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Central Nervous System Tuberculosis: An Imaging Perspective

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Abstract

The increasing prevalence of tuberculosis in both immunocompetent and immunocompromised individuals in recent years makes the disease a topic of universal concern. It has insidious onset and can affect virtually any organ system in the body, including the central nervous system (CNS). CNS tuberculosis (TB) is becoming more and more complex and atypical with onset of multidrug-resistant TB. Routine diagnostic techniques using serology and body tissue are time consuming and may delay the definitive management. Hence, it is important to be familiar with various radiologic features of CNS TB to ensure early and accurate diagnosis, thereby reducing high morbidity and mortality associated with the disease. The newer imaging techniques further help to improve the characterization and diagnosis of atypical CNS TB. The authors review the imaging characteristics of different forms of CNS tuberculosis involving the brain and spine and discuss the role of advanced imaging modalities in differentiating CNS TB from other disease process.

Résumé

La prévalence accrue de la tuberculose au cours des dernières années, tant chez les personnes immunocompétentes qu'immunodéficientes, font de cette maladie une source de préoccupation mondiale. Il s'agit d'une affection insidieuse qui peut s'attaquer à pratiquement tous les systèmes et appareils de l'organisme, y compris au système nerveux central (SNC). La tuberculose du SNC devient de plus en plus complexe et atypique, et une forme multirésistante commence à se propager. Les techniques courantes utilisées pour le diagnostic, à partir de résultats sérologiques et de tissus, prennent du temps et retardent parfois la prise en charge de la maladie. Il est donc important de connaître les différentes caractéristiques radiologiques de la tuberculose du SNC pour assurer un diagnostic juste et précoce, et ainsi réduire les taux élevés de morbidité et de mortalité associés à la maladie. Les nouvelles techniques d'imagerie facilitent d'autant plus la caractérisation et le diagnostic de la tuberculose du SNC. Les auteurs se sont penchés sur les caractéristiques des différentes formes de tuberculose du SNC qui touchent le cerveau et la colonne vertébrale et discutent du rôle des modalités d'imagerie évoluées pour différencier la tuberculose du SNC d'autres maladies.

Key Words: Central nervous system; Computed tomography; Magnetic resonance imaging; Magnetic resonance spectroscopy; Magnetization transfer imaging; Tuberculosis

The increasing incidence of human immunodeficiency virus infection and drug resistant strains has resulted in an increased incidence of tuberculosis (TB) worldwide. As many as 9 million cases of TB are detected worldwide every year [1]. Among all forms of TB, central nervous system (CNS) TB accounts for approximately 10% of all cases and carries the highest mortality [2]. Granulomatous inflammatory reaction in the CNS, caused by *Mycobacterium tuberculosis*, may involve the meninges, brain, spinal cord, calvarium, or bony spine. It may manifest in a variety of forms including meningitis, parenchymal and leptomeningeal tuberculomas, abscesses, cerebritis, vasculitis, infarction, and osteomyelitis. The CNS TB can also mimic a number of infectious and noninfectious disease entities. In this extensive review we present typical and atypical imaging appearances of CNS TB involving the brain and spine, and discuss the role of advanced imaging modalities in differentiating CNS TB from other disease processes [1,3].

Pathophysiology

Mycobacterium tuberculosis is the most common organism causing tuberculous infection of CNS. Other species of

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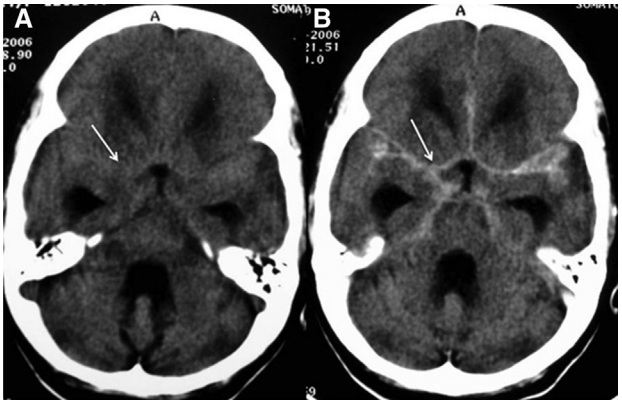

Figure 1. Tuberculous meningitis. (A) Axial noncontrast computed tomography image shows effacement of basal cisterns by hyperdense exudates (arrow). (B) The corresponding axial contrast-enhanced computed tomography image demonstrates dense enhancement of basal exudates and thickened meninges along the basal cisterns giving a characteristic spider leg appearance (arrow). Communicating hydrocephalus due to obstruction to cerebrospinal fluid flow by inflammatory basal exudates is also evident.

mycobacteria may be involved in immunocompromised patients. Rich and McCordock [4] suggested that bacilli reach the oxygen-rich CNS by hematogenous route secondary to disease elsewhere in the body either during the stage of bacillemia of primary tuberculous infection or following late reactivation of TB. Initially, a small tuberculous lesion (Rich focus) develops in the CNS. These lesions may be inoculated in the meninges, subpial or subependymal surfaces of brain and the spinal cord, and may remain dormant for years. Later, rupture or growth of 1 or more of these tuberculous lesions produces various types of CNS TB. The type and extent of lesion depend on the number and virulence of bacilli and immune response of the host. Infrequently, infection may spread to CNS from a site of discal TB, tuberculous otitis, or osteogenic tuberculous foci in spine or cranial vault [2–4].

Spectrum of Lesions in CNS TB

1. Meningeal TB
    a. Tuberculous meningitis (TBM)
    b. Chronic tuberculous infection of dura (pachymeningitis)
    c. Granulomatous basal meningitis
2. Parenchymal TB
    a. Tuberculous granuloma (tuberculoma)
    b. Tuberculoma en plaque
    c. Miliary TB
    d. Tuberculous abscess
    e. Tuberculous Encephalopathy
3. Spinal TB
    a. Spinal tuberculoma
    b. Tuberculous myelitis
    c. Tuberculous arachnoiditis (myeloradiculopathy)
    d. Tuberculous spondylitis (Pott's disease)

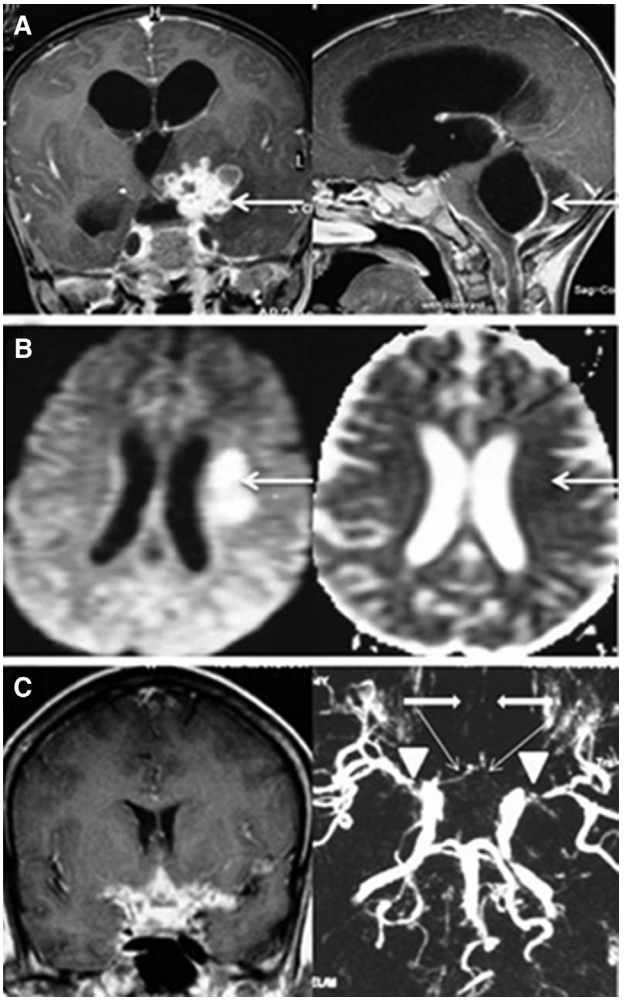

Figure 2. Complicated tuberculous meningitis. (A) Coronal and sagittal T1-weighted contrast-enhanced magnetic resonance imaging shows noncommunicating hydrocephalus due to mass effect caused by conglomerate tuberculomas in left temporal lobe and adhesive granulomatous ventriculitis involving the fourth ventricle. (B) Diffusion-weighted image and corresponding apparent diffusion coefficient mapping reveals acute infarct in left basal ganglia region due to vascular compromise. (C) Coronal T1-weighted contrast-enhanced magnetic resonance imaging shows dense enhancing exudates in suprasellar cisterns and along the anterior hemispheric fissure. Magnetic resonance angiogram of same patient demonstrates severe narrowing of bilateral proximal middle cerebral (arrow heads), anterior cerebral (thin arrows), and pericallosal (thick arrows) arteries due to vasculitis caused by inflammatory basal exudates.

4. Miscellaneous forms of CNS TB
    a. Tuberculous hypophysitis
    b. Orbital TB
    c. Tuberculous otitis media and temporal bone TB
    d. TB of calvarium and base of skull

Meningeal TB

TBM is the most common manifestation of CNS TB, frequently seen in children and adolescents [3]. Exudates in basal cisterns are most specific manifestation of leptomeningeal TB. They are commonly present in