Oncologic Imaging
Spine and Spinal Cord Tumors

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To my co-authors, Joon Woo Lee and Eugene Lee, who proved their excellence and hard work through the publishing process of this book.

Heung Sik Kang

To God, for his eternal love and support.
To my wife, Cho, for her love and support.

Joon Woo Lee

To my parents, Lee and Chun, whom I love and respect most in the world.
Thanks to the two respected teachers, Kang and Lee, for their warm heart and understanding.

Eugene Lee

Preface

Tumors of the spine and spinal cord can be neurologically and systemically devastating, and can manifest as nonspecific back pain, making their correct diagnosis crucial for effective prognosis.

However, only a limited number of textbooks are available for clinicians and radiology trainees who are interested in embarking upon a self-learning course in imaging interpretations of spine and spinal cord tumors. With this point in mind, this book consists of three sections: warm-up part of basic concepts, tumor details, and practical tips for differential diagnosis. To enhance the readers' understanding, a total of 538 illustrations have been included.

There are several characteristic features of *Oncologic Imaging: Spine and Spinal Cord Tumors*. First, we describe the compartmental approach and histological basis of imaging appearances and then suggest the systemic approach to image interpretation for spine and spinal cord tumors in Part I. This section will be very useful for trainees in understanding the basic concepts of imaging interpretation for spine and spinal cord tumors. Second, we show the top three tumors for each compartment (e.g., intramedullary) or special condition (e.g., childhood), based on their incidence and clinical impact. For these top three tumors, we provide several cases for the readers to fully understand the imaging characters. Third, we attempt to cover all spine and spinal cord tumors that have been reported until recently according to Google search results, and we present these tumors in an alphabetical order with representative cases. This section will be useful as a quick reference when encountering difficult cases during routine practice. Finally, this book presents common confusing tumors with practical tips for differential diagnoses and case illustrations.

This book is intended for physicians and radiologists caring for patients with spine and spinal cord tumors. We hope that the readers will find this self-learning journey as richly rewarding as it has been for the authors over the course of its preparation.

Finally, we would like to thank Dr. Le Roy Chong for his assistance in editing the manuscript and our clinical fellows (Hoseok Lee, Yun Hee Cho, Yeon Jee Ko, Jiwoon Seo, Chi Young Park, and Yeon Hong Yoon) for their assistance in case preparation.

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Part I

Warm-Up: Basic Concepts

Compartmental Approach to Spinal Tumors

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Contents

The first step in the compartmental approach to spinal tumors is to determine if the lesion is intraosseous, extradural, intradural extramedullary (IDEM), or intramedullary (IM) in location. The possible differential diagnoses and optimal surgical approaches of these tumors are different depending on their compartmental location. In most cases it is not difficult to identify the compartment in which these tumors are situated on MRI, although it can be confusing in some instances. In the chapter, we will discuss radiological clues that can be helpful in localizing the compartment to which these tumors belong.

1.1 Extradural Versus Intradural Tumor

The main clues favoring an extradural tumor are extrinsic dural sac compression and tumor extension into the neural foramen. With severe tumor compression of the dural sac, however, it can be difficult to tell if the dural/cord compression is extrinsic (by an extradural tumor) or due to a space occupying lesion within the dura (by an intradural tumor). The clue that points toward an extradural tumor lies in the appearance of the subarachnoid space at the margin of the tumor; due to extrinsic compression of the dura, the subarachnoid space between the dura and spinal cord is obliterated at its margin of the tumor. With an intradural tumor, the dura bulges out instead with

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a convex appearance, while the cord is compressed by the tumor, resulting in widening of the subarachnoid space at the edge of the tumor.

1.2 Intradural Extramedullary Versus Intramedullary Tumor

The clue that can be used to differentiate an extramedullary from an intramedullary tumor lies in the appearance of the outer contour of the spinal cord at the margin of the tumor. With an extramedullary tumor, the outer contour of the spinal cord at the interface with the tumor is indented upon and compressed by the tumor resulting in widening of the subarachnoid space, whereas with an intramedullary tumor the outer contour of the spinal cord has a convex bulge resulting in narrowing of the subarachnoid space.

Exophytic intramedullary tumors can occasionally be confusing and mimic appearances of extramedullary tumors, especially in the lower thoracic spinal cord and conus medullaris. In such cases, the axial images have to be reviewed carefully. With intramedullary tumors part of the tumor can be shown to be contiguous with the spinal cord, and if this can be established, it can be concluded that the tumor originates from the spinal cord.

1.3 Illustrations: Compartmental Approach to Spinal Tumors

1.3.1 Four Compartments of the Spine

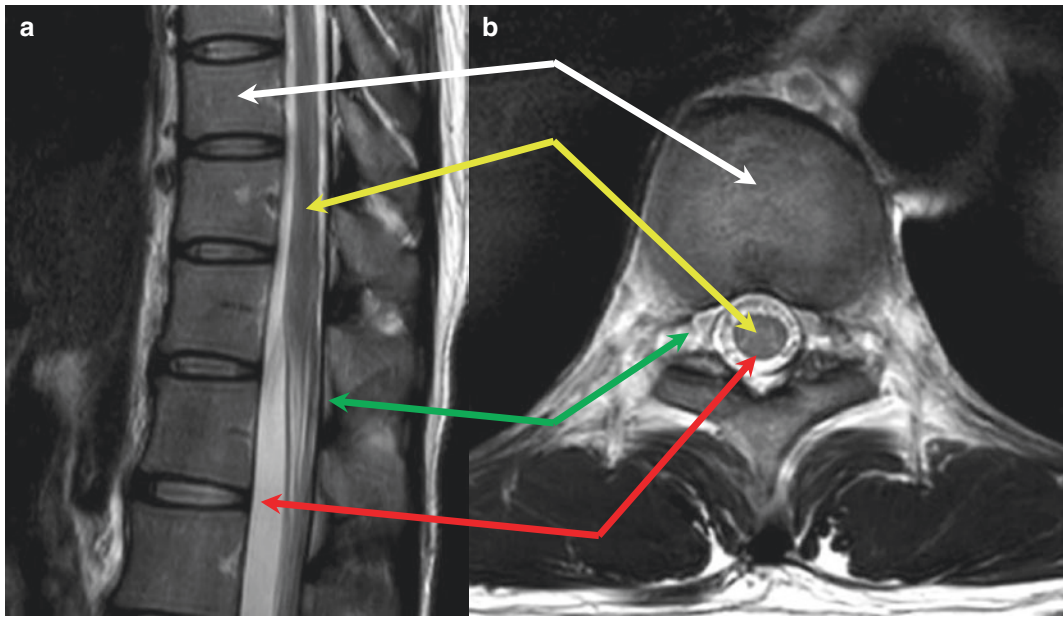

Fig. 1.1 The concept of compartmental locations of the spine on the T2-weighted magnetic resonance (MR) images, sagittal (**a**) and axial (**b**) scans. The compartments are composed of four different locations: intraosseous (*white arrow*), intramedullary (IM, *yellow arrow*), extradural space (*green arrow*), and intradural extramedullary (*red arrow*)

1.3.2 Extradural Versus Intradural Tumor

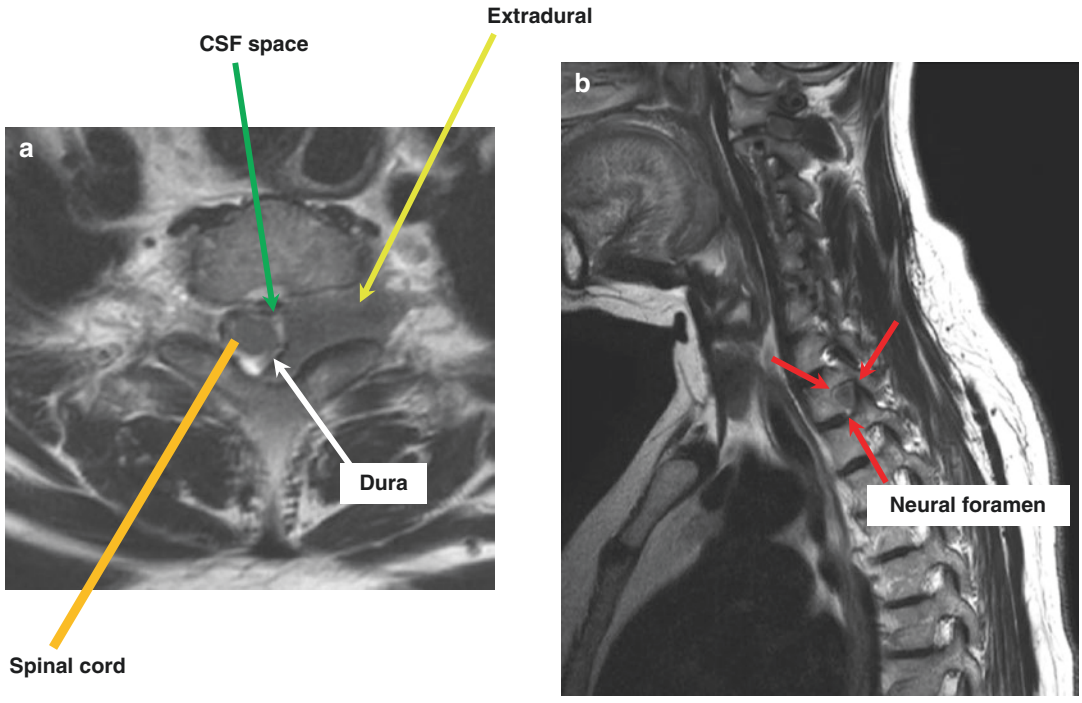

Fig. 1.2 An approximately 2 cm extradural mass encasing the left T1 nerve root in a 58-year-old female. The axial T2-weighted image (**a**) shows extrinsic dural sac compression (*white arrow*) and tumor extension to the neural foramen (*yellow arrow*). The subarachnoid space between the dura and spinal cord (*green arrow*) is obliterated at the margin of the tumor due to extrinsic compression by the tumor. The sagittal T2-weighted image (**b**) shows widening of the neural foramen due to tumor extension

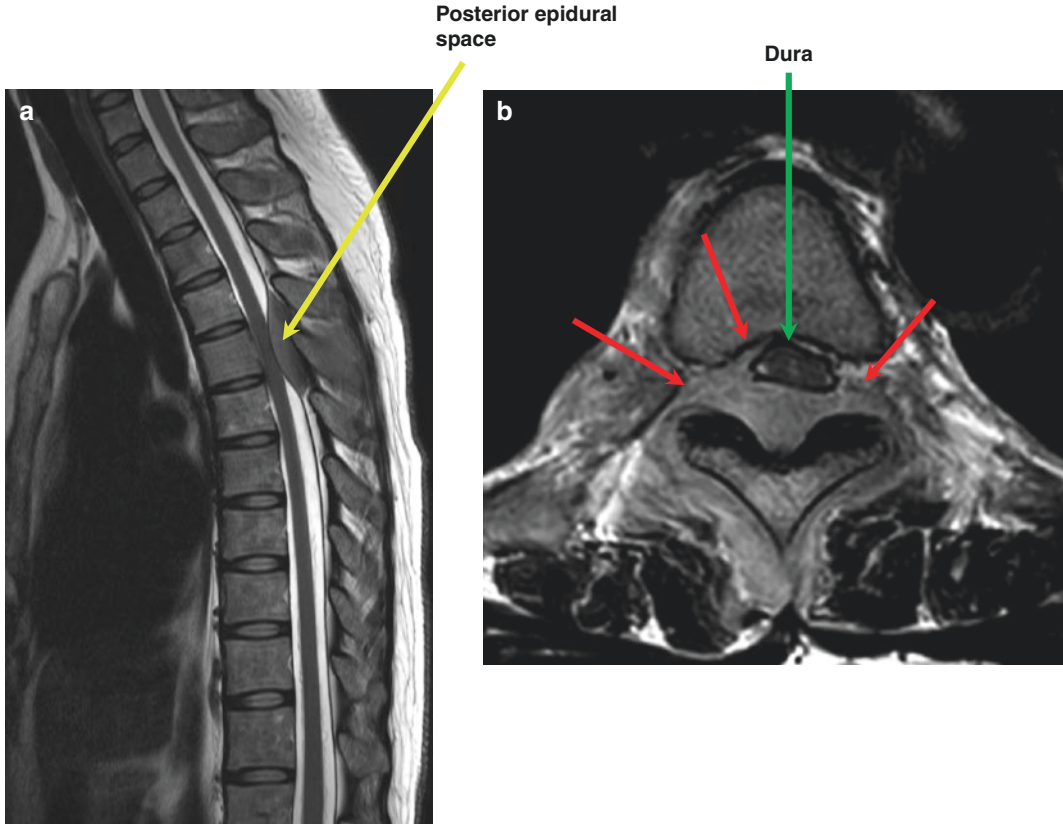

Fig. 1.3 Known B-lymphoblastic lymphoma involvement of the extradural space from T4 to T6 in a 48-year-old female. (**a**) Tumor is mainly located in the posterior epidural space with dural sac compression (*yellow arrow*). The subarachnoid space is obliterated anteroposteriorly with mild cord compression. (**b**) Axial T2-weighted MR image shows severe tumor compression of the dural sac (*green arrow*). Tumor also extends into the bilateral neural foramen and anterior epidural space (*red arrows*)

1.3.3 Intradural Extramedullary Versus Intramedullary Tumor

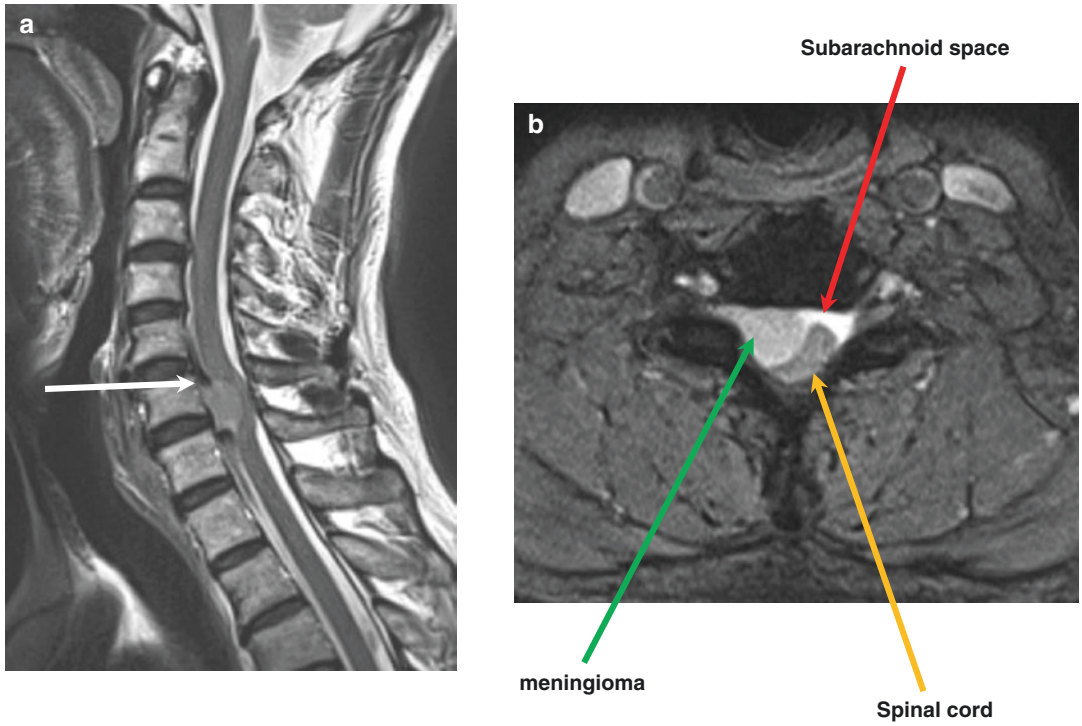

Fig. 1.4 An approximately 1.5 cm intradural extramedullary (IDEM) mass at C6–C7 spinal level in a 63-year-old female. (**a**) The sagittal T2-weighted image shows a high signal intensity mass with "dural tail sign" (*white arrow*) combined with craniocaudal flow artifact. There is severe cord compression by the tumor. (**b**) On the axial T2-weighted MR image, there is left-sided cord deviation with signal change indicating compressive myelopathy (*yellow arrow*). The outer contour of the spinal cord at the interface with the tumor is indented and compressed by the tumor resulting in widening of the subarachnoid space (*red arrow*). All these findings (**a**, **b**) are compatible with an intradural extramedullary tumor, such as a meningioma

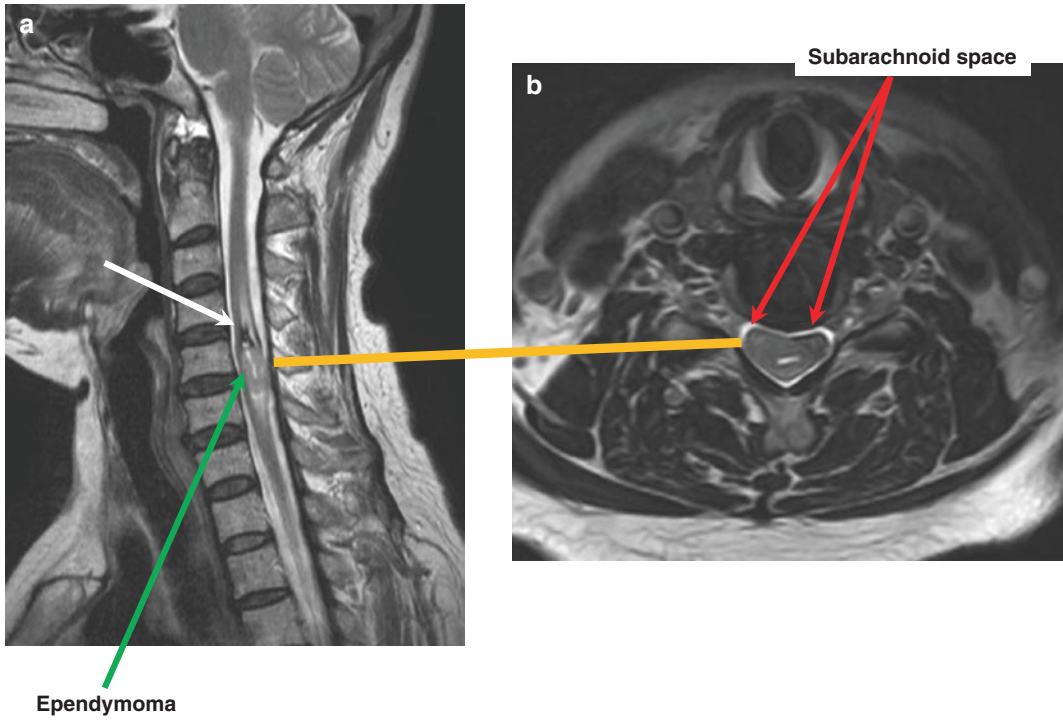

Fig. 1.5 Intramedullary ependymoma at C5–C6 spinal level (*green arrow*) in a 37-year-old female. (**a**) The sagittal T2-weighted MR image shows a 1.5 cm well-defined intramedullary mass with surrounding cord edema and hemosiderin deposition ("hemosiderin cap") at its cranial aspect (*white arrow*). (**b**) The axial T2-weighted MR image shows that the outer contour of the spinal cord has a convex bulge resulting in narrowing of the subarachnoid space (*red arrow*)

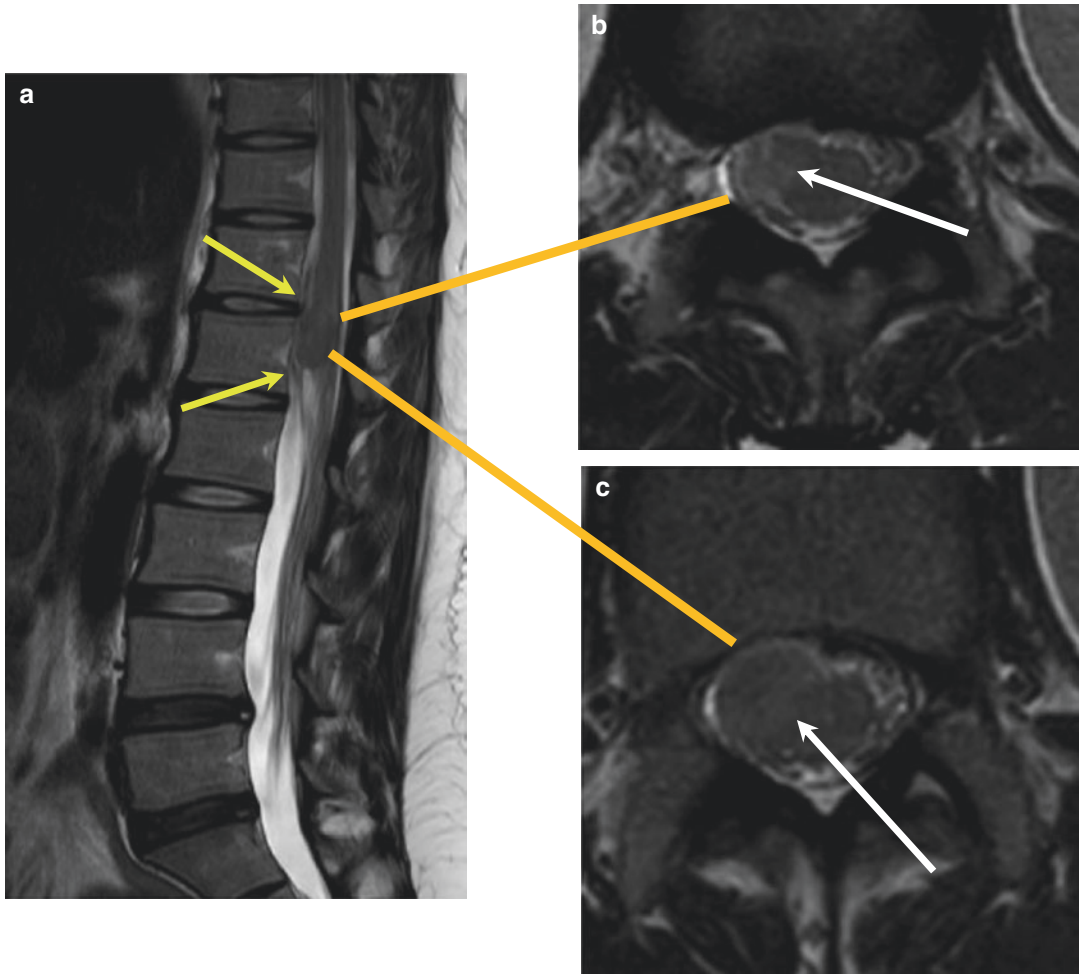

Fig. 1.6 Exophytic intramedullary tumor at the conus medullaris in a 46-year-old female. (**a**) On the sagittal T2-weighted image, the tumor mimics appearance of an intradural extramedullary tumor with cord compression (*yellow arrow*). (**b**, **c**) The axial T2-weighted MR images show that part of the tumor is contiguous with the spinal cord (*white arrows*), and it can be concluded that the tumor originates from the spinal cord

Bibliography

Kang HS, Lee JW, Kwon JW. Radiology illustrated: spine. Heidelberg: Springer Science & Business Media; 2014.

Kim DH, Chang U-K, Kim S-H, Bilsky MH. Tumors of the spine. Philadelphia: Elsevier Health Sciences; 2008.

Merhemic Z, Stosic-Opincal T, Thurnher MM. Neuroimaging of spinal tumors. Magn Reson Imaging Clin N Am. 2016;24(3):563–79. doi:10.1016/j.mric.2016.04.007.

Ross JS, Moore KR. Diagnostic imaging: spine. Philadelphia: Elsevier Health Sciences; 2015.

Cramer GD, Darby SA. Clinical anatomy of the spine, spinal cord, and ANS. Philadelphia: Elsevier Health Sciences, 2013.

Histologic Basis for Imaging Appearances of Spinal Tumors

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Contents

It is important to understand the histologic basis for the imaging appearances of spinal tumors in order to arrive at the correct diagnosis or formulate reasonable differential diagnoses. For example, hemangiomas in the vertebral bodies commonly contain fatty stroma and reveal high T1 and T2 signal on MR imaging, which is the main clue for its diagnosis. Highly cellular tumors such as lymphomas show intermediate signal intensity on T2-weighed images, which is also a clue for its diagnosis.

2.1 Tumors with Fatty Component

Fatty components within tumors show high signal on T1-weighted and T2-weighted MR images and can be suppressed with fat suppression MR techniques. The most common tumor containing fatty component is a hemangioma. If we see a fat-containing tumor in the vertebral body, the most probable diagnosis is that of a hemangioma. However, note that in contrast to vertebral hemangiomas, epidural hemangiomas do not show fatty signal in most cases. The most common fat-containing tumor in the epidural space is an angiolipoma, while the most common fat-containing tumors in the paravertebral muscles are lipomas and liposarcomas.

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2.2 Red Marrow Component

Red marrow hyperplasia can mimic bony metastasis. Red marrow can show intermediate signal on T1-weighted images with patchy areas of slight enhancement. The signal of red marrow should be isointense or hyperintense to that of the intervertebral disc on T1-weighted images. Similar signal can be seen in multiple myeloma; however, multiple myelomas show strong enhancement in most cases.

2.3 Tumors with Vascular Component

Vascular components of spinal tumors show strong enhancement similar to those seen in venous structures on MRI. Usually, these vascular components show high signal intensity on T2-weighted images; however, in cases of intratumoral hemorrhage areas of low signal intensity can be seen on T2-weighted images. Common vascular tumors of the bony vertebrae include hemangiomas, telangiectatic osteosarcomas, and aneurysmal bone cysts. The common vascular tumors in the epidural space are hemangiomas and angiolipomas. The most common vascular tumor in the intradural extramedullary space is a paraganglioma, and the most common vascular tumor in the spinal cord is a hemangioblastoma.

2.4 Tumors with High Cellularity

Highly cellular components of tumors show intermediate signal intensity on T2-weighted images and demonstrate enhancement. This is often seen in lymphomas and meningiomas and can be found in some highly cellular metastases or sarcomas.

2.5 Tumors with Hemorrhagic Component

Hemorrhagic components within tumors can show variable signal intensity depending on the stage of bleeding. Chronic repetitive bleeding can result in hemosiderin deposition within or around the tumor. Hemosiderin is of dark signal on T1-weighted and T2-weighted images. Such signal change can be exaggerated on gradient echo images due to susceptibility blooming artifacts.

2.6 Tumors with Calcification/ Ossification

Calcification/ossification can be more easily and reliably detected on CT compared to MR images, demonstrating high attenuation on CT images while on MRI showing low signal intensities on all sequences. Intratumoral calcifications can be seen in chondrosarcomas and meningiomas, while intratumoral ossification can be found in osteoblastomas and osteosarcomas.

2.7 Illustrations: Histologic Basis for Imaging Appearances of Spinal Tumors

2.7.1 Tumors with Fatty Component

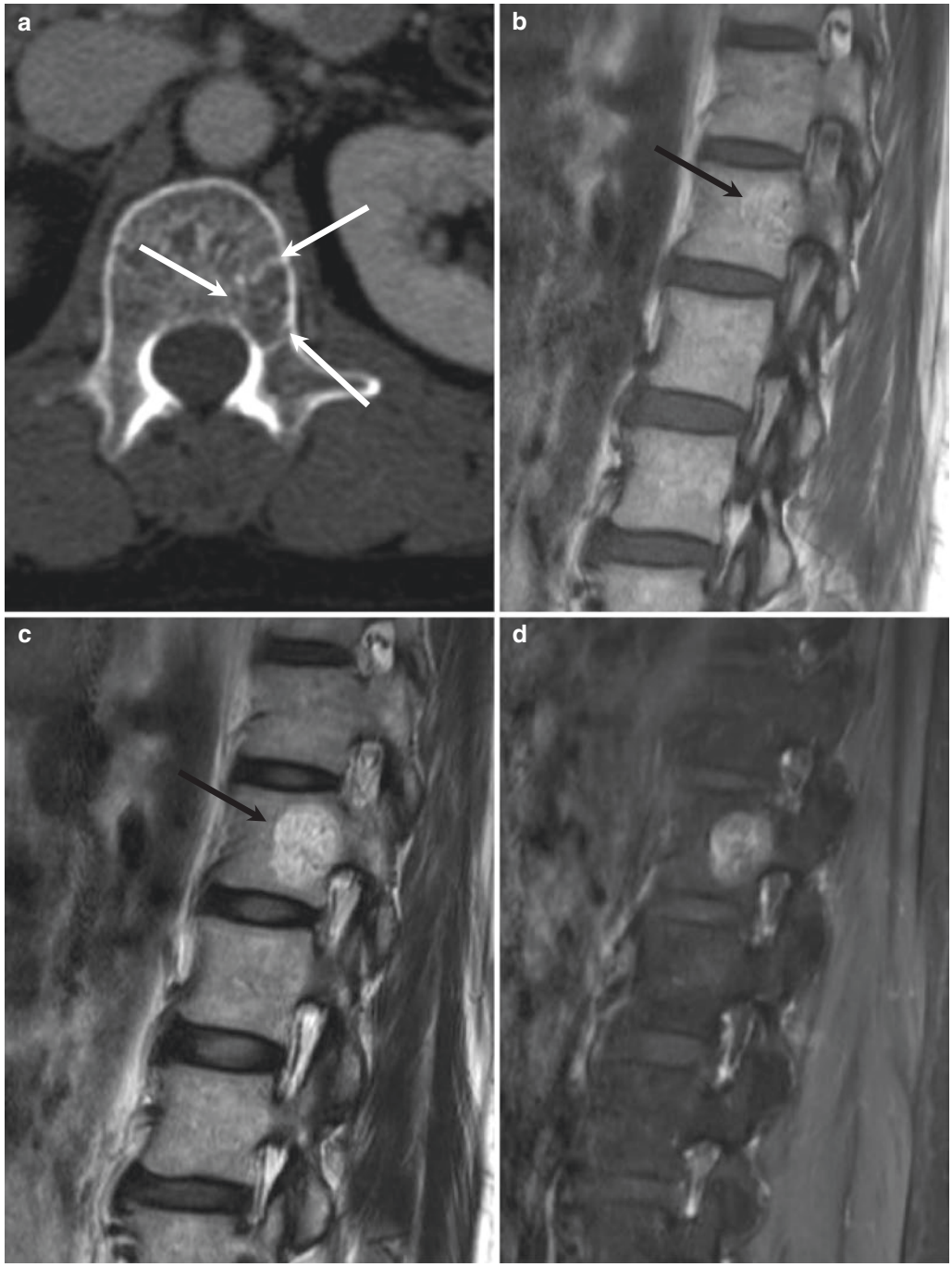

Fig. 2.1 Hemangioma at L1 vertebra in a 57-year-old woman. Axial CT scan of lumbar spine (**a**) shows an osteolytic lesion in the left posterior corner of the vertebral body with internal dot-like trabeculation (*white arrows*). T1-weighted sagittal (**b**) and T2-weighted sagittal (**c**) MR images show high signal intensities indicating internal fat component with preserved coarse trabeculation (*black arrows*). Contrast-enhanced T1-weighted sagittal MR image (**d**) shows avid enhancement