Active Inflammatory Lesions Detected by Magnetic Resonance Imaging in the Spine of Patients with Spondyloarthritis – Definitions, Assessment System, and Reference Image Set

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ABSTRACT. ***Objective.*** Currently available magnetic resonance imaging (MRI) assessment systems for spine inflammation in patients with spondyloarthritis (SpA) identify only the overall inflammation in the discovertebral units. We aimed to develop and illustrate a detailed anatomy-based set of definitions and an assessment system for active inflammatory lesions in the spine of patients with SpA.

Methods. MRI definitions of different inflammatory lesions at various anatomical locations in the spine, and an accompanying assessment system, were agreed by consensus within the Canada-Denmark MRI working group. Subsequently, a reference image set of representative examples of the individual pathologies, as well as borderline cases and important artefacts, were collected.

Results. The defined lesions were (a) vertebral body inflammatory lesions, subdivided into corner, non-corner, massive, and lateral inflammatory lesions; and (b) vertebral inflammatory lesions not involving the vertebral body, subdivided into facet joint and other posterior element inflammatory lesions. All definitions were based on presence of increased signal intensity on sagittal T2-weighted fat-suppressed or STIR-images, as compared with the normal bone marrow signal. Vertebral body inflammatory lesions are assessed at each vertebral endplate at all 23 spinal levels from C2/3 to L5/S1, whereas facet joint or posterior element inflammatory lesions are to be assessed by segmental level (cervical, thoracic, and lumbar).

Conclusion. An anatomy-based set of definitions and an assessment system for active inflammatory lesions in the spine of patients with SpA was developed and illustrated. The system is designed to study the temporal and spatial patterns of inflammation and their relation to the development of structural damage. (J Rheumatol 2009;36 Suppl 84:3-17; doi:10.3899/jrheum.090616)

Key Indexing Terms:
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Magnetic resonance imaging (MRI) allows direct visualization of active inflammatory change in the spine of patients with spondyloarthritis (SpA), including ankylosing spondylitis (AS). MRI scoring methods for assessment of the overall inflammatory activity in the spine have been developed[1-3] and high reproducibility, sensitivity to change, and discriminatory ability have been demonstrated[4]. However, these scoring systems identify inflammation in the discovertebral unit as a whole, without any information about localization of inflammatory changes, and they ignore changes outside the vertebral body. Moreover, the methods are validated only as sum scores.

Inflammatory spinal lesions frequently occur outside the vertebral body, as in the costovertebral joints, the zygapophyseal (facet) joints, and other posterior elements of the spine[5]. Such lesions are likely to have considerable clinical and, possibly, prognostic significance. Examination only of discovertebral units by MRI may contribute to an apparent dissociation between clinical symptoms and findings on one hand and MRI findings on the other.

For exploration of the disease process in SpA, such as the spatial and temporal pattern of inflammation in the spine, the currently available scoring systems are not sufficient. A more detailed anatomy-based system of assessment that separates inflammation in different anatomical areas could provide important additional information. For example, inflammation isolated to the vertebral bodies as compared to the facet or costovertebral joints, and even in different locations within the vertebral body itself, may have quite different implications. Such a system would allow longitudinal studies of the relationship between inflammation and damage in SpA spines: for example, the relation between the development of radiographic syndesmophytes and prior inflammation at exactly the same anatomical location[6].

In summer 2007, a Canadian-Danish collaboration of researchers from a mixed rheumatological and radiological background (the Canada-Denmark MRI working group) was formed with the principal aim to develop and validate a detailed MRI assessment system of the key pathologies in the spine of patients with SpA. This article describes and illustrates the group's proposed definitions and assessment system of active inflammatory lesions in the spine of patients with SpA.

METHODS

At a 3-day meeting in Edmonton, Canada, in September 2007, preliminary definitions of different inflammatory lesions at various anatomical locations in the spine of patients with SpA were agreed by consensus between the participants in the Canada-Denmark MRI working group. After subsequent review and testing of the definitions on SpA spine image sets, and discussion at video teleconferences, the definitions were slightly modified.

Two critical factors influenced the group's decisions: (i) The definitions were developed bearing in mind the key requirement for correlation of MRI data with other measures and outcomes, most particularly radiographic correlation; and (ii) Future screening of SpA spines with MRI will always, and sometimes only, include images in the sagittal plane. It is intended that the definitions would, as far as possible, allow:

1. Separation of precursors of anterior vertebral body syndesmophyte (visible on lateral radiographs) from vertebral body syndesmophyte at other locations (less consistently seen on radiographs).
2. Separation of discovertebral involvement from costovertebral involvement.
3. Separation of vertebral body changes that are clearly due to discovertebral disease from vertebral body changes that could be manifestations of inflammatory processes emanating from the posterior elements.
4. Separation of posterior element involvement that may result in relatively early ankylosis (facet joint) from other posterior element disease (transverse and spinous processes).

Thereafter, a series of representative examples of the individual pathologies, as well as borderline cases, were collected. These were discussed, revised, and finally agreed upon by consensus, at video teleconferences and a 2 day meeting in Edmonton in May 2008. The selected examples thereafter constituted a "reference image set." Key examples from this reference image set are presented here (Figures 1–10), while a more comprehensive collection of reference images can be found on our website at www.arthritisdoctor.ca.

All illustrations in Figures 1–10 have the following format: Left: Sagittal T1-weighted MR image of the spine. Center: Matching sagittal short-tau inversion recovery (STIR) MR image of the spine. Right: Diagram of STIR image depicting anatomy and significant pathological lesions.

All T1 weighted images were acquired with repetition time (TR) 400–500 ms and echo time (TE) 13–18 ms. All STIR images were acquired with TR 4000–4500 ms, inversion time (TI) 140–145 ms, and TE 50–55 ms.

RESULTS

Here we present key points of the MRI definitions of pathologies, which anatomical areas to assess for them, and the proposed assessment/scoring system. The definitions are listed in Table 1 with additional clarification provided in the text along with references to illustrations of definitions and a description of the assessment system.

Definitions

Signal alteration. All definitions of inflammatory lesions relate to their appearance on sagittal T2-weighted fat-suppressed (T2FS) or sagittal STIR images. In both, increased water content is seen as an increased signal intensity, which we here refer to as inflammation.

1. The term "increased signal in bone marrow" refers to signal intensity higher than the "normal bone marrow signal." The bone marrow signal in the center of the vertebra, if normal, constitutes the reference for designation of normal signal or, alternatively, in the center of the closest available normal vertebra.

Anatomical location of MR image. The images of the thoracic and lumbar spine on a sagittal MRI scan are divided into "central" and "lateral" slices, which are defined as follows:

1. Central sagittal slices: the sagittal slices that include the spinal canal. The pedicle may be partially seen but is not continuous between the vertebral body and posterior elements.
2. Lateral sagittal slices: the sagittal slices that are located lateral to the spinal canal. These slices do not include

the spinal canal, and either the pedicle must be continuous between vertebral body and posterior elements or the slice is lateral to the pedicle.

Anatomical location of lesion. The inflammatory lesions are divided as follows:
1. Vertebral body inflammatory lesions are subdivided into corner inflammatory lesions, non-corner inflammatory lesions, and lateral inflammatory lesions.
2. Vertebral inflammatory lesions not involving the vertebral body are subdivided into facet joint lesions and other posterior element (such as transverse or spinous processes) lesions.

Detailed definitions of inflammatory lesions.
A. Vertebral body inflammatory lesion is an umbrella term for corner, non-corner, and lateral inflammatory lesions, which are subdivided as follows:
A1. Corner inflammatory lesion (CIL) is defined as increased signal in bone marrow on STIR/T2FS at the vertebral corner, in at least one central sagittal slice (Figures 1–4). These lesions are further subdivided by location, size, and morphology. By location: an anterior CIL (aCIL) is a CIL at the anterior corner (Figures 1–4) of the vertebral body; a posterior CIL (pCIL) is a CIL at the posterior corner (Figure 3); and a massive inflammatory lesion (MIL) is a lesion that, in any central sagittal slice, involves both anterior and posterior corners and is continuous across the entire anterior-posterior vertebral diameter (Figures 5 and 6). aCIL and pCIL may be further categorized as "large" if the lesion involves more than 25% of the anteroposterior diameter of the original endplate and/or of the original height of the vertebra (Figure 3). aCIL and pCIL may also be further categorized as "dimorphic" or "type B" if the inflammatory signal on the T2FS or STIR sequence does not itself extend to the corner, but the lesion does extend to both the vertebral endplate and the anterior or posterior border of the vertebral body adjacent to the corner. The signal intensity of the bone marrow in the corner may be

Table 1. Definitions of inflammatory lesions in the spine of patients with SpA.

DEFINITIONS	
A. Vertebral body inflammatory lesion	Increased signal in bone marrow on STIR/T2FS in a vertebral body
A1. Corner inflammatory lesion (CIL)	Inflammatory lesion at the vertebral corner, in at least one central sagittal slice
Location	Anterior CIL (aCIL): CIL at the anterior corner Posterior CIL (pCIL): CIL at the posterior corner Massive IL (MIL): A lesion that in any central sagittal slice involves both the anterior and the posterior corners and is continuous across the entire anterior-posterior vertebral diameter
Size (for aCIL and pCIL)	Large: Involvement of more than 25% of the AP diameter of original endplate and/or of the original height of the vertebra, in any central sagittal slice. Not large: Does not fulfil definition of large
Type (for aCIL and pCIL)	Regular: The inflammatory signal itself reaches the corner Dimorphic (type B): The inflammatory signal itself does not extend to the corner, but does extend to both the adjacent vertebral endplate and anterior or posterior cortex. The extreme corner of the vertebra may contain another lesion such as fat infiltration or erosion
A2. Non-corner inflammatory lesion (NIL)	Inflammatory lesion adjacent to the vertebral endplate but not involving the anterior or posterior vertebral corner in any central sagittal slice
A3. Lateral inflammatory lesion (LIL)	Inflammatory lesion adjacent to the endplate in any lateral sagittal slice
B. Facet joint or posterior element inflammatory lesion (FIL/PIL)	Increased signal in bone marrow on STIR/T2FS in: A facet of a facet joint (FIL) *OR* Another posterior element (PIL) excluding pedicle, facet, and pars interarticularis
C. Additional definitions	
Normal bone marrow signal	Bone marrow signal in the center of the vertebra, if normal
Increased signal in bone marrow	Signal intensity higher than the normal bone marrow signal
Central sagittal slices	Sagittal slices that include the spinal canal. The pedicle may be partially seen but is not continuous between the vertebral body and posterior elements
Lateral sagittal slices	Sagittal slices that are located lateral to the spinal canal. These slices do not include the spinal canal, and the pedicle must be continuous between vertebral body and posterior elements unless the slice is lateral to the pedicle

normal or decreased on T2FS/STIR and may appear as a corner lesion on T1-weighted images such as fat infiltration or erosion (Figure 4). Regular CIL (type A) reach the corners themselves (Figure 4).
A2. Non-corner inflammatory lesion (NIL) is defined as increased signal in bone marrow on STIR/T2FS adjacent to the vertebral endplate but involving neither the anterior nor posterior vertebral corner in any central sagittal slice (Figure 4).
A3. Lateral inflammatory lesion (LIL) applies only to thoracic and lumbar spine and is defined as increased signal in bone marrow on STIR/T2FS adjacent to the endplate in any lateral sagittal slice (Figures 7 and 8).
B. Vertebral inflammatory lesions not involving the vertebral body is an umbrella term for lesions that involve facet joints or other posterior elements, which are further described as follows:
B1. Facet joint inflammatory lesion (FIL) is defined as increased signal in bone marrow on STIR/T2FS in at least one facet of a facet joint (Figure 8).
B2. Posterior element inflammatory lesion (PIL) is defined as increased signal in bone marrow on STIR/T2FS in one of the other posterior elements at which there are ligamentous or muscular attachments. This most often applies to the transverse or spinous processes but may also include the lamina. The pedicle, facet processes, and pars interarticularis are excluded (Figures 9 and 10).

Assessment system.
A. Vertebral body inflammatory lesions: Vertebral body inflammatory lesions are assessed at each vertebral endplate at all 23 spinal levels from C2/3 to L5/S1. For each of the 46 vertebral endplates, the following should be noted:
Vertebral body inflammatory lesion (IL); Anterior corner inflammatory lesion (aCIL) (including type and size); Posterior corner inflammatory lesion (pCIL) (including type and size); Massive inflammatory lesion (MIL); Non-corner inflammatory lesion (NIL); Lateral inflammatory lesion (LIL).
B. Facet joint or posterior element inflammatory lesions: Facet joint or posterior element inflammatory lesions (FIL/PIL) are to be assessed by spinal segment – cervical, thoracic, and lumbar. For each of the 3 spinal segments, the following should be noted: Inflammatory lesion in any facet joint (FIL); Inflammatory lesion in any other posterior element (PIL).

DISCUSSION

We present an anatomy-based set of definitions and an assessment system for active inflammatory lesions in the spine of patients with SpA, proposed by the Canada-Denmark MRI working group. Whereas described assessment systems, such as SPARCC[2] (Spondyloarthritis Research Consortium of Canada), Berlin[3], and AS-Spi-MRIa[1] (AS Spine MRI Activity) systems for scoring overall spinal inflammatory activity, are useful as outcome measures in clinical trials, the present (CanDen) system is designed to study the temporal and spatial patterns of inflammation, and their relation to the development of structural damage lesions – erosions, syndesmophytes, and ankylosis.

The definitions of inflammatory lesions are based on the presence of areas in the bone marrow on T2FS or STIR images with a higher signal intensity than in the normal bone marrow. Such areas are generally referred to as bone marrow edema. Bone marrow edema has been shown to represent inflammatory cell infiltrates both in the spine[7] and sacroiliac joints[8] in SpA, as well as in peripheral joints in rheumatoid arthritis[9,10], and can, therefore, also be referred to as osteitis in SpA. In other conditions, however, a similar high T2 signal intensity is not necessarily associated with cellular infiltration, and MRI evidence of "bone marrow edema" cannot be considered as synonymous with inflammation in all circumstances[11].

We have chosen to subcategorize the corner inflammatory lesion (CIL) into regular and dimorphic (type B) not only because of the obvious difference in appearance on MRI but also because the type B lesion may have different implications. It probably develops after an initial regular CIL and the bone marrow in the corner may be undergoing reparation, more chronic inflammation, or frank erosion. However, whether a type B lesion can develop de novo has not been established.

MRI is a noninvasive technique that often provides unique information. However, a sometimes frustrating feature of MRI is that it is subject to more artefacts than most medical imaging modalities, and even highly trained observers find MRI interpretation challenging. Subtle areas of signal alteration will be seen somewhere in most scans, and frequently the reader will not be confident that the change constitutes a true lesion (Figures 2 and 6). The interpretation of such borderline lesions may influence the overall assessment of the patient. In this reference image set we have provided examples of such borderline lesions. We suggest that lesions clearer than these should be considered pathological and should be scored, i.e., findings less obvious than these should not be scored as pathological. Whether the borderline lesion (at the threshold for detection) is scored or not will depend on several factors, including overall image quality, artefact in the immediate vicinity, observation of the same borderline lesion on multiple images, and reader experience.

Some artefacts are present on every scan, and readers should become familiar with their appearance and how they are likely to cause misinterpretation. Scanning at large fields of view always results in variation in the strength of the signal reaching the receiver coils (coil

artefact) as the thoracic kyphosis and lumbar lordosis result in variability in the distance of vertebrae from the antennae. STIR sequences are particularly subject to a certain type of motion artefact (phase-encoding artefact) such as spurious signals from blood flowing in the great vessels (aorta and inferior vena cava – Figures 6 and 9), pulsation artefact from cerebrospinal fluid, and breathing artefact. Other commonly encountered artefacts include patient movement, incomplete fat suppression, and partial-voluming effects (Figure 7).

The cervical spine is generally the most difficult to assess due to several factors. The anatomical structures are much smaller overall. The shape of the posterior elements is very different from the thoracic and lumbar spine – in the cervical spine the facet joints lie posterolateral to the intervertebral disc, which comprises about half the overall diameter of the vertebra. Consequently, a "lateral slice" in the cervical spine is lateral to the vertebral body, and therefore the distinction between central and lateral slices in the cervical spine would serve no useful purpose. Further, due to time constraints, the entire spine is often scanned at large fields of view that result in proportionally greater limitation of spatial resolution in the cervical spine.

The predominant curvature of the spine (lordosis/kyphosis) renders the sagittal plane ideal for MRI screening for most inflammatory lesions. By including axial or coronal images visualization may be improved in some cases, but due to time constraints this is seldom done. We focused our definitions and examples on the most commonly acquired sequence (sagittal), which is also the plane most likely to be used for radiographic correlation. In general, sagittal images are only problematic in the detailed assessment of the extreme lateral edges of the vertebral body and/or the costovertebral joint, and most lesions in the posterior structures are easily reviewed on the sagittal images by a trained observer [facet joint (Figure 8), spinous process (Figure 9), transverse process (Figure 10)]. Further, all our definitions can still be applied if additional images are available in other planes; the additional images would provide added clarity or certainty only in some cases, and only occasionally alter the reader's perception significantly, a factor that would have to be weighed against reader fatigue and/or confusion of having a set of additional images to review.

It should be stressed that no individual lesion described is pathognomonic for SpA, and that the authors do not claim the described features as specific for SpA. This article only provides a tool for description of inflammatory features in the spine of SpA patients, whereas other studies, mainly longitudinal studies of patients with undifferentiated inflammatory back pain/early signs of axial inflammation, are needed to clarify the diagnostic value of spine MRI. For example, the distinction is particularly difficult between a small lesion in the center of a vertebral endplate due to spondylodiscitis (NIL) and a Schmorl's node (a defect in the vertebral endplate that is either developmental in origin or related to degenerative disc disease).

We prefer the term active inflammatory lesion as compared to the term acute, which is frequently used for similar lesions. This is because acute implies a "recent onset" or a "short-lived" condition versus chronic, which implies a more insidious onset or protracted process. The increased signal intensity seen on T2FS or STIR reflects increased water content (either intracellular or extracellular) related to active inflammation. No conclusions concerning how long the lesion may have been present or how long it will persist can be made from a single set of images, and serial scans at short intervals are rarely available that would permit determination of the timing of the processes. It should also be noted that not all active inflammatory processes are associated with a detectable increase in water content on T2FS/STIR. MRI sequences that employ contrast enhancement with gadolinium (Gd) may identify some additional lesions not seen on T2FS/STIR. However, the lesions that are positive only with Gd-enhanced MRI may be different in some important yet undetermined way, and this does not invalidate the use of T2FS/STIR for assessment of "active inflammatory lesions."

In conclusion, an anatomy-based set of definitions and an assessment system for active inflammatory lesions in the spine of patients with SpA have been developed and illustrated. The system is designed to study the temporal and spatial patterns of inflammation, and their relation to the development of structural damage. Future studies will reveal the validity of the system and its usefulness for the study of disease course in SpA.

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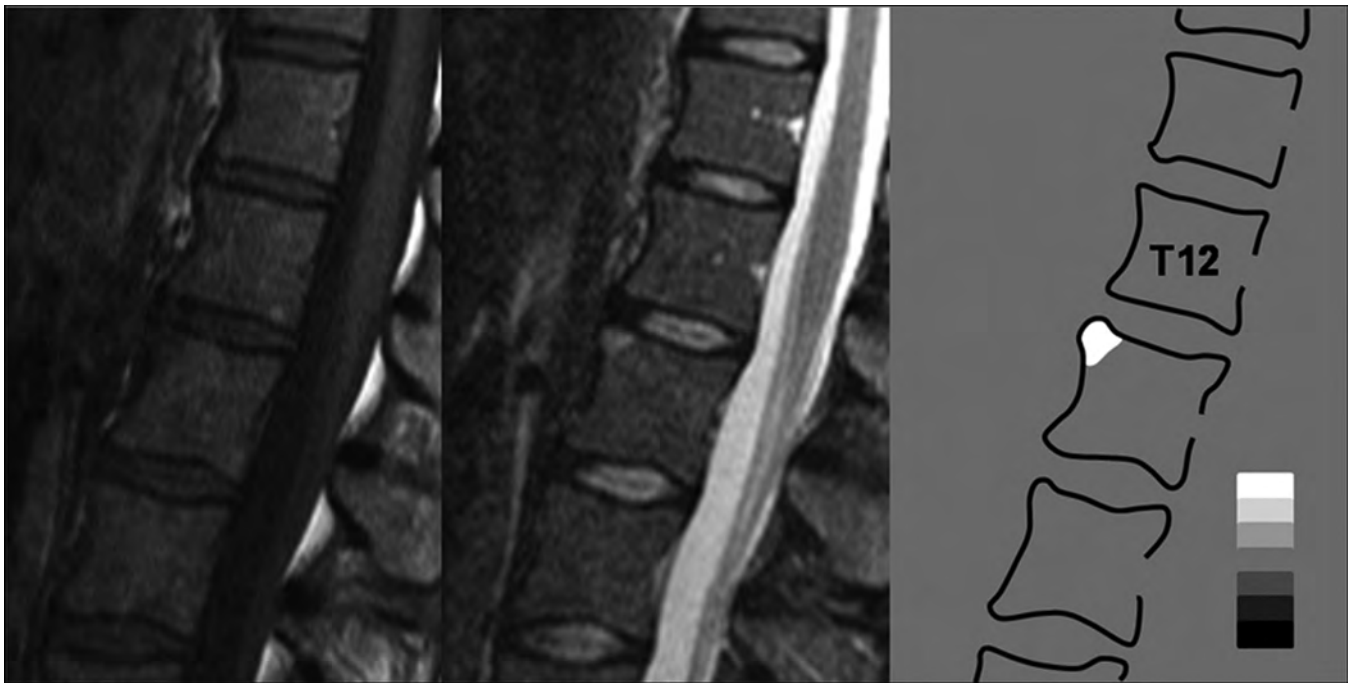

Figure 1. Corner inflammatory lesion (CIL). An anterior CIL (aCIL) is clearly identified as a solitary focus of increased signal intensity on this STIR image at the anterior border of the superior endplate of the first lumbar vertebra. Note that the disc and annulus fibrosus appear normal. The shape of the lesion is typical for a spondylitic process, being of equal length along the endplate and the anterior border of the vertebra. This and all other figures are designed according to the following format: Left: sagittal T1-weighted image of the spine; Center: matching sagittal STIR image of the spine; Right: diagram of STIR image depicting the anatomy and significant pathological lesions.

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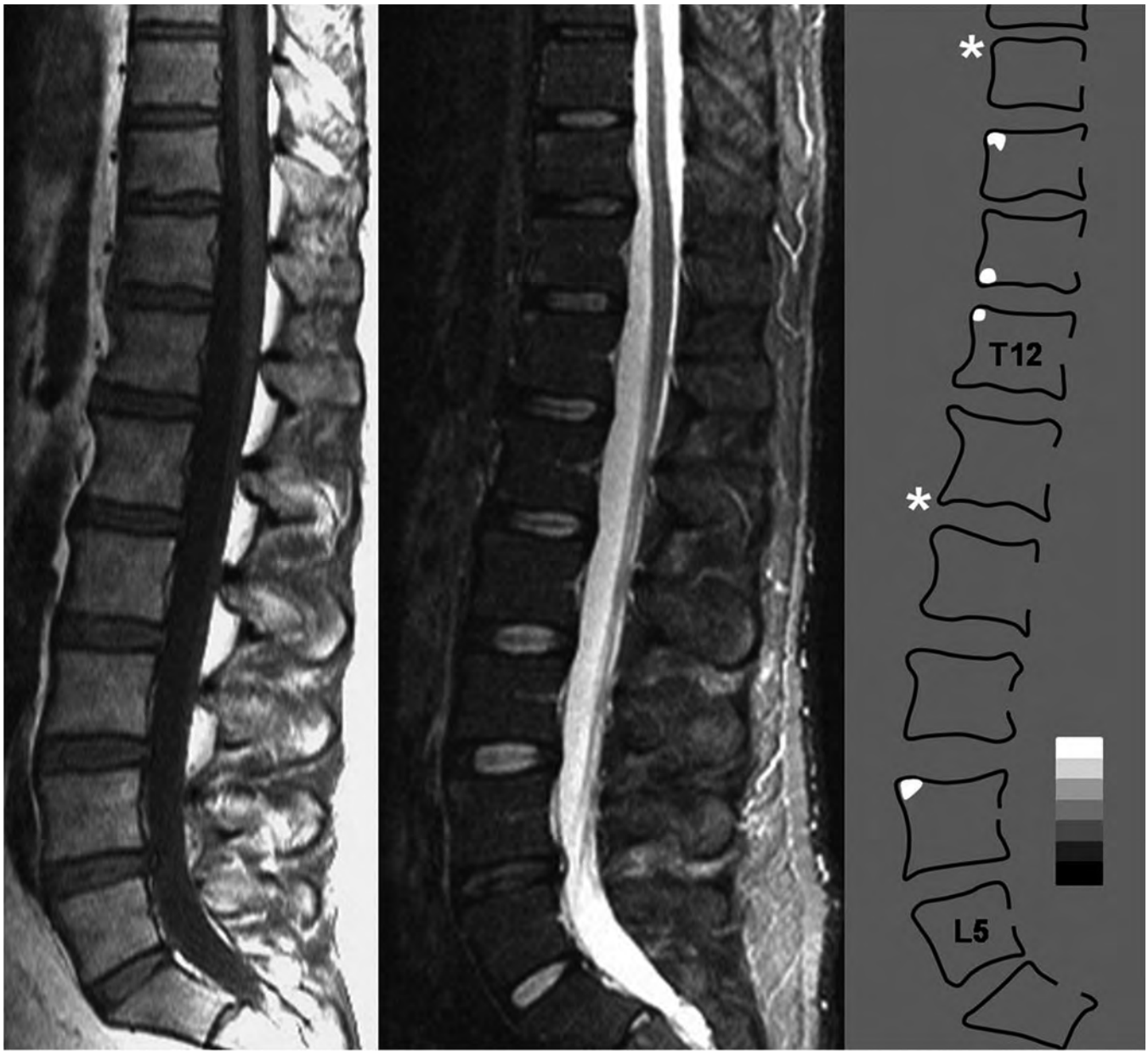

Figure 2. Anterior corner inflammatory lesions (aCIL). Threshold of detection. Small foci of bright signal intensity are identified at the anterior corners of multiple thoracic and lumbar vertebrae. Many factors have to be considered before deciding whether to call an MRI feature as "positive" for abnormality. The primary influences are overall image quality and lesion conspicuity, which is affected by size and signal intensity. The reader's confidence will be influenced by whether the finding is also observed on adjacent images. In this image, small aCIL are seen anteriorly at the corners of the endplates of T10 superior, T11 inferior, T12 superior, and L4 superior. All aCIL are regular (type A) and small (see Table 1 and Figure 3 below for explanation). Other tiny foci of possible signal alteration are just within normal limits (below the threshold of detection). These are marked with asterisks at T9 superior and L1 inferior endplates.

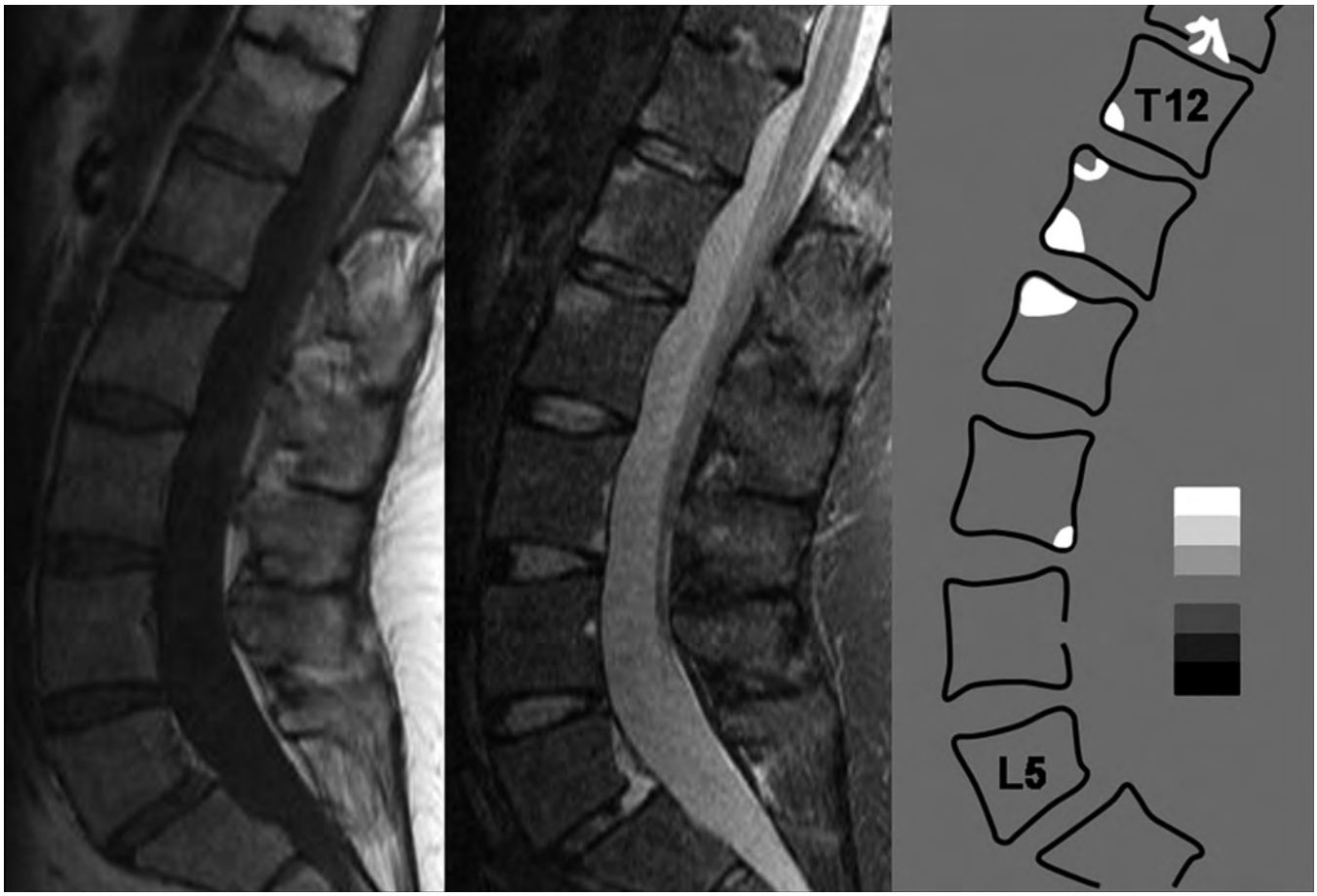

Figure 3. Corner inflammatory lesion (CIL). Variable appearances – size and type. CIL may vary in ways other than signal intensity. If a corner lesion itself reaches the corner, it is a regular CIL. Typical CIL are seen anteriorly at several endplates: T12 inferior, L1 inferior, and L2 superior. A posterior CIL (pCIL) is seen at the L3 inferior endplate. If the inflammatory lesion itself does not extend to the corner, but does extend to both the vertebral endplate and anterior cortex adjacent to the corner, then it is subclassified as a dimorphic CIL or type B CIL. A typical dimorphic aCIL can be seen at the L1 anterosuperior corner. It is likely that this appearance is an indication that the process in the extreme corner is at a different phase of evolution of the inflammatory process. If a corner inflammatory lesion involves more than 25% of the anterior-posterior diameter of original endplate and/or of the original height of the vertebra, in any central sagittal slice, it is considered "large." Large aCIL are seen in the endplates of L1 inferior and L2 superior whereas CIL at the other locations are not large. Finally, a non-corner IL is noted at the T11 inferior endplate (see Table 1 and Figure 4 for explanation).

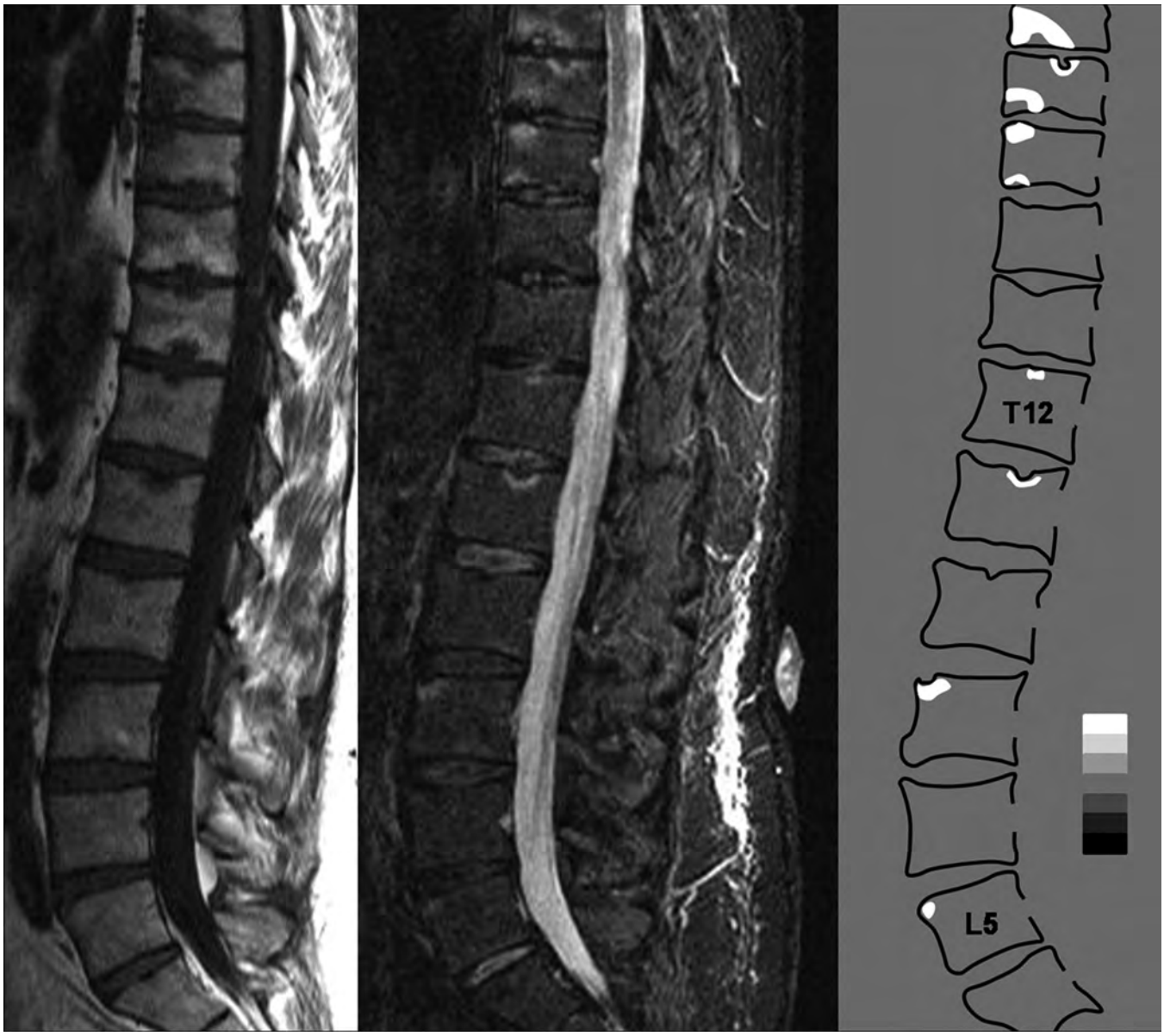

Figure 4. Non-corner inflammatory lesion (NIL). NIL is a focus of bright signal intensity on a T2FS or STIR image in the subchondral bone marrow adjacent to the vertebral endplate, which extends to neither the anterior nor the posterior border of the vertebra, in any central sagittal slice. Two typical NIL are seen at the endplates of T8 superior and at L1 superior. The inflammation often surrounds a small erosion of the endplate and is often crescentic in shape. A tiny NIL is also present at T12 superior. This lesion is precisely at the lower limit of detection, and reader confidence may be influenced by the high quality of the image (lack of artefact) and the presence of a corresponding abnormality of the T1-weighted image. Other lesions in this figure include regular aCIL at T7 inferior (with abnormal endplate), T9 superior, T9 inferior, and L5 superior; and dimorphic aCIL at T8 inferior and L3 superior.

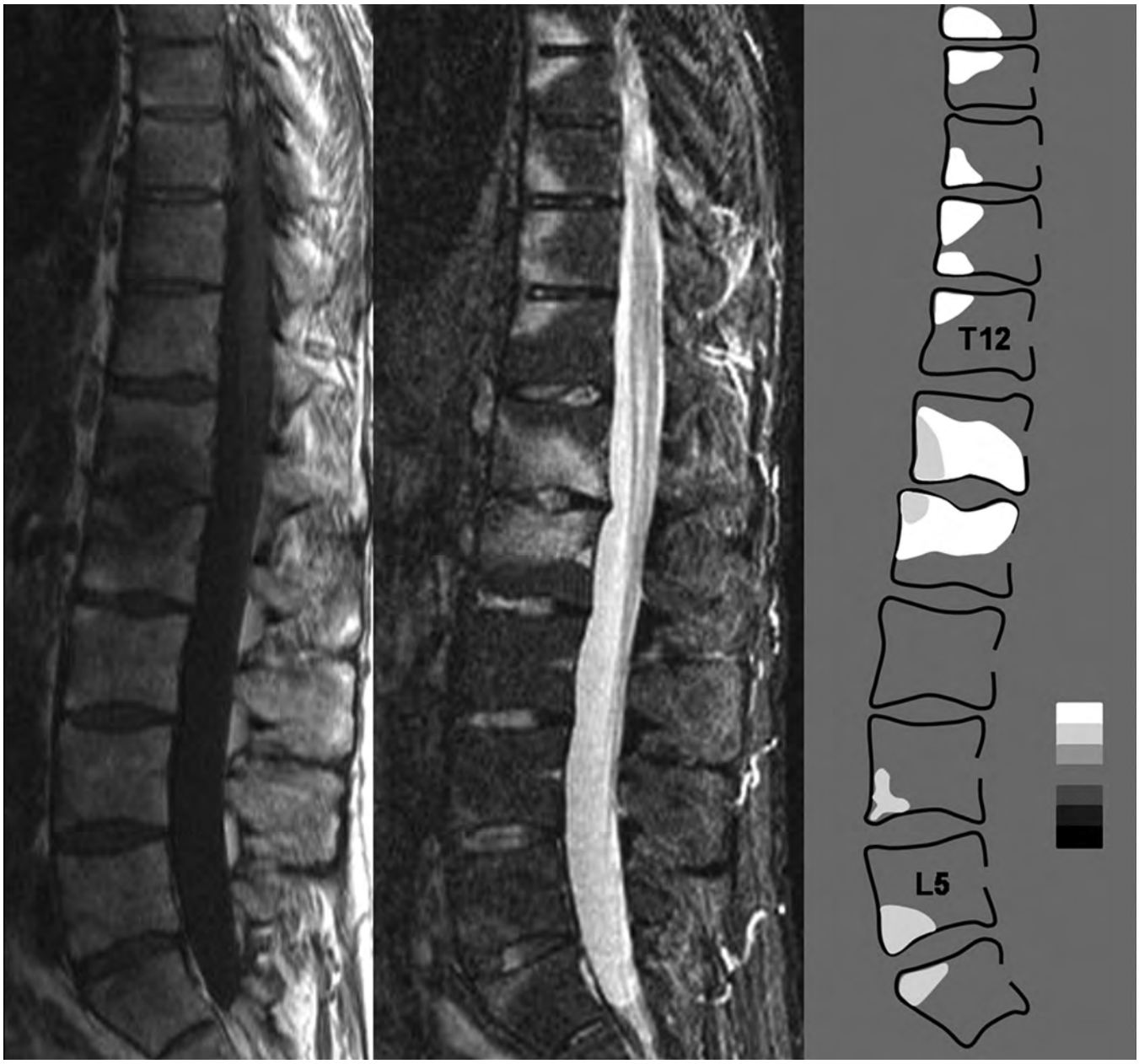

Figure 5. Massive inflammatory lesion (MIL). MIL is a focus of bright signal intensity on a T2FS or STIR sequence within the subchondral bone marrow of a vertebra, which in at least one central sagittal slice involves both the anterior and the posterior corners and is continuous across the entire anterior-posterior vertebral diameter. Typical MIL are present at the endplates of L1 inferior and L2 superior. This represents extensive active spondylodiscitis. In this patient, large CIL are seen anteriorly at T8 inferior, T9 superior, T10 inferior, T11 superior, T11 inferior, and T12 superior corners. More subtle aCIL are present at L4 inferior, L5 inferior, and S1 superior. Of these, the aCIL at L5 inferior and S1 superior clearly meet the definition of being large.

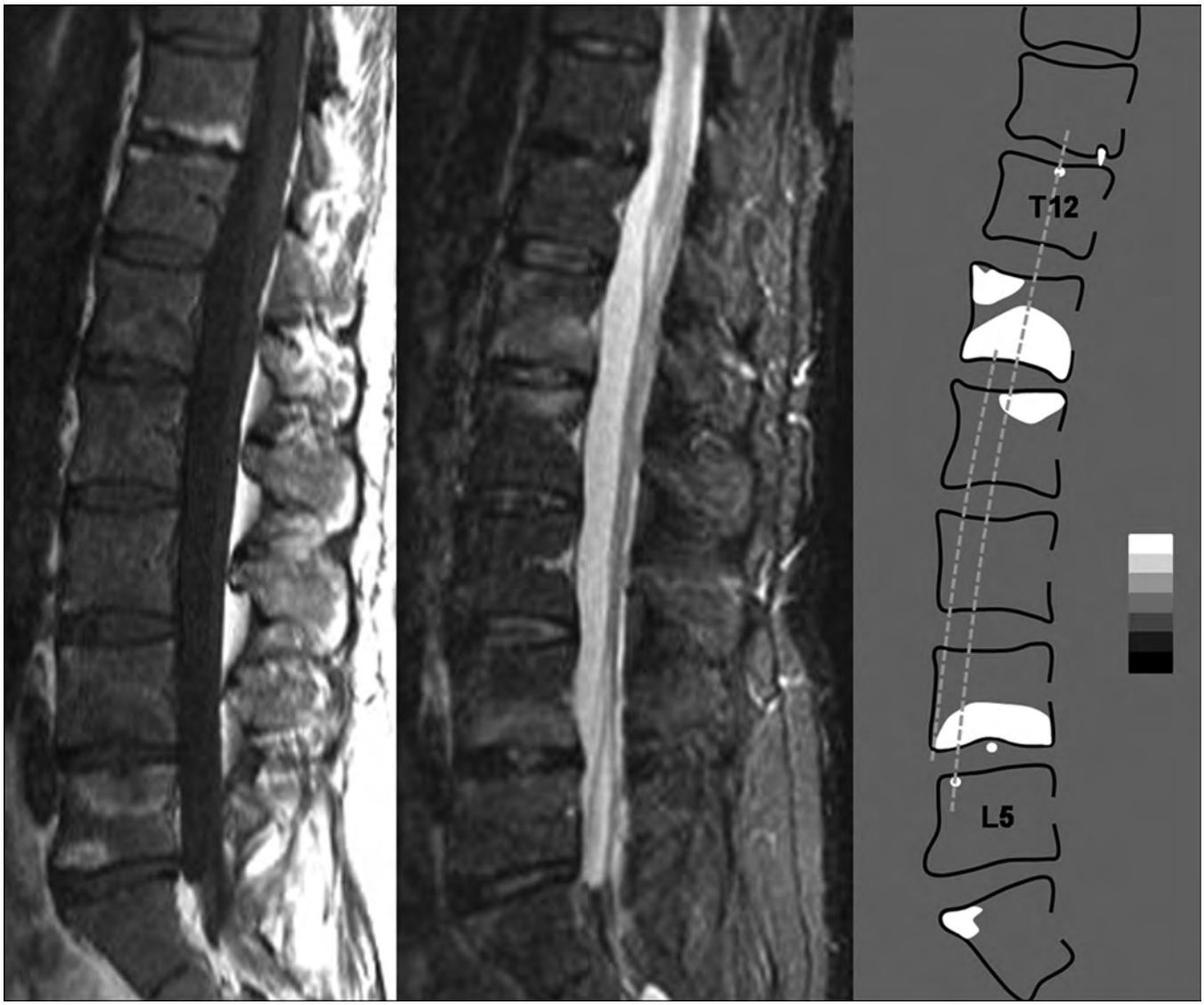

Figure 6. Pitfalls – phase-encoding artefact. In this case the STIR image is difficult to read in some areas. A phase-encoding artefact produces a false increase in signal intensity that is easiest to see as it crosses the L3 vertebra and adjacent discs (dotted line). Several obvious lesions are present: aCIL in the endplates of L1 superior and S1 superior, pCIL at L2 superior, and MIL at L1 inferior and L4 inferior. However, other small areas of irregular signal are more difficult to interpret. A tiny bright focus at T11 is partly in the disc and too small to call positive. A tiny bright focus at the superior endplate of T12 is too small to count and also lies in the plane of the artefact. A tiny bright focus seen in the L4/5 intervertebral disc is highlighted to illustrate that it is clearly in the disc and should be ignored. Finally, another tiny irregularity is observed at the anterosuperior border of L5. The presence of an obvious abnormality at this level on the T1 image and in the adjacent L4 vertebra might persuade one that the finding is a genuine abnormality. However, the focus of altered signal is once again precisely in line with the phase-encoding artefact. It is impossible to be certain whether the "abnormality" seen at L5 on the STIR sequence is genuine or not.

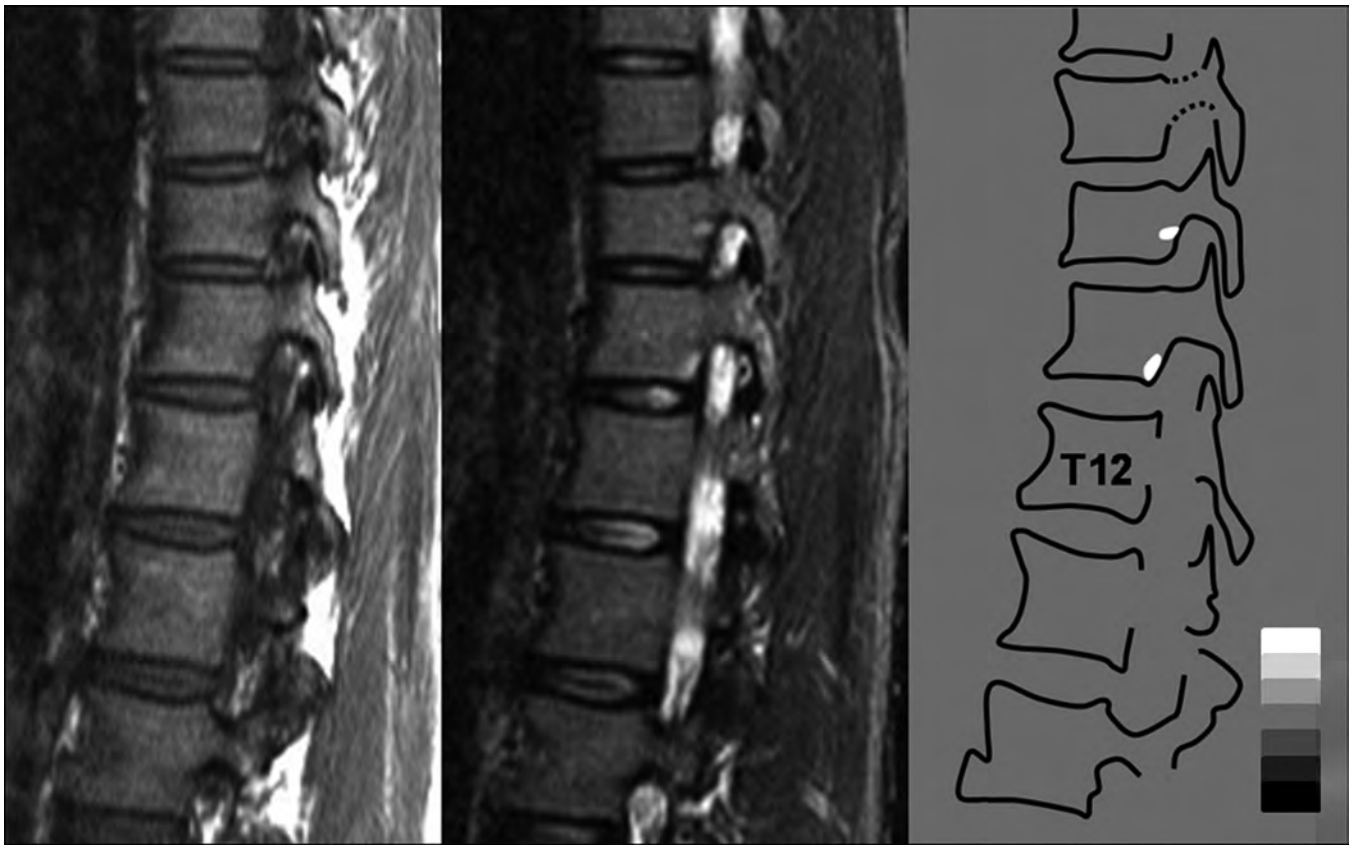

Figure 7. Lateral inflammatory lesion (LIL). Foci of vertebral body inflammation identified on sagittal images that include the pedicle are defined as a LIL. In this example, a small LIL is present at the posterior corner of the inferior endplate of T11 (T11 inferior). A second focus of bright signal projected over the T10 vertebral body at the inferior border of the pedicle is a normal structure – an epidural vein exiting the neuroforamen. It is also important to be aware how anatomy may vary from level to level and slice to slice, a feature that is exaggerated with even mild scoliosis. In these images, the T10, T11, and L2 vertebra are "lateral slices" through these levels. At T12 and L1, the images are "central slices" as the pedicles are not continuous between vertebral body and posterior elements (see Table 1 for definitions of central and lateral slice), a feature that is more easily discerned on the T1-weighted images. However, at T9, the STIR image appears "lateral" and the T1 image "central." This may occur either because of variation in artefact (partial-volume averaging) or because the patient moved between the acquisition of the 2 images.

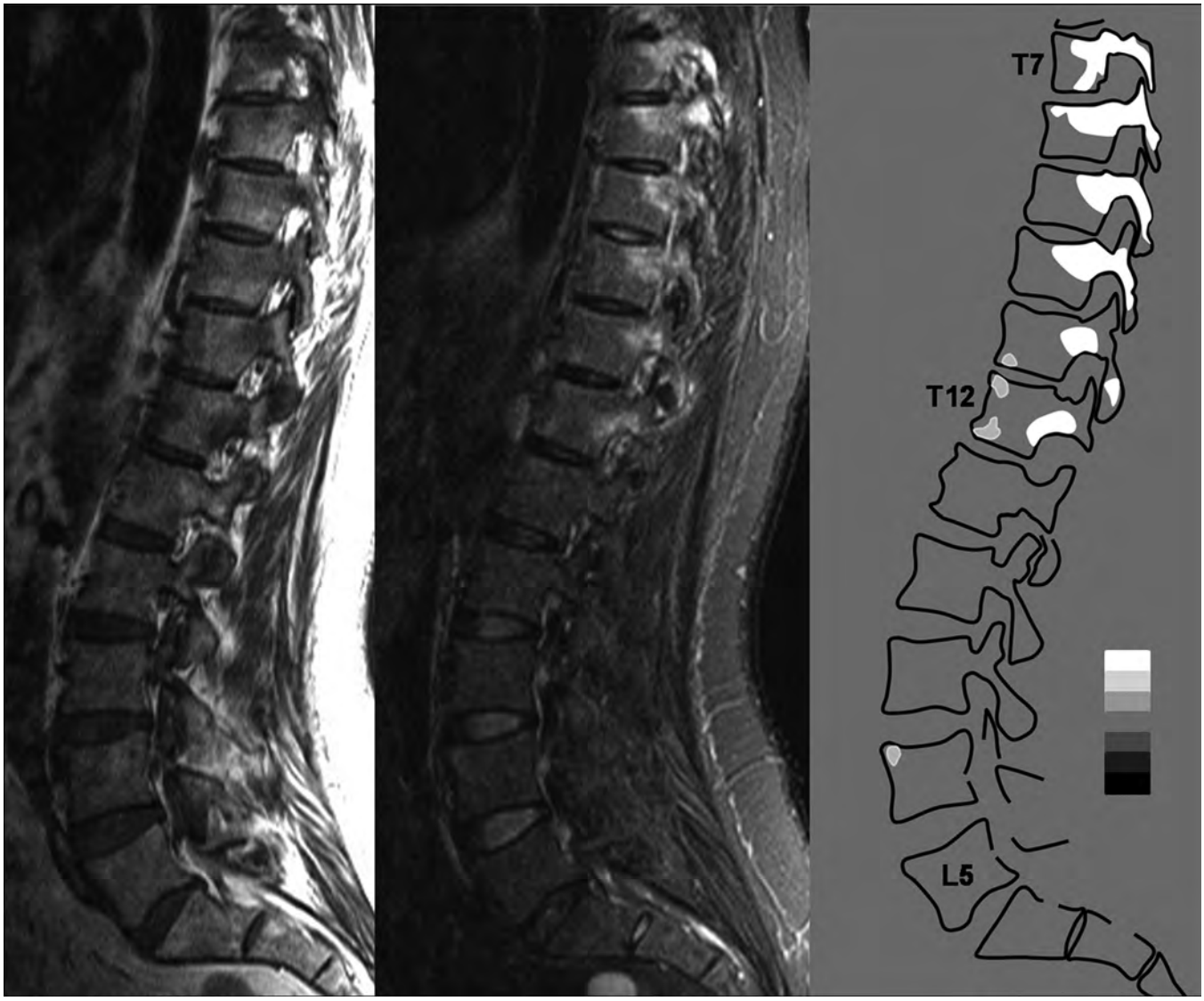

Figure 8. Lateral inflammatory lesions (LIL) and facet joint inflammatory lesions (FIL). Multiple foci of inflammation are easily identified in the lateral aspects of 6 consecutive thoracic vertebrae (T7–T12). At T7/8, intense edema is present in the facet processes. More mild edema is also seen in the facets at other levels. The vertebral body edema may develop in relation to processes that arise primarily in the posterior elements or the body itself. At all 6 levels in this case, some or all of the edema is due to costovertebral inflammation. It is possible to be certain of this at T11 and T12. At these 2 levels, the crescentic inflammation in the vertebral body extends part way across the pedicle without reaching the vertebral endplate, facet, or other posterior element structures. This is because of the anatomy of the head of the rib, which articulates directly with the side of the vertebra and the pedicle – always at T12 and usually at T11. At all other thoracic levels, the rib articulates with the vertebrae at the level of the discs and endplates. Faint anterior lesions are present at T11 (inferior), T12 (superior and inferior), and L4 (superior) but only the L4 lesion is an aCIL because the image is only a central slice at L4 and L5.

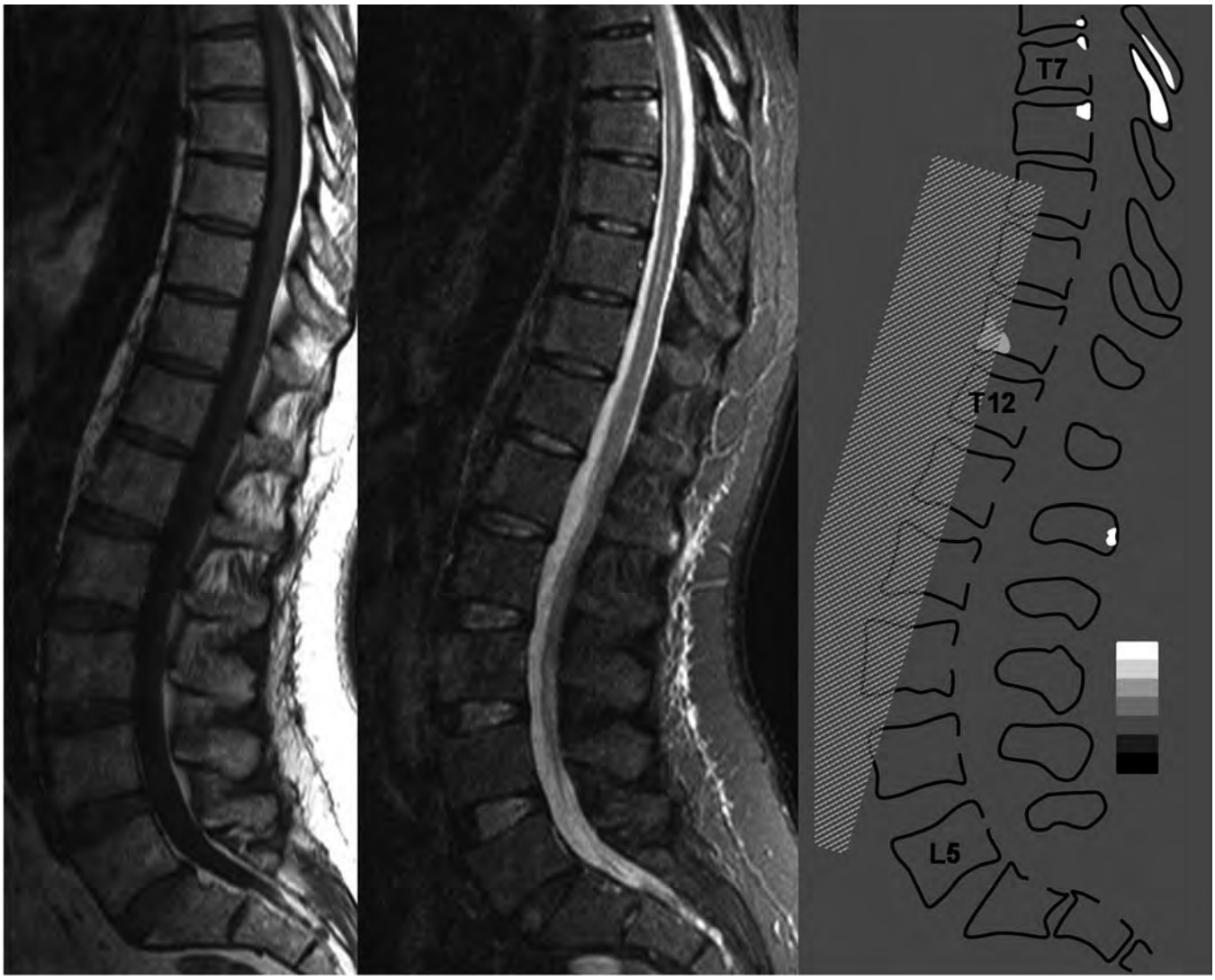

Figure 9. Posterior element inflammatory lesion (PIL). Spinous process. Intense bone marrow edema is seen as bright signal in the spinous processes of the T6 and T7 vertebrae, with a smaller lesion at the tip of the L1 spinous process. These lesions are classified as PIL, representing increased signal in bone marrow on STIR/T2FS in posterior elements other than the pedicle, facet joint process, or pars interarticularis. A small posterior CIL is present in the T8 vertebral body. Tiny foci of inflammation are also present in the posterior corners of the T6 and T7 vertebrae on either side of the T6/7 intervertebral disc. Despite the very small size of these lesions (pCIL), they are conspicuous against the dark background of the fat-suppressed bone marrow. In the lumbar spine, a heterogeneous phase-encoding artefact (hatched area in diagram) is projected across the anterior aspects of most of the vertebral bodies, and no definite abnormalities are present at most of these levels. A faint anterior CIL is present at T11, positive at the threshold of detection.

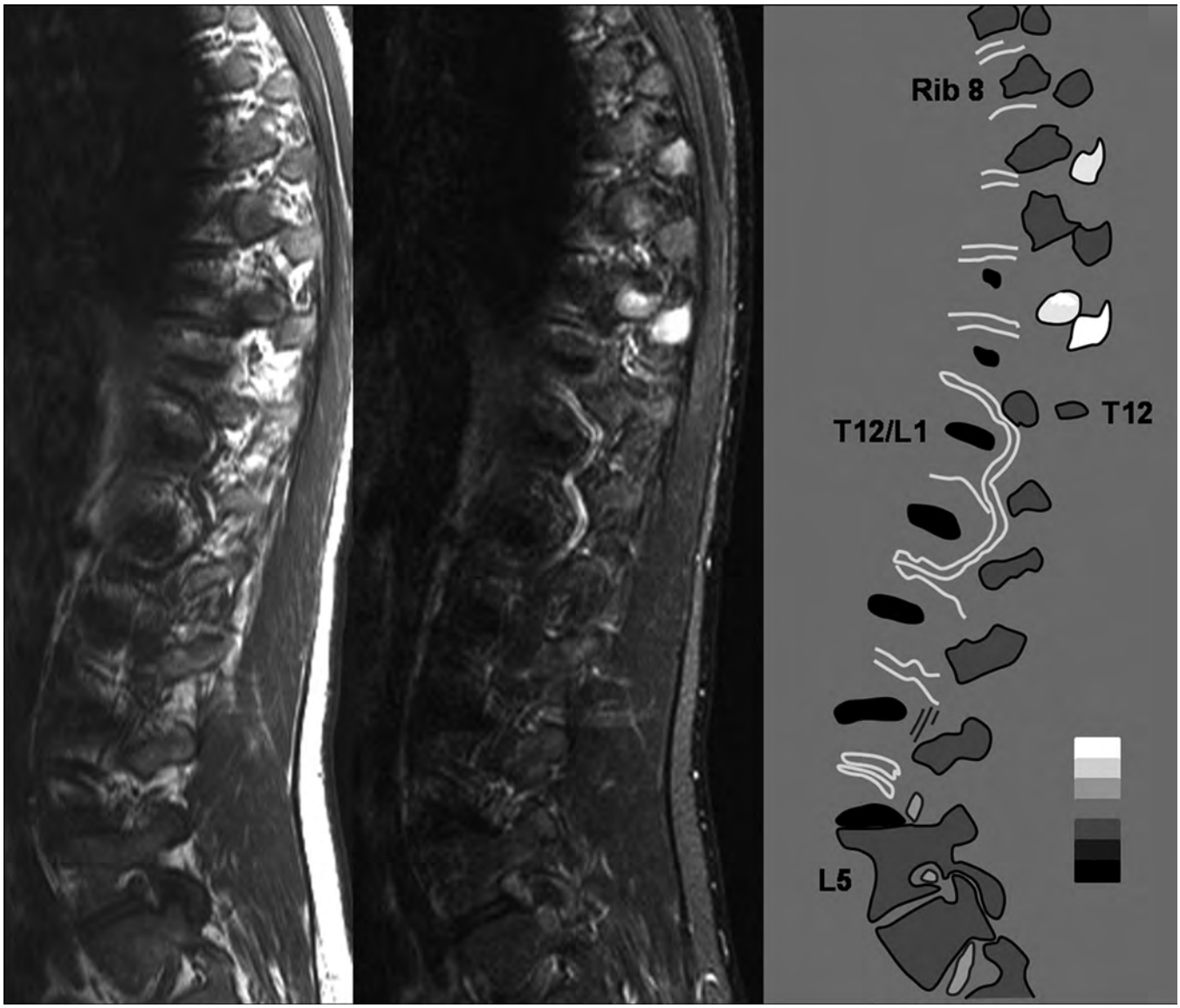

Figure 10. Posterior element inflammatory lesions (PIL). Transverse process. In this extreme lateral slice, the image at most levels is lateral to the vertebral body. Bone marrow edema is clearly seen in the T9 and T11 transverse processes and the 11th rib. Black: annulus fibrosus of the lateral aspect of the intervertebral disc; dark grey: normal bone; light grey: nerve; white curved line: para-vertebral vein.