

Occult fractures around the hip

Hip fractures occur within the area extending between the proximal edge of the femoral head and 5 cm distal to the lesser trochanter. Hip fractures have an incidence of over 70 000 per annum in the UK and carry significant health, social and financial burdens (British Orthopaedic Association, 2007). With an increasing elderly population, the annual rate of hip fractures is predicted to exceed 100 000 by 2020 (National Institute for Health and Care Excellence, 2014).

Optimal hip fracture management involves coordinated multidisciplinary care, timely surgical intervention and early mobilization (British Orthopaedic Association, 2007; National Institute for Health and Care Excellence, 2014). Any delay in establishing a diagnosis and treatment is associated with an increased risk of avascular necrosis of the femoral head, non-union, thromboembolic events and unnecessary pain (Parker, 1992; Marottoli et al, 1994). Furthermore, a delay in treatment exceeding 48 hours, in a patient with controlled comorbidities, doubles the 1-year mortality risk (Zuckerman et al, 1995).

For this review describing ‘occult fractures around the hip’, both the proximal femur and acetabulum will be included.

What is an ‘occult’ hip fracture and why is it important to be aware of it?

Not all hip fractures are clinically or radiographically obvious. Those not detectable on standard radiographic imaging performed in the accident and emergency department are termed occult. The prevalence of occult hip fractures has been reported to be between 0.7 and 2.7% of all hip fractures that present to accident and emergency (Rehman et al, 2016; Pejic et al, 2017).

Undetected fractures can initially be labelled as ‘soft tissue injuries’, leading patients to be treated non-operatively and instructed to weight bear as comfort allows. This error in diagnosis produces inappropriate management decisions that can result in unnecessary pain and possible morbidity. For example, if a patient with an undisplaced occult fracture is permitted to weight bear, the fracture could displace, reducing the available treatment options. Owing to the serious consequences of misdiagnosing occult hip fractures, it is perhaps unsurprising that missing such fractures frequently leads to lawsuits against emergency physicians (Perron et al, 2002).

Anatomy

The anatomical region of this review includes both the acetabulum and proximal femur. The reader should be familiar with the anatomy and the baseline radiographic assessments routinely performed when a patient presents to accident and emergency (O’Regan et al, 2006; Kiu and Khan, 2010). Peri-acetabular fractures can be classified using the Judet–Letournel classification, with isolated or combined fractures of the anterior and/or posterior columns and anterior and/or posterior walls (Judet et al, 1964). Proximal femoral fractures are classified as being either intracapsular (subcapital, transcervical, basicervical)

or extracapsular (intertrochanteric, subtrochanteric). Isolated fractures of the greater or lesser trochanter can also be encountered.

Both the acetabulum and the proximal femur are particularly vulnerable to occult fractures because of the high percentage of trabecular bone present; disruption of trabecular bone, especially when already diminished in the setting of osteopenia or osteoporosis, is more difficult to detect than disruption of cortical bone (Lee et al, 2004). This is particularly the case in the proximal femur as the trabeculae are arranged in different patterns.

Occult fractures around the hip are more likely to involve the proximal femur (60%) than the acetabular region (40%) (*Case study 1*) (Pejic et al, 2017). Most proximal femur fractures are likely to involve the trochanteric (*Case study 2*), followed by the subcapital regions (*Case study 3*) (Rehman et al, 2016; Pejic et al, 2017). Occult acetabular fractures often involve the pubic ramus or have a mixed pattern of injury (Pejic et al, 2017).

Presentation

Occult hip fractures have been reported in both adults and children. However, occult fractures most commonly occur in the elderly. The clinical presentation of an occult hip fracture can be similar to that of patients with radiographically identifiable neck of femur fractures.

Typically, patients with occult hip fractures present with an acute inability to weight bear following a fall from standing height (low-energy trauma). These patients are likely to be aged 70 years or above, have a history of osteopenia or osteoporosis, and may have a history of previous falls. The circumstances surrounding the fall should be elicited to determine if any underlying cardiac, neurological, metabolic or other conditions were responsible. If the patient has a history of low bone density, his/her previous treatment should be documented. Lastly, the patient’s pre-injury mobility

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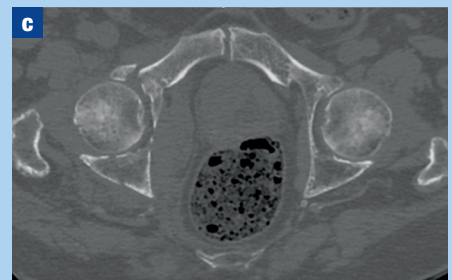
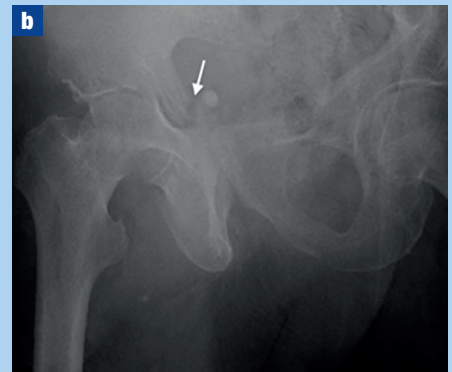
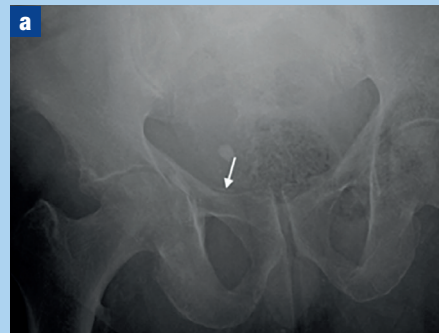
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CASE STUDY 1

A 71-year-old woman presented to the accident and emergency department after slipping on an icy road, with pain over her right buttock and difficulty walking on her right side. She was able to actively straight leg raise with difficulty, denied right pain with passive rotation, but reported right buttock pain with axial loading of the lower extremity. An anteroposterior radiograph of the pelvis (*Figure 1a*) revealed no obvious fracture in the proximal femur, but a linear cortical density was noted along the iliopectineal line (white arrow). Judet view of the right acetabulum revealed evidence of a posterior column fracture with extension into the weight-bearing dome (*Figure 1b*), which was further confirmed with a computed tomography scan (*Figure 1c*). Careful retrospective review of the anteroposterior pelvis demonstrates medialization of the right femoral head and over-coverage of the femoral head, consistent with a probable acetabular fracture. The patient was admitted to orthopaedics and underwent internal fixation of the acetabulum.

Figure 1. a. Anteroposterior radiograph demonstrates disruption of the medial right acetabular wall with loss of the normal 'tear-drop' configuration, cortical thickening of the anterior column and a cortical fragment adjacent to the superior pubic ramus (arrow). **b.** Corresponding (iliac oblique) Judet view clearly illustrates the medial acetabular fracture with intra-articular extension (arrow). **c.** Axial computed tomography image through acetabulum clearly illustrates fracture.



status, place of residence and social support should be reviewed.

One must always beware of atypical clinical presentations. Young patients presenting with hip fractures could have underlying osteopenia and subsequently present with a stress fracture secondary to a variety of conditions that should be evaluated (e.g. vitamin D deficiency, rickets, anorexia, or functional anorexia (diet in addition to excessive exercise)). Elderly patients with extreme osteopenia may present without a history of trauma. Patients on bisphosphonate therapies can present with atypical femur fractures (Koh et al, 2017), as the long-term use of bisphosphonates carries a risk of severe suppression of bone turnover, impairing bone remodelling.

The fractures are most commonly located along the proximal femoral diaphysis between the subtrochanteric region and the diaphysis just proximal of the supracondylar flare. Prophylactic intra-medullary nailing is the first line of treatment for complete and impending fracture fractures. Non-operative measures in asymptomatic patients with an impending fracture carry a high failure rate. In all patients with atypical fractures secondary to bisphosphonate use, radiographs of the contralateral side should be obtained routinely and carefully scrutinized (*Case study 4*).

Clinical examination

It is possible for a patient with an occult hip fracture to have a normal hip examination.

Therefore a high index of suspicion is prudent, especially if the history is consistent with such possibility and the aforementioned

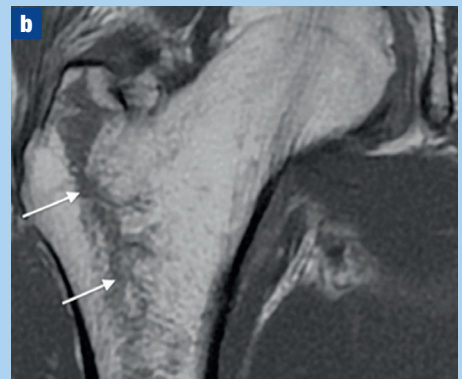
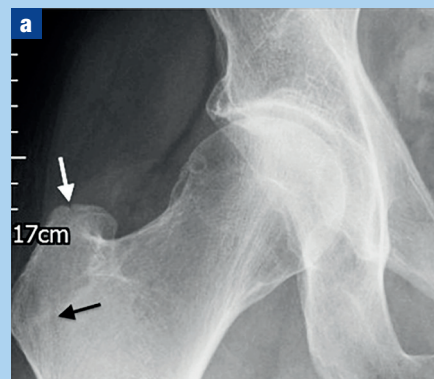
CASE STUDY 2

A 67-year-old woman presented to the emergency department with pain in her right hip after falling while jogging in a park. Her past medical history was significant for hypertension and she had never undergone bone mineral density testing. On physical examination, the patient could limp on her right leg, but had too much pain to actively perform a right straight leg raise. She had point tenderness on palpation

of her greater trochanter, but denied pain with passive hip motion.

Plain radiographs (*Figure 2a*) demonstrated a radiolucent defect at the tip of the trochanter, but no obvious fracture line or displacement. As a result of clinical suspicion, magnetic resonance imaging was ordered which revealed a non-displaced intertrochanteric fracture (*Figure 2b*).

Figure 2. a. Anteroposterior hip radiograph shows subtle disruption of the right greater trochanteric cortex (white arrow) and possible lucent line crossing the intertrochanteric bone (black arrow). **b.** Coronal STIR and coronal T1-weighted magnetic resonance images more clearly demonstrate bone the undisplaced right intertrochanteric fracture (arrows).

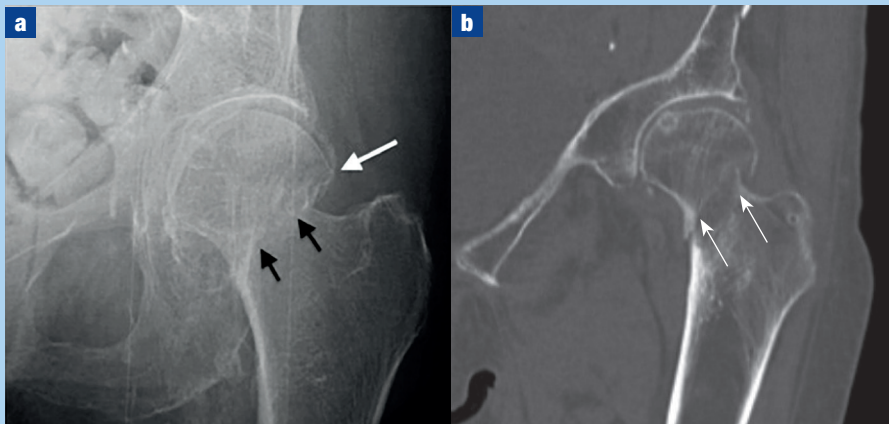


CASE STUDY 3

A 91-year-old woman with a past medical history of osteoporosis, hypothyroidism and breast cancer presented to the emergency department after falling from a chair. She normally used a walker to ambulate but refused to bear weight on her left leg following the fall. On physical examination, the patient could not straight leg raise and had hip pain with internal rotation.

Radiographs (*Figure 3a*) demonstrated marked osteopenia of the proximal femur, a double shadow along the lateral femoral head, but no obvious fracture. A subsequent computed tomography scan (*Figure 3b*) showed a valgus impacted femoral neck fracture with malrotation. The patient was admitted to orthopaedics and underwent expedited surgical management.

Figure 3. a. Antero-posterior plain radiograph demonstrates buckling of the left femoral cortical margin (white arrow), loss of alignment of the femoral head and the femoral head–neck junction with disruption of the smooth reversed S curve. Transverse sclerosis across the femoral neck (black arrow) interrupting the normal trabecular pattern is indicative of an impacted fracture. **b.** Corresponding coronal computed tomography reformat confirms a mildly impacted and displaced left intracapsular femoral fracture (arrows).



risk factors are present. In addition, the presence of dementia, intoxication, other injuries or neurological compromise may further compromise the ability to elicit positive findings on exam.

Most series on occult hip fractures describe patients who self-discharged from the hospital while being fully ambulatory. Although the patient is highly likely not to be able to weight bear, this is not 100% sensitive. Most patients will have pain on axial loading (sensitivity 76%) (Hossain et al, 2007). Similarly, there will be pain on range of movement assessments including internal or external rotation manoeuvres (sensitivity 70%) and an inability to straight leg raise (sensitivity 50%) (Hossain et al, 2007). Other findings may include pain on palpation over the groin area.

Despite the low documented sensitivity, the authors believe that the straight leg raise test should be an integral assessment tool for all patients who may have an occult hip fracture.

Imaging required

Routine anteroposterior and lateral radiographs of the pelvis and affected hip should be scrutinized for the presence of a fracture using a systematic approach (O'Regan et al, 2006; Kiu and Khan, 2010).

CASE STUDY 4

An 82-year-old woman with a 12-year history of osteoporosis treated with bisphosphonates presented to the accident and emergency department with a displaced right femoral neck fracture (*Figure 4a*) that underwent surgical fixation (*Figure 4b*). The patient then presented to the accident and emergency department 9 months later with acute left thigh pain and an

obvious bony deformity in the proximal femur. The patient denied any trauma or fall before the onset of the left thigh pain.

Radiographs showed a displaced transverse fracture in the subtrochanteric region with evident cortical remodelling at the fracture site (*Figure 4c*). Review of previous radiographs (*Figure 4a, b*) revealed progressive

subtrochanteric cortical thickening and periosteal stress response, a pathognomonic finding of a bisphosphonate-related fracture. Further history elucidated a 4-month history of progressive discomfort in the left hip. The patient was admitted to orthopaedics and underwent surgical fixation with a cephalomedullary nail.

Figure 4. a. Anteroposterior pelvic radiograph in a patient on bisphosphonates demonstrates an impacted right intracapsular fracture with resultant femoral shortening. There is subtle focal cortical thickening of the left lateral subtrochanteric femur (arrow), an indicator of atypical femoral fractures in long-term bisphosphonate users. **b.** Anteroposterior pelvic radiograph in the same patient 6 months later demonstrates a right hemiarthroplasty and progression of the left lateral subtrochanteric femoral cortical thickening and periosteal stress response (arrow). **c.** Anteroposterior radiograph in the same patient following minimal trauma 9 months later shows that the atypical femoral fracture has progressed to a complete non-comminuted transverse fracture, a typical appearance and location of bisphosphonate fracture.



“ Magnetic resonance imaging is the best imaging modality to detect an occult hip fracture. ”

Careful assessment of the femoral head alignment (varus or valgus) is required to avoid missing subtle femoral neck fractures or sclerosis suggestive of a stress fracture (especially with non-acute presentation). The radiographic alignment of the femoral head and neck should be convex (Lowell's alignment theory) creating an S or reverse S sign. The lateral view is often the most challenging to obtain (positioning can be limited as a result of pain or fragility, frail or sick patients, incorrect exposure) and interpret, possibly leading to an inability to detect up to 50% of fractures (Harding et al, 2013).

It is recommended that if no fracture is detected, but there is high clinical suspicion, the opinion of a more experienced interpreter, such as a radiologist and/or an orthopaedic surgeon, should be requested (Collin et al, 2016). Furthermore, additional radiographic views should be taken. Traction views, while usually used to aid with more complex fractures, may help with diagnosis of occult fractures if there is any slight alteration in alignment. The internal rotation view (Bristol hip view) allows for better assessment of the femoral neck. In the Bristol hip view, the beam is angled at 30° from the vertical towards the midline on the symptomatic side, therefore the angle of incidence relative to the femoral neck is nearer to orthogonal. This view has been shown to be of value in intracapsular fractures (subcapital and transcervical) and occult fractures (Bradley et al, 2006; Harding et al, 2013).

If a fracture is not visible on radiographs, advanced imaging should be obtained if a strong clinical suspicion remains. In the past, nuclear medicine (bone) scan was used to help with diagnosis, but modern imaging in the form of a magnetic resonance imaging or computed tomography scan has made bone scans obsolete in diagnosis of occult fractures. Magnetic resonance imaging is the best imaging modality to detect an occult hip fracture (Lubovsky et al, 2005; Hakkarinen et al, 2012; Haubro et al, 2015) (*Case study 2*). Magnetic resonance imaging also permits assessment of the surrounding soft tissues in case no associated bony injury is found (Oka and Monu, 2004; Verbeeten et al, 2005).

However, limitations of magnetic resonance imaging use include its availability, cost and possible contraindications (metal implants or pacemakers).

Although computed tomography is more readily available, it has inferior diagnostic performance when it comes to occult hip fractures. In the largest retrospective series to date, which included 78 patients, the sensitivity and specificity of a computed tomography scan to detect occult hip fractures was 86% and 98% respectively with one false positive and four false negative results (Sadozai et al, 2016).

The British Orthopaedic Association Standards for Trauma (BOAST) guidelines state that magnetic resonance imaging is the diagnostic modality of choice if an occult hip fracture is suspected, with computed tomography used if magnetic resonance imaging is unavailable within 24 hours of presentation; the use of bone scan is not recommended (British Orthopaedic Association, 2012).

Conclusions

Occult fractures around the hip are common. In patients presenting with hip pain and/or reduced mobility and 'normal' plain radiographs of the hip, clinicians should have a low threshold for ordering axial imaging. This would eliminate the risk of mismanagement of such patients and improve long-term outcome. **BJHM**

Conflict of interest: none.

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KEY POINTS

- Even without a history of trauma, maintain a high index of suspicion of fracture (occult) in the osteopenic patient with a sudden decline in function and/or pain.
- Keep in mind that fractures around the hip joint may present with pain in the thigh or knee.
- Careful review of anteroposterior pelvis (comparing sides) and lateral hip view will increase the likelihood of diagnosing subtle fractures with basic imaging. If in doubt ask for expert review.
- In the setting of an acute change in function, if unable to identify a fracture on plain imaging, advanced imaging is suggesting to avoid missing occult fractures.
- Early diagnosis and return to mobility is essential to optimize patient outcomes in this at risk population.

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TOP TIPS

- When encountering elderly patients who cannot weight bear and/or perform a straight leg raise, maintain a high index of suspicion for a hip fracture.
- If you suspect a hip fracture, do not discharge the patient until advanced imaging has been completed. Consult radiology or orthopaedics if the diagnosis remains unclear.
- Transverse fractures around the hip occurring with minimal trauma are likely pathological. Always inquire about bisphosphonate use and history of malignancy to help determine the fracture aetiology.

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