

# From the RSNA Refresher Courses

## Adult Chronic Hip Pain: Radiographic Evaluation<sup>1</sup>

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### CME FEATURE

See accompanying  
test at [http://  
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education  
/lrg\\_cme.html](http://www.rsna.org/education/lrg_cme.html)

### LEARNING OBJECTIVES FOR TEST 1

*After reading this  
article and taking  
the test, the reader  
will be able to:*

- Describe normal radiographic landmarks in the hip.
- Recognize subtle abnormalities of the hip.
- List early radiographic findings in common adult hip processes.

Adult chronic hip pain can be difficult to attribute to a specific cause, both clinically and radiographically. Yet, there are often subtle radiographic signs that point to traumatic, infectious, arthritic, neoplastic, congenital, or other causes. Stress fractures appear as a lucent line surrounded by sclerosis or as subtle lucency or sclerosis. Subtle femoral neck angulation, trabecular angulation, or a subcapital impaction line indicates an insufficiency fracture. Apophyseal avulsion fractures appear as a thin, crescentic, ossific opacity when viewed in tangent and as a subtle, disk-shaped opacity when viewed en face. Effusion, cartilage loss, and cortical bone destruction are diagnostic of a septic hip. Transient osteoporosis manifests as osteoporosis and effusion. The earliest finding of avascular necrosis is relative sclerosis in the femoral head. Subtle osteophytes or erosive change is indicative of arthropathy. Osteoarthritis can manifest as early cyst formation, small osteophytes, or buttressing of the femoral neck or calcar. Rheumatoid arthritis may manifest as classic osteopenia, uniform cartilage loss, and erosive change. A disturbance of the trabecular pattern might suggest an early permeative pattern due to a tumor. Knowledge of common causes of chronic hip pain will allow the radiologist to seek out these radiographic findings.

**Abbreviations:** ACR = American College of Radiology, AP = anteroposterior

**Index terms:** Hip, anatomy, 442.92 • Hip, arthritis, 442.71 • Hip, dysplasia, 442.153, 442.155 • Hip, infection, 442.20 • Hip, injuries, 442.412, 442.415 • Hip, necrosis, 442.44

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## Introduction

Chronic hip pain in the setting of a normal-appearing radiograph and a nonspecific history and clinical findings can be a difficult diagnostic dilemma. Trauma, infection, arthritis, avascular necrosis, tumor, and hip dysplasia can all manifest with extremely subtle radiographic abnormalities. This article is designed to familiarize the reader with early radiographic signs in occult hip disease and to assist the reader in developing a routine approach to evaluating the hip radiograph such that subtle abnormalities will not be overlooked. Specific topics discussed are normal anatomic features, normal variants, occult trauma, infection, transient osteoporosis, avascular necrosis, arthropathies, tumor, and dysplasia.

## Normal Anatomic Features

As with any other site in the body, a systematic evaluation of the hip radiograph includes several key features.

The important soft-tissue structures are the fat pads. These include the gluteal, iliopsoas, and obturator fat pads, which delineate these respective muscles surrounding the hip (Fig 1). The fat pads should be distinct and straight. Convexity of a fat pad implies distention of the hip joint with fluid. An important caveat is that the hip must be in a perfect AP position for this evaluation to be valid. Flexion or rotation of the hip will produce a false-positive fat pad sign. (Unfortunately, patients often find they can reduce their hip pain by flexing and externally rotating the hip, so that a true AP radiograph may be difficult to obtain.) In addition, the fat pads are inconsistently seen. Therefore, this sign suggesting hip effusion can be helpful if seen on an appropriately positioned radiograph, but its absence is not of diagnostic value.

There are several lines that should be evaluated to ensure that there is structural integrity of the hip and hemipelvis. On an AP radiograph, the anterior and posterior columns of the pelvis are represented by the iliopubic and ilioischial lines, respectively (Fig 2). Checking that these lines are uninterrupted should ensure that there is not an occult fracture of the pelvis (Fig 2). In addition, one should be certain to evaluate for integrity of both the anterior and posterior acetabular rims. Transient (reduced) hip dislocations



**Figure 1.** Fat pads. Anteroposterior (AP) radiograph of the left hip shows that the gluteal, iliopsoas, and obturator fat pads (arrows) surround the hip and are seen to be normal in this case. Bulging of a fat pad would indicate the presence of an effusion in the hip.

with accompanying rim fractures may be detected as an interruption in one of these acetabular rim lines (usually posterior). Finally, the radiographic teardrop must always be noted and evaluated for symmetry if the opposite hip is included on the radiograph (Fig 2). The teardrop is a radiographic rather than an anatomic structure that represents a summation of shadows of the medial acetabular wall as seen on the AP radiograph (Fig 2). There are two concepts of teardrop “width” in common use. The most frequently used is that which yields a measurement from the teardrop to another anatomic landmark such as the femoral head. When compared with the opposite side, this measurement may yield a subtle increase on one side, which may connote the presence of a hip effusion. The other concept of teardrop width is a true increase in mediolateral size of the teardrop itself. This observation may also require comparison with the opposite side. An increase in width of the teardrop implies that, during the period of growth prior to skeletal maturation, the femoral head was displaced lat-



**Figure 2.** Osseous anatomy. AP radiograph shows the iliopectic line (short straight arrows on the right hip) and ilioischial line (long straight arrows on the right hip), which represent the anterior and posterior columns of the pelvis, respectively. The anterior and posterior acetabular rims (short and long straight arrows, respectively, on the left hip) can be seen and guarantee integrity of the acetabular rims. The teardrop (curved arrow) is a radiographic structure representing the summation of shadows of the medial acetabular wall. Side-to-side comparison of the teardrop width is a valuable exercise.

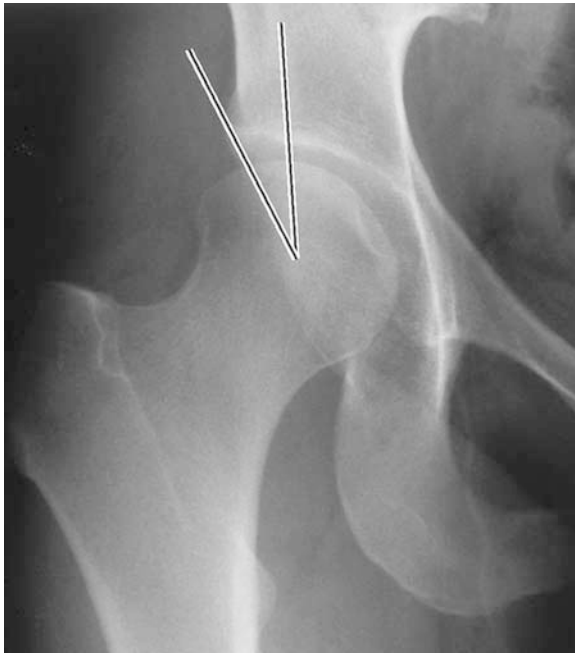


**Figure 3.** Sacroiliac joints. AP radiograph shows that the sacroiliac joints are rather complicated, appearing obliquely and therefore giving the appearance of both the anterior and posterior joints. Both the sacrum (short arrows) and posterior iliac wing (long arrows) must be clearly seen. Overlap of these structures causes one to occasionally overlook the absence or destruction of one of them.

erally and not completely “contained” within the acetabulum. This displacement could develop either due to a hip dysplasia with its usual lateral displacement or due to a chronic hip effusion, which displaces the hip laterally for an extended period. In either circumstance, the medial wall of the acetabulum has a period of unopposed growth, with consequent overgrowth.

The medial acetabular wall normally projects lateral to the ilioischial line. If the acetabular wall projects medial to the ilioischial line, the patient has protrusio acetabuli. The generally accepted measurements for medial projection are 3 mm in men and 6 mm in women to qualify for protrusio (1).

The sacroiliac joints are seen at an angle on the AP radiograph, resulting in display of both anterior and posterior joint spaces. The sacral ala and its neural foramina can be difficult to evaluate due to overlying bowel gas and contents. Ensure that you also distinctly see the posterior iliac wing, which is located posterior to the sacral ala (Fig 3). Absence of these structures may indicate a destructive process, which could easily be overlooked.



**Figure 4.** Center-edge angle. This angle is used to quantify the coverage of the femoral head by the acetabulum. The angle is formed by two lines, each originating at the center of the femoral head, with one line extending vertically and the second extending to the lateral acetabulum. Coverage of the femoral head is considered adequate if the angle measures at least  $25^\circ$ . AP radiograph of the right hip shows that the center-edge angle is slightly less than normal, indicating mild hip dysplasia in this case.

The femoral head should be examined for adequate “coverage.” To develop properly, the femoral head must be covered or “contained” by the acetabulum. Adequate coverage is defined by the center-edge angle. This angle is formed by two lines, each originating at the center of the femoral head (Fig 4). One line extends vertically, and the second extends to the lateral acetabulum. To ensure adequate femoral head coverage, the center-edge angle must be greater than  $25^\circ$ .

The pattern of trabeculae is quite distinct around the hip. Prominent trabeculae seem to



**Figure 5.** Trabecular pattern. AP radiograph of the left hip shows prominent trabeculae outlining a lucent triangular region (black arrows) in the superior acetabulum. This is a normal finding and is usually symmetric. In addition, the major trabeculae in the femoral metaphysis form a distinctive arc that leaves a relatively lucent area in the medial and lateral femoral head (white arrows). Again, this is a normal appearance and should be bilaterally symmetric.

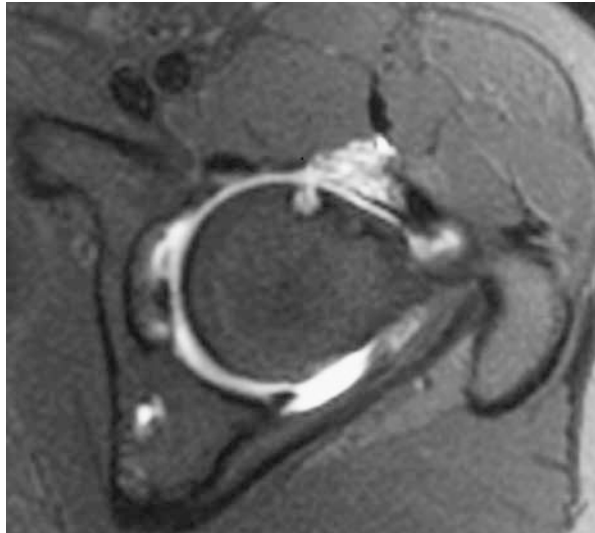
outline a more lucent triangular region in the superior acetabulum, which should not be mistaken for a destructive process. In the femoral metaphysis, the major trabeculae arc in a distinctive pattern that leaves relatively lucent regions in the medial and lateral inferior portions of the femoral head, as well as in the intertrochanteric portion of the femoral neck (Fig 5). These areas should be recognized as normal, but the trabecular pattern should also be evaluated to detect early permeative processes.



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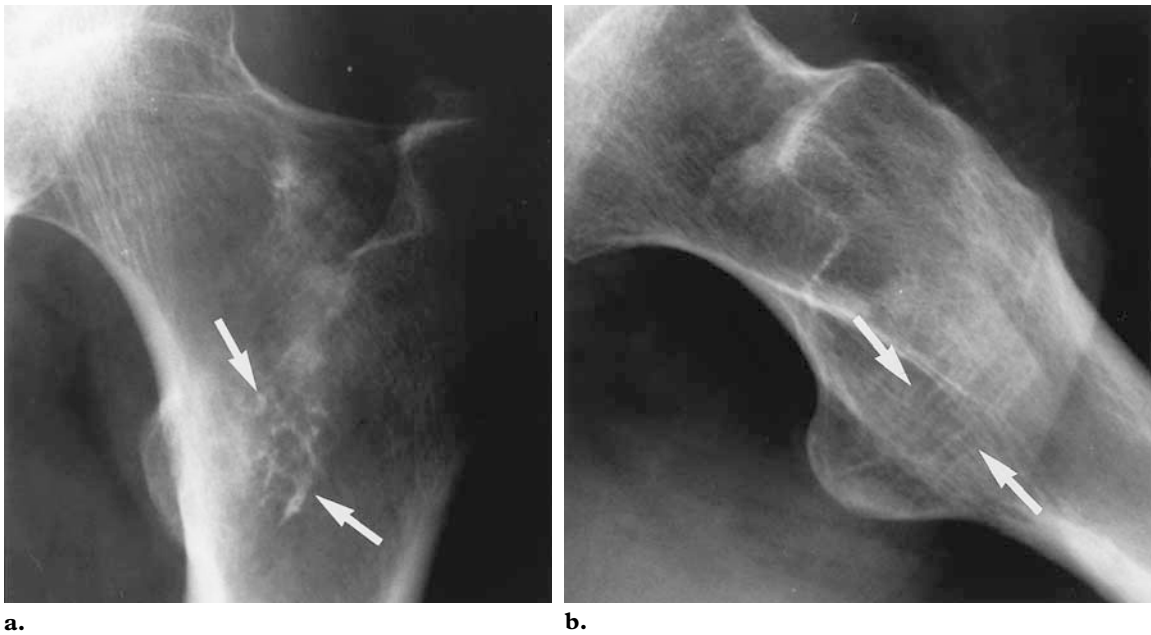
**Figure 6.** Herniation pit. (a) AP radiograph of the right hip shows a well-circumscribed, round lucent area (arrow) in the superolateral portion of the femoral neck. (b) Lateral radiograph of the groin shows the anterior location of this area (arrow). (c) Axial T1-weighted fat-saturated magnetic resonance (MR) arthrogram shows fluid signal intensity within the herniation pit.

### Normal Variants

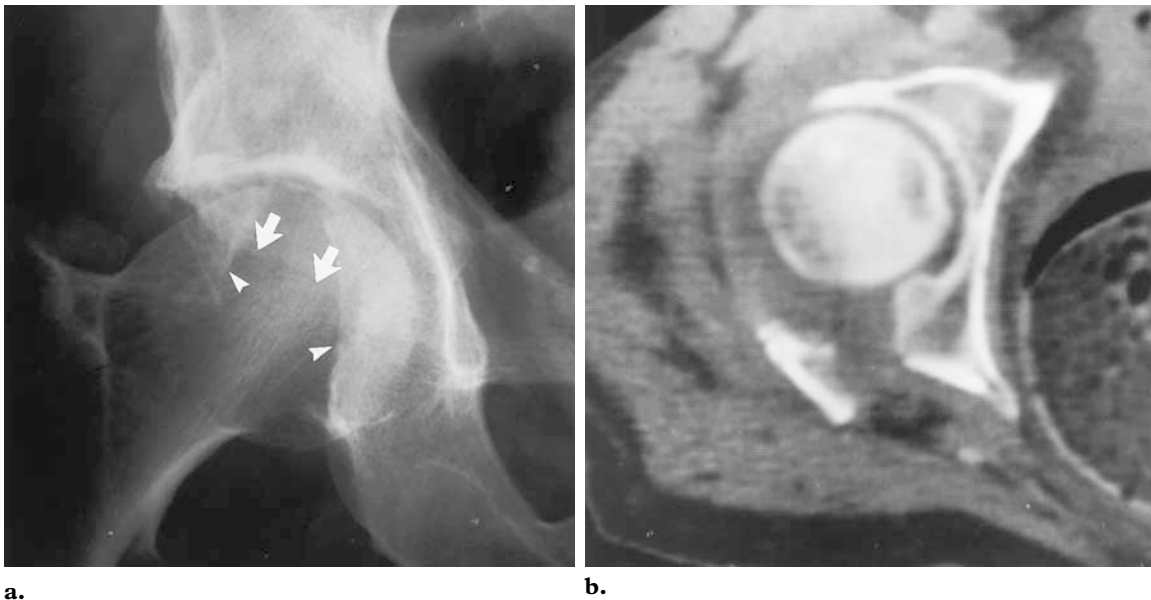
Round, well-circumscribed lucent areas located at the anterolateral cortex of the femoral neck are a normal variant termed *herniation pits* (Fig 6). They are distinguished by their appearance and location and are thought to represent sites of in-

growth of fibrous and cartilaginous elements. The only confusing feature is that they may be seen to enlarge over time. If MR images are obtained, they will demonstrate fluid signal intensity.

Another normal variant relates to normally thickened trabeculae in the femoral metaphyseal region, adjacent to the lesser trochanter. These can give the appearance of a calcified chondroid matrix on the AP radiograph (Fig 7) and are often misdiagnosed as representing an enchondroma. The lateral radiograph reveals the true nature of these trabecular bars, which are seen “on end” on the AP radiograph. These trabecular bars are much more apparent in the patient with osteoporosis.



**Figure 7.** Trabecular “bars.” **(a)** AP radiograph of the left hip shows the appearance of a chondroid matrix (arrows) in the femoral metaphysis. **(b)** Frog-leg lateral radiograph shows the true nature of this “matrix”; here, it is seen simply to be thickened trabecular bars (arrows). This is a common variant that is seen particularly well in patients with osteoporosis.

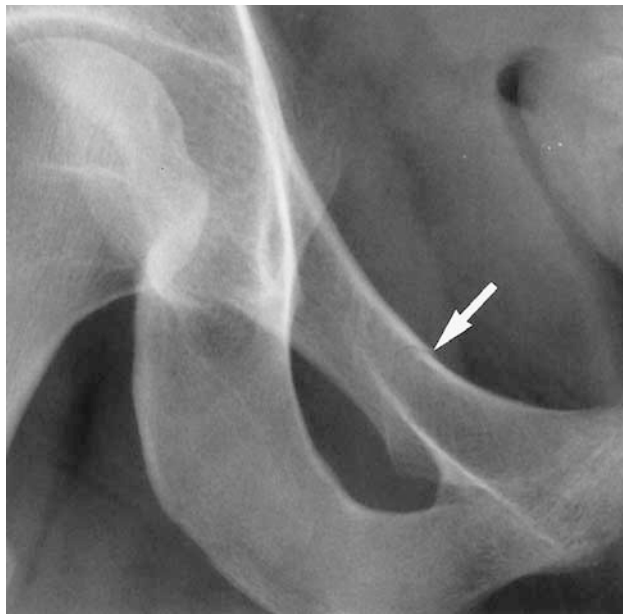


**Figure 8.** Acetabular fracture. **(a)** AP radiograph of the right hip shows a posterior acetabular rim fracture as an interruption of the acetabular rim (arrowheads). The anterior acetabular rim (arrows) is seen to be intact. See Figure 2 for the normal appearance of the posterior acetabular rim on an AP radiograph. **(b)** Computed tomographic (CT) scan shows the fracture.

### Occult Trauma

Acetabular rim fractures can be easily overlooked. We are used to carefully looking for subcapital fractures, but if the acetabular rims are

not carefully identified as being intact, a fracture resulting from transient dislocation could be missed (Fig 8). Another site of occult trauma related to transient dislocation is an impaction fracture of the femoral head (Fig 9). These are seen

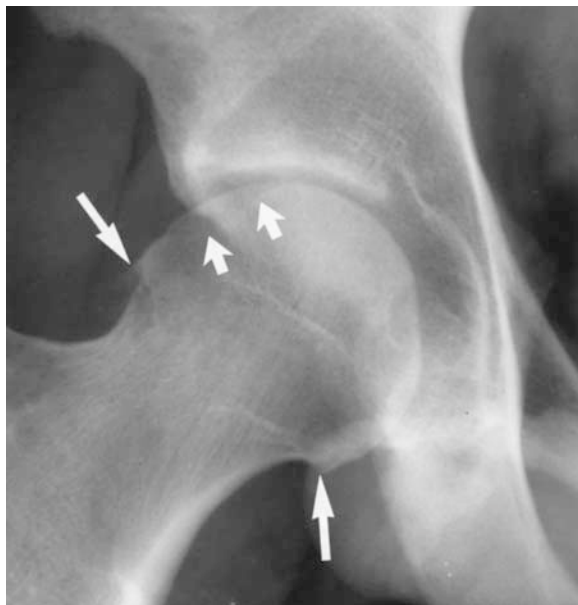


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**Figures 10, 11.** (10) Stress fracture. Joggers frequently develop stress fractures at the superior and inferior pubic rami. AP radiograph of the pubic bone shows the fracture as minimal displacement at the superior pubic ramus (arrow). As in other locations of the body, stress fractures can be very difficult to detect because they are rarely displaced. (11) Subacute stress fracture in a jogger at the typical location of the medial femoral neck. AP radiograph of the right hip shows the fracture as an area of sclerosis (long arrow) because it is subacute. The patient chose to complete a marathon and “ran through the pain,” resulting in completion of this basicervical fracture, as demonstrated by the more acute lucent line (short arrows) extending to the lateral femoral neck.

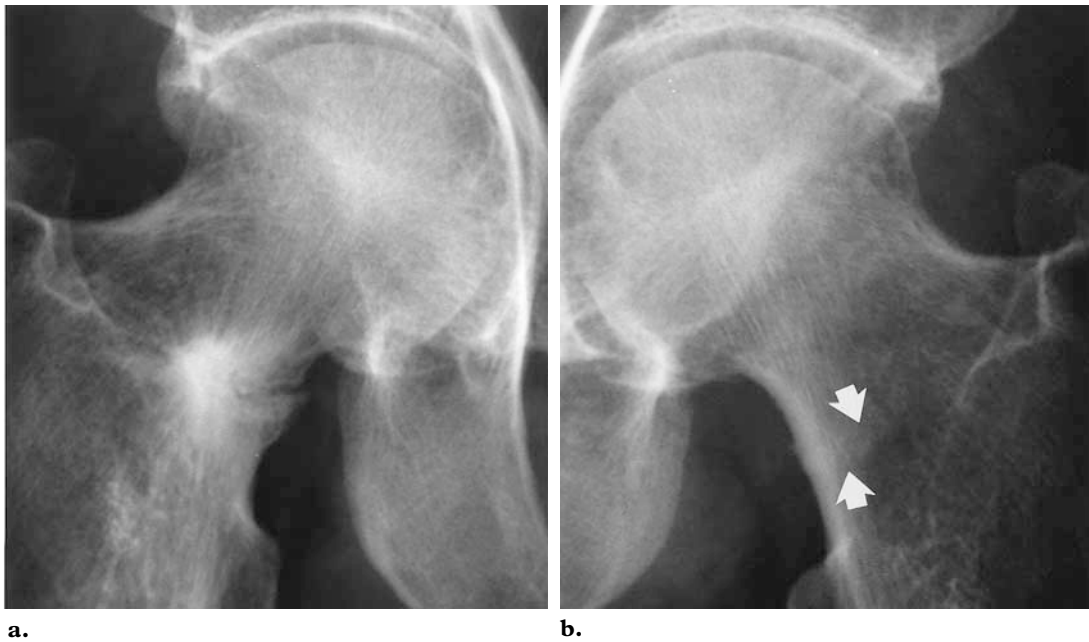


**Figure 9.** Femoral head impaction in a 19-year-old man with a history of trauma but no known fracture or dislocation. AP radiograph of the right hip, obtained when the patient returned with a complaint of hip pain, shows small osteophytes (long arrows). Close inspection demonstrates a concave sclerotic line (short arrows) at the weight-bearing portion of the femoral head. This is not the appearance of a subchondral fracture of avascular necrosis but represents an impaction fracture of the femoral head from transient dislocation, analogous to the Hill-Sachs fracture of a humeral head dislocation. (From the American College of Radiology [ACR] Learning File, MSK case 372.)

Sachs impaction fracture seen following shoulder dislocation.

Stress fractures can be occult because they are usually nondisplaced. It is crucial to know their expected location to not miss these subtle injuries. Runners may develop stress fractures either at the pubic ramus (Fig 10) or at the medial femoral neck (Fig 11). When they are subacute,

as sclerotic concave lines, as opposed to the lucent subchondral lines seen with avascular necrosis. These fractures are analogous to the Hill-

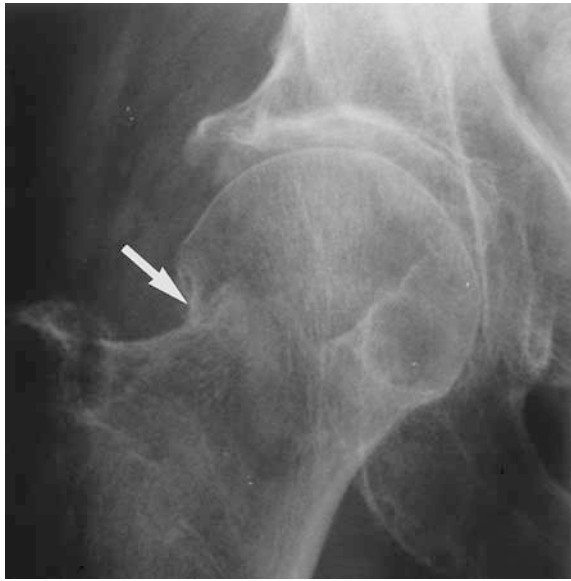


**Figure 12.** Stress fracture. (a) AP radiograph of the right hip shows a subacute stress fracture in the typical location of the medial femoral neck, with a lucent line and prominent sclerosis from attempted healing. (b) AP radiograph of the left hip of the same patient shows a more subtle stress fracture; the only hint of abnormality is extremely subtle sclerosis (arrows). The combination of the location, sclerosis, and a high degree of suspicion led to a correct diagnosis in this case.

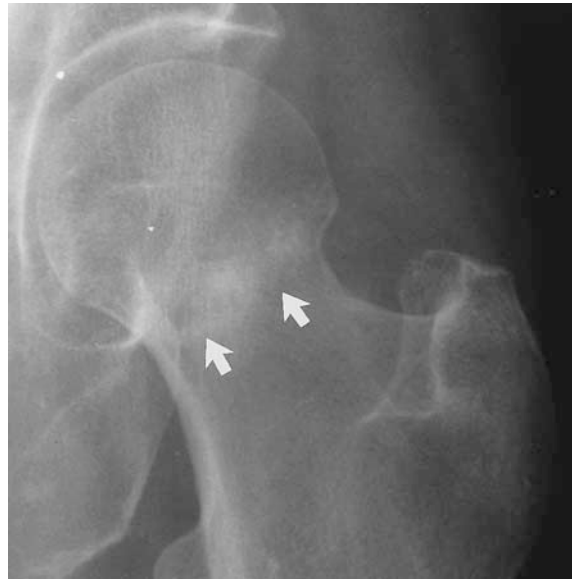
these fractures are easily seen as a lucent line surrounded by sclerosis, but more acute fractures may be detected only as either a subtle lucency or sclerosis (Fig 12).

Insufficiency fractures are most commonly located in the subcapital site. The findings that may alert you to this diagnosis are subtle femoral neck angulation, trabecular angulation, or a subcapital impaction line (Figs 13, 14). If the greater trochanter is short enough, a frog-leg lateral view may be helpful in confirming the diagnosis (Fig 14). Positioning of the hip can pose

difficulties because patients tend to hold the hip in flexion and external rotation, which foreshortens and obscures the femoral neck (Fig 15). MR imaging is efficacious in the setting of a strong clinical suspicion for fracture but with a normal radiograph. Especially when length of hospital stay is considered, a single coronal MR image is cost-effective (2). T1-weighted MR images show the fracture line itself. T2-weighted and short inversion time inversion-recovery (STIR) images may show the fracture line, but it may be obscured by the surrounding high-signal-intensity edema (Fig 16). STIR imaging may be helpful in the setting of an old, known insufficiency fracture with clinical suspicion for acute refracture. High



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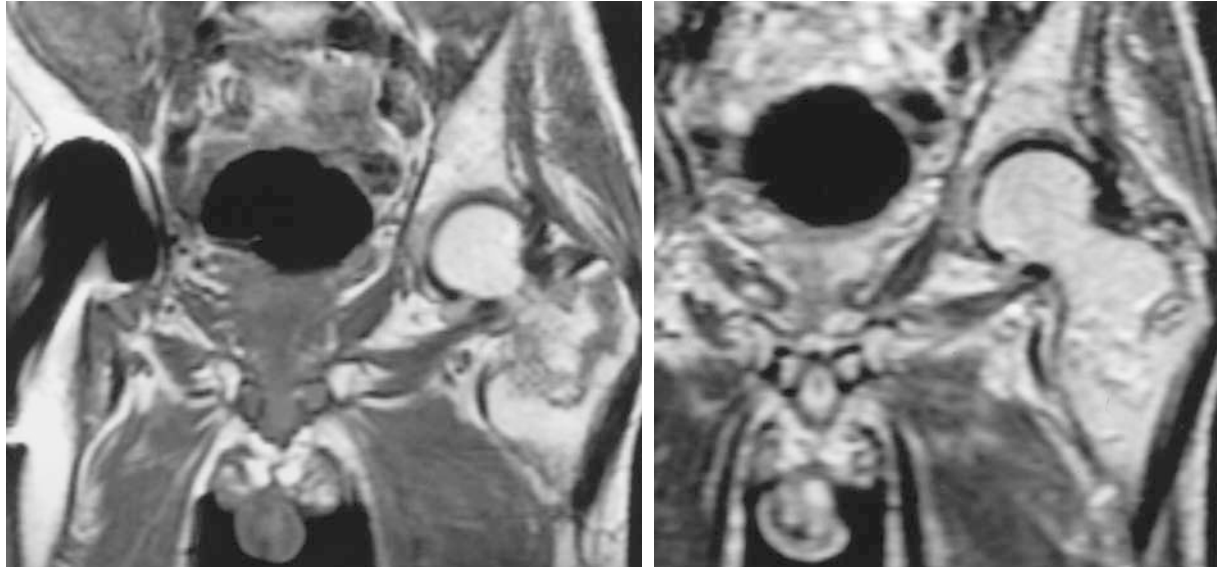
14b.



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**Figures 13–15.** (13) Insufficiency fracture in a patient with osteoporosis. AP radiograph of the right hip shows an insufficiency fracture of the subcapital region as abrupt angulation at the lateral femoral neck cortex (arrow). The actual fracture line is often not seen in these patients. (From the ACR Learning File, MSK case 371.) (14) Insufficiency fracture. (a) AP radiograph of the left hip shows an insufficiency fracture, detected only as a sclerotic line (arrows) at the subcapital portion of the femoral neck. (b) Frog-leg lateral radiograph shows the fracture more clearly, as both the sclerotic impaction line and the lucent fracture line (arrows) can be seen. This was an acute fracture, and the sclerosis is due to impaction rather than healing at this point. (From the ACR Learning File, MSK case 370.) (15) Insufficiency fracture. Position can pose a difficulty in patients with subcapital fractures or hip pain in general. Painful hips are often held in flexion and abduction, which can foreshorten the femoral neck and obscure an abnormality by overlap with the greater trochanter. On this AP radiograph of the right hip, the sclerotic line (arrow) of the subcapital fracture can barely be detected. (From the ACR Learning File, MSK case 370.)

**Figure 16.** Insufficiency fracture in a 68-year-old man with left hip pain and a completely normal radiograph but high clinical suspicion for fracture. **(a)** Coronal T1-weighted MR image shows a intertrochanteric fracture nicely as a low-signal-intensity line. **(b)** Coronal T2-weighted MR image shows the fracture line less distinctly due to the surrounding edema. The patient has hardware in the right hip. (From the ACR Learning File, MSK case 373.)



**a.**

**b.**

signal intensity resolves within 6 months following an insufficiency fracture in 90% of patients (3). One caveat of this study is that none of the patients were older than 50 years. In addition, although we are always suspicious of hidden subcapital fractures in the patient population at risk for insufficiency fractures of the hip, acetabular insufficiency fractures also occur and should be looked for carefully in these patients (Fig 17).

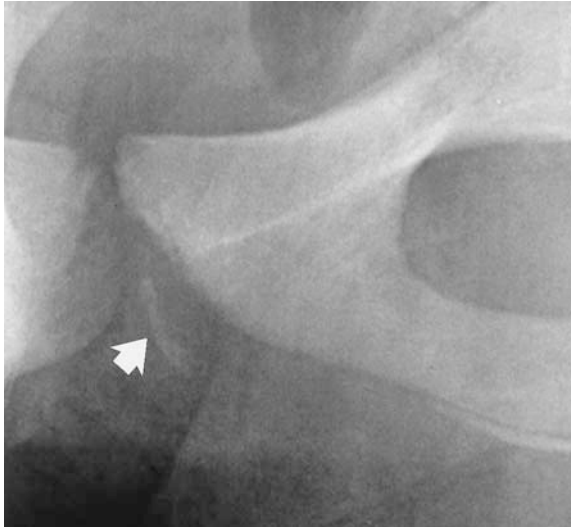
Apophyseal avulsion fractures about the hip and pelvis are seen in young adults because the pelvic apophyses appear only at puberty and do not fuse before age 25 years. Apophyseal frac-

tures can occur at the anterior superior iliac spine, anterior inferior iliac spine, ischial tuberosity, and pubis. They appear either as a thin, crescentic, ossific opacity if viewed in tangent (Fig 18) or else as a very subtle disk-shaped opacity if seen en face (Fig 19). These injuries can be quite subtle when acute and may later develop prominent heterotopic ossification at the site.

### Infection

Septic hip is diagnosed when effusion, loss of cartilage, and cortical bone destruction are present. The cartilage loss will not be seen in early septic hips, and the radiographic findings may then be extremely subtle. Hip effusion will be detected by paying careful attention to the fat pads, with a

**Figures 18, 19.** Avulsion fracture. (18) Oblique radiograph shows a crescentic adductor avulsion fracture (arrow). Note that the donor site is not distinctly seen. These fractures are recognized by means of their location and shape. (19) AP radiograph shows an avulsion fracture of the anterior superior iliac spine (arrows) that has a different appearance than that in Figure 18. In this case, the fracture fragment is seen en face, resulting in a very thin disklike appearance. Again, the donor site is not seen, and the diagnosis was made on the basis of the location and a high degree of suspicion.

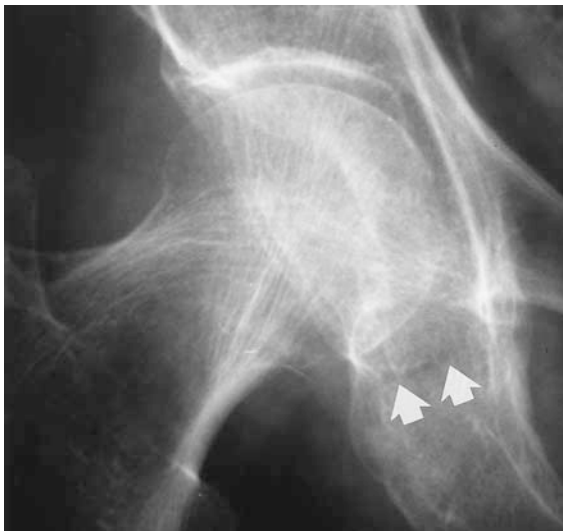


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**Figure 17.** Insufficiency fracture of the acetabulum in a 76-year-old woman with osteoporosis and hip pain. (a) AP radiograph of the right hip shows no subcapital fracture, but a fracture line is seen at the inferomedial acetabular wall (arrows). (b) Axial T1-weighted MR image shows the same finding (arrow). (From the ACR Learning File, MSK case 310.)



a.



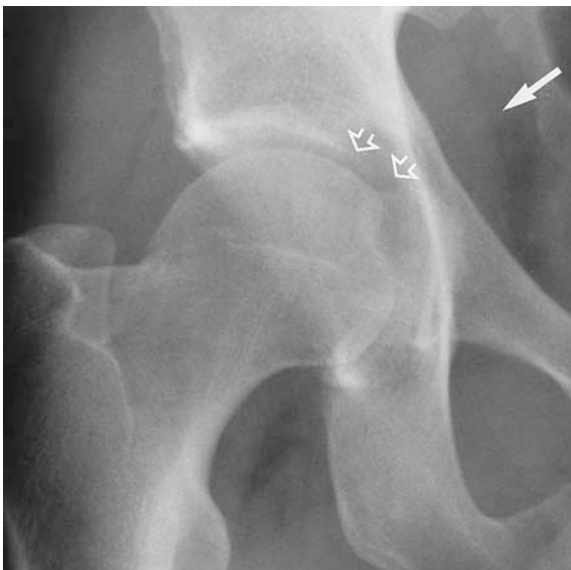
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20a.



20b.



21a.



21b.

**Figures 20, 21.** Septic joint. (20) AP radiographs show an infected right hip (a) compared with a normal left hip (b). The gluteal and iliopsoas fat pads (long and short arrows, respectively) are bulging on the right hip compared with the left. This finding indicates fluid in the joint. Although the cartilage does not appear to be destroyed at this point, there is subtle indistinctness of the cortical line of the right femoral head compared with the left. This indistinctness is best seen in the weight-bearing portion. (21) AP radiographs show a bulging obturator fat pad (solid arrow) in an abnormal right hip (a) compared with a normal left hip (b). In addition, very subtle loss of the normal sclerosis of the acetabular cortex (open arrows in a) will be noted only at side-to-side comparison.



**Figure 22.** Transient osteoporosis in a 33-year-old man. **(a)** AP radiograph of the left hip shows severe osteoporosis with apparently intact cartilage. The other hip was normal. **(b)** Posterior bone scan shows abnormal uptake in the left hip, an expected but nonspecific finding. Because these two studies alone cannot help differentiate transient osteoporosis from septic hip, aspiration of the hip was performed. **(c)** AP radiograph shows contrast material injected to confirm placement of the needle for aspiration. The aspirate was negative, and transient osteoporosis could then be assumed as a diagnosis of exclusion. The patient became asymptomatic after 4 months, and his radiograph returned to a normal appearance, with completely normal bone density.

side-to-side comparison (Fig 20). Early cortical bone loss or a decrease in cortical “distinctness” should be sought both on the acetabulum and the femoral head (Figs 20, 21). The diagnosis must be secured by means of hip aspiration and culture of the aspirate. It is important to note that aspiration of a suspected septic hip is one of the true orthopedic emergencies encountered by radiologists. Delay in aspiration and treatment results in rapid destruction of the hip joint.

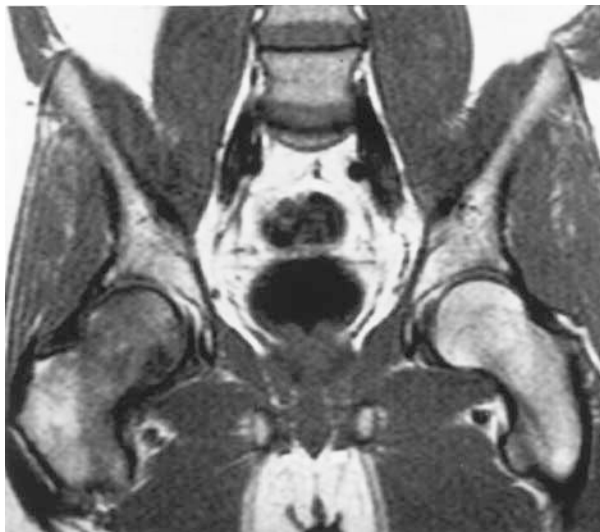
### Transient Osteoporosis

Transient osteoporosis is a process in which periarticular osteoporosis occurs, with cartilage remaining intact. A painful disease, it is more common in males than females, may be migratory, and is self-limited, with complete resolution of symptoms and all imaging findings. Because it manifests radiographically as osteoporosis and effusion and shows increased uptake on a bone scan, as well as abnormal signal intensity on MR images (Figs 22, 23), the differential diagnosis is septic hip. Transient osteoporosis is a diagnosis

**Figure 23.** Transient osteoporosis in a 45-year-old man with right hip pain. (a) AP radiograph of the right hip shows findings of osteoporosis. A bone scan (not shown) showed increased uptake in the femoral head, as in the case in Figure 22. (b, c) Coronal MR images show the nonspecific pattern of femoral head edema with low signal intensity on the T1-weighted image (b) and high signal intensity on the T2-weighted image (c). When a negative aspirate was obtained, transient osteoporosis was presumed. Within 6 months, the patient's symptoms resolved and findings of all imaging studies returned to normal.



a.



b.



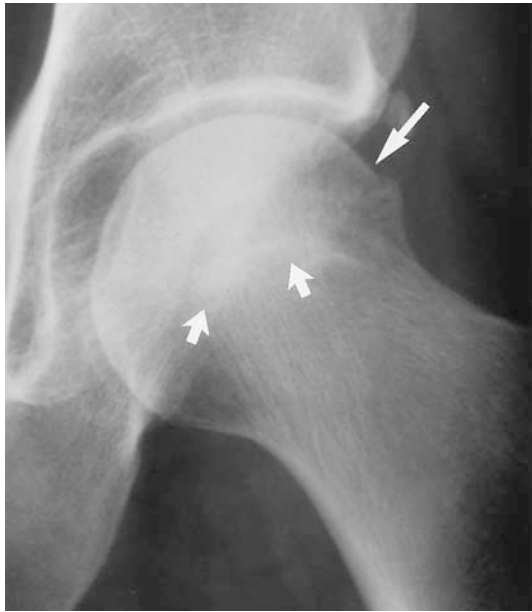
c.

of exclusion, and hip aspiration is often necessary to differentiate it from a septic process.

### **Avascular Necrosis**

It is clearly advantageous to diagnose avascular necrosis in its earliest stage, prior to collapse of the weight-bearing surface of the femoral head. The earliest radiographic finding of avascular necrosis is relative sclerosis, which occurs in the femoral head, related to resorption of surrounding vascularized bone (Fig 24). This sclerosis can

be quite subtle and should be sought in all cases of chronic adult hip pain. Careful observation will sometimes demonstrate minimal collapse in the weight-bearing portion of the femoral head; this finding can be seen more easily on a frog-leg lateral radiograph (Fig 25). Avascular necrosis has been demonstrated to be detected earlier with MR imaging than with radiography, and there are specific findings that can secure the diagnosis. However, not all signal intensity abnormalities in the hip detected on MR images represent avascular necrosis. MR imaging is 98% specific in differentiating normal from abnormal



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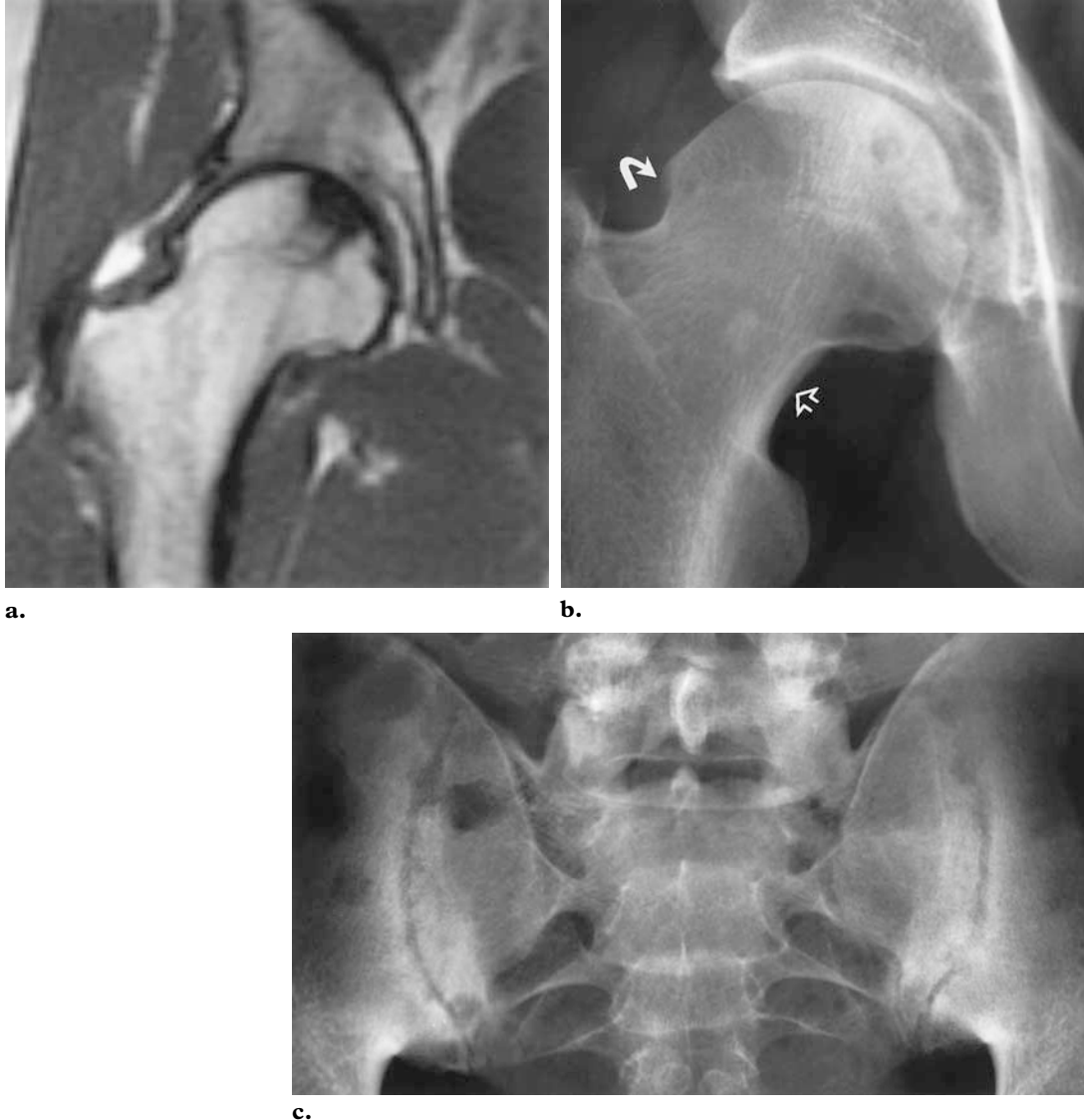
25a.



25b.

**Figures 24, 25.** Avascular necrosis. (24) AP radiograph of the left hip shows the early sign of sclerosis in the central portion of the femoral head (short arrows), as well as the later sign of subchondral fracture with collapse (long arrow). (25a) AP radiograph of the left hip shows a fairly obvious subchondral fracture and flattening of the weight-bearing portion of the femoral head (arrow). (25b) Frog-leg lateral radiograph shows the subchondral fracture (arrows) and flattening to even greater advantage. (From the ACR Learning File, MSK case 258.)

**Figure 26.** Nonspecificity of MR signal intensity abnormalities in the hip in a 25-year-old man. **(a)** Coronal T1-weighted MR image of the right hip shows abnormal signal intensity in the weight-bearing area of the femoral head. This finding was presumed to represent avascular necrosis. This MR image should not be interpreted in isolation from the radiograph. **(b)** AP radiograph shows osteophyte formation (curved arrow), calcar buttressing (open arrow), and subchondral cyst formation in the area of abnormality on the MR image. This combination of findings simply represents osteoarthritis. One should of course wonder why a 25-year-old man has osteoarthritis of the hip. The answer is easily found in evaluation of his sacroiliac joints. **(c)** AP radiograph of the sacroiliac joints shows a bilateral erosive pattern, typical of ankylosing spondylitis. Ankylosing spondylitis commonly involves the large proximal joints and is most frequently found in young adult men.



hips, but only 85% specific in differentiating avascular necrosis from non-avascular necrosis hip abnormalities (4). It is advisable to interpret hip MR images with the aid of the radiograph, as demonstrated in Figure 26.

### Arthropathies

Hip arthropathies can be quite subtle. Early cartilage loss is often not detected on radiographs

because pelvic radiographs are not routinely obtained in an upright position. Subtle osteophytes or erosive change should be sought, and it should be remembered that spondyloarthropathies are frequently associated with hip abnormalities (>50% of cases in ankylosing spondylitis). Spondyloarthropathy should be considered in young adults with hip pain, and if protrusio or other abnormalities are found, the sacroiliac joints should be examined (Figs 27–29).



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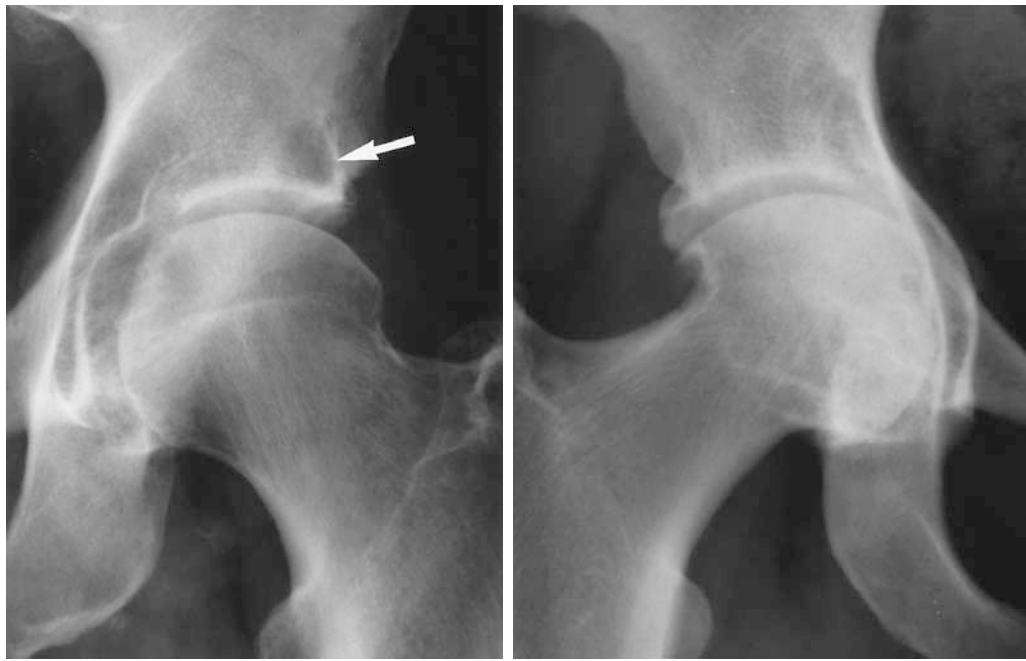


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**Figures 27–29.** Spondyloarthropathy in a 17-year-old girl. AP radiograph of the hips shows cartilage loss and erosive change without productive change in the left hip. These findings alone are not specific but when combined with the unilateral right sacroiliac joint sclerosis and widening, psoriatic arthritis becomes the most likely diagnosis. (From the ACR Learning File, MSK case 201.) **(28)** Spondyloarthropathy in a 22-year-old woman with left hip pain. AP radiograph shows subtle protrusion and a ring osteophyte on the left hip (arrow), with a normal right hip for comparison. With the left hip abnormality seen in this young adult, one should look carefully at the sacroiliac joints. In this case, there is bilateral widening and sclerosis of the sacroiliac joints. The patient has ankylosing spondylitis. **(29)** Spondyloarthropathy in a 32-year-old man with bilateral hip pain. AP radiograph shows no cartilage narrowing, but the presence of very small osteophytes (arrowheads) is noted bilaterally. The sacroiliac joints are abnormal bilaterally but asymmetrically, with the left showing more significant erosive change and sclerosis. The patient has ankylosing spondylitis. Note how very subtle productive changes about the hips can be seen. A high degree of suspicion is necessary in cases such as this.



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b.

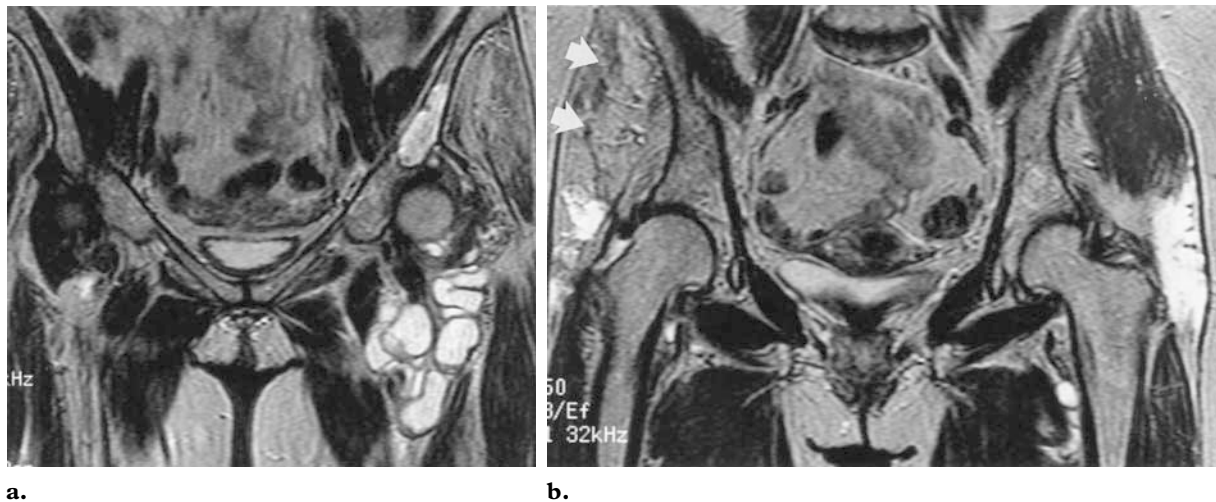
**Figure 30.** Osteoarthritis. (a) AP radiograph of the left hip shows early osteoarthritis with no significant cartilage loss; the disease is heralded by a small subchondral cyst (arrow) in the acetabulum. A minimal osteophyte is seen at the lateral margin of the femoral head. (b) AP radiograph of the right hip in another patient shows a more unusual pattern of osteoarthritis. In this case, the direction of migration is medial, with protrusio. This appearance is often mistaken for that of rheumatoid arthritis. However, note the normal bone density and the osteophyte formation. The patient represents one of the 20% of those with osteoarthritis who have a pattern of medial migration of the hip. (Fig 30b from the ACR Learning File, MSK case 229.)



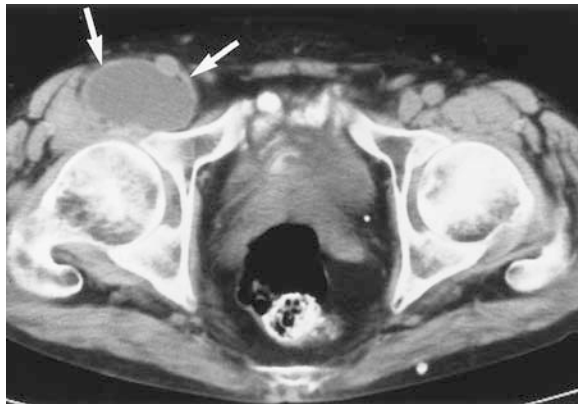
a.

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**Figure 31.** Otto pelvis (primary protrusio). AP radiographs of the right hips in two patients show a variant of osteoarthritis, with primary protrusio and secondary productive change of the hips in a 31-year-old woman (a) and, in a more advanced form, in her 49-year-old mother (b). (From the ACR Learning File, MSK case 555.)



**Figure 33.** Rheumatoid arthritis in a 55-year-old woman. The radiographs were normal. Coronal T2-weighted MR images demonstrate the soft-tissue abnormalities that can occur in this disease process. **(a)** Image obtained far anteriorly shows the complex cystic appearance of synovial fluid decompressing into the iliopsoas bursa. **(b)** Image obtained slightly more posteriorly shows an acute rupture of the left gluteal tendon as high signal intensity adjacent to the greater trochanter. The right gluteal tendons have ruptured as well, but this is a subacute abnormality as there is fatty atrophy (arrows) replacing this musculature (compare with left side).

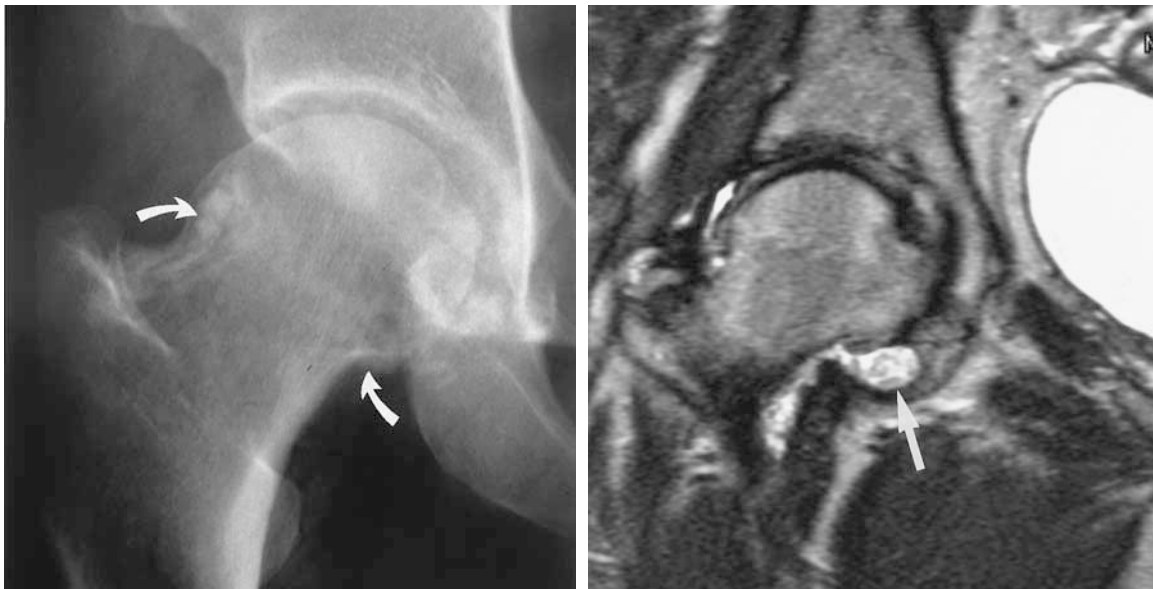


**Figure 32.** Rheumatoid arthritis in a 66-year-old man with right hip pain and a soft-tissue mass anterior to the hip. The radiograph was normal. CT scan shows a water-attenuation mass (arrows) in the iliopsoas bursa, displacing muscle and vasculature. The osseous structures are normal. This is a typical appearance of decompression of synovial fluid into the iliopsoas bursa, not infrequently seen in patients with rheumatoid arthritis.

Osteoarthritis can manifest as early cyst formation, very small osteophytes, or buttressing of the femoral neck or calcar (Fig 30). These abnormalities can each be seen alone and can be quite subtle. Remember also that 20% of patients with osteoarthritis develop protrusio rather than the more common superolateral subluxation. One

unusual form of osteoarthritis is Otto pelvis (primary protrusio), in which protrusio and degenerative change are established at an early age. It is seen more frequently in women and is hereditary (Fig 31). It is thought to be due to a failure of acetabular ossification or remodeling. Early osteoarthritis can also result from previous slipped capital femoral epiphysis. If the femoral head appears somewhat medially displaced relative to the femoral neck, slipped capital femoral epiphysis can be considered as the cause of secondary osteoarthritis.

Rheumatoid arthritis may manifest as the classic osteopenia, uniform cartilage loss, and erosive change. However, the hip often appears normal during the early disease process. MR imaging may show pannus. The hip also characteristically decompresses a large effusion through the weak anterior capsule, into the iliopsoas bursa. Thus, patients with rheumatoid arthritis may have a normal radiograph but present with a mass in the anterior groin, which is easily diagnosed as bursal fluid at CT or MR imaging (Figs 32, 33). Patients with rheumatoid arthritis also often develop tendon ruptures, which can certainly be found around the hip (Fig 33).

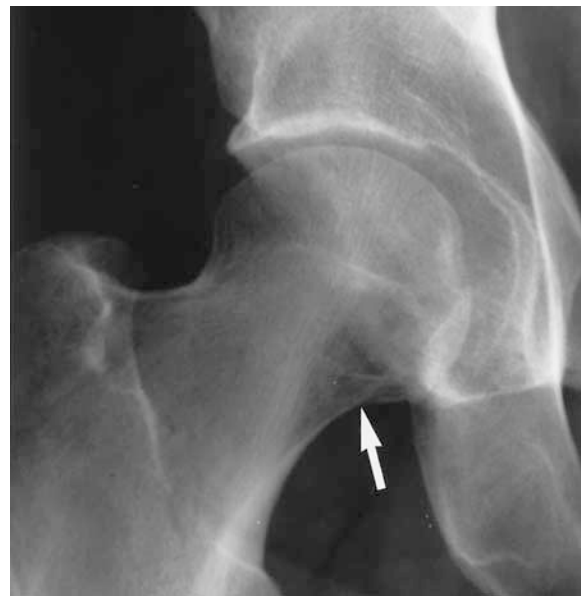


**Figure 34.** Synovial chondromatosis in a 31-year-old woman who originally presented at age 28 years with right hip pain; the radiograph obtained then was normal. Synovial chondromatosis occasionally manifests without radiographic evidence of ossified bodies. **(a)** AP radiograph of the right hip shows multiple round bodies in the redundant portion of the hip joint around the femoral neck (arrows). This finding is diagnostic of synovial chondromatosis. **(b)** Coronal T2-weighted MR image shows an effusion with multiple loose bodies within it (arrow). (However, MR imaging is not needed to make the diagnosis.) It is worth remembering that in this disease process the bodies need not be seen, and indeed erosive change may be seen without radiographic evidence of bodies.

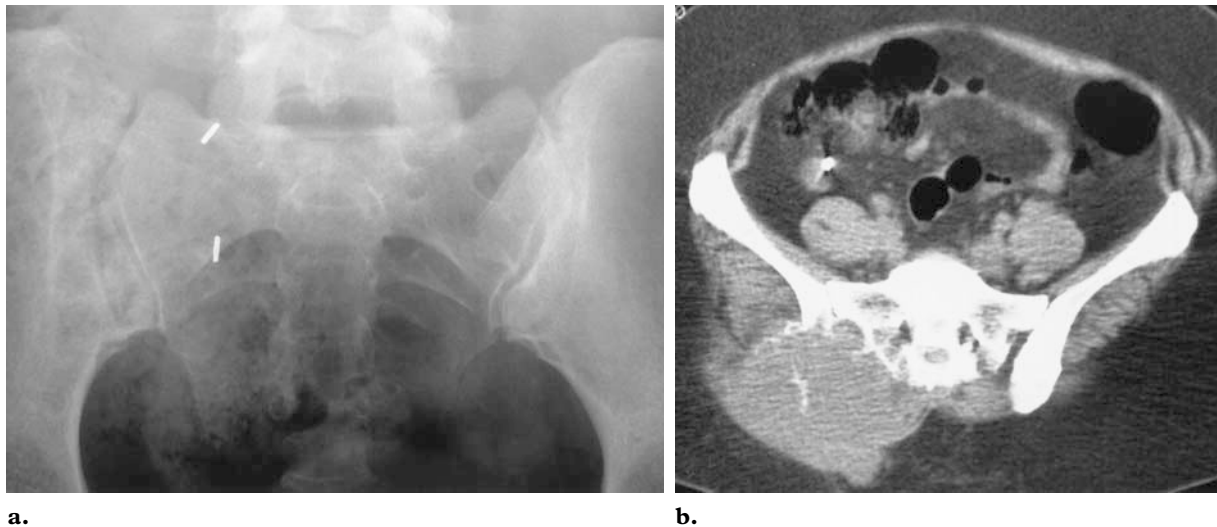
Other arthropathies involving the hip may be quite subtle but may have characteristic abnormalities that allow diagnosis. Pseudogout arthropathy may show chondrocalcinosis and typically demonstrates large subchondral cysts. Pigmented villonodular synovitis also may have prominent cysts and may have the typical low signal intensity with all MR imaging sequences. Synovial osteochondromatosis may have erosions and usually shows multiple round bodies of similar size, but the bodies occasionally are not calcified early in the process (Fig 34).

### Tumor

Virtually all osseous tumors can occur about the hip, and early lytic lesions can be difficult to discern. Watch particularly for a disturbance of the trabecular pattern, which might suggest an early permeative pattern (Fig 35). Be alert to overall bone density; a generalized decrease in bone den-



**Figure 35.** Tumor in a 39-year-old man. AP radiograph of the right hip shows that the normal expected lucency (arrow) in the medial femoral head and neck region is slightly enlarged. It is most useful to compare this appearance with that of the opposite normal side (see Fig 5 for the patient's normal left hip). Disturbance of trabecular pattern may be the only early indication of tumor. This lytic lesion of the femoral head and neck progressed to a very destructive lesion, which proved to be lymphoma at biopsy.



**Figure 36.** Tumor. **(a)** AP radiograph shows that a destructive lesion is extremely easy to miss. Despite the clips seen over the region of the right sacrum, it is easy to overlook the fact that the posterior iliac wing is missing on the right side (note how easily both the posterior iliac wing and the anterior and posterior sacroiliac joints are seen on the normal left side). **(b)** CT scan shows how extensive the soft-tissue mass is, as well as the destructive nature of this angiosarcoma.



**Figure 37.** Tumor in a 55-year-old woman. AP radiograph of the right hip shows an avulsed lesser trochanter (arrow), which proved at biopsy to be due to metastatic thyroid carcinoma. An avulsion of the lesser trochanter should be considered pathologic in an adult until proved otherwise.

sity in a middle-aged man may be seen in multiple myeloma without any focal lesions. Posterior iliac wing lesions are easily missed due to the superimposed sacral wing and soft tissues; be sure to identify both of these overlapping osseous structures (Fig 36). Watch also for a lesser trochanter lesion; an avulsion of this structure in an adult is usually due to a pathologic fracture (Fig 37).

Osteoid osteoma of the hip can be particularly confusing. A common site for this lesion is the cortex of the femoral neck. Because this location is within the joint capsule, the associated reactive bone formation may be found several centimeters away from the nidus; this appearance can be so



**Figure 38.** Osteoid osteoma. AP radiograph of the right hip shows that the combination of a small intra-articular nidus and distant reactive bone formation can be misleading. The medial cortex shows tremendous reaction in the region of the lesser trochanter as well as distal to it. This appearance led to a biopsy of the reactive bone (arrow). The culprit in this case is the small nidus of an osteoid osteoma (arrowheads) located in the medial femoral neck. With an intra-articular osteoid osteoma, the associated sclerosis may be remote from the lesion itself.

misleading that biopsy may be performed at the wrong site (Fig 38). The lesion can induce synovitis and result in early osteoarthritis with osteophyte formation and calcar buttressing, which may be confused with simple arthritis (Fig 39). The diagnosis, although occasionally difficult, can usually be made on radiographs; CT enables confirmation of the diagnosis and allows accurate localization for a limited surgical resection.

### Dysplasia

There is a 0.1% prevalence of late diagnosis of hip dysplasia despite routine screening of infants. Although the diagnosis is sometimes obvious, it may also be subtle, with a normally shaped femoral head and neck that simply lacks normal coverage by the acetabulum. If measurement is necessary, the center-edge angle is most often used on an AP radiograph (Fig 40); coverage of the ante-



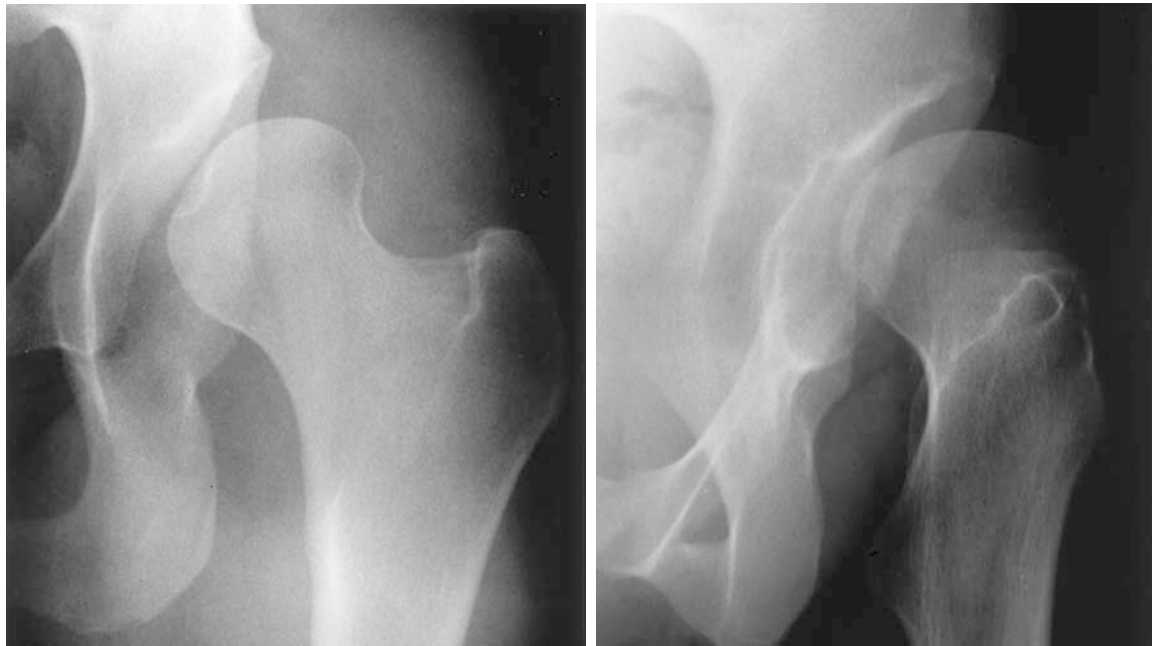
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b.

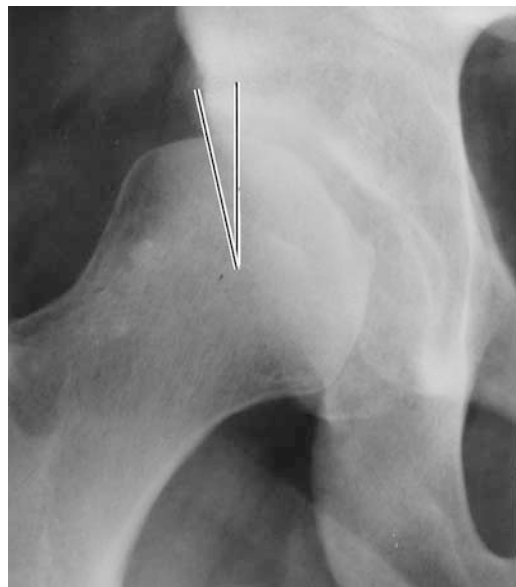
**Figure 39.** Osteoid osteoma in a 17-year-old boy. (a) AP radiograph shows an appearance that may be confusing at first glance. A patient of this age should not have osteophytes (open arrows) and buttressing of the medial femoral neck (straight solid arrow). The explanation is the nidus of an osteoid osteoma (curved arrows) in the femoral neck. This should be a plain radiographic diagnosis; however, CT is extremely helpful in providing the surgeon with the information necessary to make a localized resection. (b) CT scan shows the osteoid osteoma (arrow). (From the ACR Learning File, MSK case 107.)

rior portion of the femoral head is measured on a false-profile radiograph in much the same way, with the angle normally measuring greater than 25° on each radiograph (5). An additional measurement of the verticality of the acetabulum is provided by the horizontal toit extern angle. On an AP radiograph, an oblique line is drawn from the most medial point of the weight-bearing ac-



a.

b.



c.

**Figure 40.** Hip dysplasia. (a) AP radiograph of the left hip shows that there is insufficient coverage of the femoral head by the acetabulum. The center-edge angle in this case would approach  $0^{\circ}$ . (See Fig 4 for discussion of the center-edge angle.) (b) False-profile radiograph shows that anterior coverage of the femoral head is insufficient, as with lateral coverage. (c) AP radiograph of the right hip shows more subtle hip dysplasia, with a center-edge measurement (the angle formed by the lines) approximating  $15^{\circ}$ .

etabulum to the lateral edge of the acetabulum. An angle is determined by this line with a horizontal line (parallel to the transischial line) (5). The normal horizontal toit extern angle is  $10^{\circ}$  or less; the angle can become quite large (the lateral opening of the acetabulum quite vertical) in hip dysplasias.

### Conclusion

Correct diagnosis of the cause of chronic hip pain in adults can often be made with careful analysis of radiographs.

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