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Pictorial Review

A practical approach to diseases affecting dentate nuclei

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A wide variety of diseases affect the dentate nuclei. When faced with the radiological demonstration of signal changes in the dentate nuclei, radiologists and clinical neurologists have to sieve through the many possibilities, which they do not encounter on a regular basis. This task can be challenging, and therefore, developing a clinical, radiological, and laboratory approach is important. Information on the topic is scattered and the subject has not yet been reviewed. In this review, a combined clinicoradiological approach is presented. The signal changes in T1, T2, fluid-attenuated inversion recovery (FLAIR), diffusion, susceptibility weighted, and gadolinium-enhanced images can give specific or highly suggestive patterns, which are illustrated. The role of computed tomography (CT) in the diagnostic process is discussed. Specific radiological patterns do not exist in a significant proportion of patients where the clinical and laboratory analysis becomes important. In this review, we group the clinical constellations to narrow down the differential diagnosis and highlight the diagnostic clinical signs, such as tendon xanthomas and Kayser–Fleischer rings. As will be seen, a number of these conditions are potentially reversible, and hence, their early diagnosis is desirable. Finally, key diagnostic tests and available therapies are outlined. The practical approach thus begins with the radiologist and winds its way through the clinician, towards carefully selected diagnostic tests defining the therapy options.

Introduction

Radiological demonstration of abnormal signals in the dentate nuclei forms a perplexing problem for the radiologist, as well as clinicians, as a variety of neurological disorders are known to affect the dentate nuclei. A significant proportion of these are modifiable, and hence, early diagnosis is important. Cerebellar ataxia forms the common clinical denominator of this group and additional

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neurological involvements beyond cerebellar ataxia are common. Diagnostic categories can be formulated based on clinical constellations of neurological and sometimes systemic features. Similarly, specific or highly characteristic radiological patterns exist to guide the diagnostic process; hence, it is important to develop a clinical and radiological approach towards diagnosing these diverse conditions.

Over the years, clinicoradiological information on this subject has accumulated but is scattered in case reports and case series, and this subject has not been comprehensively reviewed. In this review, we discuss the clinical and radiological constellations to help evolve a diagnostic process. The radiological approach precedes the clinical, as the problem often begins with radiological demonstration of lesions in the dentate nuclei and the first "problem solver" is the radiologist.

Radiological approach

Dentate nuclei lesions are usually demonstrated on magnetic resonance imaging (MRI) and occasionally on computed tomography (CT). A wide spectrum of diseases with variable clinical symptoms affects the dentate nuclei as listed in Table 1. Isolated dentate diseases are very uncommon and most of the diseases involve other areas of the brain and occasionally the spinal cord. Multisystem/multi-organ involvement is sometimes seen. Due to significant overlap of imaging characteristics, correlation with clinical history, examination, pertinent laboratory tests, and follow-up imaging is mandatory to arrive at the exact diagnosis.

Table 1
Conditions affecting the dentate nuclei

Physiological
• Age-related calcification
Leukodystrophies
• Krabbe's disease
• Alexander's disease
• Canavan's disease
• Aicardi–Goutières disease
• Infantile neuro-axonal dystrophy
Metabolic, toxin, and drug induced
• Maple syrup urine disease
• Cerebrotendinous xanthomatosis
• L-2-hydroxyglutaric aciduria
• Glutaric aciduria type 1
• Mucopolysaccharidosis
• Metronidazole, cycloserine[1] and isoniazid toxicity[2]
• Methyl bromide poisoning
• Fahr's syndrome
• Wernicke's encephalopathy
• Leigh's disease
• Wilson's disease
Neurodegenerative
• Spinocerebellar ataxia type 20
• NBIA
Inflammatory and infectious
• Progressive multifocal leukoencephalopathy
• Viral cerebellitis
• Enteroviral encephalitis
• Langerhans' cell histiocytosis
• Erdheim–Chester disease
• Multiple sclerosis
Miscellaneous
• Gadolinium deposition
• Neurofibromatosis type 1
• Post-radiation changes
• Haemorrhage-hypertensive and amyloid angiopathy
• Ischaemic cerebrovascular disease
• Lymphoma

NBIA, neurodegeneration with brain iron accumulation.

Although CT has a limited role, it is an excellent imaging technique to detect calcification; hence, it is useful in conditions such as Fahr's syndrome, Aicardi–Goutières syndrome, and subtypes of spinocerebellar ataxias, where calcification can be seen (Fig 1).[3–5] Hyperdensity is often noted on unenhanced CT in the early stages of Krabbe's disease, hypercellular tumoural diseases, such as primary central nervous system lymphoma and acute haemorrhage.[6,7]

MRI includes routine pulse sequences such as T1-weighted (W), T2W, fluid attenuated inversion recovery (FLAIR), gradient echo (GRE), and/or susceptibility weighted (SWI) and diffusion-weighted (DWI) sequences. Contrast-enhanced T1-weighted sequences and MR spectroscopy may be additionally performed.

At MRI, most of the diseases exhibit hyperintense signal changes on T2W and FLAIR sequences, which are often non-specific (Figs 2 and 3). In addition, one can also notice T1 hyperintensity (Figs 4 and 5), T2 hypo-intensity (Fig 6), T2 shortening/blooming on GRE or SWI sequences (Fig 7), restricted diffusion (Figs 8 and 9) and post-contrast enhancement (Figs 10–12) which have diagnostic significance as listed in Table 2. Frequent exposure

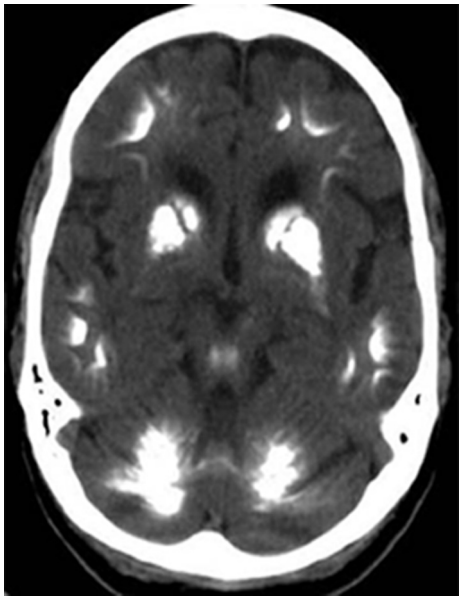

Figure 1 Unenhanced CT image showing dense calcification in the dentate nuclei, basal ganglia and cerebral white matter in a case of Fahr's disease.