

Diagnostic Algorithm in the Elderly

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Abbreviations

BMD	Bone mineral density
BMI	Body mass index
CCL	Chronic lymphatic leukemia
CEUS	Contrast-enhanced ultrasound
CT	Computed tomography
CUS	Compression ultrasound
DR	Digital radiology
DXA	Dual-energy x-ray absorptiometry
FRFSE	Fast Relaxation Fast Spin Echo
GFR	Glomerular filtration rate
MDCT	Multidetector computed tomography
MRI	Magnetic resonance imaging
NM	Nuclear medicine
PET-CT	Positron emission tomography-computed tomography
PRF	Pulsed radiofrequency
QCT	Quantitative computed tomography
QUS	Quantitative Ultrasound
RF	Radiofrequency
RSNA	The Radiological Society of North America
SE	Spin echo
SPECT	Single-photon emission computed tomography
STIR	Short T1 inversion recovery
US	Ultrasound
WHO	World Health Organization

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2.1 Introduction

Our purpose in this chapter is to establish a linear, step-by-step procedure for use in musculoskeletal diagnostic imaging of elderly patients, describing some of the clinical peculiarities of old age and suggesting some specific technical choices. The authors start from the first symptoms that lead elderly patients to imaging, that is, pain (acute, breakthrough, or chronic), related to a traumatic lesion or a nontraumatic disease, to reach a clinical flowchart (algorithm). Consequently, the authors propose three flowcharts, one for axial trauma, one for appendicular skeletal trauma, and one for nontraumatic skeletal diseases to describe the procedures for diagnostic imaging in the elderly. The goal of this step-by-step procedure is to aid the diagnostician in sorting through the possible diagnoses and, if possible, to reach the correct diagnosis, and so approach the best therapy.

2.2 General Considerations

In the elderly, the increased presence of degenerative or sometimes malignant diseases, often associated with acute trauma, leads to an increase in musculoskeletal injuries. The boundary between the normal aging of tissue and the related appearance of structural changes and real pathological conditions can be difficult to determine. Aging organs and tissues lose volume and elasticity due to reduced water content and vascularization associated with delayed cell growth. Added to the increase of the connective tissue and deposition of lipids and calcium, these changes cause considerable alterations of the tissues that make up the musculoskeletal system. The distinctive features of the musculoskeletal system, such as the elastic and contractile capacity of muscles and tendons or the mass resistance of bone and cartilage, inevitably change with age.

The gradual process of aging varies widely among individuals and can hardly be classified by rigid schemes related to chronological age, especially with regard to the musculoskeletal

system. The relationship between various levels of exercise and the morphology of skeletal muscle has been studied in the elderly: the age-related structural and functional changes seem reduced in physically active subjects (Klitgaard et al. 1990).

Currently many healthy people over 65 years, the definition of elderly, can still perform mid- or high-level physical activity and participate in sports. Traumatic incidents, however slight or moderate, or onset of inflammatory disease or tumor involving the musculoskeletal system, however, put the elderly at risk of serious deterioration of musculoskeletal functions, caused by the reduced ability to respond to dynamic stress and limited possibilities of structural repair. Musculoskeletal effects can have very different consequences in the elderly than in younger adults: in old age the lesion is established on tissue characterized by a biologically easy progression to disability (Guglielmi et al. 2006).

Musculoskeletal diseases can lead to death in the elderly (an example is hip fracture and its complications) but more frequently cause disability and impaired quality of life. Preventing progression from disease to disability is quite important (Ferrucci et al. 2008). To prevent disability, the patient must be able to maintain three basic skills: standing, reaching, and grasping. Diagnostic methods should aim for the correct identification and evaluation of all conditions that can cause disability and to monitor their state through time.

2.2.1 Clinical Traits

Pain and functional limitations are the most common symptoms of musculoskeletal affections in the elderly. The elderly are more likely to have arthritis, bone, joint and musculoskeletal disorders, and other chronic diseases including primitive or secondary bone neoplasm. They are often accompanied by chronic pain and often complicated by minor or major trauma. Rheumatologic diseases in geriatric patients may begin with atypical manifestations, different from typical findings in younger patients. Elderly subjects

may have nonspecific complaints, a decline in physical function, or confusion (Michet et al. 1995). The consequences of misunderstanding and/or undertreating pain are a poorer quality of life, resulting in depression, social isolation, loss of sleep, and sometimes immobility (Fig. 2.1). Therefore, pain is the first sign to be measured in the elderly patient (Fig. 2.2).

In recent years, collaboration among physicians, such as geriatricians, orthopedists, and radiologists, has much improved our knowledge of the multifactorial etiology of pain. Consequently, modern diagnostic imaging must consider the most common clinical manifestations of the “healthy” and the “ill” elderly. Because the pathologies of old age are often different than those in younger adults, identifying the etiology of pain (often multifactorial) in the elderly, by use of geriatric assessment and retrospective history of the patient, is nowadays “the challenge” for modern radiologists. It should be noted that in the elderly comorbidity, defined as co-occurrence of multiple chronic conditions (Ferrucci et al. 2008), is common and can make the clinical diagnosis of musculoskeletal disorders difficult (Van Schaardenburg et al. 1994). Symptoms may be caused by a set of conditions in the musculoskeletal system or in other organs and can mask the clinical manifestations of uncommon pathologies. In particular, in one of two patients with a rheumatic disease, at least one other chronic condition will be diagnosed (Van Schaardenburg et al. 1994). The coexistence of multiple pathologies also involving the musculoskeletal system causes a significant reduction in quality of life and can lead to serious disability.

A large proportion of elder people suffer chronic joint symptoms (Ferrucci et al. 2008); these can cause major functional limitations, considering only the musculoskeletal system, and most commonly affect the shoulder joint. Frequently, the disability is related to other concomitant afflictions: in a Dutch community survey, a walking disability, defined as an inability to walk at least 500 m, was found in 60 % of the subjects over 85 years old. According to the report, hip and knee osteoarthritis, impaired vision, cognitive impairment, and neurological

disease were the main causes of disability (Van Lankveld et al. 2005).

Cancer is the second leading cause of death in the USA and epidemiologists estimate that in the next few years it will exceed the current leader, heart disease (Berger et al. 2006; Muss 2009).

The incidence of cancer increases with age: skeletal metastases are the most common malignant bone tumor. In woman the primary cancer is most frequently in the breast, and in men the primary cancer is in the prostate. They are followed, by frequency of bone metastases, by malignant tumors of the lung, kidney, thyroid, gastrointestinal tract, bladder, and skin (Cheong et al. 2008).

In the elderly population of the USA, Europe, and Japan, cancer mortality has stopped its long-term rise; multiple myeloma is the exception. It is estimated that 20 % of both men and women aged 65–84 will be affected by multiple myeloma (Levi et al. 2001).

In old age the incidence of multiple myeloma, malignant bone marrow cancer, is high. It can present with bone lesions (Fig. 2.3): imaging findings are critical to the diagnosis, classification, and clinical follow-up. Other oncohematologic disorders, like CCL (chronic lymphatic leukemia), aplastic anemia, and osteomyelofibrosis/osteomyelosclerosis, may affect the elderly with high or moderate degree of bone impairment (Baur-Melnyk and Reiser 2008).

The radiologist must be cautious in making the association between clinical history and imaging: a bone replacement lesion in a patient with a previous cancer should not lead one to diagnose a metastasis. In addition to the bone oncohematologic lesions, there are also chondrosarcomas, which are frequent in the elderly but do not always have typical imaging features (Baur-Melnyk and Reiser 2008; Cheong et al. 2008).

Paget disease is usually diagnosed before an advanced age; but because of its slow progression, this condition is often seen in geriatric patients: bone changes are often asymptomatic and are found incidentally (Cheong et al. 2008).

Genetics, hormonal balance, renal function, and lifestyle all contribute to the development of osteoporosis in the elderly: the bone is frailer due to an altered balance between production and

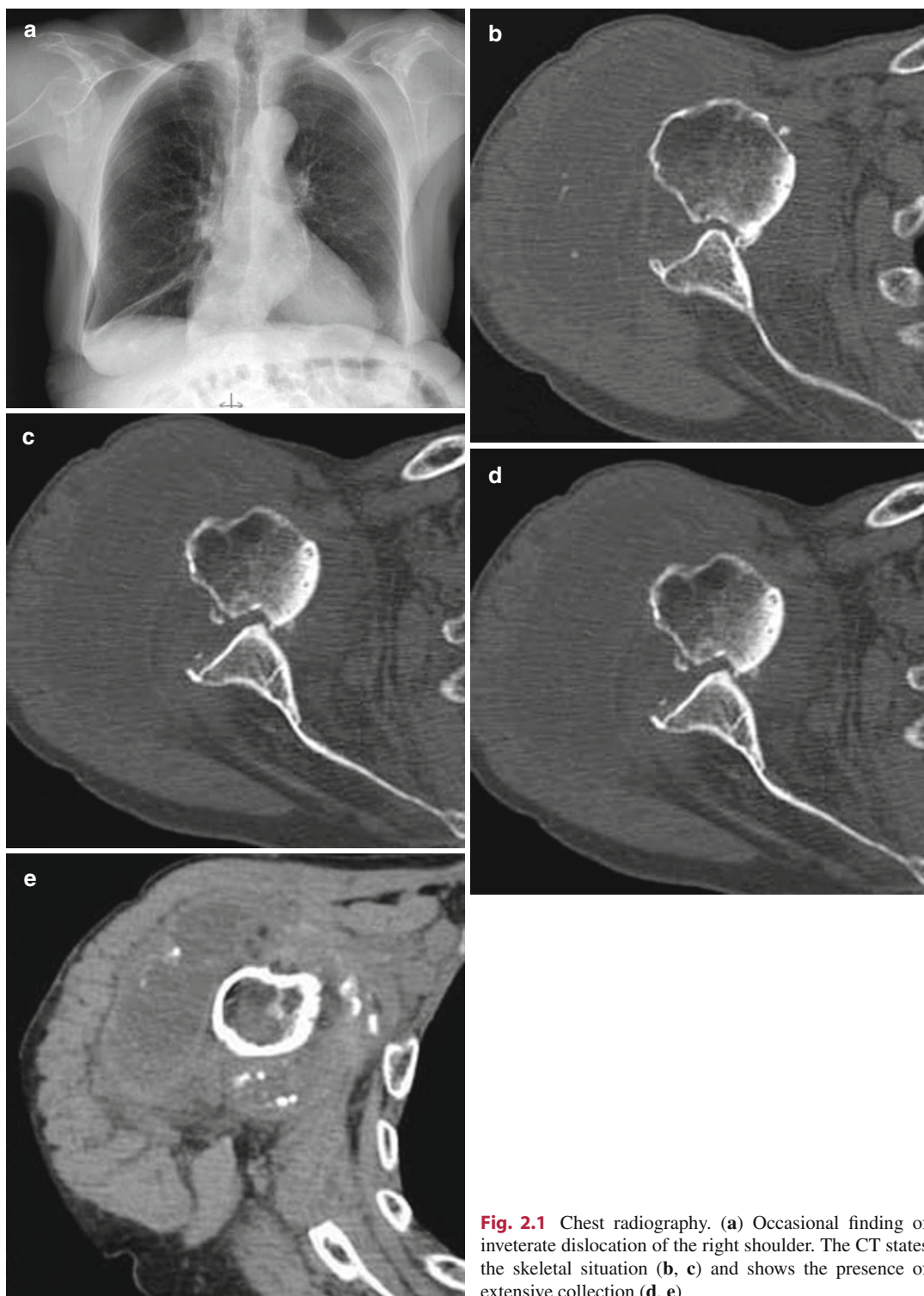


Fig. 2.1 Chest radiography. (a) Occasional finding of inveterate dislocation of the right shoulder. The CT states the skeletal situation (b, c) and shows the presence of extensive collection (d, e)

Fig. 2.2 Clinical algorithm in elderly with musculoskeletal pain

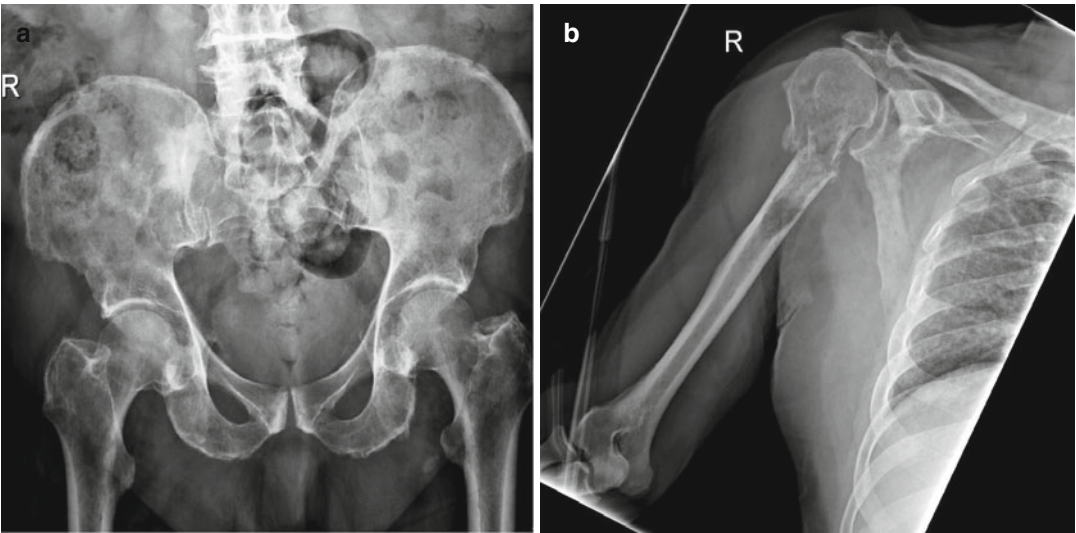
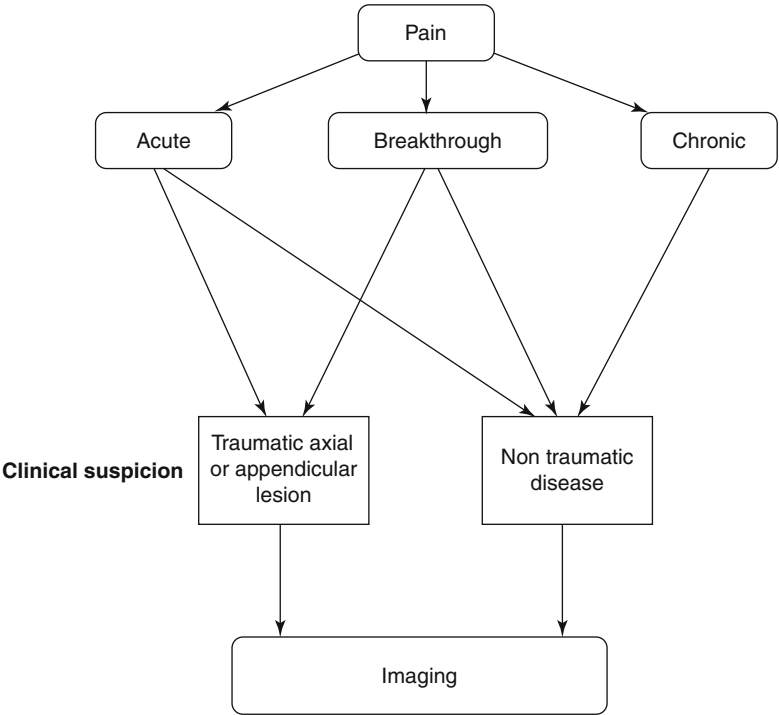


Fig. 2.3 Multiple myeloma lesions. Pelvis radiography (a). Right arm radiography (b) shows a pathological fracture. Spine CT: coronal (c, d) and sagittal (e, f) reformat-

ted. Spine scans: MRI: STIR (g), T2W FRFSE (h), T1W SE (i), T2W FRFSE (j), STIR (k), T1W SE (l)

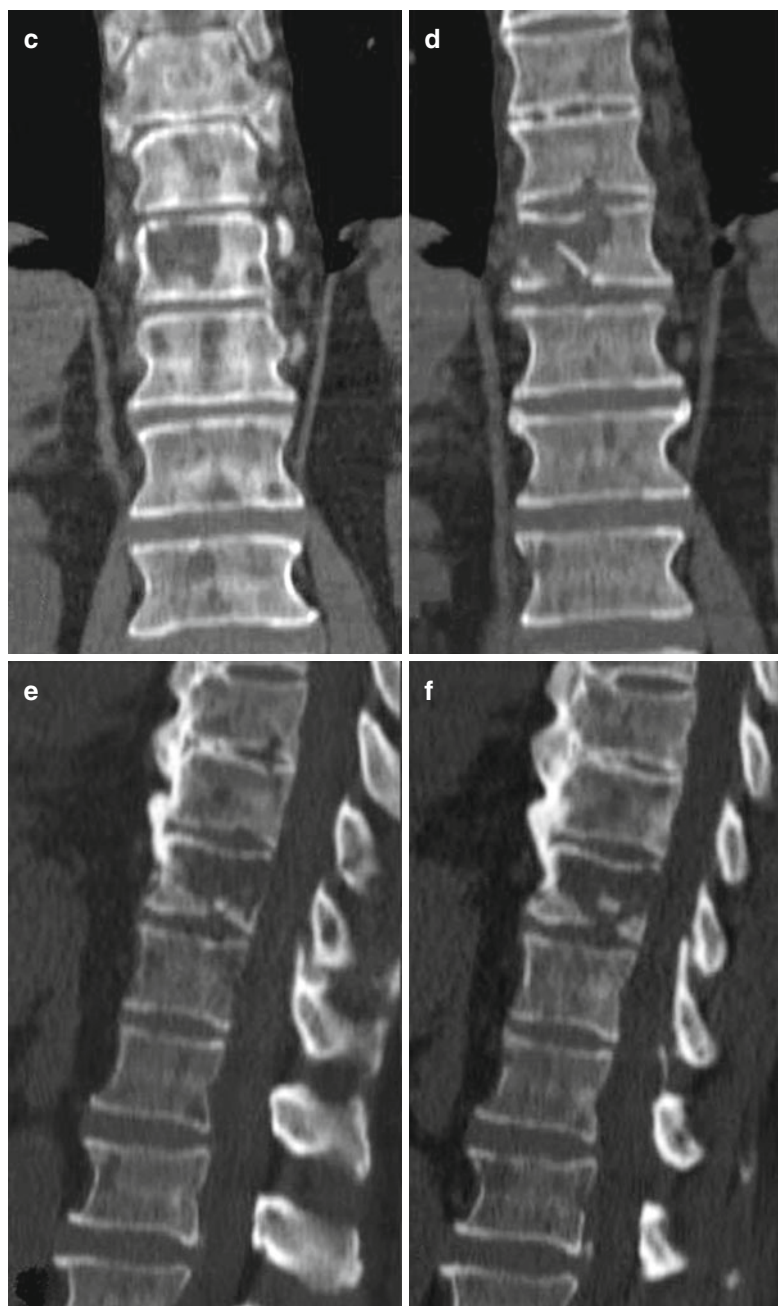
Fig. 2.3 (continued)



Fig. 2.3 (continued)

resorption and its calcium content reduced, increasing the risk of fractures (Guglielmi et al. 2006, 2008).

Paradoxically, the calcium is deposited in many normally non-calcified structures (Fig. 2.4). Extra skeletal calcifications of vascular walls, ligament insertions, chondral portions of ribs,

elaioma, and other sites are quite common in the elderly. These calcified structures can overlap on bone lesions in conventional radiography. They may not even be visible, or they may require many exposures in different views to be seen.

Diagnostic procedures can also be used also to guide interventional therapy. Therapy can often

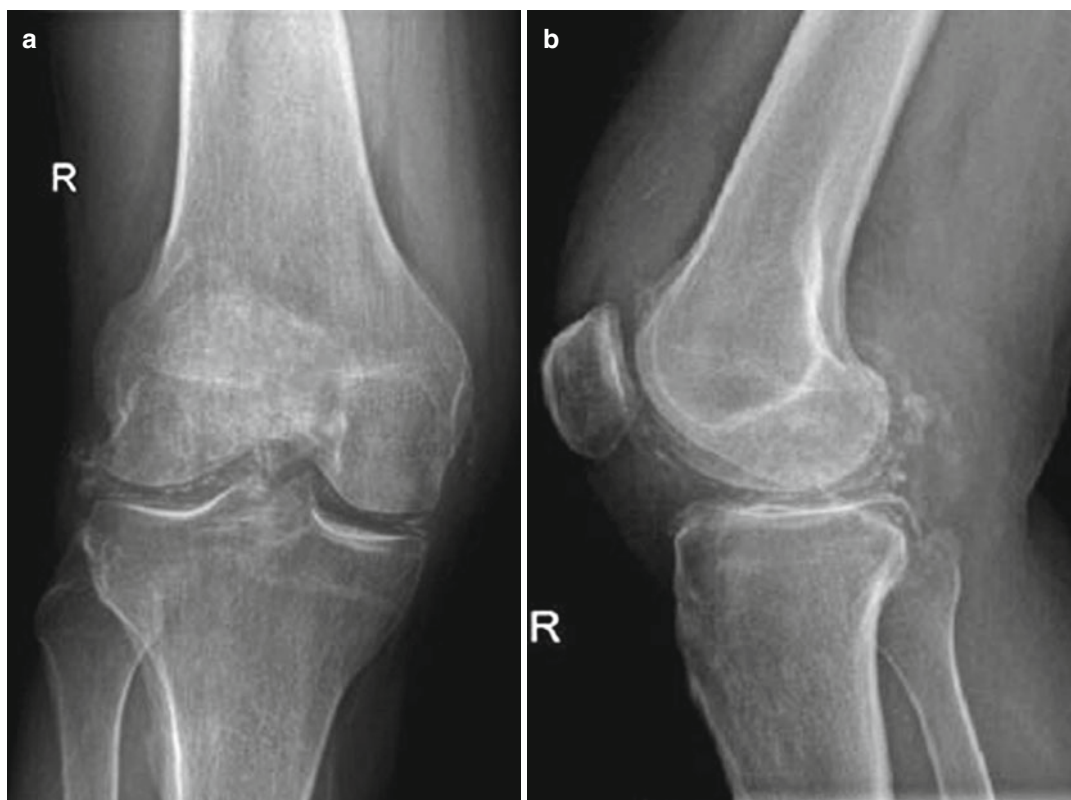


Fig. 2.4 (a, b) Right knee radiography shows the presence of meniscus and ligament calcifications in chondrocalcinosis

substitute for surgery or at least mitigate the surgical approach. Any invasive procedure will be less well tolerated by the elderly, especially if there are comorbidities. Many interventional radiology techniques require only local anesthesia or none at all.

2.2.2 Technical Choices

The elderly patient suffering from a musculoskeletal pathology can be a fragile subject from a psychological perspective, requiring special care. Discomfort, due to medical conditions, especially pain, is often increased by the difficulty of communicating caused by the common disabilities of old age: diminished hearing and seeing, difficulty in expressing oneself, or lack of physical coordination. The medical and paramedical staff caring for the elderly patient should work to reduce any

psychological trauma. The professionalism of the imaging department team necessitates empathy: in listening to the problems reported by the patient and explaining in a simple way the procedures to be performed while fully respecting the patient's privacy and dignity (Ferrucci et al. 2003; Serraino et al. 2001).

The Radiological Society of North America (RSNA) has published guidelines, based on diagnostic and interventional radiology, medical physics, nuclear medicine, radiation oncology, ultrasound, and MR imaging, for choosing the best techniques for use in different clinical situations (RSNA 2011). Based on the clinical characteristics of elderly patients, the first diagnostic level is plain radiography, which is widely available and relatively inexpensive (Fig. 2.5). Unfortunately in geriatric patients, radiography may be difficult: correct positioning may require devices, more or less stiff, to



Fig. 2.5 Pelvis radiography: occasional finding of inveterate pseudoarthrosis of an unrecognized fracture of the right femoral neck, in a patient with dementia

assure correct posture and immobilization. Mobile x-ray equipment with high-quality digital panels and radiolucent beds and gurneys are useful to avoid unnecessary movement for the patient.

With regard to radiation protection, the elderly do have one advantage in that there is no need to be concerned with pregnancy or the effects of radiation on offspring. The elderly are often subjected, however, to numerous and repeated studies of different anatomical sites. Digital radiology (DR) is to be preferred to conventional techniques: thanks to post-processing, digital capture allows assessment with a single exposure to radiations of bone and soft tissue injuries that are characterized by different levels of radiopacity. Window and contrast level can be manipulated to evaluate the osteoporotic bone with a focused study during the reading.

With regard to the technical exposure data (mAs and kV), techniques that assure a rapid acquisition are to be preferred, not only to avoid breath and movement artifacts, but because elderly people often cannot hear instructions or cannot collaborate because of impaired mental status (Cáceres 2005).

Due to the difficulty of localizing exactly the site of pain because of preexisting algological pathologies, diagnostic procedures on the musculoskeletal system may be more extended. Panoramic radiographs are preferable to targeted x-rays, at least during the initial diagnosis (e.g., pelvis rather than a single hip).

Plain radiography remains the only imaging technique that allows functional study under loading, as standing is the most common physiological situation for humans (Guglielmi et al. 2006). Imaging the patient while standing allows full display of the limbs and spine in two orthogonal projections, which is useful for preoperative evaluation. In fact, it is essential for surgical planning and the choice of prosthetic material to know the position and spatial relations of the structures with a precise evaluation of the size, axis, and angles under load (Fig. 2.6).

Ultrasound (US) of joints, muscles, and tendons is normally well accepted by elderly subjects; this technique allows repeated control and may also be performed in the emergency room or at the bedside. B-mode echography may be complemented in the same session by color- and power-Doppler studies of the focalized musculoskeletal lesions; CUS (compression ultrasound) or color Doppler to complete an arteriovenous study of a limb can be performed to evaluate associated vascular problems.

During dynamic imaging with CEUS (contrast-enhanced ultrasound), intravenous contrast media can be used for typing of soft tissue expansive juxta-skeletal lesions or to assess the extent of traumatic muscle injury and the subsequent repair process. The contrast media is made of elastic gaseous microbubbles that remain in the vascular bed and do not reach extravascular spaces, and they are safe for use in the elderly patients too, except in the presence of serious heart disease.

QUS (quantitative ultrasound) and DXA (dual-emission x-ray absorptiometry) are used for qualitative and quantitative evaluation of bone. Five risk factors are considered predictors of osteoporotic fracture: four clinical factors – old age, history of fracture, a failed chair test, a recent fall – and the low heel qualitative US stiffness index (Guessos et al. 2008). DXA quantitative determination of bone mineral density (BMD) is a reliable means to improve accuracy in osteoporosis screening and fracture risk. The WHO classification of osteoporosis is based on the *T*-score (difference of BMD against a standard young adult population) and the *Z*-score

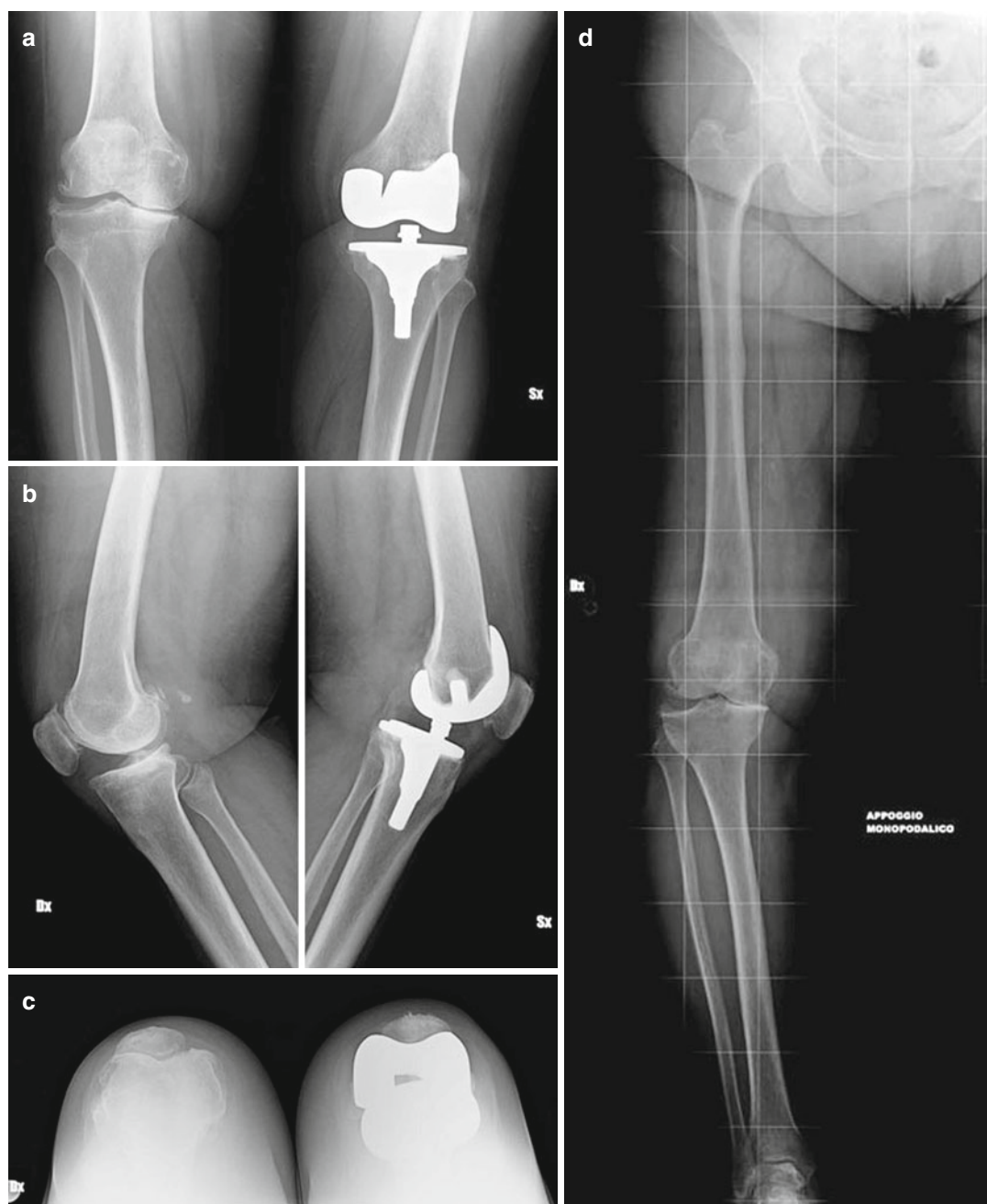


Fig. 2.6 Knee radiological study to plan prosthetic surgery: comparative frontal (a) and lateral views (b); axial patellar projection (c) and teleradiography in orthostasis of the whole limb (d)

(difference of BMD against the mean of race-, age-, and gender-matched controls). In the elderly, the Z-score is more important; however in very old subjects, the Z-score cannot be determined because there have been no studies of large

populations of the elderly for reference yet. The choice of the site of BMD evaluation is important: in the elderly the proximal femur up to the lumbar spine is to be preferred, because vertebral degenerative calcifications may falsify the

measurement. Recent studies stress the importance of body composition and body mass index (BMI) as complements to bone mass density (BMD) in elderly patients (Andreoli et al. 2011).

An interesting application of DXA is the study of juxta-prosthesis bone in hip replacement to help diagnose after-surgery complications.

Vertebral morphometry, which can assure precise and comparable measurements of vertebral body deformation, is easier to realize with DXA than with radiography, because it is not necessary to move the patient from the supine to the lateral decubitus position (Guglielmi et al. 2008).

QCT (quantitative computed tomography) is a very precise method to evaluate bone density in vertebral sites because the operator can select the areas of interest to be measured, choosing only trabecular bone with more metabolic turnover than the surrounding cortical bone (Guglielmi et al. 2008).

Diagnostic examinations that require a long time in a stationary decubitus position are often unsuitable to the elderly patient, especially if he or she is left alone in the room and placed in a complex diagnostic equipment, such as during *CT* and *MRI* examinations. The elderly may have difficulty understanding the course of the procedure and the information must be provided in a simple way: beepers or lights can be used to communicate with the patient. The patient's position on the scanning table should be as comfortable as possible, remembering that long periods on hard surfaces can promote pressure ulcers in specific areas of the body (e.g., the heel), especially if the tissues are hypotrophic and poorly vascularized, as they frequently are in the elderly. In debilitated patients, permanent tissue damage can occur in less than 2 h; pressure ulcers form where soft tissues are compressed between a bony prominence and a hard surface, with a microthrombosis mechanism.

In addition, logistical problems often overlap: radiology facilities may be far from the elderly person's home or hospital room and the subject has to be accompanied or transported with extensive involvement of relatives or assisting staff (Cáceres 2005). Delays and abnormal life rhythms are also to be taken into account. The use of

MDCT (multidetector computed tomography) shortens the examination and presumably minimizes discomfort (Cáceres 2005). Regarding *CT* and *MRI*, acquisition with large field of view is recommended. The wide field of view allows more information to be gained from post-processing reformatting, though such techniques are beyond the scope of this chapter.

Particular attention must be paid in cancer diagnostics: the correlation of imaging data and laboratory values is critical to differentiate multiple myeloma bone lesions from skeletal metastatic disease. A whole body MDCT may be performed in these cases with a low-dose protocol, thanks to the technique's high contrast between bone and soft tissue. *MRI* use is indicated to detect pattern and degree of bone marrow infiltration, which is useful for setting and monitoring the correct treatment (Baur-Melnyk and Reiser 2008). The diagnostic process can be completed with PET-CT (positron emission tomography-computed tomography).

MRI is highly reliable in the study of anatomical components of the joints and can be supplemented with intra-joint contrast medium. *MRI* also allows a panoramic assessment of the musculoskeletal structures. These characteristics make *MRI* quite useful in surgical planning.

Artifacts from metallic implants, often present in the elderly patient, can limit the optimization of *CT* and *MRI* images. Especially for *CT*, careful planning of the specific technical parameters in the execution of the exam and the use of dedicated reformatting programs allow a complete and correct diagnosis. The use of "open"- or low-field *MRI* equipment, dedicated to the study of the limbs, makes it possible to study patients with claustrophobia or mental health problems who cannot tolerate the positioning in traditional high-field instruments, thus avoiding the need for anesthesia. If the patient has a cardiac pacemaker, *CT* must be used in lieu of *MRI*.

In nuclear medicine (NM) procedures, elementary radionuclides are combined with other elements to form chemical compounds that localize to specific organs or cellular receptors. The extent of a disease process in the body, at least those related to changes in tissue anatomy, can be

visualized. In NM imaging, radiopharmaceuticals are taken intravenously or orally. Then, external detectors (gamma cameras) capture and form images according to the radiation emitted by the radiopharmaceuticals. The most common techniques for musculoskeletal examinations are:

- 2D scintigraphy: the use of an internal radionuclide allows to create two-dimensional images.
- 3D SPECT (single-photon emission computed tomography): a 3D tomographic technique that uses gamma camera data from many projections that can be reconstructed in different planes.
- PET (positron emission tomography): coincidence detection to image functional processes.

It is also possible to combine SPECT or PET with CT (Gotthardt et al. 2010). The most common uses are evaluation of bone metastases and tumors and in the study of inflammatory bone and joint lesions. In skeletal infections, even in the early stages, maximum accuracy results from the association of technetium (Tc^{99m}), Gallium (Ga^{67}) and Indium (I^{111})-labeled leucocyte scintigraphy (Cheong et al. 2008; Datz et al. 1997; Seabold et al. 1997a, b).

2.2.3 Use of Contrast Media

The use of contrast media is necessary to improve the diagnostic evaluation of some musculoskeletal diseases (Fig. 2.7); the media can be administered directly into the joint space or intravenously. Intravascular iodine contrast media should be used with particular caution in the geriatric patient, especially regarding the prevention of kidney failure: age is not in itself a risk factor but it may be accompanied by multiple risk factors, including nonobvious ones (Mehran et al. 2004). First, there may be latent impairment of renal function, due to the parapsybiologic reduction with age, and clinically occult kidney or hematological disease may also be present (Barrett and Parfrey 2006; Solomon 2005). In addition, all personnel should be explicitly aware that

potentially nephrotoxic drugs are being used. If it is necessary to discontinue a drug, the medical conditions that first indicated its use must be carefully monitored.

Assessment of the glomerular filtration rate (GFR) is highly recommended in geriatric patients. Serum creatinine measurements provide a good approximation of the GFR; laboratory data, gender, race, and age of the patient are factors in approximating the GFR (Fadem and Rosenthal 2001; Levey et al. 2006). Patients are stratified into four risk categories: low, medium, high, and dialysis or pre-dialysis. Medium- or high-risk subjects must follow a drug protocol that includes pre-exam hydration, taking into account the cardiovascular status of the subject to determine the water load. In the presence of a greater risk, one or more dialysis sessions are to be programmed.

In the elderly, particular attention to contrast media dose should be paid: a personalized assessment must be based on patient weight, renal function, and type of investigation. Repeated use of contrast media in different studies done with different media needs to be monitored.

There are no particular restrictions on the use of gadolinium contrast media in MRI, given the limited doses; if used in iodine-allergic patients for radiological or CT exams, the precautions are similar to the above indications for iodinated contrast media (Guglielmi et al. 2006).

2.3 Traumatic Diseases

Trauma is the fifth leading cause of death in patients over 65 years of age. The high frequency of fractures in the elderly is due to a combination of osteoporosis and decreased physical coordination leading to falls. Falls are common in elderly people for many reasons: central nervous system pathologies, equilibrium problems, impaired vision, and loss of muscular strength. The most common sites of fractures in elderly patients are the wrist, hip, surgical neck of the humerus, ankle, and vertebrae, all of which are exacerbated by weakened osteoporotic bone (Cheong et al. 2008).

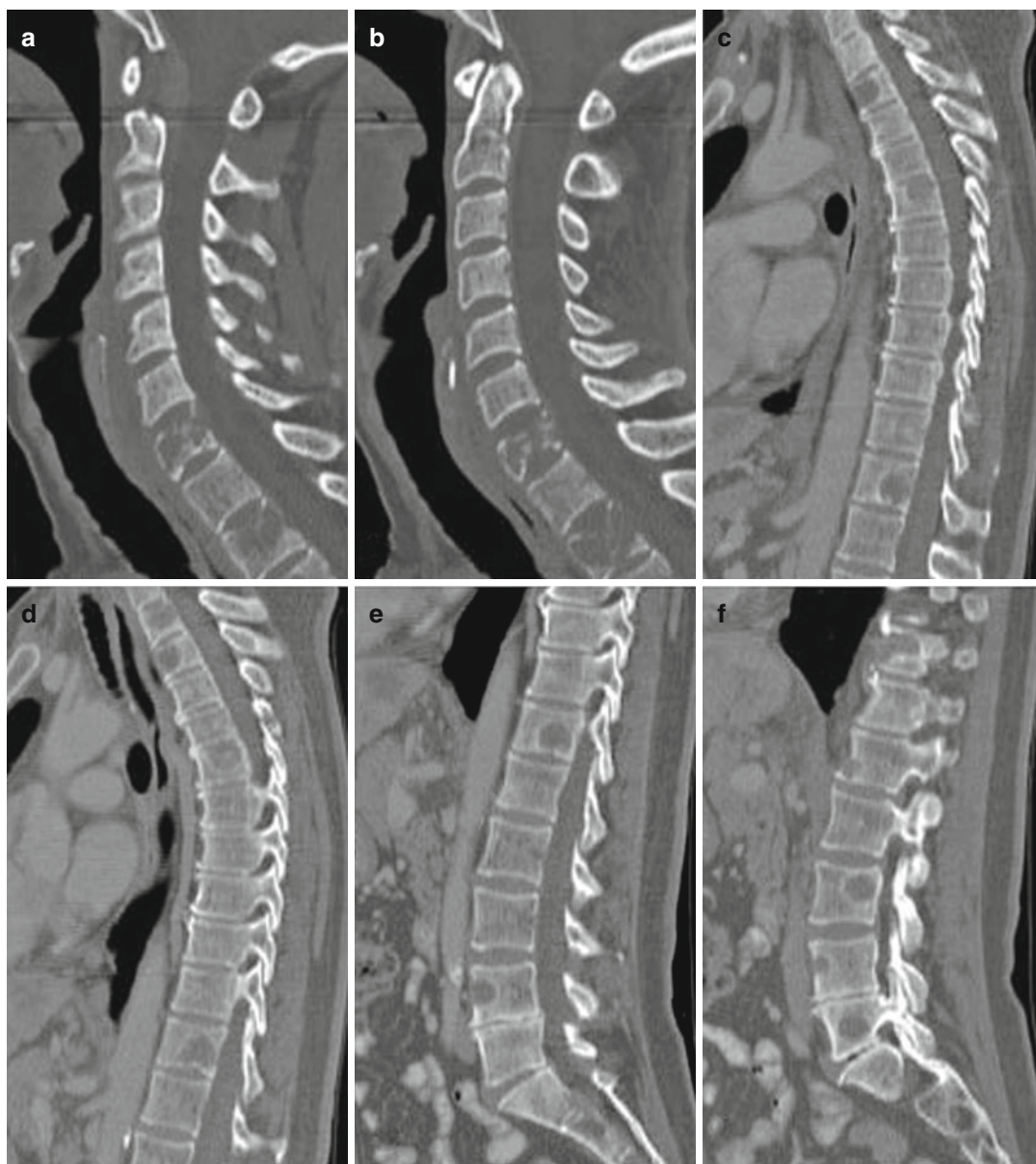


Fig. 2.7 Multiple spine metastases from lung carcinoma: sagittal CT reformatted (a–f). MRI scan: STIR (g, j), T1W FSE (h, i), T1W FSE with intravenous gadolinium contrast medium (k, l)

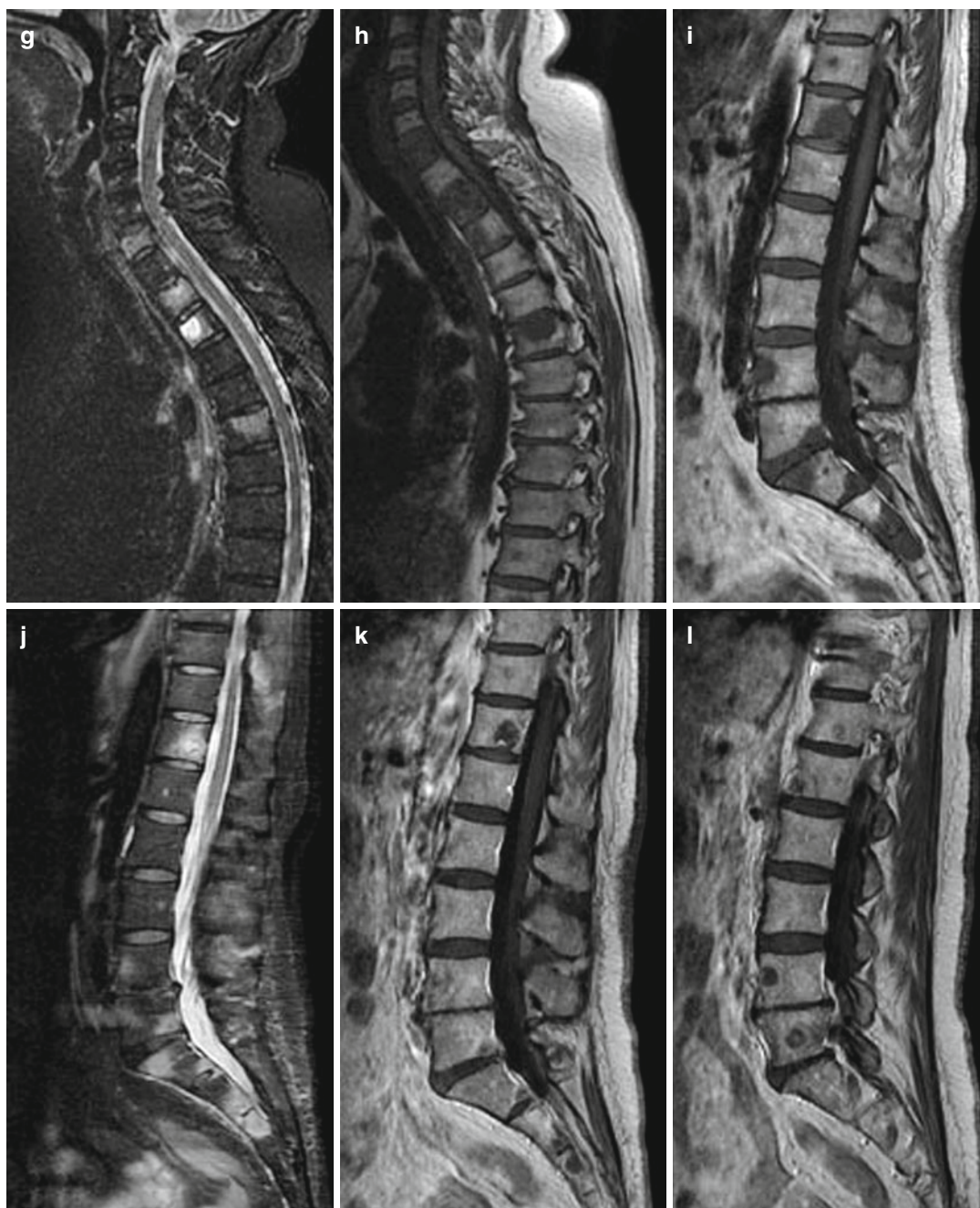


Fig. 2.7 (continued)

Traumatic lesions can be more serious and the effects more various than might be expected considering only the impact energy and the dynamic mechanism. Osteoporosis and osteopenia facilitate fractures, hematological diseases or anticoagulant

therapies increase bleeding or hematomas, prosthetic devices may induce local damage, and alterations of the intervertebral discs and joints increase the risk of injury to the spine or spinal cord (Figs. 2.8 and 2.9).

An accurate assessment of skeletal damage is essential both in the initial diagnosis of fracture and in the evolution of the callus. During the period of immobilization, the elderly are at a very high risk of local and general vascular complications like segmental hypovascular syndromes, edema, deep vein thrombosis, or muscle atrophy (which is difficult to recover from even with

intensive physical therapy) or bone disuse atrophy with increased brittleness.

In the diagnostic imaging algorithm of the elderly with axial (Fig. 2.10) or appendicular (Fig. 2.11) skeletal trauma, the first step is always plain radiography. If the evidence for a bone lesion is clear, and there is no suspicion of complex lesions or comorbidity (e.g., insufficiency

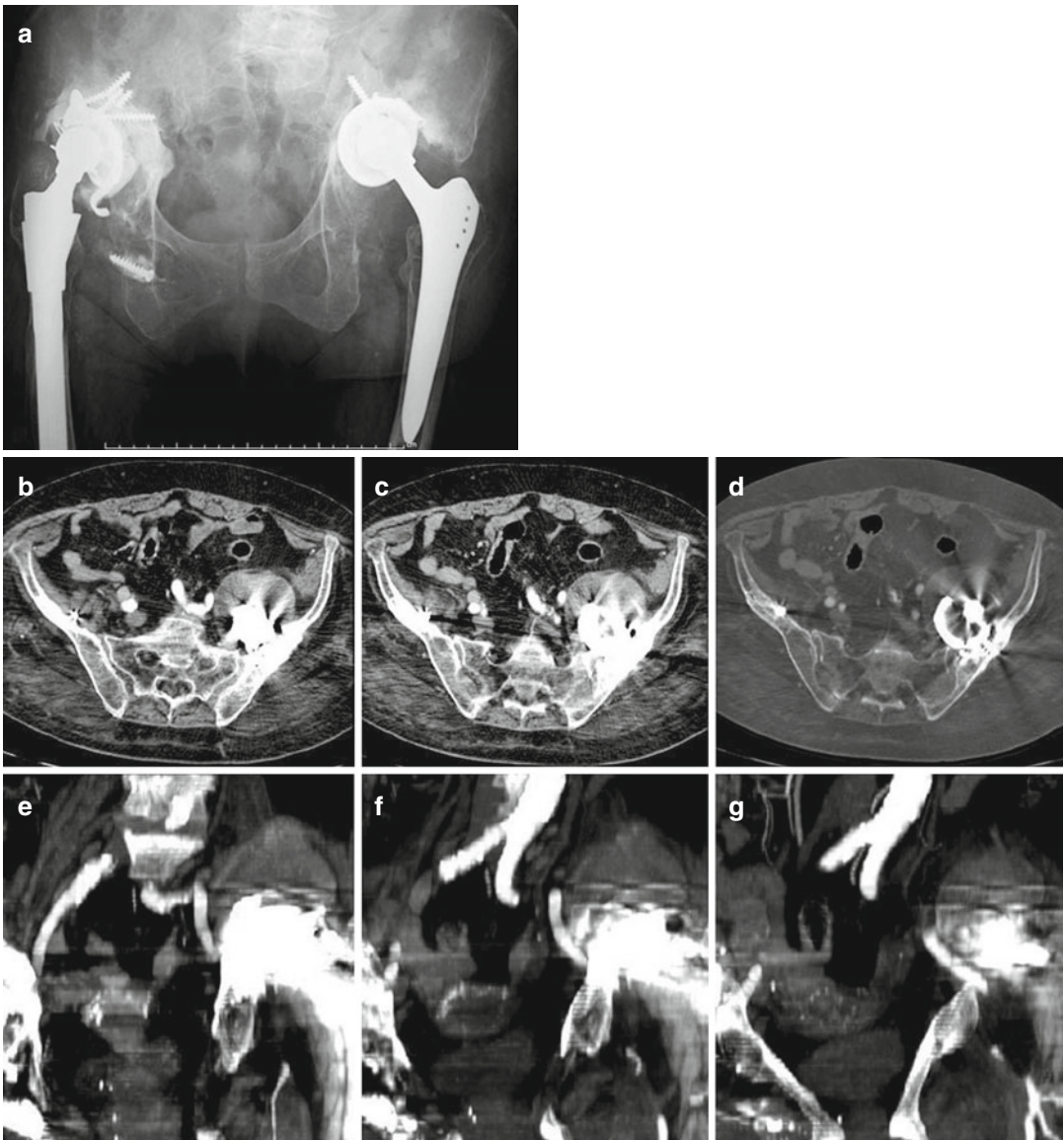


Fig. 2.8 Broken left acetabulum in aseptic loosening of total hip replacement: pelvis radiography (a). CT axial (b–d) and reformatted (e–g) for surgical planning to show bone-vessel relations. X-ray controls after surgery (h)

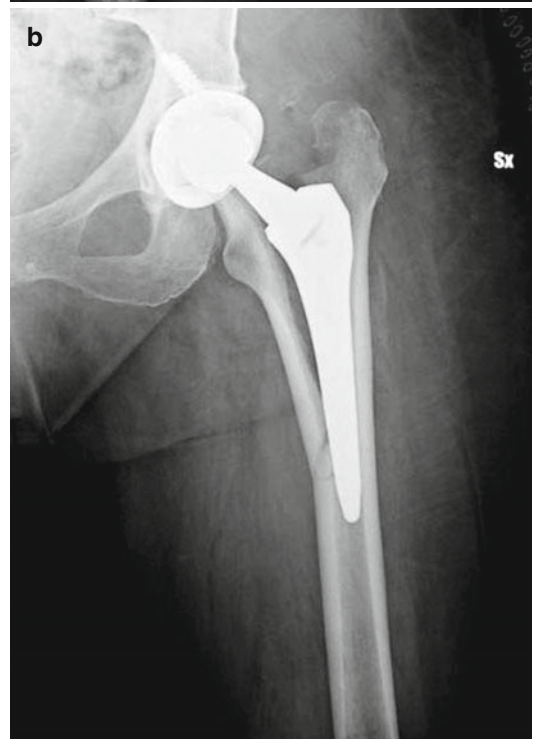
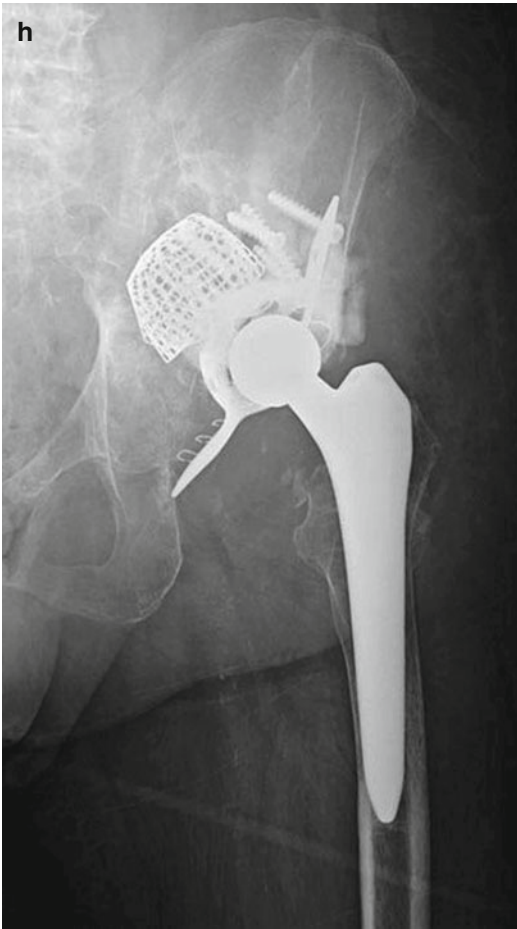


Fig. 2.8 (continued)

fracture or metastatic bone impairment), plain radiography is entirely adequate and will lead to the correct diagnosis (Fig. 2.12).

If doubts persist about the nature of the skeletal lesion, based on hard clinical suspicion but with nothing visible on plain radiography, MDCT is the next step. MDCT can usually correctly identify and evaluate bone impairment, such as microfractures or stress fractures (Fig. 2.13).

In case of axial skeletal trauma, MRI will be the second step if neurological symptoms are present or there are still suspicions of an insufficiency fracture, especially when multiple coexisting lesions need to be dated (Fig. 2.14). On the other hand, if limb muscle or acute tendon disease such as muscular hematoma or degenerative

Fig. 2.9 Typical fractures in total hip replacement. Plain radiography: fracture at the apex of the stem (a) and opening in the shaft along the stem (b)

Fig. 2.10 Diagnostic imaging algorithm in elderly with axial skeleton trauma

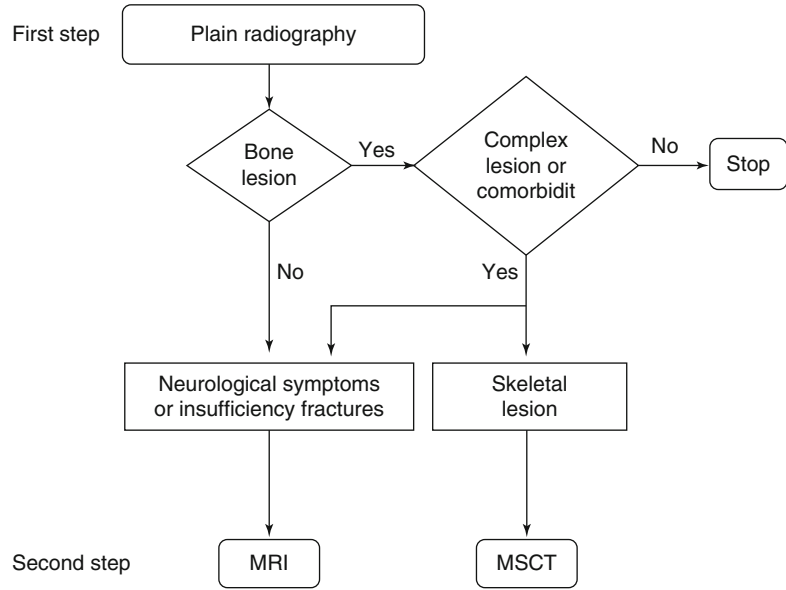
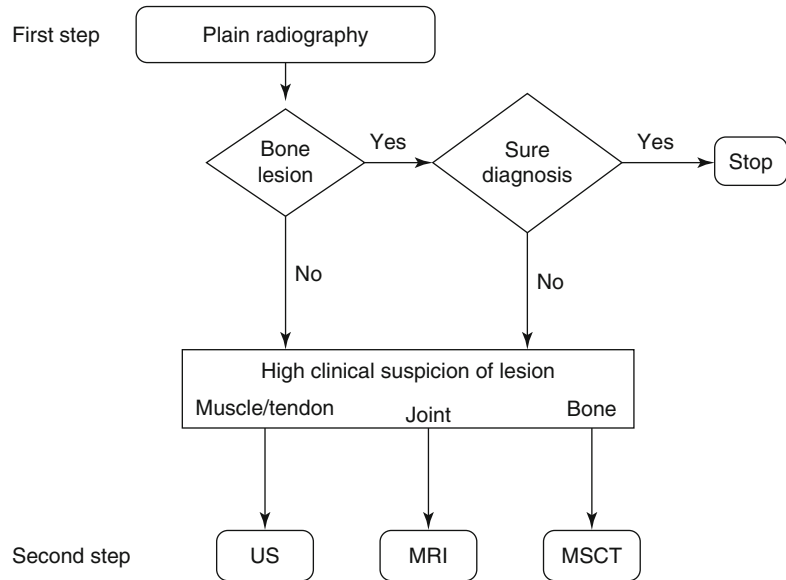


Fig. 2.11 Diagnostic imaging algorithm in elderly with appendicular skeleton trauma



tendon rupture is suspected, US will be the second step (Fig. 2.15). MRI is appropriate for the diagnosis of suspected joint trauma (Fig. 2.16).

2.4 Nontraumatic Diseases

If clinical suspicion of nontraumatic musculoskeletal diseases of the elderly persists,

associated with acute, breakthrough, or chronic pain, reevaluation of preceding imaging is very important for further investigation. If plain radiographs are negative for bone lesions, the second step will depend on where the damage seems to be. Prevalent damage involving muscles or tendons are best examined with US; joints are seen on MRI, and MSCT is best for evaluating bone damage (Cheong et al. 2008;

Fig. 2.12 Wrist radiological study: frontal (a) and lateral views (b) show an angled radius fracture; after traction, frontal (c) and lateral views (d) show the realignment in plaster cast



Link [2010](#); Michet et al. [1995](#)) (Fig. [2.17](#)). US is useful in finding evidence of soft tissue or muscular lesions, in tissue infections, in neoplastic diseases, or in metabolic disorders

such as calcium pyrophosphate arthropathy involving tendons and ligaments. MRI is of fundamental importance in diagnosing many pathologic conditions, such as insufficiency

Fig. 2.13 Left knee study after trauma. Plain radiography (**a**, **b**) shows signs of osteoarthritis but not fractures. CT, performed after aspiration of joint fluid with a fatty content, shows fracture lines of tibia plateau (**c–f**)



spine fractures, spinal disc degenerations, spondylodiscitis, diabetes mellitus-related bone lesions, bone-compromising primitive lesions (myeloma, chordoma), or metastatic bone lesions

(Baur-Melnyk and Reiser 2008; Guglielmi et al. 2008; Link 2010; Michet et al. 1995).

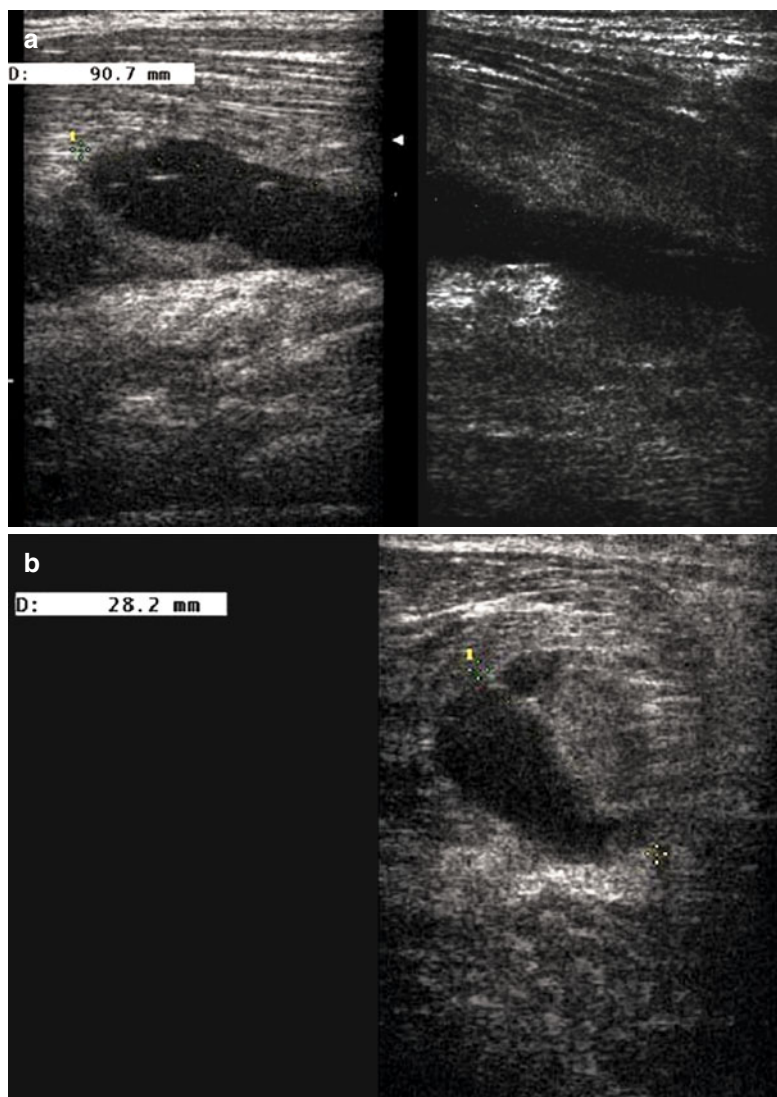
The third step in diagnosis calls on the broadest array of imaging techniques. That's where US,



Fig. 2.14 Lumbar spine radiography: frontal (a) and lateral (b) views show multiple vertebral fractures treated by vertebroplasty and other vertebral body deformities. Spine

MRI, performed with T1W SE (c), T2W FRFSE (d), and STIR (e) scans, shows a recent fracture in T12

Fig. 2.15 Ultrasound study of a traumatic muscular hematoma: longitudinal (a) and transverse (b) scan



MRI, MDCT or other imaging techniques (such as NM, QUS, DXA, MRI Arthrography, Angiography) are required for final diagnosis. The choice of imaging method depends on the type of disease suspected from the clinical and instrumental assessment. The diagnostic procedures can also be customized to the individual patient to reduce discomfort, but the ability to do so is limited by the type of equipment that is available.

More frequent skeletal nontraumatic affections of the elderly may be categorized into four main groups: degenerative (Fig. 2.18), infectious,

neoplastic, and metabolic; Paget disease and neuropathic arthropathy are to be considered separately (Cheong et al. 2008). The widespread use of prosthetic surgery has increased interest in the study of implant complications, especially in regard to septic or aseptic loosening, which often requires the use of many diagnostic methods (Fig. 2.19).

In particular the application of the chosen method should be directed at obtaining a detailed diagnosis, focused on setting up the most appropriate and safe treatment, choosing between medical therapy, interventional radiology treatment,

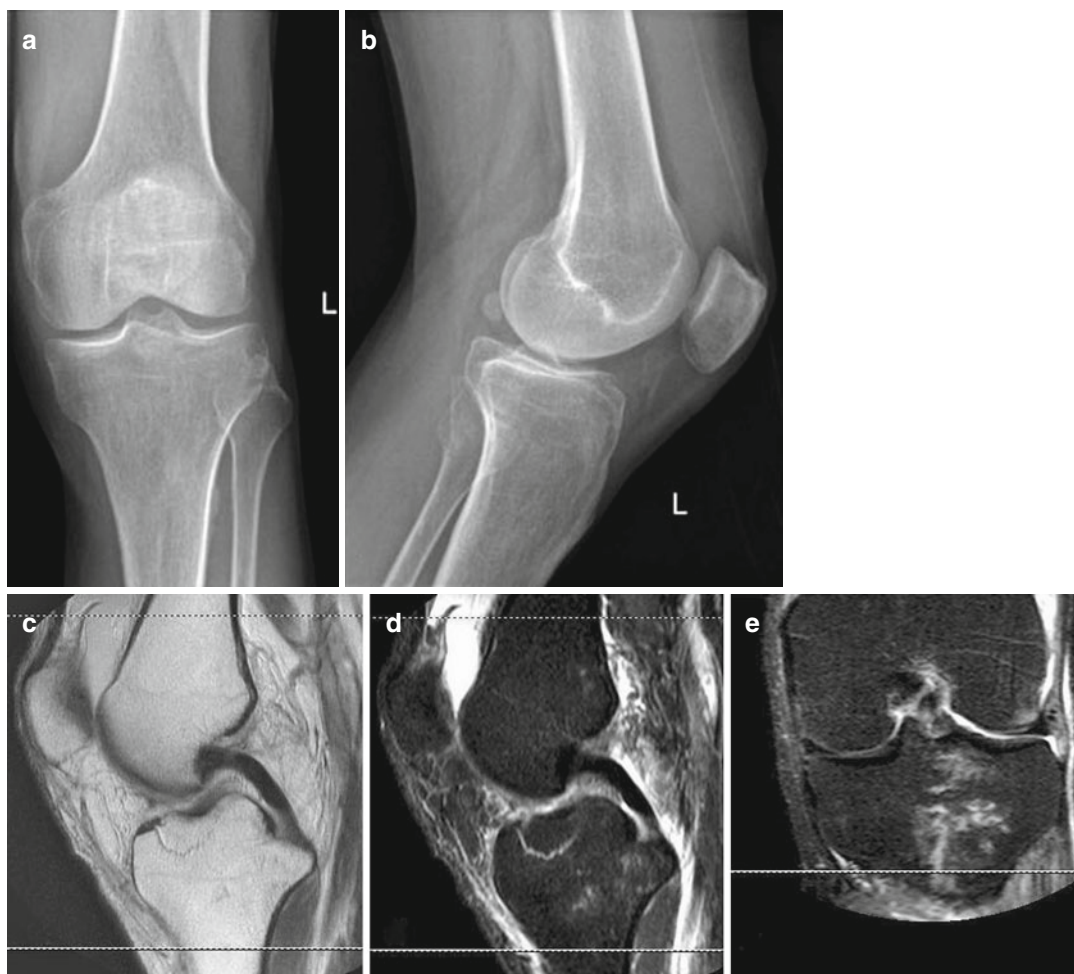


Fig. 2.16 Left knee study after trauma. Plain radiographs (a, b) do not show signs of traumatic lesions. MRI, performed after aspiration of hematic joint fluid, shows composed fracture of tibia plateau (c–e)

and surgery. When surgery is indicated, the goal is a correct diagnosis of preoperative planning to allow the best choice between more and less invasive surgical techniques.

Some interventional radiology techniques have particular uses in the elderly patient who cannot undergo surgery because of comorbidity, or who may refuse surgery, often because of the high risk associated with it. Many imaging methods (US, x-rays, CT, and MRI) can be used as guidance and control of interventional therapy, according to the anatomical site and the type of procedure to be performed.

The primary effect of these techniques is pain reduction or remission, at least temporarily: the life quality of the patient should be improved and

the conditions for efficient rehabilitative therapy, to consent an improvement in the global movement of the subject and in a better articulation of joints, will be created.

A side effect, also significant, is dose reduction or discontinuation of the analgesic drugs: these chemical compounds are often toxic to patients with hepatic-, renal-, or gastric-compromised function or, worse, cause osteoporosis and therefore increase bone altering (Migliore et al. 2011).

With regard to the axial joints, it is still not clear whether it is preferable to inject local anesthetics or corticosteroids or both (Peterson and Hodler 2010a).

At the level of peripheral joints (especially knee), viscosupplementation with hyaluronan or

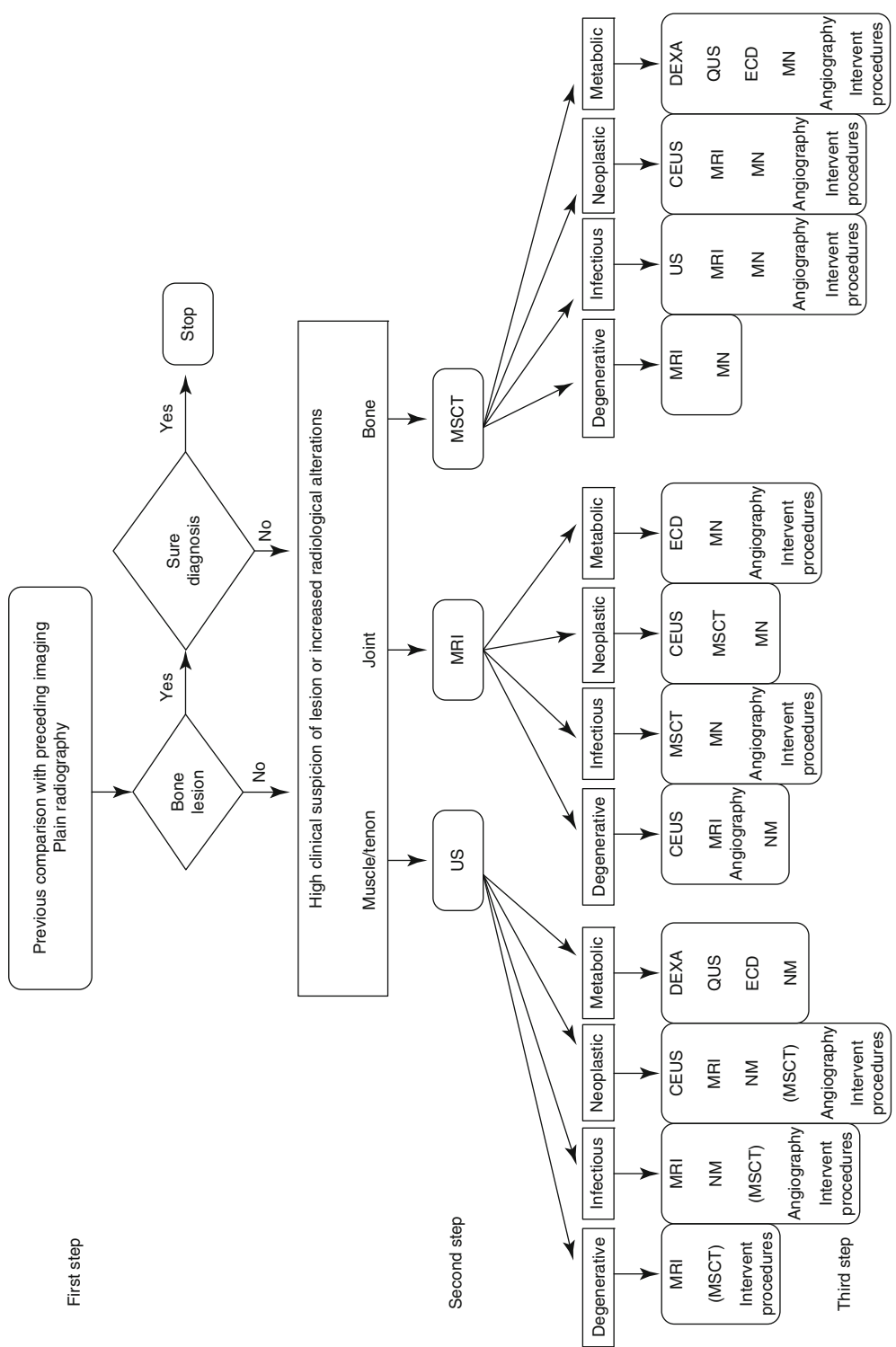


Fig. 2.17 Diagnostic imaging algorithm in elderly with nontraumatic musculoskeletal disease

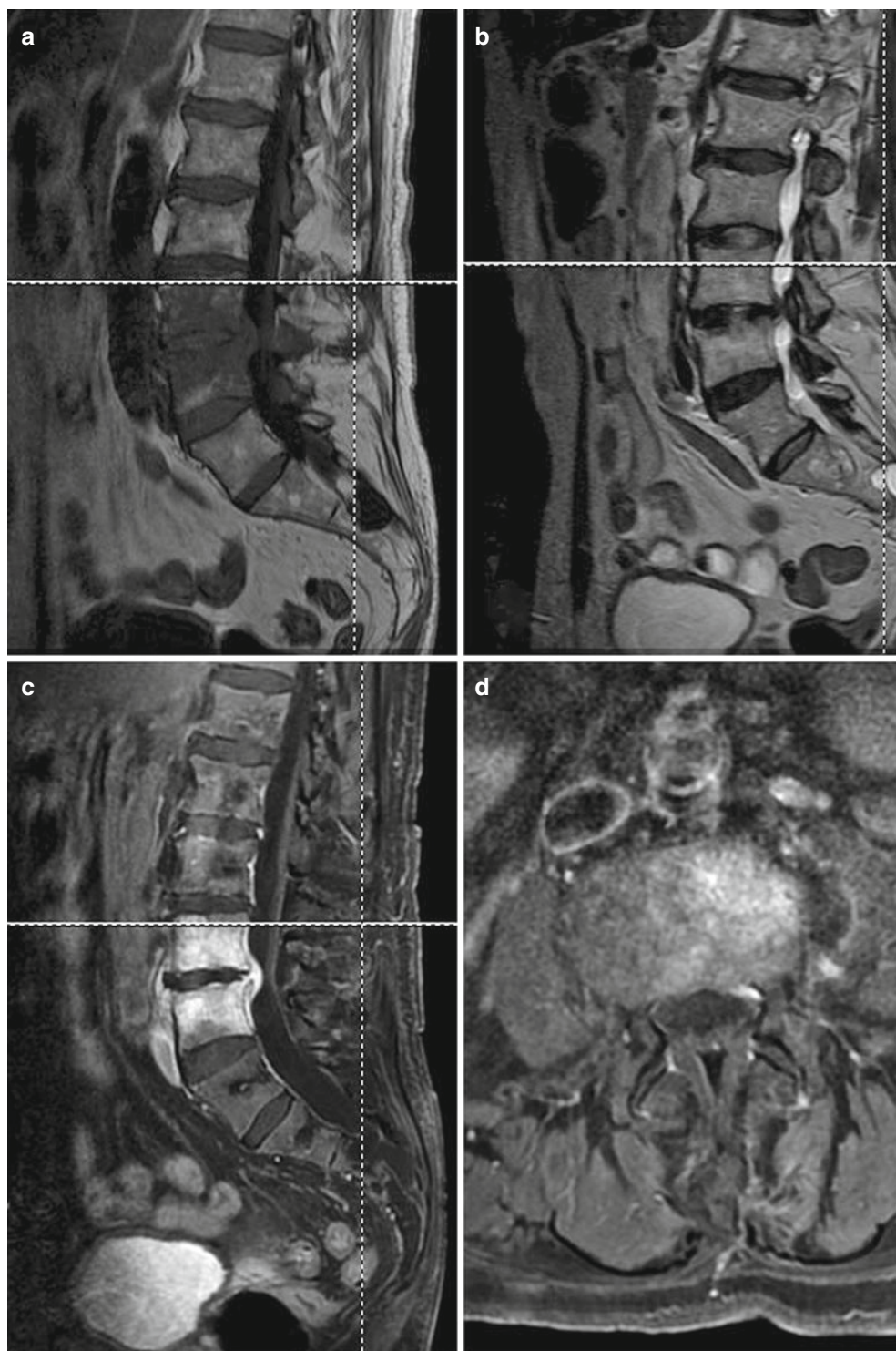


Fig. 2.18 MRI study of lumbar spondylodiscitis: sagittal T1W FSE (a) and sagittal T2W FRFSE (b) scans; sagittal T1W FSE (c) and axial T1W FSE (d) scans with intravenous gadolinium contrast medium

hylan products seems to allow more prolonged therapeutic effects of corticosteroids (Peterson and Hodler 2010b). The local therapeutic action of hyaluronic acid correlates with its elastoviscous properties that underlie the capacity of lubricating and cushioning synovial fluid (Ogston and Stanier 1953); the substance also appears to have a protective role toward tissue, limiting the penetration of inflammatory cells and/or proteolysis enzymes.

Within the musculoskeletal system, some radiofrequency (RF) techniques can be also used on sensory nerve branches; RF is the application of electrical pulses with a needle probe placed under ultrasound, radiologic, CT, or MRI guidance (Fukui and Nosaka 2001; Kawaguchi et al. 2001). Pain transmission can be stopped permanently with thermoablation, used in Morton neuroma and still under study in painful hip

replacement. Pulsed radiofrequency (PRF) has some reversible effects that do not cause permanent anatomical damage, keeping electrode temperature at noninjurious levels (42 °C) (Wu and Groner 2007), so it can be used in refractory tendinopathies or in osteoarthritis.

Among the clinical manifestations of diabetes (which affects approximately 6% of the world population), the so-called “diabetic foot” (Fig. 2.20) deserves special attention, since it causes 1 million leg amputations per year. Ulcerative lesions are caused by peripheral neuropathy, minor trauma, foot deformity, and especially peripheral vascular disease. Limb ischemia can be corrected with revascularization techniques which can be performed during interventional angiographic therapy (International Working Group on the Diabetic Foot 2005).

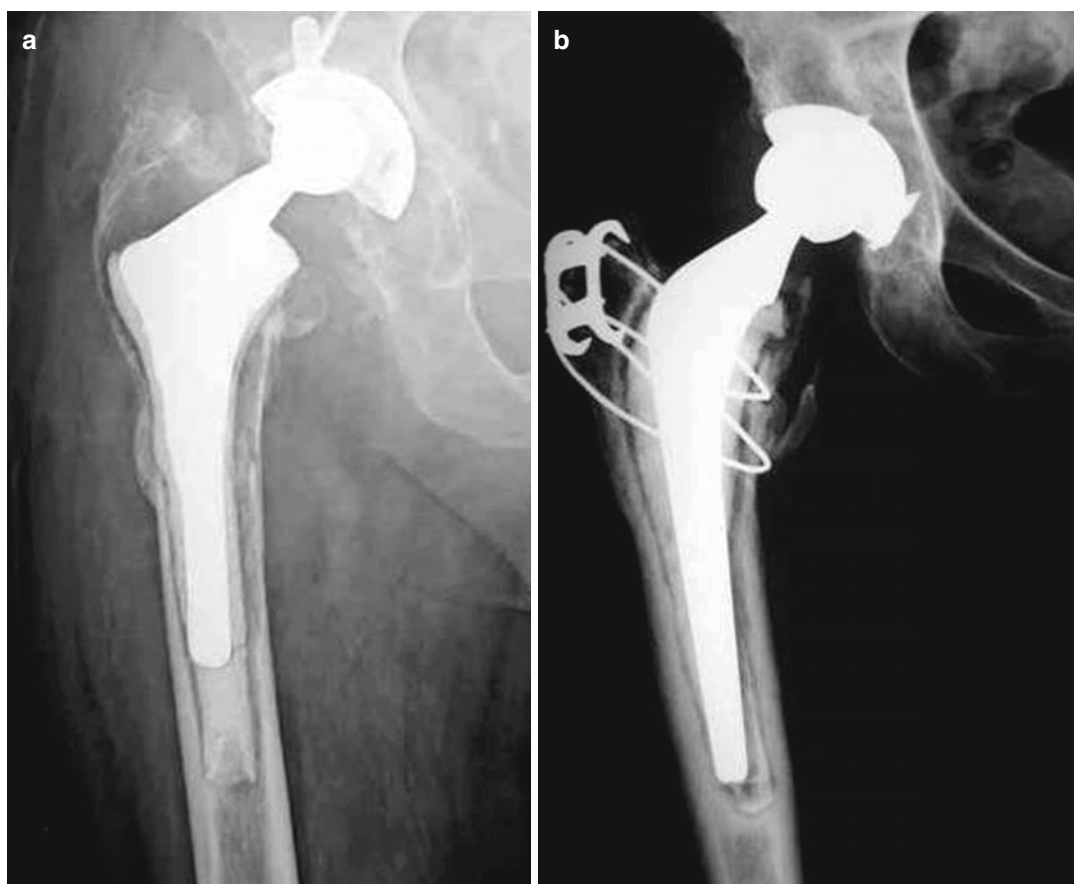


Fig. 2.19 Hip implant complications. Aseptic loosening: right hip radiography (a). Septic loosening: right hip radiography (b), ultrasound study of a flogistic collection

(c–f), technetium (g) and indium-labeled leukocyte (h) scintigraphy

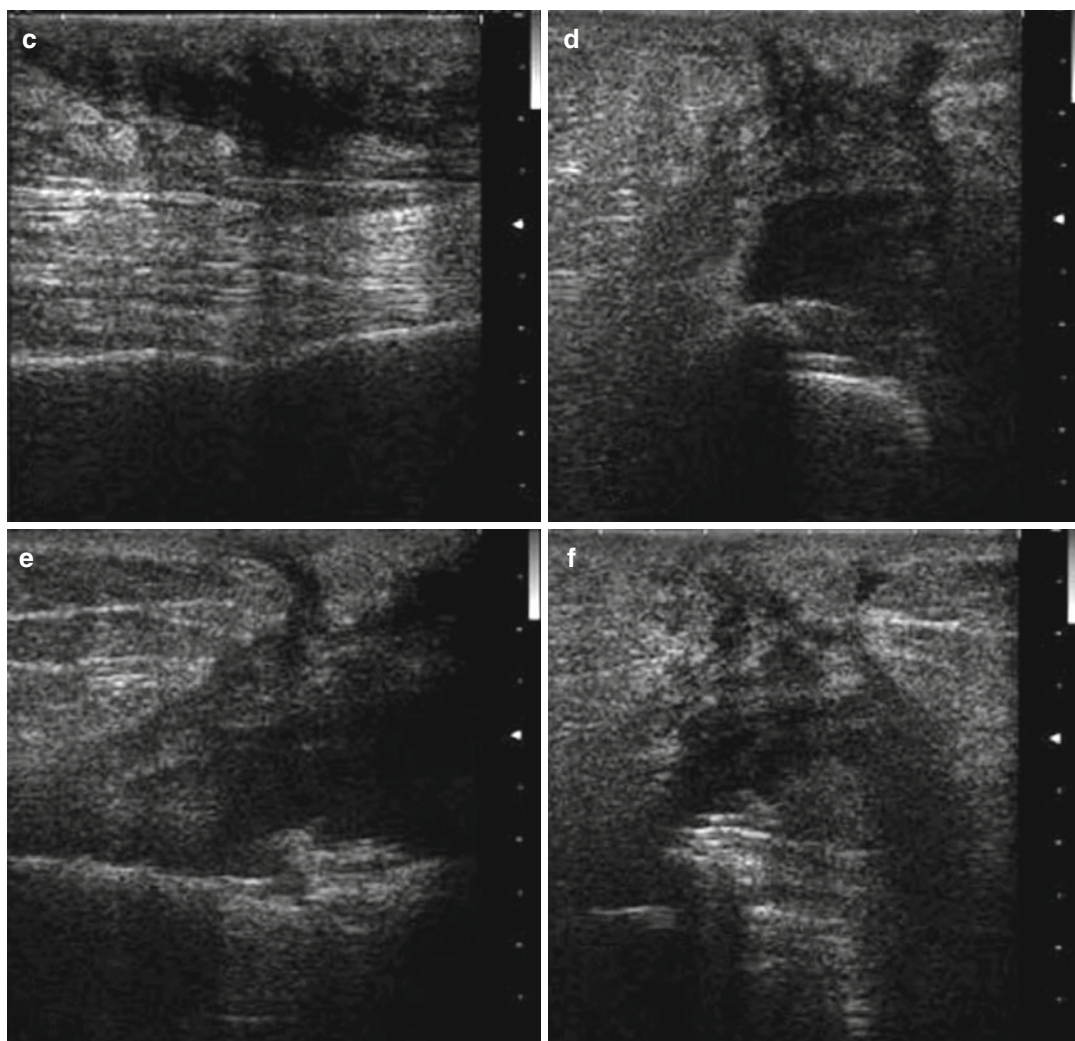


Fig. 2.19 (continued)

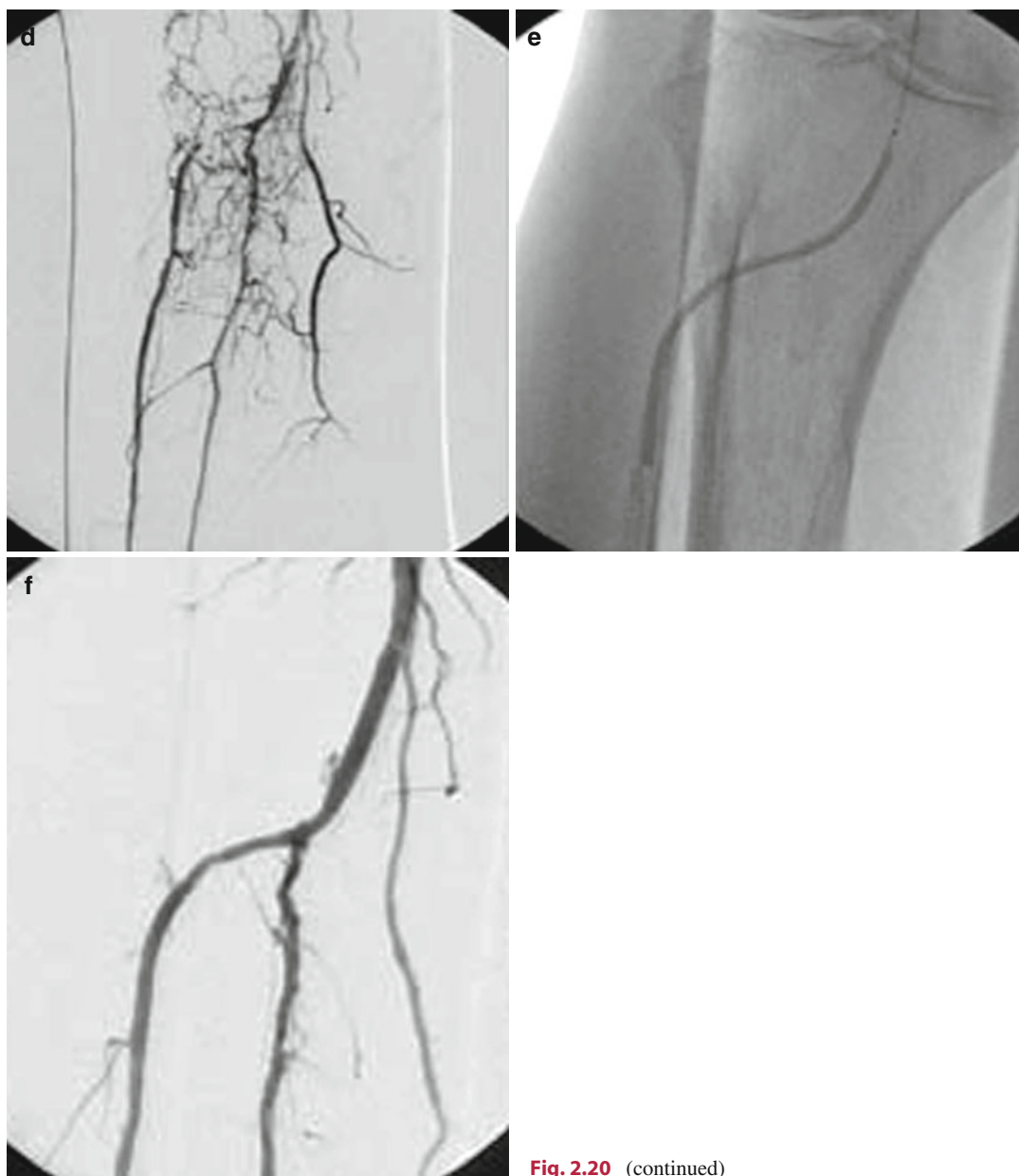


Fig. 2.19 (continued)



Fig. 2.20 Diabetic foot. Right foot radiological study: frontal (**a**), oblique (**b**), and lateral (**c**) views show widespread reduction in bone density, destructive remodeling of the metatarsal heads and phalanges, and extensive calcification of

blood vessel walls. Percutaneous transluminal angioplasty on anterior tibial artery stenosis: diagnostic angiography (**d**), angioplasty with balloon catheter (**e**), and control of revascularization after the procedure (**f**)

**Fig. 2.20** (continued)

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