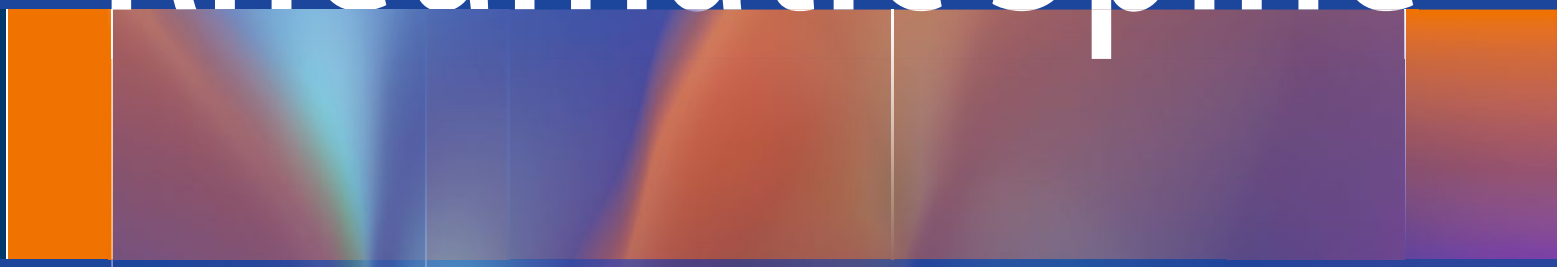
Paola D'Aprile

MRI of Rheumatic Spine



A Case-Based Atlas

Springer

MRI of Rheumatic Spine

Paola D'Aprile

MRI of Rheumatic Spine

A Case-Based Atlas

In collaboration with Alfredo Tarantino

Springer

Paola D'Aprile
Radiology – Neuroradiology Section
S. Paolo Hospital
Bari, Italy

ISBN 978-3-319-05626-5 ISBN 978-3-319-05627-2 (eBook)
DOI 10.1007/978-3-319-05627-2
Springer Cham Heidelberg Dordrecht London New York

Library of Congress Control Number: 2014940717

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

Foreword

Recent technological advances in diagnostic imaging have deeply increased the diagnostic accuracy in rheumatic spine diseases. Magnetic resonance imaging (MRI) is the gold standard in the diagnosis of "early arthritis" as much as in follow-up assessing the response to modern therapeutic approaches. Despite this, there is still a need of narrowing the gap between the increasing complexity of questions raised by the clinicians and the deepening of radiological investigation.

This case-based atlas strengthens this common pathway through an up-to-date classification of rheumatic diseases and an accurate description of pathogenetic aspects and treatment options from both a clinical and radiological point of view. Each case is presented with exhaustive clinical history, very well chosen and reproduced images, and final diagnosis and comments on the presented images with summarizing pertinent data.

All information found in this book reflects the general and in-depth knowledge of Dr. D'Aprile through her long-year experience and provides a valuable reference tool for radiologists, rheumatologists, and all those dedicated to caring and managing of patients affected by inflammatory spinal diseases.

This Atlas will surely become a useful companion to clinicians helping them in resolving complex issues and difficult diagnostic problems.

Giuseppe Guglielmi
Department of Radiology, Scientific Institute Hospital,
"Casa Sollievo della Sofferenza"
San Giovanni Rotondo (FG), Italy

Preface

If it is true, as Henry Bergson wrote, that "the eye sees only what the mind is prepared to comprehend", then in the context of the pursuit of diagnosis you will have to have time to prepare the mind, to avoid a disorientation that results in partial cognitive blindness.

With this atlas, we wanted to share our knowledge and case studies, on the aspects of magnetic resonance imaging (MRI) of rheumatic inflammatory lesions, the osteoarticular and ligaments structure that make up the spine.

The rheumatic condition of the spine comprises a group of non-infectious inflammatory lesions that affect both the osteoarticular structure and the ligaments of the spine.

The term used for these injuries is axial spondyloarthritis.

Because the main clinical manifestation of a rheumatic condition manifests itself as spinal or back pain, we felt it was necessary to provide to the rheumatologist as well as to the radiologist and the neuroradiologist, some "cultural tools" that could be beneficial in clinical and radiological management of patients with inflammatory rheumatic back pain.

Today, the appropriate use of MRI sequences and specific procedures is fundamental to the diagnosis of patients with suspected or known rheumatic condition.

To recognise the typical lesions involving both vertebrae, joints as well as soft tissue, in this case the vertebral ligaments, allows an accurate diagnosis, of the rheumatic condition of the spine.

In recent years, the use of biological therapy (anti-TNF) still requires a more accurate radiological diagnosis, using MRI as a method of choice (gold standard) during both the diagnostic and the therapeutic follow-up. Therefore, this text is a useful aid for all specialists who deal with the axial spondyloarthritis.

With the hope that we can reach a diagnosis, at an increasingly early stage, to prevent structural damage to the patient that may become irreversible and lead to serious impaired mobility.

Our commitment, together with all the other professionals dedicated to the management of these very widespread pathologies with a great socio-economic impact, is to reach an increasingly "early diagnosis".

I would like to thank my colleague rheumatologists, in particular Dr. Carlo Bonali, who have contributed towards a close collaboration that has led not only to the realization of this atlas, but above all, it has allowed many patients to have an accurate and often early diagnosis and therefore a specific therapeutic treatment with improvement not only for the radiological aspect but mostly for the clinical one, particularly less pain and increased mobility.

Bari, Italy — Paola D'Aprile

Acknowledgements

I thank all the technical staff at the MRI, and the administrative and nursing staff, without whose cooperation and dedication I would not have been able to work peacefully and in harmony, respecting the patient, always trying to give affirmative and appropriate answers to all those who have chosen to undergo neuroradiological examinations in our Department.

My gratitude is also owed to Prof. Giovanni Lapadula, Dr. Alfredo Tarantino and Dr. Anita Strada for their contributions and to Luca Salamanno for the technical management of images.

A special thanks goes to my son Giuseppe Pagliarulo for the drawings.

I would also like to thank Springer Milan and in particular Antonella Cerri and Andrea Ridolfi for showing trust in my project.

Bari, Italy Paola D'Aprile

Contents

Contributors

Giovanni Lapadula Institute of Rheumatology, “Policlinico” Hospital, University of Bari, Bari, Italy

Giuseppe Pagliarulo Via Delle Murge 59a, Bari, Italy

Anita Strada Department of Radiology-Neuroradiology, “San Paolo” Hospital, Bari, Italy

Alfredo Tarantino Department of Radiology-Neuroradiology, “San Paolo” Hospital, Bari, Italy

Part I

Clinical and Technical Aspects

Clinical Assessment of Spondyloarthritis

1

1.1 Introduction

The spondyloarthritis (SpA) or spondylo-enthesoarthritis represent a group of seronegative inflammatory joint diseases that share many epidemiological, pathogenetic, clinical, and radiological aspects [1]. The term spondylo-enthesoarthritis emphasizes the three main aspects of these diseases, such as the involvement of the spine, the entheses, and peripheral joints.

This group encompasses the following diseases:

- *Ankylosing spondylitis* (*AS*) *primitive*
- *Psoriatic arthritis* (*PsA*)
- *Reactive arthritis* (*ReA*)
- *SpA associated with inflammatory bowel disease* (*enteropathic arthritis*, *EA*)
- *Undifferentiated SpA* (*U-SpA*)

The prevalence of SpA varies, depending on the populations studied, from 0.2 to 1.9 %. In Italy has been reported the prevalence of approximately 1 % for Spa, among which the PsA is the most frequent (0, 42%) [2].

The disease starts between 20 and 40 years; earlier or later beginnings are not uncommon. Early diagnosis and therapy are essential to achieve adequate control in the inflammatory process, preventing structural damage and disability.

1.1.1 Etiopathogenesis

The histocompatibility antigen of class I HLA-B27 is closely related to the susceptibility to SpA and, in particular, to its axial location; however, the prevalence of this marker varies in relation to the type of disease (90–95 % in AS patients, up to 40 % in patients with PsA) and to the ethnicity of the patient.

Bacterial infections have long been recognized as a possible etiological factor of many SpA as some bacteria (Chlamydiae and some other bacteria) have the ability of triggering ReA.

1.1.2 Clinical Aspects

The primary site of the inflammatory process of SpA is the entheses, the point of bony insertion of ligaments, tendons, and other fibrocartilagineous components of the musculoskeletal system [3]. Such involvement is responsible for most of the clinical manifestations of SpA, both axial and peripheral devices, such as sacroiliitis, spondylitis, enthesitis, and arthritis [4].

Extra-articular manifestations also characterize this group of diseases such as involvement of eye (anterior uveitis, conjunctivitis), of the skin (psoriasis, keratoderma pseudoblenorragicum, balanitis circinata), of cardiovascular system (aortic insufficiency, disorders of atrioventricular), and of intestine (chronic colitis).

There are no "diagnostic" laboratory tests for SpA. They are usually called "seronegative" as the tests for rheumatoid factor are negative. The acute phase reactants (APR) increase in approximately 60 % of cases. The presence or absence of the HLA-B27, singly taken, is not sufficient to confirm or rule out a diagnosis.

1.1.3 Imaging

Although the diagnosis of SpA is primarily based on clinical manifestations, imaging modalities are essential to confirm the suspected diagnosis, to define the extension of the disease, and to monitor its evolution.

Conventional radiology is usually late in detecting abnormalities. Early signs of entheseal involvement can be revealed by ultrasonography combined with power Doppler or, better, by magnetic resonance imaging (MRI).

MRI studies of the sacroiliac joints and the spine in patients with SpA have made a major contribution in the last decade to a better understanding of the course of the disease, to an early diagnosis, and have been used as an objective outcome measure for clinal trails.

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_1,

1.1.4 Classification

In 1991, the European Spondyloarthropathy Study Group (ESSG) proposed the classification criteria [5]. These criteria with high specificity and sensitivity proved unable to classify oligosymptomatic patients (peripheral arthritis, dactylitis, enthesitis, isolated inflammatory back pain, or acute anterior uveitis).

The coeval Amor criteria behave better than ESSG, as they are able to classify as undifferentiated SpA even diseases without one of the two major ESSG criteria [6]. Nevertheless, even Amor criteria are unable to classify patients as monosymptomatic (no single criterion reaches the minimum score of 6).

The SpA may be clinically divided in forms with predominant involvement of peripheral or axial joints, with varying degrees of overlap between the two sub-types (ASAS criteria) [3, 4]. The advantage of this classification is in a better representation of the disease at an early stage and in improving the therapeutic strategies according to the prevalent form, axial or peripheral.

The introduction of new imaging techniques, particularly MRI, and the possibility of new and more effective treatments has renewed interest in the classification of SpA group ASAS (Assessment of Spondyloarthritis International Society) that has recently developed and validated new criteria for the axial forms (spondylitis, sacroiliitis) (Fig. 1.1) and for the peripheral forms (arthritis, enthesitis, dactylitis) [7, 8].

The ASAS criteria work better than the previous criteria in classifying the different forms of SpA although specificity and sensitivity of peripheral SpA criteria appear not completely satisfying.

1.1.5 Therapy

The treatment of SpA is based, in general, on the association of non-steroidal anti-inflammatory drugs (NSAID) with drugs called disease modifying anti-rheumatic drugs (DMARDs), such as sulfasalazine and methotrexate. In the last decade, the treatment of SpA has improved dramatically with the introduction of biologics directed against TNF-a. Tumor necrosis factor α blockers (A-TNF α), infliximab, adalimumab, etanercept, and golimumab, very effective on the symptoms and signs of SpA, have been shown to halt or delay the progression of radiological damage [9–11].

1.2 Ankylosing Spondylitis

Ankylosing spondylitis (SA), the most typical form of SpA, is a chronic inflammatory disease of unknown etiology that predominantly affects the axial skeleton (sacroiliac joints and spine) but may also involve peripheral joints and entheses [12].

The primitive (or idiopathic) spondylitis occurs independently of any other condition, and should be distinguished from secondary spondylitides that may appear during cutaneous psoriasis, reactive arthritis, or inflammatory bowel disease.

The prevalence of SA varies, depending on ethnicity and classification criteria used, between 0.2 and 1.8 %. In Italy, a recent study in the Marche region showed a prevalence of 0.37 % [2].

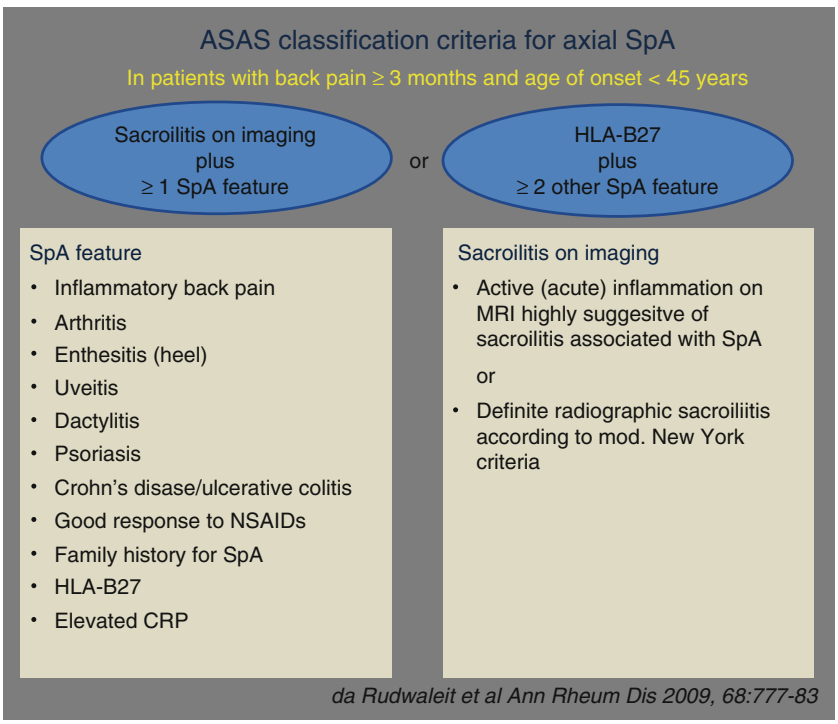


Fig. 1.1 ASAS classification criteria for the axial and peripheral forms

The disease usually begins in people between the ages of 20 and 40 years; less than 5 % of cases has an onset after the age of 45. The F:M ratio is 1:3. Usually the clinical expression of SA is more severe in males.

1.2.1 Clinical Aspects

The typical presenting symptom is inflammatory back and/or buttock pain (IBP), sometimes involving the back of thighs (so-called atypical sciatica) [13].

The involvement of the costovertebral joints, manubriosternal, condrosternal joints and the entheses at respiratory muscle insertions can cause chest pain that is accentuated by coughing or sneezing.

The involvement of the entire spine with its progressive stiffening is responsible for a significant functional limitation and typical postural abnormalities (hyperlordosis of the cervical spine, dorsal kyphosis, flattening of the lumbar lordosis). The involvement of the thorax skeleton results in a reduced ventilatory capacity compensated by the increase in diaphragmatic breathing.

Enthesopathy or inflammation of some entheseal-like fibrocartilagineous structures are responsible for tenderness in some extra-articular sites such as costosternal joints, the spinous processes, the iliac crests, the large femoral trochanter, the ischial tuberosity, the tibial tuberosity, and the heel (plantar fasciitis and Achilles enthesitis).

Hips are extra-axial joints most frequently involved. Their involvement causes pain at the joint level, radiating to the anterior side of the thigh, up to the knee. Abduction, intrarotation, and extrarotation are limited.

1.2.2 Extra-articular Manifestations

Acute anterior uveitis (or iridocyclitis) is the most common extra-articular manifestation of SA (25 % of cases). It is not related to the activity of the joint disease and is more frequent in HLA-B27 positive patients. The iridocyclitis is typically acute, unilateral, and recurrent; clinical symptoms are redness and pain, visual disturbances, photophobia, and hyperlacrimation.

Cardiovascular events may also occur (ascending aortitis, aortic insufficiency, disorders of cardiac conduction), more frequent in later stages of disease.

ESR is often elevated (up to 75 % of patients) but seems not to correlate with disease activity. The detection of the presence of HLA-B27 cannot be used as a single diagnostic test; such antigen, in fact, present in 70–90 % of patients, is not the expression of a "disease gene", as it is present also in healthy subjects with a variable prevalence (4–5 % in Italy).

Although the diagnosis of SA is primarily based on clinical manifestations, imaging modalities are essential to confirm the suspected diagnosis.

As abnormalities detectable by conventional radiology are usually late, the early signs of axial involvement can be catched by using methods with higher sensitivity such as MRI with the proper technique (gadolinium administration, if necessary, T1 and/or T2 sequences with fat suppression).

Sometimes, a CT scan shows a clear superiority for highlighting bony erosion and/or the initial sclerosis of the sacroiliac joints.

1.3 Psoriatic Arthritis

Psoriatic arthritis (PA) is characterized by a chronic arthroentheseal inflammation that occurs in individuals with psoriasis or with a family history of psoriasis, and that can affect enthuses and joints both peripheral and axial [4]. Psoriasis affects about 2 % of Caucasians. A variable percentage (from 7 to 42 %) of patients suffering from psoriasis presents the PsA, with an F:M ratio of 1:1.

The clinical picture is as widely variable as the outcome variable is [14, 15]. Over the years, a number of classification criteria for PsA have been proposed. The group CASPAR (Classification of Psoriatic Arthritis) has proposed a new set of criteria [16].

Fig. 1.2Cutaneous manifestations precede the arthritis in about 60 % of cases; in 25 % of cases, the arthritis appears with any cutaneous involvement, in 15 % is concurrent. Onicopathy is related to a high predisposition to psoriatic arthritis. Severity and extension of cutaneous lesions are not predictors of incidence or severity of joint involvement. In patients in whom the arthritis precedes the skin lesions (PsA "sine psoriasis"), a definitive diagnosis is sometimes impossible before the appearance of the first psoriatic skin lesion.

In these brief notes, I prefer to underline a few aspects I consider more relevant.

- The axial involvement, albeit minimal, can be present in any variant of the PA. It is found in 20–40 % of patients.
- Dactylitis (present in about 30 % of patients, regardless of the subset) is characterized by diffuse swelling of an entire finger that assumes an aspect of "sausage". Although it is usually considered more frequent in the PA than in other SpA, dactylitis can be observed in all forms including undifferentiated spondyloarthritis. Sometimes dactylitis and/or enthesitis can be for a long time the only clinical manifestation of an HLA-B27 associated SpA and of psoriatic disease.

Dactylitis appears to be associated to flexor tenosynovitis, with or without associated arthritis.

- The enthesitis is the hallmark of spondyloarthritis and may be variously distributed. Main symptoms are pain and swelling at the site of insertion, the most frequent being the posterior and inferior enthesitis of heel (plantar fasciitis and Achilles enthesitis).

ESR is elevated in half of the cases, especially in polyarticular forms. Rheumatoid factor, usually absent, can be present in 5–15 % of patients.

In 10–20 % of patients, hyperuricemia is found. It is traditionally attributed to the rapid cell turnover in psoriatic skin.

1.4 Reactive Arthritis (ReA)

ReA are aseptic arthritides which develop following a localized infection at a distant site such as the genitourinary tract or the intestine [17].

The ReA's incidence varies from 4 to more than 25 cases per 100,000 inhabitants. It affects mostly males in post-veneral forms (the M:F ratio is 9:1); in post-dysenteric forms, the two sexes are equally involved. The histocompatibility antigen HLA-B27 is present in more than 80 % of the cases. Arthritogenic germs are *Salmonella*, *Shigella*, *Campylobacter*, *Yersinia*, or *Chlamydia trachomatis*.

A mono-oligoarthritis (especially if localized at the lower limbs) or, more rarely, a polyarthritis, which develops after an infectious episode of the genitourinary tract (urethritis, cervicitis) or after a dysenteriform syndrome, is, probably, a ReA. The triggering infection can often remain inapparent. Enthesitis, bursitis, tenosynovitis (including dactylitis), and axial involvement (spine and sacroiliac joints) can be present. The clinical onset is usually acute, often with marked local signs of inflammation; sometimes there are constitutional symptoms such as fever. In most cases, the patient recovers within 6 months. Approximately in 30 % of the cases the disease becomes chronic and may progress to a clinical picture indistinguishable from that of the primitive AS. Acute relapses, often related to reinfection episodes, is the most common course. Pathognomonic extrarticular manifestations encompass the "pseudoblenorragic" keratoderma (palmar and/or plantar), a psoriasis-like onychopathy, the balanitis circinata.

Other common extrarticular manifestations, besides the signs and symptoms of the triggering infection, are ocular involvement (conjunctivitis and anterior uveitis) and oral aphthosis. The cardiac involvement is similar to that found in AS and consist in aortic insufficiency (sometimes associated with mitral regurgitation) and conduction disturbances (AV and intraventricular block, sinus node syndrome).

Acute phase reactants (APR) can be increased since the onset of the disease.

In the "post-venereal" forms, searching chlamydia antigens by PCR methods in the urine, genital swab, or in the cervical brushing samples can be useful. Serological tests are of limited utility.

In "post-dysenteric" forms, coprocultures can be tempted within few weeks from onset. *Yersinia* and *Salmonella* infections can be demonstrated with serological tests. The *Shigella* germ is more difficult to detect. Previous campylobacteriosis are difficult to demonstrate in serum samples.

1.5 Spondyloarthritis Associated with Inflammatory Bowel Diseases – Enteroarthritis (EA)

The most common EA are those that are associated with chronic inflammatory bowel disease (IBD): ulcerative colitis (UC) and Crohn's disease (CD).

The musculoskeletal involvement, often preceding the onset of intestinal symptoms, is reported in 50 % of the cases.

Two types of peripheral arthritis are described: oligoarticular, generally lasting few weeks and closely related intestinal inflammation (as well as the extra-articular manifestations of the latter, e.g., erythema nodosum), and polyarticular, of longer duration (years), unrelated with the course of the IBD. This last form is associated with uveitis. The joint involvement is rarely erosive. Both subsets of disease appear to have similar characters in the UC and in CD and do not appear associated to an increased prevalence of HLA-B27.

The axial engagement is described in both types of EA. A sacroiliitis can be seen in 15 % of the cases.

Axial ankylosing forms can become clinically indistinguishable from the primitive AS with a course totally independent from the extension and severity of the intestine involvement.

There are no diagnostic tests. Common findings are an increase of APRs and a hypochromic anemia caused both by intestinal bleeding and chronic inflammation.

1.6 Undifferentiated Spondyloarthritis (U-SpA)

The term undifferentiated SpA identifies a condition that presents typical clinical manifestations of the group of SpA but not sufficient for making a diagnosis of definite SpA (AS, PA, ReA, or EA).

Their prevalence is variable and is estimated to be 0.5 %, in average. The undifferentiated SpA can begin at any age.

The undifferentiated SpA have a wide clinical spectrum resulting from various combinations of the typical manifestations of SpA.

The clinical suspicion of an undifferentiated SpA can be placed on the basis of the presence of the typical manifestations of SpA, HLA-B27 positivity, and family history of associated diseases (psoriasis, inflammatory bowel disease).

In many cases, the diagnosis of undifferentiated SpA is only a temporary diagnosis that is changed when incomplete forms of SpA become defined.

An U-SpA can have two outcomes:

1. Moving towards a definite spondyloarthritis (AS PsA)
2. Remain in an undifferentiated state for a long time

Generally, blood tests are not very useful. The ESR and CRP are not always high. The HLA-B27 is not a diagnostic test.

Acknowledgments I would like to thank **Prof. Giovanni Lapadula** for his contribution in writing this chapter.

References

1. Dougados M, Baeten D (2011) Spondyloarthritis. Lancet 377(9783): 2127–2137
2. De AR, Salaffi F, Grassi W (2007) Prevalence of spondyloarthropathies in an Italian population sample: a regional community-based study. Scand J Rheumatol 36(1):14–21
3. Lioté F (2002) Pathogénie du rhumatisme psoriasique. Rev Rhum 69(6):608–614
4. McGonagle D, Lories RJ, Tan AL, Benjamin M (2007) The concept of a "synovio-entheseal complex" and its implications for understanding joint inflammation and damage in psoriatic arthritis and beyond. Arthritis Rheum 56(8):2482–2491
5. Dougados M, van der Linden S, Juhlin R, Huitfeldt B et al (1991) The European Spondylarthropathy Study Group preliminary criteria for the classification of spondylarthropathy. Arthritis Rheum 34(10):1218–1227
6. Amor B, Dougados M, Mijiyawa M (1990) Criteria of the classification of spondylarthropathies. Rev Rhum Mal Osteoartic 57(2): 85–89
7. Rudwaleit M, van der Heijde D, Landewe R, Akkoc N et al (2011) The Assessment of SpondyloArthritis International Society classification criteria for peripheral spondyloarthritis and for spondyloarthritis in general. Ann Rheum Dis 70(1):25–31
8. Rudwaleit M, van der Heijde D, Landewe R et al (2009) The development of Assessment of SpondyloArthritis international Society classification criteria for axial spondyloarthritis (part II): validation and final selection. Ann Rheum Dis 68(6): 777–783
9. Barkham N, Keen HI, Coates LC, O'Connor P et al (2009) Clinical and imaging efficacy of infliximab in HLA-B27-Positive patients with magnetic resonance imaging-determined early sacroiliitis. Arthritis Rheum 60(4):946–954
10. Goulabchand R, Mouterde G, Barnetche T et al (2014) Effect of tumour necrosis factor blockers on radiographic progression of psoriatic arthritis: a systematic review and meta-analysis of randomised controlled trials. Ann Rheum Dis 73(2):414–419
11. Lord PA, Farragher TM, Lunt M et al (2010) Predictors of response to anti-TNF therapy in ankylosing spondylitis: results from the British Society for Rheumatology Biologics Register. Rheumatology (Oxford) 49(3):563–570
12. Braun J, Sieper J (2007) Ankylosing spondylitis. Lancet 369(9570): 1379–1390
13. Sieper J, Rudwaleit M, Baraliakos X et al (2009) The Assessment of SpondyloArthritis international Society (ASAS) handbook: a guide to assess spondyloarthritis. Ann Rheum Dis 68(Suppl 2): 11–44
14. Bardin T, Fournié B (2014) Formes cliniques et évolution du rhumatisme psoriasique. Rev Rhum 69:630–634
15. Cantini F, Niccoli L, Nannini C et al (2010) Psoriatic arthritis: a systematic review. Int J Rheum Dis 13(4):300–317
16. Taylor W, Gladman D, Helliwell P et al (2006) Classification criteria for psoriatic arthritis: development of new criteria from a large international study. Arthritis Rheum 54(8):2665–2673
17. Carter JD, Hudson AP (2009) Reactive arthritis: clinical aspects and medical management. Rheum Dis Clin North Am 35(1):21–44

MRI in Spondyloarthritis

2

MRI is considered a fundamental technique in the diagnosis of spondyloarthritis (SpA) and in particular constitutes the gold standard technique to visualize early changes of the disease [1–10]. However, MRI findings of spondyloarthritis are typical but not specific, and similar changes may be seen in degenerative or other spinal disorders as well [1–3]. It is therefore of particular importance for radiologists and neuroradiologists to know MRI findings of these inflammatory lesions. Moreover, an efficient spinal imaging protocol is needed to correctly interpret MRI findings.

Typical lesions in spondyloarthritis comprise:

- Spondylitis (Romanus lesion)
- Discitis
- Spondylodiscitis (Andersson lesion)
- Osteoarthritis of the facet joints, costovertebral, and costotransverse joints
- Osteoarthritis of the sacroiliac joints (sacroiliitis)
- Enthesitis

It is helpful to know that inflammatory spinal lesions rarely occur in isolation but are frequently associated among them and in particular with sacroiliitis.

2.1 Vertebral Bodies

The earliest changes of spondylitis were described by Romanus and Yden on conventional radiographs [11]. These changes consist of blurring and erosions involving the anterior and posterior edges of the vertebral endplates and are also known as Romanus lesions. Later, sclerosis occurs in these areas, which is referred to as shiny corners.

MRI allows for the detection of these lesions at the beginning of their course. The early changes of the vertebral bodies are constituted by edema – osteitis in correspondence of the subchondral bone marrow. These changes are depicted on MRI as reduced signal on T1-weighted images and increased signal on T2-weighted/STIR images.

When these changes are localized to the anterior vertebral edges, the condition is called anterior spondylitis; when the changes involve only the posterior vertebral edges, we speak about posterior spondylitis; the combined form is named as marginal spondylitis.

In the further course of the disease, the epiphyseal rings may become hyperintense on T1-weighted images. Such hyperintensity indicates a circumscribed area of postinflammatory fatty degeneration of the bone marrow. This is the stage at which the changes first appear on conventional radiographs as shiny corners [4, 5].

Similar to conventional radiography, MRI depicts syndesmophytes as bone bridges of the anterior vertebral edges, which may be of lower or higher signal intensity on T2-weighted images depending on the floridity of the disease [4].

2.2 Intervertebral Discs

Inflammatory lesions of the intervertebral disc or discovertebral complex are known as discitis or spondylodiscitis, i.e., Andersson lesion, from the author who first described them [12].

Active spondylodiscitic lesions are characterized by hyperintense discovertebral changes on T2-weighted images and hypointense changes on T1-weighted images, indicating an edematous pattern of disc and/or subchondral bone marrow of adjacent vertebral bodies. Contrast enhancement of the same lesions is the indicator of inflammatory activity (i.e., osteitis and discitis).

In the further course of the disease, typical findings are constituted by erosions, fatty degeneration of the subchondral bone marrow, sclerosis, and transdiscal ankylosis.

As in anterior spondylitis (Romanus lesion), MRI is superior to conventional radiography in detecting Andersson lesions, since the edematous changes in early disease are not radiographically visualized [4, 5]. Radiography may show erosions of the vertebral endplates in the late course of the disease.

In literature, it is also described as a noninflammatory type of Andersson lesion, corresponding to an insufficiency

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_2, © Springer International Publishing Switzerland 2014

fracture of the ankylosed spine, which may occur at the level of a disc (transdiscal) or a vertebral body (transvertebral) [13]. Such fractures may occur spontaneously or after minor trauma, frequently in association with osteoporosis.

2.3 Facet Joints, Costovertebral Joints, and Costotransverse Joints

Facet joints (or zygapophyseal joints), costovertebral joints, and costotransverse joints (Fig. 2.1) represent another target for spondyloarthritis. They are all synovial joints.

MRI findings of arthritis involving the abovementioned joints are similar, including joint effusion, synovitis, erosions of the articular surfaces, and bone marrow edema. In the further course of the disease, affected joints may undergo ankylosis.

MRI clearly depicts these lesions, but it is necessary to examine carefully the sagittal images and obtain additional images on the axial plane.

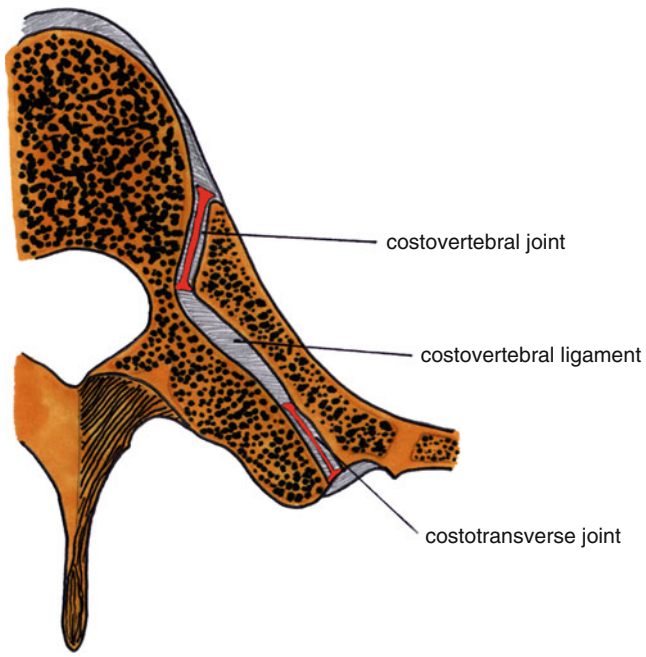


Fig. 2.1 Costovertebral and costotransverse joints. These are synovial joints. The costovertebral joint is the articulation that connects the head of the rib with the bodies of two adjacent thoracic vertebrae. The costotransverse joint is the articulation that connects the tubercle of the rib to the transverse process of the adjacent vertebra. This joint is strengthened by the costotransverse ligament

2.4 Sacroiliac Joints

The sacroiliac joint is the joint between the sacrum and the ilium of the pelvis. This is a complex joint constituted by an anterior synovial compartment and a posterior fibrous compartment.

The synovial compartment includes the articular surfaces covered by cartilage, a synovial membrane, and a capsule; in the so-called retroarticular space, there is the fibrous compartment, with the interosseous ligaments (Fig. 2.2). Both the synovial compartment (more commonly) and the fibrous compartment may be affected by inflammatory lesions.

Sacroiliitis constitutes an important target of spondyloarthritis, and it is included in the classification criteria [14].

MRI detects sacroiliitis in both acute and chronic phases. Acute changes are constituted by edema of the subchondral bone marrow, juxta-articular osteitis, synovitis, and capsulitis. Chronic changes are constituted by fatty degeneration of the subchondral bone marrow, osteosclerosis, erosions of the articular surfaces, and transarticular bone bridges (Fig. 2.3).

MRI clearly detects all the abovementioned changes. In particular, bone marrow edema appears as hyperintense in T2-weighted images with fat saturation and STIR images. Contrast enhancement of the cancellous bone indicates osteitis.

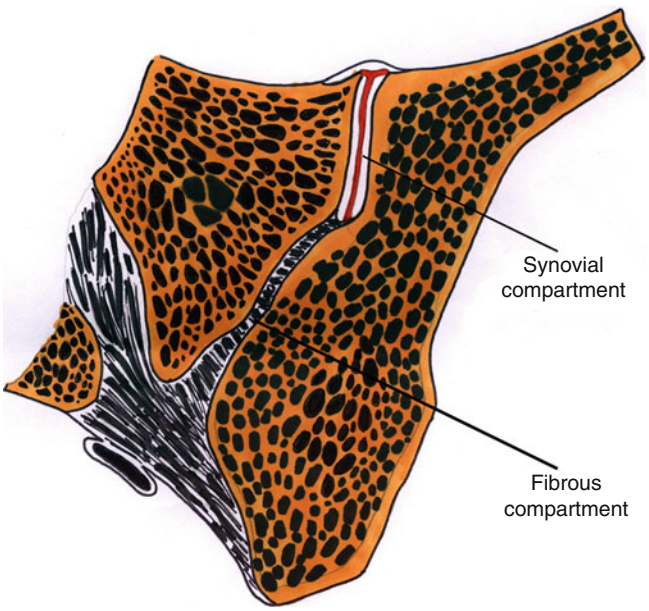


Fig. 2.2 Sacroiliac joint. This is a complex joint constituted by an anterior synovial compartment and a posterior fibrous compartment

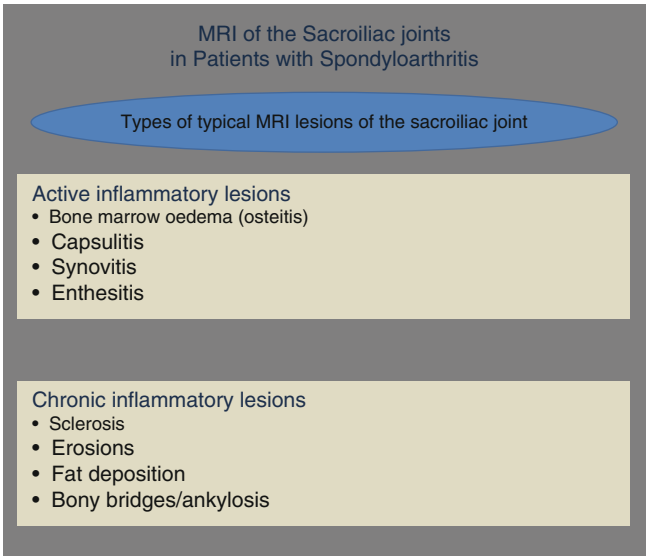


Fig. 2.3 Typical lesions of the sacroiliac joint in patients with spondyloarthritis

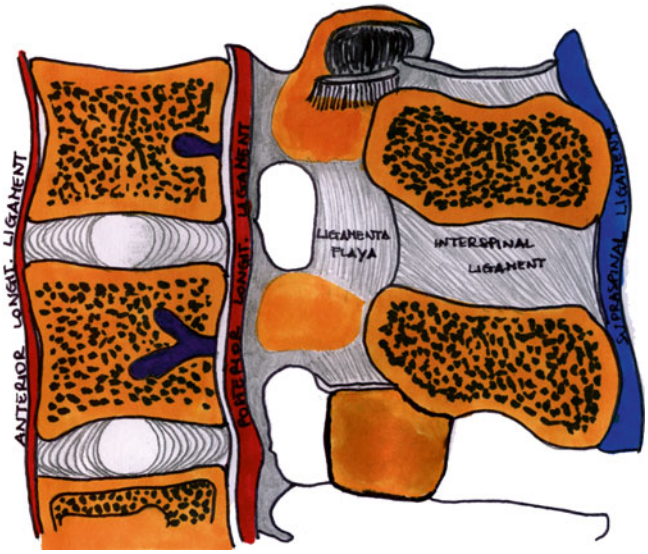


Fig. 2.4 Spinal ligaments

Synovitis is reflected by contrast enhancement in the anterior (synovial) part of the sacroiliac joint. Similarly, capsulitis is highlighted by contrast enhancement of the joint capsule.

From the above, the crucial role of the contrast medium in the detection of inflammatory activity must be emphasized.

Erosions are depicted as discontinuities of the cortical bone; gradient-echo T2* images may be more useful in detecting erosions [14]. Confluence of erosions may be seen as the so-called pseudodilation of the sacroiliac joints.

Sclerotic changes are depicted as low-intensity or signal-free bands by all sequences (T1, T2, STIR, contrast-enhanced T1-weighted images).

Transarticular bone bridges are the first sign of the ankylosing process. The presence of bone bridges may lead to increasing blurring of the joint cleft until complete ankylosis occurs [5].

2.5 Enthesitis

Enthesitis is the inflammation of the elastic cartilage at the sites of attachment of tendons and ligaments and constitutes an important sign of spondyloarthritis.

In particular, enthesitis may affect interspinous, supraspinous, and interosseous ligaments.

Interspinous and supraspinous ligaments attach to the spinous processes of the vertebrae (Fig. 2.4). Interosseous ligaments are situated between the sacrum and the ileum in the posterior compartment of the sacroiliac joints, i.e., the so-called retroarticular space (Fig. 2.2).

Inflammation of these ligaments is characterized by increased signal intensity on T2-weighted images with fat saturation and STIR sequences and by enhancement after contrast medium administration. Moreover, enthesitis may be better detectable by using contrast-enhanced T1-weighted images as compared to T2/STIR sequences [14].

References

1. Baraliakos X, Landewé R, Hermann KG et al (2005) Inflammation in ankylosing spondylitis: a systematic description of the extent and frequency of acute spinal changes using magnetic resonance imaging. Ann Rheum Dis 64(5):730–734
2. Bollow M, Enzweiler C, Taupitz M et al (2002) Use of contrast enhanced magnetic resonance imaging to detect spinal inflammation in patients with spondyloarthritides. Clin Exp Rheumatol 20(Suppl 28):S167–S174
3. Bochkova AG, Levshakova AV, Bunchuk NV et al (2010) Spinal inflammation lesions as detected by magnetic resonance imaging in patients with early ankylosing spondylitis are more often observed in posterior structures of the spine. Rheumatology (Oxford) 49(4):749–755

4. Hermann KG, Althoff CE, Schneider U et al (2005) Spinal changes in patients with spondyloarthritis: comparison of MR imaging and radiographic appearances. Radiographics 25(3):559–569; discussion 569–570
5. Hermann KG, Bollow M (2004) Magnetic resonance imaging of the axial skeleton in rheumatoid disease. Best Pract Res Clin Rheumatol 18(6):881–907
6. Jevtic V (2001) Magnetic resonance imaging appearances of different discovertebral lesions. Eur Radiol 11:1123–1135
7. Lambert RGW, Pedersen SJ, Maksymowych W, Maksymowych WP et al (2009) Active inflammatory lesions detected by magnetic resonance imaging in the spine of patients with spondyloarthritis – definitions, assessment system, and reference image set. J Rheumatol 84(Supplement 12):3–17. doi:10.3899/jrheum.090616
8. Maksymowych WP, Crowther SM, Dhillon SS et al (2010) Systematic assessment of inflammation by magnetic resonance imaging in the posterior elements of the spine in ankylosing spondylitis. Arthritis Care Res (Hoboken) 62(1):4–10
9. Weber U, Pfirrmann CW, Kissling RO et al (2007) Whole body MR imaging in ankylosing spondylitis: a descriptive pilot study in patients with suspected early and active confirmed ankylosing spondylitis. BMC Musculoskelet Disord 8:20
10. Zochling J, Baraliakos X, Hermann K-G et al (2007) Magnetic resonance imaging in ankylosing spondylitis. Curr Opin Rheumatol 19(4):346–352. doi:10.1097/BOR.0b013e32816a938c
11. Romanus R, Yden S (1952) Destructive and ossifying spondylitic changes in rheumatoid ankylosing spondylitis. Acta Orthop Scand 22:88–99
12. Andersson O (1937) Rontgenbilden vid spondylarthris ankylopoetica. Nord Med Tidskr 14:2000–2003
13. Dihlmann W, Delling G (1978) Disco-vertebral destructive lesions (so called Andersson lesions) associated with ankylosing spondylitis. Skeletal Radiol 3:10–15
14. Sieper J, Rudwaleit M, Baraliakos X et al (2009) The Assessment of SpondyloArthritis international Society (ASAS) handbook: a guide to assess spondyloarthritis. Ann Rheum Dis 68:ii1–ii44. doi:10.1136/ard.2008.104018

Magnetic Resonance Technique

3

Magnetic resonance imaging (MRI) has made a major contribution in the last decade to an early diagnosis of spondyloarthritis, other than a better understanding of the course of the disease [1–3]. Moreover, MRI may be used as an objective outcome measure for clinical trials [1, 4, 5].

Regarding other radiological techniques, conventional radiography can only detect chronic bony changes (i.e., osteosclerosis, erosions, syndesmophytes) in the late stages of spondyloarthritis. Such bony structural changes can be better detected by computed tomography (CT), but this imaging technique is rarely used because of a much higher radiation exposure. Finally, scintigraphy has been used in the past to detect foci of active inflammation but no longer plays a role in the diagnosis and follow-up of spondyloarthritis because of limited sensitivity and specificity and radiation exposure [1, 6].

In this perspective, MRI emerges as the gold standard imaging technique to detect spinal inflammation in clinical practice, in both early and late disease stages.

It is mandatory to use a proper MRI study protocol, given that "standard" examinations do not always allow a correct diagnosis.

All the patients in this series were examined with a 1.5 T MR system (Siemens Symphony-TIM) by using the following basic study protocol:

Cervical/Dorsal/Lumbosacral Spine

- TSE T1-weighted images on the sagittal plane.
- TSE T2-weighted images with fat saturation on the sagittal plane.
- TSE T2-weighted images with fat saturation on the axial plane (eventually to be conducted on the pathologic area, for a better spatial characterization of the edematous lesion).
- TSE/SE T1-weighted images with fat saturation on the sagittal and axial planes following the administration of contrast medium (eventually to be conducted to identify the active inflammatory stage of the disease). In this series, we administered Dotarem, Guerbet (0.5 mmol/ml, 0.2 ml/kg, dose), as intravenous paramagnetic contrast medium.

Sacroiliac Joints

The sacroiliac joints are imaged in axial orientation and semicoronal section orientation along the long axis of the sacral bone (Fig. 3.1a, b):

- TSE T2-weighted images with fat saturation on the axial and semicoronal plane
- TSE T1-weighted images on the axial plane
- GE T2*-weighted images on the semicoronal and axial plane (eventually to be obtained to highlight joint erosions)
- TSE/SE T1-weighted images with fat saturation on the semicoronal and axial planes following the administration of contrast medium (eventually to be conducted to identify the active inflammatory stage of the disease)

An efficient spinal imaging protocol must comprise fat-suppressed T2-weighted sequences, in particular with fat saturation technique or STIR sequences, in order to clearly visualize hyperintensity corresponding to edematous lesions, otherwise not easily identifiable with "standard" imaging sequences without fat suppression (Figs. 3.2 and 3.3).

In the same way, the administration of contrast medium must be followed by T1 sequences with fat saturation in order to clearly identify the active inflammation [1, 7–9].

The indication for contrast medium administration was based on the evidence of osteoarticular or muscular-ligamentous edema in T2-weighted images with fat saturation to identify the active inflammatory stage of the disease.

In some selected cases, we administered contrast medium although the basic scan failed to disclose edematous lesions on T2-weighted images (e.g., in cases of clinical-radiological discrepancy).

The fat saturation (FS) technique consists in a spectral saturation of the fat, by adding a selective radio-frequency impulse on the fat frequency. To determine the fat frequency, the machine checks for the presence of approximately a 130-Hz peak, as compared with the resonance frequency of water, at which point it emits the RF impulse. The effect of the impulse is to excite the fat over 180°, whereby it will be unable to return the signal. Such a

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_3, © Springer International Publishing Switzerland 2014

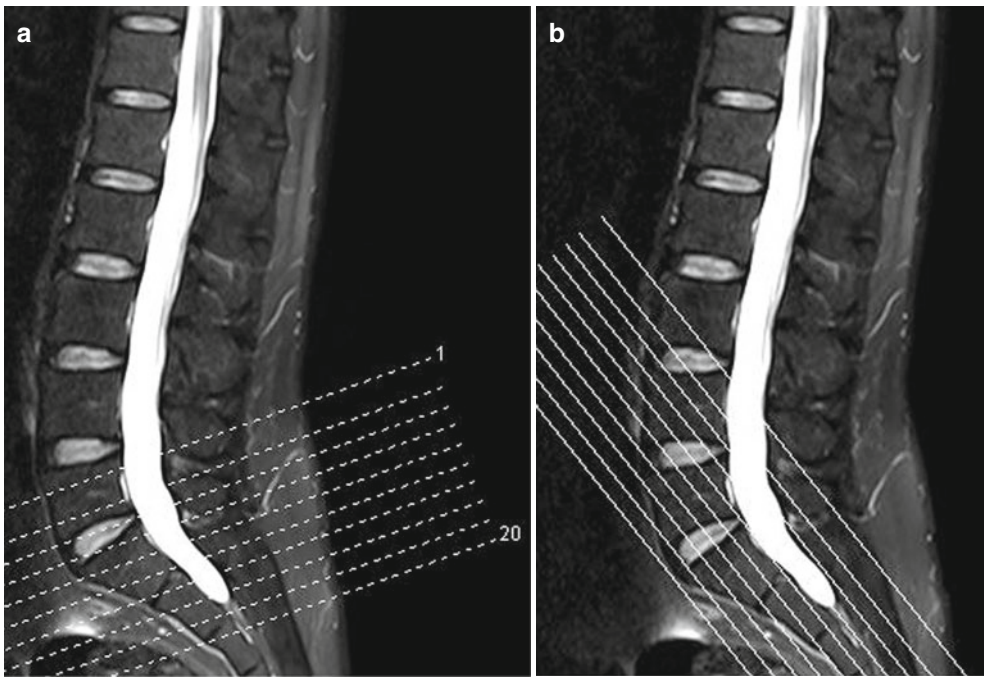


Fig. 3.1 MRI of the sacroiliac joints. Correct positioning of the slices in axial orientation (**a**) and semicoronal orientation along the long axis of the sacral bone (**b**)

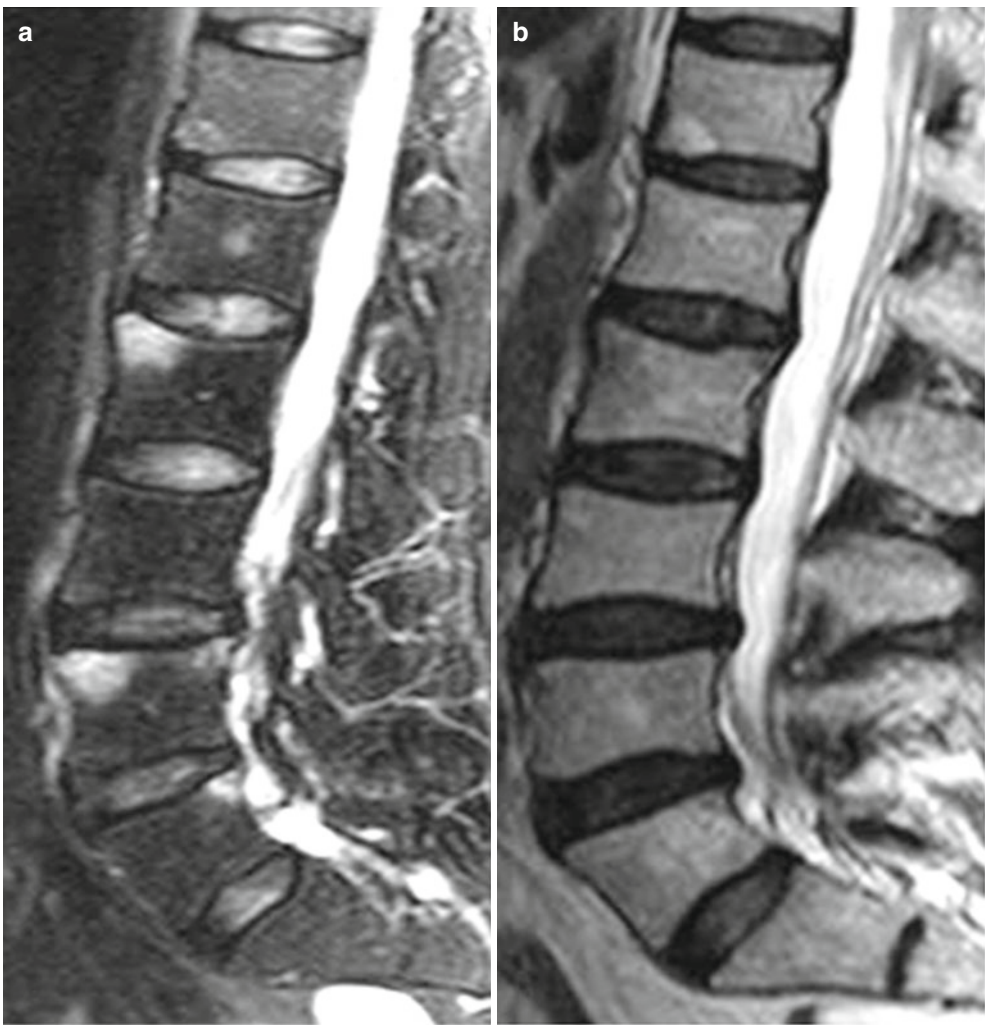


Fig. 3.2 Sagittal TSE T2-weighted image with fat saturation (**a**) and "standard" sagittal TSE T2-weighted image without fat saturation (**b**). Hyperintense lesions in fat-suppressed T2-weighted image in the anterior corners of the vertebral bodies L2 and L4, indicating edematous lesions (**a**). Note that the sequence without fat saturation does not show the same lesions (**b**)

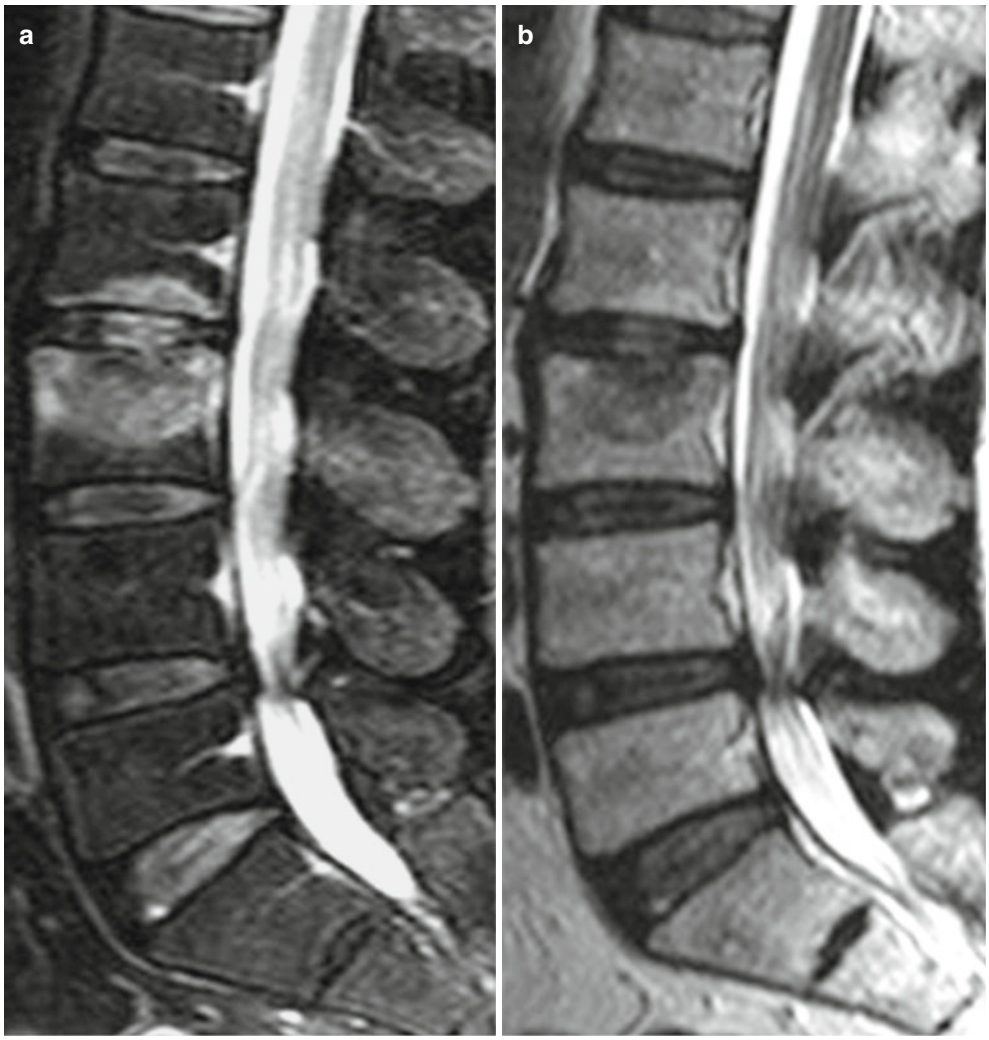


Fig. 3.3 Sagittal TSE T2-weighted image with fat saturation (**a**) and "standard" sagittal TSE T2-weighted image without fat saturation (**b**). Hyperintense lesions in the subchondral bone of the opposing vertebral bodies L2/L3, indicating edema of the bone marrow (**a**). The sequence without fat saturation fails to show the edematous component of the same lesions (**b**)

technique enables the saturation of the fat signal on almost all of the available sequences, from spin echo to gradient echo, using any type of MRI sequence (T1, T2, T2*) [10].

We have to remember that fat signal can be suppressed also by using short tau inversion recovery (STIR) sequences [1, 8], but in our experience, this technique has longer acquisition time, whereas the FS technique substantially does not increase the relative scan time. However, there are a number of artifacts and pitfalls associated with the fat saturation technique (Figs. 3.4 and 3.5).

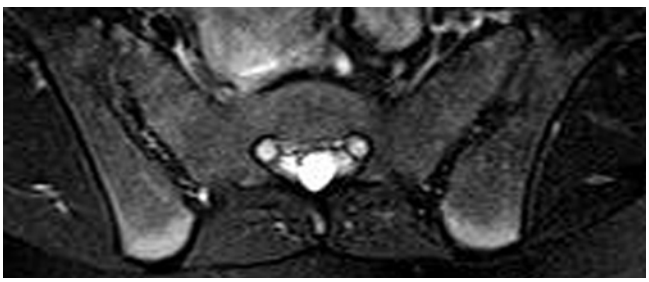


Fig. 3.4 Axial T2-weighted image with fat saturation. Note T2-hyperintensity at the back of the iliac bones. This is an artifact of the fat saturation technique

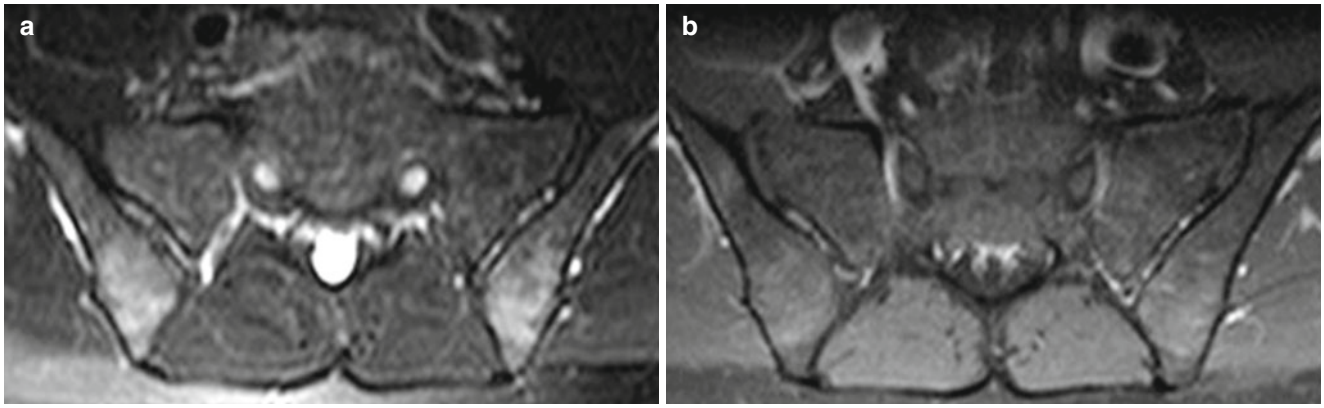


Fig. 3.5 Axial T2-weighted image with fat saturation (**a**) and SE T1-weighted image with fat saturation after contrast medium administration (**b**). Areas of high signal intensity at the back of the iliac bones (**a**). T1-weighted image does not show any signal changes nor contrast enhancement (**b**). In this case, the patient is not affected by sacroiliitis. The signal changes in T2 correspond to artifacts due to the fat saturation technique

References

1. Sieper J, Rudwaleit M, Baraliakos X et al (2009) The Assessment of SpondyloArthritis international Society (ASAS) handbook: a guide to assess spondyloarthritis. Ann Rheum Dis 68:ii1–ii44. doi:10.1136/ard.2008.104018
2. Hermann KG, Bollow M (2004) Magnetic resonance imaging of the axial skeleton in rheumatoid disease. Best Pract Res Clin Rheumatol 18(6):881–907
3. Hermann KG, Althoff CE, Schneider U et al (2005) Spinal changes in patients with spondyloarthritis: comparison of MR imaging and radiographic appearances. Radiographics 25(3):559–569; discussion 569–570
4. Baraliakos X, Davis J, Tsuji W et al (2005) Magnetic resonance imaging examinations of the spine in patients with ankylosing spondylitis before and after therapy with the tumor necrosis factor alpha receptor fusion protein etanercept. Arthritis Rheum 52(4):216–223
5. Rudwaleit M, Baraliakos X, Listing J et al (2005) Magnetic resonance imaging of the spine and the sacroiliac joints in ankylosing spondylitis and undifferentiated spondyloarthritis during treatment with etanercept. Ann Rheum Dis 64:1305–1310. doi:10.1136/ard.2004.032441
6. Sonh IH, Carrasco-Fernandez J, Rudwaleit M et al (2008) The diagnostic value of scintigraphy in assessing sacroiliitis in ankylosing spondylitis: a systematic literature research. Ann Rheum Dis 67:1535–1540
7. Bollow M, Enzweiler C, Taupitz M et al (2002) Use of contrast enhanced magnetic resonance imaging to detect spinal inflammation in patients with spondyloarthritides. Clin Exp Rheumatol 20(Suppl 28):S167–S174
8. Baraliakos X, Hermann KG, Landewé R et al (2005) Assessment of acute spinal inflammation in patients with ankylosing spondylitis by magnetic resonance imaging: a comparison between contrast enhanced T1 and short tau inversion recovery (STIR) sequences. Ann Rheum Dis 64:1141–1144. doi:10.1136/ard.2004.031609
9. Hermann KG, Landewé R, Braun J et al (2005) Magnetic resonance imaging of inflammatory lesions in the spine in ankylosing spondylitis clinical trials: is paramagnetic contrast medium necessary? J Rheumatol 32(10):2056–2060
10. D'Aprile P, Tarantino A, Jinkins JR et al (2007) The value of fat saturation sequences and contrast medium administration in MRI of degenerative disease of the posterior/perispinal elements of the lumbosacral spine. Eur Radiol 17:523–531

MR Imaging in the Follow-Up Post Therapy

4

Great advances have been made in recent years regarding the treatment of spondyloarthropathies.

The aim of spondyloarthritis (SpA) treatment is to control the signs and symptoms of the patient, to prevent joint damage, and to maintain the patient's quality of life and ability function.

The treatment of spondyloarthritis must be tailored to each patient's individual case, including the grade of the general conditions, the effectiveness of specific therapies, and the occurrence of any side effects.

A common treatment regimen for all the spondyloarthropathies (ankylosing spondylitis, reactive arthritis, psoriatic arthritis, enteropathic arthritis, and undifferentiated spondyloarthropathy) includes medication and daily exercise (to relax the muscles and reduce joint pain).

The nonsteroidal anti-inflammatory drugs (NSAIDs) are still the first stage of medication in treating the pain and stiffness, but these drugs can cause important side effects or not be effective [1].

The second-line medication is the so-called disease-controlling antirheumatic drugs (sulfasalazine, methotrexate, and corticosteroids) used in the rheumatic and psoriatic arthritis, but these drugs do not have an effectiveness in the ankylosing spondylitis.

New and most promising drugs for ankylosing spondylitis are the biologics, the TNF-blockers. TNF-alpha (tumor necrosis factor-alpha) is a cytokine involved in the inflammatory process. Excess amounts of TNF-alpha have been associated with various forms of inflammatory arthritis.

The treatment with TNF-blockers is recommended after the failure of NSAIDs. The TNF-blockers are very effective drugs and also show a sustained and stable long-term response [2].

The effectiveness of all these drugs can be monitored by MRI imaging. Longer periods of treatment are needed to see further effects of anti-TNF treatment on spinal inflammation as detected by MRI [3, 4].

MRI is considered the most sensitive imaging method for detecting inflammatory changes of the spine and sacroiliac joints in the diagnosis of early lesions and follow-up after pharmacological therapy [3, 5].

The active inflammatory lesions are best visualized on fat-suppressed T2-weighted or STIR sequences [6]. This technique has been increasingly used in practice to assess disease activity and to monitor and evaluate therapeutic response [7, 8].

The fat saturated T1-weighted sequences, used after the administration of the contrast agent, seem to be a more specific depiction of inflammatory spinal lesions [6, 9], in particular in the study of intra-articular synovitis, in spondylodiscitis (Andersson lesions) that is characterized by flogosis of the cortical plates and intervertebral disc, and in the study of enthesitis of spinal ligaments (supraspinal, interspinal, and flava ligaments). So in the clinical practice during the follow-up of the therapy, an efficient spinal imaging protocol comprises T1-weighted and fat-saturated T2-weighted sequences in the sagittal planes; a contrast agent is often used to confirm possible abnormalities detected by fat-saturated T2-weighted sequences [10]; the use of axial slices (fat-saturated T2-weighted and fat-saturated T1-weighted post-contrast sequences) can be helpful for the assessment of the posterior elements, the costovertebral and facet joints [8].

MRI provides therapeutic guidance at any time during the course of the disease, and it supplies objective information on the degree of inflammation and response to treatment [11].

Acknowledgments I would like to thank **Dr. Anita Strada** for her contribution in writing this chapter.

References

1. Zochling J, Bohl-Buhler MM, Baraliakos X et al (2006) Non steroidal anti-inflammatory drug use in ankylosing spondylitis a population-based survey. Clin Rheumatol 25(6):794–800
2. Song IH, Haibel H, Poddubnyy D et al (2013) Withdrawal of biologic therapy in axial spondyloarthritis the experience in early disease. Clin Exp Rheumatol 31(suppl 78):s37–s42

DOI 10.1007/978-3-319-05627-2_4,

3. Baraliakos X, Davis J, Tsuji W et al (2005) MRI examinations of the spine in patient with ankylosing spondylitis before and after therapy with the TNF-alpha receptor fusion protein etanercept. Arthritis Rheum 52:1216–1223
4. Rudwaleit M, baraliakos X, Listing J et al (2005) Magnetic resonance imaging of the spine and the sacroiliac joint in ankylosing spondylitis and undifferentiated spondyloarthritis during treatment with etanercept. Ann Rheum Dis 64:1305–1310
5. Rudwaleit M, van der Heijde D, Khan MA et al (2004) How to diagnose axial spondyloarthritis early. Ann Rheum Dis 63:535–543
6. Sieper J, Rudwaleit M, Baraliakos X et al (2009) The Assessment of Spondyloarthritis International Society (ASAS) handbook: a guide to assess spondyloarthritis. Ann Rheum Dis 68(suppl 2):1–44
7. Bollow M, Enzeweller C, Taupitz M et al (2002) Use of contrast enhanced magnetic resonance imaging to detect spinal inflammation in patients with spondyloarthritides. Clin Exp Rheumatol 20(suppl 28):s167–s174
8. Canella C, Schau B, Ribeiros E et al (2013) MRI in Seronegative Spondyloarthritis: imaging features and differential diagnosis in the spine and sacroiliac joint. AJR Am J Roentgenol 200:149–157
9. Baraliakos X, Hermann K-GA, Landewe R et al (2005) Assessment of acute spinal inflammation in patients with ankylosing spondylitis by magnetic resonance imaging: a comparison between contrast enhanced T1 and short tau inversion recovery (stir) sequences. Ann Rheum Dis 64:1141–1144
10. Bennet AN, Rehman A, Hensor EM et al (2009) Evaluation of the diagnostic utility of spinal magnetic resonance imaging in axial spondyloarthritis. Arthritis Rheum 60:1331–1341
11. Chary-valckenaere I, D'Agostino MA, Loeuille D (2011) Role for imaging studies in ankylosing spondylitis. Joint Bone Spine 78: 138–143

Part II

Spondyloarthritis: Clinical Cases

Ankylosing Spondylitis

Case 1

Anterior Spondylitis

- A 49-year-old man
- Patient with dorsal pain
- Stiffness

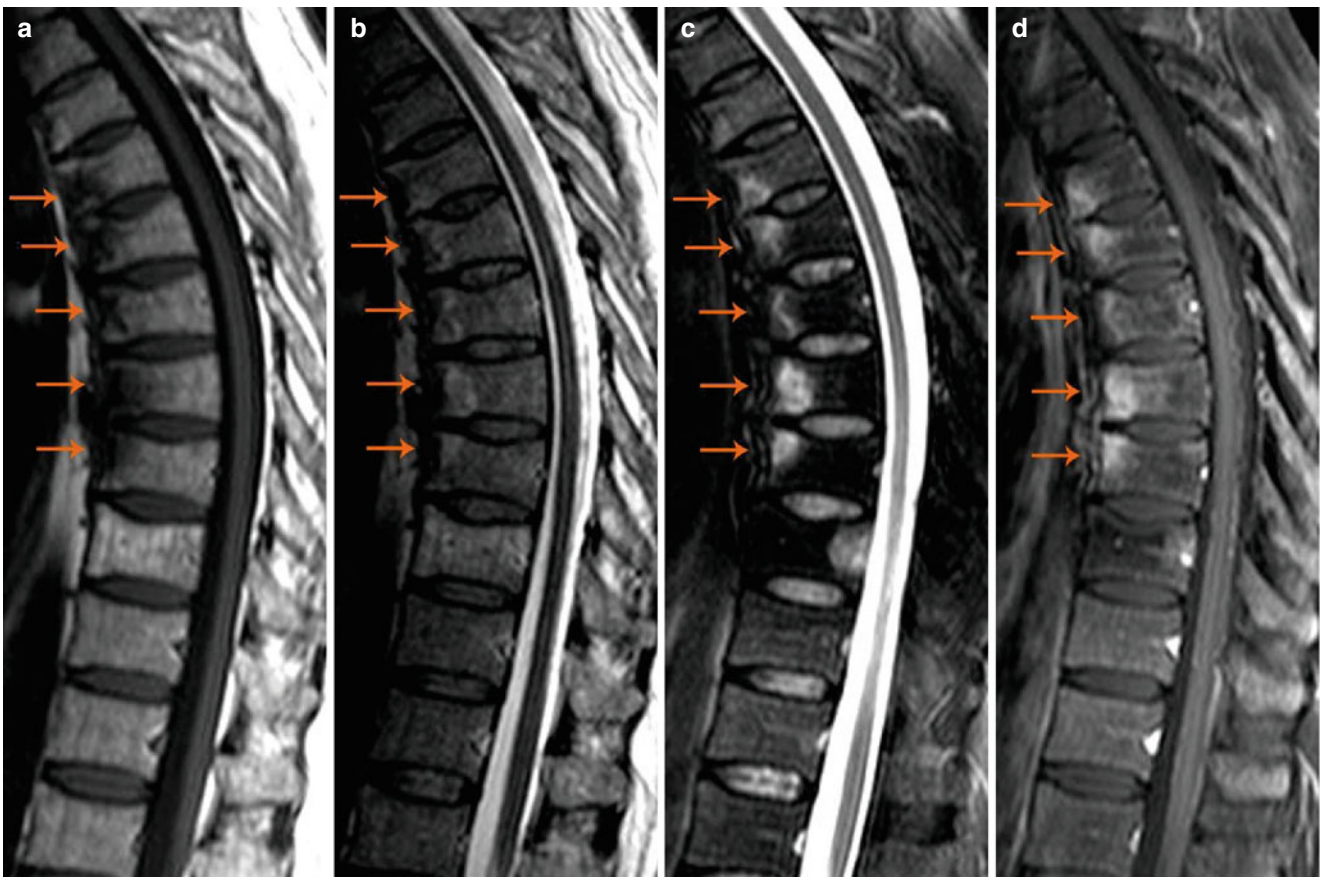


Fig. 1 Sagittal SE T1-weighted image (**a**), sagittal TSE T2-weighted image (**b**), sagittal TSE T2-weighted image with fat saturation (**c**), sagittal SE T1-weighted image with fat saturation after the administration of contrast medium (**d**). Typical active anterior spondylitis. Edema and contrast enhancement of the anterior corners of the vertebral bodies from D3 to D8 (**a–d**, *arrows*). Note that the edema is better depicted on T2-weighted images with fat saturation (**c**) with respect to standard T2-weighted images (**b**). It coexists with a vertebral body hemangioma at D9

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_5, © Springer International Publishing Switzerland 2014

Ankylosing Spondylitis

Case 2

Anterior Spondylitis

- A 54-year-old male
- Chronic dorsal and lumbar pain
- Presence of HLA-B27

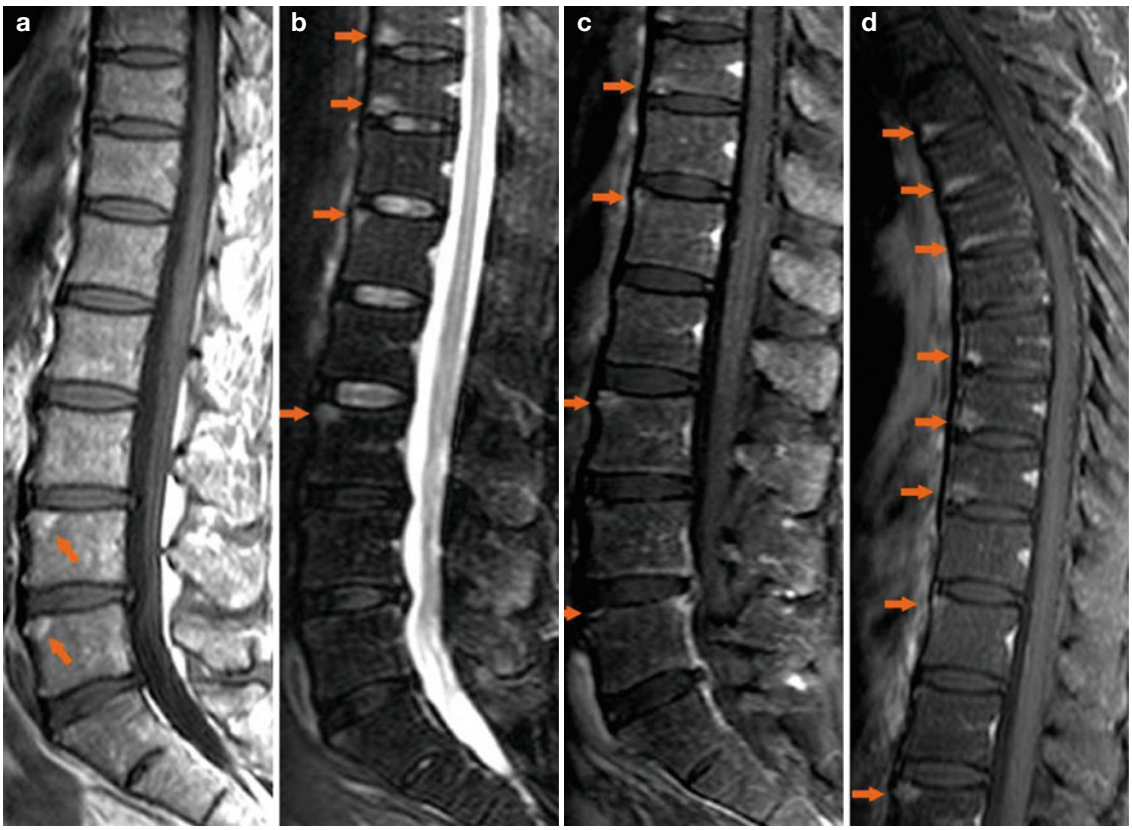


Fig. 1 Sagittal SE T1-weighted image (**a**), sagittal TSE T2-weighted image with fat saturation (**b**), sagittal SE T1-weighted images with fat saturation following the administration of contrast medium (**c–d**). In this patient, we detect multiple foci of predominantly anterior spondylitis. Most of these foci of spondylitis exhibit hyperintense signal in T2 (**b**, *arrows*) and contrast enhancement (**c**, **d**, *arrows*), indicating inflammatory activity (in the thoracic and upper lumbar spine); others show postinflammatory areas of fatty degeneration of the bone marrow (anterior edges of the vertebral bodies at L4 and L5, *arrows* in **a**). We observe only a single area of posterior spondylitis at L5

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_6, © Springer International Publishing Switzerland 2014

Psoriatic Arthritis

Posterior Spondylitis

Case 3

- A 59-year-old patient
- Low back pain exacerbated by hyperextension
- Psoriasis

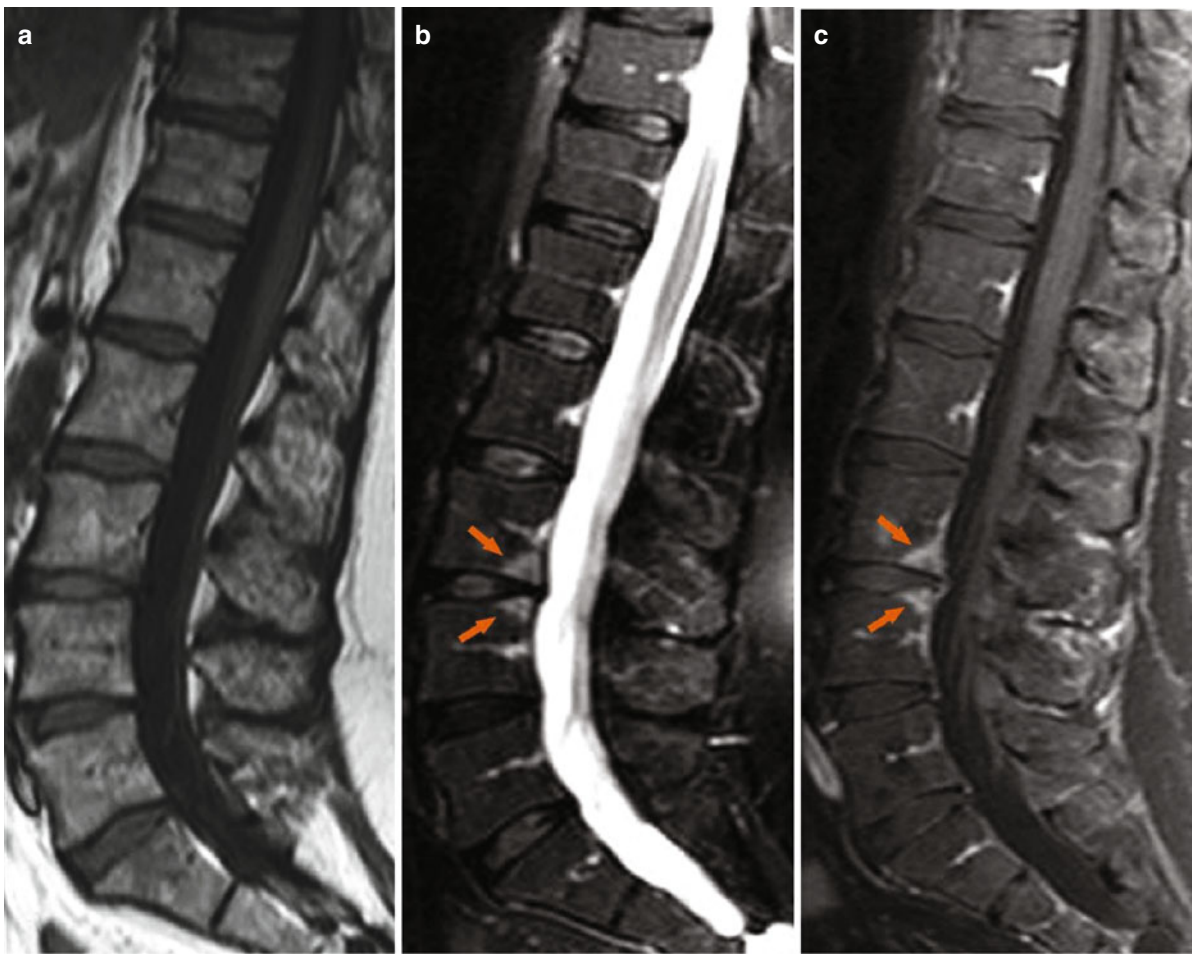


Fig. 1 Sagittal SE T1-weighted image (**a**), sagittal TSE T2-weighted image with fat saturation (**b**), sagittal SE T1-weighted image with fat saturation following the administration of contrast medium (**c**). T2-hyperintensity and contrast enhancement in the posterior corners of the opposing vertebral bodies L3/L4 (**b**, **c**, *arrows*). Posterior spondylitis in active inflammatory stage

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_7, © Springer International Publishing Switzerland 2014

Undifferentiated Spondyloarthritis

Case 4

Spondylitis in Chronic Phase

- A 65-year-old male
- Chronic low back pain

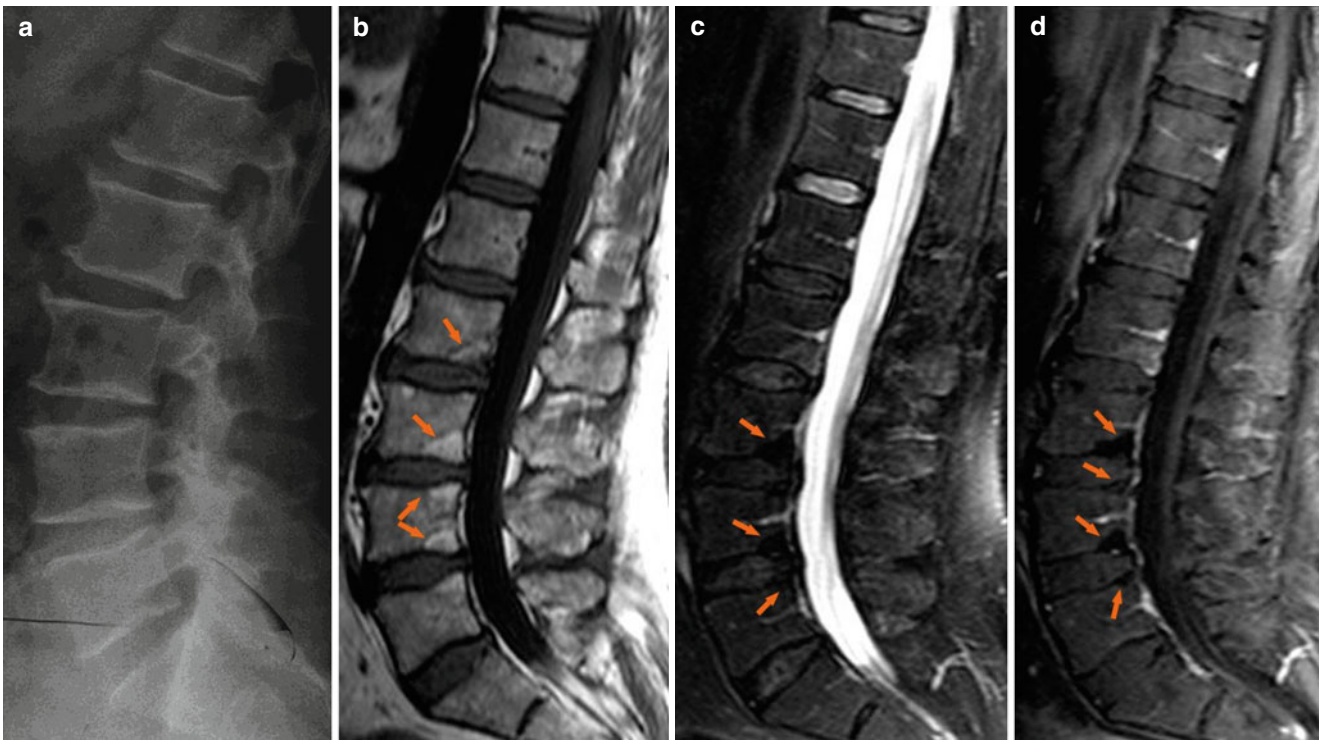


Fig. 1 Lateral plain film radiograph (**a**), sagittal SE T1-weighted image (**b**), sagittal TSE T2-weighted image with fat saturation (**c**), sagittal SE T1-weighted image with fat saturation following the administration of contrast medium (**d**). X-ray does not show specific changes; in particular, there are no signs of spondylitis (**a**). Hyperintense lesions in T1 in the posterior margins of the endplates from L2 to L5 (**b**, *arrows*), with no edematous pattern in T2 (**c**, *arrows*) and no contrast enhancement (**d**, *arrows*). These findings indicate postinflammatory fatty degeneration of the bone marrow (i.e., posterior spondylitis in chronic phase)

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_8, © Springer International Publishing Switzerland 2014

Psoriatic Spondylitis

Case 5

Spondylitis in Active and Inactive Phases

Spondylodiscitis

- A 65-year-old male
- Chronic dorsal and lumbar pain
- Stiffness
- Presence of HLA-B27

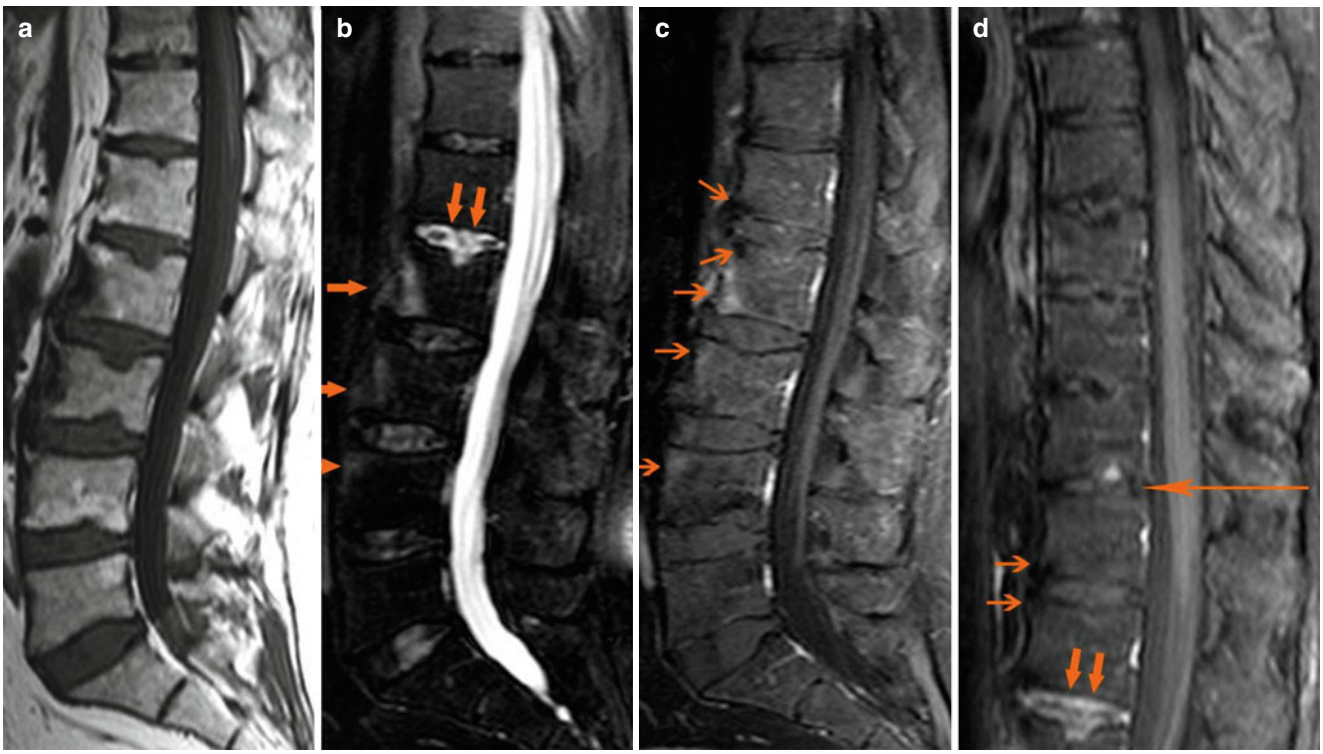


Fig. 1 Sagittal SE T1-weighted image (**a**), sagittal TSE T2-weighted image with fat saturation (**b**), sagittal SE T1-weighted images with fat saturation after the administration of contrast medium (**c**, **d**). In this patient, we can find multiple areas of spondylitis in different phases. Active anterior spondylitis at L2/L3 and L3/L4, with edema and contrast enhancement in the anterior edges of the vertebral bodies (**a**–**c**). In addition, a florid Andersson lesion (spondylodiscitis) is seen at T11/T12, with a small area of contrast enhancement (**d**). Syndesmophyte at L1/L2 (**a**). Chronic phase of anterior spondylitis in dorsal spine, with no contrast enhancement of the anterior edges of the vertebral bodies (*double thin arrows*, **d**)

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_9, © Springer International Publishing Switzerland 2014

Arthritis Associated with Inflammatory Bowel Disease

Case 6

Spondylitis and Sacroiliitis in Postinflammatory Phase

- A 44-year-old male
- Patient with dorsal and lumbar pain
- Stiffness
- Ulcerative colitis

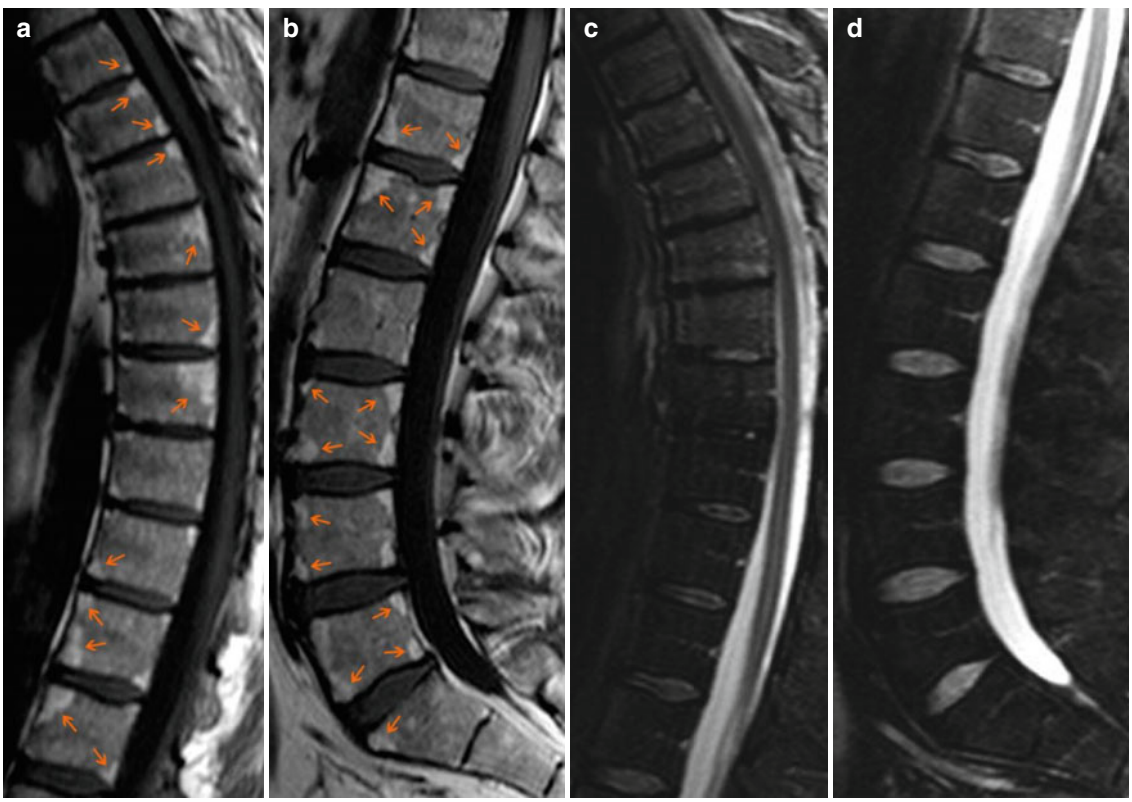


Fig. 1 Sagittal SE T1-weighted images (**a**, **b**), sagittal TSE T2-weighted images with fat saturation (**c**, **d**), sagittal and axial SE T1-weighted images with fat saturation following the administration of contrast medium (**e–g**). Multiple small areas of anterior and posterior spondylitis in chronic stage, with postinflammatory fatty degeneration of the bone marrow (**a–f**). The administration of contrast medium detects only one enhancing area at the level of the intervertebral disc D6/D7, indicating aseptic discitis (**e**, *arrow*). The same patient presented bilateral sacroiliitis in chronic phase, with fatty degeneration of the subchondral bone marrow and no contrast enhancement (**g**)

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_10,

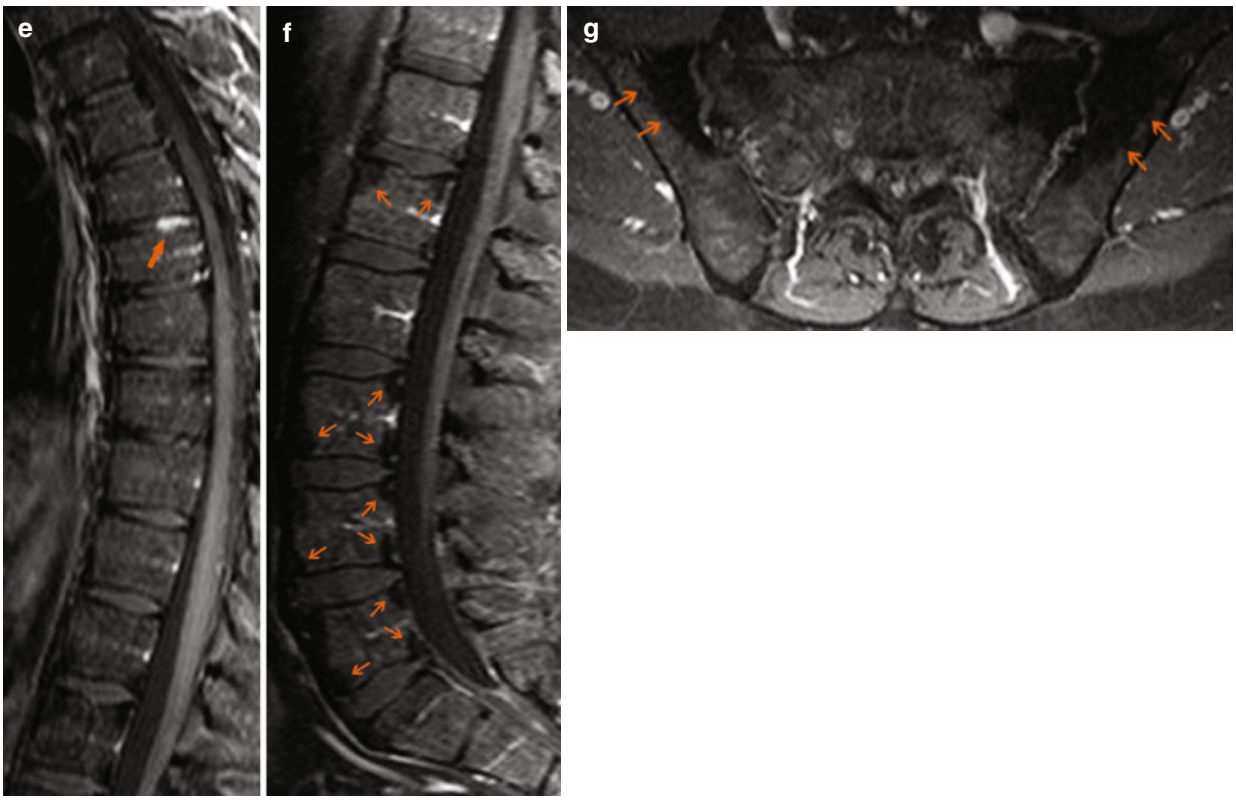


Fig. 1 (continued)

Juvenile Spondylitis

Case 7

Spondylitis and Sacroiliitis

- A 14-year-old male
- Low back pain
- Pain at night with improvement upon getting up

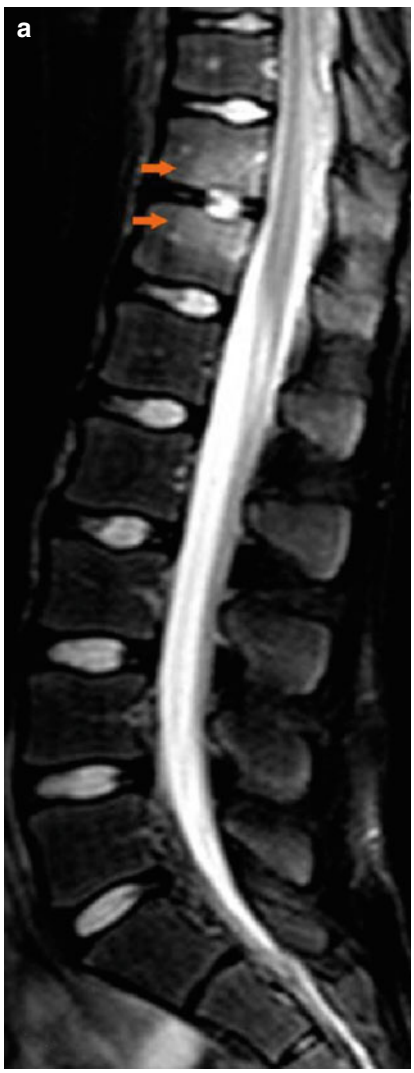
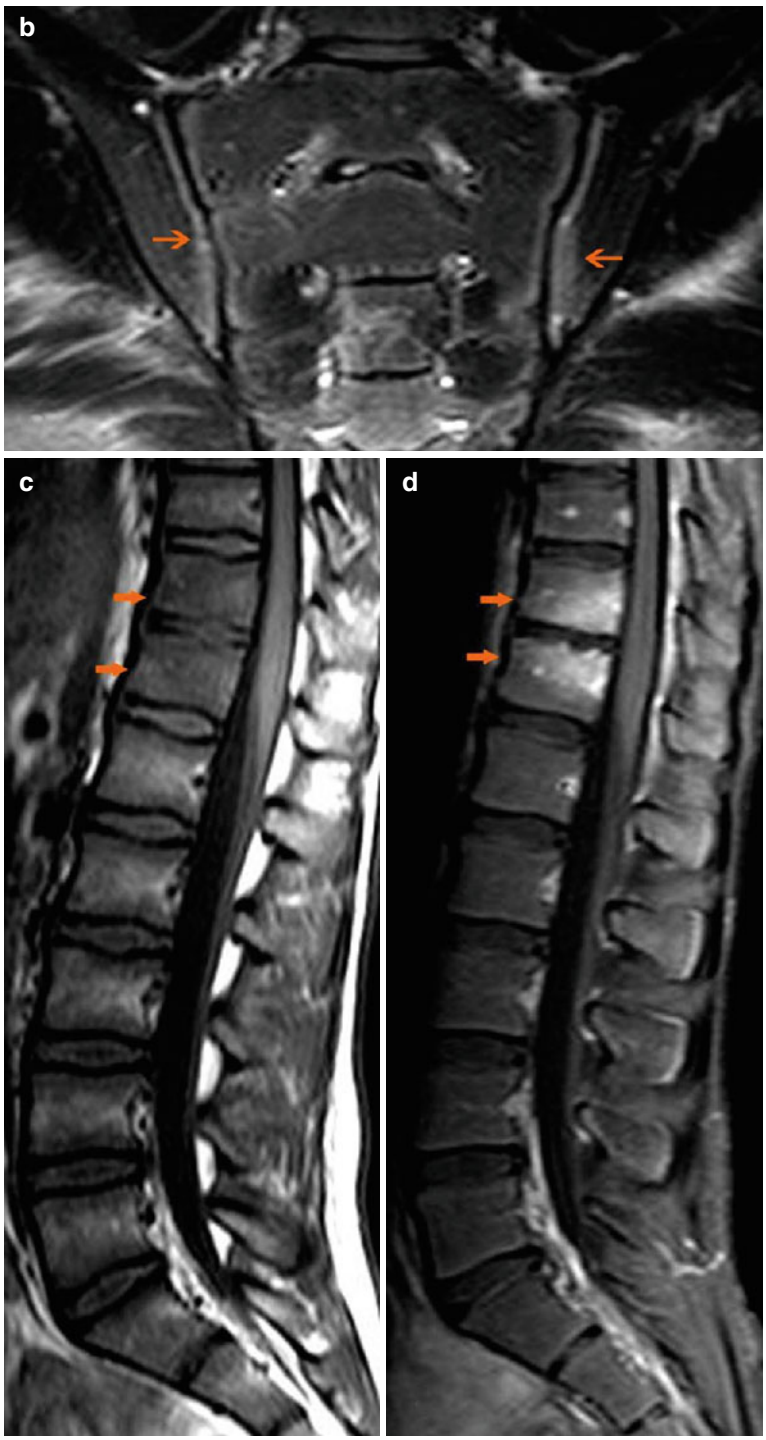


Fig. 1 Sagittal and coronal T2-weighted images with fat saturation (**a, b**), sagittal T1-weighted image (**c**), sagittal T1-weighted image with fat saturation following contrast medium administration (**d**). Posterior spondylitis at D11/D12 (**a**, **c**–**d**, *arrows*). Pattern of edema-inflammation of the posterior part of the vertebral bodies. The same patient presented an edematous pattern of the sacroiliac joints (**b**, *arrows*)

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_11, © Springer International Publishing Switzerland 2014

Fig. 1 (continued)



Psoriatic Arthritis

Spondylodiscitis

Case 8

- A 62-year-old man
- Lumbar and dorsal pain during the night
- Psoriasis

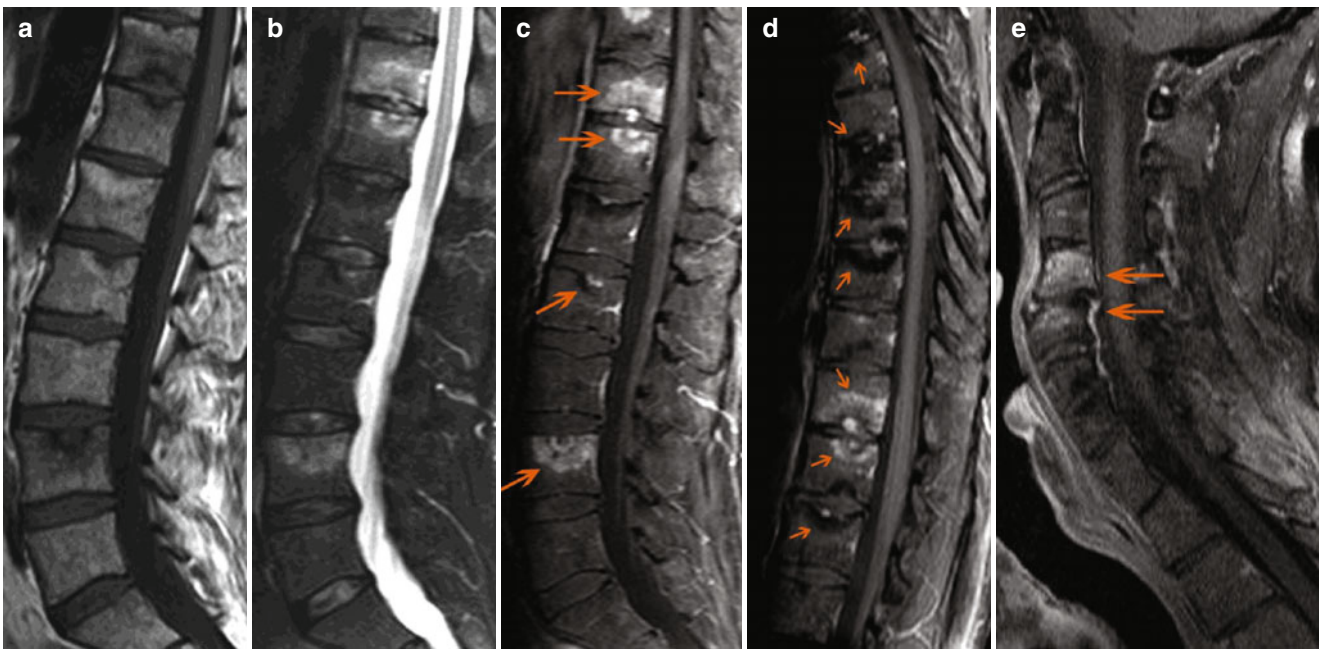


Fig. 1 Sagittal SE T1-weighted image (**a**), sagittal TSE T2-weighted image with fat saturation (**b**), sagittal SE T1-weighted images with fat saturation after the administration of contrast medium (**c**–**e**). Spondylodiscitis with multiple lesions in acute and/or chronic phase in cervical, dorsal, and lumbar spine (**a**–**e**, *arrows*). A typical active Andersson lesion (spondylodiscitis) is visualized at D11/D12, with subchondral edema-osteitis, discitis, and erosions (**a**–**d**). An older Andersson lesion with fatty degeneration of the bone marrow is visualized at L1 (**a**)

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_12,

Psoriatic Arthritis

Spondylitis and Costovertebral Arthritis

Case 9

- A 53-year-old man
- Long history of back pain
- Limitation of motion of the spine
- Psoriasis

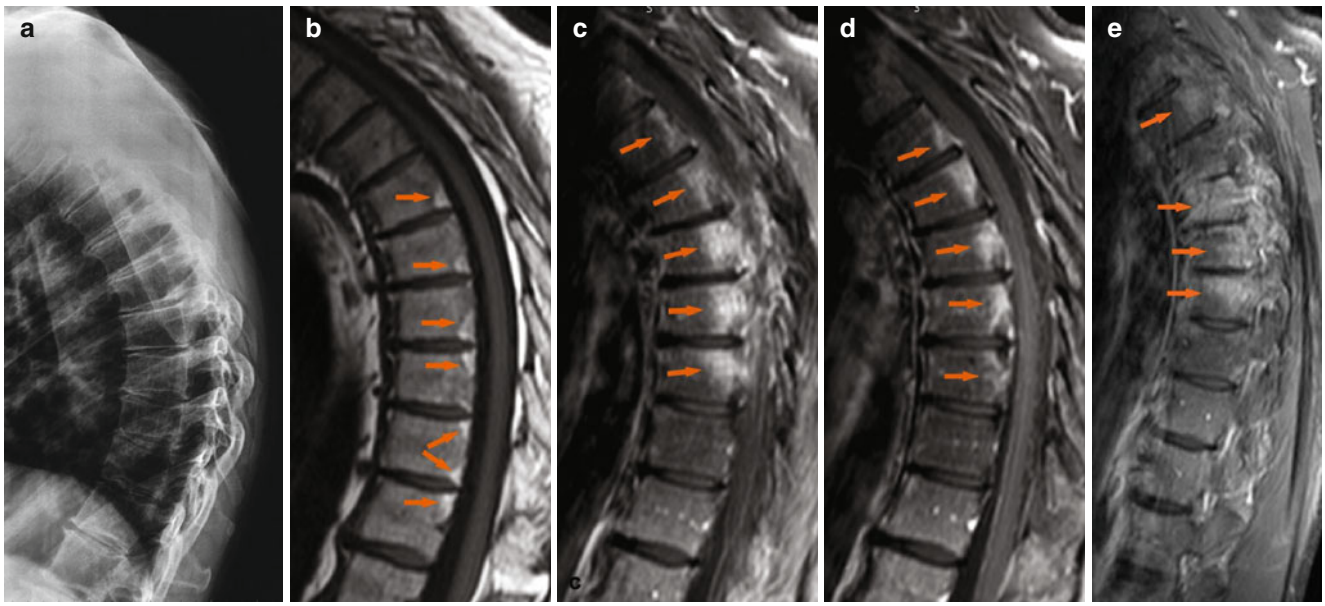
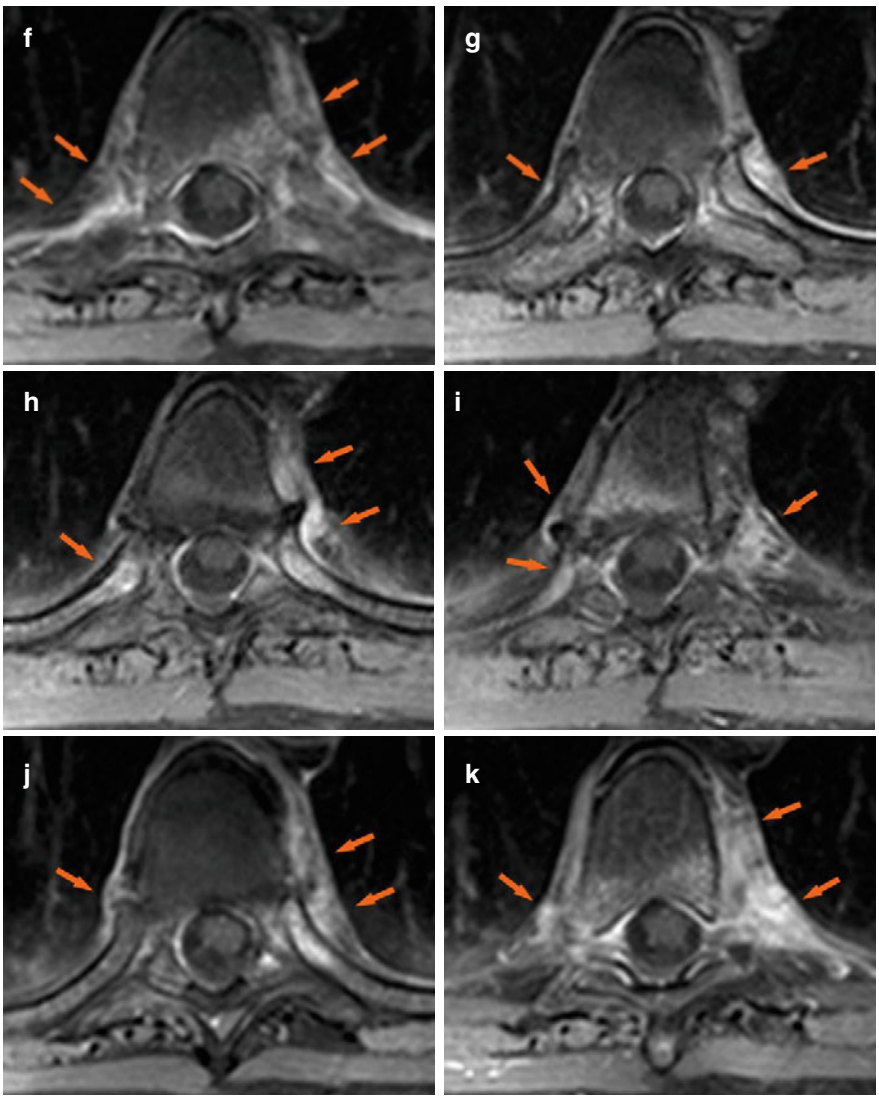


Fig. 1 Lateral plain film radiography (**a**), sagittal SE T1-weighted image (**b**), sagittal and axial SE T1-weighted images with fat saturation following the administration of contrast medium (**c–k**). Dorsal hyperkyphosis, syndesmophytes, reduction in the height of the intervertebral spaces, and small shiny corners (**a**). Multiple areas of postinflammatory fatty degeneration of the bone marrow in the posterior edges of the vertebral bodies, corresponding to Romanus lesions (**b**, *arrows*). Multiple areas of contrast enhancement in the joint clefts, side parts of the vertebral bodies, pedicles, head of the ribs, and adjacent soft tissues, indicating bilateral costovertebral arthritis with periarticular inflammation (**c–k**, *arrows*)

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_13,

Fig. 1 (continued)



Ankylosing Spondylitis

Case 10

Spondylitis

Spondylodiscitis

- A 33-year-old patient
- Dorsal and lumbar pain
- Morning stiffness
- Presence of HLA-B27

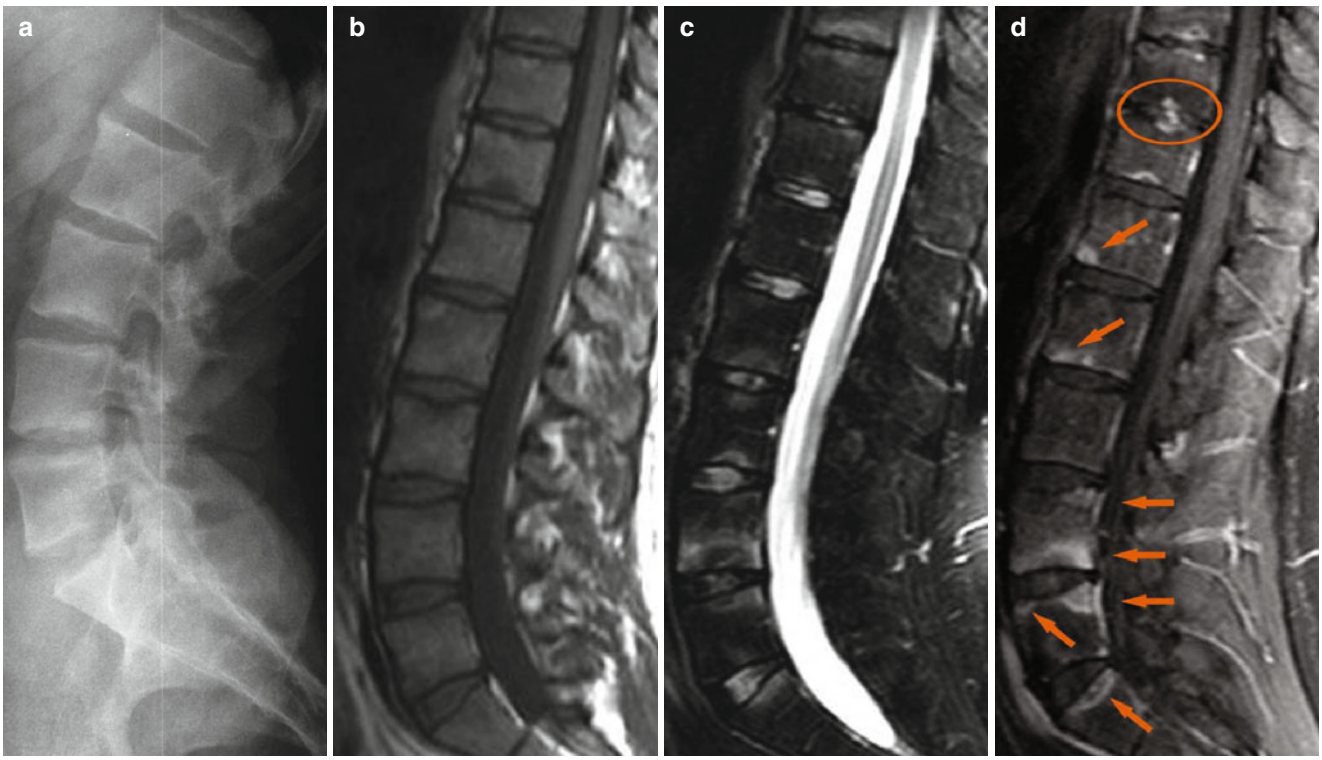


Fig. 1 Plain film radiography (**a**), sagittal SE T1-weighted image (**b**), sagittal TSE T2-weighted image with fat saturation (**c**), sagittal SE T1-weighted image with fat saturation following the administration of contrast medium (**d**). Mild osteosclerosis in the edges of the vertebral bodies at L3/L4 and L4/L5 and shiny corners at L1/L2 (i.e., Romanus lesion) (**a**). MRI shows multiple inflammatory lesions of the spine (**b**–**d**). Most of the lesions are in active inflammatory phase, with edematous pattern and contrast enhancement. Anterior spondylitis (corresponding to the so-called Romanus lesion) at L1, anterior and posterior spondylitis (i.e., marginal spondylitis) at L4/L5 (**c**, **d**, *arrows*), and spondylodiscitis at D11/D12 (**c**–**d**, *circle*)

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_14, © Springer International Publishing Switzerland 2014

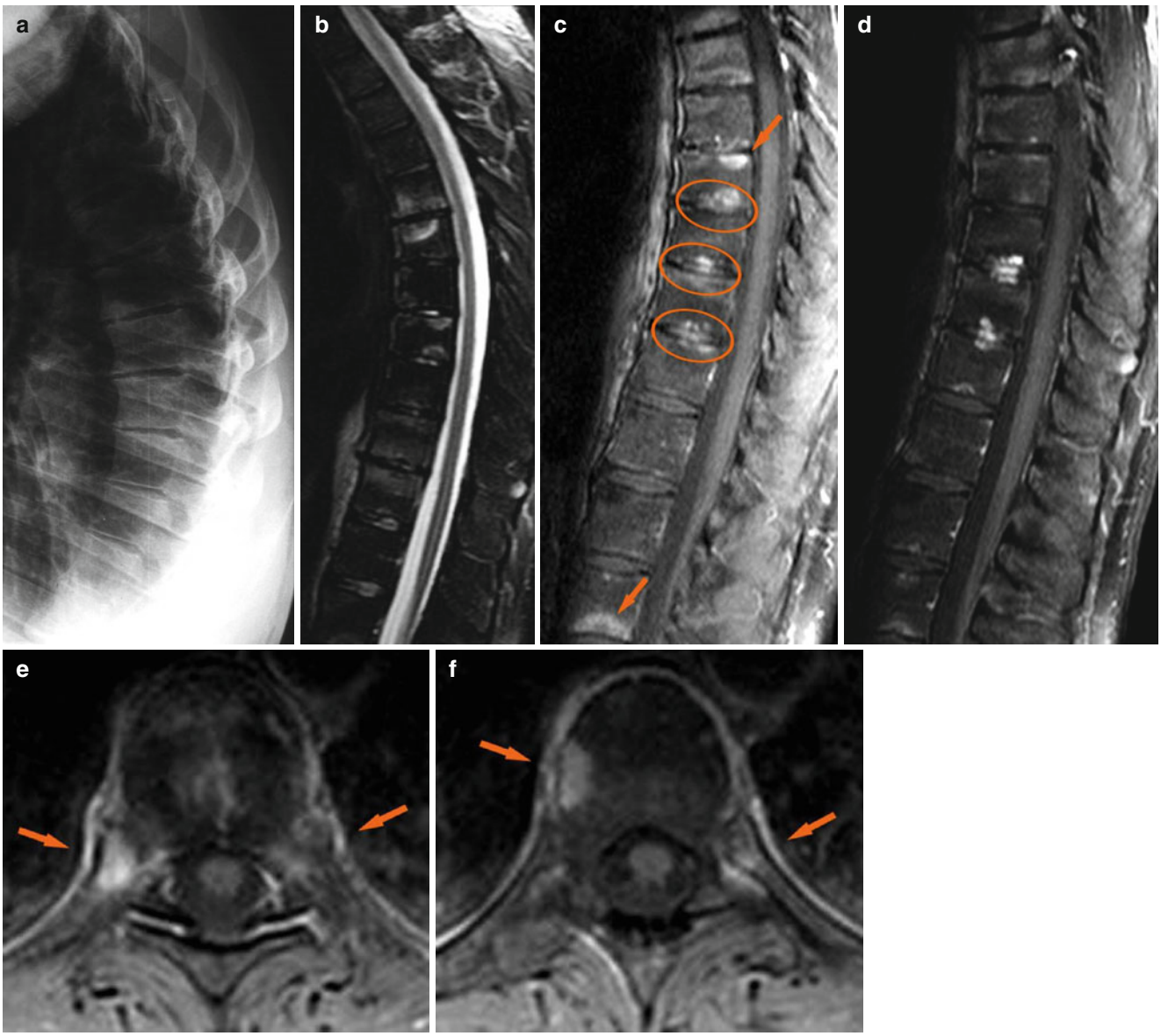


Fig. 2 Plain film radiography (**a**), sagittal TSE T2-weighted image with fat saturation (**b**), sagittal and axial SE T1-weighted images with fat saturation after the administration of contrast medium (**c–f**). Osteosclerosis of the edges of the vertebral bodies and shiny corners (**a**). Florid spondylodiscitis in the middle thoracic spine (**b–d**, *arrows* and *circle*). The same patient presented bilateral costovertebral arthritis (**e**, **f**, *arrows*)

Psoriatic Spondyloarthritis

Case 11

Spondylitis

Costovertebral Arthritis

Sacroiliitis

- A 16-year-old male
- Back pain exacerbated by chest expansion
- Low back pain on the left side
- Psoriasis

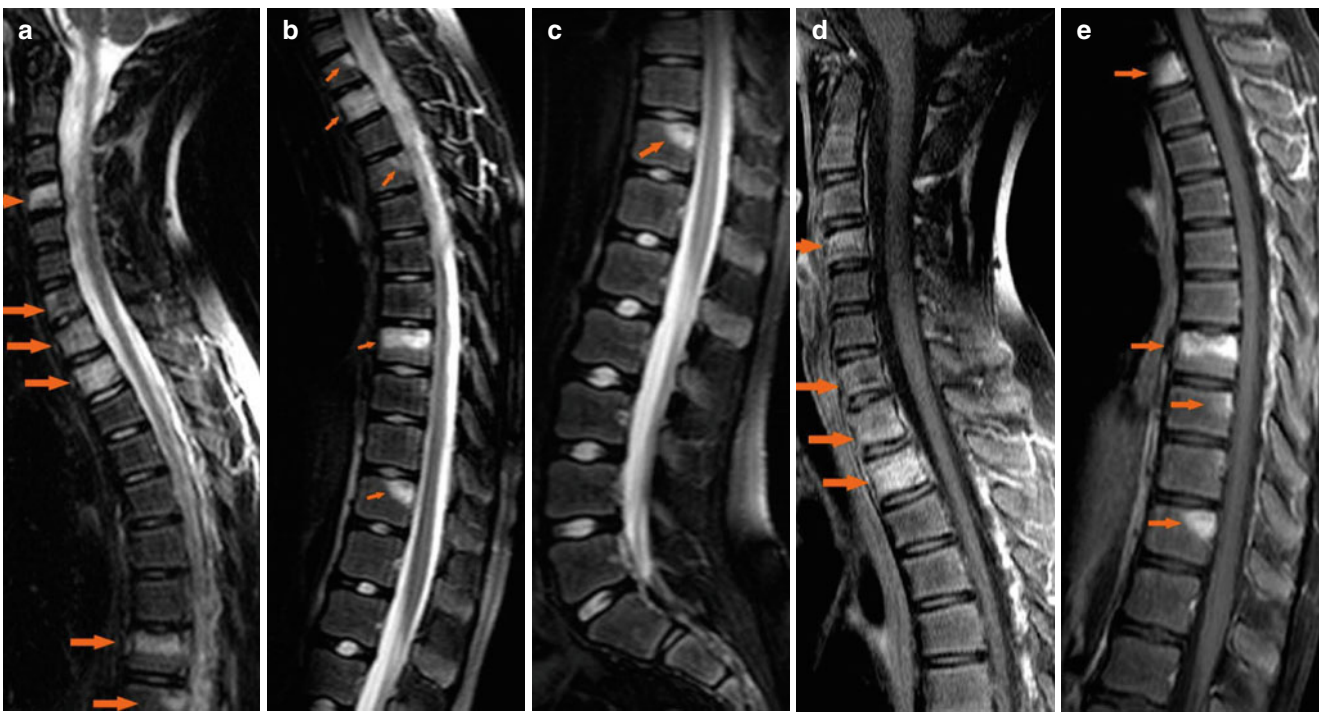


Fig. 1 Sagittal TSE T2-weighted images with fat saturation (**a**–**c**) and sagittal, axial, and coronal SE T1-weighted images with fat saturation following the administration of contrast medium (**d**–**i**). Hyperintense areas in T2, with contrast enhancement, at C4, C7–D2, D8, D9, and D11, indicating active spondylitis (**a–e**, *arrows*). Axial contrast-enhanced fat-saturated T1-weighted images show pronounced enhancement of the costovertebral joints and adjacent soft tissue, indicating osteitis, synovitis, and periarticular inflammation (**f**, **g**, *arrows*). The same patient also presented a marked sacroiliitis on the left side (**h**, **i**, *arrow*)

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_15, © Springer International Publishing Switzerland 2014

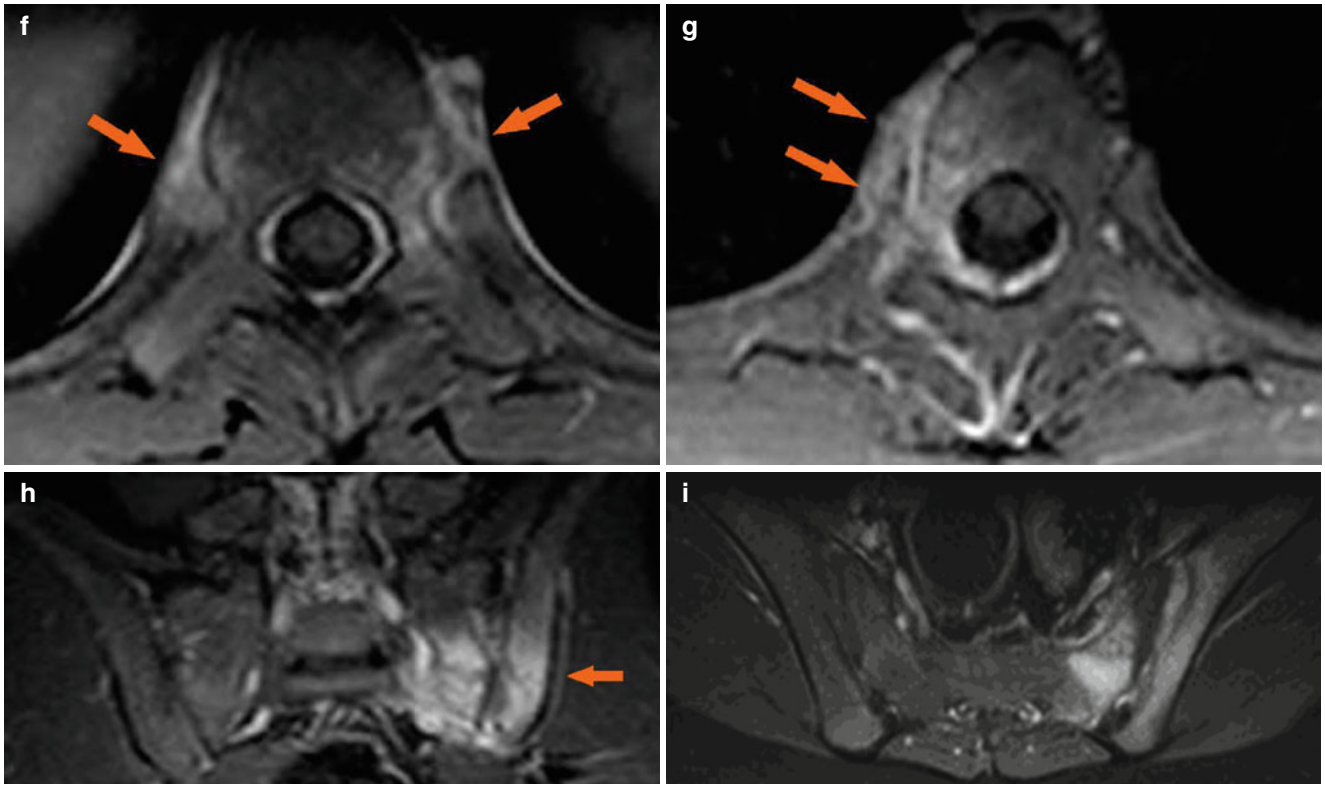


Fig. 1 (continued)

Psoriatic Arthritis

Case 12

Spondylitis

Progression of the Disease

- A 29-year-old woman
- Patient with psoriatic spondyloarthritis
- Needle biopsy of the vertebral body lesion

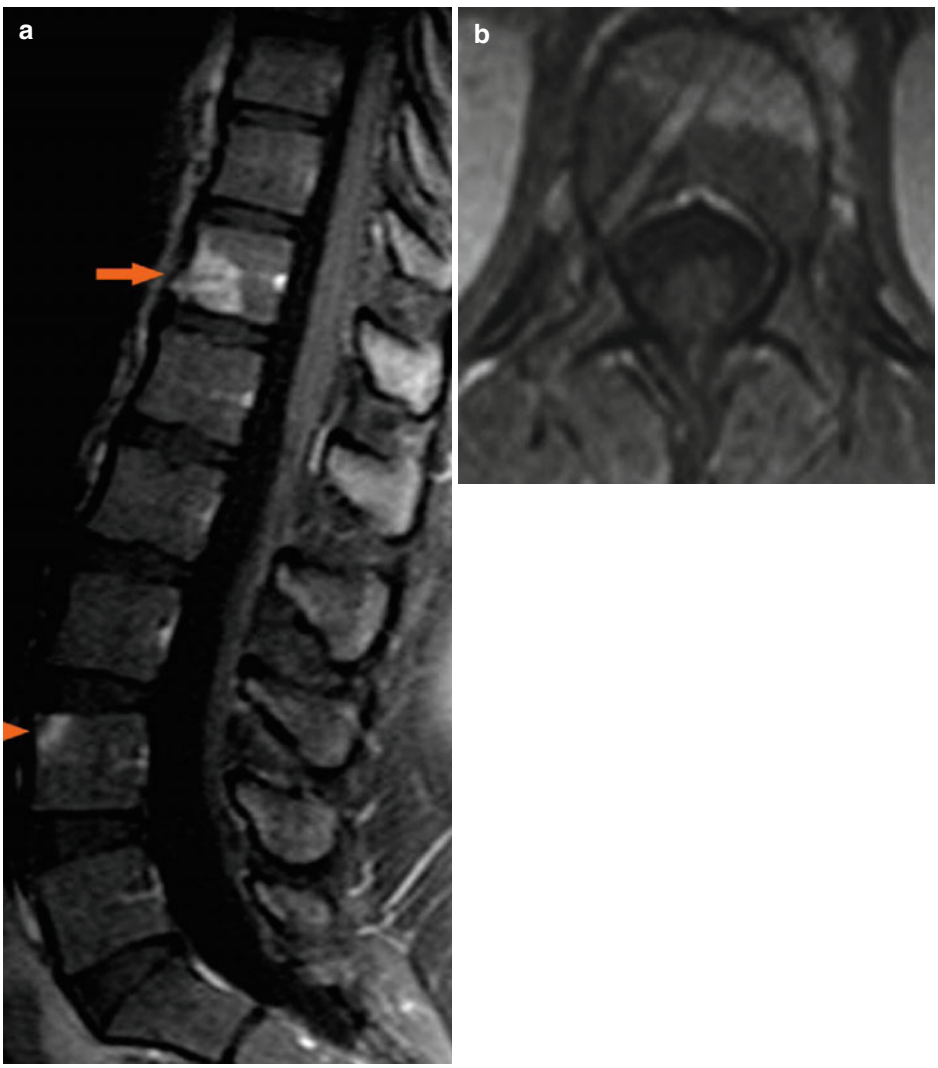


Fig. 1 Sagittal and axial SE T1-weighted images with fat saturation after the administration of contrast medium (**a**, **b**). Areas of contrast enhancement in the anterior edges of the segments T12 and L4 (**a**, *arrows*), corresponding to anterior spondylitis. The patient had a previous diagnosis of infectious spondylitis, carried out in another hospital, where she was subsequently subjected to needle biopsy (see the sign of the needle in **b**). The biopsy showed an aseptic spondylitis. The patient was then reassessed at our hospital where she was diagnosed with a psoriatic spondylitis

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_16, © Springer International Publishing Switzerland 2014

MRI follow-up after 16 months
Progression of the disease

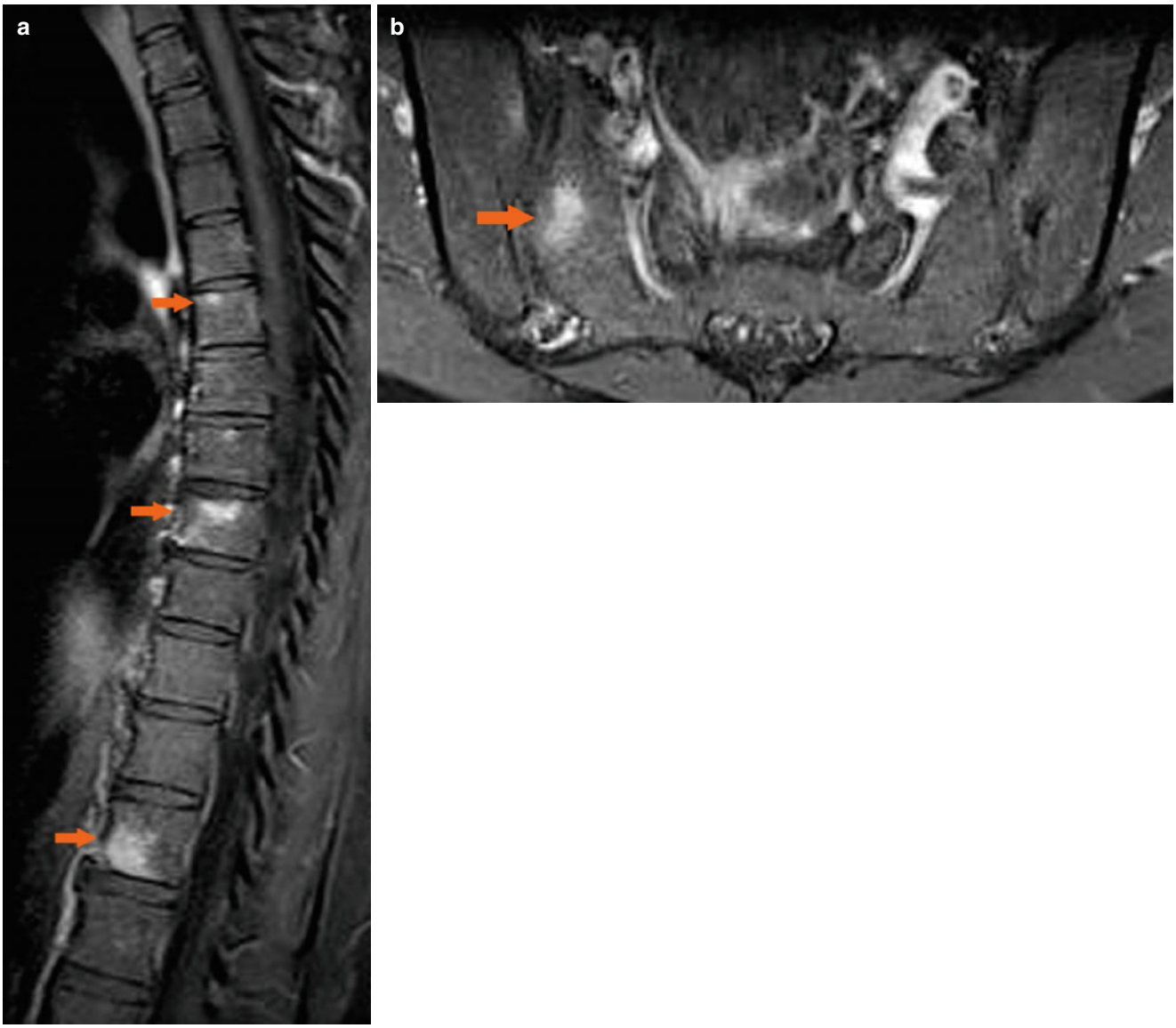


Fig. 2 Sagittal and axial SE T1-weighted images with fat saturation after the administration of contrast medium (**a**, **b**). Progression of the disease, with multiple areas of spondylitis in the dorsal region (**a**, *arrows*) and occurrence of sacroiliitis (**b**, *arrow*)

MRI follow-up after 24 months
Progression of the disease

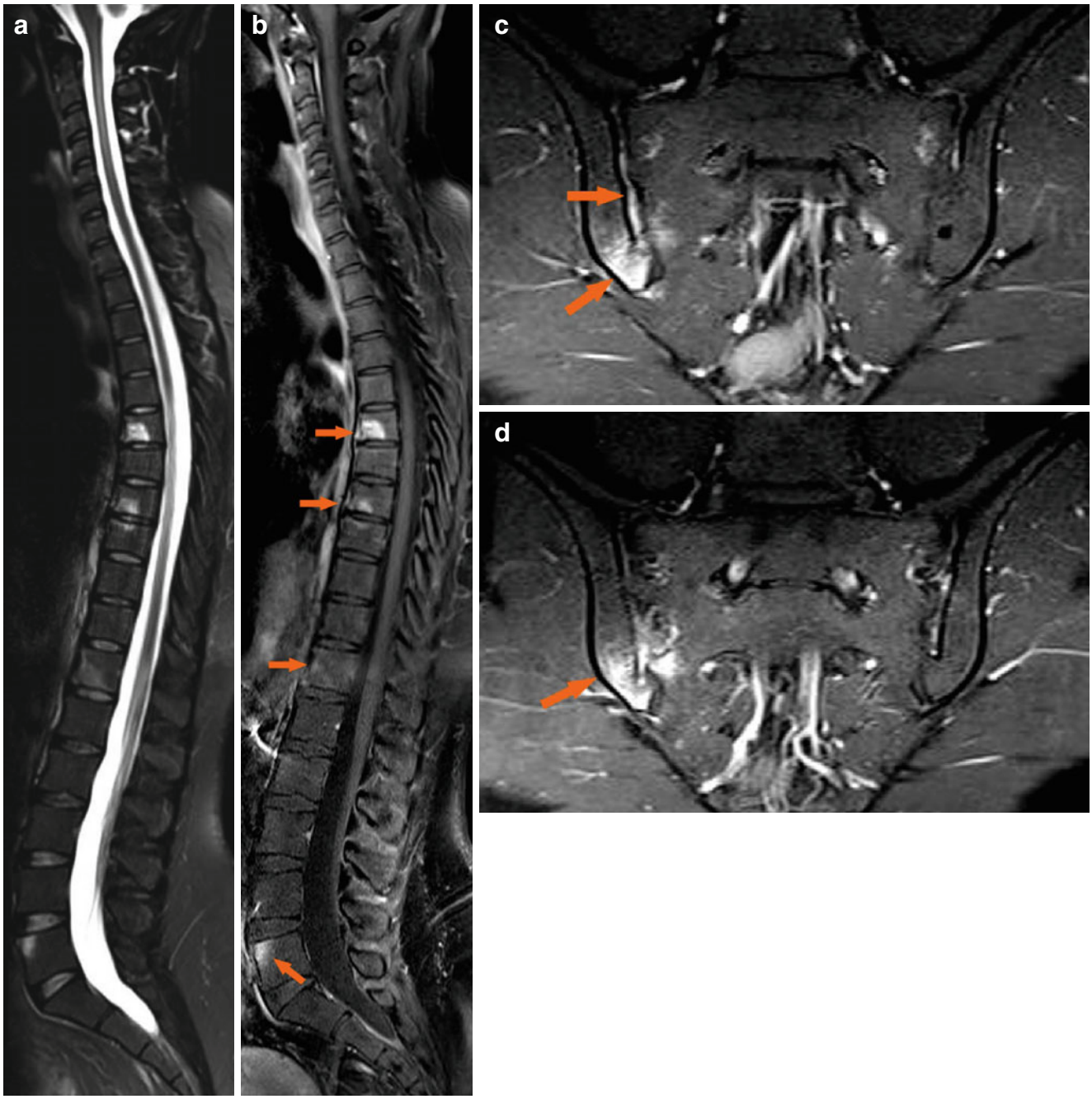


Fig. 3 Sagittal TSE T2-weighted image with fat saturation (**a**) and sagittal and coronal SE T1-weighted images with fat saturation after the administration of contrast medium (**b–d**). Further progression of the disease, with new foci of spondylitis at D6, D8/D9, and L5 (**a–b**). The right sacroiliitis has worsened, with marked osteitis and synovitis (**c**–**d**)

Ankylosing Spondylitis

Case 13

Spondylodiscitis and Osteoarthritis

- Patient with chronic back pain
- Dorsal hyperkyphosis
- Limitation of motion of the spine
- Presence of HLA-B27

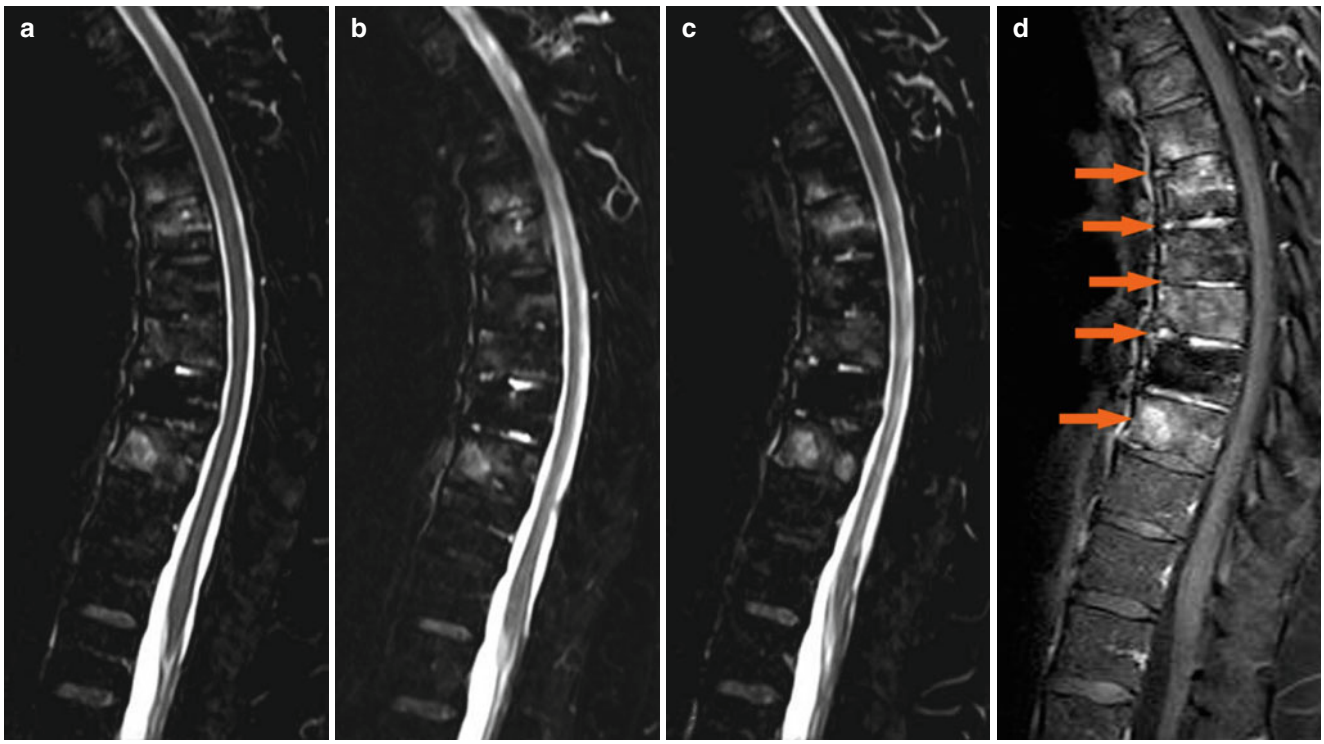


Fig. 1 Sagittal T2-weighted images with fat saturation (**a–c**), sagittal and axial SE T1-weighted images with fat saturation, following contrast medium administration (**d–h**). Multiple areas of hyperintensity in T2 and contrast enhancement in the vertebral bodies and discs of the thoracic spine, indicating active spondylitis and discitis (aseptic spondylodiscitis) (**a–f**, *arrows*). Multiple erosions of vertebral body endplates. Note also bilateral osteoarthritis of the costovertebral joints and inflammation of the adjacent soft tissues (**g**, **h**, *arrows*)

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_17,

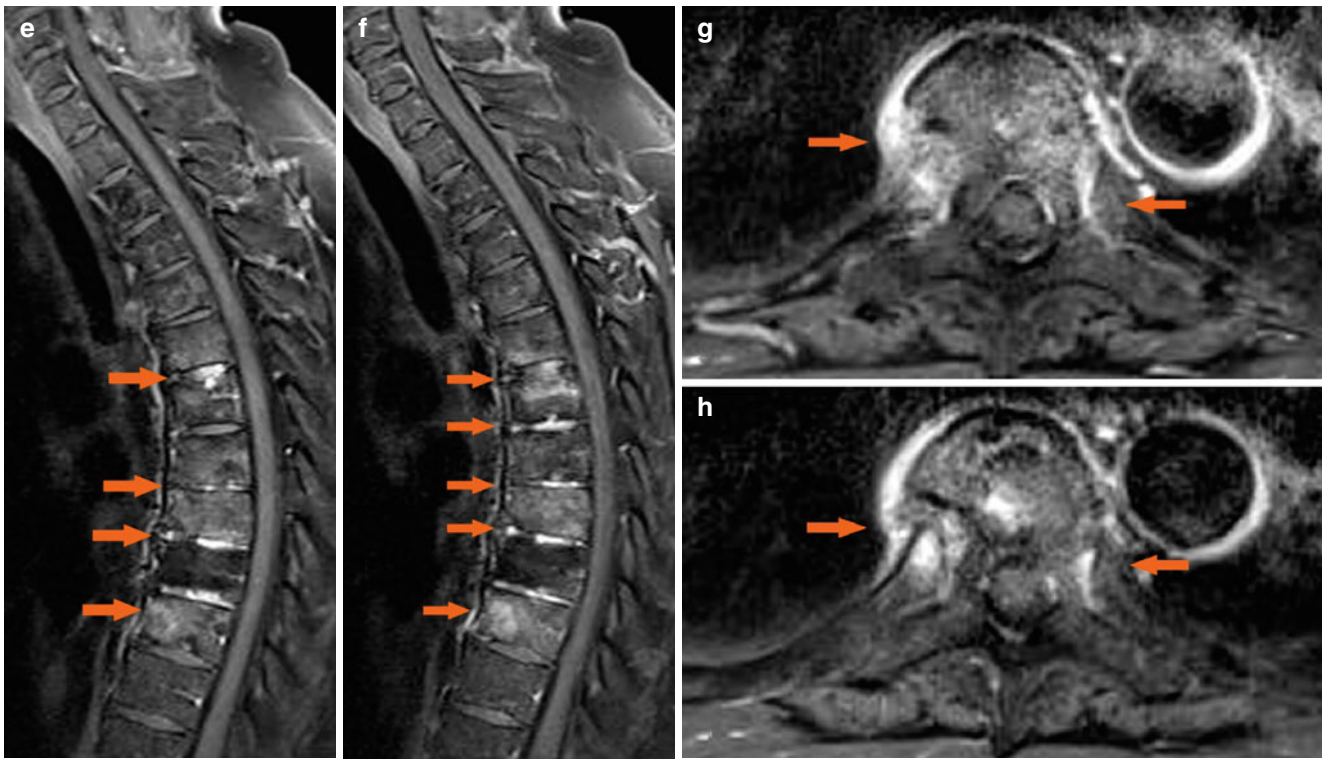


Fig. 1 (continued)

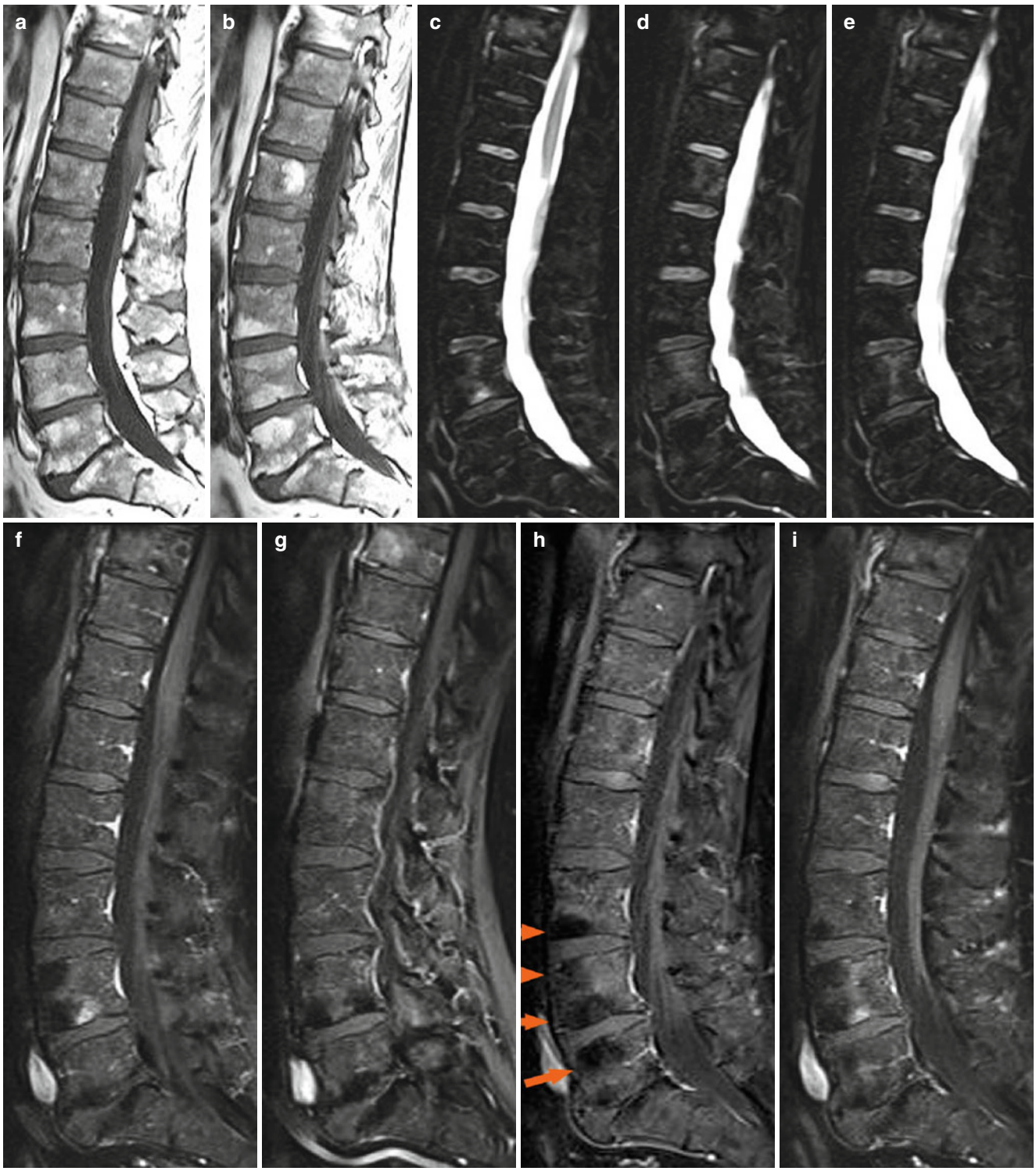


Fig. 2 Sagittal SE T1-weighted images (**a**, **b**), sagittal T2-weighted images with fat saturation (**c**–**e**), sagittal SE T1-weighted images with fat saturation, following contrast medium administration (**f**–**i**). The same patient, in the lumbar spine, presented areas of edema-osteitis (vertebral body of L4) and areas of postinflammatory fatty degeneration of the bone marrow (vertebral bodies of L3, L4, L5, *arrows*)

Arthritis Associated with Inflammatory Bowel Disease

Case 14

Spondylitis and Sacroiliitis

- A 46-year-old male
- Patient with low back pain, more marked on the left side
- Patient affected by Crohn disease

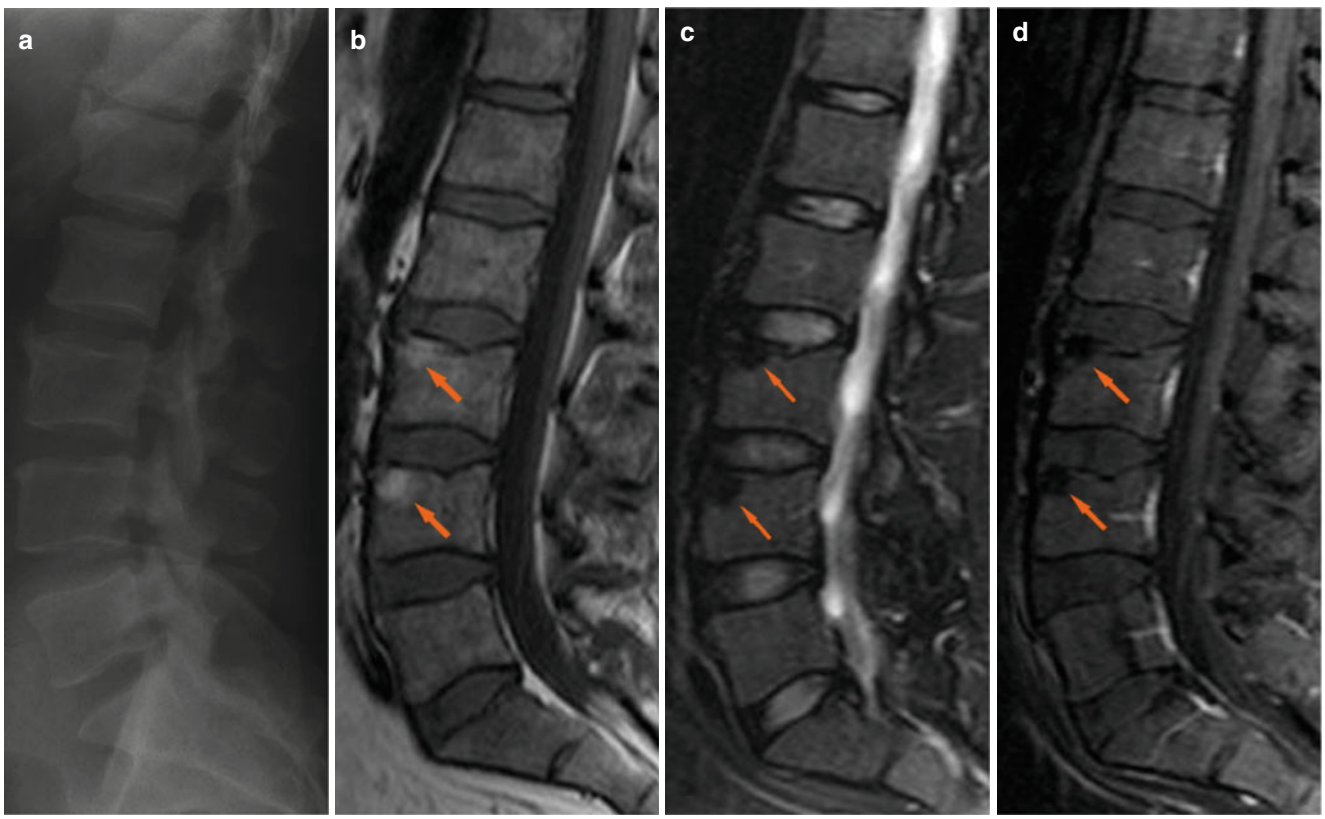


Fig. 1 X-ray of the lumbar spine (**a**), sagittal SE T1-weighted image (**b**), sagittal T2-weighted image with fat saturation (**c**), sagittal SE T1-weighted image with fat saturation after contrast medium administration (**d**). Plain film radiography shows mild osteosclerosis in the anterior corners of the vertebral bodies at L3 and L4 (**a**). MRI reveals signal changes in the same anterior edges of the vertebral bodies L3 and L4, hyperintense in T1, and hypointense in T2, with no contrast enhancement (**b–d**, *arrows*). These findings indicate postinflammatory fatty degeneration of the bone marrow, which is the sign of an older spondylitis

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_18,

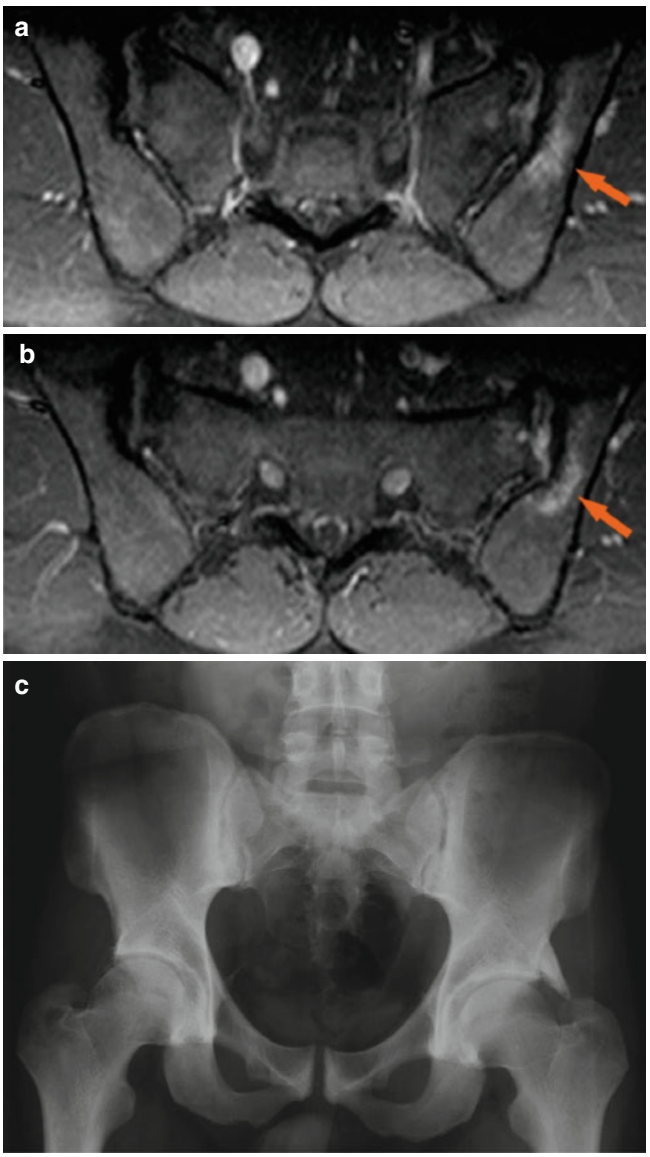


Fig. 2 Axial SE T1-weighted images with fat saturation after contrast medium administration (**a**, **b**). X-ray of the pelvis (**c**). The same patient presented bilateral sacroiliitis, in different phases: on the left side, contrast enhancement of the joint space and subchondral bone indicates the active inflammatory stage of the sacroiliitis (*arrows*); on the right side, hypointensity indicates postinflammatory degenerative changes (**a**, **b**). Plain film radiography shows bilateral osteosclerosis of the sacroiliac joints (**c**)

Undifferentiated Spondylitis

Case 15

Spondylitis in Chronic Phase

Spondylodiscitis

- A 68-year-old male
- History of chronic dorsal and lumbar pain

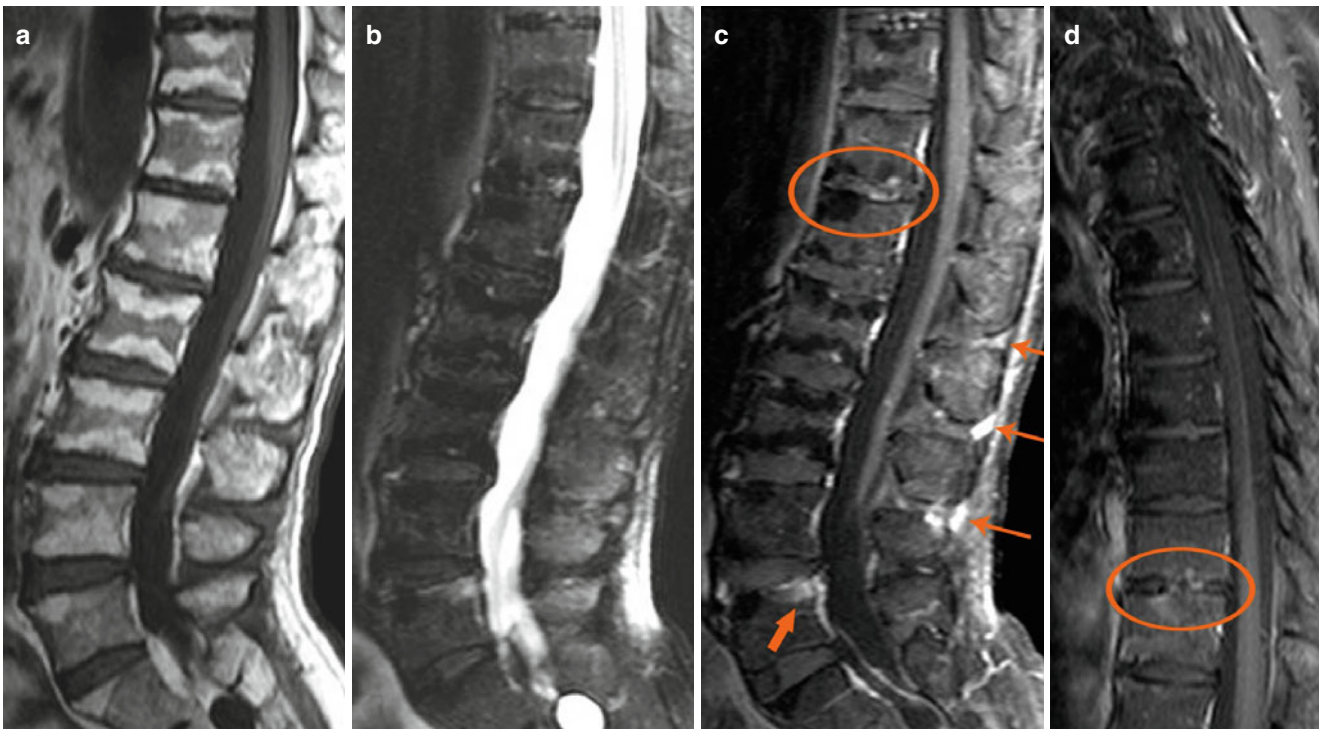


Fig. 1 Sagittal SE T1-weighted image (**a**), sagittal TSE T2-weighted image with fat saturation (**b**), sagittal SE T1-weighted images with fat saturation after contrast medium administration (**c**–**d**). Multiple areas of hyperintensity in T1 and hypointensity in T2 in the dorsal and lumbar spine, indicating postinflammatory fatty degeneration of the bone marrow (**a**–**d**). In the same patient, we can find multiple small areas of contrast enhancement in the disc-vertebral unit, indicating spondylodiscitis (**c**, **d**, *circle*). Note also contrast enhancement of the supraspinous and interspinous ligament at L2/L3 and L3/L4, indicating ligamentous inflammation (**c**, *thin arrow*)

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_19, © Springer International Publishing Switzerland 2014

Psoriatic Arthritis

Anterior Spondylitis

Discitis

Case 16

- A 70-year-old male
- History of chronic low back pain

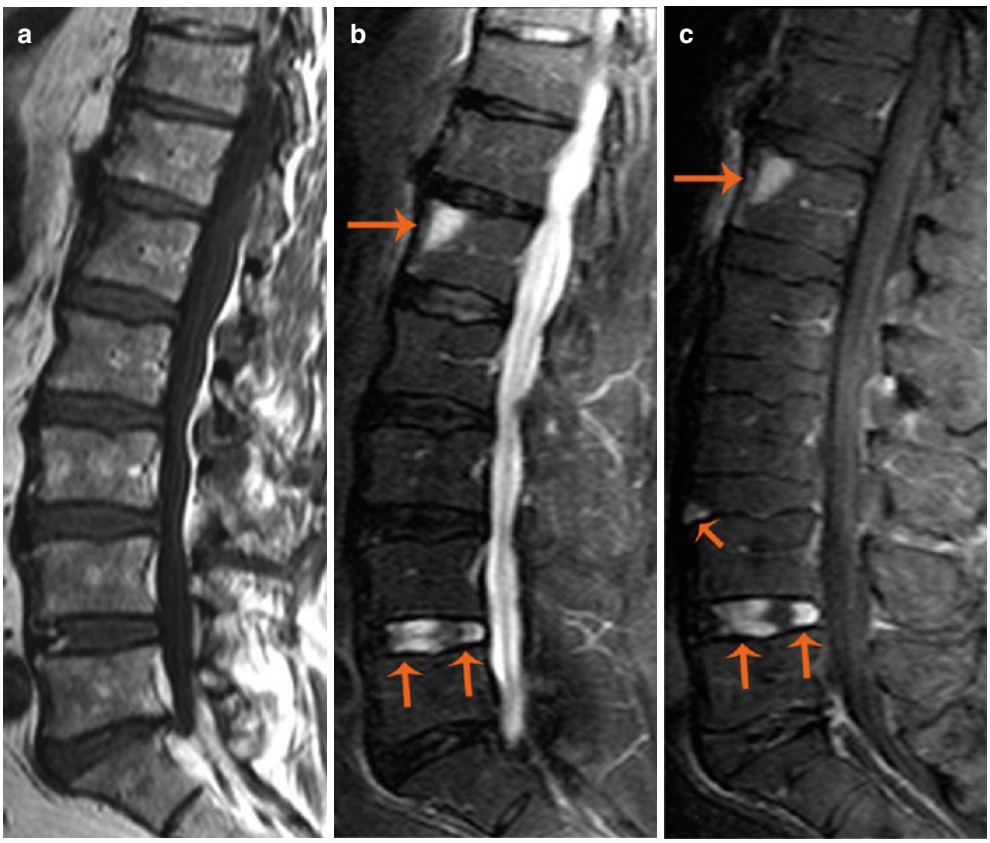


Fig. 1 Sagittal SE T1-weighted image (**a**), sagittal TSE T2-weighted image with fat saturation (**b**), sagittal SE T1-weighted image with fat saturation after contrast medium administration (**c**). Anterior spondylitis at L1, with edematous pattern (hypointensity in T1 and hyperintensity in T2) and contrast enhancement of the lesion (**a**–**c**, *long arrow*). T2-hyperintensity (**b**) and contrast enhancement (**c**) of the intervertebral disc at L4/L5, indicating aseptic discitis (early Andersson lesion) (**b**, **c**, *double arrow*). Note also a small area of anterior discitis at L3/L4 (**c**, *small arrow*)

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_20, © Springer International Publishing Switzerland 2014

Undifferentiated Spondyloarthritis

Case 17

Spondylodiscitis

Zygapophyseal Arthritis

Spondylitis

- A 47-year-old-man
- Patient with persistent neck pain, more marked on the right side
- Neck stiffness

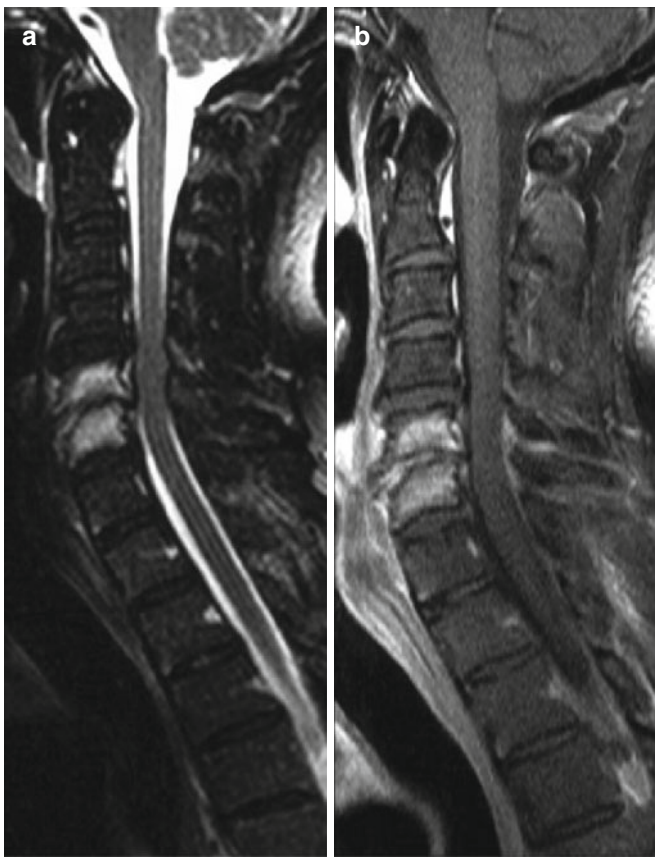
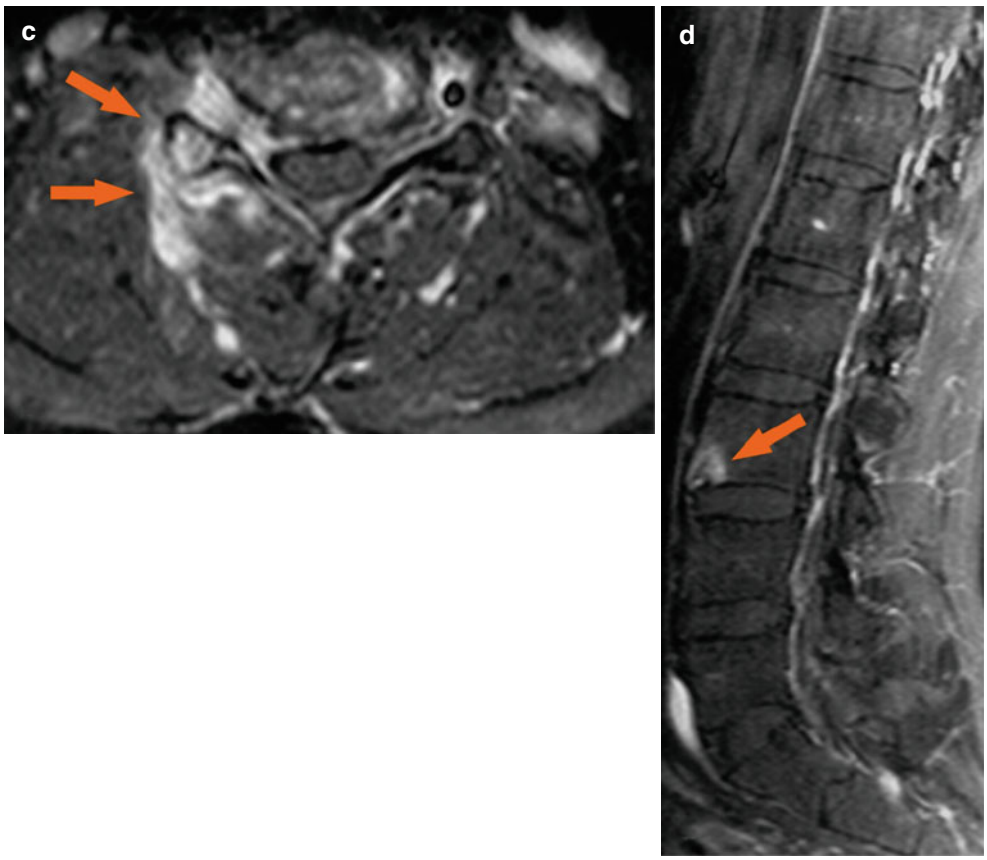


Fig. 1 Sagittal T2-weighted image with fat saturation (**a**), sagittal and axial T1-weighted images with fat saturation following the administration of contrast medium (**b**–**d**). Spondylodiscitis at the level of C5/C6 (**a**–**b**). Osteoarthritis of the right facet joint at C5/C6 and inflammation of the periarticular soft tissues (**c**, *arrows*). The same patient presented anterior spondylitis at L3 (**d**, *arrow*)

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_21, © Springer International Publishing Switzerland 2014

Fig. 1 (continued)



Ankylosing Spondylitis

Case 18

Spondylodiscitis

Sacroiliitis

- A 60-year-old male
- Long history of spinal pain in the cervical, dorsal, and lumbosacral region
- Stiffness
- Presence of HLA-B27

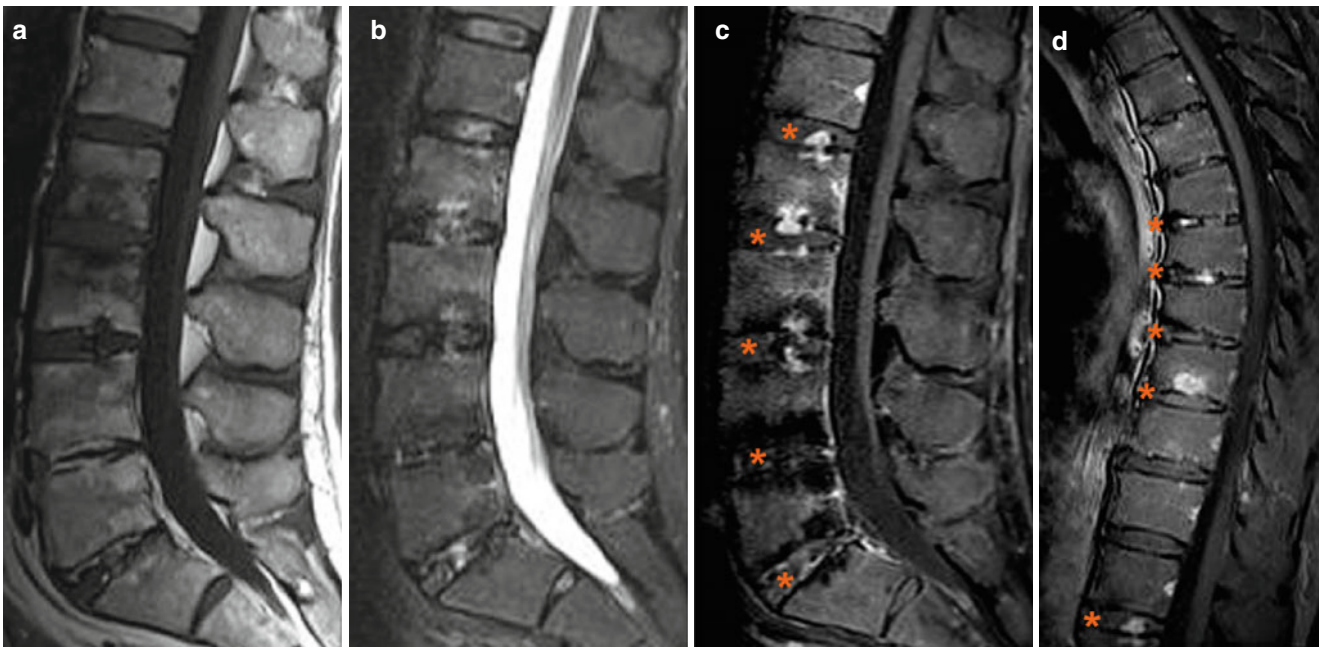
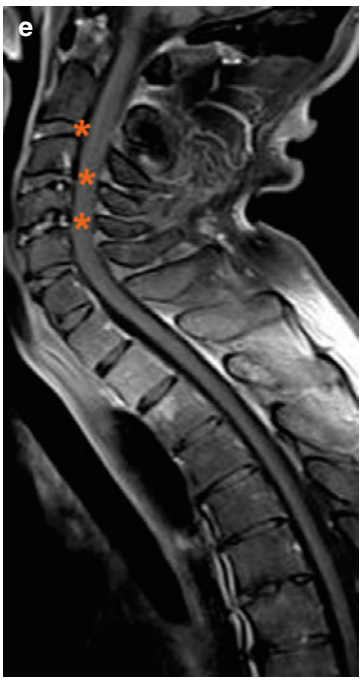
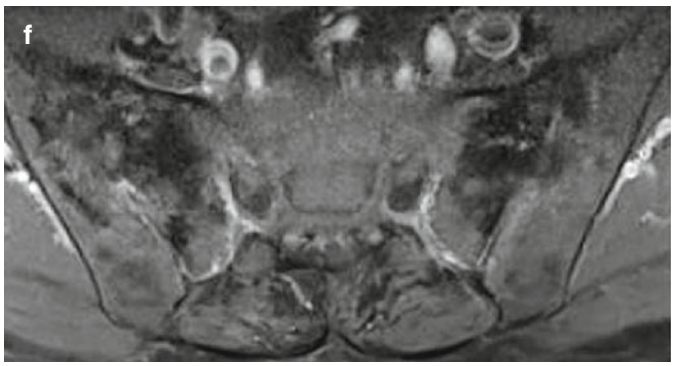


Fig. 1 Sagittal SE T1-weighted image (**a**), sagittal TSE T2-weighted image with fat saturation (**b**), sagittal and axial SE T1-weighted images with fat saturation following the administration of contrast medium (**c**–**f**). Typical inflammatory lesions affecting the entire vertebral column, in both active and chronic phases. In particular, note multiple areas of active spondylodiscitis (i.e., inflammatory Andersson lesions), with enhancement after contrast medium administration, in the cervical, dorsal, and lumbar spine (**a**–**e**, *asterisks*). The same patient presented bilateral sacroiliitis, with small areas of contrast enhancement indicating mild inflammatory activity (**f**)

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_22, © Springer International Publishing Switzerland 2014

Fig. 1 (continued)





Psoriatic Arthritis

Case 19

Costovertebral Arthritis and Sacroiliitis

- Patient with psoriasis
- Chronic low back pain
- Tenderness of the costovertebral joints

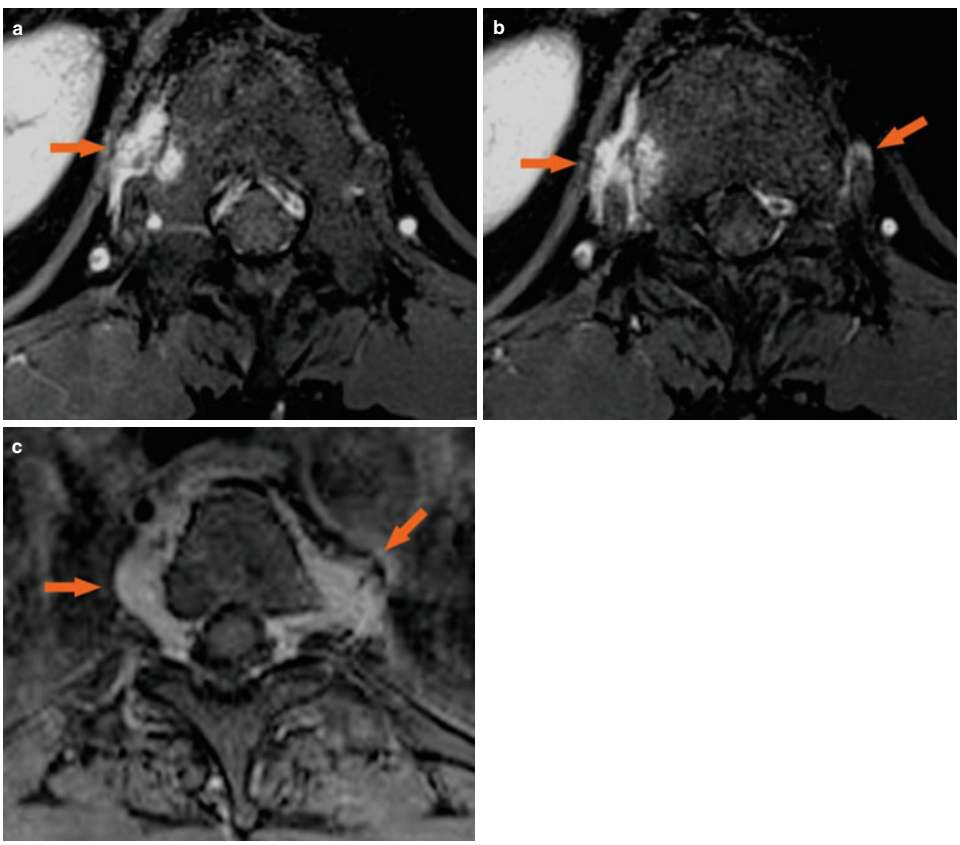


Fig. 1 Axial SE T1-weighted images with fat saturation following contrast medium administration (**a**–**f**). Bilateral osteoarthritis of the costovertebral joints, more marked on the right side (**a**–**c**, *arrows*). Note contrast enhancement in the joint cleft, subchondral bone marrow of the vertebral body, and head of the rib on the right side. In addition, the adjacent soft tissues show contrast enhancement at both sides, indicating a marked periarticular inflammation (**a**–**c**). Bilateral sacroiliitis, more marked on the right side (**d**–**f**). Note contrast enhancement of the subchondral bone and joint space, indicating a phase of inflammatory activity

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_23, © Springer International Publishing Switzerland 2014

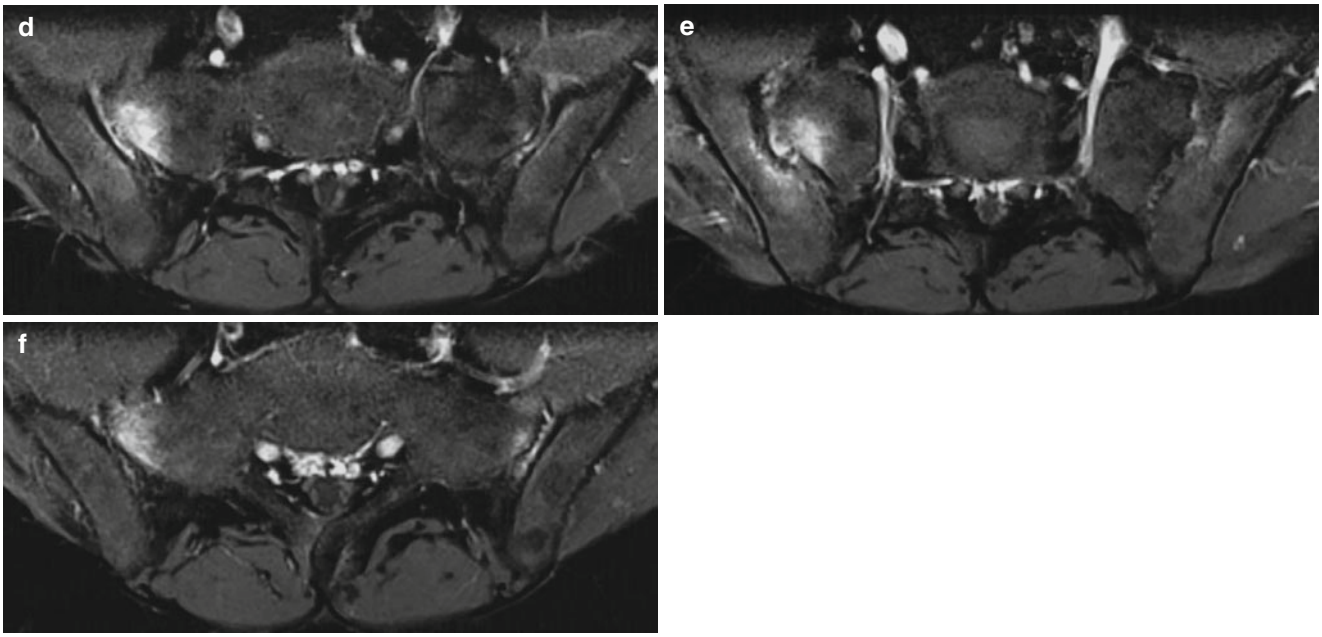


Fig. 1 (continued)

Psoriatic Arthritis

Case 20

Spondylitis

Discitis

Costovertebral Arthritis

Sacroiliitis

Inflammation of Ligaments

- A 52-year-old male
- Cervical, dorsal and lumbar pain
- Psoriasis

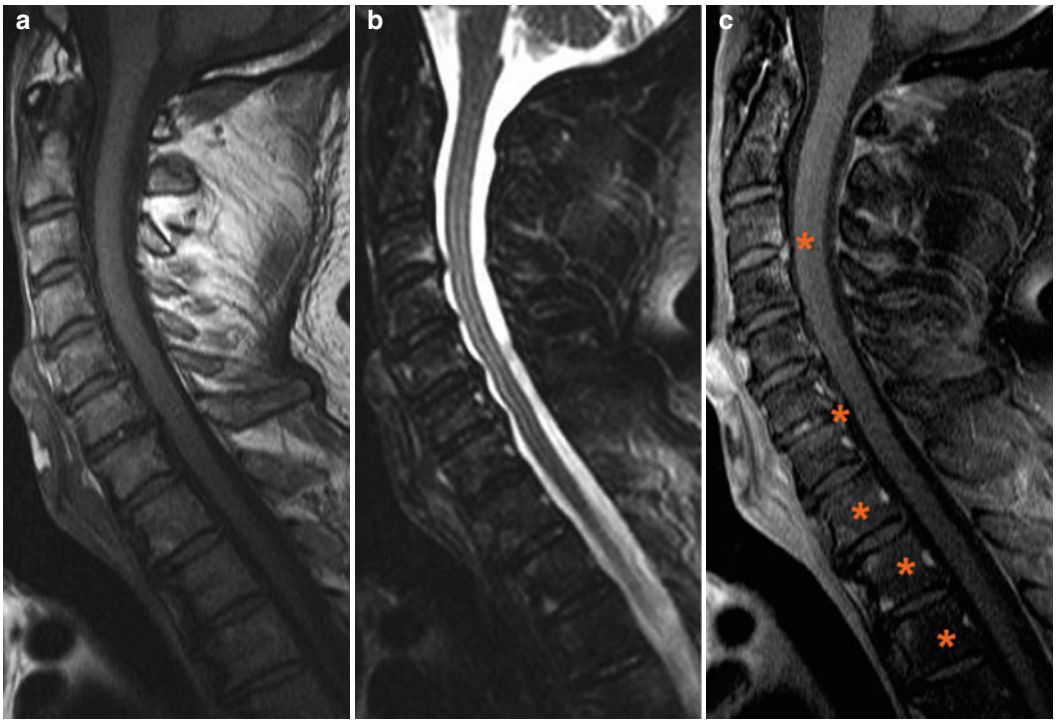


Fig. 1 Sagittal SE T1-weighted image (**a**), sagittal TSE T2-weighted image with fat saturation (**b**), sagittal SE T1-weighted image with fat saturation after the administration of contrast medium (**c**). Multiple areas of anterior and posterior spondylitis in active phase (*asterisks*)

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_24, © Springer International Publishing Switzerland 2014

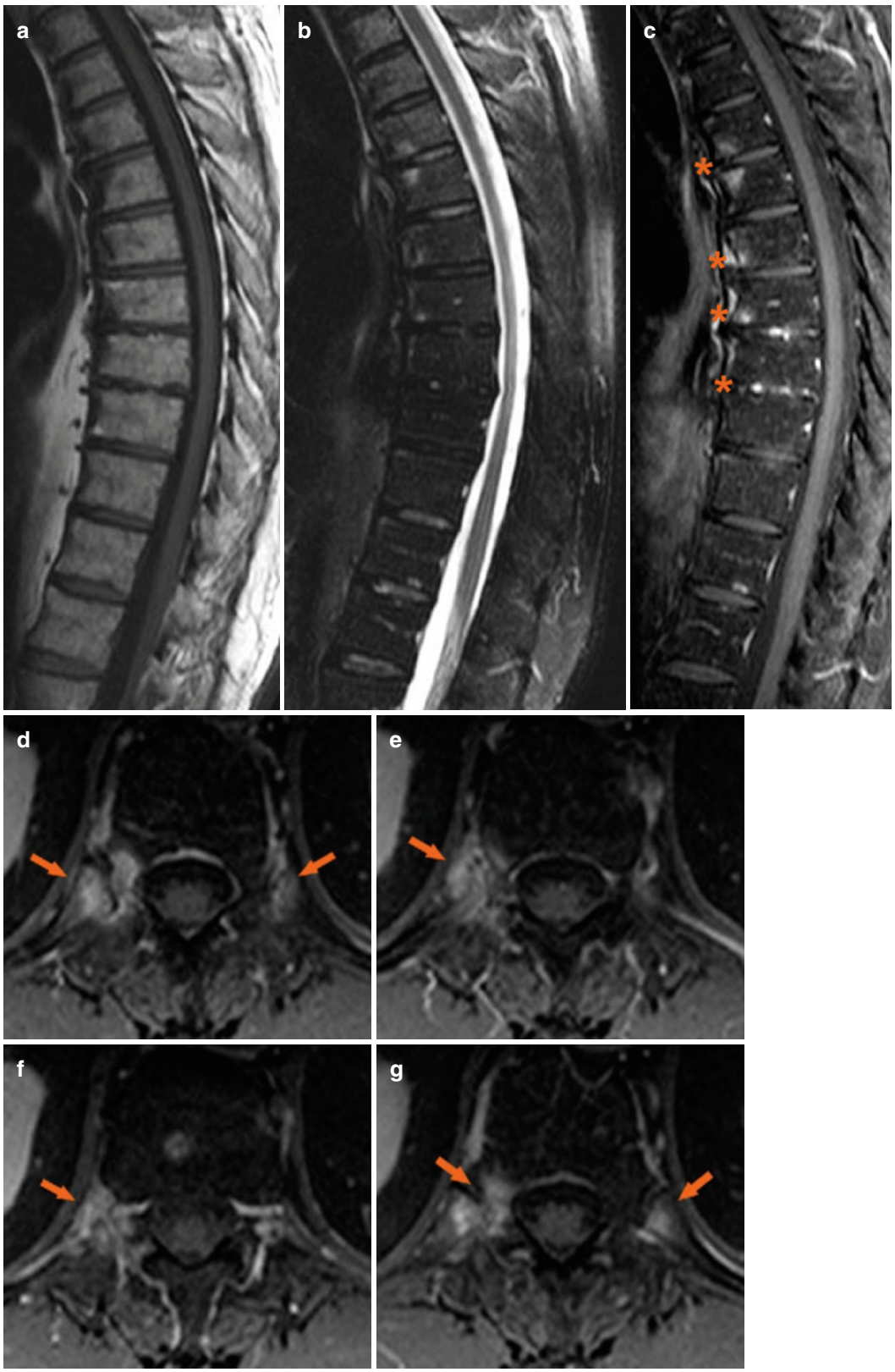


Fig. 2 Sagittal SE T1-weighted image (**a**), sagittal TSE T2-weighted image with fat saturation (**b**), sagittal and axial SE T1-weighted images with fat saturation after the administration of contrast medium (**c–g**). Anterior spondylitis and discitis (**a–c**). Note lesions in both the acute phase and chronic phase. In particular, as a sign of active spondylitis, the lesions are shown as hypointense in T1 and hyperintense in T2, with contrast enhancement, indicating edema-osteitis (**a–c**, *asterisks*). Postinflammatory lesions are shown as hyperintense in T1 and isointense in T2 with fat saturation, with no contrast enhancement, indicating fatty degeneration of the bone marrow (**a–c**). The same patient presented bilateral costovertebral arthritis, more marked on the right side, with contrast enhancement of the joint space and subchondral bone marrow (**d–g**, *arrows*)

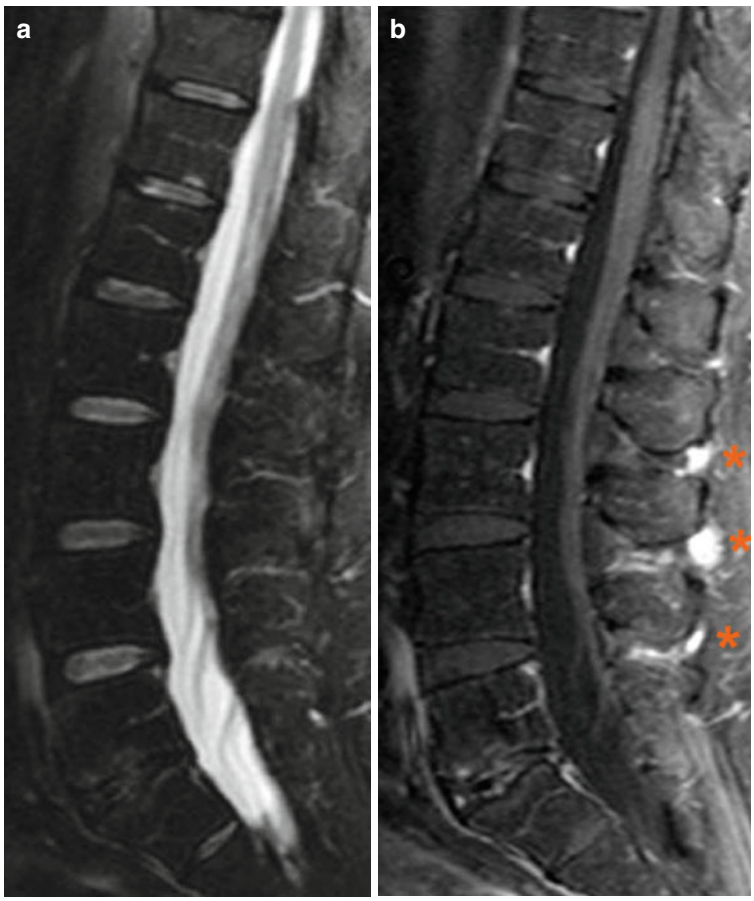


Fig. 3 Sagittal TSE T2-weighted image with fat saturation (**a**), sagittal SE T1-weighted image with fat saturation after the administration of contrast medium (**b**). Contrast enhancement of the interspinous and supraspinous ligaments at L2/L3, L3/L4, and L4/L5, indicating inflammation of the same ligaments (**b**, *asterisks*). See also discitis at L5/S1

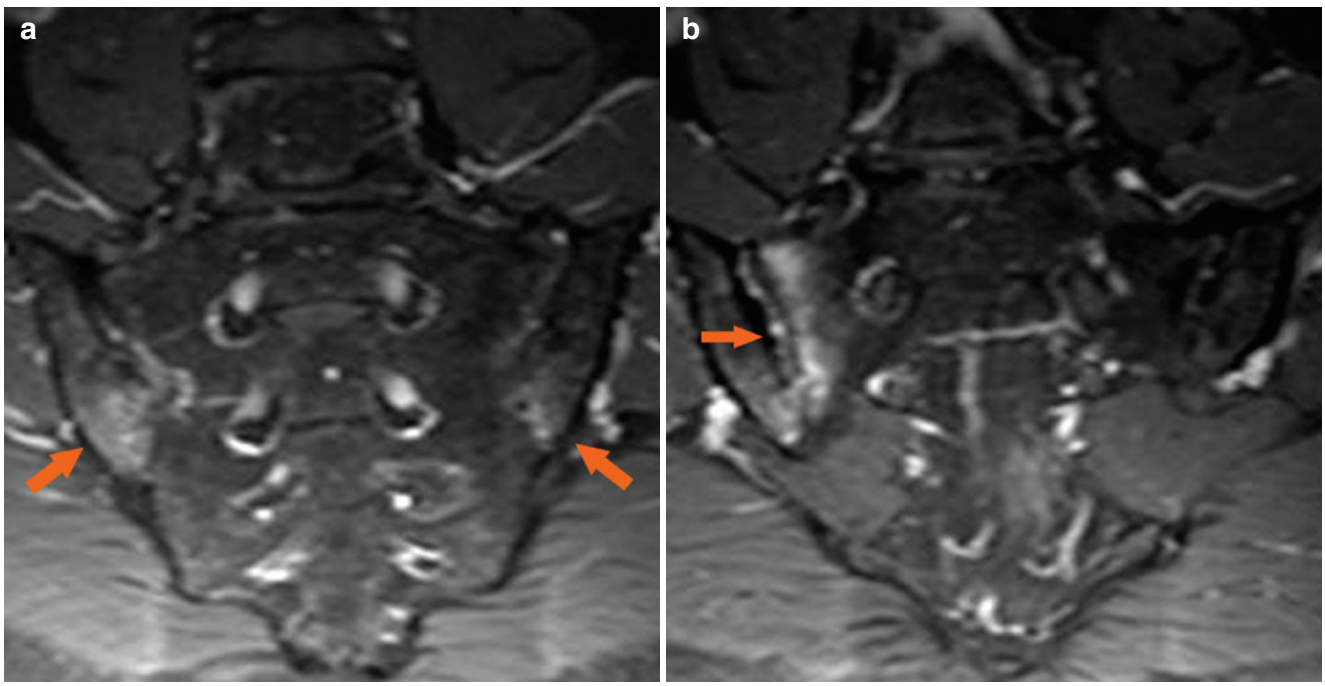


Fig. 4 Coronal SE T1-weighted images with fat saturation after the administration of contrast medium (**a**, **b**). The same patient presented contrast enhancement of the subchondral bone and synovium predominantly in the sacroiliac joint, indicating active sacroiliitis (**a**, **b**, *arrows*)

Ankylosing Spondylitis

Case 21

Spondylodiscitis

Sacroiliitis with Synovitis

- A 35-year-old man
- Long history of dorsal and lumbar pain

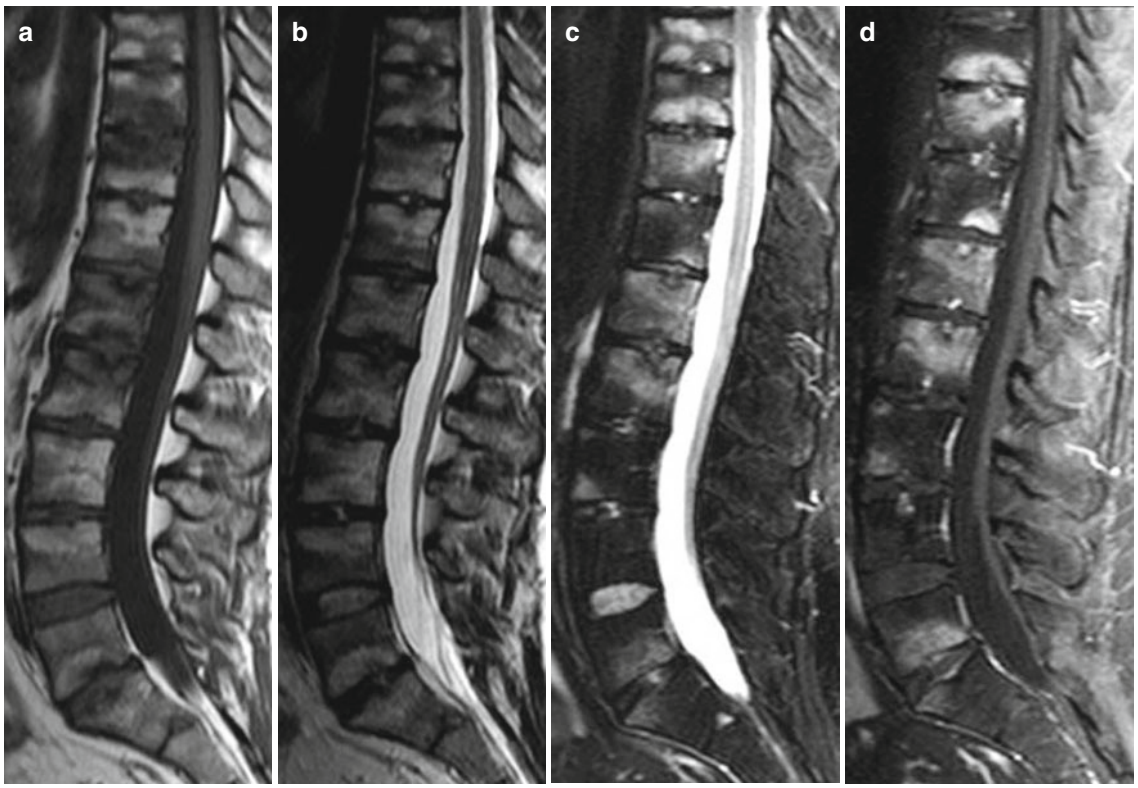


Fig. 1 Sagittal SE T1-weighted image (**a**), sagittal TSE T2-weighted image (**b**), sagittal T2-weighted image with fat saturation (**c**), sagittal, coronal, and axial SE T1-weighted images with fat saturation following administration of contrast medium (**d**–**g**). Multiple areas of active spondylodiscitis (Andersson lesions) in the thoracic and lumbar spine, with subchondral edema-osteitis, discitis, and erosions of vertebral body endplates. Note that edematous lesions are best depicted on T2-weighted images with fat saturation (**c**) with respect to standard T2-weighted images without fat saturation (**b**). Note also multiple areas of postinflammatory fatty degeneration of the bone marrow. The same patient presented contrast enhancement of the sacroiliac joint space at both sides, indicating synovitis (**g**, *arrows*). In particular, synovitis is constituted by inflammation of the anterior, synovial part of sacroiliac joints. See also contrast enhancement in the subchondral left sacrum, attributable to osteitis

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_25, © Springer International Publishing Switzerland 2014

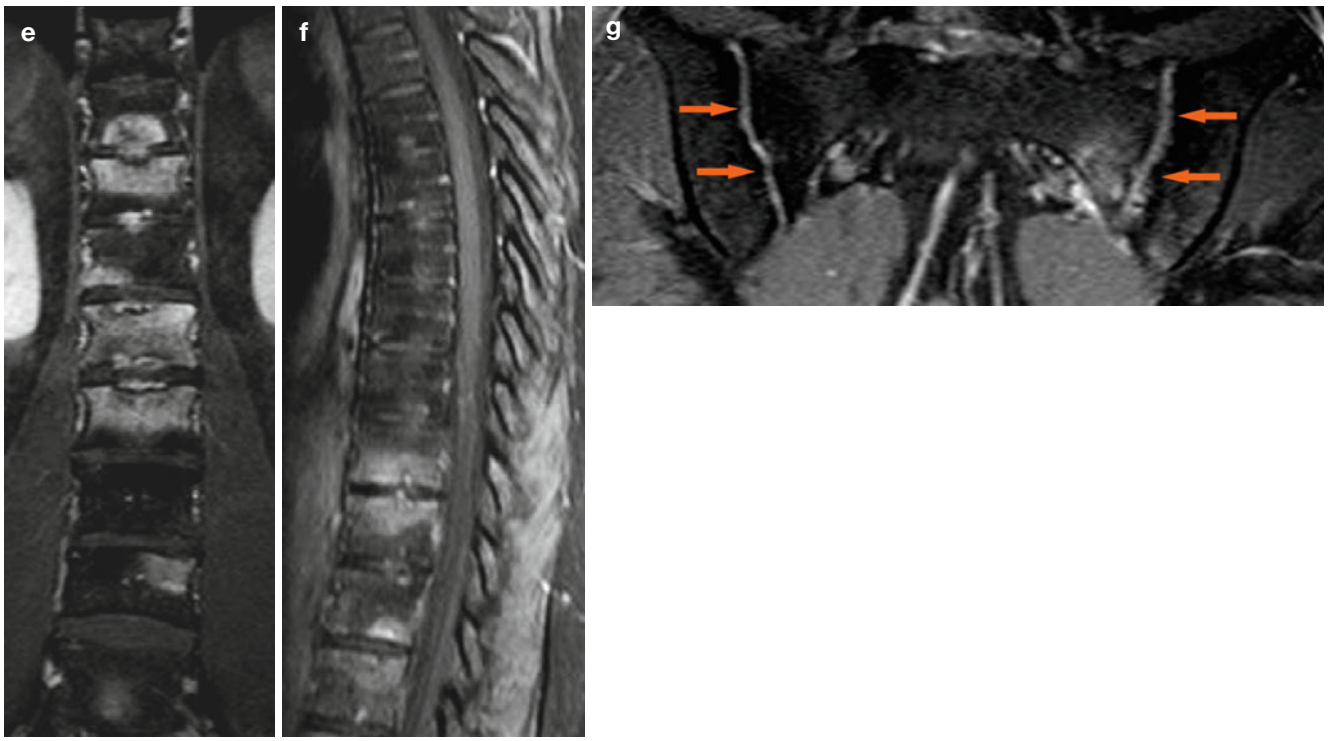


Fig. 1 (continued)

Ankylosing Spondylitis

Case 22

Spondylitis

Sacroiliitis

- A 42-year-old male
- Chronic low back pain
- Presence of HLA-B27

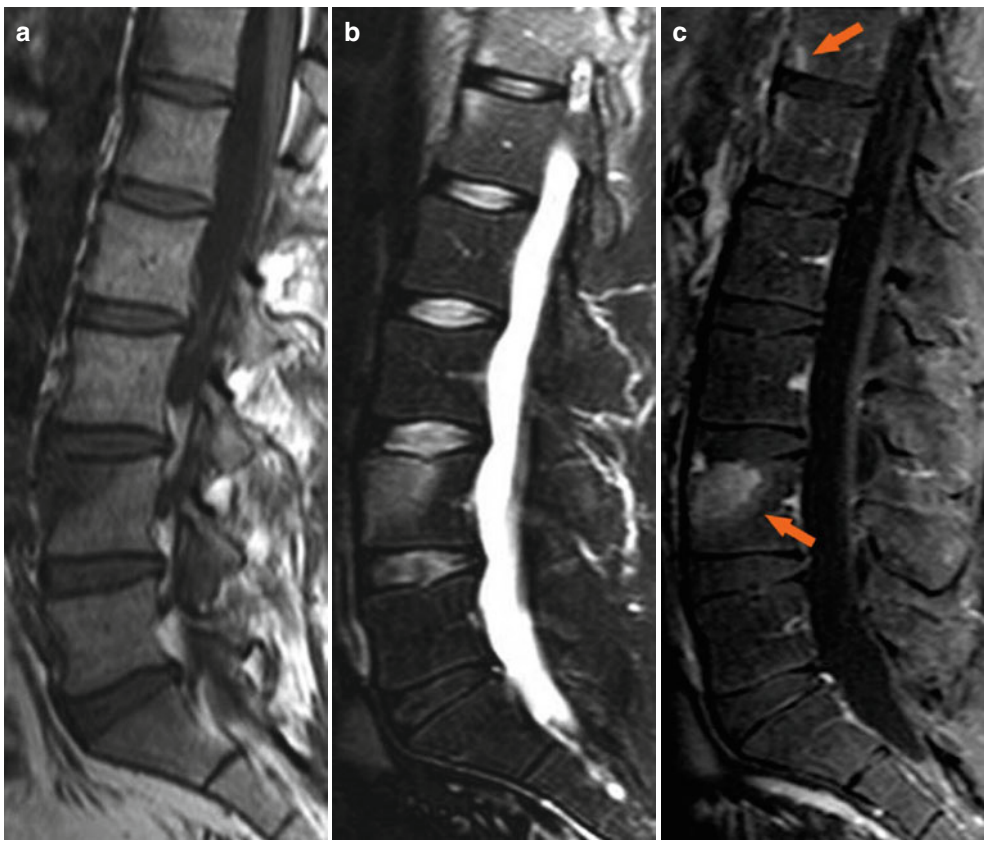


Fig. 1 Sagittal SE T1-weighted image (**a**), sagittal TSE T2-weighted image with fat saturation (**b**), sagittal SE T1-weighted image with fat saturation following the administration of contrast medium (**c**). Typical anterior spondylitis, with edema-osteitis in the anterior edges of the vertebral bodies D12/L1 and L4 (**a**–**c**, *arrows*). Active inflammatory lesions appear typically as hypointense on T1-weighted images (**a**) and hyperintense on T2-weighted images (i.e., edematous pattern, **b**), with enhancement after administration of contrast medium (which is direct sign of inflammation and its extension, **c**)

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_26, © Springer International Publishing Switzerland 2014

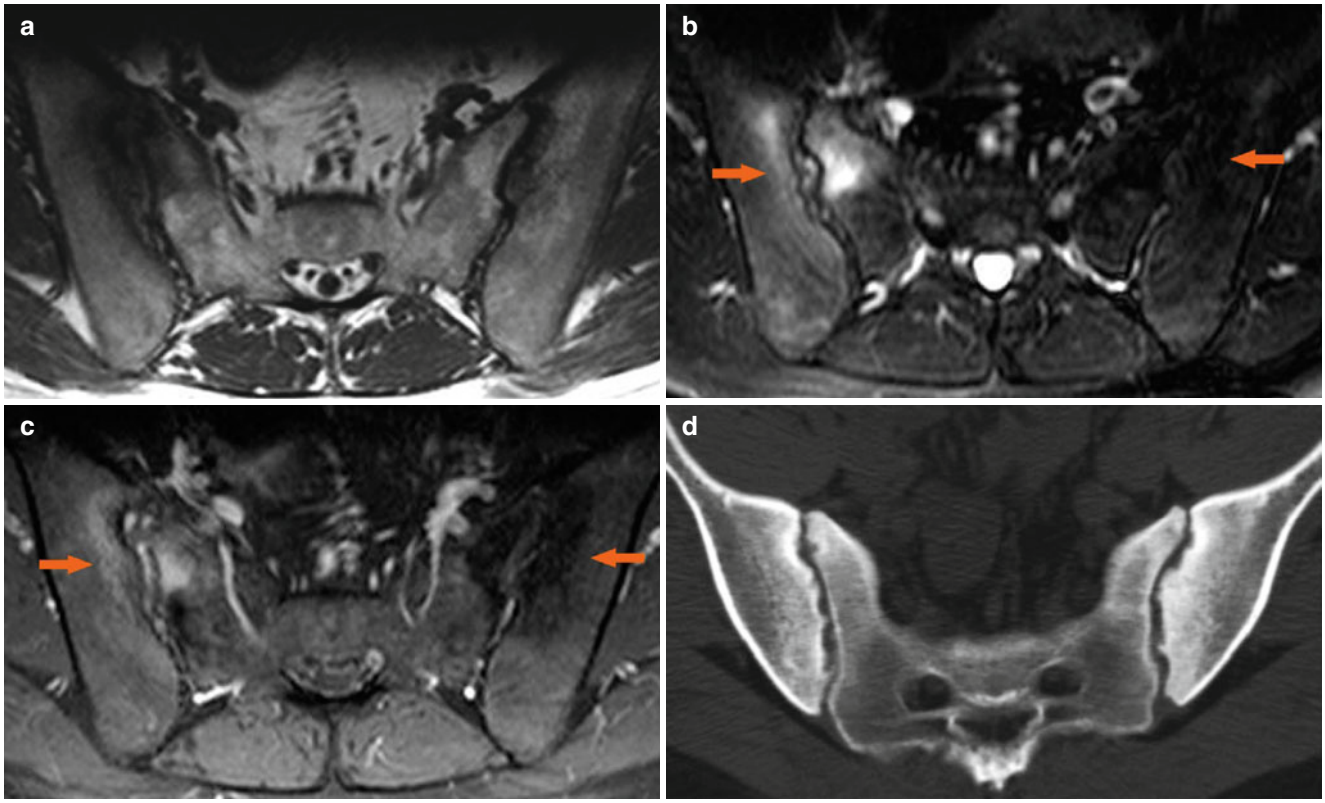


Fig. 2 Axial SE T1-weighted image (**a**), axial TSE T2-weighted image with fat saturation (**b**), axial SE T1-weighted image with fat saturation following the administration of contrast medium (**c**), axial CT scan (**d**). The same patient presented bilateral sacroiliitis, in acute and chronic phases (**a**–**c**, *arrows*). Active sacroiliitis on the right side, with subchondral edema-osteitis of iliac and sacral bone. Postinflammatory fatty degeneration of the subchondral bone marrow on the left side. CT scan reveals bilateral osteosclerosis and erosions (**d**)

Ankylosing Spondylitis

Case 23

Discitis

Syndesmophytes

- A 63-year-old patient
- Chronic low back pain
- Stiffness
- Presence of HLA-B27
- Familial history of ankylosing spondylitis

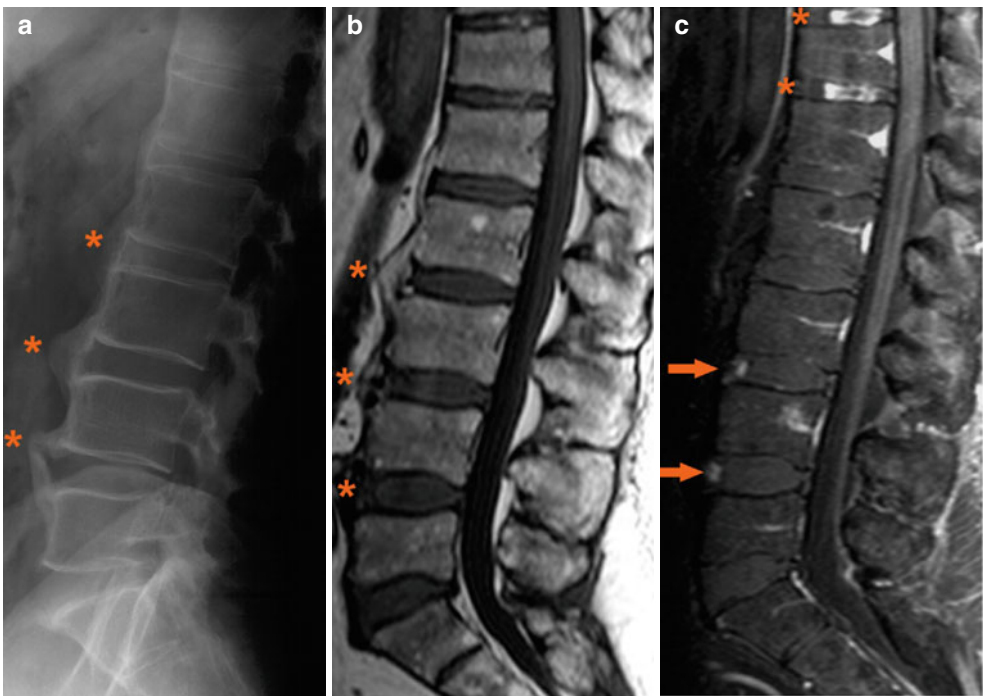
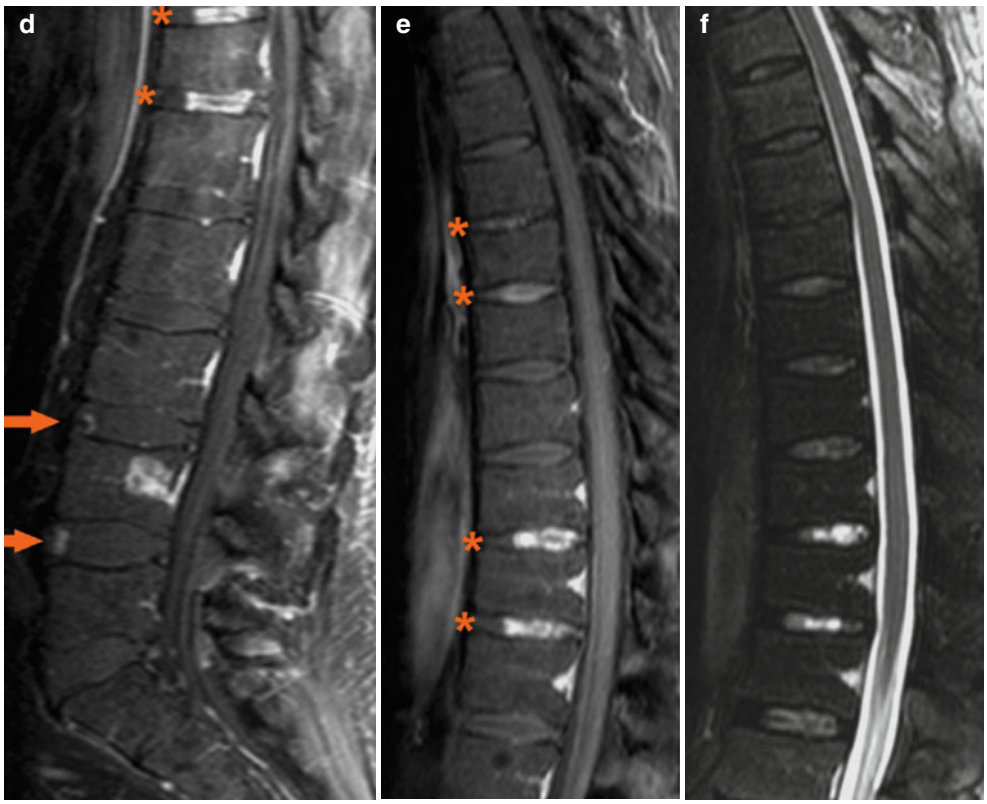


Fig. 1 X-ray (**a**), sagittal SE T1-weighted image (**b**), sagittal SE T1-weighted images with fat saturation following the administration of contrast medium (**c–e**), sagittal TSE T2-weighted image with fat saturation (**f**). The radiograph shows multiple syndesmophytes (**a**, *asterisks*). T1-weighted image documents the same syndesmophytes as well, with prediscal ankylosis (**b**, *asterisks*). MRI documents also aseptic discitis at D11/D12 and D12/L1 as hyperintense lesions in T2 (**f**) with contrast enhancement (**c**–**e**, *asterisks*). The same patient presented a small area of posterior spondylitis at L4, with postinflammatory fatty degeneration of the bone marrow (T1-hyperintensity in **b**) and residual inflammatory activity (contrast enhancement in **c**–**d**, *arrows*)

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_27, © Springer International Publishing Switzerland 2014

Fig. 1 (continued)



Ankylosing Spondylitis

Insufficiency Fractures

Case **24**

- A 54-year-old man
- Acute low back pain
- Dorsal and lumbar stiffness
- Presence of HLA-B27

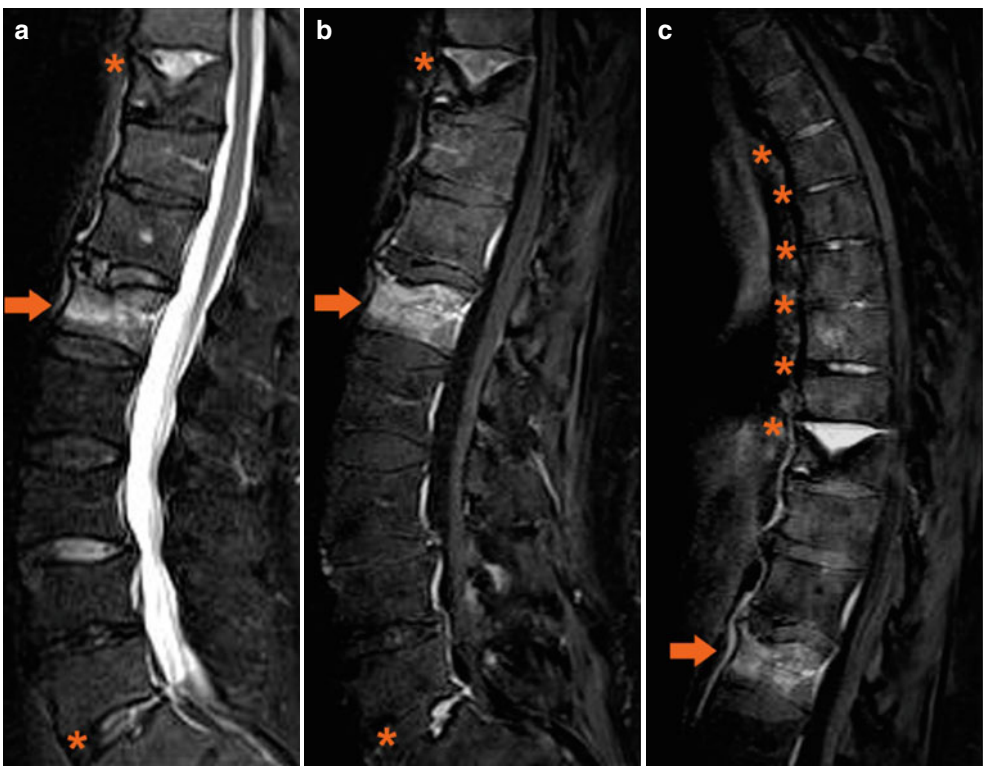


Fig. 1 Sagittal TSE T2-weighted image with fat saturation (**a**), sagittal SE T1-weighted images with fat saturation following the administration of contrast medium (**b**, **c**). Insufficiency fractures (Andersson II lesion) of the ankylosed spine, as a consequence of chronic spondylodiscitis. The fracture of the vertebral body at L1 presents diffuse edema (**a**–**c**, *arrow*). An older fracture is seen at D10, with no edema of the vertebral body (**a**, **b**, *asterisk*); an aseptic discitis is associated at D9/D10. Such fractures of the ankylosed spine occur spontaneously or after minor trauma, frequently in conjunction with osteoporosis

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_28, © Springer International Publishing Switzerland 2014

Ankylosing Spondylitis

Case 25

Active Inflammatory Lesions and Ankylosis

- A 75-year-old male
- Limitation of motion of the spine
- Presence of HLA-B27

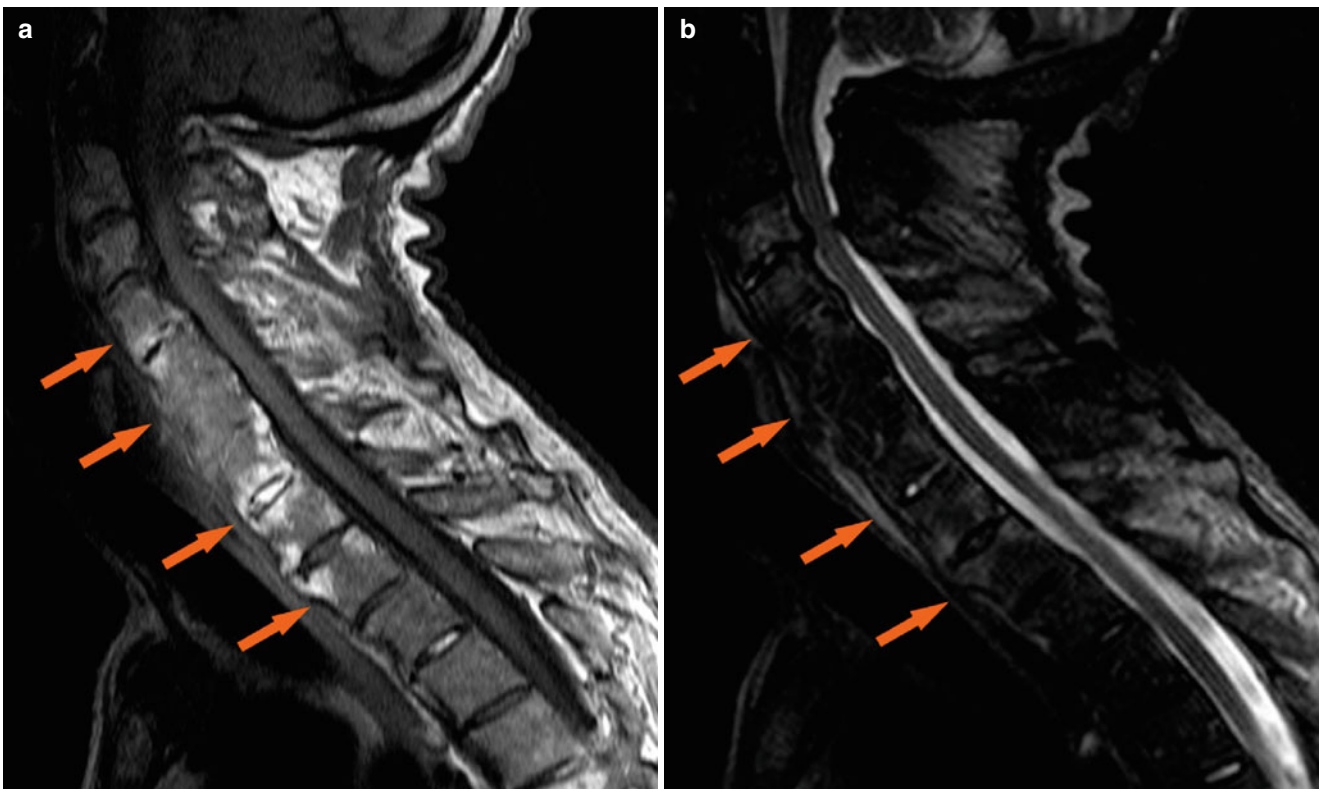
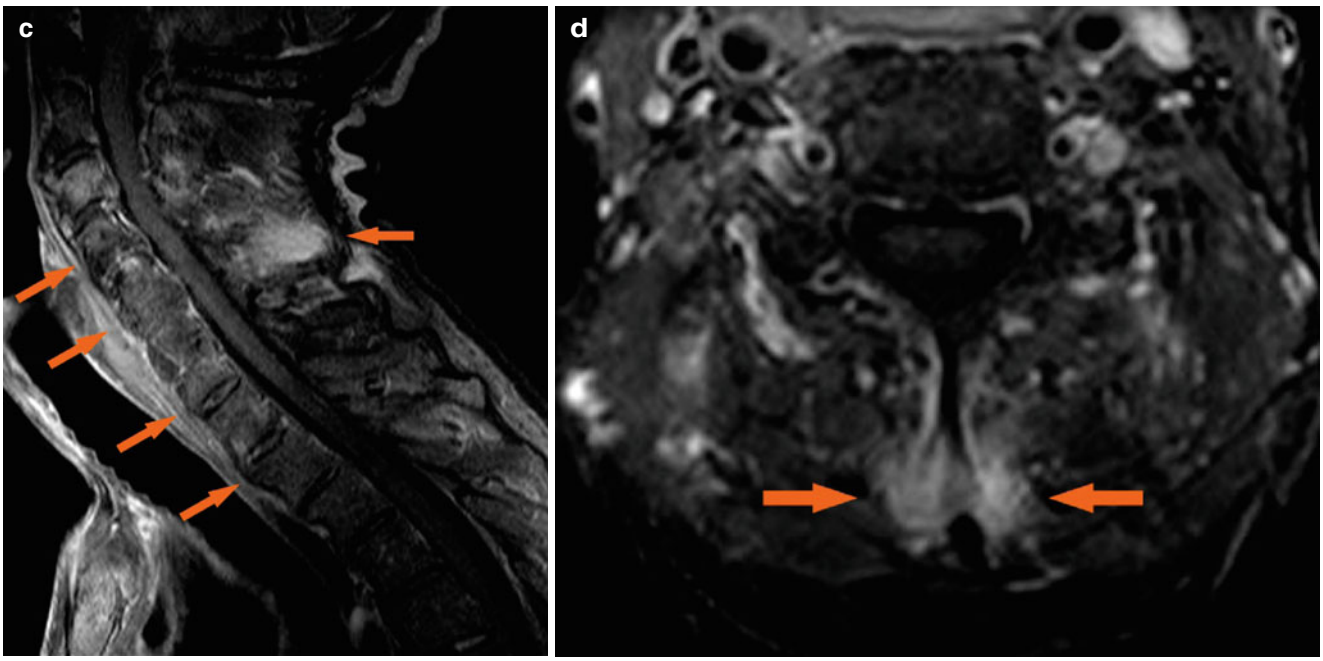


Fig. 1 Sagittal T1-weighted image (**a**), sagittal T2-weighted image with fat saturation (**b**), sagittal and axial T1-weighted images with fat saturation following the administration of contrast medium (**c**–**e**). Ankylosis of the cervical spine from C4 to D1 (**a**–**c**, *anterior arrows*). Note both transdiscal ankylosis and prediscal ankylosis with syndesmophytes (**a**). The ankylosing process is better seen in the T1 sequence (**a**) than in T2-weighted image with fat saturation (**b**). The areas of contrast enhancement in vertebral bodies and discs indicate foci of active spondylitis and discitis (**c**). Contrast enhancement of the interspinous ligament can be seen at C5/C6 (**c**–**e**, *posterior arrows*), indicating inflammation of the same ligament and its attachment (i.e., enthesitis)

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_29, © Springer International Publishing Switzerland 2014



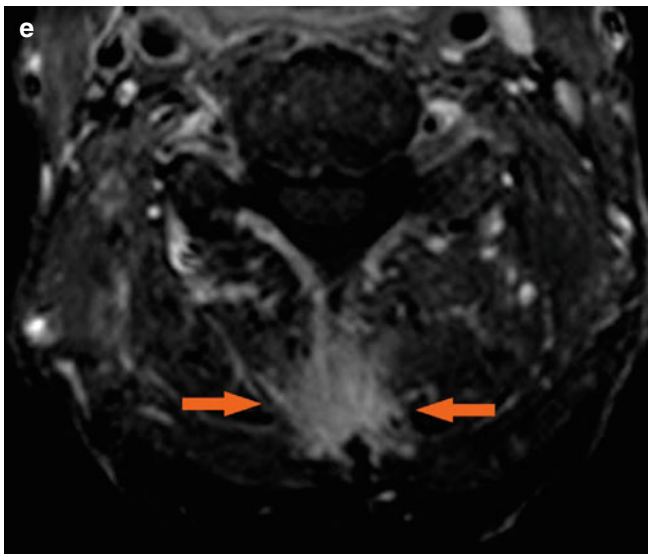


Fig. 1 (continued)

Ankylosing Spondylitis

Case 26

Ankylosis

- A 35-year-old male
- Chronic back pain
- Marked dorsal and lumbar stiffness
- Presence of HLA-B27
- Familial history of ankylosing spondylitis

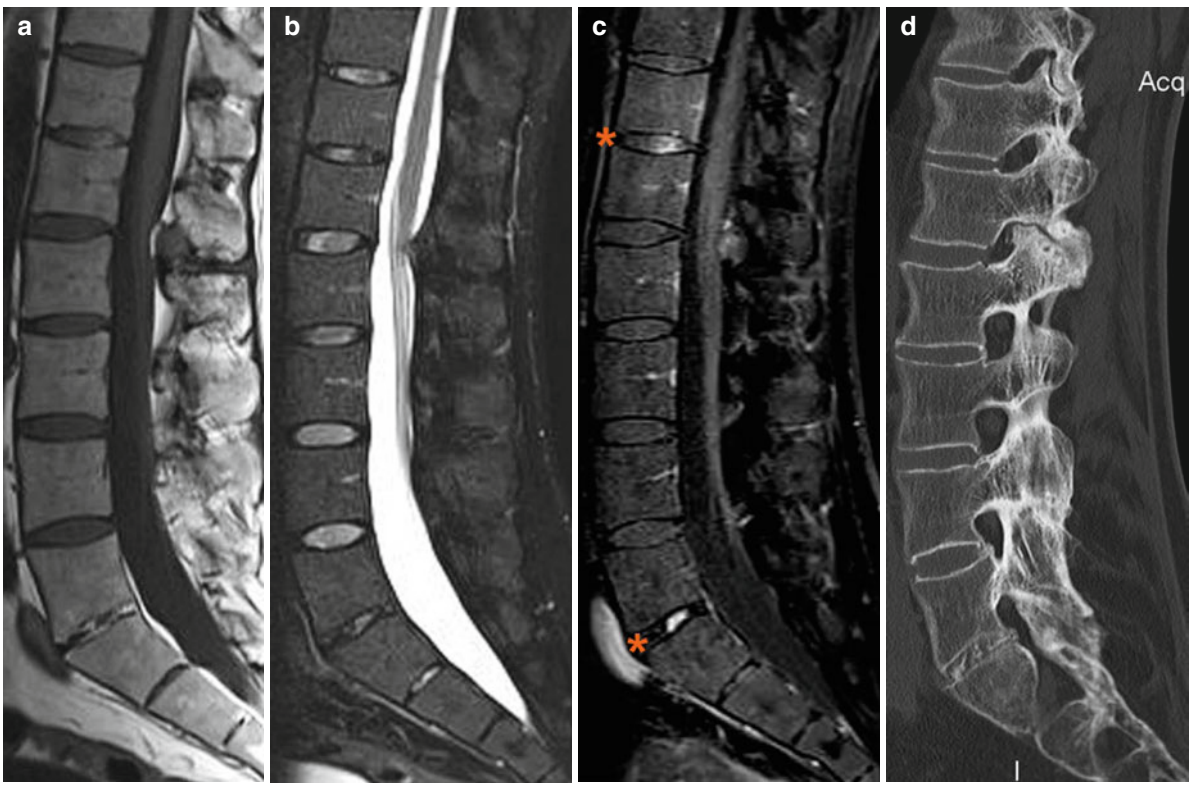
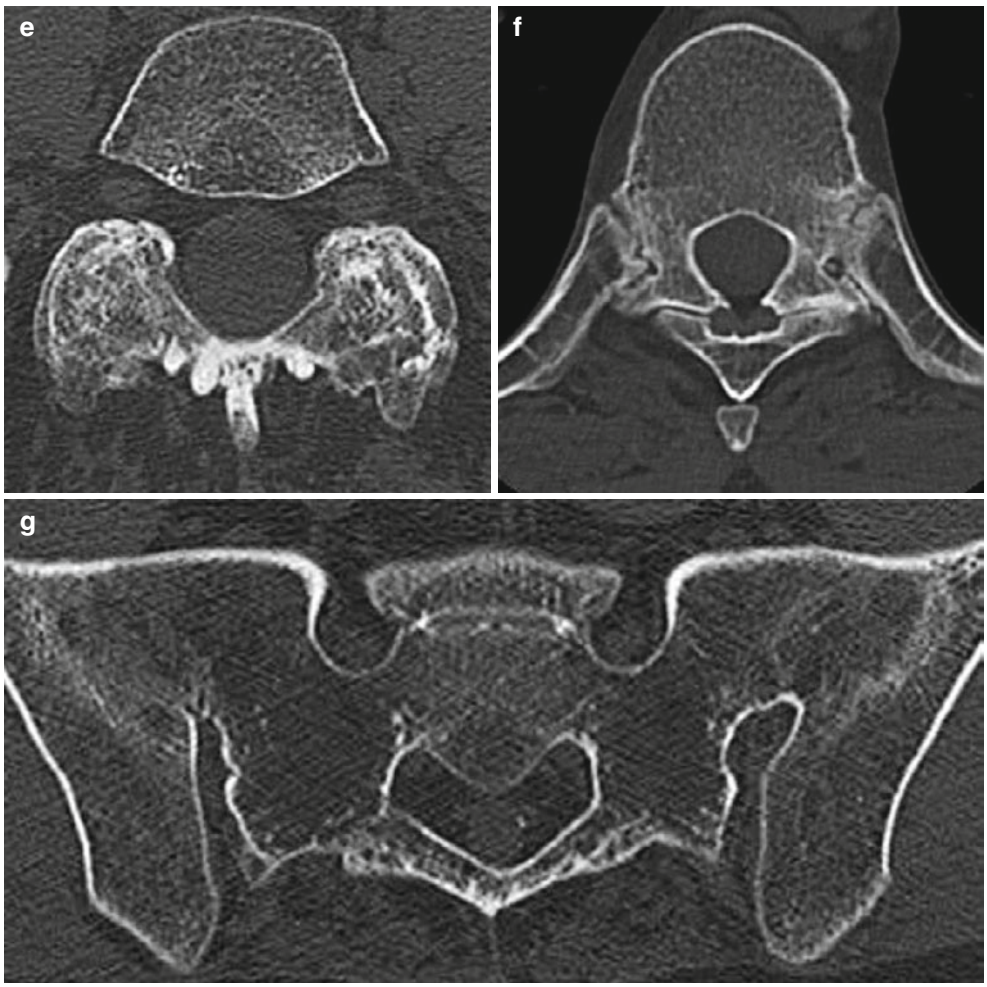


Fig. 1 Sagittal SE T1-weighted image (**a**), sagittal TSE T2-weighted image with fat saturation (**b**), sagittal SE T1-weighted image with fat saturation following the administration of contrast medium (**c**), axial CT scans and sagittal reconstruction (MPR) (**d**–**g**). The intervertebral disc L5/S1 presents reduction in height, calcification, and a small area of contrast enhancement referable to aseptic discitis (**a**–**c**); another small area of aseptic discitis is seen at D12/L1 (**c**, *asterisks*). CT scans show diffuse and bilateral ankylosis of facet, sacroiliac, and costotransverse joints and confirm the intradiscal calcification at L5/S1

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_30, © Springer International Publishing Switzerland 2014

Fig. 1 (continued)



Psoriatic Arthritis

Case 27

Costovertebral and Facet Joints Arthritis

- A 36-year-old patient
- Back pain that worsens during the night and improves upon getting up
- Presence of HLA-B27

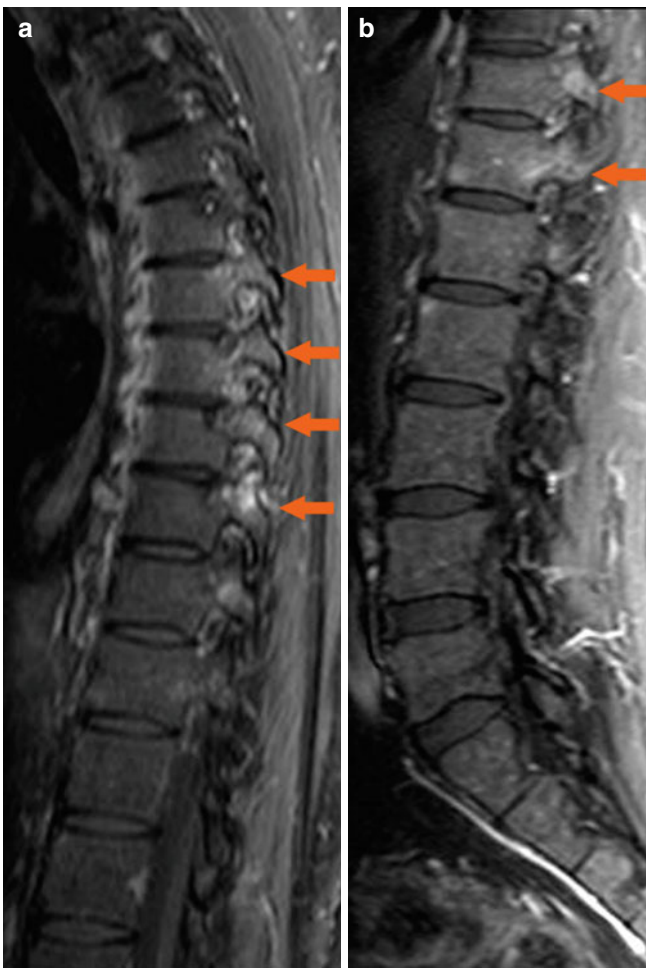


Fig. 1 Sagittal and axial SE T1-weighted images with fat saturation following administration of contrast medium (**a**–**g**). The images on the sagittal plane demonstrate active inflammation of facet joints from T7 to T12 (*arrows*), and inflammation of the anterior corners of the vertebral bodies at T12 and L2 (**a**, **b**). The images on the axial plane show bilateral osteoarthritis of the costovertebral joints and inflammation of the adjacent soft tissues (**c**, **g**)

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_31,

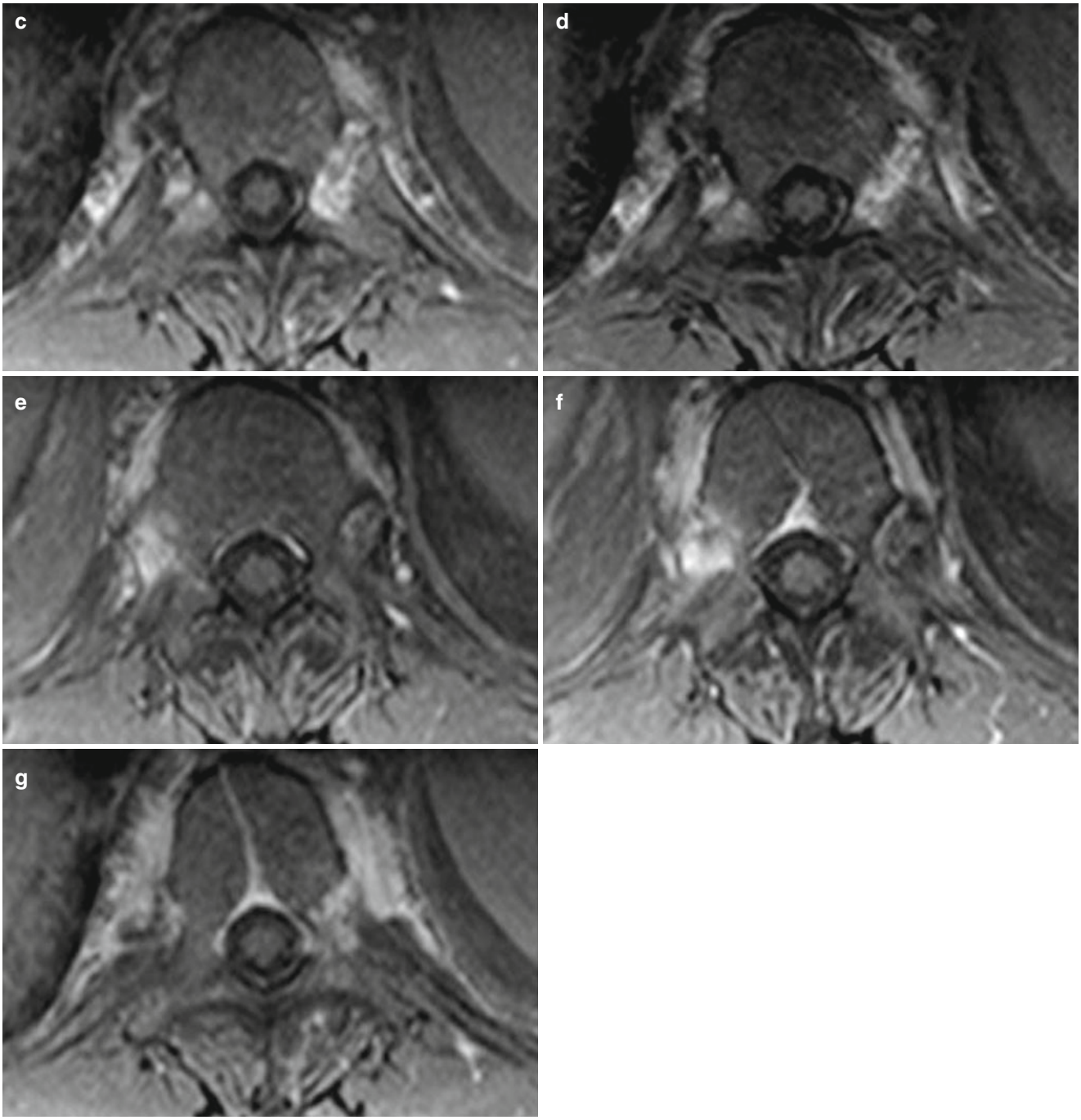


Fig. 1 (continued)

Psoriatic Arthritis

Facet Joints Arthritis

Case **28**

- A 24-year-old patient
- Familial history of SpA
- Acute left back pain that worsens during the night and improves upon getting up
- Limitation of motion of the spine

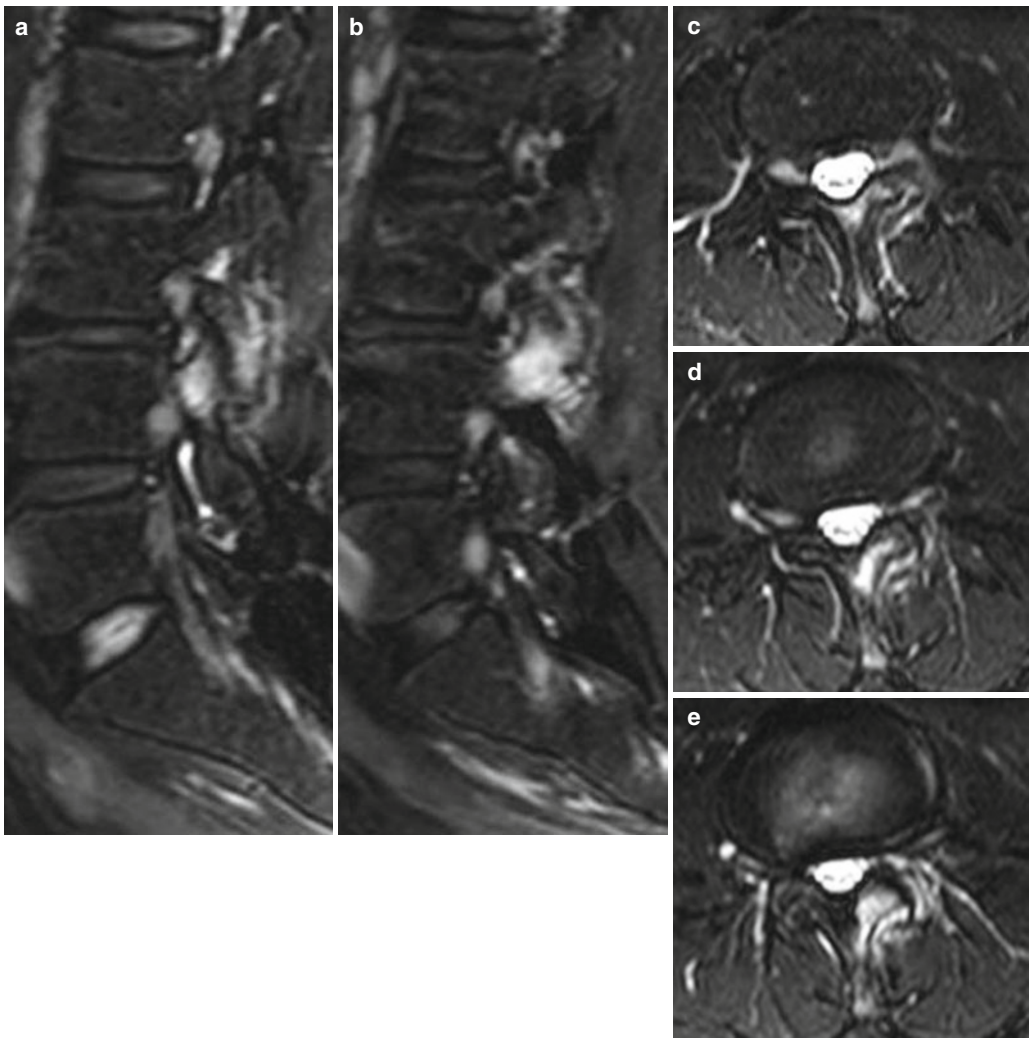


Fig. 1 Sagittal and axial TSE T2-weighted images with fat saturation (**a–e**) demonstrating bone marrow edema of the left facet joint at L3–L4 (**a**–**b**), extending to the left pedicle, lamina, and spinous process (**c**–**e**)

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_32,

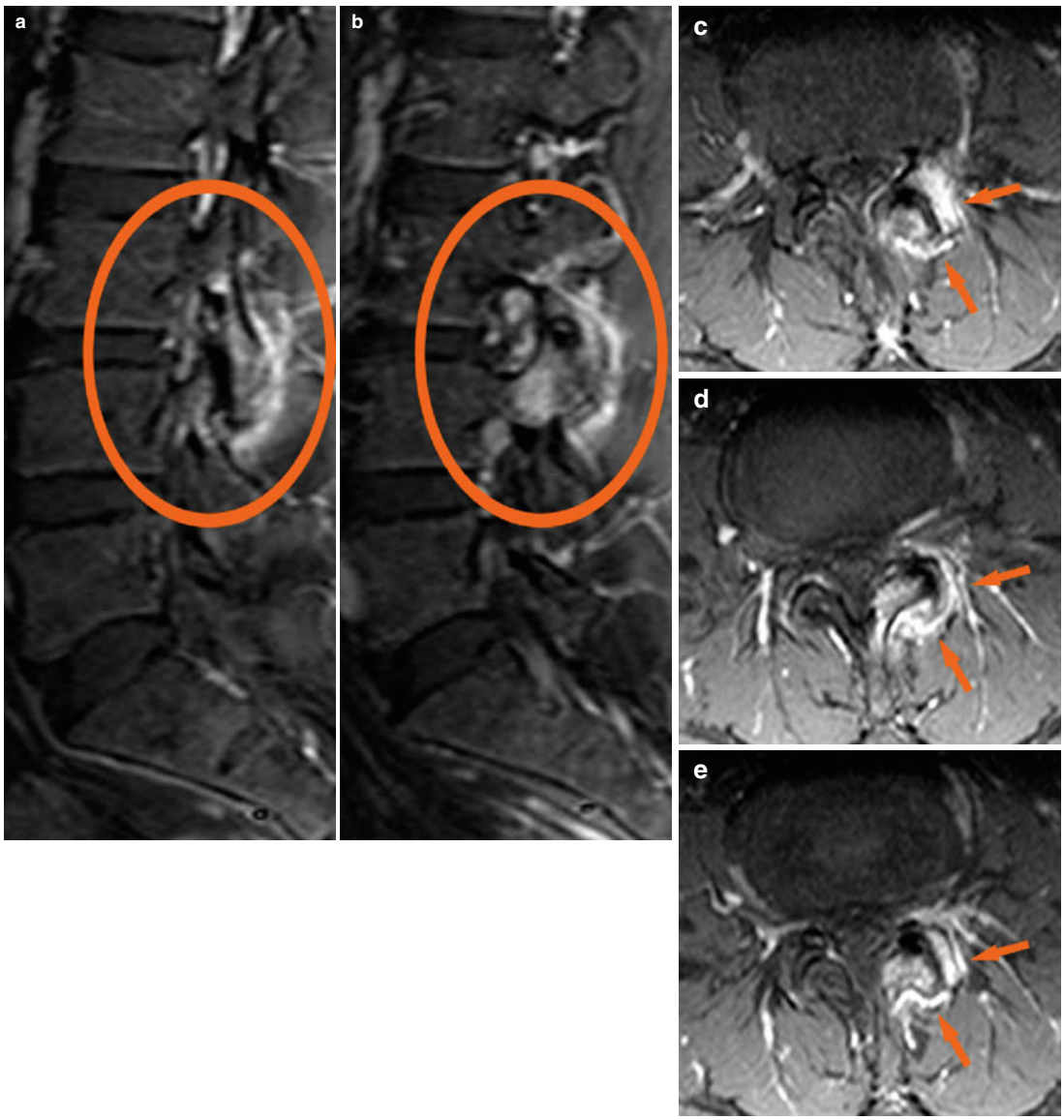


Fig. 2 Sagittal and axial SE T1-weighted images with fat saturation following the administration of contrast medium (**a–e**) confirm acute inflammation of the left facet joint at L3–L4 (**a–e**, *circle* and *arrow*). Note also the inflammation of periarticular soft tissues

Psoriatic Arthritis

Facet Joints Arthritis

Case 29

- A 28-year-old patient
- Familial history of SpA
- Acute left back pain that worsens during the night and improves upon getting up
- Limitation of motion of the spine

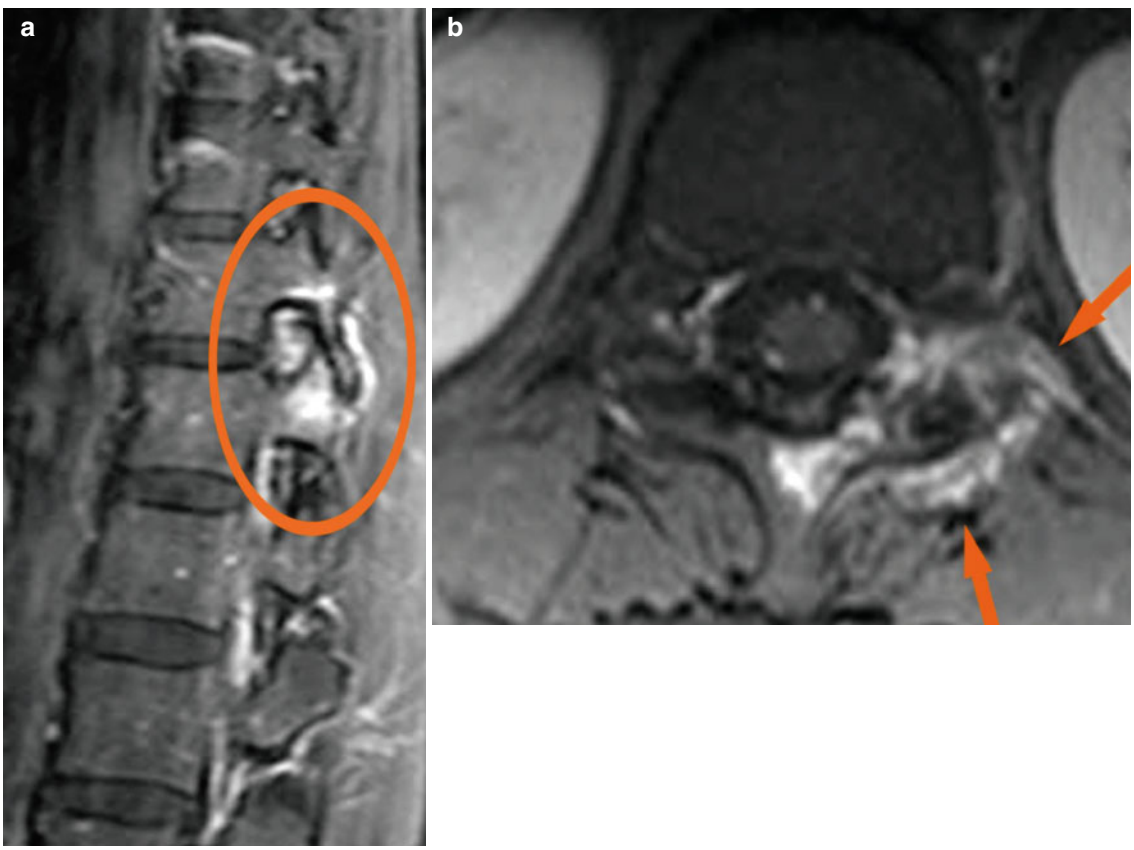


Fig. 1 Sagittal and axial SE T1-weighted images with fat saturation following the administration of contrast medium (**a**–**b**). The images show acute inflammation of the left facet joint at L1–L2 (**a**, *circle*), better demonstrated in the axial plane, extending to the lamina and adjacent soft tissues (**b**, *arrows*)

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_33, © Springer International Publishing Switzerland 2014

Psoriatic Arthritis

Costovertebral and Facet Joints Arthritis

Case 30

- A 21-year-old patient
- Back pain that worsens during the night and improves upon getting up
- Limitation of motion of the spine in the frontal planes

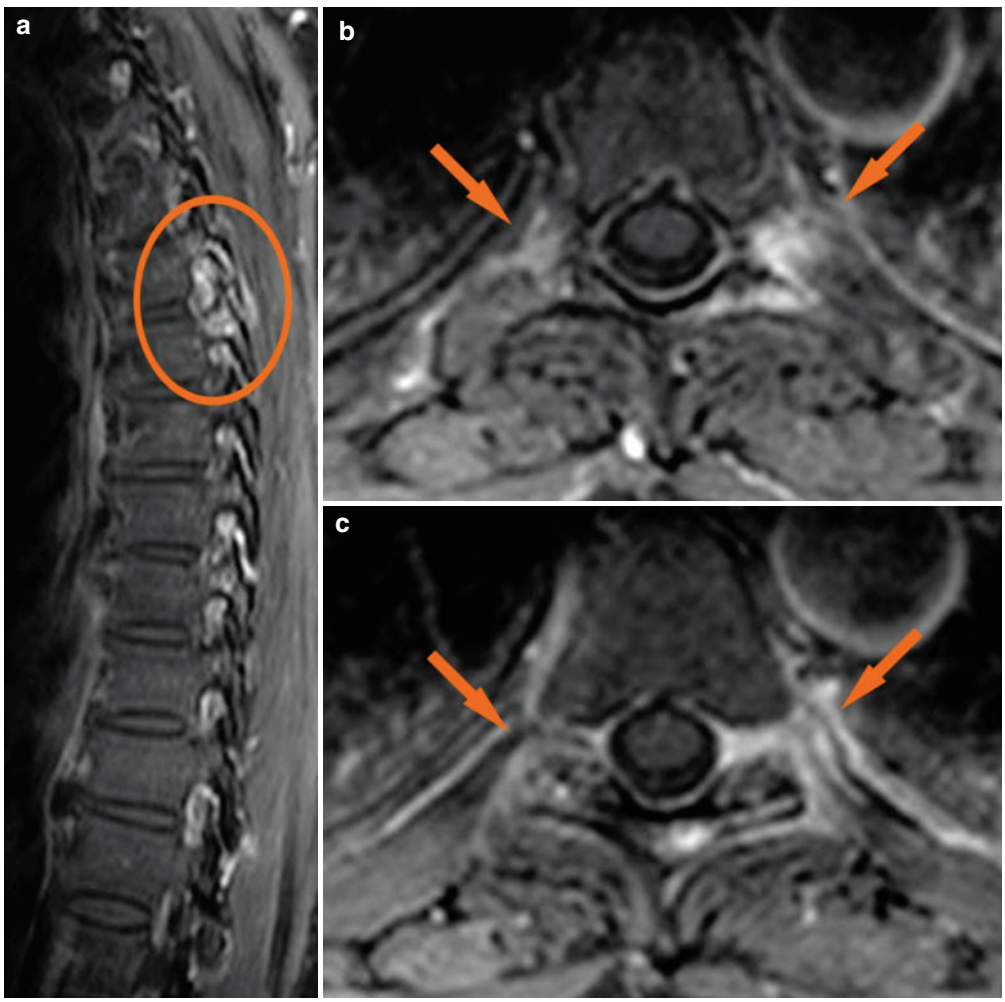


Fig. 1 Sagittal and axial SE T1-weighted images with fat saturation following the administration of contrast medium (**a–c**). The sagittal image shows contrast enhancement, i.e., active osteoarthritis, of the zygapophyseal joint at T5/T6 (**a**, *circle*); the axial images show contrast enhancement of the costovertebral joints and adjacent soft tissues, more evident on the left side (**b–c**, *arrows*), indicating osteoarthritis with periarticular inflammation

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_34, © Springer International Publishing Switzerland 2014

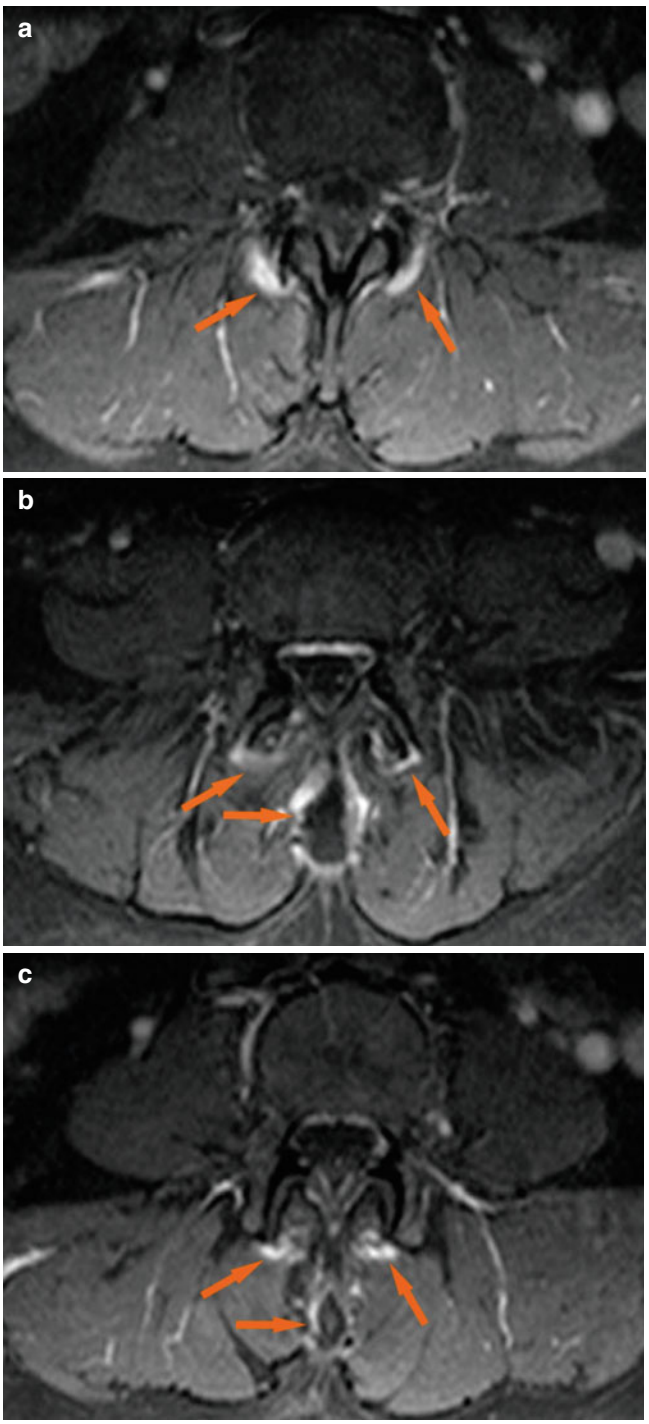


Fig. 2 Axial SE T1-weighted images with fat saturation following the administration of contrast medium images (**a–c**). These images demonstrate bilateral periarticular inflammation (**a**, **c**) and inflammation of the interspinous ligament (**b**)

Ankylosing Spondylitis

Case 31

Costovertebral and Facet Joints Arthritis

- A 49-year-old male
- Chronic back pain
- Stiffness
- Presence of HLA-B27

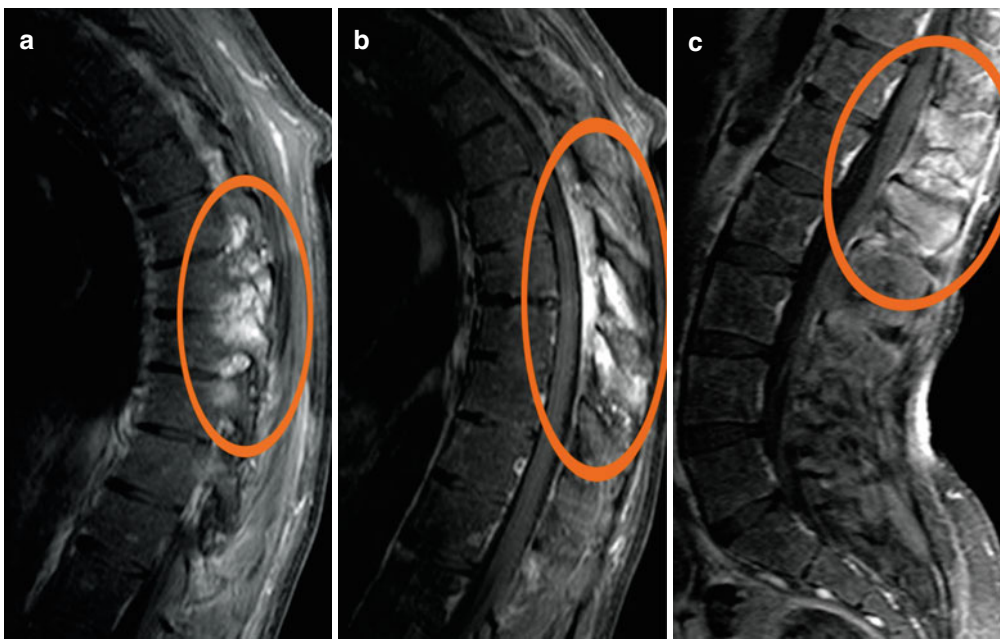
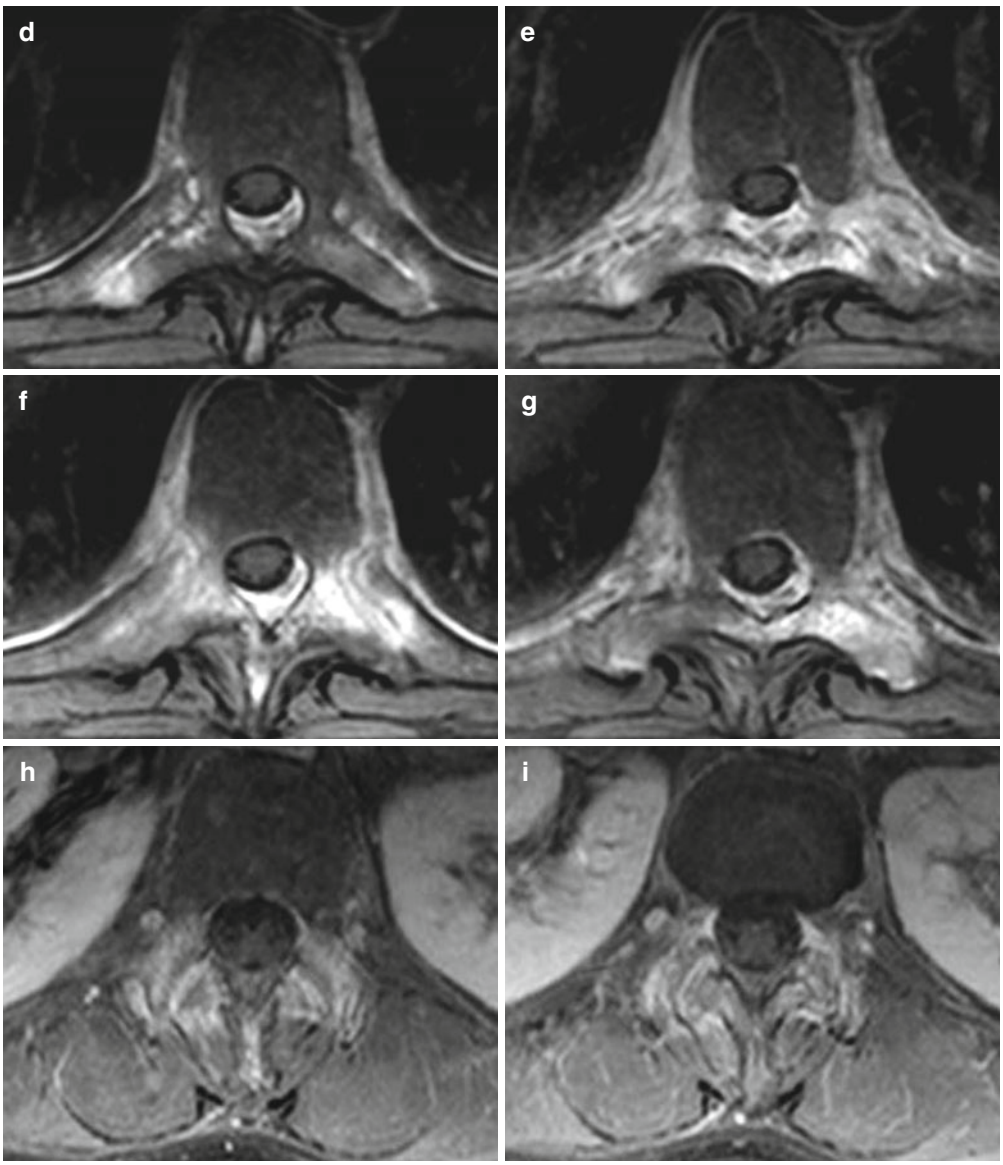


Fig. 1 Sagittal and axial SE T1-weighted images with fat saturation after the administration of contrast medium (**a**–**i**). Dorsal hyperkyphosis. Marked bilateral costovertebral and costotransverse osteoarthritis (**a**, **d**–**g**). Marked bilateral facet joint osteoarthritis (**h**, **i**). It coexists an inflammation of the flava ligaments and interspinous ligaments (**b**–**h**). There is intense contrast enhancement of the abovementioned joints and ligaments

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_35, © Springer International Publishing Switzerland 2014

Fig. 1 (continued)



Psoriatic Arthritis

Costovertebral Arthritis

Case 32

- A 56-year-old female
- Patient with persistent dorsal pain
- Psoriasis

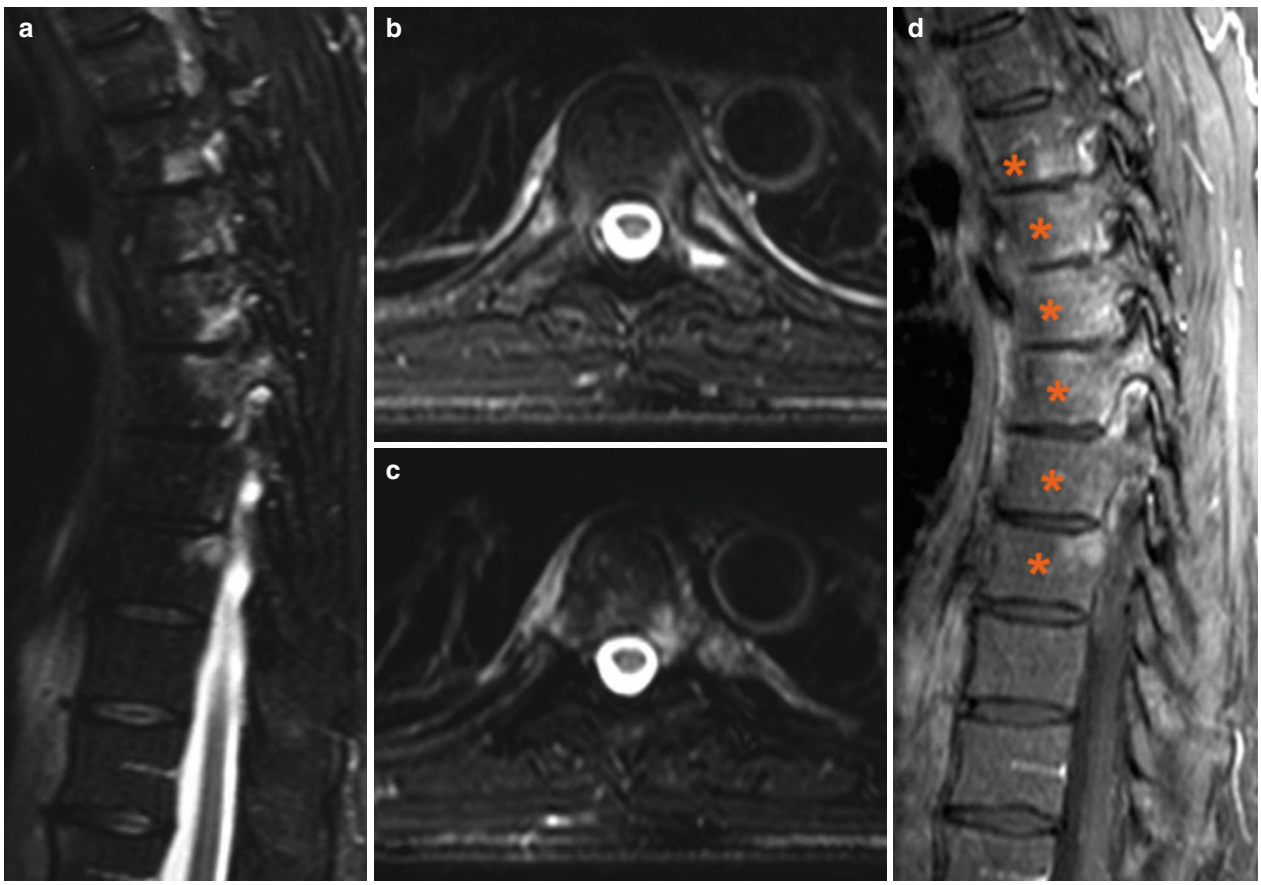


Fig. 1 Sagittal and axial T2-weighted images with fat saturation (**a**–**c**), sagittal and axial T1-weighted images with fat saturation following contrast medium administration (**d**–**g**). Multiple areas of hyperintensity in T2 (**a**–**c**), with contrast enhancement (**d**–**g**, *asterisks* and *arrows*), in the costovertebral and costotransverse joints bilaterally, indicating active osteoarthritis of the same joints. It is necessary to obtain transverse slices (**b**, **c**, **e**–**g**) in addition to sagittal images to precisely localize these lesions. The patient was affected by psoriasis, which suggested the diagnosis of psoriatic arthritis

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_36, © Springer International Publishing Switzerland 2014

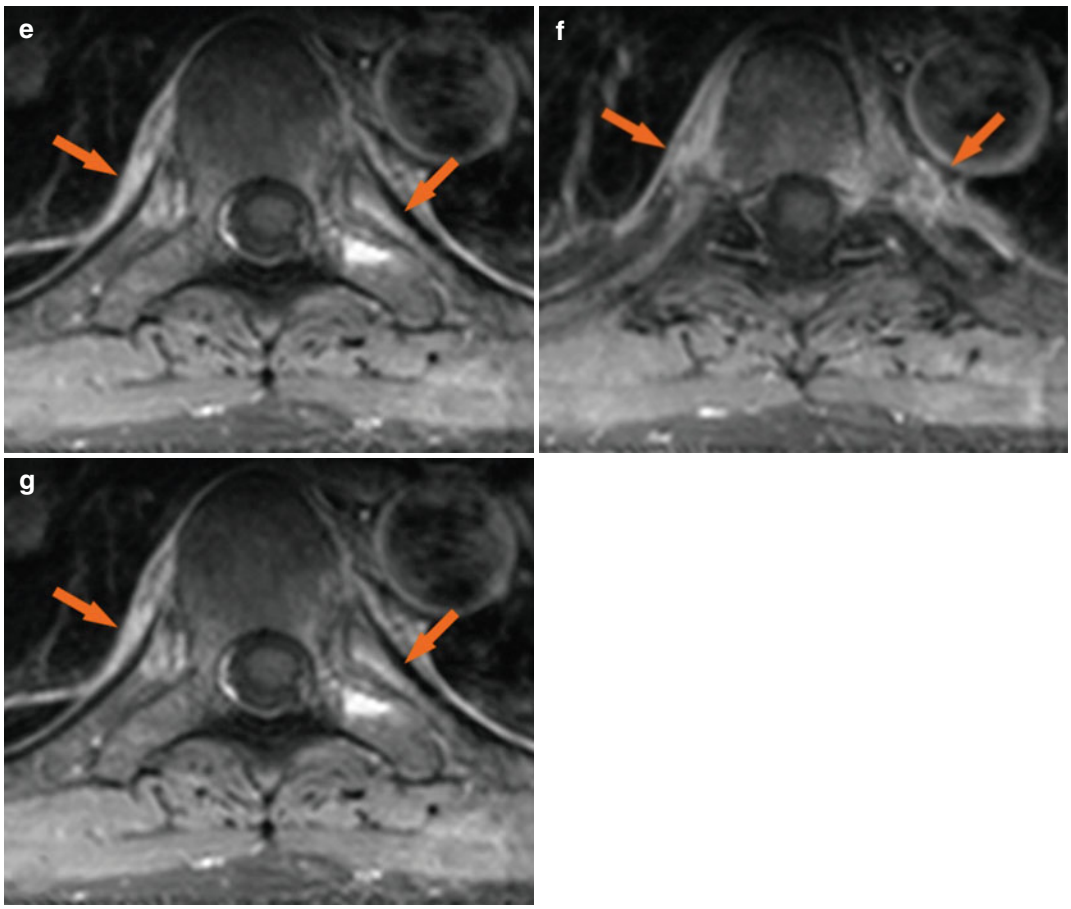


Fig. 1 (continued)

SAPHO Syndrome

Case 33

Spondylitis

- A 16-year-old male
- Acute and diffuse back pain
- Pustulosis

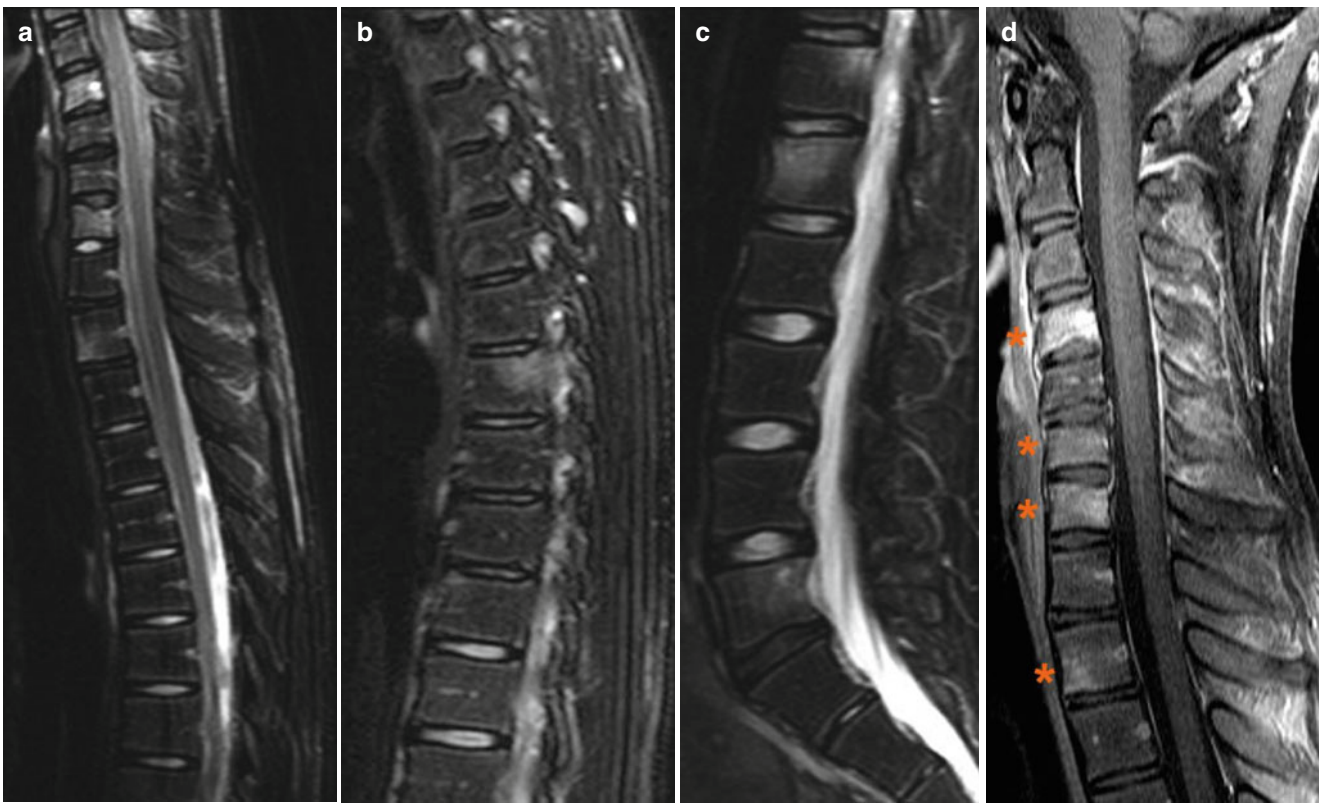


Fig. 1 Sagittal TSE T2-weighted images with fat saturation (**a–c**), sagittal contrast-enhanced SE T1-weighted images with fat saturation (**d–f**). Multiple areas of edema-osteitis of the vertebral bodies in the cervical, thoracic, and lumbar spine. The young patient also presented pustulosis on the palms of the hands and soles of the feet. Diagnosis: spondylitis in SAPHO syndrome. This is a chronic disorder that involves the skin, bone, and joints. SAPHO is an acronym for the combination of synovitis, acne, pustulosis, hyperostosis, and synovitis

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_37, © Springer International Publishing Switzerland 2014

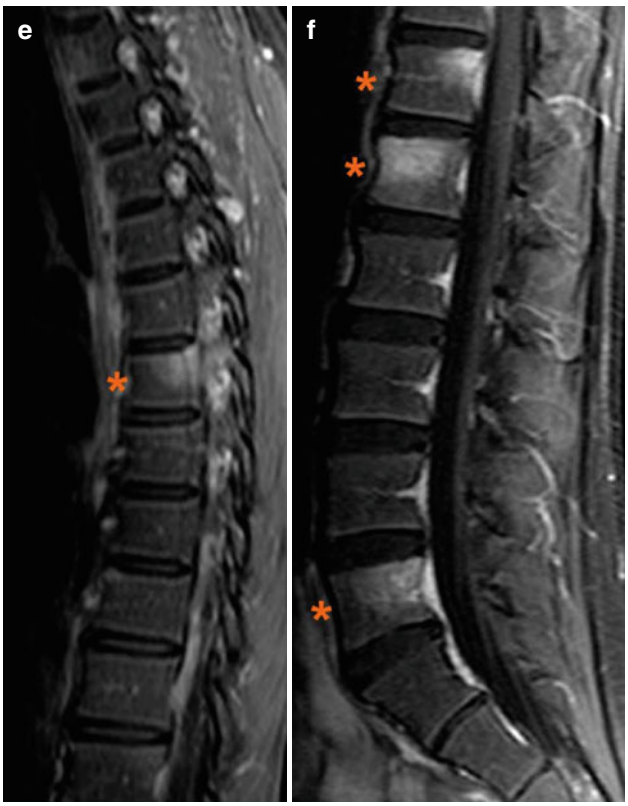


Fig. 1 (continued)

Follow-up after 4 months of medical therapy

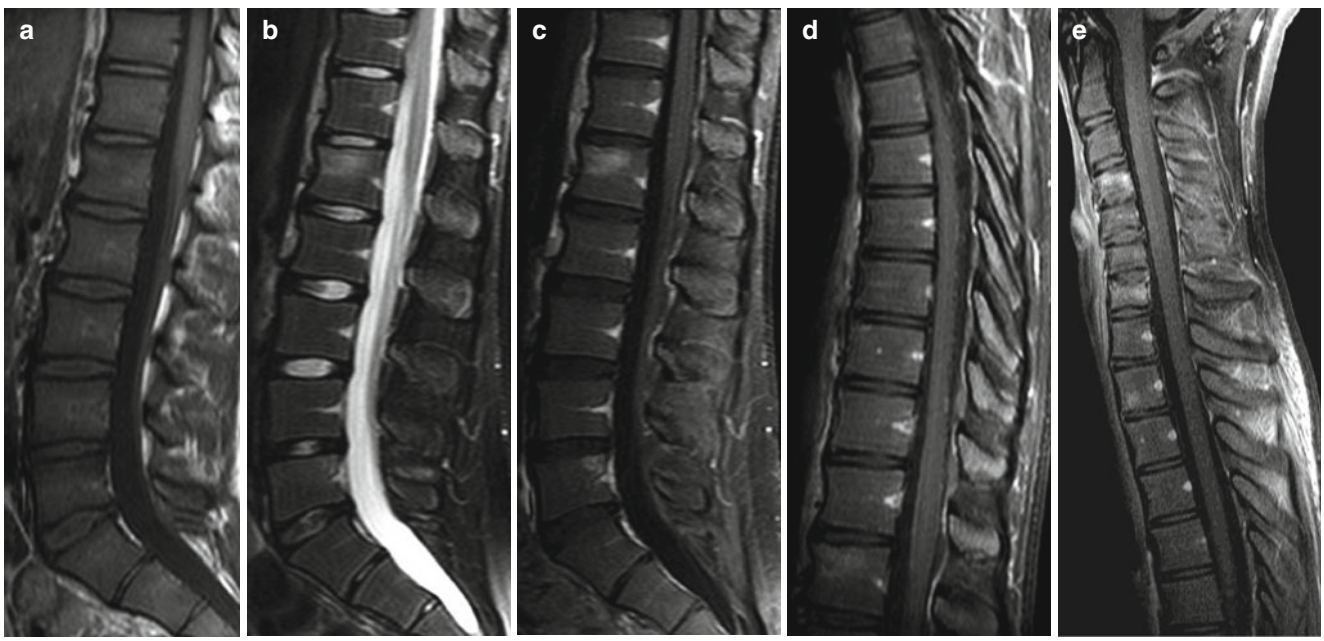


Fig. 2 Sagittal SE T1-weighted image (**a**), sagittal TSE T2-weighted image with fat saturation (**b**), sagittal contrast-enhanced SE T1-weighted images with fat saturation (**c–e**). Most of the lesions have disappeared. The remaining lesions appear reduced in extension

Juvenile Idiopathic Arthritis

Case 34

Sacroiliitis

- A 12-year-old female
- Asymmetric oligoarthritis
- Low back pain
- Tenderness at examination of sacroiliac joints

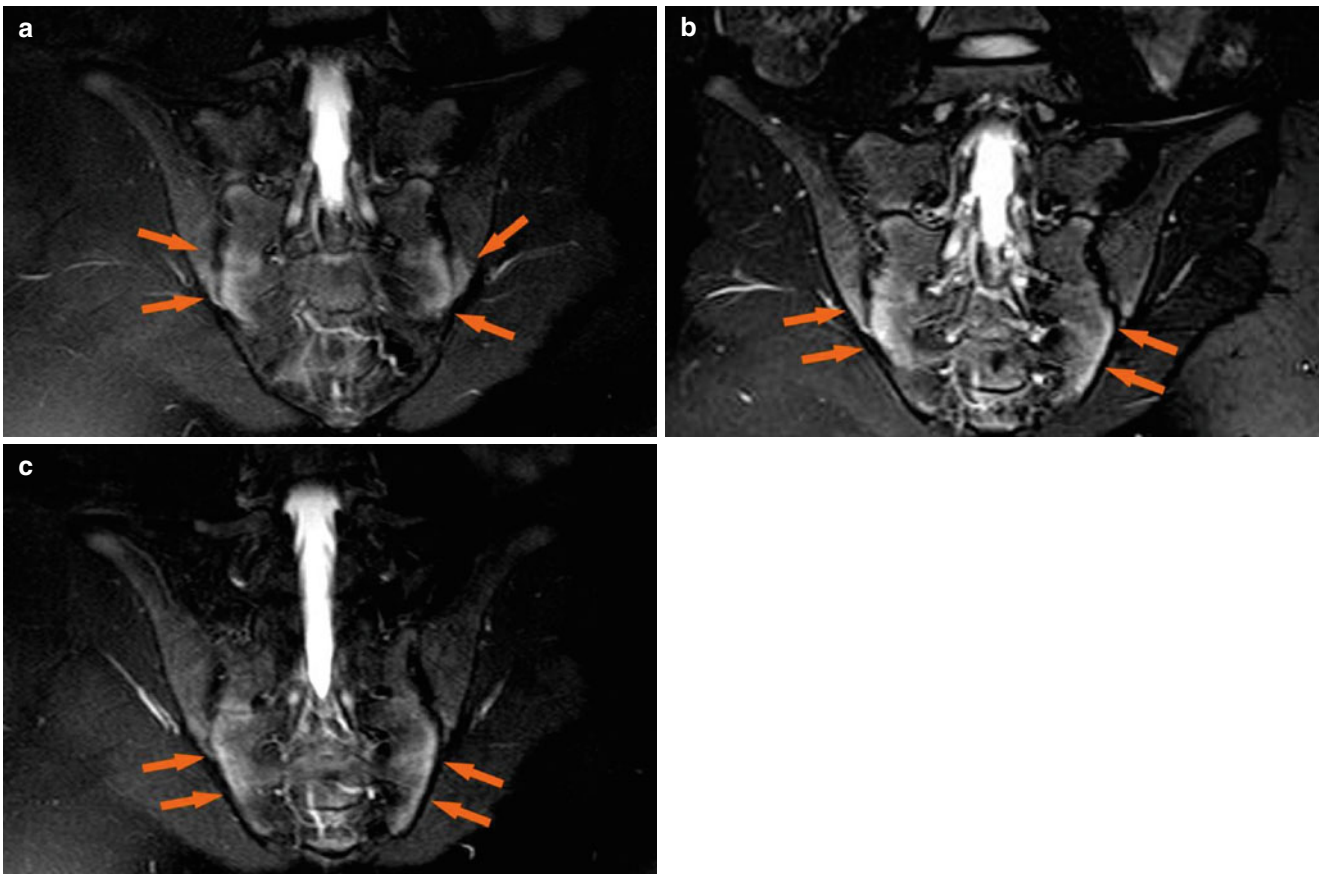


Fig. 1 Coronal T2-weighted images with fat saturation (**a–c**). Hyperintense signal on fat-suppressed T2-weighted images in the iliac and sacral bone at both sides, indicating bone marrow edema-osteitis (*arrows*). Diagnosis: sacroiliitis in juvenile idiopathic arthritis

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_38, © Springer International Publishing Switzerland 2014

Follow-up MRI after 2 years of medical treatment

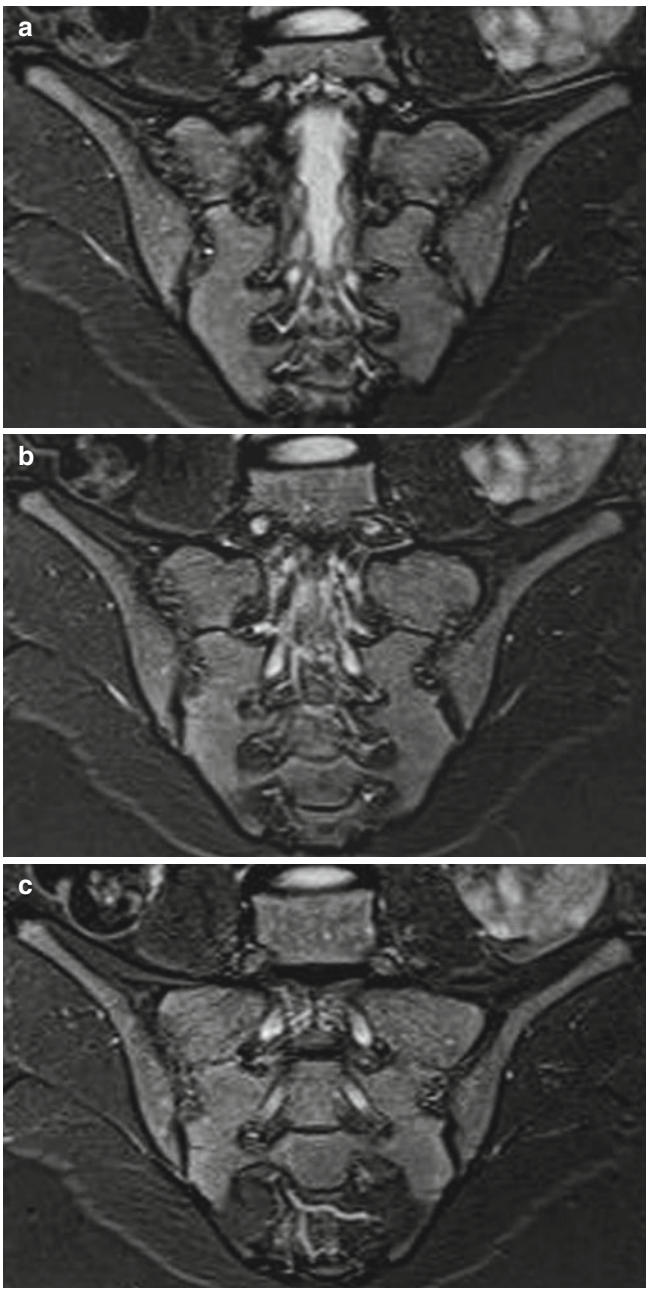


Fig. 2 Coronal T2-weighted images with fat saturation (**a–c**). The abovementioned lesions disappeared after 2 years of therapy with methotrexate

Psoriatic Arthritis

Sacroiliitis

Case **35**

- A 34-year-old patient
- Patient with chronic back pain
- Psoriatic polyarthritis with sacroiliitis

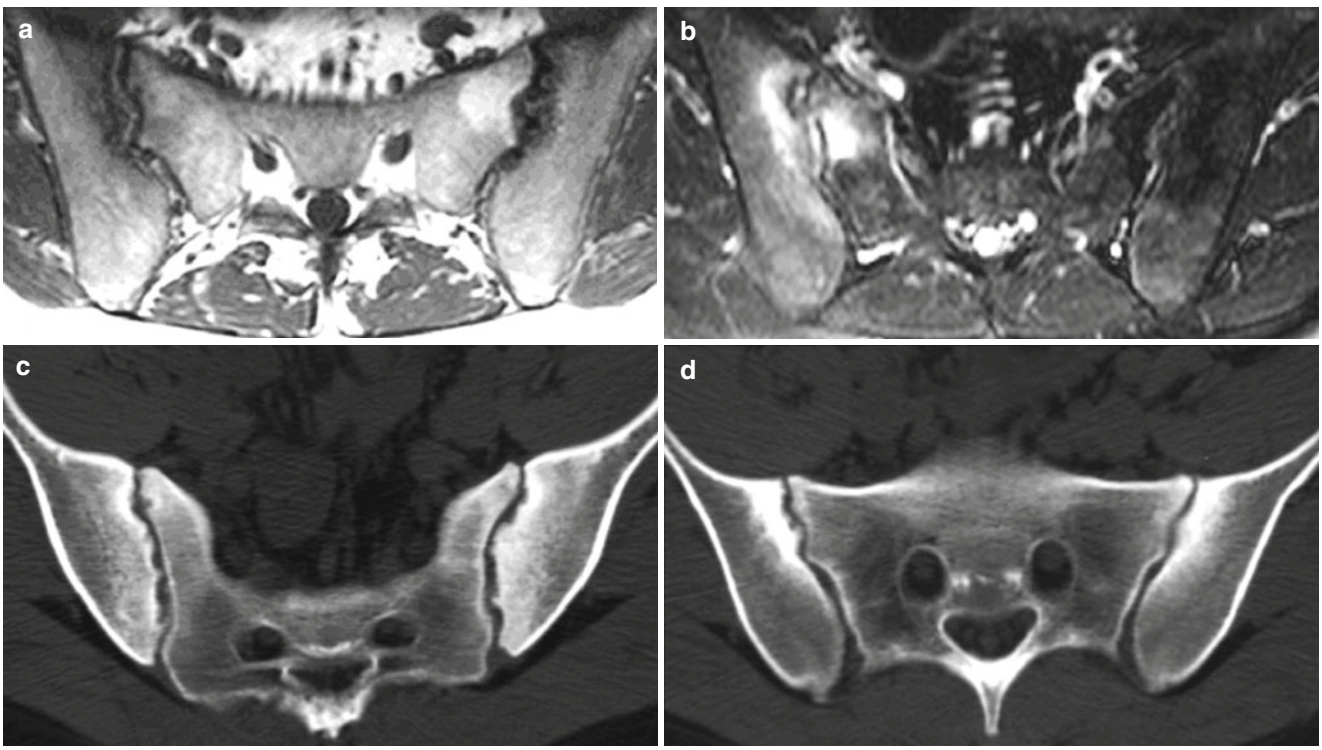


Fig. 1 Axial SE T1-weighted image (**a**), axial TSE T2-weighted image with fat saturation (**b**), CT images (**c–d**). Bilateral sacroiliitis in different stages. On the left side, there is adipous transformation of the bone marrow in the sacral side of the joint and osteosclerosis in the iliac side (**a**, **b**). Subchondral edema and joint effusion of the right sacroiliac joint, indicating an active inflammatory stage (**a**, **b**). Note that CT evaluation shows bilateral subchondral osteosclerosis and microerosions (**c**, **d**)

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_39, © Springer International Publishing Switzerland 2014

Arthritis Associated with Inflammatory Bowel Disease

Case 36

Sacroiliitis

- A 39-year-old patient
- Right-sided back pain
- Patient affected by Crohn disease

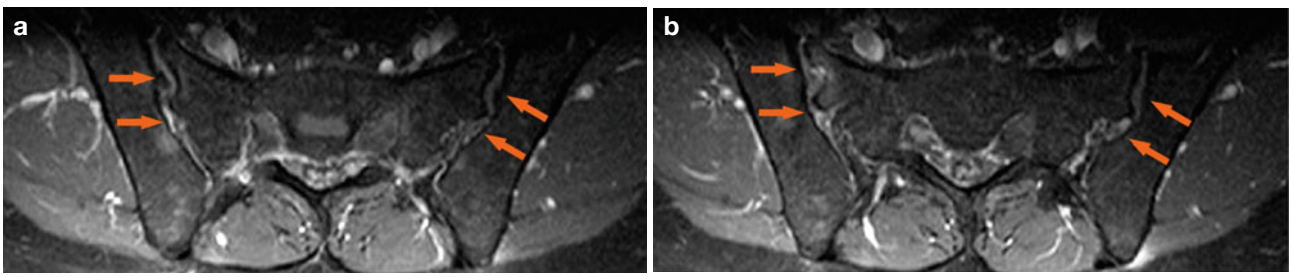


Fig. 1 Axial SE T1-weighted images with fat saturation following the administration of contrast medium (**a**–**b**). Right sacroiliitis. Note contrast enhancement in the joint space, indicating an active inflammatory stage of the process. Note also bone erosion on the sacral side

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_40, © Springer International Publishing Switzerland 2014

Psoriatic Arthritis

Case 37

Sacroiliitis

Enthesitis

- A 35-year-old patient
- Patient with chronic back pain
- Psoriatic arthritis

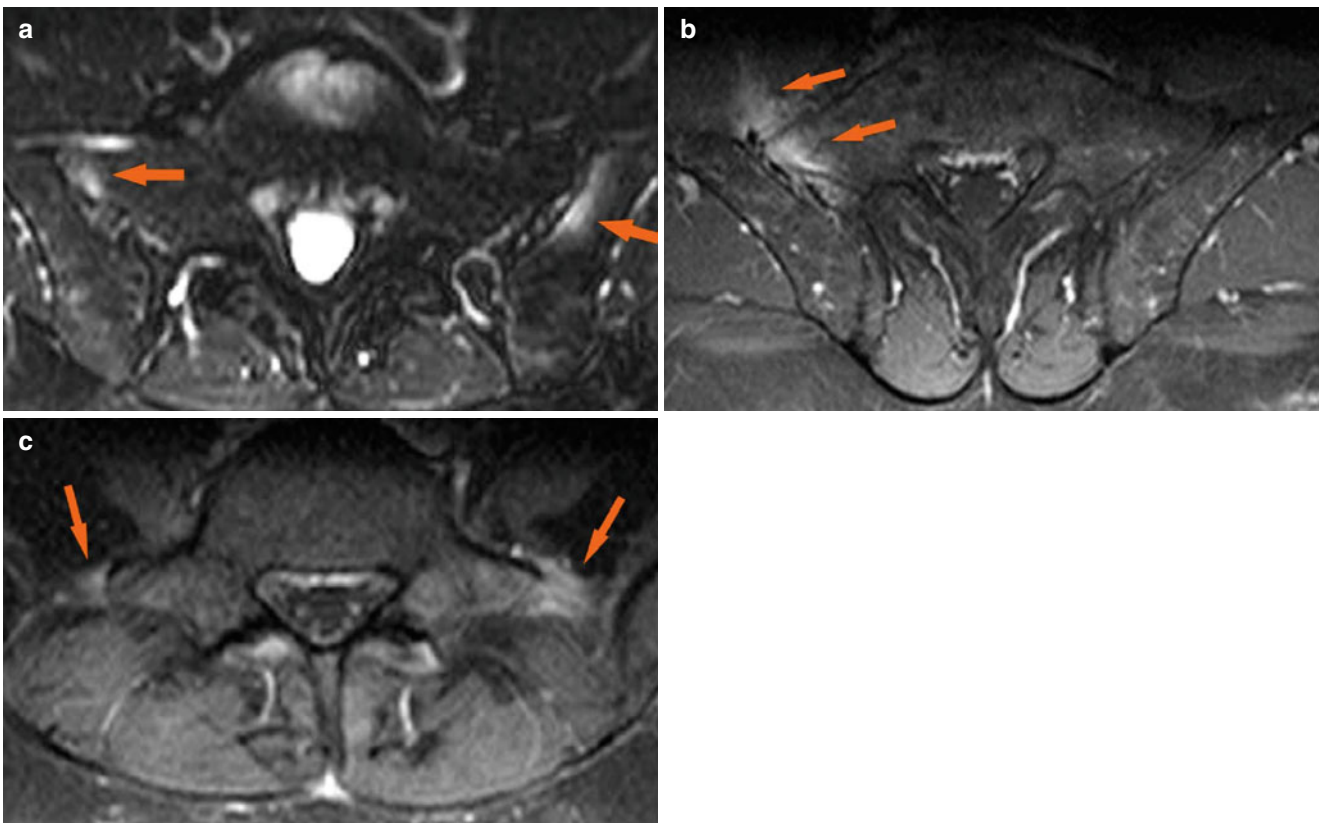


Fig. 1 Axial TSE T2-weighted image with fat saturation (**a**), axial SE T1-weighted images with fat saturation following the administration of contrast medium (**b**, **c**). Different planes. Anterior capsulitis of the right sacroiliac joint (**a**). Subchondral osteitis on the right sacral side and left iliac side. Multiple foci of contrast enhancement at the sites of attachment of ligaments, indicating enthesitis

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_41, © Springer International Publishing Switzerland 2014

Psoriatic Arthritis

Case 38

Sacroiliitis

- A 48-year-old patient
- Chronic low back pain
- Psoriatic skin lesions

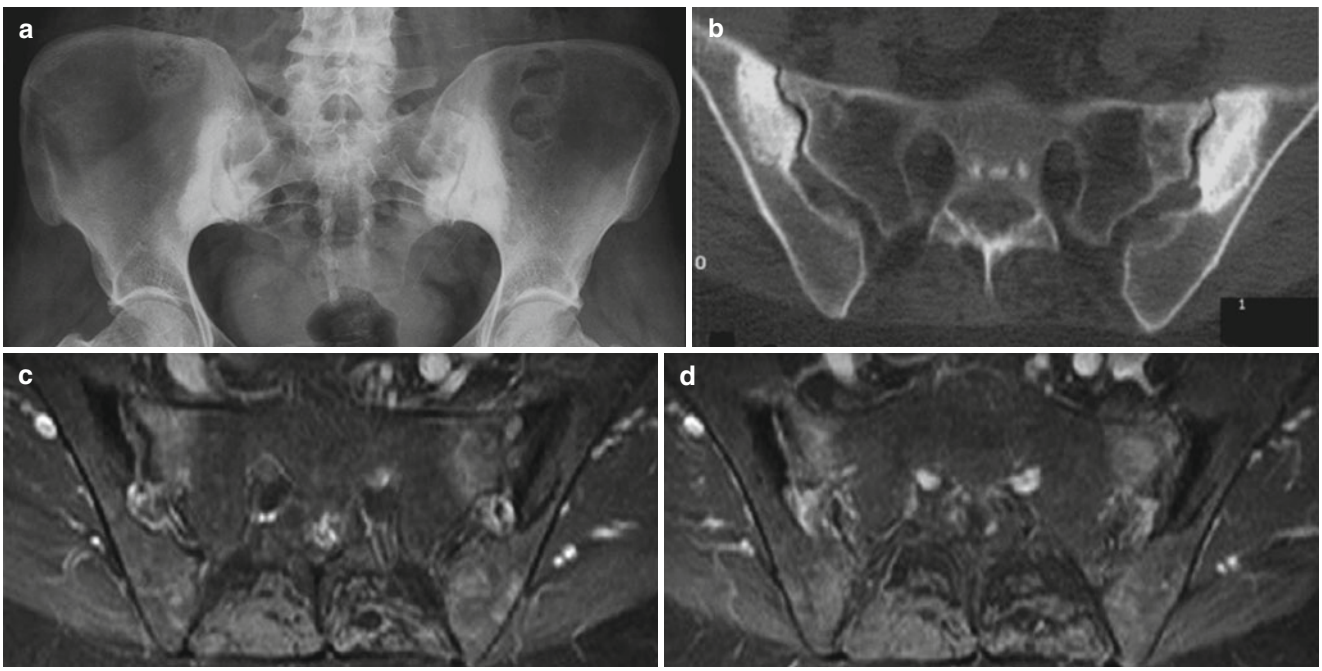


Fig. 1 Plain film radiography (**a**), axial CT scan (**b**), axial contrast-enhanced T1-weighted images with fat saturation (**c, d**). Bilateral osteosclerosis of the sacroiliac joints (**a**). Axial CT scan (**b**) permits to better highlight the subchondral osteosclerosis that is more marked on the iliac sides. MRI shows contrast enhancement on the subchondral sacral sides of the joints (**c**, **d**), indicating the active inflammatory phase of sacroiliitis

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_42, © Springer International Publishing Switzerland 2014

Ankylosing Spondylitis

Case 39

Ankylosis of the Sacroiliac Joints

- A 55-year-old patient
- Patient with ankylosing spondylitis
- Ankylosing process of the sacroiliac joints

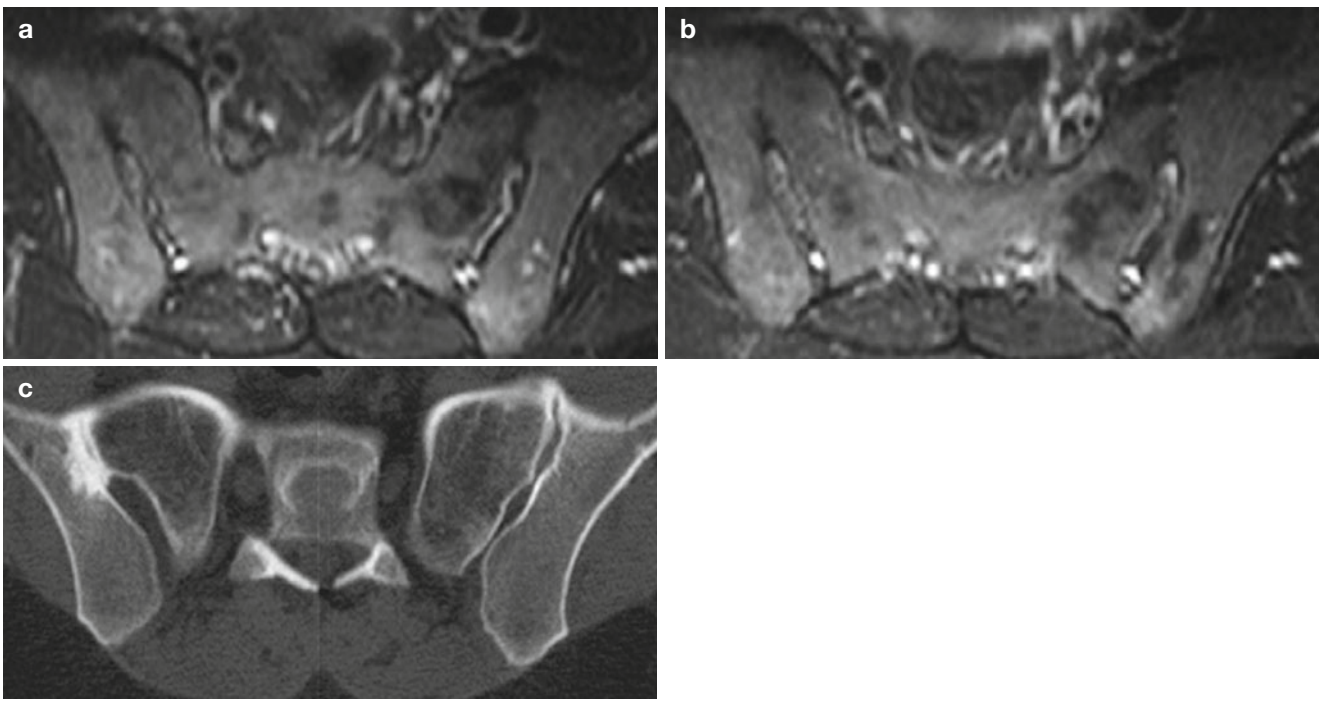


Fig. 1 Axial SE T1-weighted images with fat saturation following the administration of contrast medium (**a**, **b**), axial CT image (**c**). Chronic changes of sacroiliitis. Subchondral sclerosis is seen as areas of low signal; no enhancement is seen after the administration of contrast medium (**a**, **b**). The ankylosing process is more clearly identified by CT (**c**)

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_43, © Springer International Publishing Switzerland 2014

Psoriatic Arthritis

Enthesitis

Case **40**

- A 22-year-old patient
- Acute low back pain
- Limitation of motion of the spine
- Presence of HLA-B27

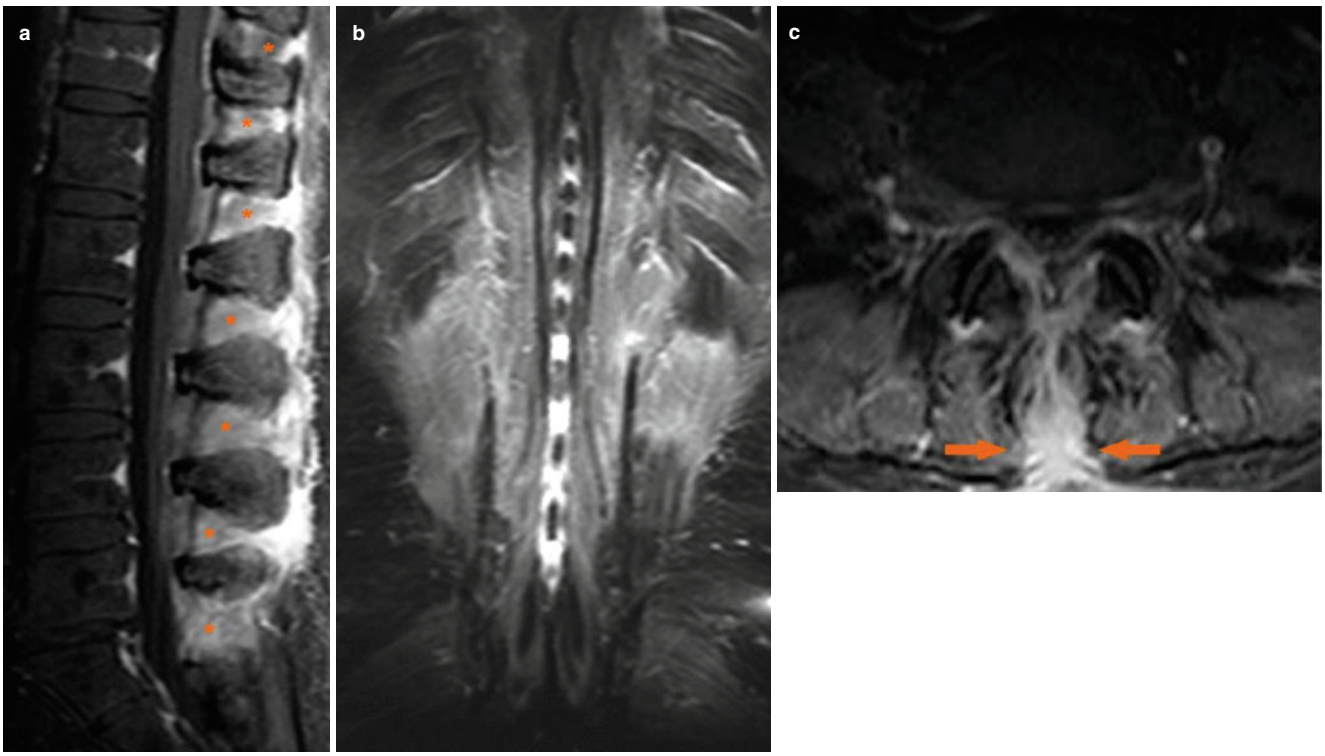


Fig. 1 Sagittal (**a**), coronal (**b**), and axial (**c**) SE T1-weighted images with fat saturation following the administration of contrast medium. Images showing marked enhancement of the interspinous and supraspinous ligaments (**a–c**, *asterisks* and *arrows*), signs of acute inflammation

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_44, © Springer International Publishing Switzerland 2014

Psoriatic Arthritis

Enthesitis

Case **41**

- A 31-year-old patient
- Low back pain
- Limitation of motion of the spine in the frontal and lateral planes
- Presence of HLA-B27

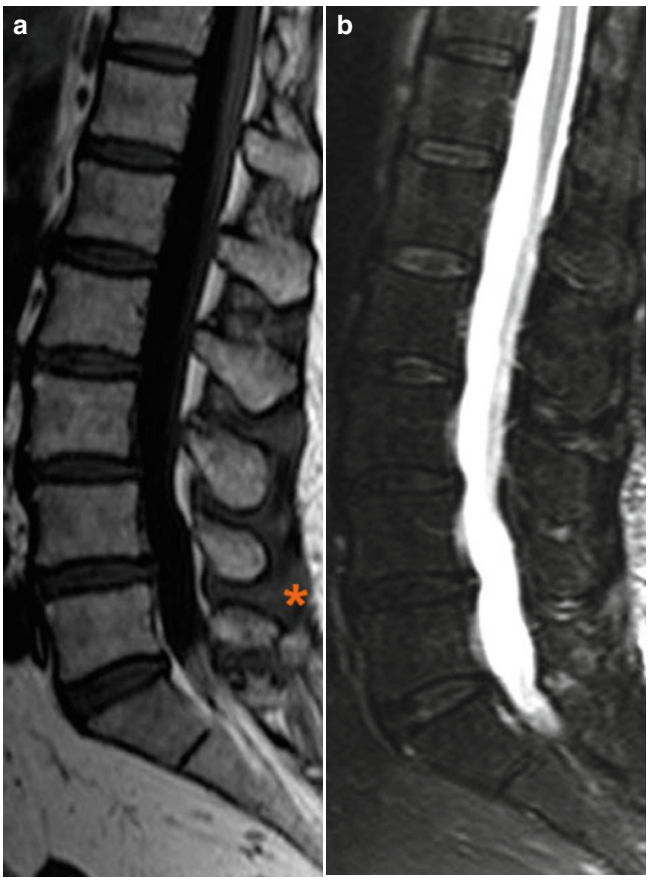


Fig. 1 Sagittal SE T1-weighted image (**a**), sagittal TSE T2-weighted image with fat saturation (**b**). High signal in T2 of the interspinous ligaments L3/L4, L4–L5 (*asterisk*), and L5/S1 (**b**)

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_45, © Springer International Publishing Switzerland 2014

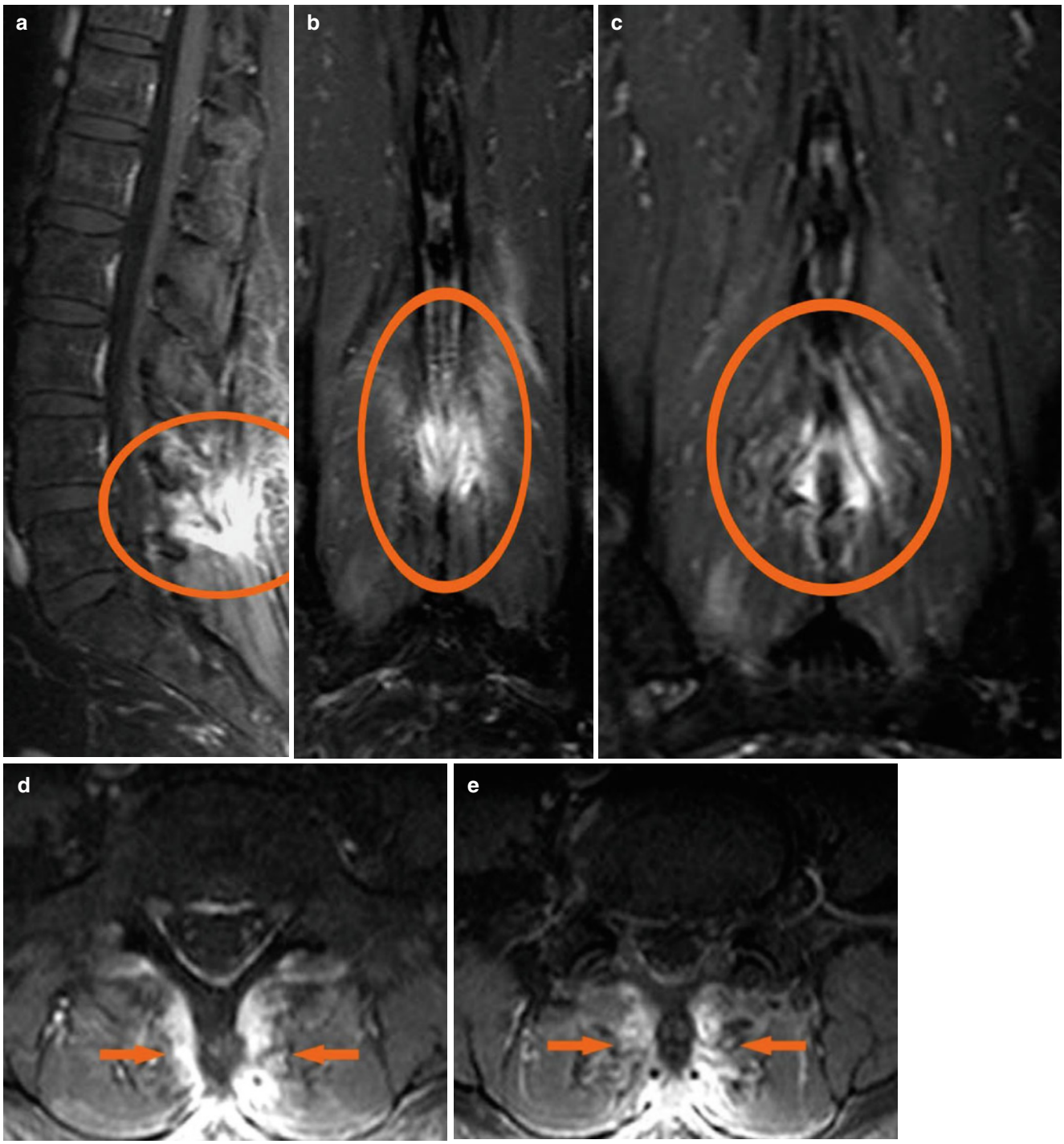


Fig. 2 Sagittal (**a**), coronal (**b–c**), and axial (**d–e**) SE T1-weighted images with fat saturation following the administration of contrast medium. These images demonstrate a marked enhancement of the interspinous and supraspinous ligaments at L4–L5 and adjacent paraspinous muscles (**a–e**, *circle* and *arrow*), indicating active inflammation of the same ligaments and muscles

Ankylosing Spondylitis

Case 42

Enthesitis

- A 25-year-old patient
- Right low back pain that worsens when sitting for a long time
- Familial history of psoriasis
- Presence of HLA-B27

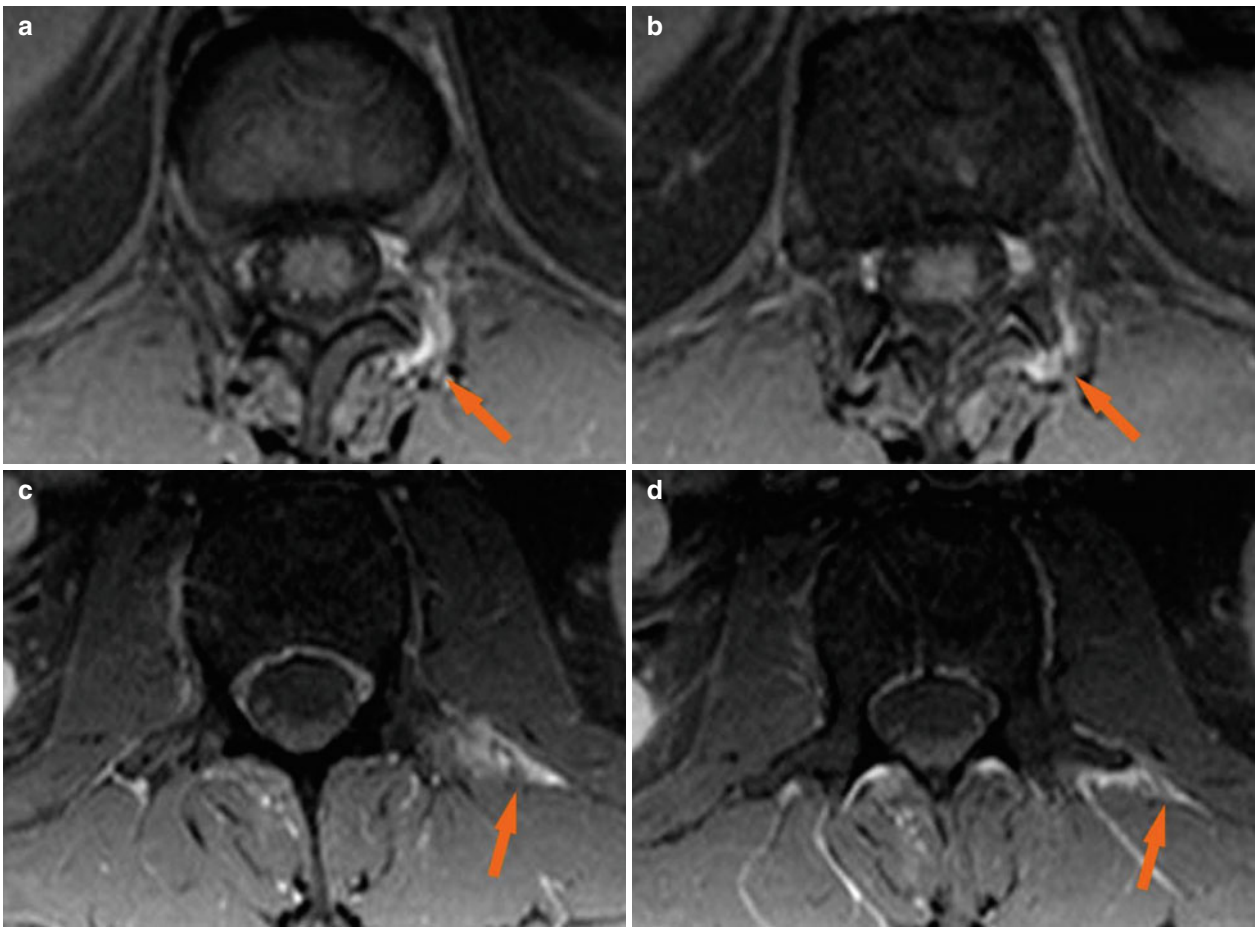


Fig. 1 Axial SE T1-weighted images with fat saturation following the administration of contrast medium (**a–d**). These images show periarticular contrast enhancement indicating active inflammation of periarticular soft tissues (**a**, **b**, *arrow*). Note also enhancement at the attachment of the left quadratus lumborum muscle, indicating enthesitis (**c**, **d**, *arrow*)

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_46, © Springer International Publishing Switzerland 2014

Ankylosing Spondylitis

Case 43

Enthesitis

- A 37-year-old patient
- Low back pain
- Limitation of motion of the spine in the frontal and lateral planes
- Familial history of spondyloarthritis

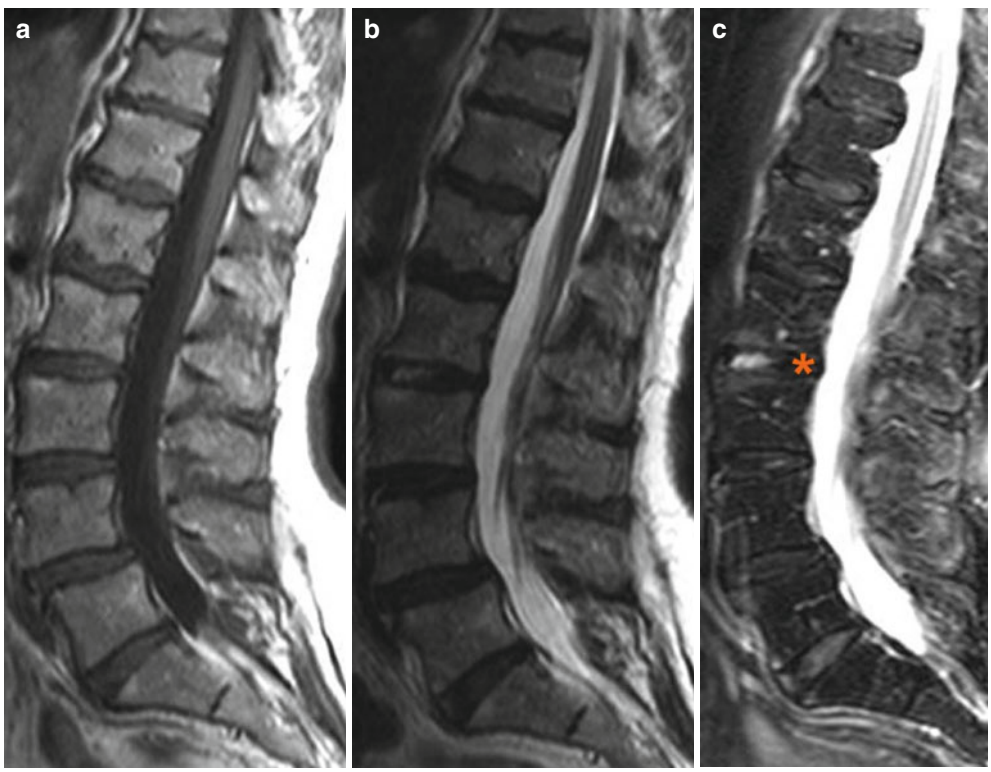


Fig. 1 Sagittal SE T1-weighted image (**a**), sagittal TSE T2-weighted image (**b**), sagittal TSE T2-weighted image with fat saturation (**c**). Small erosions of the anterior corner of L1 (**a**, **b**), with mild subchondral edema (**c**). Multiple small areas of fat infiltration of the anterior corners of the vertebral bodies (**a**, **b**). T2-weighted images with fat saturation show a mild hyperintensity of anterior corners (sign of bone marrow edema), hyperintensity in the intervertebral disc L2–L3 (*asterisk*), and diffuse hyperintensity of the spinous processes (**c**)

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_47, © Springer International Publishing Switzerland 2014

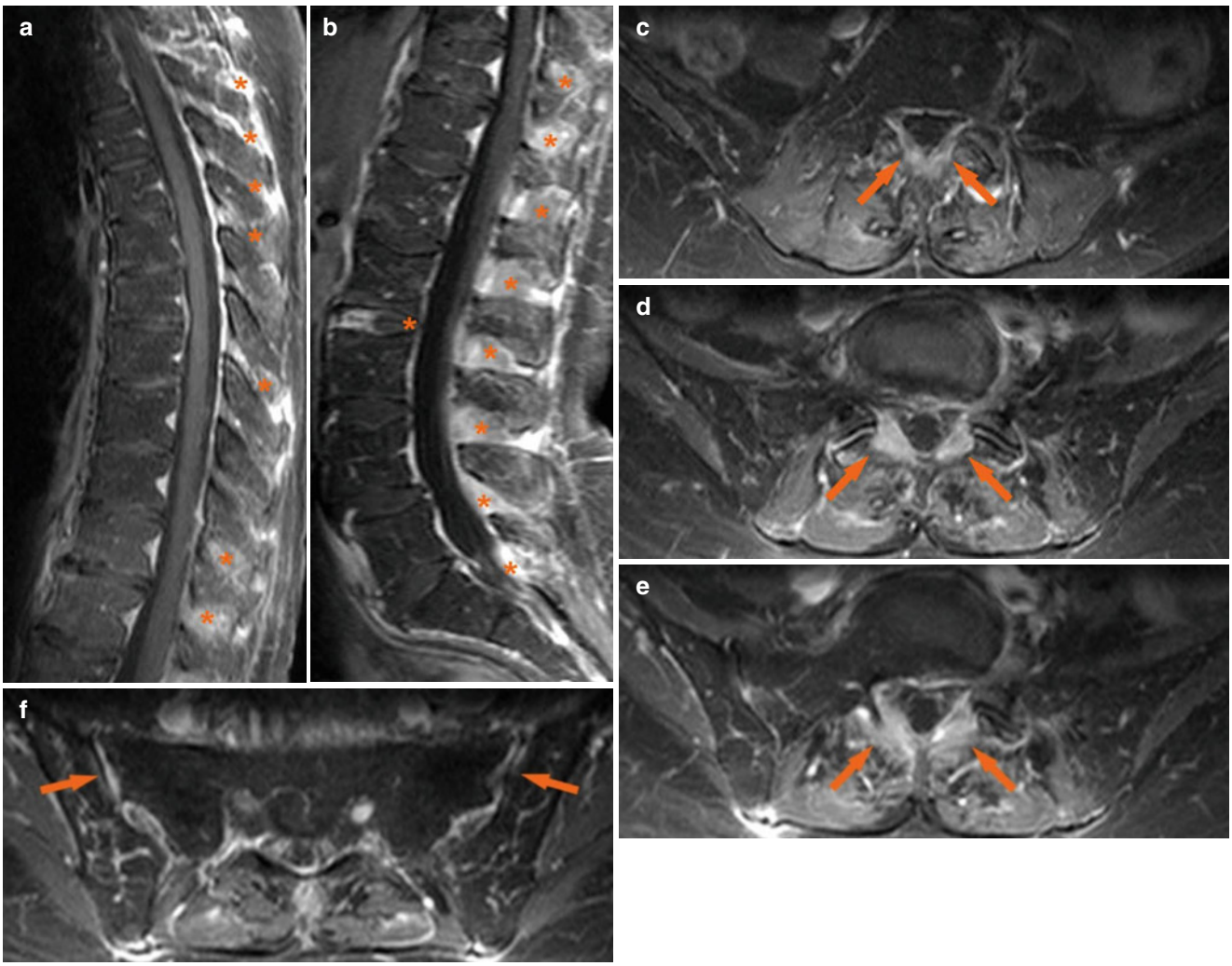


Fig. 2 Sagittal and axial SE T1-weighted images with fat saturation following the administration of contrast medium (**a-f**). These images reveal a marked enhancement of the interspinous and supraspinous ligaments of the spine (**a**–**b**, *asterisks*). The axial images show other inflammatory lesions like osteoarthritis and synovitis of facet joints (**c**–**d**), inflammation of flava ligaments (**c**–**e**, *arrows*), and bilateral sacroiliitis with synovitis and inflammation of the interosseous ligaments (**f**, *arrows*)

Case 44

Osteochondrosis Mimicking Spondylitis

- A 59-year-old woman
- Patient with chronic back pain
- No increase of the inflammatory markers

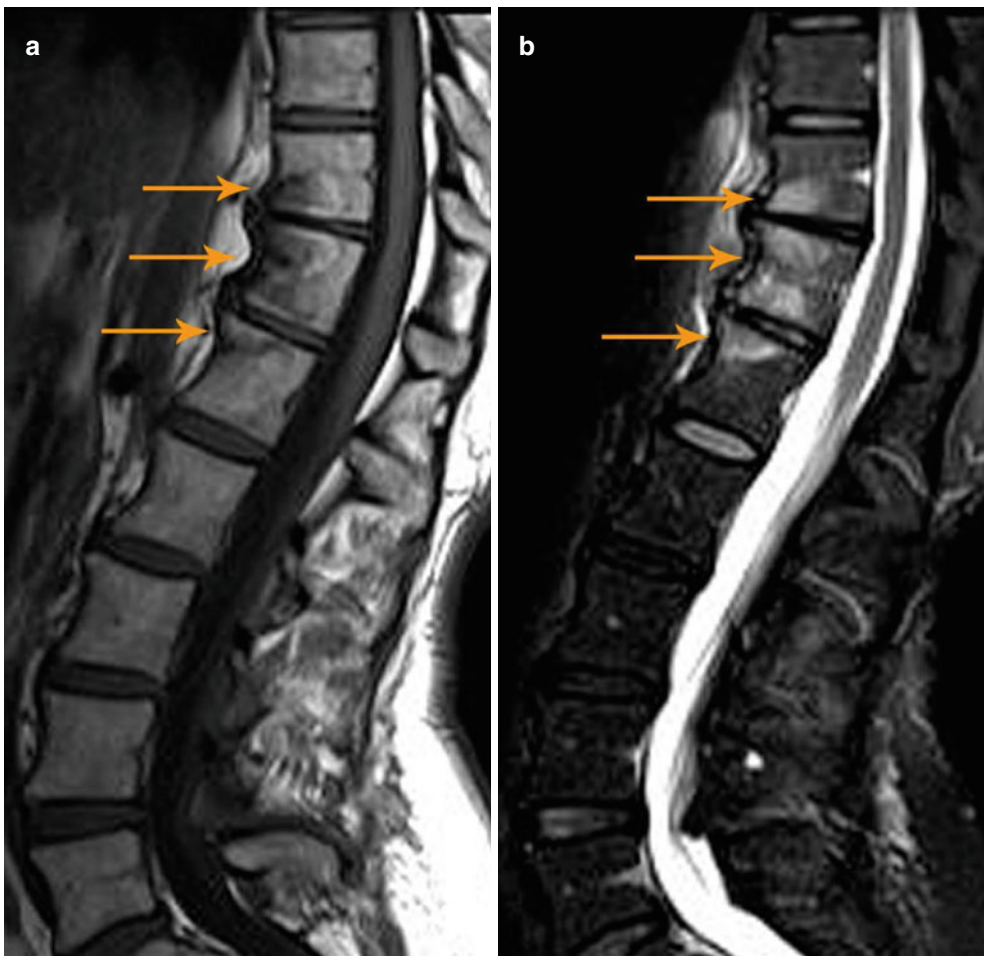


Fig. 1 Sagittal T1-weighted image (**a**), sagittal T2-weighted image with fat saturation (**b**). The opposing D11-D12-L1 vertebral bodies (*arrows*) show changes of the bone marrow in their anterior corners, with T1-hypo-/hyperintensity (**a**) and T2-hyperintensity (**b**). These findings indicate vascularized fibrous tissue, with edema, and initial fatty marrow replacement in the abovementioned areas (types 1–2 according to Modic). The pathogenesis of these lesions is not infectious but mechanical. The edematous pattern indicates a sort of "degenerative spondylitis"

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_48, © Springer International Publishing Switzerland 2014

Differential Diagnosis

Case 45

Vertebral Instability and Osteochondrosis

- A 65-year-old male
- Patient with persistent low back pain
- Limited lumbar motion
- Exacerbation of pain by extension
- There was a point tenderness at L3/L4 and L4/L5.

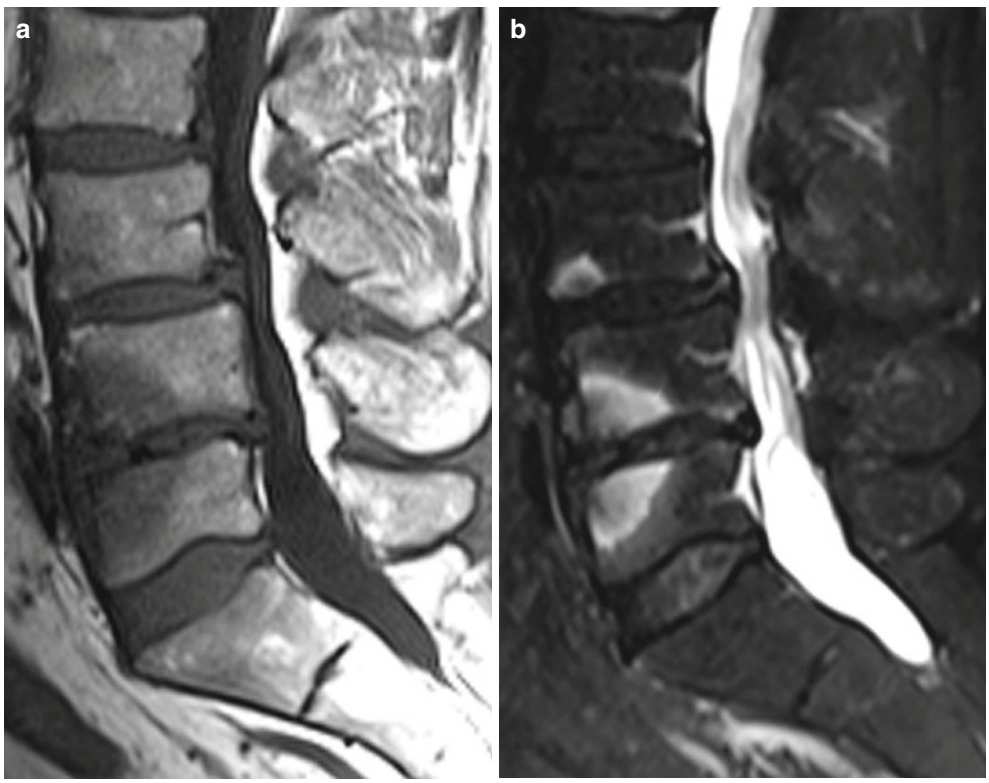


Fig. 1 Sagittal T1-weighted image (**a**) and sagittal and axial T2-weighted images with fat saturation (**b**, **c**). Anterolisthesis of L3 over L4 and retrolisthesis of L4 over L5. The opposing L3-L4-L5 vertebral bodies present signal changes in their anterior corners, indicating marked osteochondrosic degeneration, with fibrovascular transformation and edema of the bone marrow (Modic type I). These findings represent stress-related bony reactive-degenerative changes

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_49, © Springer International Publishing Switzerland 2014

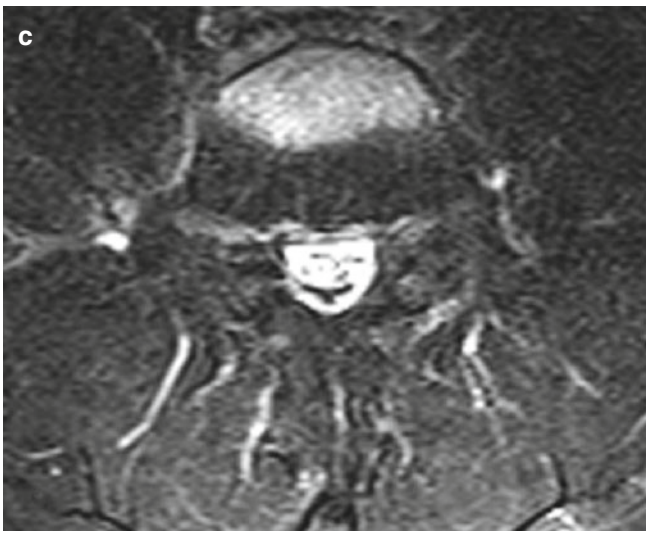


Fig. 1 (continued)

Differential Diagnosis

Case **46**

Osteochondrosis

- Patient with persistent low back pain
- Limited lumbar motion
- Exacerbation of pain by extension/flexion

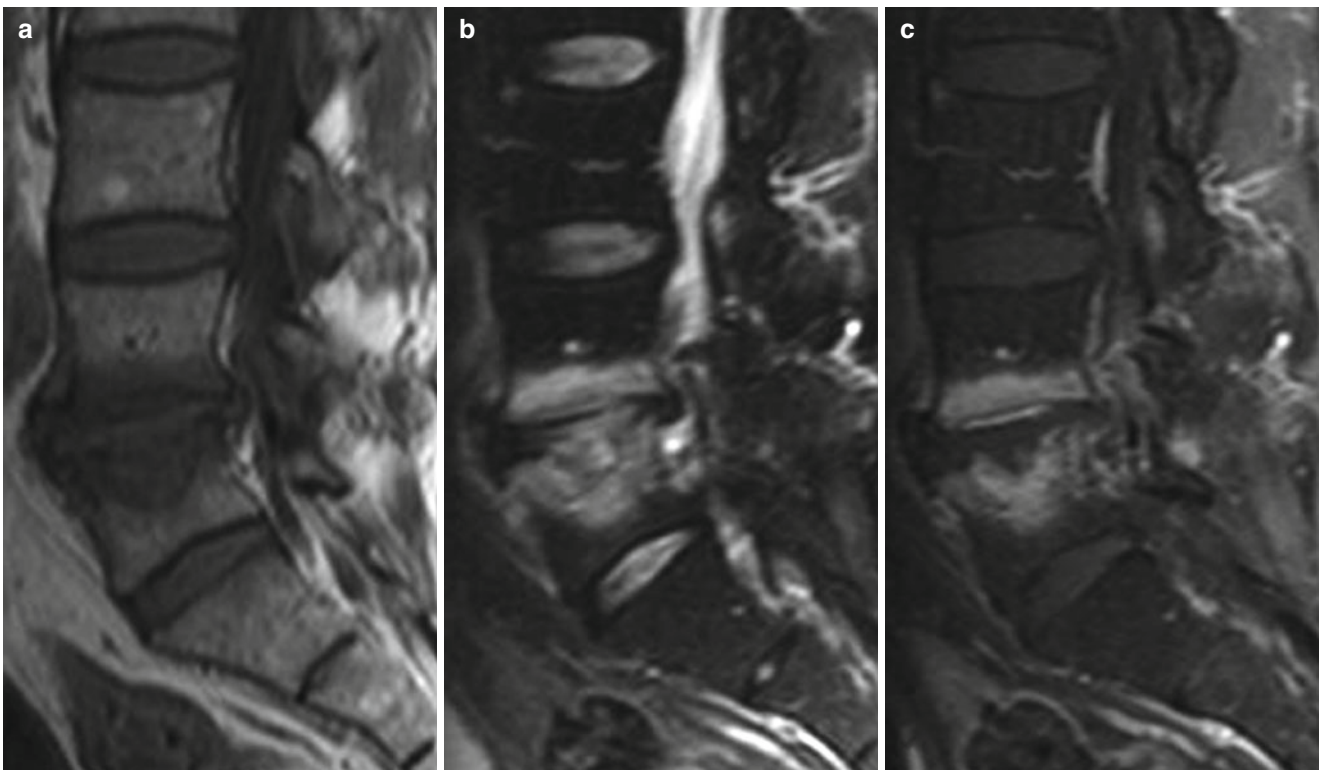


Fig. 1 Sagittal SE T1-weighted image (**a**), sagittal T2-weighted image with fat saturation (**b**), sagittal and axial T1-weighted images with fat saturation following the administration of contrast medium (**c, d**), axial CT scan (**e**). Edematous pattern with contrast enhancement in the subchondral bone marrow of adjacent vertebral bodies L4/L5 (**a–d**). See disc herniation into the subchondral spongiosa of L5. See also erosion-like contour irregularities of the superior endplate at the same level (**e**). Diagnosis: degenerative disc disease in fibrovascular stage (Modic type I) at L4/L5. Contrast enhancement of the chondral surface and subchondral bone indicates the active inflammatory stage of the degenerative process and its extension. Erosion-like contour irregularities of the endplate of L5 result from an increased fragility of the compact bone of the endplate with subsequent subchondral absorption processes and disc herniation into the adjacent spongiosa

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_50, © Springer International Publishing Switzerland 2014

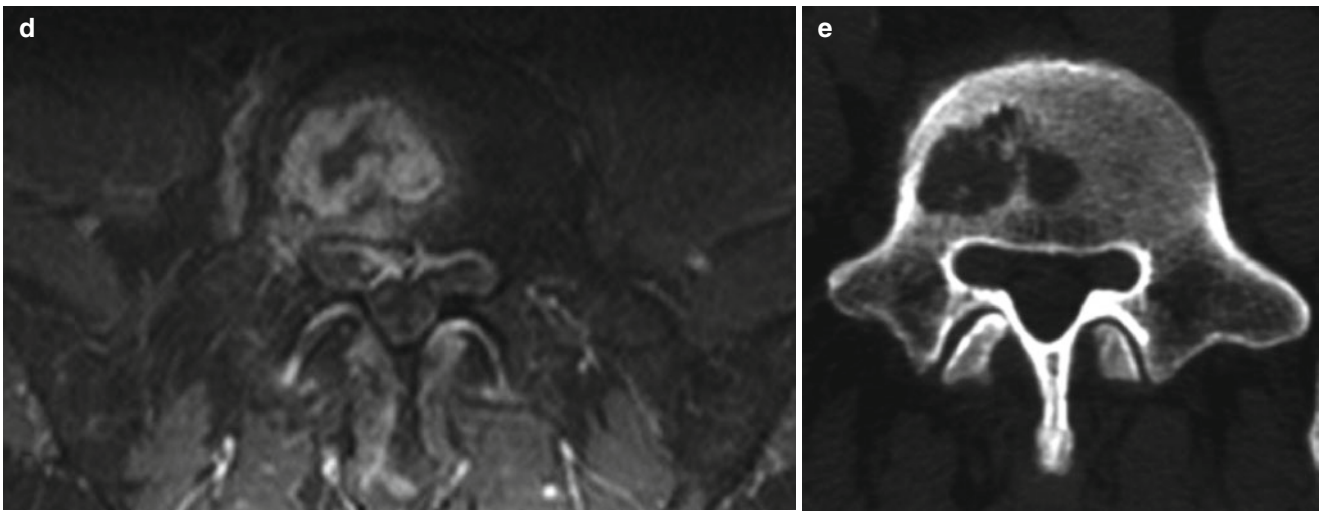


Fig. 1 (continued)

Differential Diagnosis

Case 47

Osteochondritis

- A 60-year-old female
- Persistent low back pain on the right side
- There was a point tenderness at L2/L3.

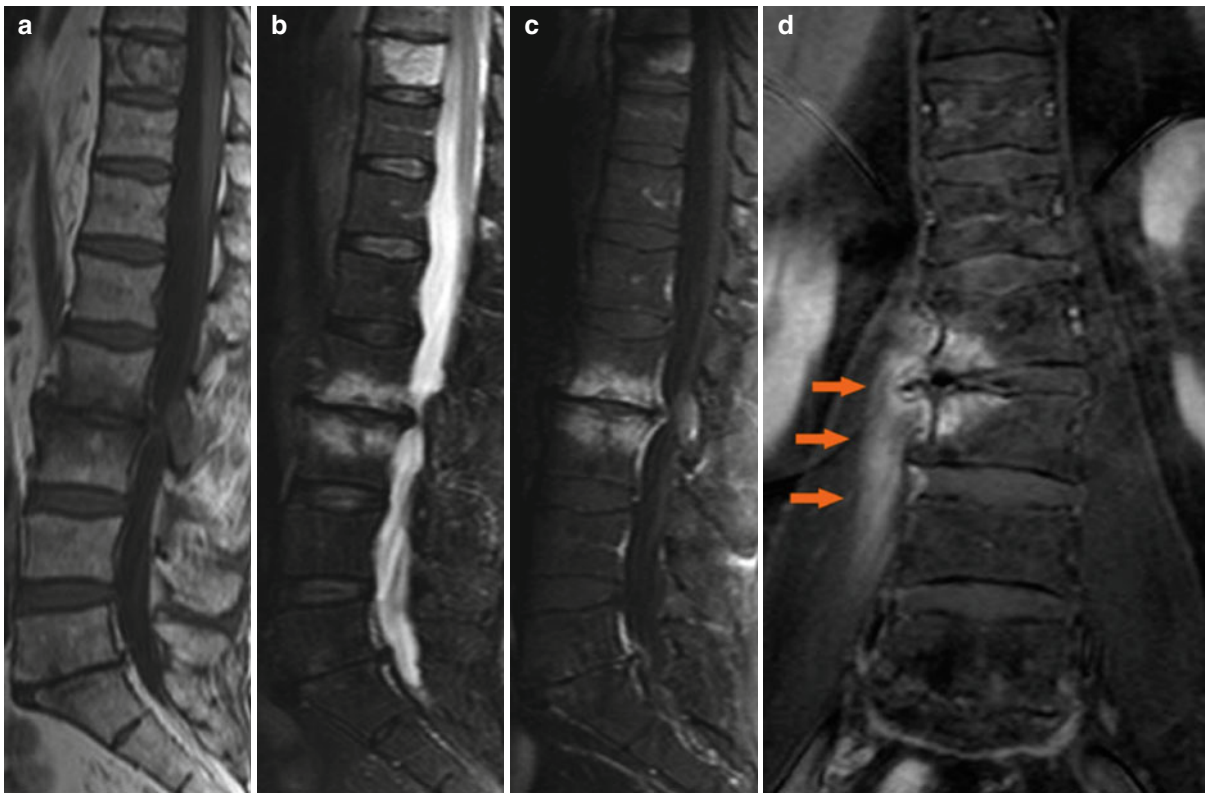
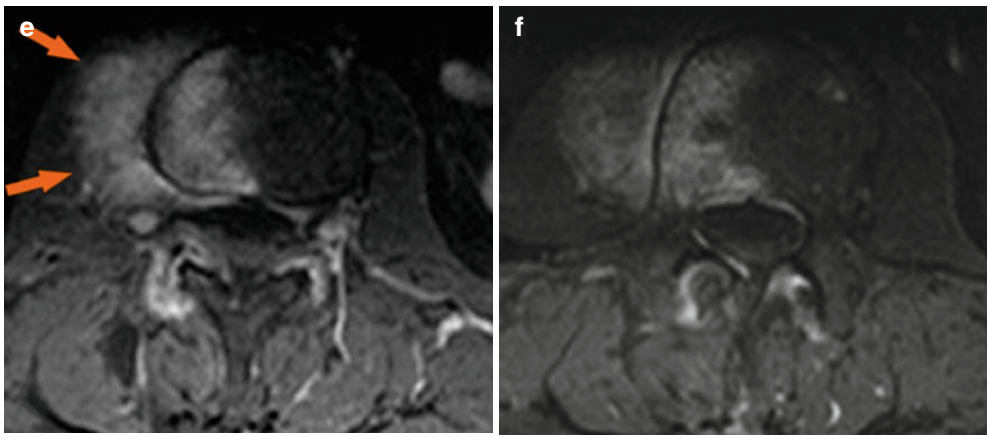


Fig. 1 Sagittal SE T1-weighted image (**a**), sagittal TSE T2-weighted image with fat saturation (**b**), sagittal, coronal, and axial contrast-enhanced SE T1-weighted images with fat saturation (**c–f**). The opposing vertebral bodies L2/L3 present signal changes on the right side, hypointense in T1 and hyperintense in T2 (i.e., edematous pattern, **a**, **b**), with enhancement after the administration of contrast medium (**c–f**). Note also contrast enhancement of the peridiscal soft tissues at the same level L2/L3 on the right side; in particular, note enhancement of the right iliopsoas muscle (**d–f**, *arrows*). Scoliosis of the lumbar spine. Vertebral body hemangioma at T10. This patient had no other clinical or radiological sign of arthropathy. The only spinal lesion of the patient is clearly localized at the point of maximum load of the scoliotic spine. Diagnosis: mechanical osteochondritis with edema-inflammation of the bone marrow and peridiscal soft tissue, including the adjacent muscular fibers

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_51, © Springer International Publishing Switzerland 2014

Fig. 1 (continued)



Differential Diagnosis

Case 48

Infectious Spondylitis

- A 45-year-old woman
- Patient with low back pain and fever
- There was a point tenderness at L5/S1.

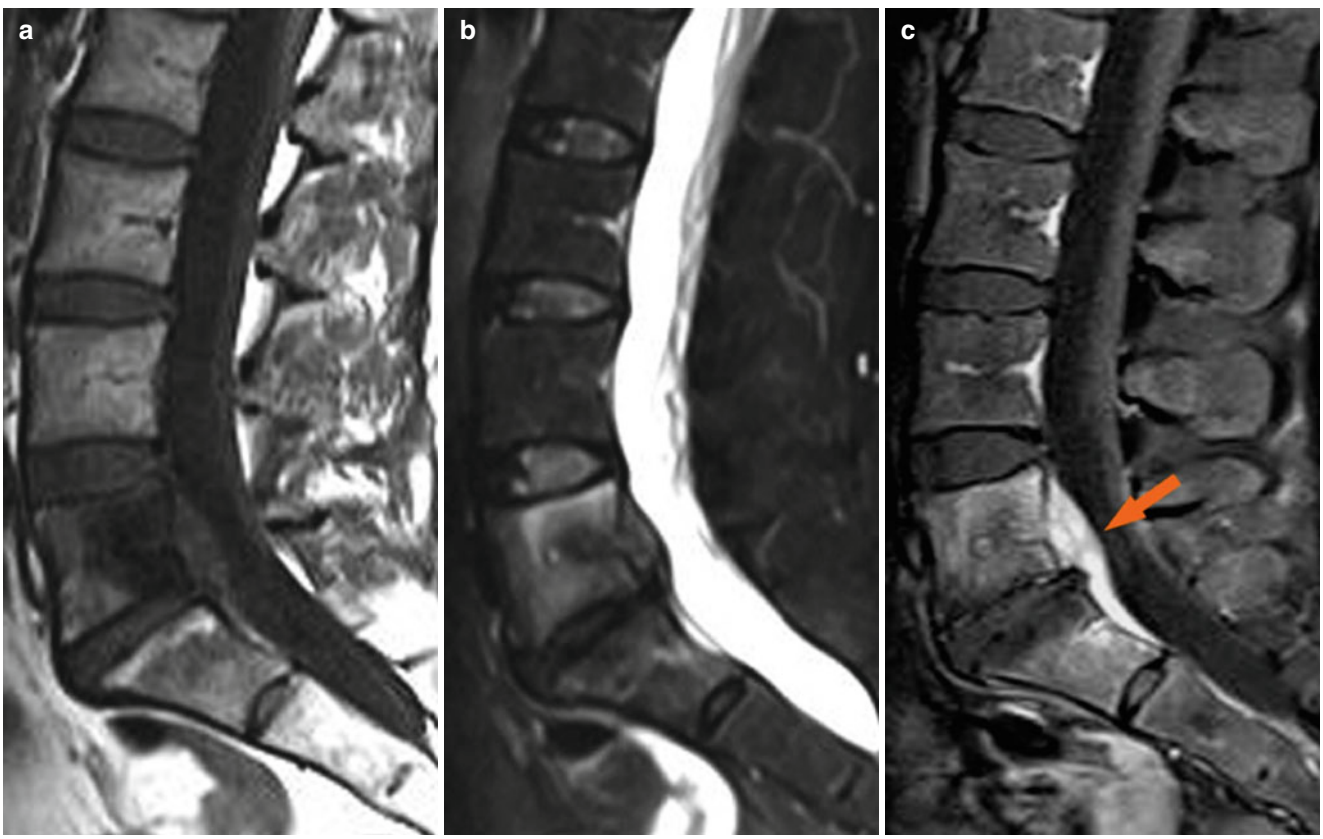


Fig. 1 Sagittal T1-weighted image (**a**), sagittal T2-weighted image with fat saturation (**b**), sagittal and axial contrast-enhanced T1-weighted images with fat saturation (**c**–**e**); CT MPR sagittal image (**f**). The vertebral bodies of L5 and S1 present signal changes, hypointense in T1 (**a**) and hyperintense in T2 (**b**), with contrast enhancement in the T1-weighted images with fat saturation (**c**–**e**), indicating infectious spondylitis. There is also infectious pathologic tissue with contrast enhancement in the anterior peridural space (**c**–**e**, *arrow* and *asterisks*). CT image shows osteosclerosis of the same vertebral bodies, more marked in L5 (**f**)

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_52, © Springer International Publishing Switzerland 2014

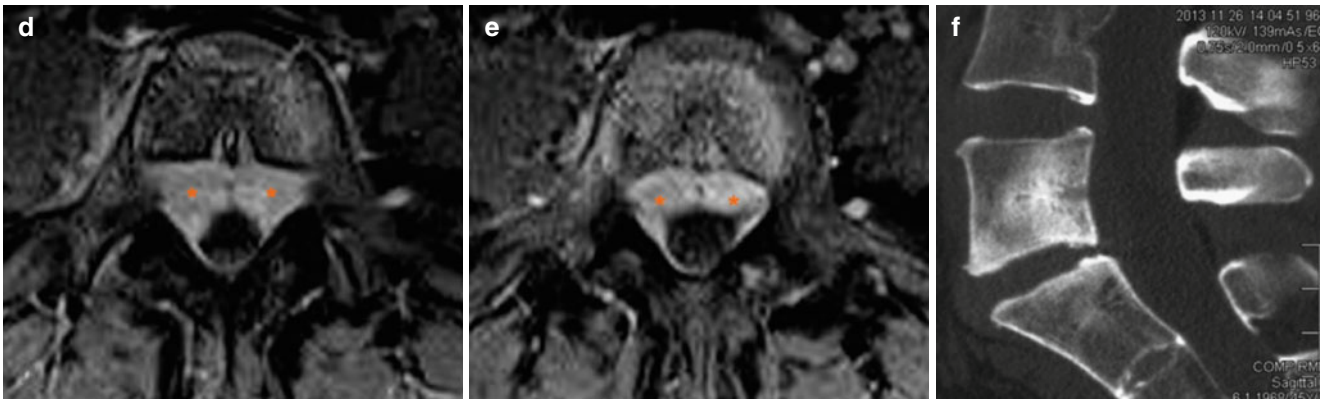


Fig. 1 (continued)

Differential Diagnosis

Case 49

Septic Sacroiliitis

- A 54-year-old woman
- Patient with painful swelling in right gluteal region
- Low back pain on the right side
- Low-grade fever

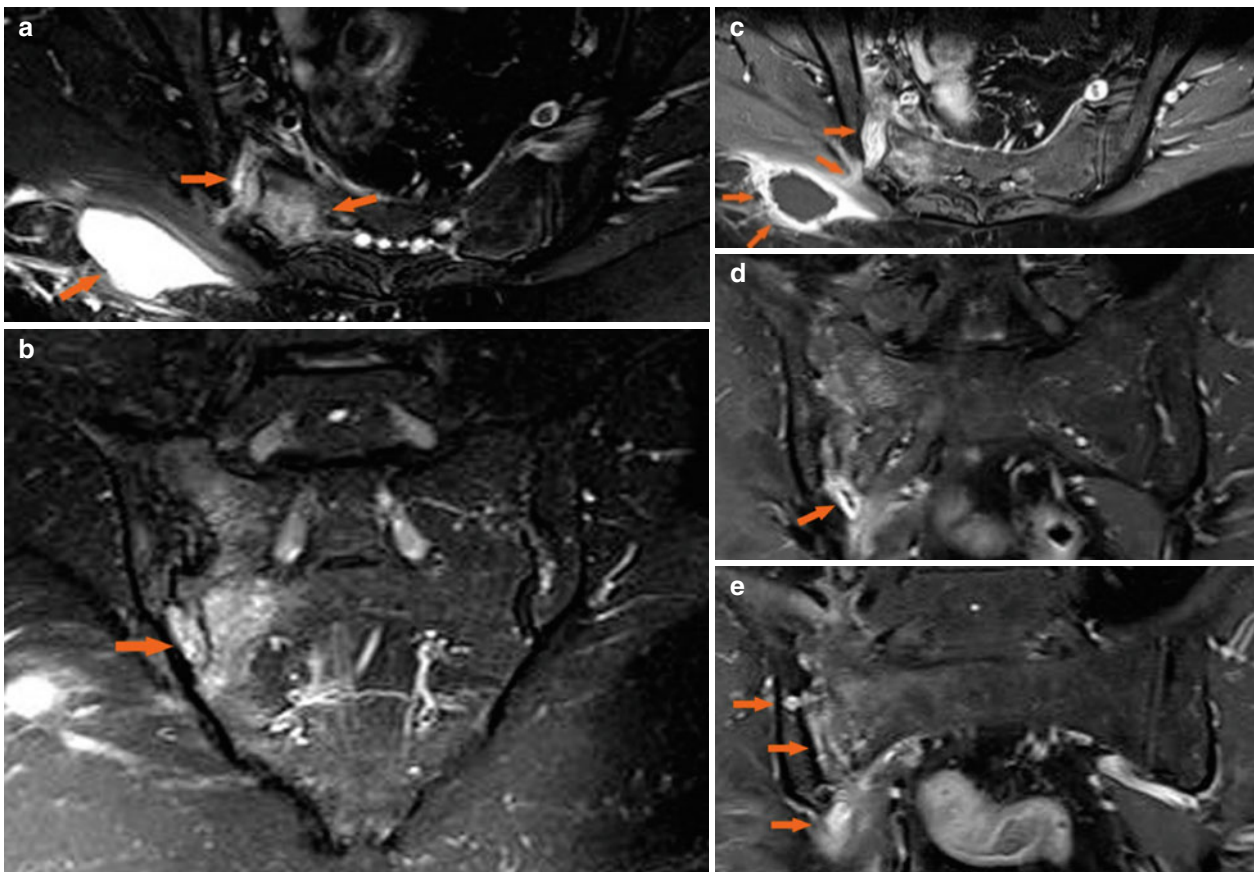


Fig. 1 Axial and coronal T2-weighted images with fat saturation (**a**–**b**), axial and coronal T1-weighted images with fat saturation after contrast medium administration (**c**–**e**). Abscess located in the deep subcutaneous and gluteus maximus muscle on the right side (**a**, **c**). The infectious process spreads, through the gluteus muscle, to the sacroiliac joint. Note edema-osteitis of the sacral bone, intra-articular microabscesses, and erosions of the articular surfaces

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_53, © Springer International Publishing Switzerland 2014

Differential Diagnosis

Case 50

Bone Fracture

- A 63-year-old woman
- Patient with low back pain during deambulation and mobilization of the pelvis
- Trauma, with fall to the ground, 2 weeks before MR examination

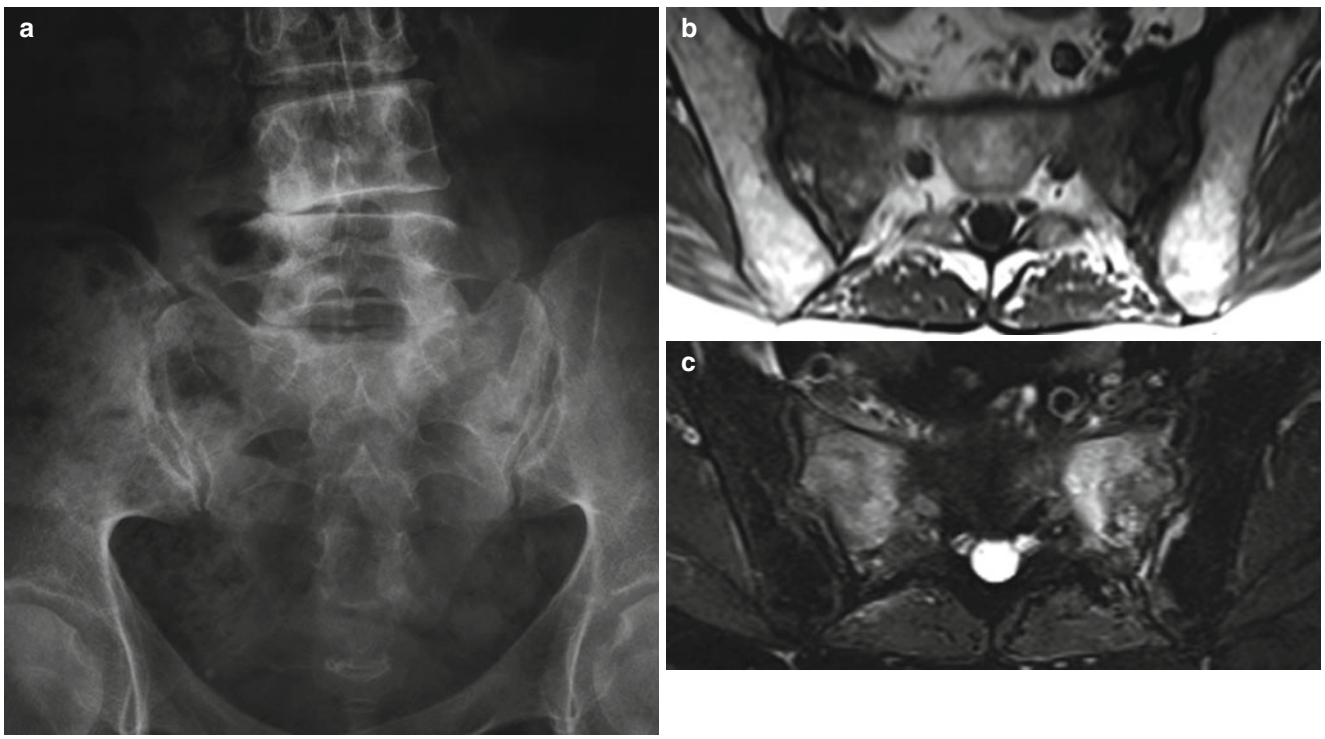


Fig. 1 X-ray of the pelvis (**a**), axial T1-weighted image (**b**), axial T2-weighted image with fat saturation (**c**), axial and coronal T1-weighted images with fat saturation after contrast medium administration (**d**, **e**), axial CT scans (**f–g**). X-ray examination does not show significant alterations (**a**). The wings of the sacrum present a widespread alteration of signal, hypointense in T1 (**b**) and hyperintense in T2 (**c**), with marked contrast enhancement (**d**, **e**); these findings are to be referred to posttraumatic bone marrow edema. CT scans clearly reveal multiple bone fractures of the sacrum (**f–g**, *arrow*)

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_54, © Springer International Publishing Switzerland 2014

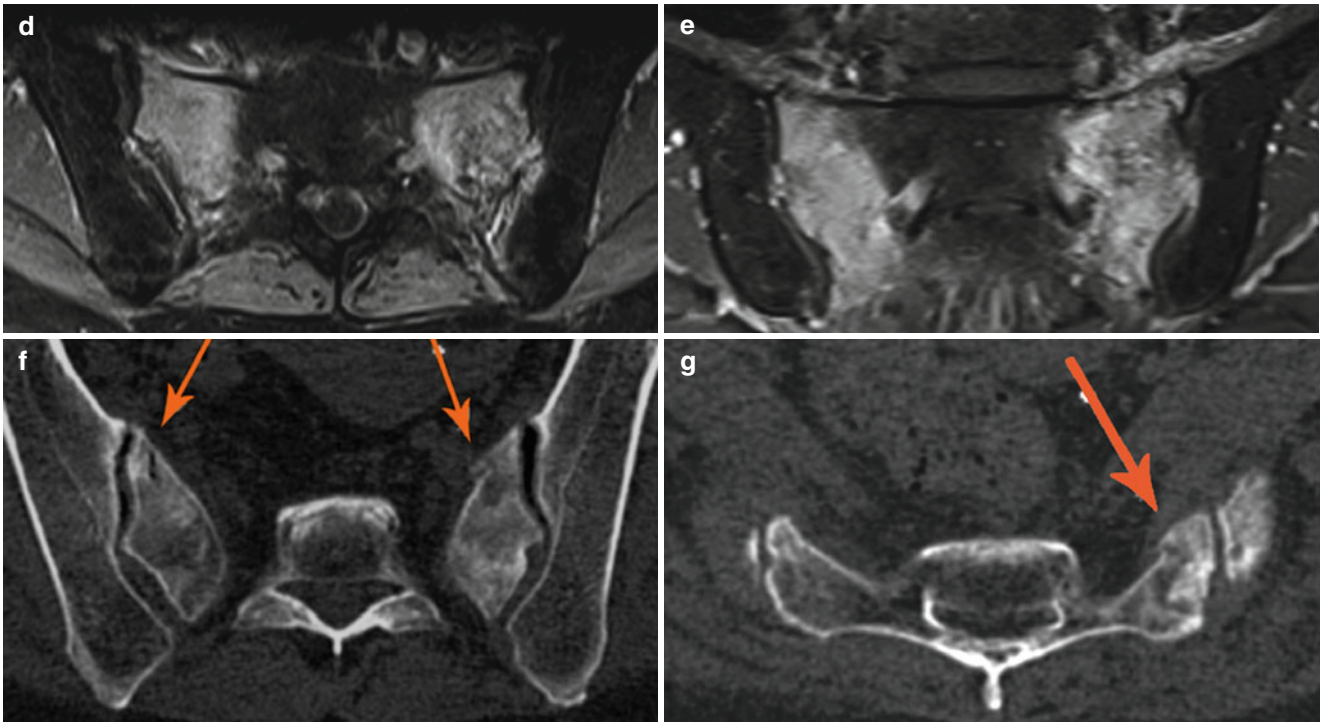


Fig. 1 (continued)

Differential Diagnosis

Case 51

Bone Fracture

- A 75-year-old female
- Patient with left low back pain during deambulation and mobilization of the pelvis
- Trauma, with fall to the ground, 15 days before MRI

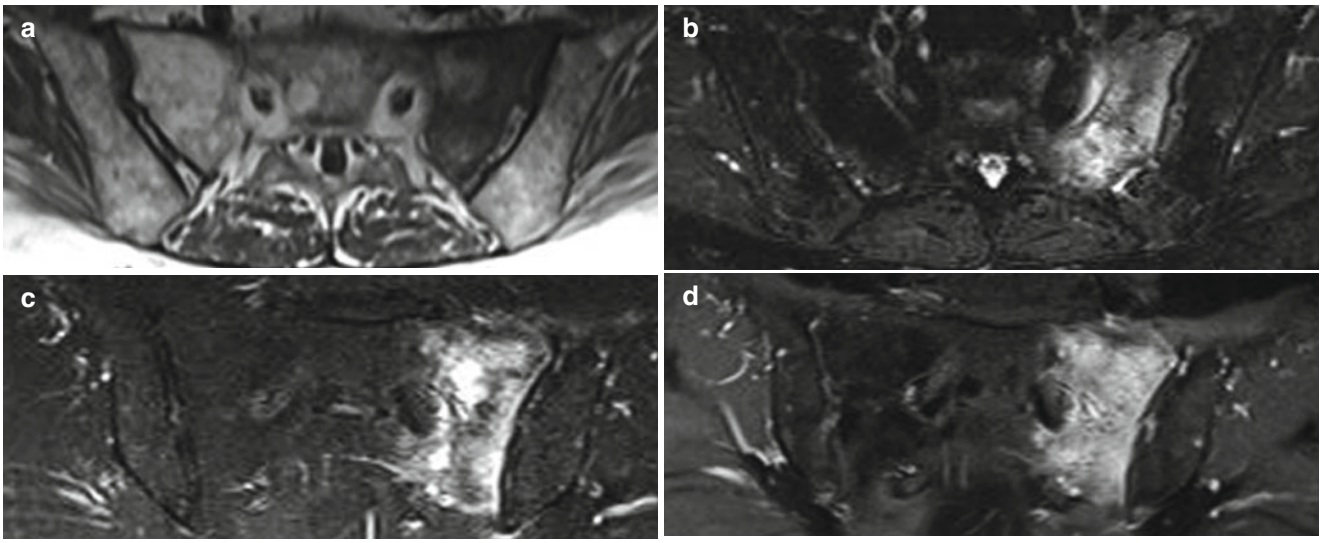


Fig. 1 Axial T1-weighted image (**a**), axial T2-weighted image with fat saturation (**b**), coronal T1-weighted images with fat saturation after contrast medium administration (**c**,**d**). The left sacral wing presents a wide area of altered signal, hypointense in T1 and hyperintense in T2, with marked contrast enhancement, indicating posttraumatic intracancellous edema. Note thin fracture lines, more evident in (**b** and **c**)

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_55, © Springer International Publishing Switzerland 2014

Differential Diagnosis

Case 52

Osteoid Osteoma

- A 20-year-old male
- Patient with chronic right back pain
- Pain relief following salicylate administration

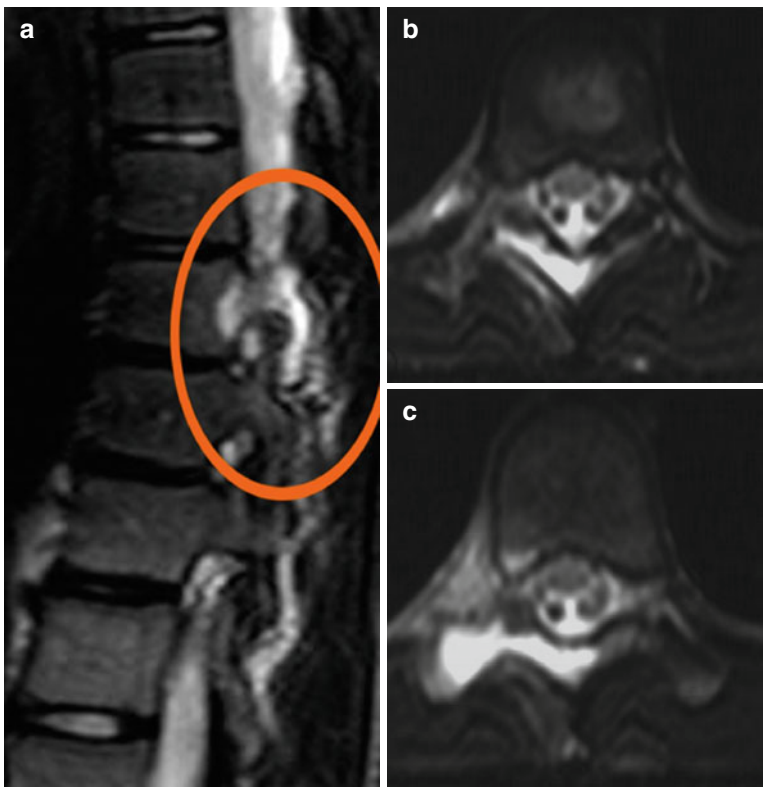
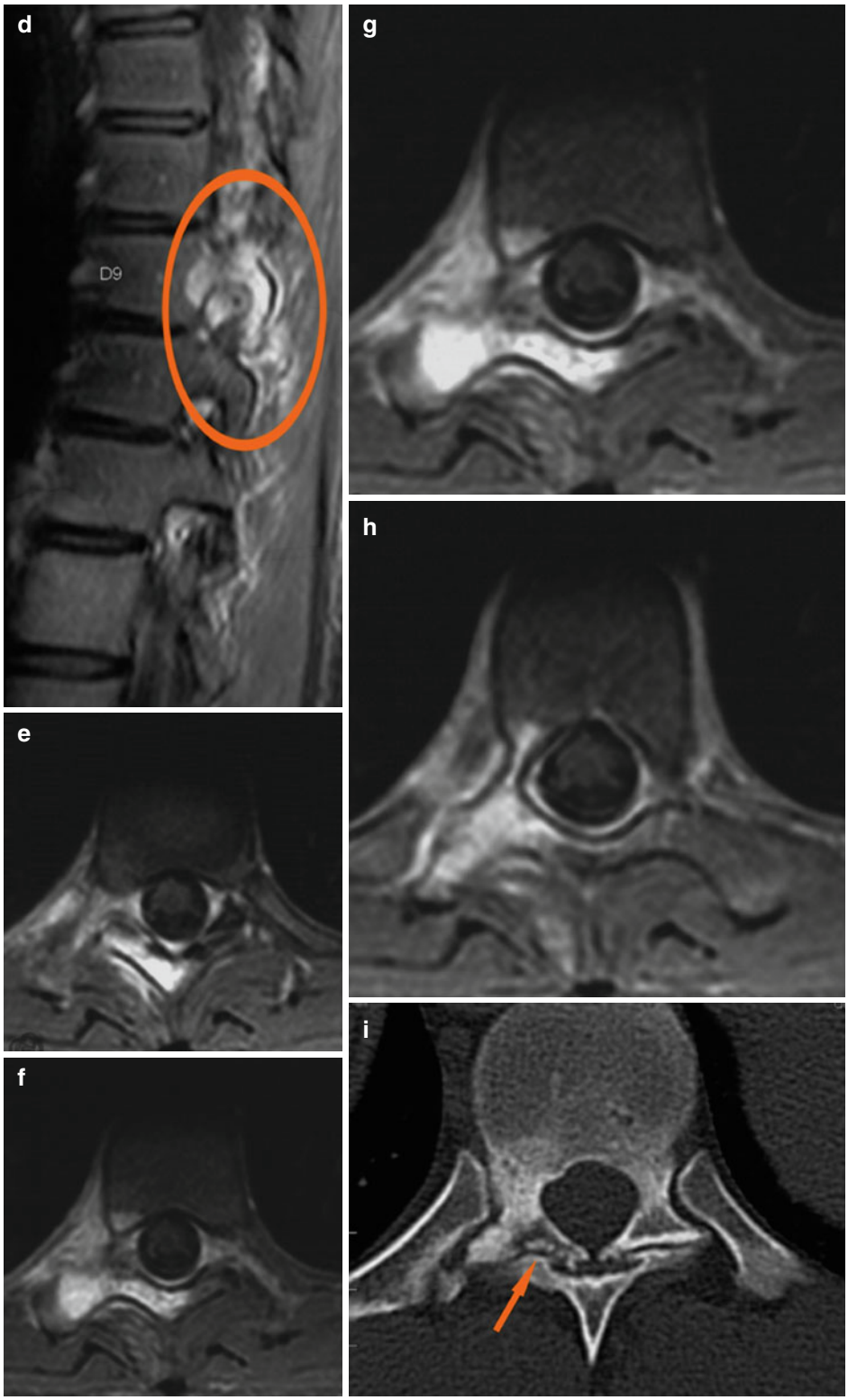


Fig. 1 Sagittal and axial T2-weighted images with fat saturation (**a**–**c**) and sagittal and axial T1-weighted images with fat saturation following the administration of contrast medium (**d**–**h**). CT scan (**i**). Bone scintigraphy (**j**). MRI shows a lesion with marked edema (**a**–**c**, *circle*) and contrast enhancement (**d**–**h**, *circle*) in the right posterior neural arch of D9. CT scan typically shows a lytic lesion of the right lamina of D9, surrounded by sclerosis of the same lamina and pedicle (**i**, *arrow*). Bone scintigraphy detects uptake of the lesion (**j**). Diagnosis: osteoid osteoma

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_56, © Springer International Publishing Switzerland 2014

Fig. 1 (continued)



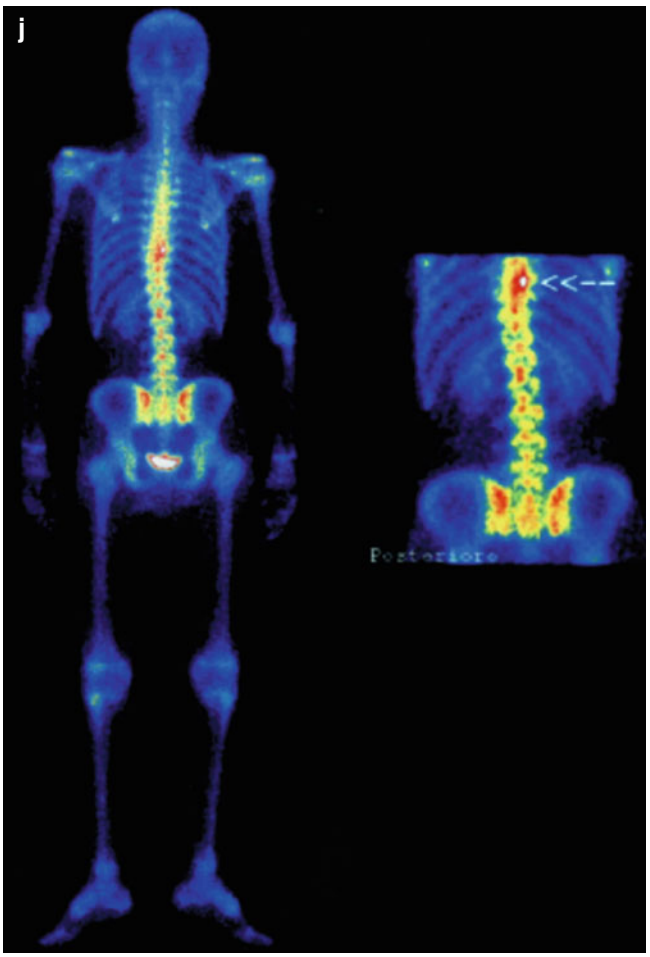


Fig. 1 (continued)

Differential Diagnosis

Case 53

Spondyloarthritis and Metastasis

- A 57-year-old male
- Patient with undifferentiated spondyloarthritis
- Chronic low back pain

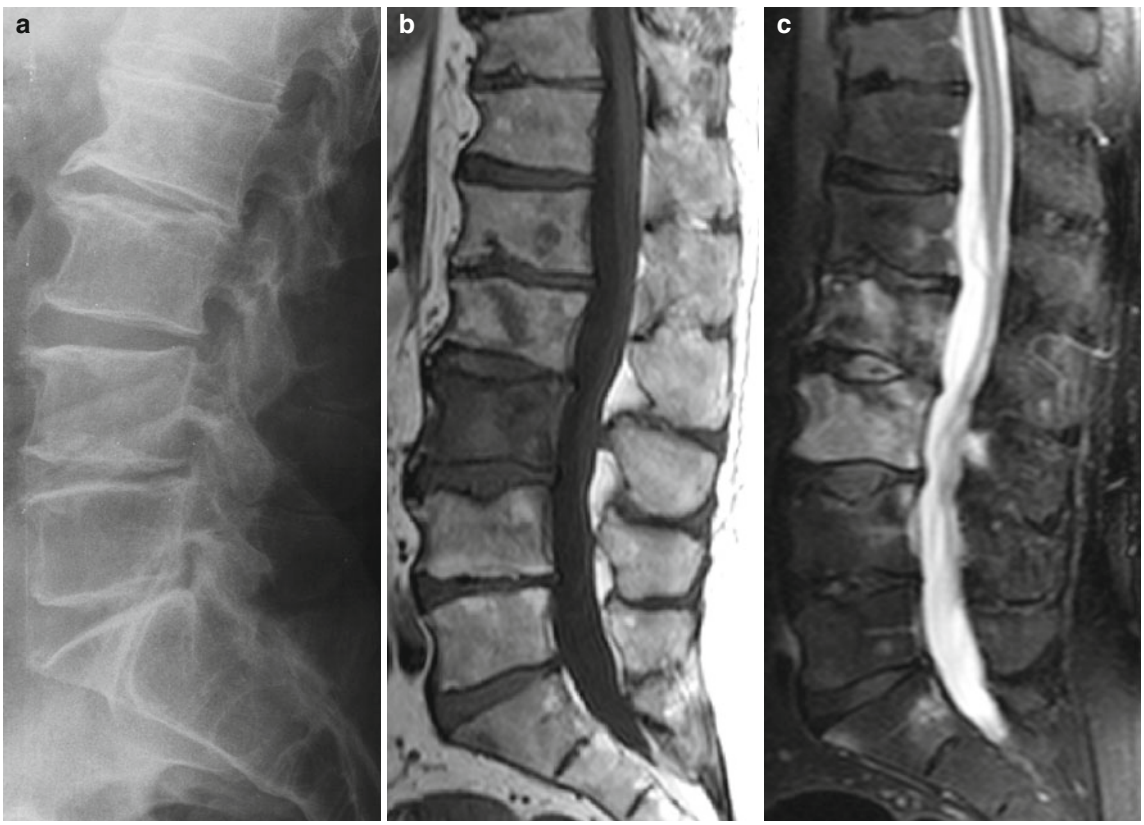


Fig. 1 Lumbar X-ray (**a**), sagittal T1-weighted image (**b**), sagittal T2-weighted image with fat saturation (**c**), sagittal and axial T1-weighted images with fat saturation following the administration of contrast medium (**d**–**f**). X-ray image shows only osteoarthrosis of the lumbar spine (**a**). MRI reveals multiple areas of spondylitis, with contrast enhancement, in the dorsal and lumbar spine (**d**–**e**, *arrows*). Note also a more extended lesion with contrast enhancement at the level of L3, interesting both the vertebral body and posterior arch, with perisomatic extension (**f**). The particular pattern of this lesion suggested the hypothesis of metastasis, which was subsequently confirmed by biopsy of the same lesion (primary source was a renal cell carcinoma)

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_57, © Springer International Publishing Switzerland 2014

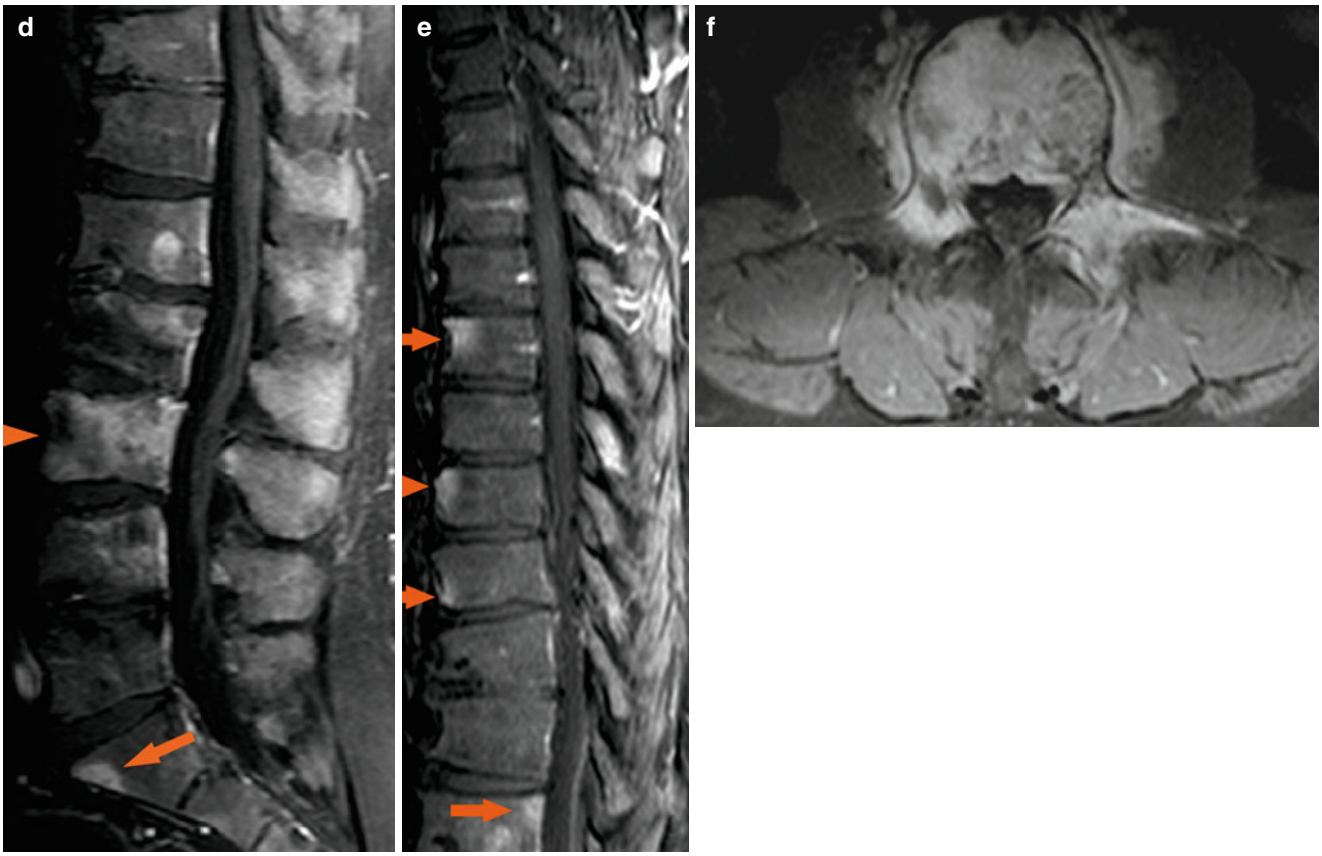


Fig. 1 (continued)

MRI of the brain after 2 months

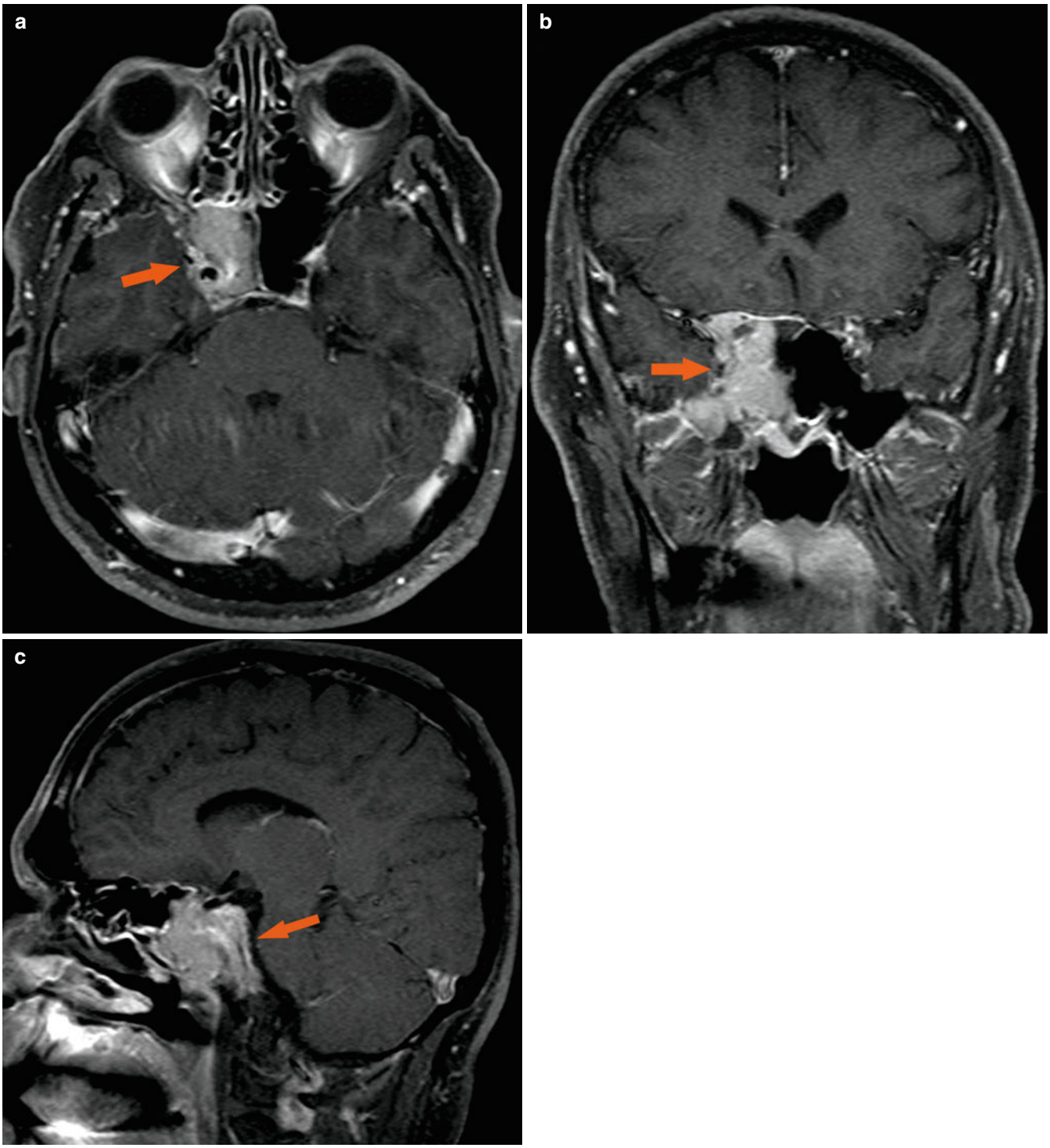


Fig. 2 Axial, coronal, and sagittal T1-weighted images with fat saturation following the administration of contrast medium (**a**–**c**). Two months after the first MRI examination, the same patient presented multiple right-side cranial nerve palsies. MRI showed a large skull base metastasis infiltrating the sphenoid, clivus, and cavernous sinus on the right side (**a**–**c**, *arrow*)

Part III

Spondyloarthritis: Clinical Cases – Post-Therapy Follow-up

Psoriatic Arthritis

Spondylitis and Sacroiliitis

Case **54**

- A 20-year-old patient
- Dorsal and lumbar pain that worsens during the night
- Sacroiliac tenderness with pain during lateral pelvic compression

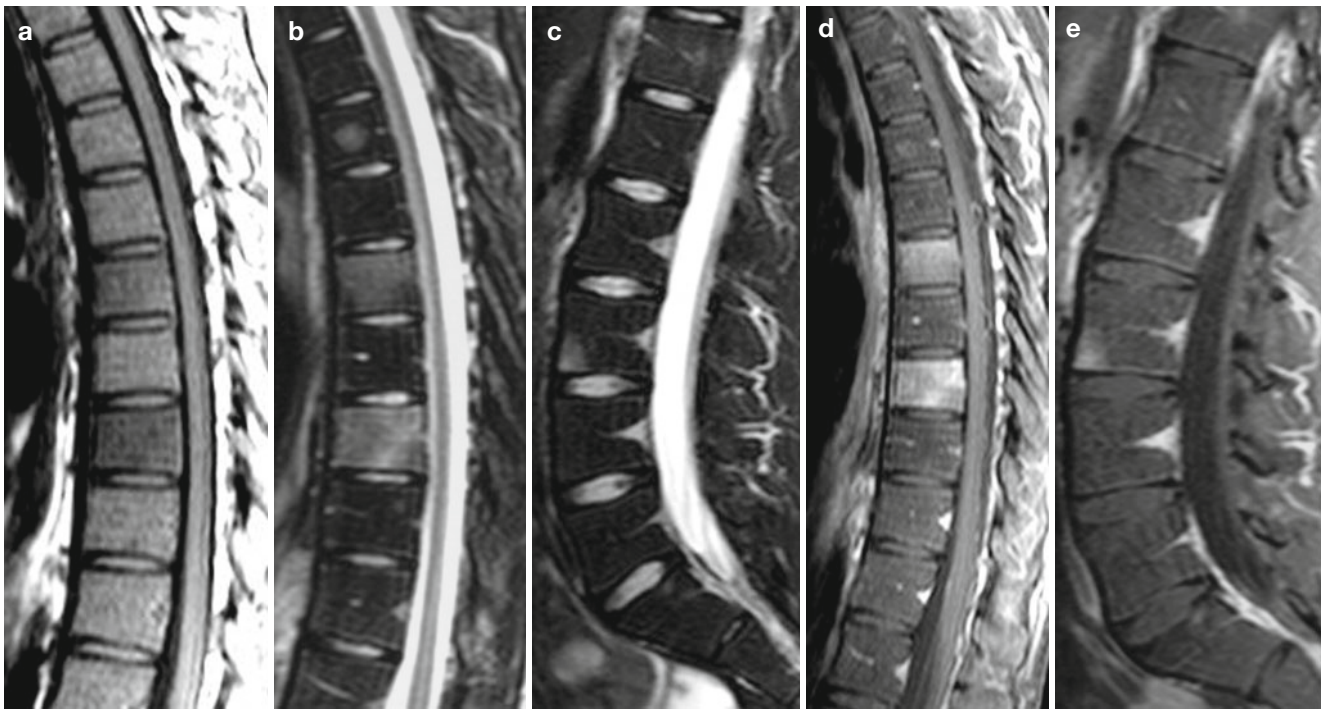


Fig. 1 Sagittal TSE T1-weighted image (**a**), sagittal TSE T2-weighted images with fat saturation (**b–c**), sagittal SE T1-weighted images with fat saturation following the administration of contrast medium (**d–e**). These images show low signal (**a**) and increased signal (**b**) of T5 and T7 vertebral bodies and anterior corner of L3 (**c**), indicating edema of the bone marrow; after contrast medium administration, note enhancement of the same lesions indicating active inflammation of the vertebral bodies (**d–e**)

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_58, © Springer International Publishing Switzerland 2014

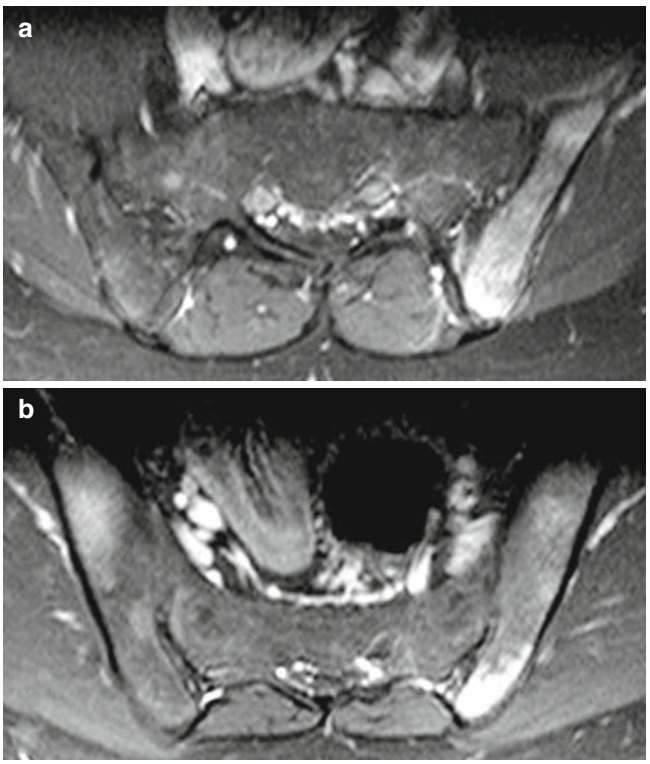


Fig. 2 Axial SE T1-weighted images with fat saturation following the administration of contrast medium (**a**, **b**): asymmetric acute inflammation of both joints (**b**), more evident on the left (**a**–**b**)

Follow-up after 12 months of TNF-blocker therapy

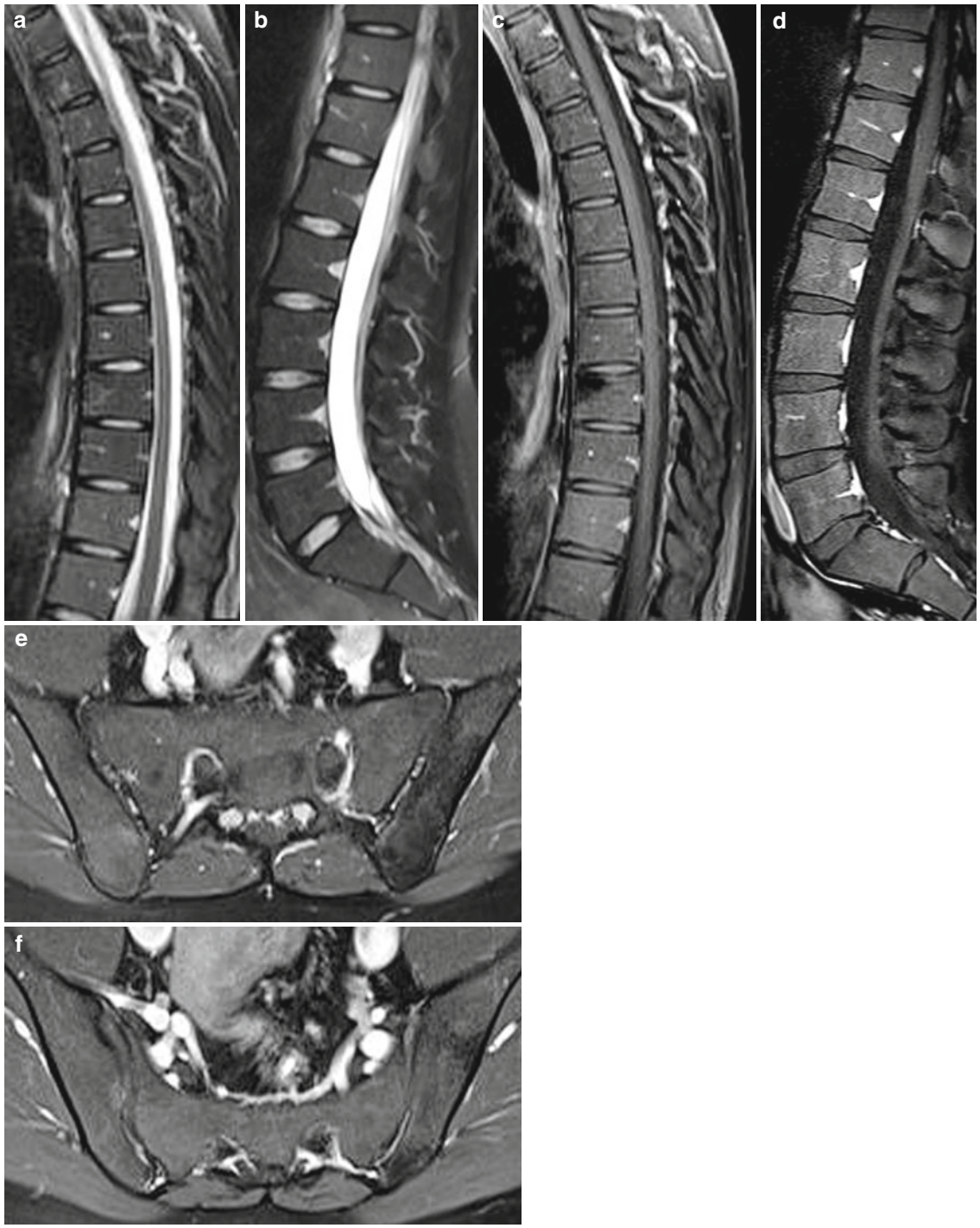


Fig. 3 Sagittal TSE T2-weighted images with fat saturation (**a–b**), sagittal SE T1-weighted images with fat saturation following the administration of contrast medium (**c–d**), and axial SE T1-weighted images with fat saturation following the administration of contrast medium (**e–f**). These images show the absence of bone marrow edema (**a**–**b**) and absence of contrast enhancement of the spine (**c**–**d**) and sacroiliac joints (**e**–**f**), indicating the resolution of the acute inflammatory lesions

Ankylosing Spondylitis

Case 55

Spondylitis in Acute and Chronic Phases

- A 37-year-old patient
- A family history of SpA
- Dorsal and lumbar pain during the night for more than 2 years
- Morning stiffness and limitation of motion of the spine in the frontal and lateral planes
- Limitation of chest expansion

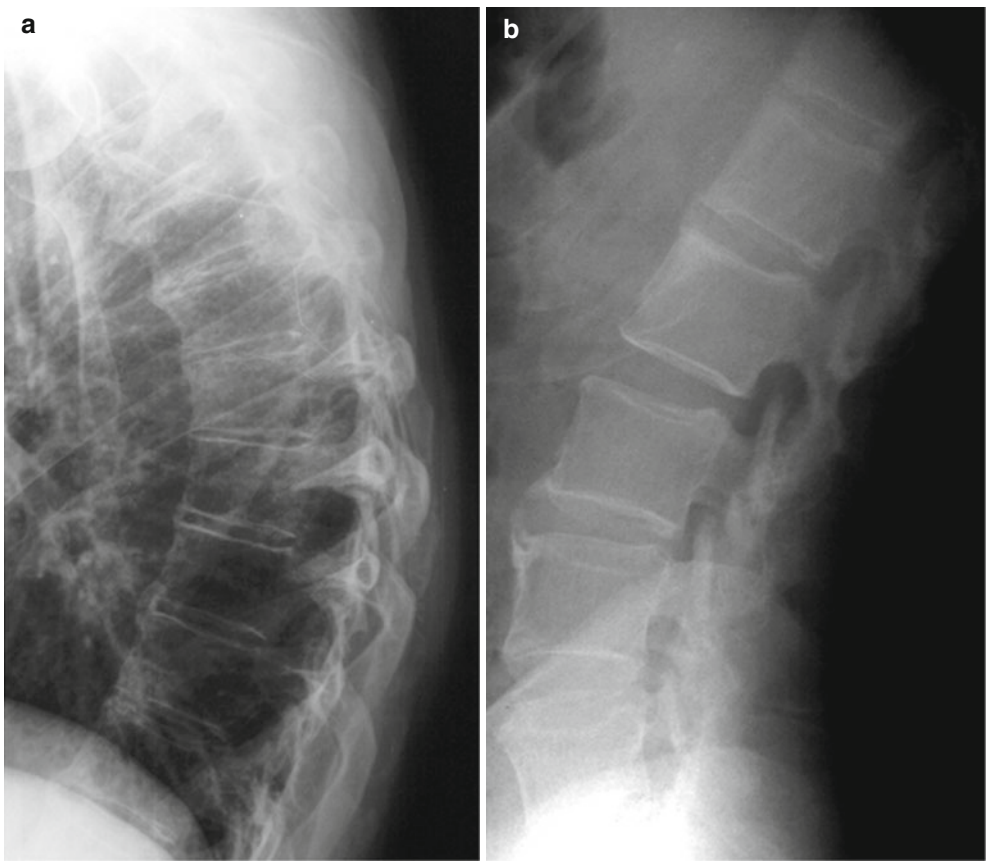


Fig. 1 X-ray of thoracic and lumbar spine. Lateral thoracic X-ray shows marginal anterior osteophytosis in the upper spine (**a**); lateral lumbar X-ray shows erosion of the anterior corner of L4 with a marginal osteophytosis and anterior syndesmophytosis L1–L2 (**b**)

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_59, © Springer International Publishing Switzerland 2014

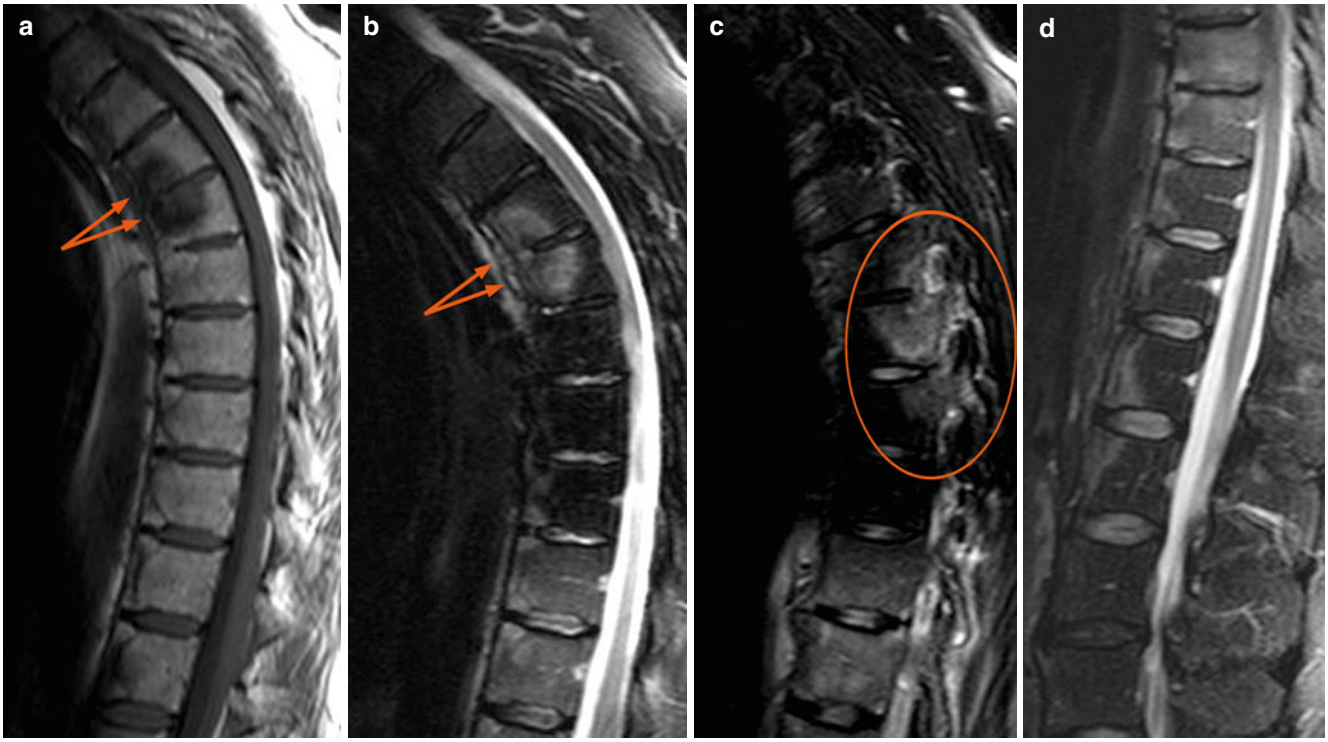


Fig. 2 Sagittal TSE T1-weighted image (**a**) and sagittal TSE T2-weighted images with fat saturation (**b–d**). The images show low signal of the T5–T6 (**a**, *arrows*) endplates and a focal fat infiltration of the vertebral corners of the thoracic spine, with ankylosis of T6–T7 and T8–T9 (**a**), increased signal of T5–T6 endplates (**b**, *arrows*) and some anterior corners indicating edema of bone marrow (**b–d**), and hyperintensity of the posterior corner and endplate of T6–T7 and zygapophyseal joints of T7–T8 and T10–T11 (**c**, *circle*)

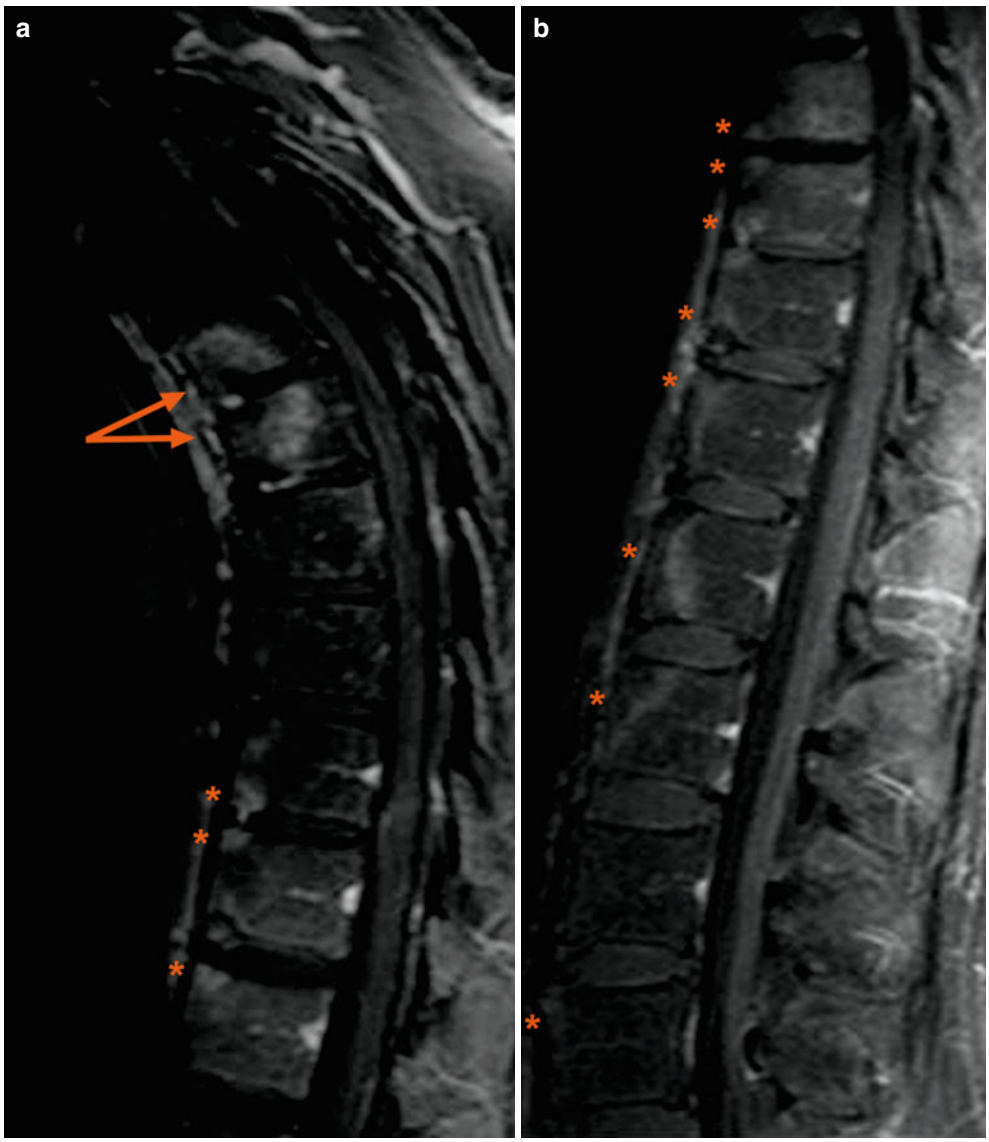


Fig. 3 Sagittal SE T1-weighted images with fat saturation following the administration of contrast medium (**a–b**). The images show enhancement of anterior endplate of T5–T6 (**a**, *arrows*) with enhancement of anterior corners (**a**, **b**, *asterisks*) that confirms an acute inflammation of the spine

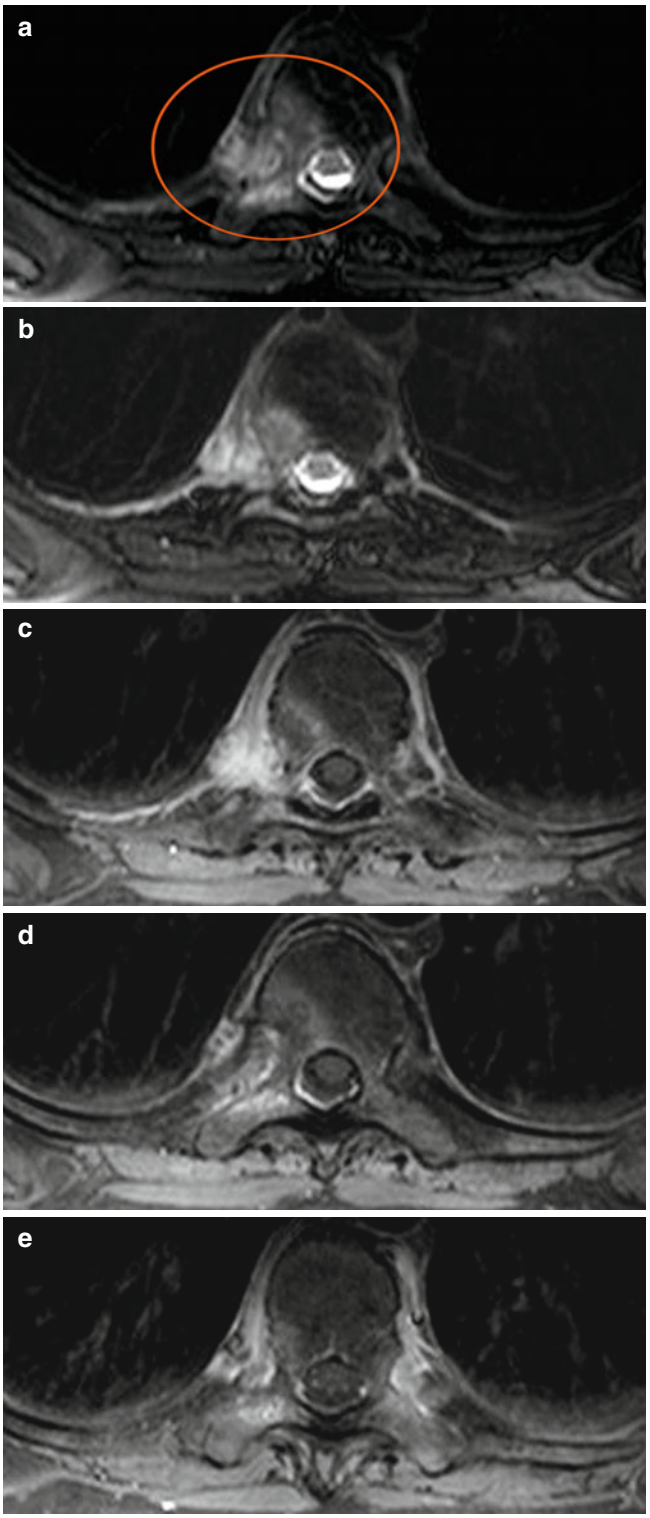


Fig. 4 Axial TSE T2-weighted images with fat saturation (**a–b**) and SE T1-weighted images with fat saturation following the administration of contrast medium (**c–e**). These images demonstrate bone marrow edema in the costovertebral joint on the right side (**a**–**b**, *circle*); after contrast medium administration, note enhancement of right costovertebral joint T10–T11 (osteoarthritis) (**d**) with flogosis of adjacent soft tissue (**c**–**e**)

Follow-up after 12 months of TNF-blocker therapy

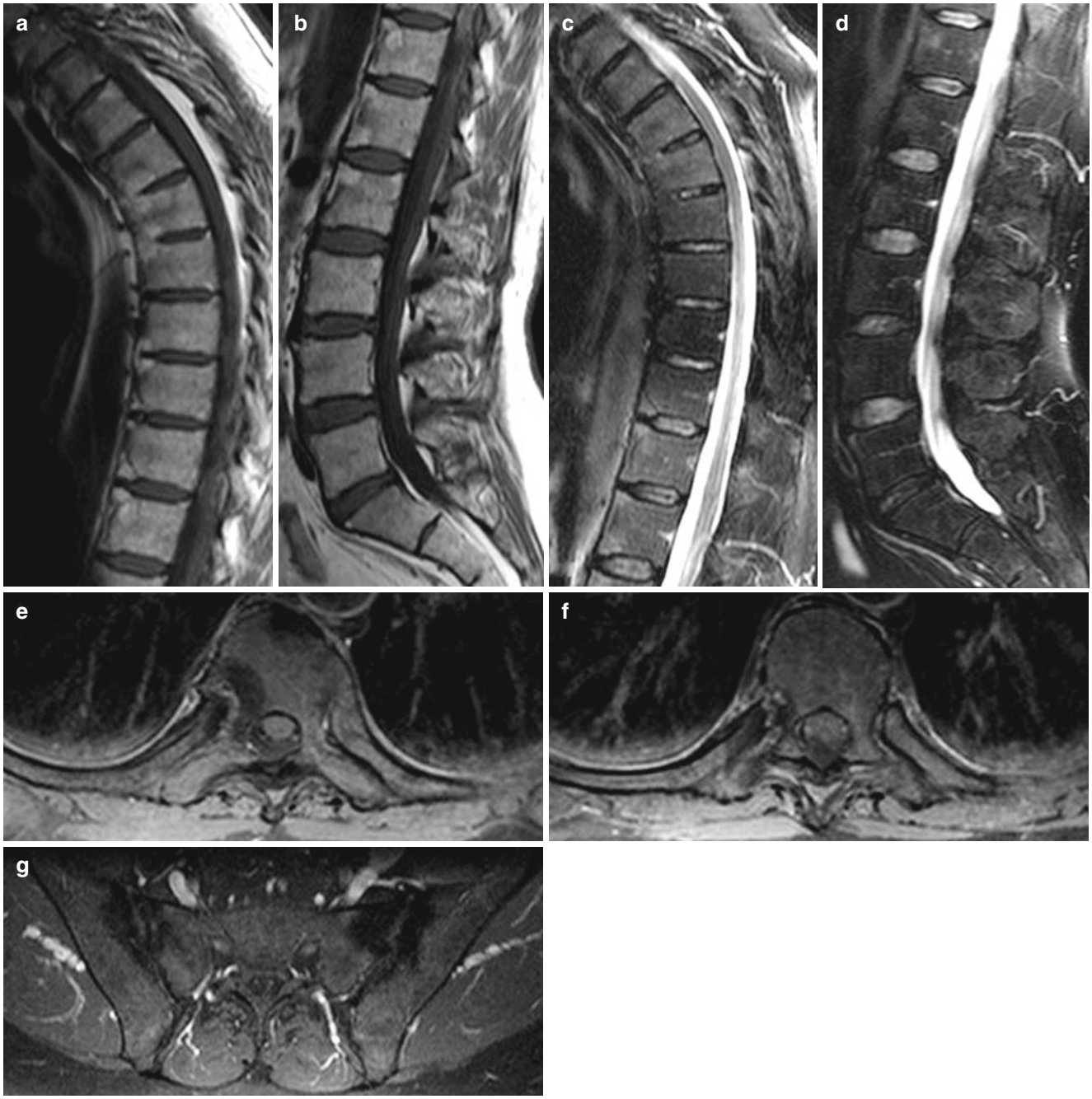


Fig. 5 Sagittal SE T1-weighted images (**a–b**), sagittal TSE T2-weighted images with fat saturation (**c–d**), axial SE T1-weighted images with fat saturation following the administration of contrast medium (**e–g**). These images show ankylosis of thoracic spine (**a**) and fat infiltration of the corners (**a**–**b**), without bone marrow edema (**c**–**d**). After contrast medium administration, the images do not show enhancement of the spine and costovertebral joints, demonstrating the absence of acute inflammation (**e**–**g**)

Follow-up 3 years after suspension of TNF-blocker therapy

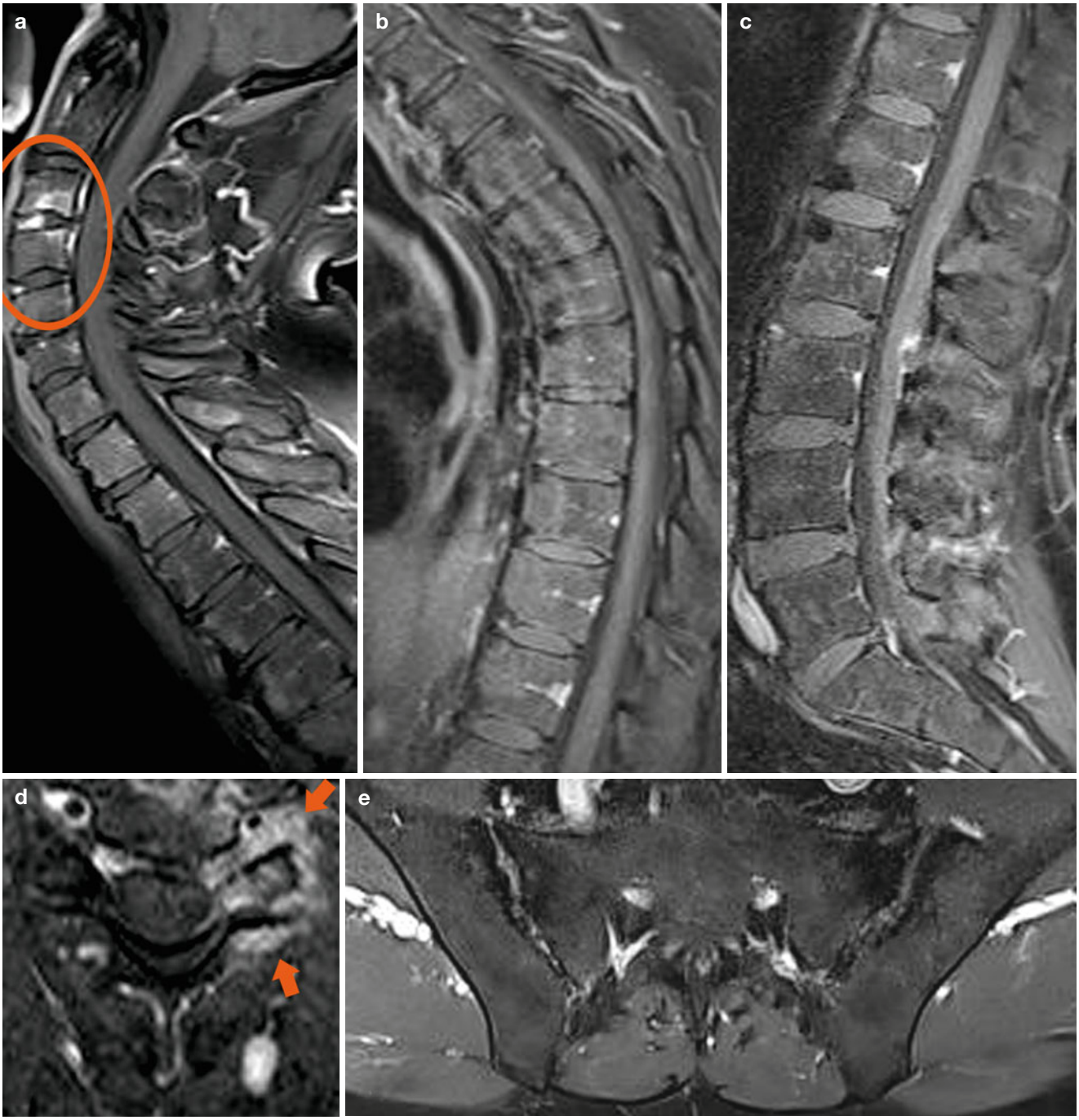


Fig. 6 Sagittal (**a**–**c**) and axial (**d**–**e**) SE T1-weighted images with fat saturation following the administration of contrast medium. These images show enhancement of the vertebral body endplate of C3–C4 and corresponding disc, indicating an aseptic spondylodiscitis (**a**, *circle*). Contrast enhancement of the left zygapophyseal joints C3–C4 and adjacent periarticular soft tissue indicating osteoarthritis and synovitis (**d**, *arrows*). The image of lumbar spine (**c**) shows inflammation of flava ligaments at L2–L3 and inflammation of interspinous ligament at L4–L5. The images of thoracic spine and sacroiliac joints (**b**, **e**) show the absence of inflammatory lesions

Psoriatic Arthritis

Sacroiliitis

Case **56**

- A 25-year-old patient
- Presence of HLA-B27
- Psoriasis
- Low back pain that worsens when sitting for a long time
- Buttock pain

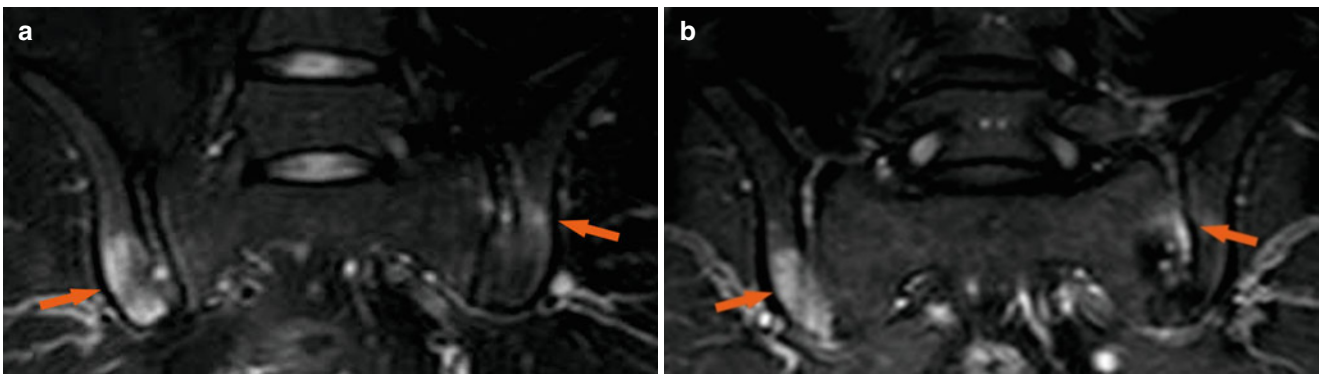


Fig. 1 Coronal TSE T2-weighted image with fat saturation (**a**) and SE T1-weighted image with fat saturation following the administration of contrast medium (**b**). These images demonstrate bone marrow edema of the sacroiliac joints, more evident on the right side (**a**, *arrows*). Contrast medium administration shows osteitis of the right joint, in particular on the iliac side, and shows bilateral synovitis (**b**, *arrows*)

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_60,

Follow-up after 9 months of TNF-blocker therapy

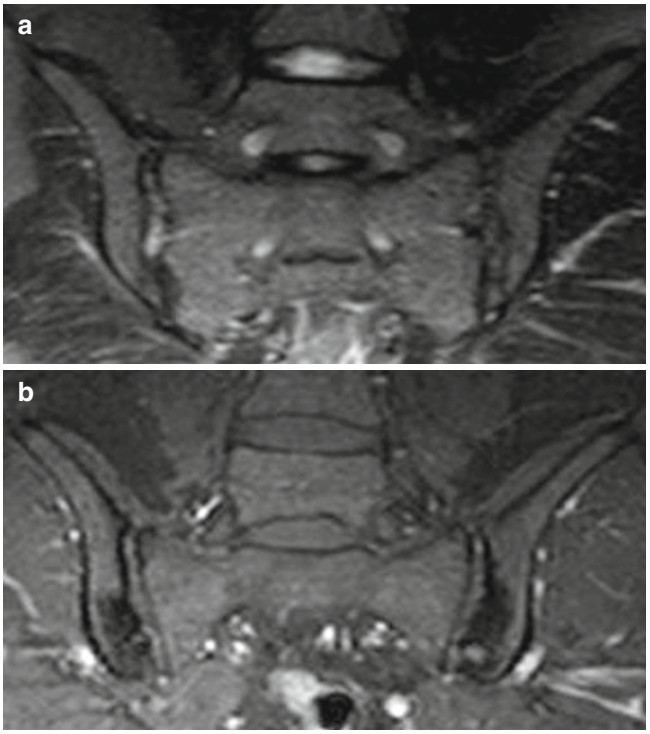


Fig. 2 Coronal TSE T2-weighted image with fat saturation (**a**) and SE T1-weighted image with fat saturation following the administration of contrast medium (**b**). The images show the absence of inflammatory lesions of the sacroiliac joints

Ankylosing Spondylitis

Case 57

Spondylitis

- A 35-year-old patient
- Dorsal and lumbar pain for more than 12 months
- Morning stiffness and limitation of motion in the frontal planes

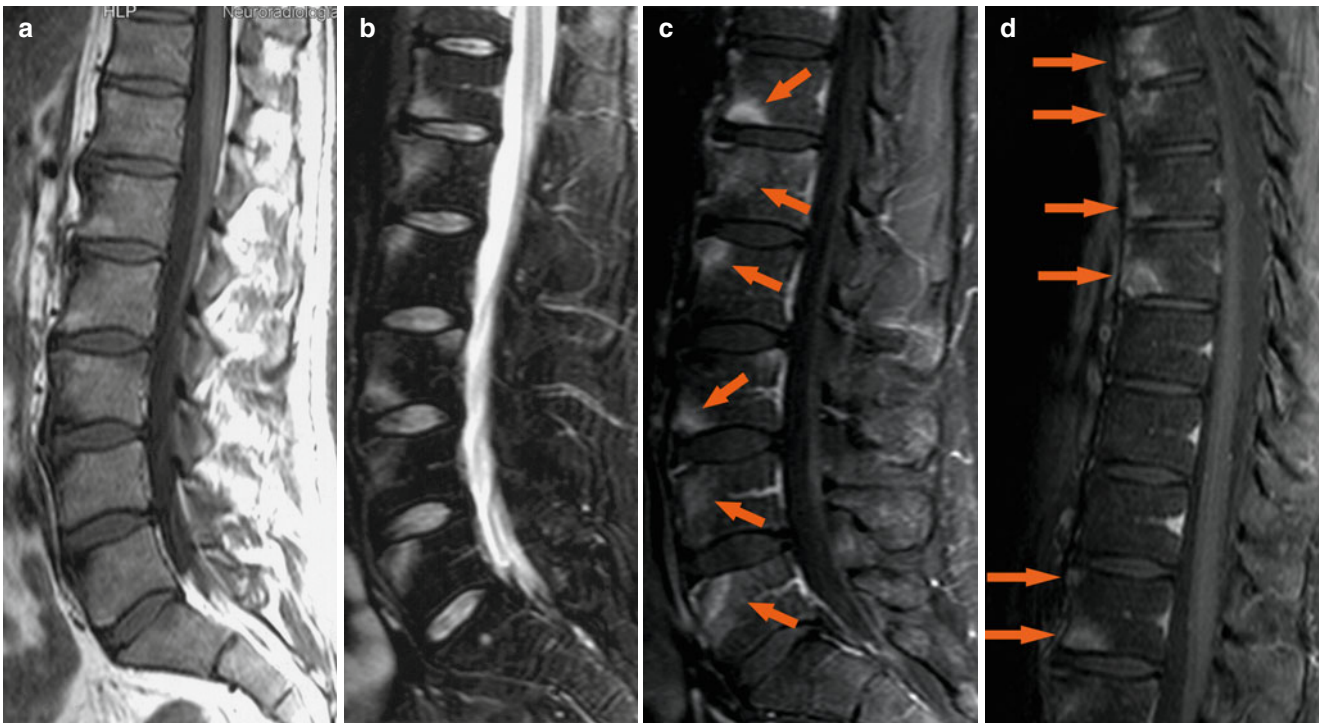


Fig. 1 Sagittal SE T1-weighted sequence (**a**), sagittal TSE T2-weighted sequence with fat saturation (**b**), sagittal SE T1-weighted images with fat saturation following the administration of contrast medium (**c–d**). The images show low signal and fat infiltration of the anterior corners of the lumbar spine (sign of chronic inflammation) (**a**), edema of the bone marrow of the anterior corners (**b**), contrast enhancement of the anterior and posterior corners, sign of active inflammation of the spine extended to the thoracic spine (**c**–**d**, *arrows*)

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_61, © Springer International Publishing Switzerland 2014

Follow-up after 14 months of TNF-blocker therapy

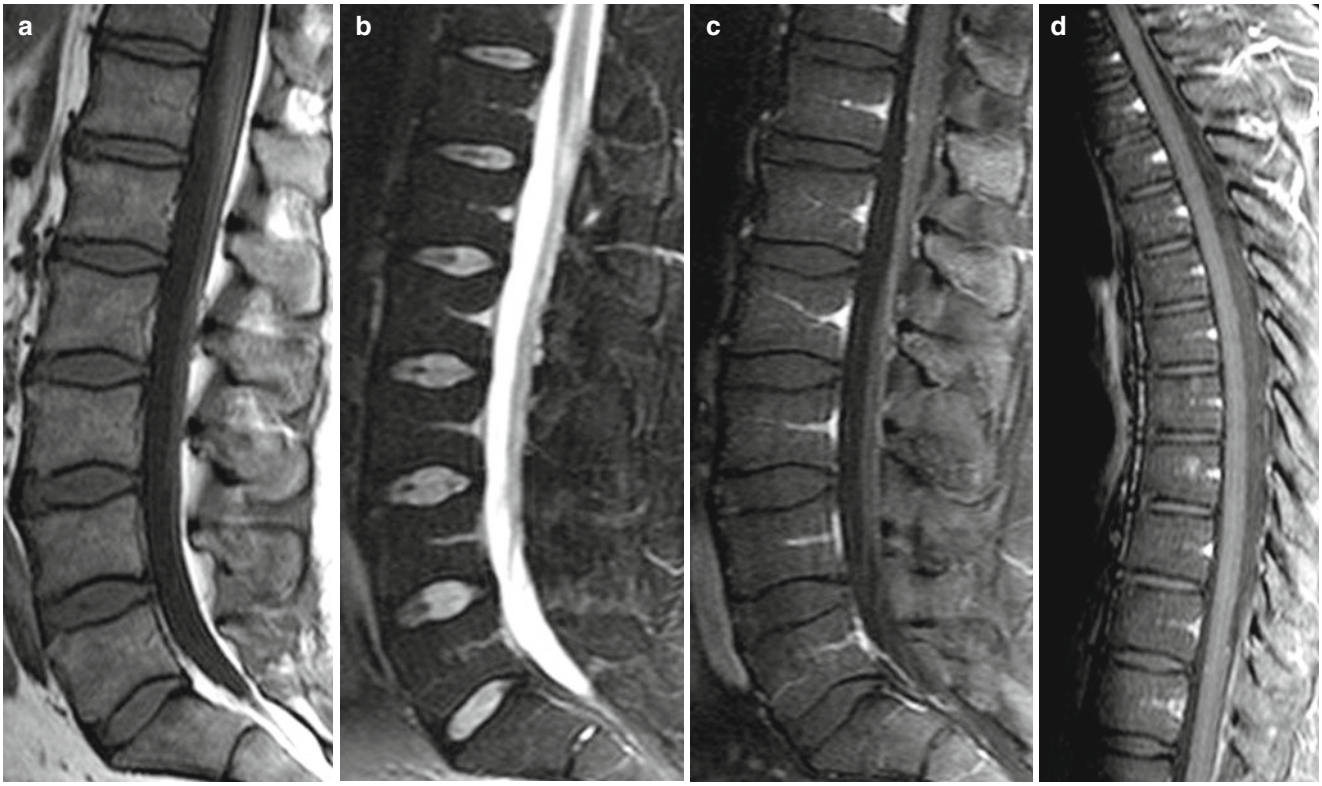


Fig. 2 Sagittal SE T1-weighted sequence (**a**), sagittal TSE T2-weighted sequence with fat saturation (**b**), sagittal SE T1-weighted image with fat saturation following the administration of contrast medium (**c–d**). The images show only fat infiltration of the anterior corners of lumbar spine (**a**), a low signal of the spine (**b**), and the absence of acute inflammatory lesions of the thoracic and lumbar spine (**c–d**)

Psoriatic Arthritis

Case 58

Sacroiliitis

- A 28-year-old patient
- Familial history of SpA
- Low back pain that worsens when sitting for a long time
- Buttock pain

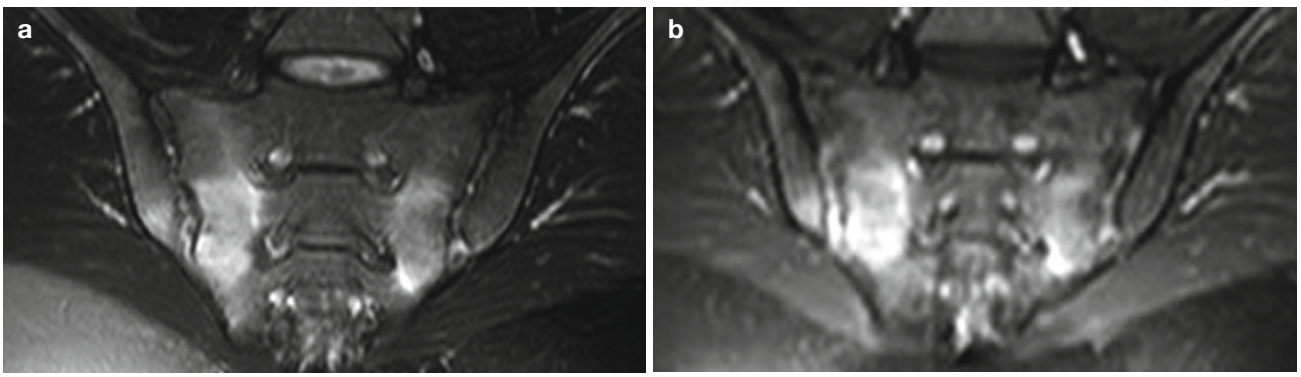


Fig. 1 Coronal TSE T2-weighted sequence with fat saturation (**a**), coronal SE T1-weighted image with fat saturation following the administration of contrast medium (**b**). Note the massive bone marrow edema and intra-articular fluid (intra-articular hyperintensity) (**a**); contrast medium administration demonstrates symmetric massive acute inflammation of both joints (osteitis), in particular on the sacral side, and intra-articular enhancement (synovitis) (**b**)

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_62, © Springer International Publishing Switzerland 2014

Follow-up after 13 months of TNF-blocker therapy

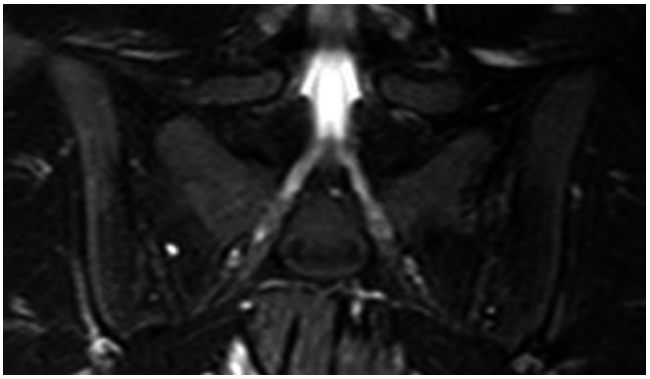


Fig. 2 Coronal TSE T2-weighted image with fat saturation showing resolution of the inflammatory signs of both joints (absence of bone marrow edema)

Ankylosing Spondylitis

Case 59

Sacroiliitis

- A 34-year-old patient
- Low back pain (with buttock pain on the left) associated with morning stiffness that improved with exercise but not with rest

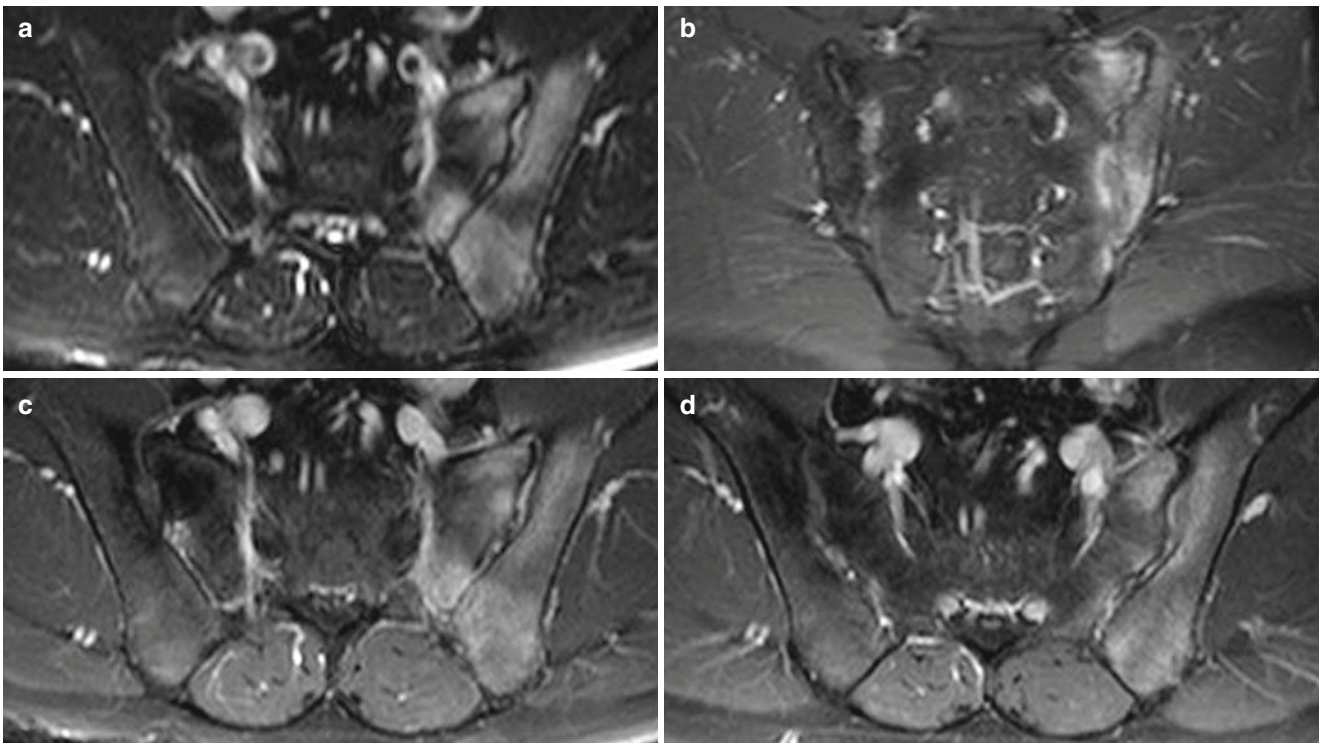


Fig. 1 Axial TSE T2-weighted image with fat saturation (**a**) and coronal (**b**) and axial (**c–d**) SE T1-weighted image with fat saturation following the administration of contrast medium. Note bone marrow edema on the left sacroiliac joint (**a–b**) and subchondral contrast enhancement (osteitis), associated with intra-articular enhancement (synovitis) (**c–d**)

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_63, © Springer International Publishing Switzerland 2014

Follow-up after 12 months of TNF-blocker therapy

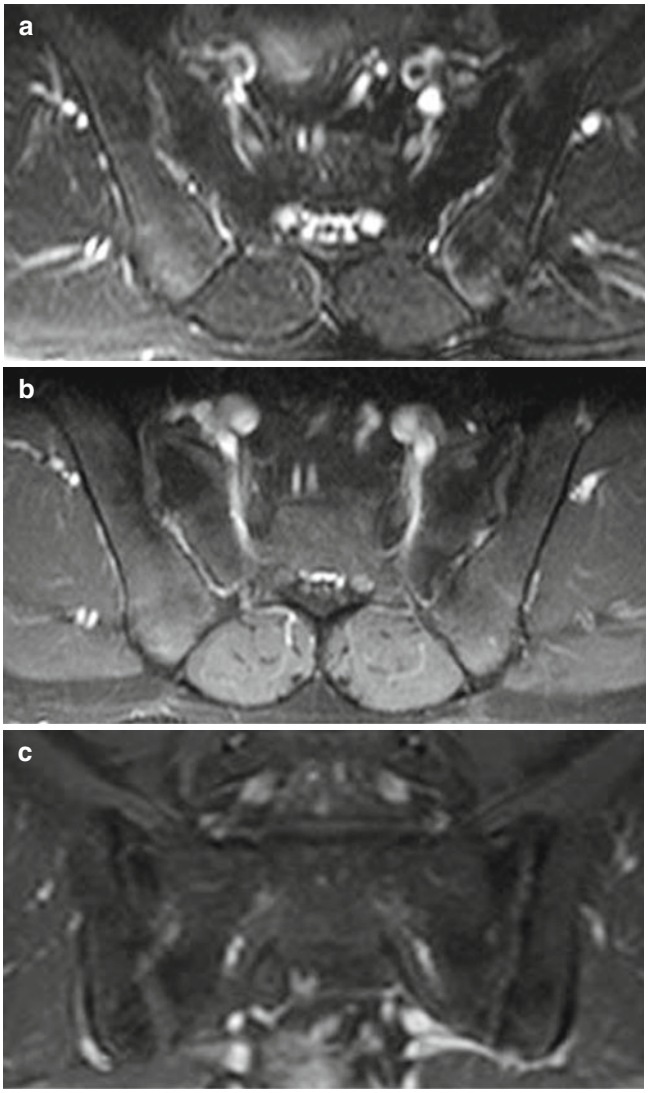


Fig. 2 Axial TSE T2-weighted with fat saturation image (**a**) and axial and coronal SE T1-weighted image with fat saturation following the administration of contrast medium (**b–c**) demonstrating the resolution of acute inflammation of the left sacroiliac joint

Ankylosing Spondylitis

Case 60

Spondylodiscitis

- A 27-year-old patient
- Presence of HLA-B27
- Dorsal back pain
- Stiffness with limitation of motion in the sagittal and frontal planes for more than 8 months

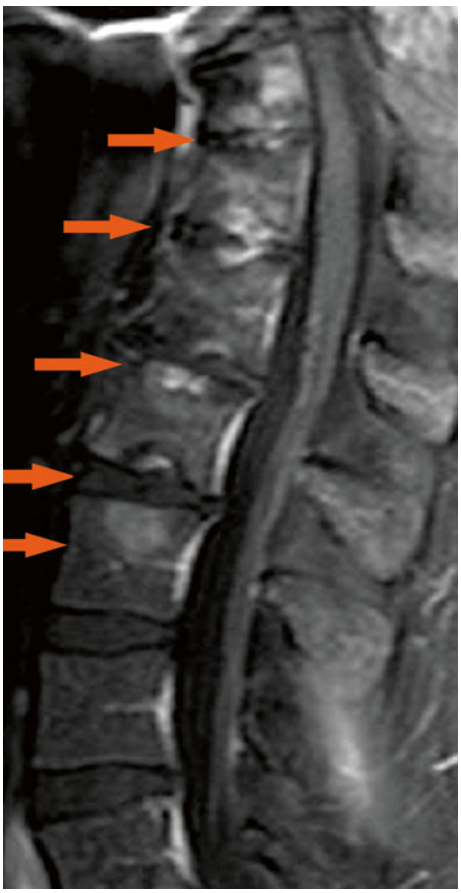


Fig. 1 Sagittal SE T1-weighted image with fat saturation following the administration of contrast medium shows bone erosion adjacent to the vertebral endplates from T11 to L3 and inflammatory involvement of the intervertebral discs (Andersson lesions)

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_64, © Springer International Publishing Switzerland 2014

Follow-up after 6 months of TNF-blocker therapy

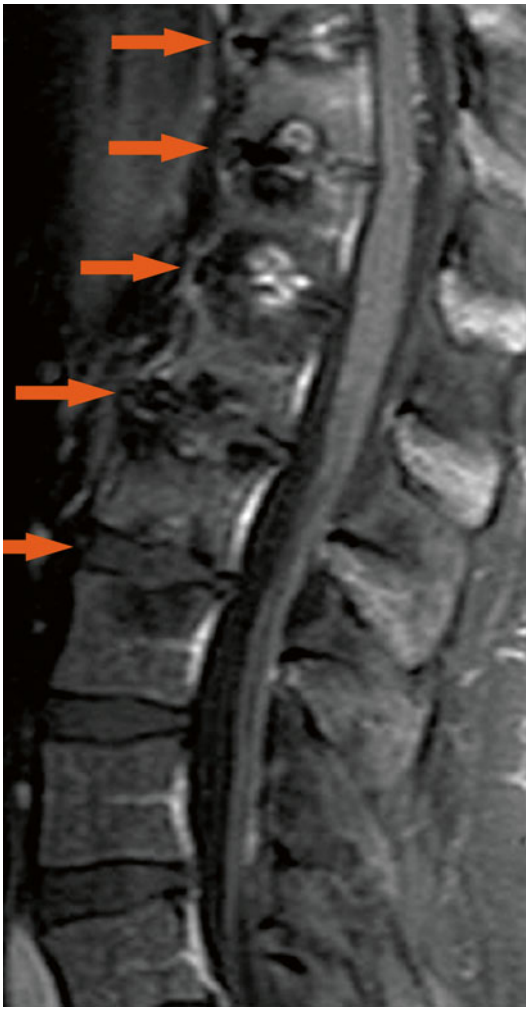


Fig. 2 Sagittal SE T1-weighted image with fat saturation following the administration of contrast medium sequence: this image shows a mild reduction of inflammatory signs

Ankylosing Spondylitis

Case 61

Spondylitis and Enthesitis

- A 30-year-old patient
- Presence of HLA-B27
- Dorsal and lumbar pain
- Stiffness for more than 10 months that improves with exercise but is not relieved by rest

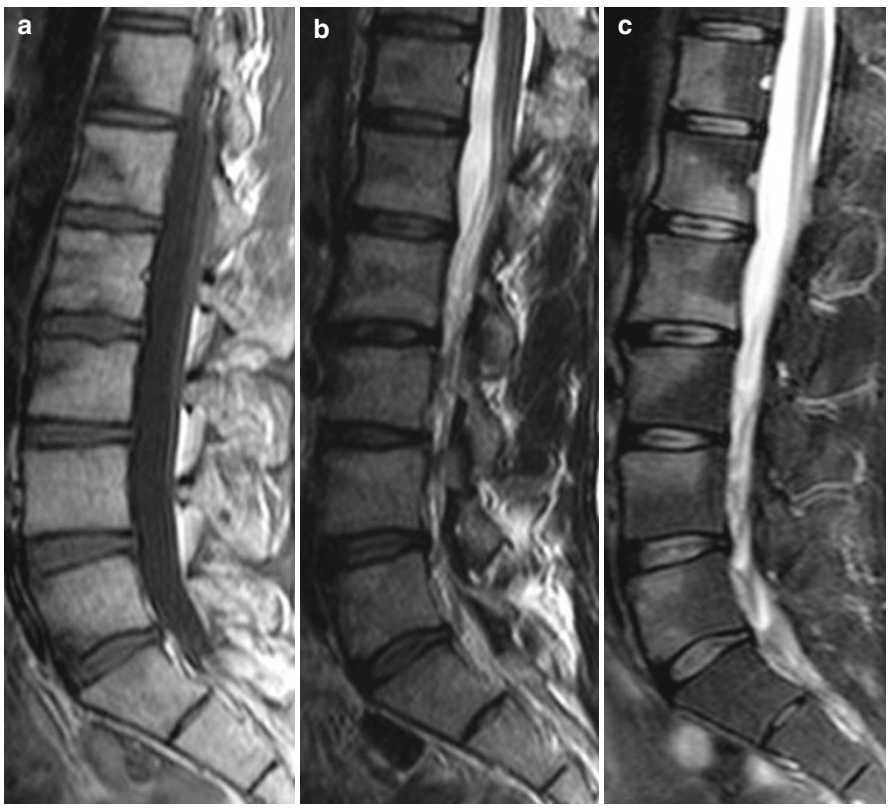
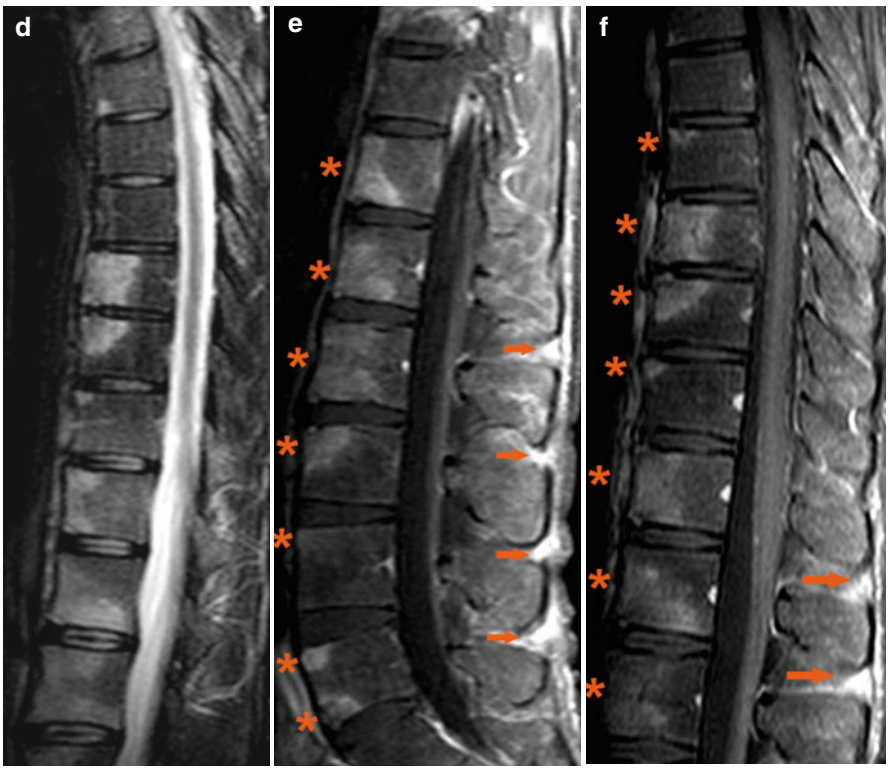


Fig. 1 Sagittal SE T1-weighted image (**a**), sagittal TSE T2-weighted image (**b**), sagittal TSE T2-weighted images with fat saturation (**c–d**), sagittal SE T1-weighted image with fat saturation following the administration of contrast medium (**e–f**). These images show a low signal at T12, L1, L2, and L3 with focal fat infiltration at vertebral corners of L1 and L2 (chronic inflammatory lesions) (**a**); T2-weighted image shows a mild hyperintensity at the same levels, while fat saturated T2-weighted image shows a more marked hyperintensity of the same lesions (**c**–**d**). Contrast medium administration shows enhancement of the vertebral corners and endplates of thoracic and lumbar spine (**e**, **f**, *asterisks*). Note how the post-contrast images also show pronounced enhancement of interspinal and supraspinous ligaments, a finding indicative of enthesitis (**e**–**f**, *arrows*)

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_65, © Springer International Publishing Switzerland 2014

Fig. 1 (continued)



Follow-up after 6 months of TNF-blocker therapy

Fig. 2 Sagittal SE T1-weighted sequences (**a–b**), sagittal TSE T2-weighted images with fat saturation (**c–d**), sagittal SE T1-weighted images with fat saturation following the administration of contrast medium (**e–f**). Focal fat infiltration of the thoracic and lumbar vertebral corners (**a**–**b**), with the absence of bone marrow edema(**c**–**d**); images after contrast medium administration confirm the resolution of the inflammation, with a minimal enhancement of the superior corner of T11 (**e**–**f**)

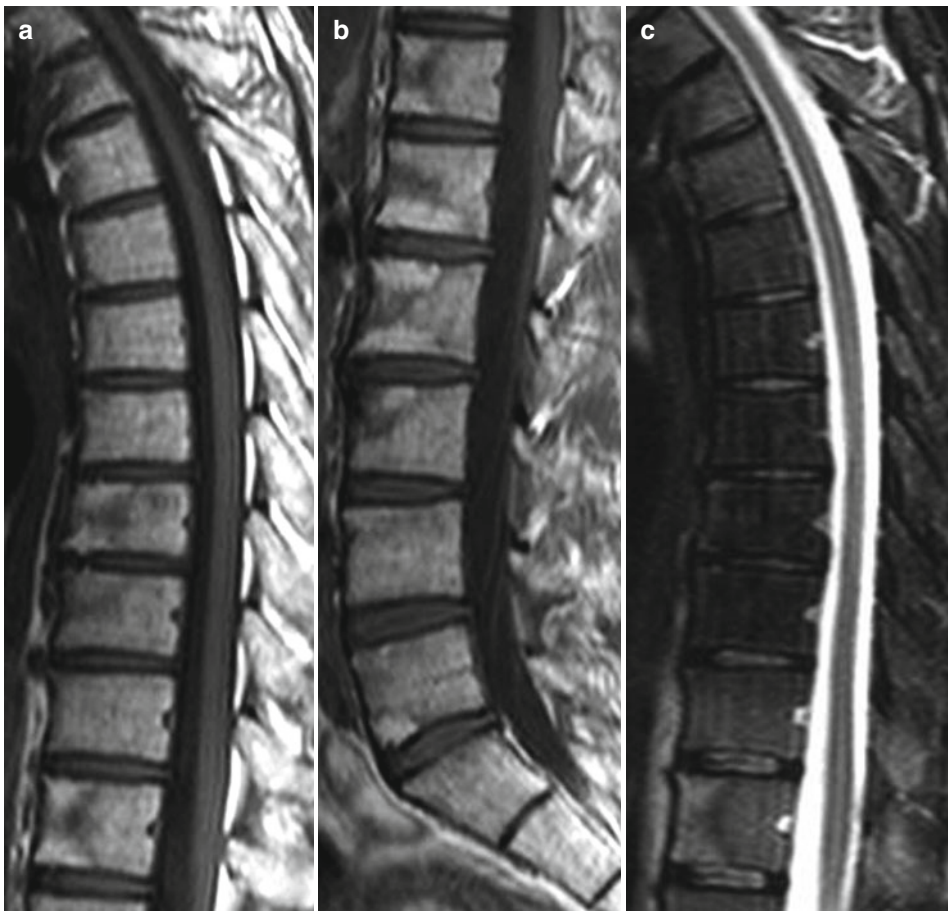
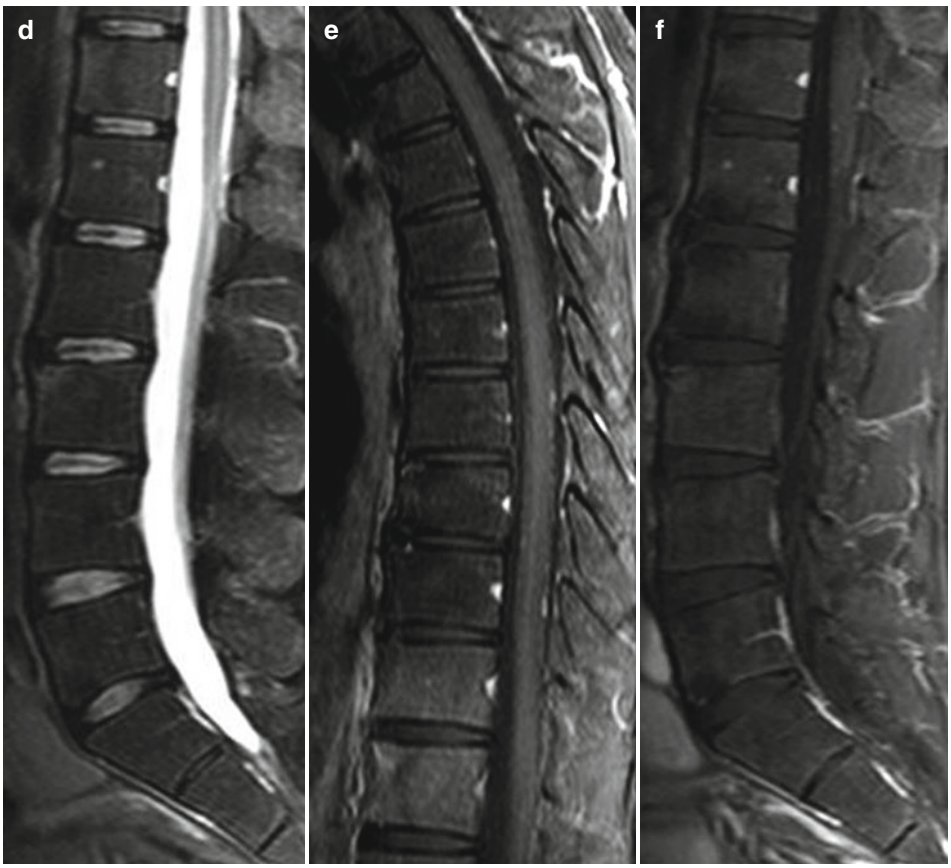


Fig. 2 (continued)



Psoriatic Arthritis

Spondylitis

Case **62**

- A 31-year-old patient
- Familial history of psoriasis
- Lumbar pain during the night with improvement upon getting up

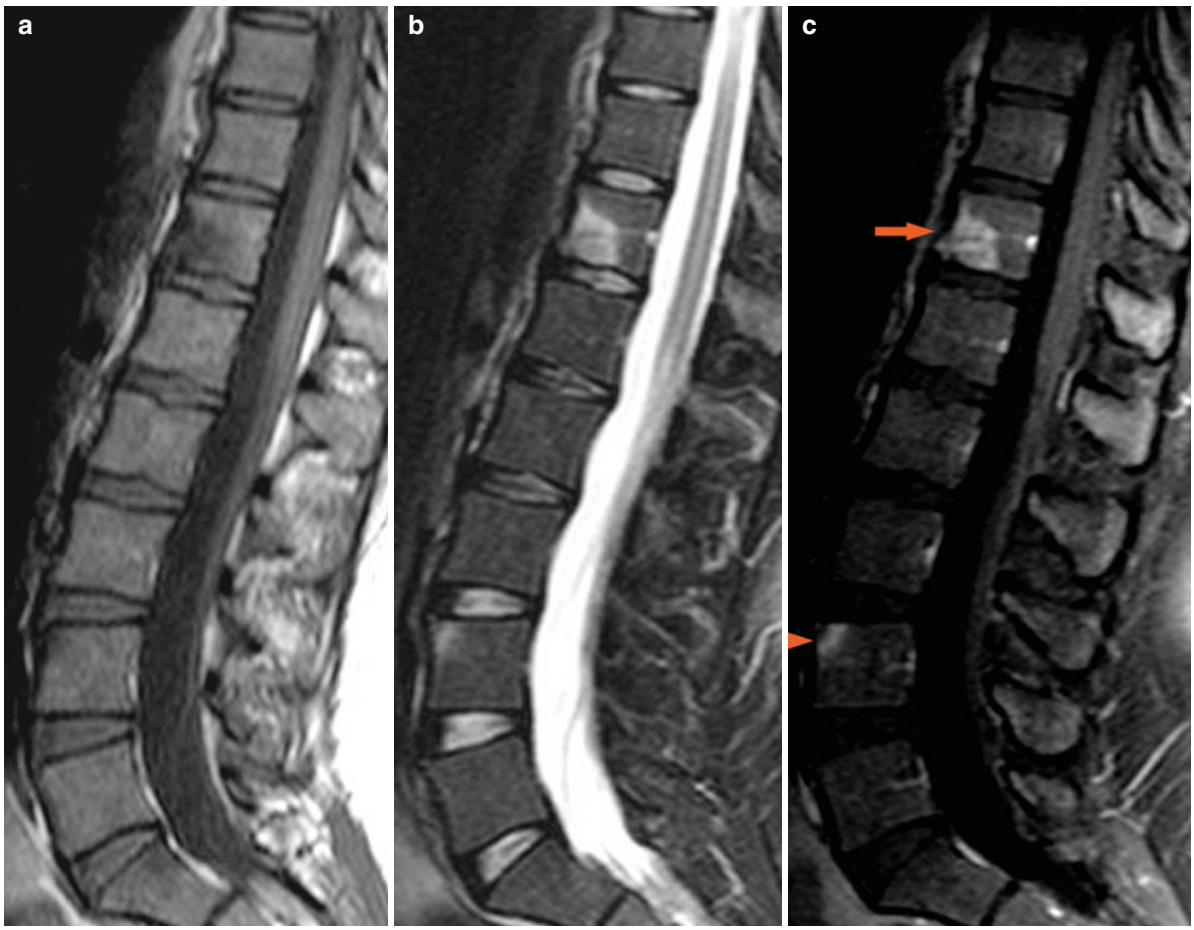


Fig. 1 Sagittal SE T1-weighted sequence (**a**), TSE T2-weighted image with fat saturation (**b**), SE T1-weighted image with fat saturation following the administration of contrast medium (**c**). These images show low signal intensity of the anteroinferior corner of T12 and the anterosuperior corner of L4 (**a**) and hyperintensity of the same lesions (**b**), sign of bone marrow edema. After contrast medium administration, note enhancement of the same lesions, sign of active spondylitis (**c**, *arrows*)

P. D'Aprile, *MRI of Rheumatic Spine*,
DOI 10.1007/978-3-319-05627-2_66, © Springer International Publishing Switzerland 2014

Follow-up after 12 months of TNF-blocker therapy

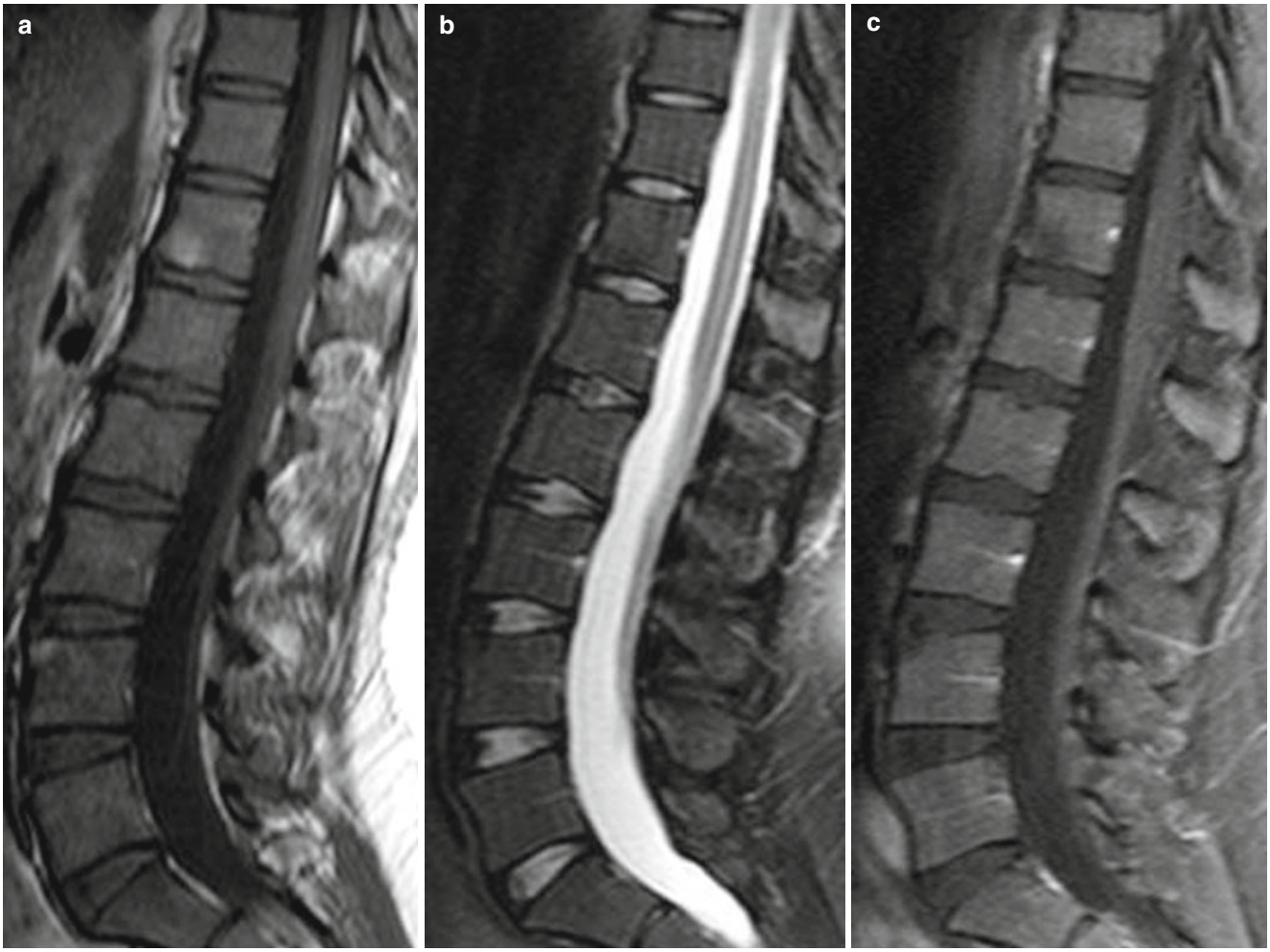


Fig. 2 Sagittal SE T1-weighted sequence (**a**), TSE T2-weighted sequence with fat saturation (**b**), SE T1-weighted image with fat saturation following the administration of contrast medium (**c**). The images show fat infiltration of the anteroinferior corner and inferior endplate of T12 and the anterosuperior corner of L4 (**a**) without enhancement after contrast medium administration, sign of resolution of inflammation (**b**–**c**)