

Abnormalities of the Osseous Structures of the Hip and Peri-Articular Soft Tissues

MRI is the most accurate imaging technique for the detection and assessment of a large number of disorders arising in the bones of the hip or the surrounding soft tissues including osteonecrosis, transient osteopenia, fractures, soft tissue injuries, and tumors. All of these disorders can be readily assessed without the use of a contrast agent. The evaluation of intra-articular structures, in particular the acetabular labrum, however, is probably best accomplished with the use of the direct injection of a Gd-chelate contrast agent into the hip joint (which is discussed in UNIT A26.2).

The protocol given below is utilized on a 1.5-Tesla system for the evaluation of disease in the region of the hip. Some modifications must be made when it is used on low-field (0.23 to 0.3 T) systems as will be discussed below.

MR IMAGING OF THE HIPS

Although MR imaging of the hips for any of these disorders can be satisfactorily performed with either the whole body radiofrequency (RF) coil or a dedicated surface coil, the torso-array coil is generally used. Following the acquisition of a scout sequence in the transverse plane, the first two sequences used are STIR (short tau inversion recovery) and short T_E spin echo sequences of both hips obtained in the coronal or oblique coronal plane. Although a fat-saturated, long T_R/T_E fast (or turbo) spin echo (FSE) sequence can be substituted for the STIR sequence on high-field systems, it appears that the STIR sequence is slightly more sensitive to the presence of abnormalities within the marrow or the surrounding soft tissues and should be used. Only moderate size acquisition matrices (e.g., 192 by 256) are employed. In the authors' experience, the use of higher resolution matrices (e.g., 384 by 512) does not generally aid in the assessment of most disorders and prolongs study time significantly. These are followed by short T_E spin echo and fat saturated, long T_E fast-spin echo sequences obtained in the transverse plane. For the detection and assessment of disease in general, these sequences are the most important and will generally suffice. In those cases in which osteonecrosis (ON) is seen in the femoral head on the coronal sequences, a fat-saturated intermediate T_E sagittal FSE sequence is acquired to help estimate the size of the focus and to look for signs of cortical collapse. The authors also evaluate the articular cartilage and acetabular labrum with this sequence, although its accuracy for these purposes in the absence of intra-articular contrast agent is unknown. On a high-field system with a torso array or similar surface coil in place, the sagittal sequence is performed at much higher resolution than the previously described coronal and transverse sequences. On a low-field system or when a torso array coil has not been applied, the resolution chosen for the sagittal series is the same as that used for the prior series.

On high-field systems (>1.0 T), this entire protocol will require ~30 min to perform.

Table A26.1.1 lists the hardware necessary to perform the procedure, along with appropriate parameters. The available gradient strength will depend on the scanner, and the echo times given below should be varied accordingly (the smaller the gradient strength, the longer the echo time for a particular scan).

NOTE: Be sure that technologists and nurses have immediate access to any emergency equipment that may be relevant to a given study, or that may be needed for a particular patient, such as crash carts or oxygen.

BASIC PROTOCOL

Table A26.1.1 Equipment Parameters for MRI of the Hips

Coil type	Torso array coil
Gradient coil strength	25 mT/m (or whatever the system permits)
Cardiac gating	No
Peripheral gating	For safety only
Respiratory gating	No
Respirator	If required by patient
Oxygen	If required by patient
Motion cushions	Useful
Use of contrast agents	No

Set up patient and equipment

1. Interview (screen) the patient to ensure that he or she has no contraindications such as cardiac pacemakers or other implants containing ferromagnetic materials. Also be sure to find out if the patient has any health conditions that may require the presence of special emergency equipment during the scanning procedure, or necessitate any other precautions. The patient should be questioned as to the location of the pain, in particular the side and whether the pain is actually in the hip or, e.g., lower in the thigh.

Generally, standard screening forms (APPENDIX 1) are used for all patients scanned in a magnetic resonance system.

The presence of any ferromagnetic metals may be a health hazard to the patient when he or she is inside the magnet, and will also affect the imaging. If in doubt as to the exact composition of the items, it is best to exclude patients with any metal implants; see Shellock (1996) for discussion of what implants may be safely scanned using magnetic resonance.

Patients may be accompanied into the magnet room by a friend or family member, who can sit in the room during the scan and comfort the patient as needed. This companion must be screened as if they were to undergo MR imaging themselves to ensure the absence of loose metal objects on the body or clothing.

2. If the procedure is a research protocol, have the patient sign any necessary consent forms.
3. Have the patient remove all jewelry and change into a gown to eliminate any metal that might be found in clothing.
4. Inform the patient about what will occur during the procedure, what he or she will experience while in the magnet, and how to behave, including the following:
 - a. If earphones or headphones are used to protect the ears from the loud sounds produced by the gradients, the patient will be asked to wear these, but will be able to communicate with you at any time during the imaging.
 - b. The patient will be given a safety squeeze-bulb or similar equipment to request assistance at any time (demonstrate how this works).
 - c. For good results the patient should not talk, and should avoid or minimize other movement, during each scan—i.e., as long as the banging sounds continue. Between scans, talking is allowed in most cases, but should be avoided when comparative positional studies are being performed; the patient will be informed when this is the case.
 - d. Nevertheless, the patient may call out at any time if he or she feels it necessary.

5. Have the patient lie down on the table with his or her feet toward the machine. Either before or right after the patient lies down in the supine position, set up any triggering devices or other monitoring equipment that is to be used.
6. Center the patient in a torso array coil or other form of dedicated radiofrequency coil at the hip(s) where the key information is desired. The superior end of the torso array coil should be located at the iliac crest and the inferior end should be well below the greater trochanter.
7. Start to move the patient into the magnet center. Locate the sagittal alignment light along the mid-sagittal plane of the patient. The transverse alignment light should be centered approximately halfway between the anterior/superior iliac spine and the symphysis pubis because the femoral head lies in that location. The coronal alignment light should fall approximately midway between the front and back of the patient. Place him or her into the center of the magnet.

Once this step has been performed, so long as the patient does not move on the table, the table itself can be moved and then replaced in the same position as before without jeopardizing the positioning of one scan relative to another.

8. Sedation is not performed routinely and should be reserved for severe claustrophobia.

Sequence 1: Rapid transverse scout

9. Obtain a scout series in the transverse plane using the sequence given in Table A26.1.2 (Fig. A26.1.1).

Sequence 2: Coronal fast-STIR

10. Obtain a coronal or oblique coronal fast-STIR sequence using the parameters given in Table A26.1.3. The plane of the slices should be parallel to an imaginary line joining corresponding locations on the left and right hips on the transverse images (Figs. A26.1.2 and A26.1.3). The field of view (FOV) should be slightly larger than the soft tissues surrounding the hips.

As is true for all multi-slice 2-D techniques, the value of T_R should be adjusted depending on the size of the patient. The number of slices is determined by the T_R , T_E and, in the case of fast-spin echo sequences, the number of echos in the echo train (i.e., echo train length). In the case of T_2 -weighted and STIR sequences, increasing the T_R does not alter the contrast and it should be increased so that only a single acquisition will cover the entire volume unless it pushes the acquisition time to the point at which patient motion is likely to interfere with image quality (>10 min).

The authors' system automatically interleaves two or more sequences (doubling or tripling the acquisition time) to cover the appropriate distance if the T_R chosen does not permit it to be covered in a single acquisition. For this reason, adjustment of T_R while studying the calculated time of acquisition is performed prior to each sequence. The T_1 will be ~150 msec at 1.5 T but should be adjusted as part of the prescan procedure for the sequence.

Note that the appropriate value of T_1 to null the signal from fat decreases with decreasing field strength and that most systems will slightly adjust the value during the pre-scan to minimize the signal from fat. Choose the value recommended by the equipment manufacturer or the applications specialist.

As with all sequences, the use of a lower field strength magnet may require changes in the sequence parameters (increased FOV or slice thickness, decreased acquisition matrix, greater N_{acq} or NEX, and others) to compensate for the lower signal-to-noise ratio (SNR). This is particularly true for the STIR sequence, which has a low SNR compared to FSE sequences.

Table A26.1.2 Transverse Scout

Patient position	Supine
Scan type	3-D short T_R gradient echo
Imaging plane (orientation)	Transverse
Central slice or volume center	Halfway between the anterior/superior iliac spine and the symphysis pubis
Echo time (T_E)	1.5 msec (or minimum)
Receiver bandwidth (RBW)	± 32 kHz
Repeat time (T_R)	6 msec (or minimum)
Flip angle (FA)	30°
Fields of view (FOV_x , FOV_y)	480 mm, 480 mm
Resolution (Δx , Δy)	1.88 mm, 3.75 mm
Number of data points collected (N_x , N_y)	256, 128
Slice thickness (Δz)	10 mm
Number of slices	15–20
Slice gap	0 mm
Number of excitations (NEX)	2
Number of acquisitions (N_{acq})	1
Swap read and phase encoding	No
Read direction	Right–left
Slice locations	From above iliac crest to below greater trochanter
Flow compensation	No
No phase wrap (NPW)	No
Chemical saturation	No
Spatial saturation	No
Scan time	~23–31 sec (depends on size of patient)

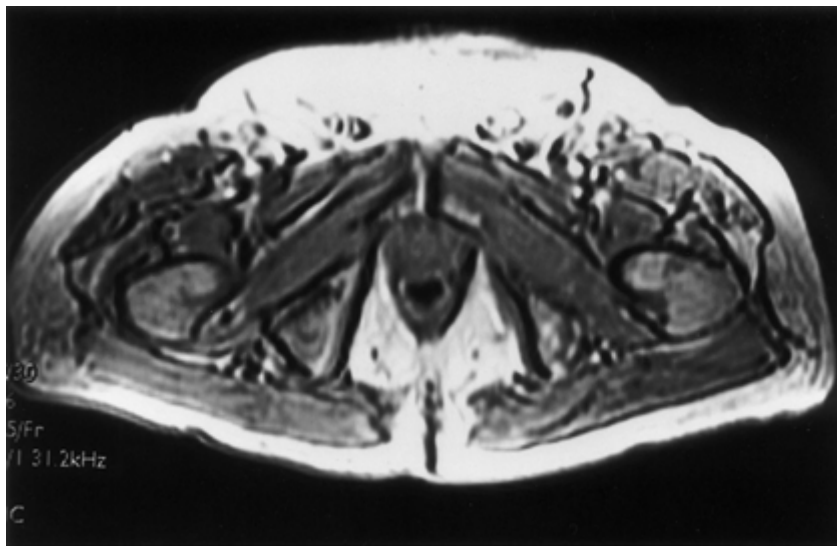
**Figure A26.1.1** A representative slice from the transverse scout series obtained using the parameters listed in Table A26.1.2

Table A26.1.3 Coronal Fast-STIR

Patient position	Supine
Scan type	2-D inversion recovery fast spin echo
Imaging plane (orientation)	Coronal or oblique coronal
Central slice or volume center	Through the femoral heads
Echo time (T_E)	~70 msec
Receiver bandwidth (RBW)	± 16 kHz
Echo train length (ETL)	8
Repeat time (T_R)	~3500 msec
Inversion time (T_I)	~150 msec (determined at prescan)
Flip angle (FA)	180° (or default)
Fields of view (FOV_x , FOV_y)	380 mm, 380 mm (should be chosen to include soft tissues lateral to hips—may be larger or smaller)
Resolution (Δx , Δy)	1.48 mm, 1.98 mm (but depends on FOV)
Number of data points collected (N_x , N_y)	256, 192
Slice thickness (Δz)	4 mm
Number of slices	30–40 (depends on size of patient)
Slice gap	0.5 mm
Number of excitations (NEX)	2
Number of acquisitions (N_{acq})	2
Read direction	Superior–inferior
Slice locations	From posterior to the SI (sacroiliac) joints to anterior to symphysis pubis
Flow compensation	Yes
No phase wrap (NPW)	Yes
Scan time	~7 min (will depend on factors discussed in text)

Sequence 3: Coronal short T_R/T_E spin echo

11. Obtain a coronal or oblique coronal short T_R/T_E SE sequence using the parameters given in Table A26.1.4 (Fig. A26.1.4). The FOV should be the same as that used for coronal fast-STIR sequence.

The number of slices will be determined by T_R and T_E . T_R can be increased to permit more slices but, if T_I weighting is to be maintained, should not be increased >800 msec at 1.5 T (less at lower field strengths). Because of the automatic interleaving of acquisitions, some adjustment of T_R with calculated acquisition times is generally performed.

Sequence 4: Transverse short T_E spin echo

12. Use T_1 -weighted coronal images to prescribe transverse images (Fig. A26.1.5). Obtain a short T_E transverse series of images using the parameters given in Table A26.1.5 (Fig. A26.1.6). The FOV should be the same as with above coronal sequences.

In contra-distinction to the T_1 -weighted coronal sequence above, no effort is made to provide T_1 weighting, so that T_R is adjusted to whatever length is required to image the region of interest in one acquisition as discussed in the steps above. The phase encoding and read directions are “swapped” so that the phase ghosts from the anterior wall are projected in the mediolateral direction to avoid hips.

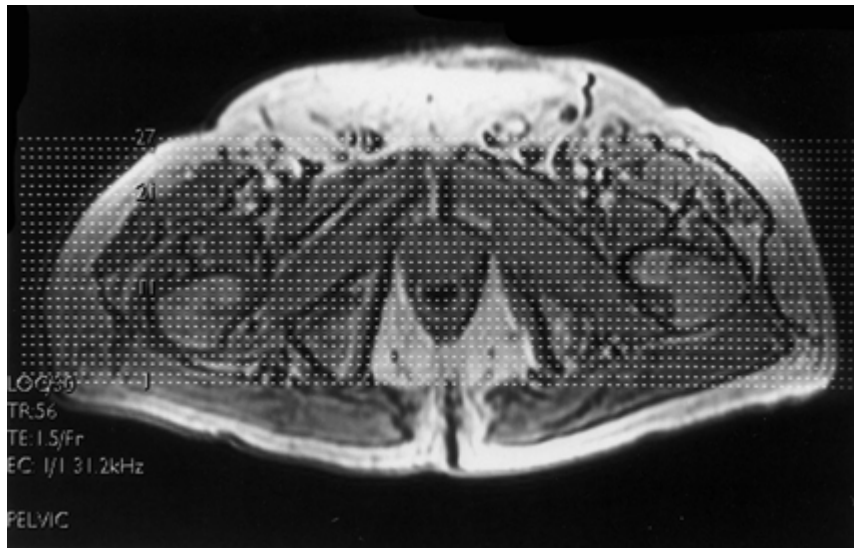


Figure A26.1.2 An image from transverse scout series with locations for the images of both the coronal series (sequences 2 and 3) indicated.

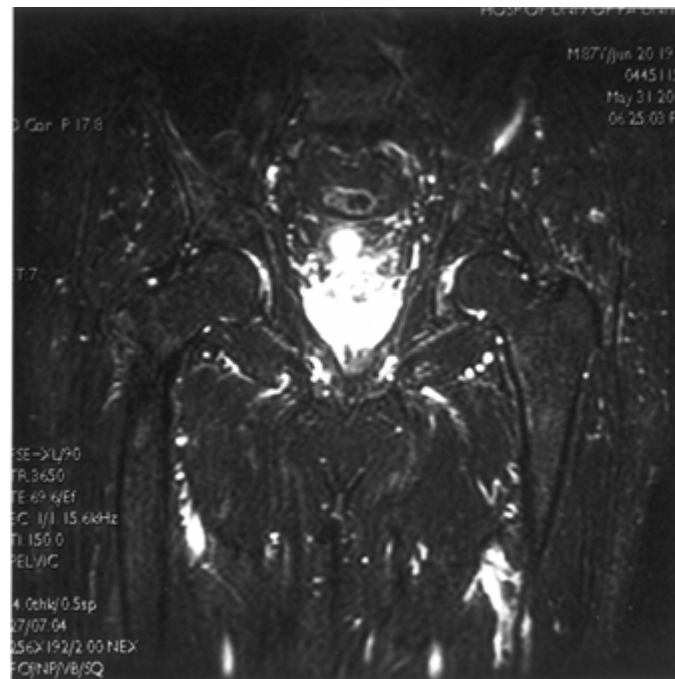


Figure A26.1.3 A representative coronal fast-STIR image obtained with parameters listed in Table A26.1.3.

Table A26.1.4 Coronal T_1 -Weighted Spin Echo

Patient position	Supine
Scan type	Spin echo
Imaging plane (orientation)	Coronal or oblique coronal
Central slice or volume center	Mid-pelvis through lesser trochanter
Echo time (T_E)	8 msec (or minimum)
Receiver bandwidth (RBW)	± 16 kHz
Repeat time (T_R)	600–800 msec (depending on size of patient)
Flip angle (FA)	90°
Fields of view (FOV_x , FOV_y)	380 mm, 380 mm (should be chosen to include soft tissues lateral to hips—may be larger or smaller)
Resolution (Δx , Δy)	1.48 mm, 1.98 mm (depends on FOV)
Number of data points collected (N_x , N_y)	256, 192
Slice thickness (Δz)	4 mm
Number of slices	30–40 (depends on size of patient)
Slice gap	0.5 mm
Number of excitations (NEX)	1
Number of acquisitions (N_{acq})	2
Read direction	Superior–inferior
Slice location	From posterior to SI joints to anterior to the symphysis pubis
No phase wrap (NPW)	Yes
Scan time	~4–6 min (depends on T_R , N_y , and N_{acq})

**Figure A26.1.4** A representative coronal T_1 -weighted spin echo image obtained with parameters listed in Table A26.1.4.



Figure A26.1.5 A T_1 -weighted coronal image with locations of the images from both transverse series (sequences 4 and 5) indicated.

Table A26.1.5 Transverse Short T_E Spin Echo

Patient position	Supine
Scan type	2-D spin echo
Imaging plane (orientation)	Transverse
Central slice or volume center	Mid-pelvis through lesser trochanter
Echo time (T_E)	8 msec
Receiver bandwidth (RBW)	± 16 kHz
Repeat time (T_R)	600–1000 msec (depends on size of patient; no attempt to maintain T_1 weighting)
Flip angle (FA)	90°
Fields of view (FOV_x , FOV_y)	380 mm, 380 mm (depends on size of patient)
Resolution (Δx , Δy)	1.48 mm, 1.98 mm (depends on FOV)
Number of data points collected (N_x , N_y)	256, 192
Slice thickness (Δz)	5 mm
Number of slices	30–40 (depends on size of patient)
Slice gap	1 mm
Number of excitations (NEX)	1
Number of acquisitions (N_{acq})	2
Swap read and phase encoding	Yes
Read direction	Anterior–posterior
Slice locations	From above iliac crests to below lesser trochanters
No phase wrap (NPW)	Yes
Spatial saturation	Superior and inferior
Scan time	~4–6 min (depends on T_R , N_y , and N_{acq})



Figure A26.1.6 A representative short T_E spin echo transverse slice obtained using the parameters listed in Table A26.1.5.

Table A26.1.6 Transverse T_2 -Weighted Fat-Saturated Fast-Spin Echo

Patient position	Supine
Scan type	2-D fast spin echo
Imaging plane (orientation)	Transverse
Central slice or volume center	From above iliac crests to below lesser trochanters
Echo time (T_E)	90 msec
Receiver bandwidth (RBW)	± 16 kHz
Echo train length (ETL)	8
Repeat time (T_R)	6000 msec (depending on factors discussed in text)
Flip angle (FA)	90° (or default)
Fields of view (FOV_x , FOV_y)	380 mm, 380 mm (same FOV as above sequences)
Resolution (Δx , Δy)	1.48 mm, 1.98 mm
Number of data points collected (N_x , N_y)	256, 192
Slice thickness (Δz)	5 mm
Number of slices	30–40 (depends on T_R)
Slice gap	1 mm
Number of excitations (NEX)	1
Number of acquisitions (N_{acq})	2
Swap read and phase encoding	Yes
Read direction	Anterior–posterior
Slice location	From above iliac crests to below lesser trochanters
No phase wrap (NPW)	Yes
Chemical saturation	Yes (fat)
Spatial saturation	Yes (superior and inferior)
Scan time	~ 5 min (depends on T_R)

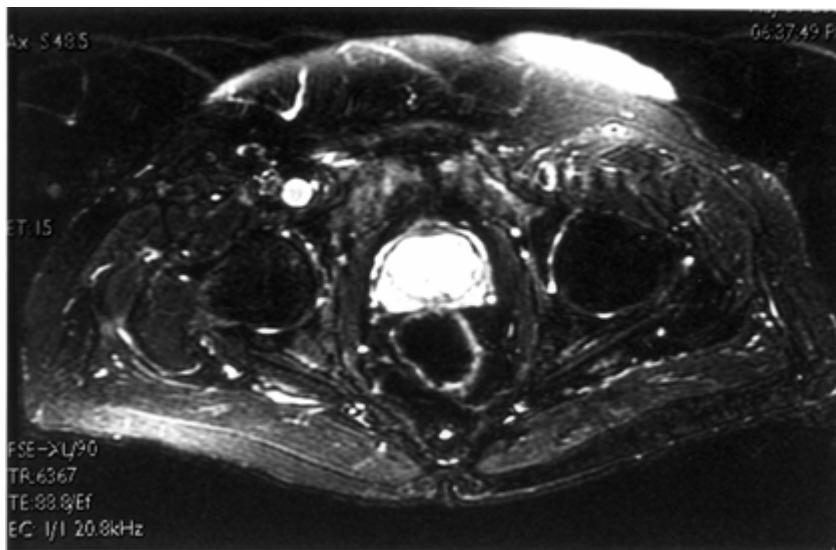


Figure A26.1.7 A representative fat-saturated T_2 -weighted fast-spin echo transverse image obtained with the parameters listed in Table A26.1.6.

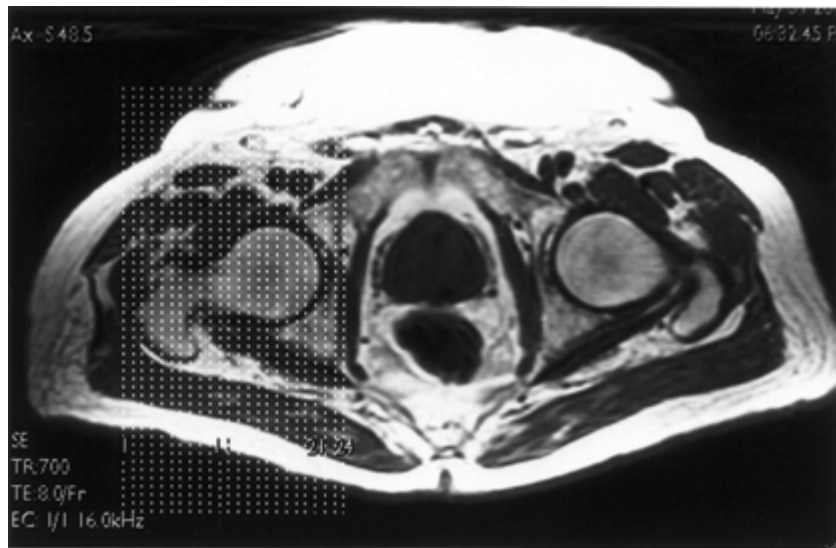
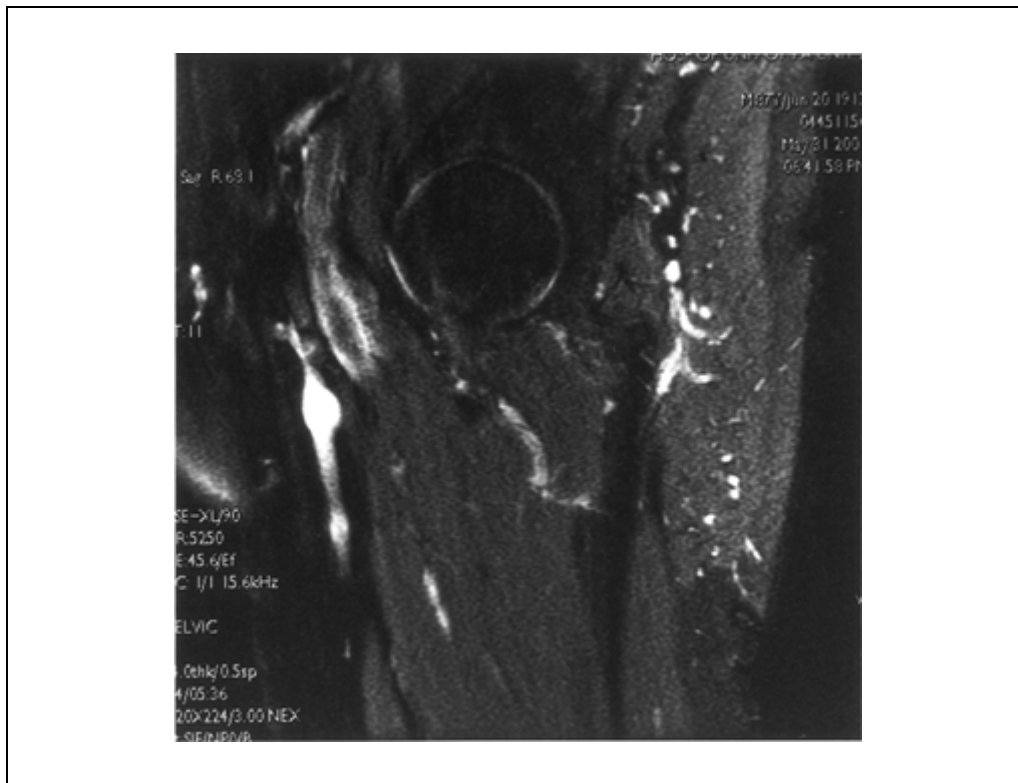


Figure A26.1.8 A short T_E transverse slice with location of the images from the sagittal series indicated.

Table A26.1.7 Sagittal Fat-Saturated Intermediate-Weighted FSE

Patient position	Supine
Scan type	Fast spin echo
Imaging plane (orientation)	Sagittal
Central slice or volume center	Through lesser trochanter
Echo time (T_E)	40 msec
Receiver bandwidth (RBW)	± 16 kHz
Echo train length (ETL)	8
Repeat time (T_R)	5000 msec (depends on factors discussed in text)
Flip angle (FA)	90° (or default)
Fields of view (FOV_x , FOV_y)	200 mm, 200 mm
Resolution (Δx , Δy)	0.78 mm, 1.04 mm
Number of data points collected (N_x , N_y)	256, 192
Slice thickness (Δz)	4 mm
Number of slices	20–25
Slice gap	0.5 mm
Number of excitations (NEX)	3
Number of acquisitions (N_{acq})	2
Swap read and phase encoding	Yes
Read direction	Anterior–posterior
No phase wrap (NPW)	Yes
Chemical saturation	Yes (fat)
Spatial saturation	No
Scan time	~5 min (depends on T_R)

**Figure A26.1.9** A representative intermediate weighted fast spin echo image.

Sequence 5: Transverse fat-saturated long T_E FSE

13. Run a long T_E FSE sequence using the parameters in Table A26.1.6 (Fig. A26.1.7). The FOV should be the same as with the coronal sequences.

Fat saturation is used because of the relatively bright signal seen from fat with T_2 -weighted FSE sequences.

Selection of precise T_R is governed by the same considerations concerning multiple acquisitions discussed above for fast-STIR sequence and will generally be performed at the time of scan.

On low-field systems, fat-saturation cannot be used, thus, the authors typically combine sequences 4 and 5 into one single long T_R , double spin echo sequence with both short and long T_E s.

Sequence 6: Sagittal fat-saturated intermediate-weighted FSE (optional)

14. Use transverse short T_E images to prescribe sagittal images (Fig. A26.1.8). If osteonecrosis is seen in the femoral head on the coronal or transverse images, run a long T_R , intermediate T_E FSE sequence using the parameters in Table A26.1.7 (Fig. A26.1.9).

The combination of fat saturation and an intermediate T_E makes the articular surface more visible for assessment of contour abnormalities. The selection of T_R is determined by the same considerations used for the selection of T_R in regard to the fast-STIR coronal and T_2 -weighted fast-spin echo transverse sequences that were discussed above.

For low-field systems, a short T_R/T_E SE sequence with the same resolution as that used with the other sequences is acquired (see Table A26.1.5 with $FOV_x = FOV_y = 200$ mm).

COMMENTARY

Background Information

Osteonecrosis and transient osteopenia

Osteonecrosis (ON) of the femoral head represents the death of bone that occurs in the absence of trauma. Although its etiology is uncertain, there are several well-established pre-disposing factors, of which the most common is the administration of steroids.

In the absence of treatment, most cases of ON of the femoral head progress to collapse of the cortical surface with the subsequent development of rapidly progressive osteoarthritis. In view of the young age of most patients (30 to 50), this poses a major problem because of the limited lifetime of hip prostheses.

Many orthopedists believe that surgical intervention, using such techniques as core decompression when performed before the onset of cortical collapse, can halt progression of the disease. For this reason, there is considerable importance attached to the early diagnosis of ON. MRI is believed to be the best means of establishing the diagnosis prior to collapse.

Transient osteopenia, also known as transient bone marrow edema syndrome, is a poorly understood but self-limited disorder that was originally described in women in the third tri-

mester of pregnancy but is more commonly seen in middle-aged and elderly men. The disease is self-limited but can result in a very painful hip for up to 9 months.

Fractures

Fractures of the hip or pelvis can result from either single traumatic events or from the application of chronic repetitive trauma (stress fractures). Plain films are always the first imaging technique that should be chosen for the detection of fractures but they may fail to detect them. Fractures of the sacrum are most commonly stress fractures and have generally been described in osteoporotic women or in women who have undergone radiation therapy for gynecologic tumors. More recently, they have been identified in female athletes, particularly those who are amenorrheic. More recently, subchondral stress fractures of the femoral head have been described in elderly women that, clinically, may potentially be confused with ON. Although radionuclide bone scans have traditionally been used to detect radiographically occult fractures, most investigators believe that MRI is as sensitive, more specific, and, in older patients, displays earlier positivity than bone scans.

The early diagnosis of these radiographically occult fractures permits the institution of appropriate therapy at an earlier stage, often avoiding the more aggressive treatment necessary for more advanced fractures.

Soft tissue abnormalities

Abnormalities of the soft tissues surrounding the pelvis represent a diverse group of disorders. All of these disorders occur elsewhere in the musculoskeletal system and include muscle injury, tendon degeneration, bursitis, and soft tissue tumors. In the authors' experience, the patient's major complaint is pain referring to the hip and the nature of the disorder is often not known. The significance of timely diagnosis of soft tissue abnormalities with MRI is heavily dependent on the nature of the abnormality.

Critical Parameters and Troubleshooting

The use of MRI for the detection of osseous and peri-articular soft tissue abnormalities is straightforward and accurate studies can be performed on almost any commercial system. The FOV is chosen to include the hips and the adjacent soft tissue that could also give rise to symptoms in the region of the hip. T_R is probably the most critical parameter for each of the

sequences and its selection involves the factors that were detailed above for the individual sequences. The use of array coils or other surface coils is not necessary for the MR diagnosis of any of these disorders although occasionally the higher resolution attainable with these coils may be useful to distinguish between two disorders with a similar appearance such as osteonecrosis and the much less common subchondral insufficiency fracture. The added value of obtaining additional images at higher resolution is unproven.

Anticipated Results

Osteonecrosis and transient osteopenia

ON is seen as a well-marginated geographic focus of variable signal in the weight-bearing surface of the femoral head with a well-defined interface. The interface has a low signal on a T_1 -weighted sequence (sequence 3; Fig. A26.1.10) and demonstrates parallel high- and low-signal lines on long T_E sequences ("double-line sign"). The region of the femoral head surrounded by the abnormal curvilinear margin most commonly demonstrates the same signal intensity as marrow fat on all sequences. Less commonly, these foci may demonstrate low signal on T_1 -weighted images and high signal on T_2 -weighted images or low signal on both

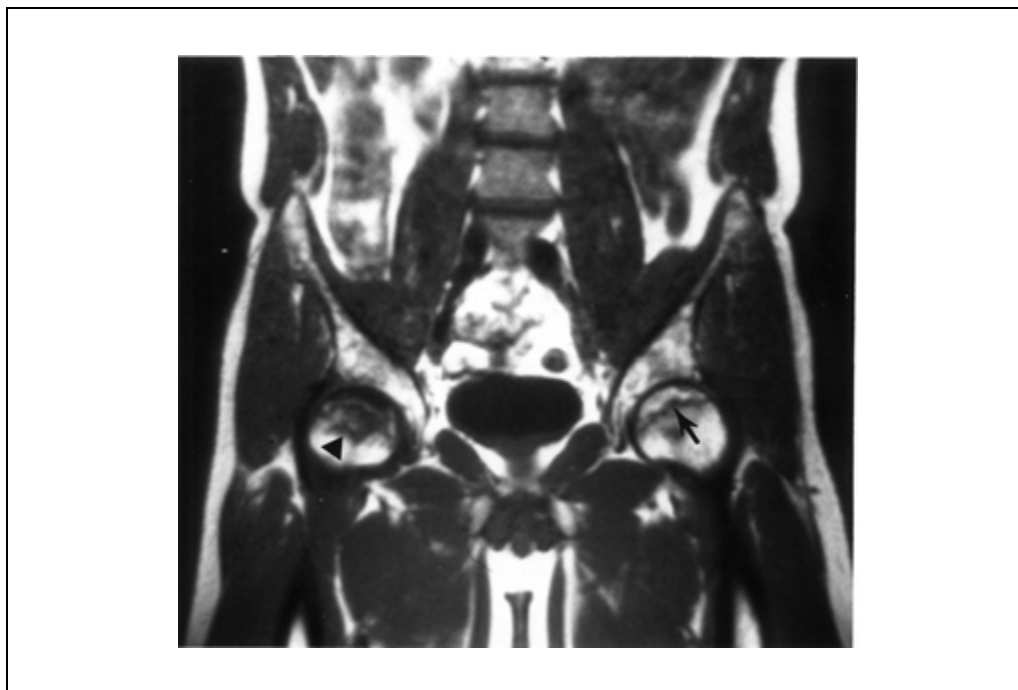


Figure A26.1.10 A coronal T_1 -weighted image through the hips of a patient with bilateral ON. In the patient's left femoral head, a low signal interface surrounds the focus of ON with the signal intensity of fat (arrow). In the right femoral head, the focus of ON demonstrates diffuse low signal (arrowhead).



Figure A26.1.11 A fast-STIR coronal image through the hips in a patient with transient bone marrow edema syndrome showing diffuse edema (e) in the left femoral head and neck.

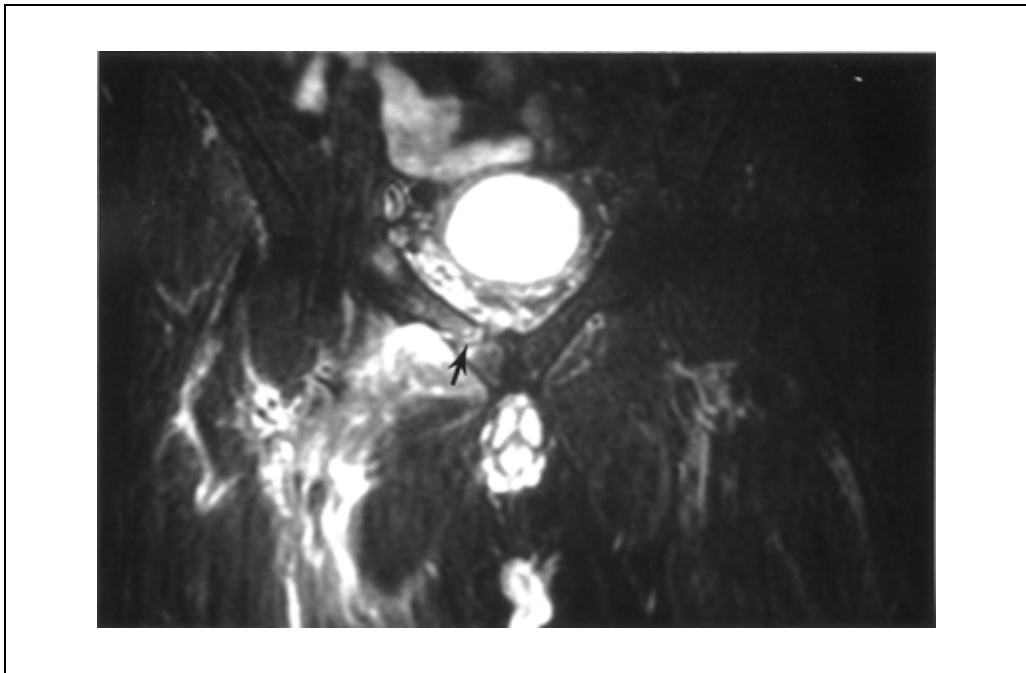


Figure A26.1.12 A fast-STIR coronal image through both ischiopubic rami demonstrates a high-signal fracture (arrow) with edema in the surrounding bone and soft tissue.

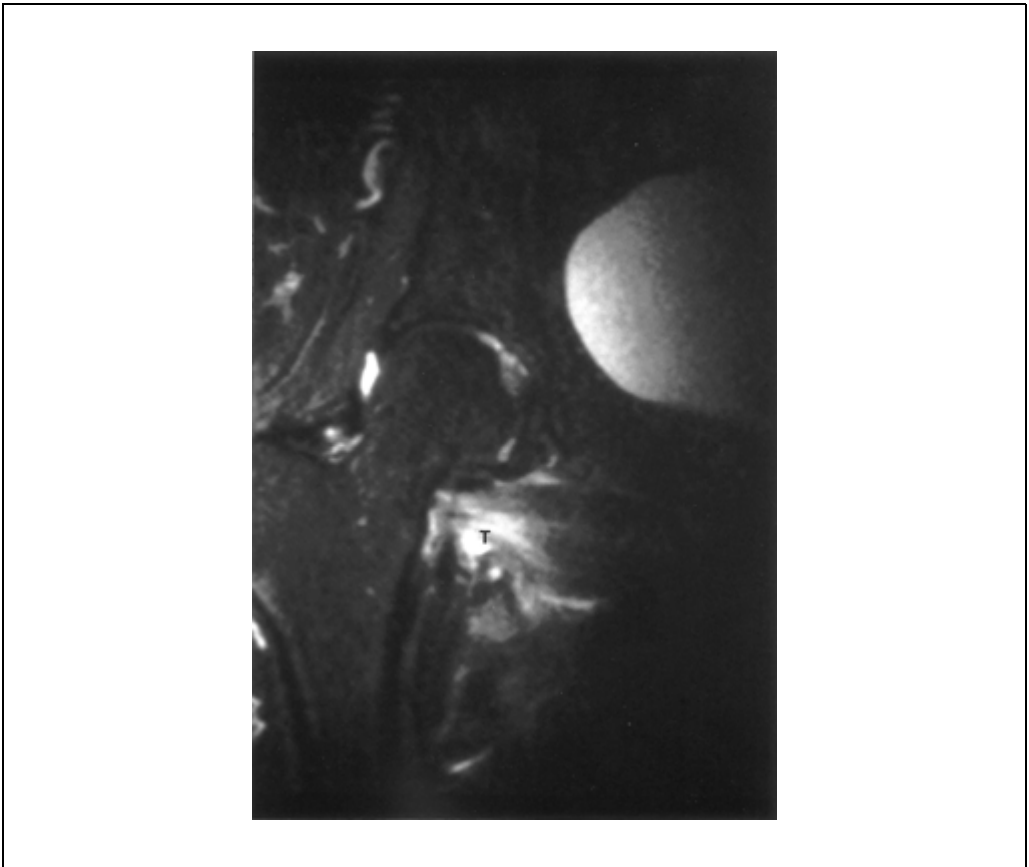


Figure A26.1.13 A coned-down fast-STIR coronal image illustrates the appearance of a tear (T) of the pectineus muscle.

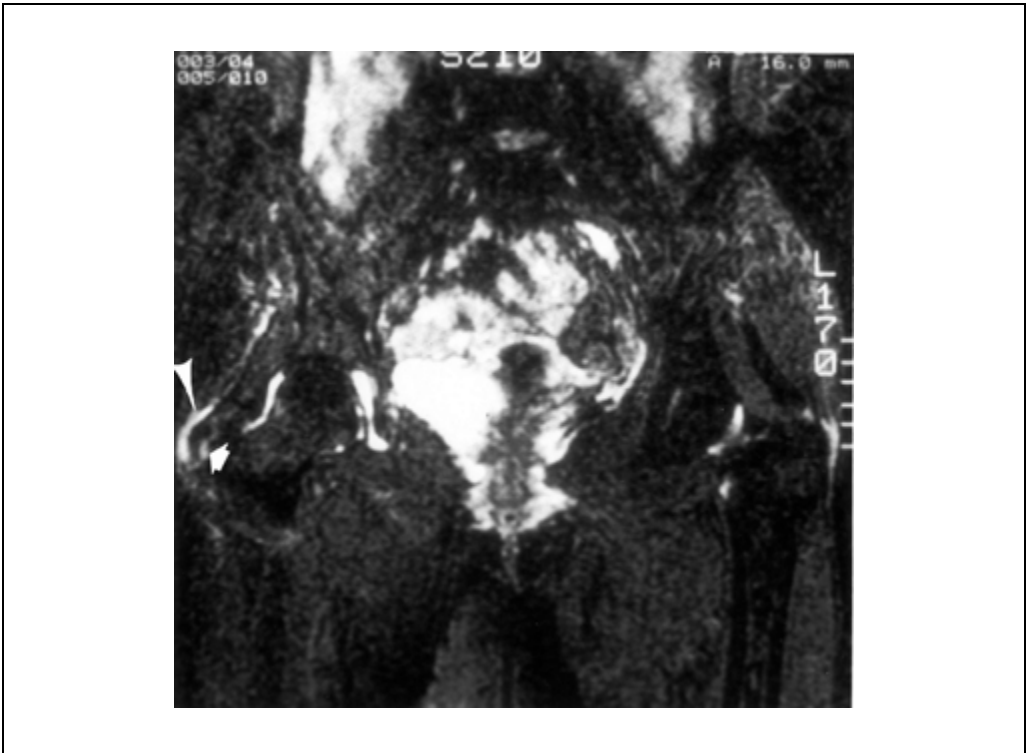


Figure A26.1.14 A fast-STIR coronal image demonstrating a partial tear of the gluteal tendon (arrow) with an accompanying trochanteric bursitis (arrowhead).

short and long T_E sequences (Mitchell et al., 1987; Lang et al., 1988). In some cases, there is a zone of surrounding bony edema that is seen as diffuse low signal on T_1 -weighted images and high signal on T_2 -weighted images. The presence of bony edema has been claimed by some investigators to be associated with hip pain.

There have been several publications that have investigated the value of measuring the size of the lesion. All have used different techniques with varying degrees of quantitation and all have agreed that the larger the lesion, the greater the probability of collapse even with performance of core decompression surgery (Beltran et al., 1990; Lafforgue et al., 1993). There is no agreement on the best technique to measure size but the percentage (by quartiles) of the weight-bearing surface involved can be readily estimated.

Transient osteopenia is seen as abnormal signal (low on T_1 -weighted and bright on T_2 -weighted and STIR sequences) that extends throughout the femoral head and neck but without the more discrete focus of abnormal signal with a well-defined margin that is typical of ON (Fig. A26.1.11; Vande Berge et al., 1999).

Fractures

Fractures are most commonly seen as linear foci with low signal on all pulse sequences, although in some cases, a high signal linear focus is seen on T_2 -weighted images (Fig. A26.1.12). There is generally ill-defined, abnormal signal in the surrounding marrow (low signal on short T_E sequences, high signal on long T_E and STIR sequences) that is believed to represent marrow edema. With the use of the STIR sequence, the marrow edema may be very bright and obscure the fracture line (Quinn and McCarthy, 1993). When the fracture occurs in the subchondral region of the femoral head, it can be difficult to distinguish from ON, although the double-line sign is less commonly seen (Yamamoto et al., 2001).

In addition to identifying the presence of pelvic fractures, MRI can also identify the presence of associated soft tissue injuries such as muscle tears (see below; Bogost et al., 1995).

Although MRI is the best technique for the detection of subtle fractures, CT (computed tomography) with reformatting or surface rendering is considered to be the most accurate technique for determining the spatial relationship among displaced fragments and for classifying complex acetabular fractures.

Soft tissue abnormalities

In view of the wide range of possible diagnoses, it is not possible to discuss the MR appearance of every disorder. Benign and malignant soft tissue tumors have a wide variety of appearances that depend on the nature of the tumor (Sundaram et al., 1988). Muscle injury is seen as increased signal on T_2 -weighted or STIR sequences with varying degrees of disruption of muscle architecture (DeSmet and Best, 2000; Fig. A26.1.13). Degeneration and tears of the gluteal tendons are seen as high signal on T_2 -weighted and STIR images within or completely interrupting the normal low signal of the tendons (Kingzett-Taylor et al., 1999; Fig. A26.1.14). Bursitis (iliopsoas, trochanteric) is seen as homogeneous high signal on T_2 -weighted and STIR sequences in the appropriate location. Trochanteric bursitis often accompanies gluteal tendon degeneration but may also occur in its absence (Fig. A26.1.14). The significance of bursitis must be interpreted in light of its location and clinical symptoms.

Literature Cited

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