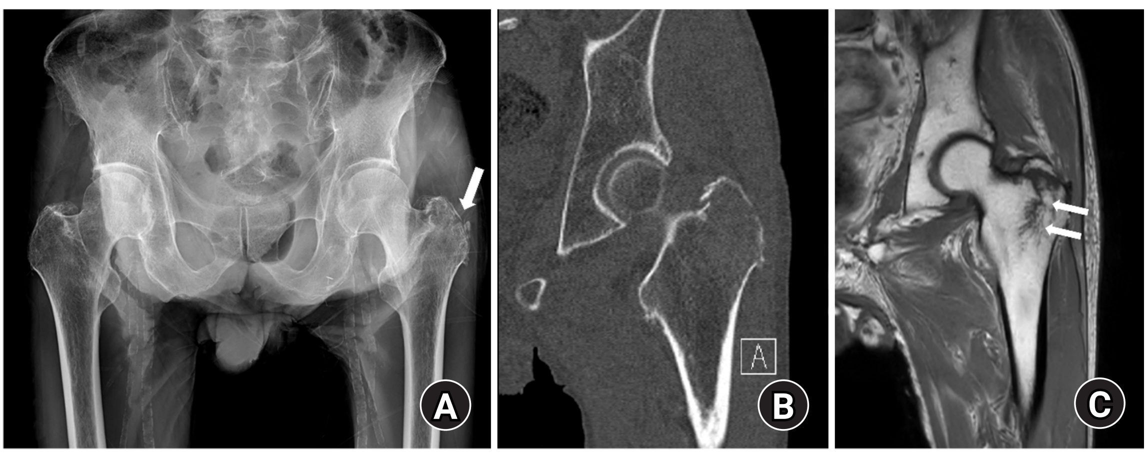

Fig. 3. A 78-year-old male patient with a greater trochanteric fracture due to a slip down injury. (A) A plain radiograph shows a left greater trochanteric fracture (arrow). (B) A computed tomography scan shows no specific findings. (C) T1-weighted midcoronal magnetic resonance imaging reveals intertrochanteric extension involving approximately 50% of the intertrochanteric line (arrows).

the rarest types of hip fractures and are typically managed with conservative treatment [15-18]. However, studies have shown that many fractures initially diagnosed as isolated GT fractures actually involve undetected intertrochanteric (IT) extension [17-20]. MRI is considered the gold standard for diagnosing IT extension, providing a more accurate assessment of the fracture and facilitating precise treatment planning (Fig. 3) [21-25] .

MRI not only enables the detection of IT extension but also helps determine its extent, allowing for the development of tailored treatment strategies. Arshad et al. [26] reported that fractures involving less than 50% of the IT line and forming an angle of 35°–42° relative to the vertical medial cortex were unlikely to progress to complete fractures. Park et al. [27] proposed using coronal T1-weighted MRI to divide the femoral canal at the lesser trochanter's upper level into thirds. Nonsurgical management was found effective for fractures confined to the lateral two-thirds, while surgical intervention was recommended for those involving the medial one-third or the medial cortex. Similarly, Kent et al. [28] supported nonsurgical management for fractures involving less than 50% of the IT line.

Currently, there is no definitive consensus on the surgical indications for isolated GT fractures, and the relative effectiveness of surgical versus nonsurgical treatment remains uncertain. Several studies highlight the use of institution-specific protocols to guide treatment decisions, with surgery being recommended primarily for high-risk patients based on arbitrarily defined criteria [26-30]. In Severance Hospital, conservative management is pursued for cases where neither the anterior nor medial cortex is involved. This approach includes pain management, hip range of motion exercises, and ambulation with weight bearing as tolerated. However, if conservative management proves intolerable, surgical treatment is considered to facilitate early ambulation. Patients managed nonoperatively are also informed about the potential risk of progression to a complete fracture.

MRI assessment of IT extension is invaluable in cases of isolated GT fractures initially diagnosed on plain radiographs. By identifying candidates for nonsurgical treatment, this approach supports more informed discussions with patients and enables individualized treatment planning tailored to fracture severity and patient needs.

High Energy Femoral Shaft Fracture: Ipsilateral Femoral Neck Fracture

Ipsilateral femoral neck fractures occur in approximately 9% of femoral shaft fractures [31-33]. Due to their nondisplaced nature, these fractures are challenging to detect, with 19%–55% remaining undiagnosed on plain radiographs, often resulting in delayed diagnoses [34,35]. Yang et al. [34] reported a detection rate of 63% for occult fractures using CT, while Tornetta et al. [36] introduced a protocol combining preoperative fine cut CT and immediate postoperative radiographs, reducing delayed diagnoses by 91%. Despite these efforts, the sensitivity of CT for detecting occult femoral neck fractures remains limited, ranging from 64% to 82% [37,38].

Alternative diagnostic and treatment approaches have been proposed to address this challenge. Routine fixation of the femoral neck during reconstruction nailing is one option; however, this method is associated with increased operative time, greater radiation exposure, and limited cost effectiveness [35]. Rogers et al. [39] highlighted the utility of rapid limited-sequence MRI, which detected occult femoral neck fractures in 12.1% of CT-negative cases. Park et al. [40,41] introduced the "CT capsular sign" as an indirect indicator of femoral neck fractures on abdomino-pelvic CT scans in trauma patients. This sign, characterized by capsular bulging due to lipohemarthrosis within the hip capsule, demonstrated 100% sensitivity for ruling out femoral neck fractures. Based on these findings, a protocol was proposed to perform preoperative MRI or prophylactic femoral neck fixation with reconstruction nailing when the CT capsular sign is positive (Fig. 4).

Delayed diagnosis of ipsilateral femoral neck fractures in the context of femoral shaft fractures can have devastating consequences, including unplanned surgeries, osteonecrosis, and nonunion [42,43]. For this reason, patients with high energy femoral shaft fractures require a heightened index of suspicion for associated femoral neck fractures. Thorough preoperative evaluation with X-rays and CT scans, including assessment for CT capsular signs, is essential. Advanced imaging modalities such as MRI should be selectively employed in cases where initial evaluations are inconclusive. Additionally, intraoperative or immediate postoperative internal rotation views should be obtained with the femur stabilized to minimize the risk of missed diagnoses. Incorporating these findings into diagnostic protocols may improve the detection and management of ipsilateral femoral neck fractures in high energy femoral shaft fractures.

Distal Spiral Tibial Shaft Fracture: Posterior Malleolar Fracture

Distal spiral tibial shaft fractures are relatively common in clinical practice and are frequently associated with posterior malleolar fractures, which occur in more than 90% of cases [44,45]. Previous studies have identified two key predictors of associated posterior malleolar fractures: a fracture obliquity angle greater than 45° and fracture extension into the distal one-third of the tibia [46,47]. Hou et al. [44] reported that a communication line between the main spiral fracture and the posterior malleolar fracture was identifiable in 92.1% of cases through detailed analysis of CT axial images.

Management of distal spiral tibial shaft fractures with concurrent posterior malleolar fractures can be achieved using either plating or nailing techniques. While plating is generally effective, nailing is often preferred in cases with soft tissue concerns or when the spiral fracture line is located at a higher level. When tibial nailing is planned, stabilizing the posterior malleolar fracture with percutaneous fixation beforehand is recommended, as intraoperative displacement of the posterior malleolar fracture has been

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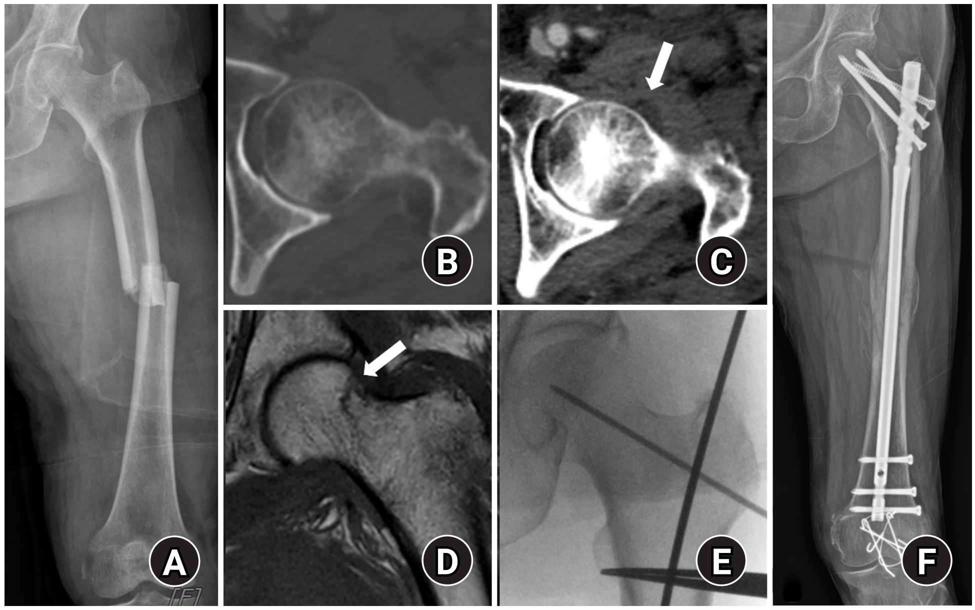

Fig. 4. A 70-year-old female patient with a femoral shaft fracture due to a motor vehicle accident. (A) Initial anteroposterior radiograph. (B, C) A preoperative bone-window computed tomography (CT) scan shows no femoral neck fracture; however, the soft-tissue-window CT scan reveals a positive CT capsular sign with lipohemarthrosis (arrow). (D) T1-weighted coronal magnetic resonance imaging reveals an incomplete ipsilateral femoral neck fracture (arrow). (E) An anterior provisional pin was inserted before nailing to prevent femoral neck displacement. (F) Uneventful bone healing was achieved at 10 months postoperatively.

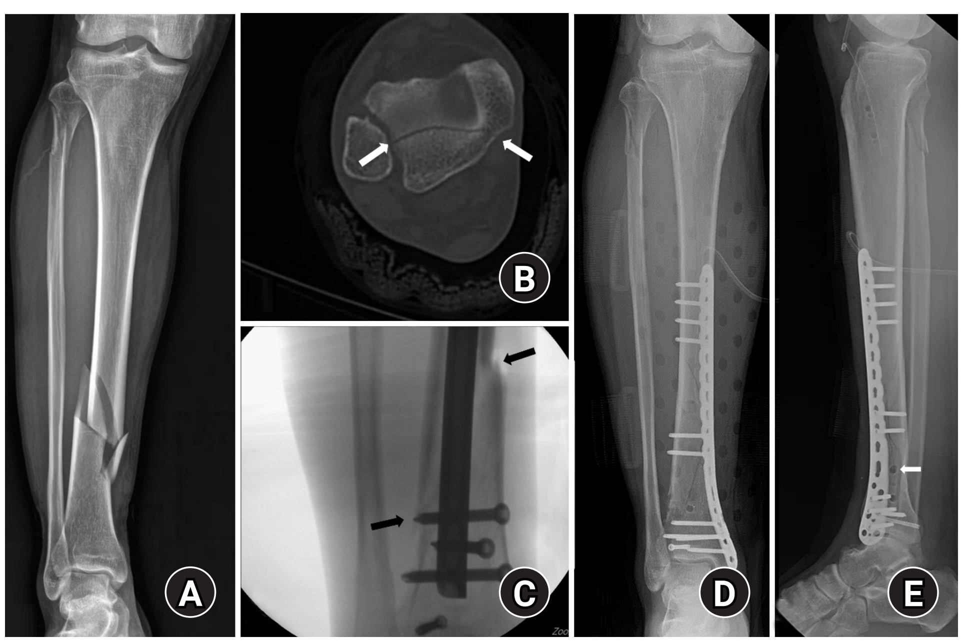

Fig. 5. A 52-year-old male patient with a distal spiral tibial shaft fracture and an associated posterior malleolar fracture. (A) Initial anteroposterior radiograph. (B) A preoperative computed tomography scan reveals the posterior malleolar fracture (arrows) with a communication line between the tibial shaft and the posterior malleolar fractures. (C) An intraoperative fluoroscopic image shows fracture displacement (arrows) after distal interlocking screws were placed, resulting in unstable fixation. Percutaneous fixation of the posterior malleolar fracture was performed prior to nailing. (D, E) Intraoperatively, nail removal and plate conversion were performed. Postoperative radiographs confirm the placement of the distal interlocking screw through the communication line (arrow).

observed in approximately 31% of cases during nailing procedures [48].

Special caution is required during distal interlocking fixation in tibial nailing, as inserting screws through the communication line may lead to malreduction or instability of the tibial fracture (Fig. 5). This highlights the critical importance of meticulous preoperative planning and precise intraoperative technique to optimize outcomes and minimize complications.

Conclusions

Nondisplaced fractures accompanying complete fractures in the lower extremity and pelvis frequently escape detection on conventional imaging, resulting in delayed diagnoses and suboptimal outcomes. In FFP, clinicians should remain vigilant for posterior lesions and ensure close monitoring. GT fractures require evaluation for IT extensions with mandatory MRI. High energy femoral shaft fractures demand assessment for ipsilateral femoral neck fractures, with the CT capsular sign serving as a valuable diagnostic tool. Distal tibial spiral fractures necessitate careful evaluation for posterior malleolar fractures and communication lines. Recognizing these easily overlooked injuries and implementing standardized clinical protocols that incorporate targeted diagnostic approaches is crucial. Early detection through comprehensive evaluation and individualized management strategies is essential for optimizing surgical outcomes and enhancing patient care.

Article Information

Author contributions

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Conflict of interest

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Data availability

Not applicable.

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