

1 MS Lesions in T2-Weighted Images

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1.1 Introduction

Multiple hyperintense lesions on T2- and PD-weighted sequences are the characteristic magnetic resonance imaging (MRI) appearance of multiple sclerosis (MS). The majority of the lesions are small, although they can occasionally measure several centimeters in diameter. Focal MS lesions are usually round or oval in shape and relatively well circumscribed.

MS lesions may occur in any part of the central nervous system where myelin exists, but lesions around the ventricles and the corpus callosum are highly suggestive. Other common sites of involvement are subcortical and infratentorial regions (Ge 2006). Although MS is a white matter disease, a subset of lesions may involve gray matter including the cerebral cortex, thalamus, and basal ganglia (Ormerod et al. 1987). Cortical involvement has been described in several pathological studies (Brownwell et al. 1962; Peterson et al. 2001), but these lesions may be missed on conventional MRI due to similarities in signal intensities of MS lesions and gray matter or partial volume effect of cerebrospinal fluid within the adjacent sulci (Kidd et al. 1999).

Postmortem studies have demonstrated a close correlation between the lesions seen on pathological examinations and the lesions seen on T2-weighted MRI (Stewart et al. 1984; De Groot et al. 2001). T2 hyperintensities are not specific, and almost any alteration in the brain tissue composition can change signal intensity.

Inflammation, demyelination, gliosis, edema, and axonal loss will increase the signal intensity, without any specific pattern (Bruck et al. 1997).

Most of the lesions – especially in the early stages of the disease – are discrete on conventional MRI, although diffuse changes throughout the normal-appearing white matter (NAWM) have been demonstrated by nonconventional MR techniques such as magnetization transfer imaging (MTI) (Ostuni et al. 1999), diffusion-weighted imaging (DWI) (Ciccarelli et al. 2002), and MR spectroscopy (De Stefano et al. 2002). Conventional T2-weighted MR images may also demonstrate diffuse, large, and irregular hyperintensities with poorly defined borders around the ventricles, especially adjacent to the occipital horn. They are known as dirty-appearing white matter (DAWM) and have been reported in 17% of the patients with remitting-relapsing multiple sclerosis (RRMS) (Zhao et al. 2000).

Acute T2 lesions may show a halo of less striking hyperintensity, probably consistent with edema that resolves over time, and they reach their final size within about 6 months.

With ongoing disease, new lesions or enlargement of preexisting lesions can be seen to occur simultaneously with the shrinkage of previously acute plaques. Most T2 lesions develop without clinical symptoms, but most clinical relapses are associated with new lesions on MRI (Smith et al. 1993; Thorpe et al. 1996). On average, MS patients will develop four or five new MRI lesions

per year, with great variability among individuals (Paty 1988).

Both cross-sectional and short-term longitudinal correlations between T2 lesion load and clinical impairment are generally poor (Rovaris et al. 2003; Barkhof 1999). Lack of pathological specificity for the extent of tissue destruction, inability of conventional MRI to detect damage in NAWM, limitations of the expanded disability status scale (EDSS), and occurrence of lesions in clinically “silent” areas are some of possible explanations for such a clinicoradiological paradox (Goodin 2006).

T2 lesions have a specific value in predicting the outcome of the patients presenting with clinically isolated syndrome (CIS). CIS patients

with normal cerebral MRI at presentation have only an 11% risk of another clinical attack in the next 10 years, whereas those with two or more cerebral lesions have a considerably higher risk (90%) (O’Riordan et al. 1998). Changes in the number and volume of T2 lesions have been used as surrogate markers in clinical trials of new therapeutic agents. These measures are based on the evaluations of serially obtained images and generally require image acquisition according to a standardized protocol (Simon et al. 2006).

This chapter deals with typical as well as atypical MS lesions on T2-weighted images, presenting MS lesions in different patterns, sizes, and locations.

1.2 Shape and Size

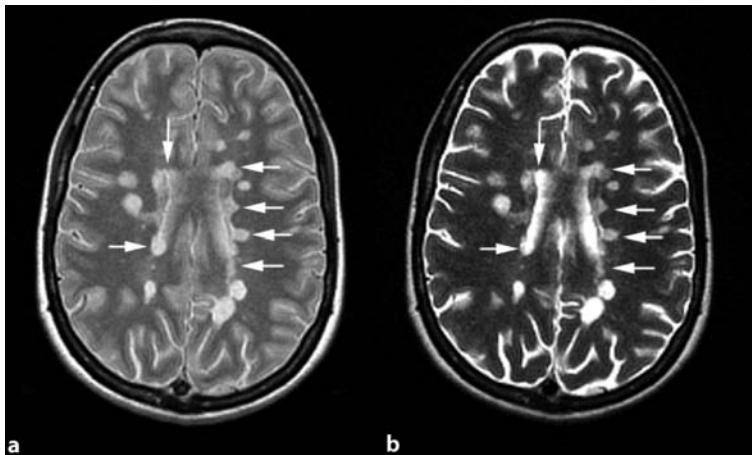


Fig. 1.1 Axial proton density (PD)- (a) and T2-weighted (b) images of a patient with relmitting-relapsing multiple sclerosis (RRMS) demonstrate classic MR appearance of the disease. Note: Multiple hyperintense lesions (plaques) with periventricular predominance are the classic MRI feature of MS (arrows)

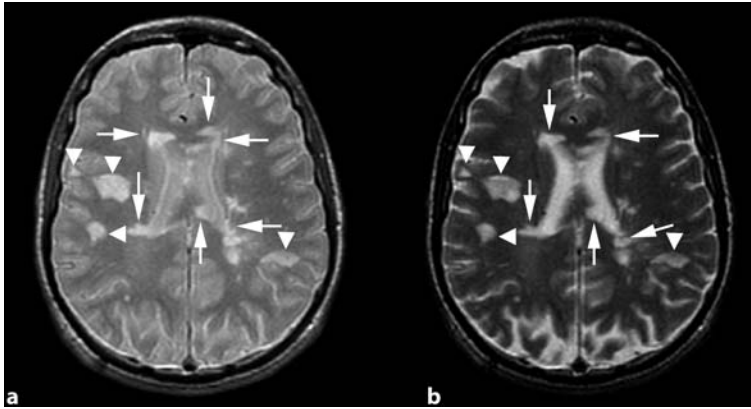


Fig. 1.2 Axial PD- (a) and T2-weighted (b) images demonstrate MS plaques in different areas of the cerebral hemisphere. Note: MS lesions can occur in different locations of the central nervous system. The most common locations are periventricular (*arrows*), juxtacortical (*arrowheads*), corpus callosum, and infratentorial structures

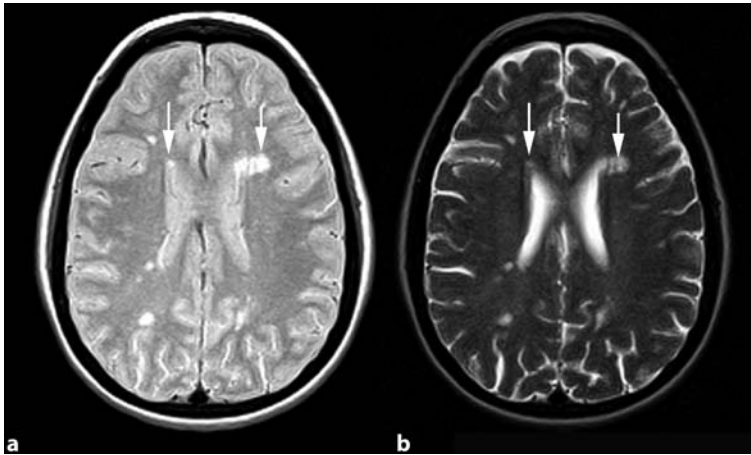


Fig. 1.3 Axial PD- (a) and T2-weighted (b) images demonstrate typical periventricular lesions in MS (*arrows*). Note: Periventricular lesions are defined as the lesions that are attached to the walls of the ventricles

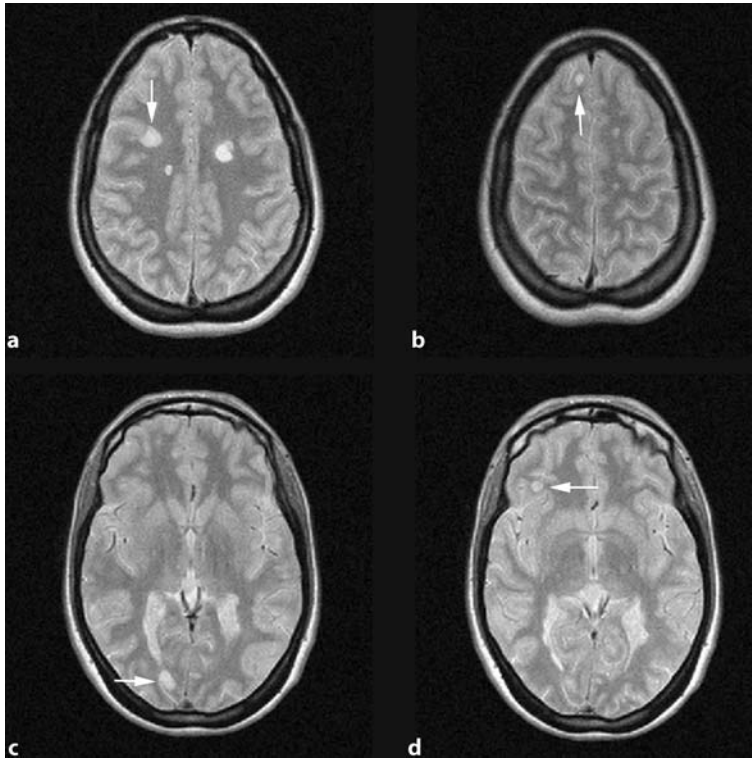


Fig. 1.4 Axial PD- (a) and T2-weighted (b) images demonstrating juxtacortical lesions in parietal (a), frontal (b, d) and occipital lobes (c) (arrows). Note: Juxtacortical lesions are defined as the lesions that touch the cerebral cortex

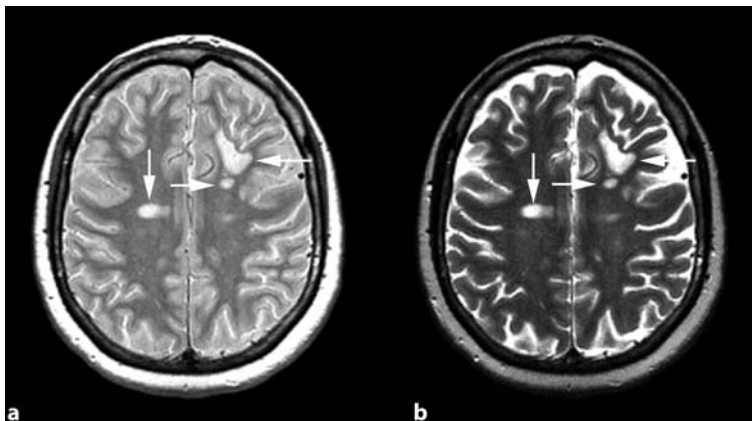


Fig. 1.5 Axial PD- (a) and T2-weighted (b) images of a patient with RRMS, demonstrating different shapes of the lesions (arrows). Note: MS lesions are usually oval or round in shape, but other complex and irregular patterns may also be seen in this disease. In fact, there is no characteristic pattern on T2-weighted images that is specific for MS

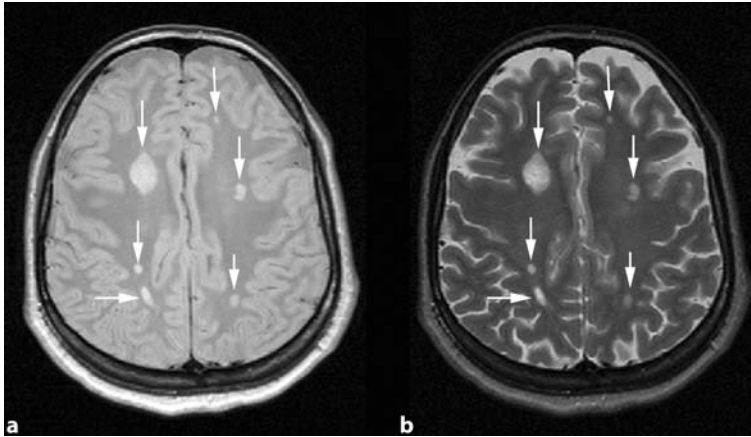


Fig. 1.6 Axial PD- (a) and T2-weighted (b) images of a patient with MS demonstrate lesions of different sizes (*arrows*). Note: MS lesions are usually small, but the diameter may vary from a few millimeters to several centimeters

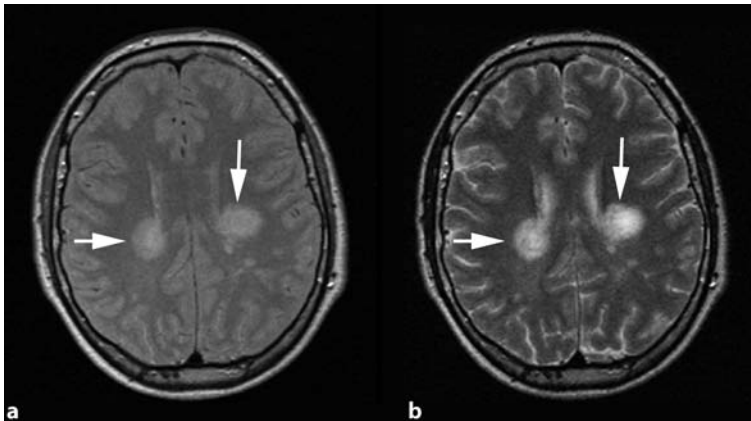


Fig. 1.7 Axial PD- (a) and T2-weighted (b) images of a patient with RRMS demonstrate lesions of different sizes. Two of the lesions are bilateral, periventricular, and relatively large (*arrows*). Note: The average lesion size has been reported to be 7 mm in nominal diameter, and most MS lesions are smaller than 1 cm in diameter

1.3 Location

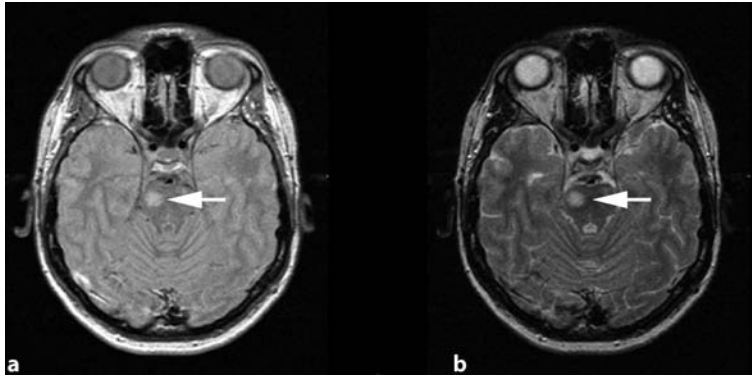


Fig. 1.8 Axial PD- (a) and T2-weighted (b) images demonstrate a lesion in the upper part of the pons (arrows). Note: Infratentorial lesions may be seen in any part of these structures, but lesions are most commonly seen in the pons, cerebellum, and cerebellar peduncles

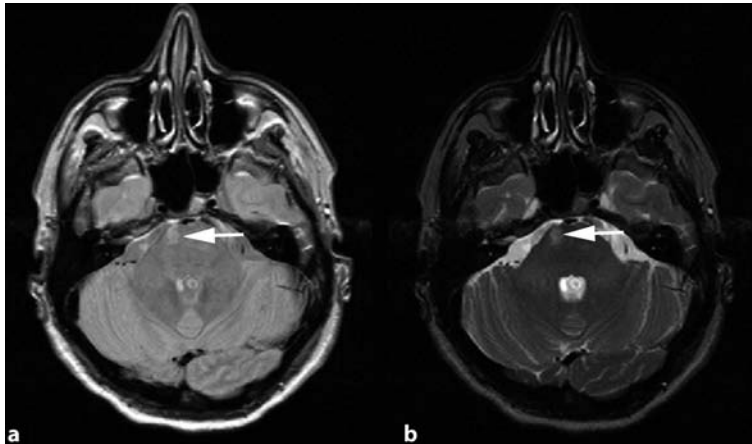


Fig. 1.9 Axial PD- (a) and T2-weighted (b) images show a lesion in the surface of the pons (arrows). Note: Some brainstem lesions may be superficial abutting the subarachnoid space. In contrast to this, abnormalities in the center of the pons are more characteristic in small vessel disease

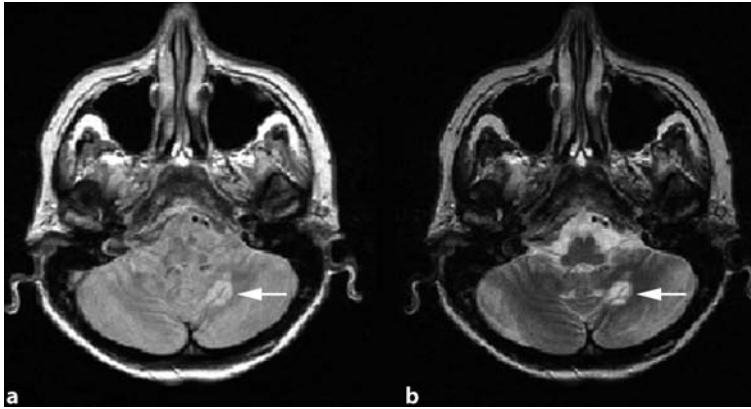


Fig. 1.10 Axial PD- (a) and T2-weighted (b) images of a patient with MS demonstrate a cerebellar lesion (*arrows*). Note: Lesions may occur in any part of the cerebellar white matter. About 50% of MS patients may have one or more lesions in this area

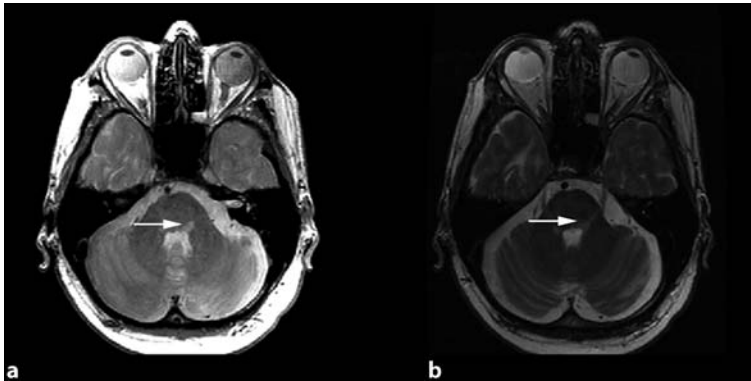


Fig. 1.11 Axial PD- (a) and T2-weighted (b) images demonstrate a lesion in the floor of the 4th ventricle (*arrows*)

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