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Cerebellar tuberculoma in an immunocompetent patient: A case report and literature review

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***Abstract*---**Background: Tuberculosis infection of the Central Nervous System is the major cause of death and morbidity in developing countries. The clinical manifestations and radiological findings in tuberculoma are nonspecific. This article reports a rare case of cerebellar tuberculoma with the manifestation related to an intracranial mass and without the typical clinical symptoms of Tuberculosis in an immunocompetent patient. Case Report: A 20-year-old female with seizure, headache, and vertigo. A mass in the posterior fossa was revealed by Magnetic Resonance Imaging. Thorax scan results showed the Tuberculosis process. The patient then underwent surgery. Histopathological examination displayed chronic granulomatous inflammation and the presence of Acid-Fast Bacilli. The patient received anti-tuberculous drug treatment for one year and anti-seizure medication. Discussion: Cerebellar tuberculoma can resemble an intracranial tumor or cranial abscess. Diagnosis is based on clinical, radiological manifestations, and histopathological analysis. Surgical intervention still has a role in the treatment of this disease. The finding of Mycobacterium tuberculosis on histopathological examination is the gold standard in diagnosing Tuberculosis. Conclusions: Although it is rare, the involvement of Tuberculosis in the CNS should be taken into account in both immunocompetent and immunocompromised patients with neurological symptoms who are living in an endemic area.

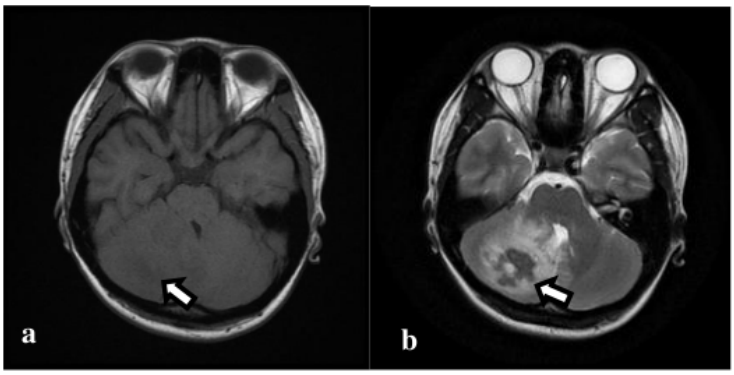
***Keywords*---**cerebellar tuberculoma, CNS tuberculosis, disseminated tuberculosis, extrapulmonary tuberculosis.

Introduction

Tuberculosis infection of the CNS is the major cause of death and morbidity in developing countries (Zahrou *et al.*, 2019). It occurs in 2-5% of TB patients and 10% of Human Immunodeficiency Virus (HIV) patients (Weidauer *et al.*, 2020). Tuberculous meningitis (TBM) is the most common form of CNS TB with a lower incidence than intracranial tuberculoma, tuberculous brain abscess, tuberculous encephalopathy, spinal cord tuberculous meningitis, non-osseous spinal cord tuberculosis, Pott's paraplegia, and Pott's spine (Chen *et al.*, 2018),(Israr Khan *et al.*, 2019). Infection of MTB can result in the hematogenous or lymphatic spread of the pathogens, which can lead to pulmonary and extrapulmonary TB (Sutantoyo and Sugianto, 2022). CNS tuberculoma is a rare cause of intracranial masses; they are granulomas that form from an inflammatory response to MTB infection, with 3-4% of cases involving the cerebellum (Bouali *et al.*, 2020),(Er *et al.*, 2018). Cerebellar or brainstem tuberculoma is found at much lower rates in adults (Bouali *et al.*, 2020). The radiological findings of CNS tuberculoma are nonspecific, and usually similar to other diseases (Agrawal *et al.*, 2020). Therapeutic approaches and results depend on identifying the source of CNS infections (Imran *et al.*, 2019). We illustrate this case because it is rare in immunocompetent patients and the issue is in preoperative analysis. We describe the clinical presentation, imaging, pathological findings, management, and outcomes.

Case report

A 20-year-old female, with no medical history, presented with the first-time seizures in her life and a history of fever, headache, vertigo, nausea, vomiting, and, tendencies to fall to the right side when standing. A neurological examination revealed an abnormal cerebellar function test. The serology of the HIV test was negative and there was an increase in the Erythrocyte Sedimentation Rate (ESR) by 62 mm/hour. Electroencephalography findings showed intermittent slow activity and sharp waves in the left temporal region suggesting there was potential epileptogenicity in the left temporal lobe. The results of thorax Computed Tomography (CT), revealed the tuberculosis process. Initial head MRI displayed solid intra-axial lesions with well-defined, irregular edges on the right cerebellum, with cerebellar tonsillar herniation (Fig.1a-d)



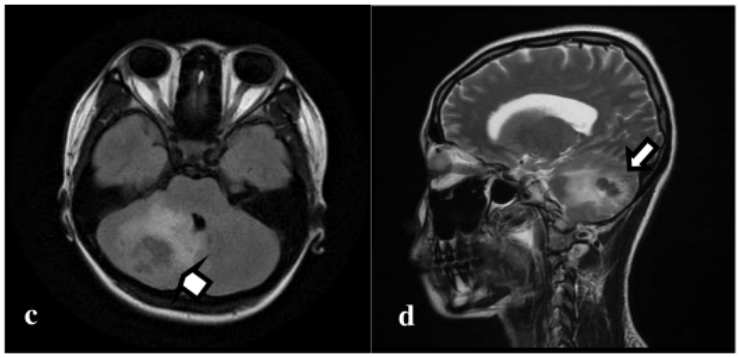


Figure 1. MRI findings: isointense on T1W1 (a), slightly hyperintense on T2W1 (b), appeared hypointense on T2 Fluid-Attenuated Inversion Recovery (FLAIR) (c), sagittal T2 (d)

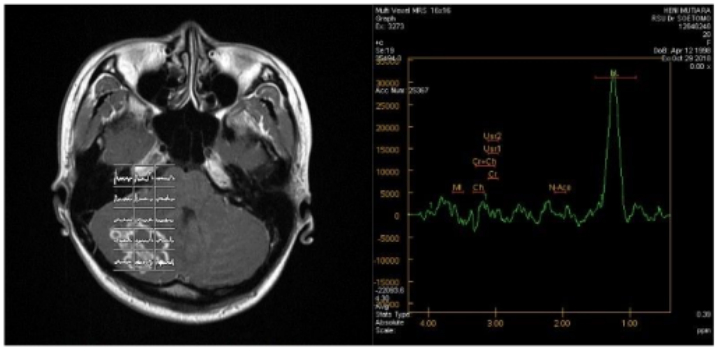


Figure 2. MR Spectroscopy

MR spectroscopy reveals increased Cholin/Creatinine and Cholin/NAA ratios, as well as high lipid concentrations in the intra- and perilesional. The patient underwent surgical specimens of the cerebellar mass, and intraoperative findings revealed a solid, spongy mass, with well-defined lobes, easily separated from the cortex. In conclusion, histopathology shows chronic granulomatous inflammation suggestive of tuberculosis.

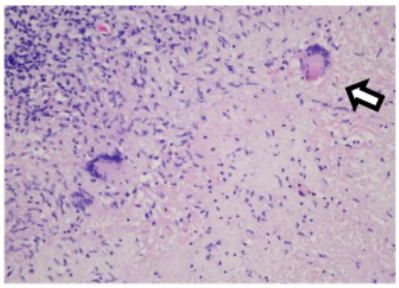


Figure 3. Histopathological appearance showing granulomatous inflammation with central caseous necrosis and datia Langhans cells 20x magnification

Rifampicin, isoniazid, and pyrazinamide were given for 2 months, followed by isoniazid and rifampicin for 10 months. The patient also received an intramuscular injection of streptomycin for the first 2 months and phenytoin for anti-seizure medication. One year of treatment led to clinical improvement and a decrease in ESR from 62 mm/hour to 3 mm/hour. The chest x-ray evaluation revealed no abnormality.

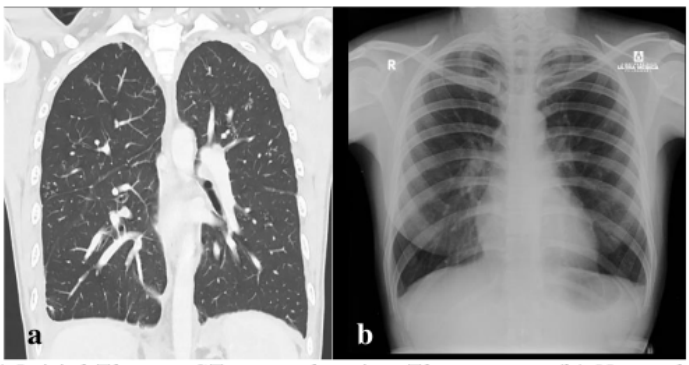


Figure 4. (a) Initial Thorax CT scan showing Tb process, (b) Normal chest x-ray evaluation

Head MRI evaluation after 1-year treatment showed gliosis and hemiatrophy on the right cerebellum.

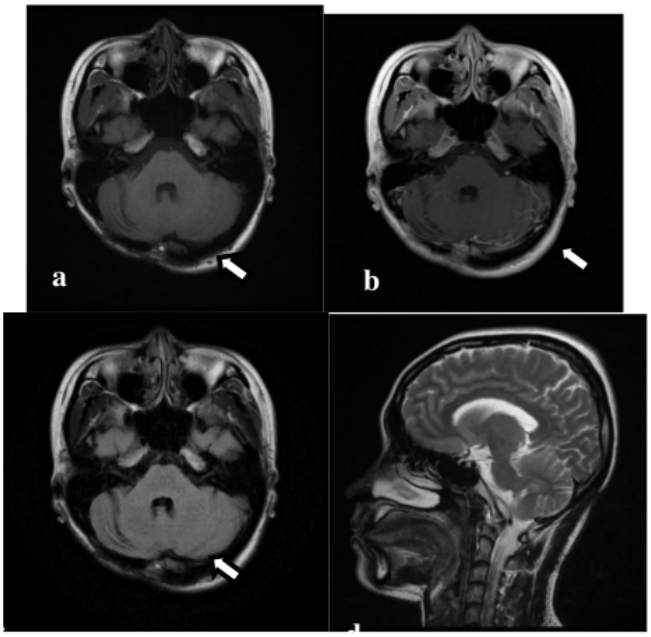


Figure 5. Radiological findings (evaluation), hypointense on T1W1 (a) no contrast enhancement (b), hypointense on T2 FLAIR (c), hyperintense on T2W1, sagittal (d)

Discussion

Epidemiology

TB remains a worldwide burden, with the vast majority of recent active TB cases occurring in underdeveloped and developing countries (Rock *et al.*, 2008). Intracranial tuberculoma expands in approximately 1% of all sufferers with active TB (Ikbal and Sugianto, 2022). However, it can develop without evidence of active disease (Chen *et al.*, 2018),(Nicolls *et al.*, 2005). Hematogenous spread of tuberculosis causes CNS involvement, which can occur supra- and infratentorial (though posterior fossa involvement is uncommon) and manifest as single or multiple lesions (Fabrizio *et al.*, 2017). Intracranial tuberculoma primarily occurs in the supratentorial region in adults and the infratentorial region in children, often in the frontal and parietal regions (Bouali *et al.*, 2020). CNS TB is more common in immunocompromised patients (Binesh, Zahir, and Bovanlu, 2013). Risk factors for CNS tuberculosis include age (children are more common than adults), HIV coinfection, malnutrition, history of measles in children, alcoholism, the presence of malignant tumors, and use of immunosuppressive agents in adults (Binesh, Zahir and Bovanlu, 2013). However, in this case, the patient is an immunocompetent young female without any risk factor and has no history of pulmonary TB.

Pathophysiology

MTB bacteria are inhaled as droplet nuclei, which leads to infection, and bacilli accumulation in the alveoli of the lungs. Bacilli are processed into draining lymph nodes early in this phase, leading up to the infection containment, and there is low-level bacteremia, in which MTB spreads to distant places in the body. The brain and other organs with high oxygen levels are where hematogenous seeding occurs most frequently (Rock *et al.*, 2008). Tuberculoma is caused by the growth of rich foci that are surrounded by intracerebral tissue (Chaulagain, 2019). Tuberculomas are considered to form when tubercles in the brain parenchyma grow without rupturing into the subarachnoid space (Rock *et al.*, 2008). A tuberculoma of the brain exhibits a classic granulomatous reaction containing epithelioid cells, giant cells, and main lymphocytes around a central area of caseating necrosis (Rock *et al.*, 2008). In contrast to pus, liquefaction of the center area of necrosis contains clear or straw-colored fluid (Rock *et al.*, 2008).

Tuberculoma of the posterior fossa is more dangerous to the patient's life than tuberculoma of the supratentorial fossa. They usually appear as solitary lesions with no indication of systemic tuberculosis, and they resemble tumors rather than the infectious process (Bouali *et al.*, 2020). According to Bernaerts and Binesh et al., tuberculoma lesions located in the infratentorial commonly occur in children (Rock *et al.*, 2008),(Bernaerts *et al.*, 2003; Binesh, Zahir and Bovanlu, 2013). The reason why the lesions in children are predominantly located in the cerebellum remains unclear (Wakisaka, Soejima, And Matsuoka, 1987). Meanwhile, adults are commonly found in the frontal and parietal lobes (Bernaerts *et al.*, 2003). According to the infection hypothesis, the hematogenic spread is further enhanced by the vascular distribution, particularly in the area of

the middle cerebral artery (Zahrou *et al.*, 2019),(Gasparetto, Tazoniero and Neto, 2003).

Clinical findings

Tuberculoma cannot be recognized from other lesions that occupy brain space only based on clinical symptoms (Nicolls *et al.*, 2005). Symptomatic intracranial tuberculoma depends on its anatomic location (Nicolls *et al.*, 2005),(Gupta *et al.*, 2022). Systemic symptoms vary, but the majority of patients complain of fever, headache, and weight loss (Davis, Meintjes,, and Wilkinson, 2018).The typical manifestation of cerebellar tumors are signs of increased brain pressure and cerebellar incoordination (Işik *et al.*, 2009). Headache, seizures, papilledema, and other indications of elevated intracranial pressure are common in individuals (Rock *et al.*, 2008). In tuberculoma, the onset of symptoms is usually measured in weeks or months (Rock *et al.*, 2008). After treatment, around 25% of these patients showed persistent impairments. Delays in diagnosis, extreme ages, and the presence of hydrocephalus at presentation were all linked to long-term neurological impairments (Nicolls *et al.*, 2005).

Diagnosis

Clinical characteristics alone are insufficient to distinguish tuberculoma from other types of brain tumors (Thwaites *et al.*, 2009). Only 30% of cerebral tuberculoma patients have a suggestive chest radiograph (Agrawal *et al.*, 2020). Also, tubercle bacilli are not always visible in the cerebrospinal fluid (CSF), so a CSF analysis may not be helpful (Agrawal *et al.*, 2020). The diagnosis is problematic because tuberculoma cannot be distinguished from other masses, however, the neuroimaging presentation can be diverse and non-specific (Agrawal *et al.*, 2020). In many situations, biopsy remains the gold standard for intracranial tuberculoma for histopathology and acid-fast bacilli stain and culture can provide a conclusive diagnosis (Agrawal *et al.*, 2020),(Nicolls *et al.*, 2005). The patient in our case underwent surgical procedures to make a diagnosis and alleviate symptomatic or life-threatening mass effects (Marais *et al.*, 2019). Histopathology and acid-fast bacilli were used to confirm the diagnosis of a CNS lesion in the cerebellum.

Radiological features

Radiological features might be helpful in the diagnosis and monitoring of the disease, as well as for the assessment of complications (Binesh, Zahir,, and Bovanlu, 2013). Any ring-enhancing lesion in the brain raises a diagnostic challenge for clinicians because the majority of these patients present with similar clinical syndromes (Soni, 2021). Tuberculoma is typically solitary lesions, but it can be multiple in 15–34 percent of cases, and it is most commonly found in the frontal and parietal lobes. Tuberculoma is a spherical granulomatous mass that is firm, avascular, and distinguished by small, round or oval-shaped nodules size in diameter from 2 to 12 mm (Agrawal *et al.*, 2020),(Rock *et al.*, 2008),(Nicolls *et al.*, 2005),(Leonard, 2021). They are clearly distinguished from the brain tissue around the lesion, which is compressed and shows gliosis and edema (Leonard, 2021). The interior of these masses may contain necrotic areas composed of

caseous material, which can be thick and purulent at times, and in which tubercle bacilli can be seen (Leonard, 2021).

CT scan

A head CT scan is necessary as the initial neuroimaging modality in individuals with a suspected brain infection (Wibawani *et al.*, 2019). On CT, early lesions may appear hypodense. Lesions become isodense and show ring-enhancement after intravenous contrast administration as the capsule forms around the tuberculoma. When lesions calcify, they become hyperdense and show little enhancement. There may be minor or severe associated edema. When multiple lesions are found, each lesion may be at a different stage of progression, resulting in a patient with a mix of ring-enhancing and solid lesions (Nicolls *et al.*, 2005).

MRI

Depending on the type of granulomatous lesion, the neuroimaging picture of cerebral tuberculoma differs (Agrawal *et al.*, 2020). The appearance of tuberculoma on MRI varies depending on its stage of maturation, that is, whether it is non-caseating, caseating with a solid center, or caseating with a liquid center (Binesh, Zahir, and Bovanlu, 2013). The degree of edema around the tuberculoma is thought to be inversely proportional to the age of the lesion (Rock *et al.*, 2008). If the tuberculoma consists of non-caseating granulomas, the lesion is commonly hypointense or isointense to gray matter on T1-weighted images and hyperintense on T2-weighted MR images (Agrawal *et al.*, 2020). On T1W and T2W images, a solid caseating tuberculoma appears isointense to hypointense, with an isointense to the hyperintense rim on T2W images (Binesh, Zahir and Bovanlu, 2013). Gliosis and monocyte infiltration can make a central region of T2-hypointensity visible. This is an important finding because it is not found in many other intracranial lesions (Agrawal *et al.*, 2020). In tuberculoma post-contrast imaging we usually see a peripheral ring-enhancement due to vasogenic edema (Agrawal *et al.*, 2020). In tuberculoma, central liquefactive necrosis can occur, making differentiation from a cerebral abscess difficult (Agrawal *et al.*, 2020).[6] According to some reports, cerebral tuberculoma has the 'target sign,' which is a ring-enhancing lesion with an additional central area of enhancement or calcification (Agrawal *et al.*, 2020).

Diffusion-weighted MRI

Diffusion-weighted MRI images of tuberculoma show restricted diffusion (Soni, 2021).

MR Spectroscopy

Advances in MR spectroscopy have shown that tuberculoma can be distinguished from cysticercosis but not from CNS non-Hodgkin lymphoma. There is an elevated lactate peak, a decreased NAA and creatinine peak, and a choline/creatinine ratio of greater than one in tuberculoma (Thwaites *et al.*, 2009),(Soni, 2021).

Table 1
Tuberculoma radiographic features (Bouali *et al.*, 2020),(Agrawal *et al.*, 2020),(Binesh, Zahir and Bovanlu, 2013),(Gupta *et al.*, 2022),(Leonard, 2021)

Modality	Non-caseating	Caseating with a solid center	Central liquefaction
CT Imaging			
Non-contrast	Hypo- to isodense, and rounded or lobulated masses, irregular walls	Hypo-to hyperdense	Hypodense
Contrast	Homogenous enhancement, irregular walls of varying thickness, surroundings vasogenic edema	A ring with heterogeneous enhancement in the center	Ring enhancement
MRI Imaging			
T1	Iso-hypointense	Iso/hypointense	Hypointense
T1 with gadolinium contrast	Homogenous enhancement	Ring enhancement	Ring enhancement
T2	Hyperintense	Iso/hypointense	Hyperintense, showing ring enhancement with a peripheral hypointense rim

Treatment
Medical management

Antituberculosis therapy (ATT) is usually effective in treating cerebral tuberculoma (Agrawal *et al.*, 2020). Similar to pulmonary TB, the majority of cases necessitate a long course of ATT lasting nine to 18 months, with an intensive phase followed by a maintenance phase (Agrawal *et al.*, 2020),(Thwaites *et al.*, 2009). The World Health Organization (WHO) recommends a 2-month initial phase of rifampicin, isoniazid, pyrazinamide, and streptomycin, followed by a 7-month maintenance phase of isoniazid and rifampicin for CNS TB, which includes tuberculoma (Leonard, 2021). The key components of the regimen are rifampicin and isoniazid. Rifampicin penetrates the CSF less well (maximum concentrations of around 30% of plasma), but the high mortality from rifampicin-resistant TBM has confirmed its central role in the treatment of CNS disease. Isoniazid easily penetrates the CSF and has potent early bactericidal activity. Even though pyrazinamide is well absorbed orally and achieves high concentrations in the CSF, there is no conclusive evidence that it improves the outcome of CNS tuberculosis (Thwaites *et al.*, 2009).

Ethambutol has the poorest penetration of the current first-line drugs, even when the BBB is inflamed, raising the question of its utility in the treatment regimen

(Davis, Meintjes and, Wilkinson, 2018). Most experts recommend streptomycin or ethambutol, though neither penetrates the CSF well in the absence of inflammation and both can cause serious side effects. Streptomycin should not be given to pregnant women or those with renal impairment, and resistance is relatively common worldwide (Thwaites *et al.*, 2009). Corticosteroids are commonly used to treat high intracranial pressure, paradoxical progression during treatment, and intracranial lesion-associated edema (Bouali *et al.*, 2020),(Nicolls *et al.*, 2005).

Surgery

Surgical intervention may be required in cases of acute complications such as obstructive hydrocephalus, large lesions with significant mass effect, or brainstem compression (Agrawal *et al.*, 2020). Additionally, surgery can be performed in cases of diagnostic confusion caused by infratentorial tumors (Bouali *et al.*, 2020). Cerebellar lesions may be more commonly resected due to their increased likelihood of causing these severe symptoms (Capone *et al.*, 2021). Stereotactic craniotomy, excision of superficial small tuberculoma, and microsurgery are now used (Davis, Meintjes and Wilkinson, 2018).

Stereotactic

Because of the lower surgical risk, stereotactic brain biopsy is preferred over craniotomy. Stereotactic biopsy has an overall complication rate of is 0.6–6.3%, and when combined with paraffin sectioning, it has been shown to have an 85 percent diagnostic efficacy. When to conduct a brain biopsy, on the other hand, is still debatable. Most experts advise evaluating the role of biopsy on a case-by-case basis. A low threshold for performing a brain biopsy for definitive diagnosis should be used when managing patients at high risk for other infectious processes or malignancies (e.g., people infected with HIV) (Nicolls *et al.*, 2005). In our case, the patient got a combination of surgery and chemotherapy. Patients were also treated conservatively because the majority of these lesions resolve completely with ATT (A, 2015). Total tuberculoma resolution is shown when scans reveal no enhancing lesions or only a calcified region (Bouali *et al.*, 2020). Accordance in this case, after ATT for a year, head MRI evaluation showed gliosis and hemiatrophy on the right cerebellum. In conjunction with established ATT, resection of these lesions remains a viable treatment option that is both safe and effective (Capone *et al.*, 2021).

Differential Diagnosis

In most developing countries, CNS tuberculoma is one of the first differential diagnoses of an enhancing intraaxial lesion (Capone *et al.*, 2021). Tuberculoma imaging features are known to overlap with those of other intracranial focal lesions, such as chronic pyogenic brain abscess, fungal granulomas, neurocysticercosis healing stage, and lymphomas (Binesh, Zahir, and Bovanlu, 2013). Some metastases and gliomas may have characteristics similar to tuberculoma and should be considered in differential diagnoses (Binesh, Zahir and Bovanlu, 2013).

Conclusion

Tuberculosis of the CNS can be difficult to diagnose because it is a rare condition that can easily be mistaken for an intracranial mass (Er *et al.*, 2018). Although rare, tuberculoma should be taken into account in both immunocompetent and immunocompromised patients with neurological symptoms who are living in an endemic area for tuberculosis (Nabiuni and Sarvarian, 2011).

Acknowledgments

None

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