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Imaging Findings of Cerebral Schistosomiasis in China

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1 Introduction and objective:

Schistosomiasis japonica remains a major public health problem in China (Ross et al 2001, Hao et al 2006, Wu et al 2007). Cerebral involvement is a unique syndrome reportedly occurring in 1.6-4.3% of infected population and cerebral schistosomiasis is an important cause of focal epilepsy in endemic areas of China (Ross et al 2001, Lei et al 2003). Before CT and MRI have become available in China, the diagnosis of cerebral schistosomiasis had to be made clinically. Since 1980, CT and MRI have been introduced in China. In consequence, the diagnosis of cerebral schistosomiasis has become reliable and early diagnosis is possible. (Wang et al 1988, Zhu et al 2000).

Today, CT and MRI play a key role for the diagnosis, therapy planning and the follow-up of cerebral schistosomiasis (Betting et al 2005); however, the descriptions of the findings in diagnostic imaging are rare and concern only few observations:

- In the Chinese-language literature, there have been case reports and studies with limited numbers of cerebral schistosomiasis (Wang et al 1988, Mao et al 1989, Peng et al 1992, Zhu et al 2000, Lei et al 2003, Dong et al 2004);
- In the English-language, recent descriptions have been limited to MR findings of cerebral S. japonicum infection (Liu et al 2008) or descriptions of uncommon cerebral infection by S. mansoni or S. hematobium (Betting et al 2005, Preidler et al 1996).

Therefore in the clinical routine, cases of cerebral schistosomiasis remain singular. Diagnostic and therapeutic concepts have still to be developed with regard to the local possibilities. Additional reports and series with larger numbers are necessary for standardizing the diagnosis and the treatment.

The purpose of this thesis is to demonstrate the findings of diagnostic imaging in cerebral schistosomiasis in Hubei Province, which is a major endemic area of China. Furthermore, the typical findings and its contribution to the therapy planning and follow up will be described.

2 Material and method

24 patients with cerebral schistosomiasis were collected. They came from 2 hospitals in endemic areas of Hubei Province of China, which are:

- The First People's Hospital of Jingzhou (n=21, Dr. Yan Long, Department of Radiology).
- Tongji Hospital of Tongji Medical College (n=3, Prof. Zhu Wenzhen, Department of Radiology).

The patients were admitted between 2000 and 2006. The clinical data of patients were reviewed retrospectively.

A long-term follow-up case was collected from The First People's Hospital of Jingzhou. Additional cases (n=10) which were selected as differential diagnosis with cerebral schistosomiasis came from our own collections (Department of Radiology, Liyuan Hospital, Tongji Medical College).

The imaging findings were reviewed and evaluated. The diagnosis was established on the basis of the published Diagnosis reference (Table 2.1) (Li 2006).

Table 2.1: Diagnosis reference for cerebral schistosomiasis

Presumptive diagnosis	Contact with the infected water, evidences of schistosome infection. Symptoms of increased intracranial pressure or intracranial space occupying, or epilepsy; or perilesional abnormal discharge on EEG; or brain lesions on CT or MRI
Clinical diagnosis	Evidences of presumptive diagnosis. Resolution of clinical symptoms or resorption of brain lesion in CT or MRI after antischisitosomiasis therapy
Definitive diagnosis	Evidences of presumptive diagnosis. Schistosome egg granuloma in the brain at surgery and histopathologic examination

All the patients were local residents of endemic area, whose sex and age distribution are shown in Table 2.2.

Table 2.2: The sex and age of 25 patients with cerebral schistosomiasis

	N	Range	median	Comment
Male	20	16-60	31	The sex and age distribution was consistent with that of schistosomiasis. In rural areas young men are more likely to be exposed to infected water during childhood and in the course of their work
female	4	18-45	32	

All the patients had history of chronic schistosomiasis, and had been exposed to infected water. The main symptoms were shown in Table 2.2.

Table 2.3: Clinical manifestation of 25 patients with cerebral schistosomiasis.

Symptoms	N	Comment
Headache	23	All cases had seizures and /or headache as initial complaint. The symptoms are variable and mixed, including headache, seizure disorders, hemiparesis, and focal neurological signs, depending on the nature of the brain lesion. Acute encephalopathy and Katayama fever may be presented
Fever	20	
Epilepsy	20	
Focal neurological signs (hemiplegia, impaired vision, unsteady gait)	16	
Paralysis, diarrhea, recurrent vomiting	10	

8 cases were proven by histopathology and pathology; surgery had been performed to remove intracranial lesion and treat complications. In all 25 cases, the diagnosis had been based on the clinical picture, which included epilepsy, acute encephalopathy, the patients' history, the laboratory findings, the imaging findings and the successful therapy (Table 2.4).

Table 2.4: Diagnosis approach and findings in 25 patients with cerebral schistosomiasis

Symptoms and Diagnosis	N	Comment
Contact with infected water	25	They were farmers or fishmen of endemic area, came in contact with infected water repeatedly in the course of their work.
Epilepsy and acute encephalopathy	24	The seizure semiology was mainly motor seizures, mostly followed by temporary functional paresis. Generalized tonic–clonic seizures or status epilepticus occurred less frequently. The seizure frequency varied greatly, from 3 times/month to 25 times/day. Acute encephalopathy may be presented, such as headache, convulsions, speech disturbance, ataxia, faint consciousness, hemiparesis, even coma, mostly with Katayama fever.
Serology	18	COPT: **C**ircum**O**val Precipitin Reaction Test for schistosomiasis (Liu et al 2008, Xiang et al 2003) It is a cheap and popular serologic method; even IHA (indirect haemagglutination test) and ELISA are performed in some hospitals.
Eggs in the stool	10	The sensitivity is dependent on the quantity of sample, the quantity of eggs in the excrete, and investigators. The results are also affected by the therapy. Praziquantel could reduce fecal excretion.
Therapeutic test • Incomplete resorption • Complete resorption	6 2 4	Therapeutic test was performed on the patients with presumptive diagnosis of cerebral schistosomiasis, and other causes of neurologic disease could not be excluded. A periodic antishistosomiasis treatment (Praziquantel, 60-120 mg/kg, 3-5 days) was taken. Repeated therapy could be performed after 2-3 weeks if clinical symptoms were alleviated or incomplete resorption was shown in CT or MRI.
Surgery and histopathology	8	Craniotomy was performed to treat intracranial multiple nodule or mass with mass effect and recurrent epilepsy. Egg granuloma would be removed in the operation. Ventricular drainage and diagnostic craniotomy should be practical, but it seemed uncommon. Dehydration therapy including corticosteroids is effective to treat cerebral swelling.

Imaging

All the patients underwent CT or/and MRI examinations. CT was performed in 8 patients, MRI in 22 patients, CT and MRI in 6 patients. In each patient, CT and/or MRI examination was performed with contrast substance. Additionally, in 6 out of 8 patients, CT scan without contrast substance was been performed, and in 18 out of 22 patients, MRI without contrast substance (Table 2.5).

Table 2.5: Imaging in 24 patients with cerebral schistosomiasis

CT of the head	8	6 patients underwent CT and MRI examination with native and enhanced scan.
• Native scan	6	
• Contrast enhanced scan	8	
MRI of the head	22	
• Native scan	18	
• Contrast enhanced scan	22	

Treatment

All the patients were treated with Praziquantel and dehydration. 8 patients underwent surgery; All suffered from epilepsy resistant to therapy; all had a space occupying lesion (mass effect), which had not decreased 9 to 22 months after the onset of the cerebral disease despite praziquantel therapy. 2 patients continued to take antiepilepsy medicine after surgery.

3 Results

3.1 Cerebral manifestations

Single lesions were observed in 23 patients, and multiple lesions (2 lesions) in 2 patients. The lesions were found in supratentorial region in 20 patients, and in infratentorial region in 4 patients. One patient had lesions in the supra- and infratentorial region. The lesions were mainly located in cortical and subcortical areas in one lobe, but the adjacent lobe was also usually involved. Almost half of the lesions (13/27) were found in the parietal lobe.

Table 3.1 gives an overview about the imaging findings of the analysed patients with cerebral schistosomiasis - the case with cerebral atrophy after cerebral schistosomiasis was not included, it will be presented separately.

Table 3. 1: Imaging findings in cerebral schistosomiasis in 24 patients

Native Scan	
Gyrus swelling, nodule, or mass with edema	Fig. 3.1.1A,B, and Fig. 3.1.2A,B
Patchy edema	Fig. 3.1.5A
Enhancement scan	
Multiple enhancing lesions, which is spotty, nodular, mass, ring-like, gyral and/or patchy	Fig. 3.1.1C,D, Fig. 3.1.2C-F, Fig. 3.1.3C-E, Fig. 3.1.4C, Fig. 3.1.5B
Central linear enhancement	Fig.3.1.1D
Peripheral vascular enhancement	Fig.3.1.1D
Adjacent leptomeningeal enhancement	Fig.3.1.3D,E

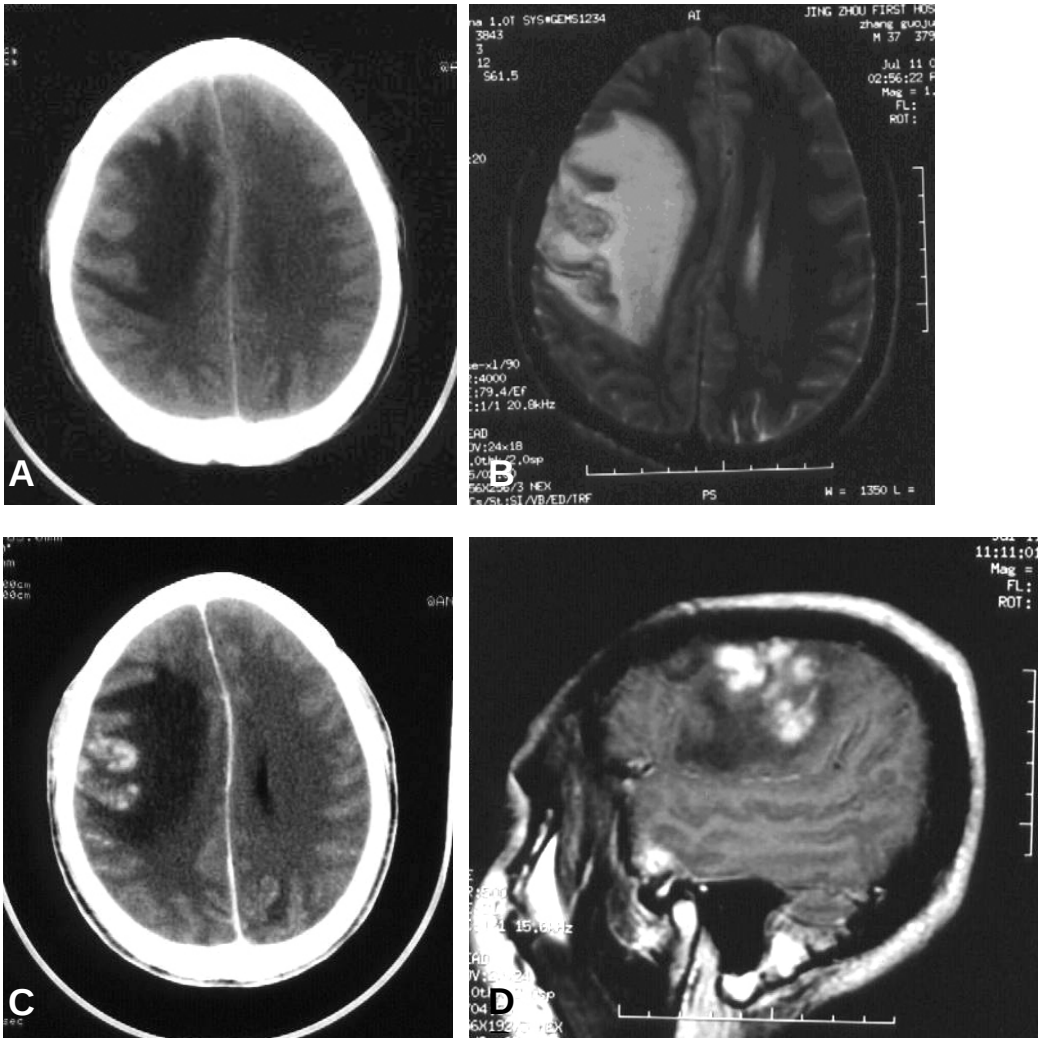


Fig.3.1.1A-D: 37-year-old man with cerebral schistosomiasis and 2-week history of headache and seizures.

A and B: Unenhanced CT (A) and axial T2-weighted MR (B). A nodule and gyrus swelling with prominent edema and mass effect in right tempoparietal lobe are visible.

C and D Enhanced axial CT (C) and sagittal T1-weighted MR (D). Multiple intensely enhancing small nodules, clustered closely together. Central linear enhancement and peripheral vascular enhancement are also seen.

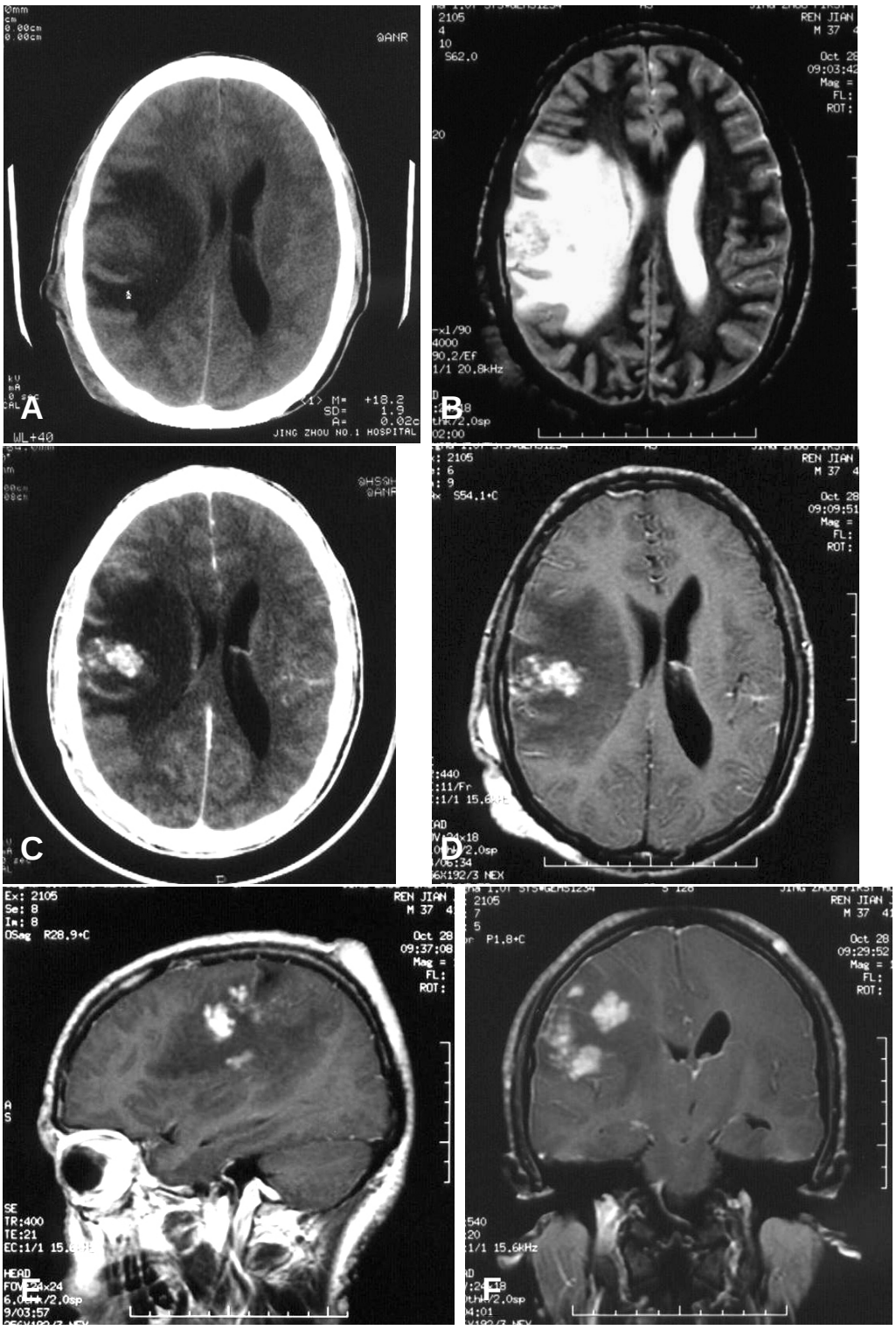


Fig.3.1.2A-F: 37-year-old man with cerebral schistosomiasis and 2-week history of headache and left hemiplegia

A and B: Unenhanced CT (A) and axial T2-weighted and MR (B). Mass with prominent edema and mass effect in right tempoparietal lobe.

C-F: Enhanced axial CT (C) and T1-weighted MR (D-F). Multiple discrete intensely enhancing small nodules, clustered closely together in cortical and subcortical areas.

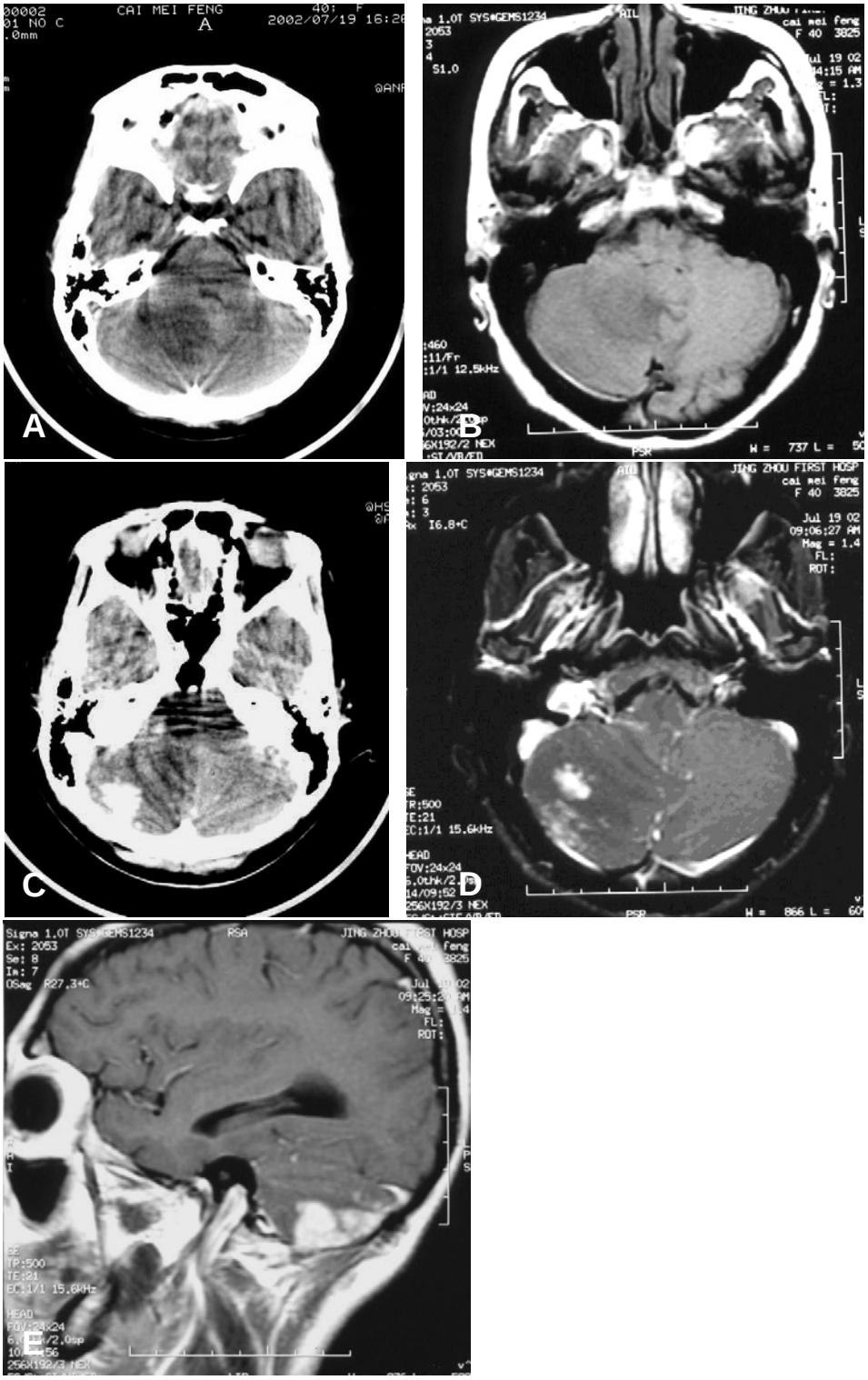
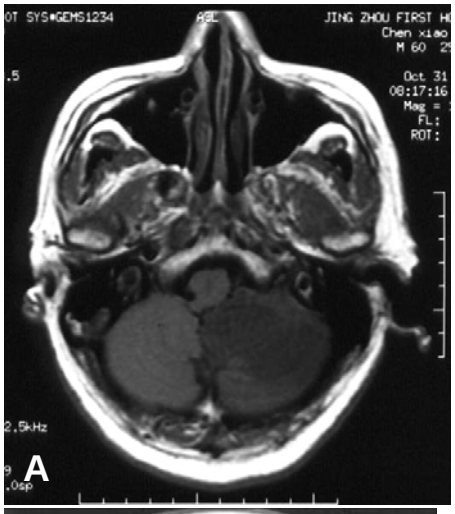
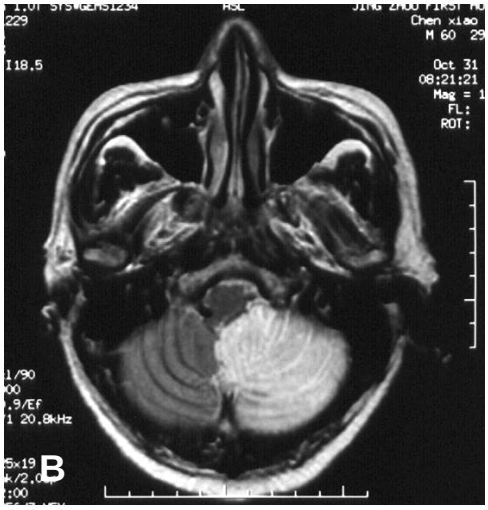


Fig.3.1.3A-E: 40-year-old woman with cerebral schistosomiasis and 2-week history of headache and unsteady gait.

A and B: Unenhanced CT (A) and axial T1-weighted MR (B). Prominent infarct-like edema in right cerebellum.

C-E: Enhanced Axial CT (C) and T1-weighted MR (D-E). Large, confluent enhancing mass and multiple discrete intensely enhancing small nodules. Adjacent leptomeningeal enhancement.





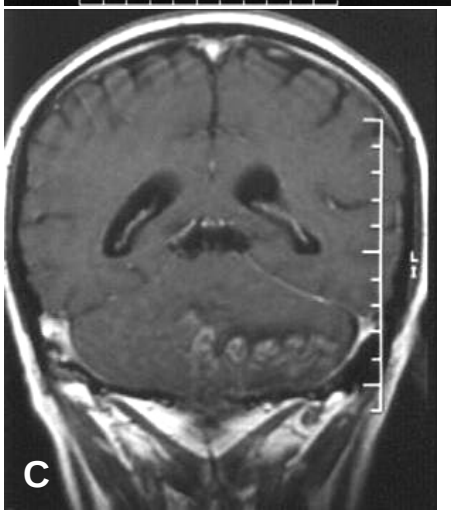


Fig. 3.1.4A-C: 60-year-old man with cerebral schistosomiasis and 1-week history of headache and fever.

A and B: Unenhanced axial T1-weighted (A) and T2-weighted MR (B). Prominent infract-like edema in left cerebellum.

C: Enhance coronal T1-weighted MR. Gyral enhancement with adjacent leptomeningeal irregular enhancement.

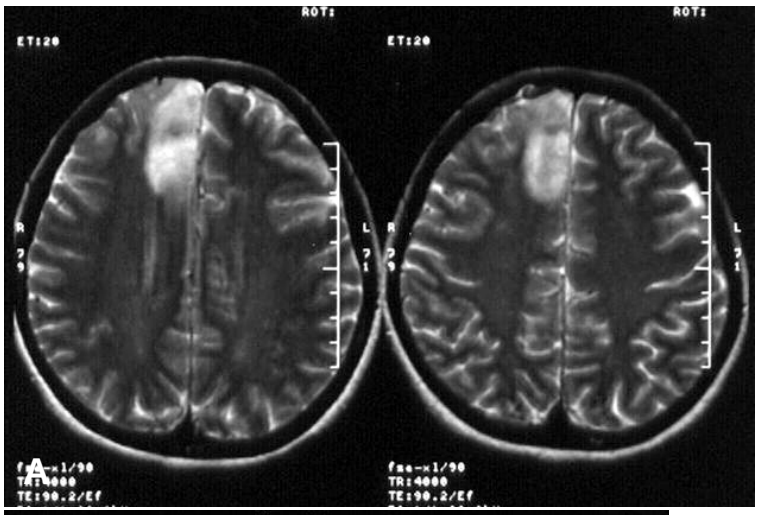
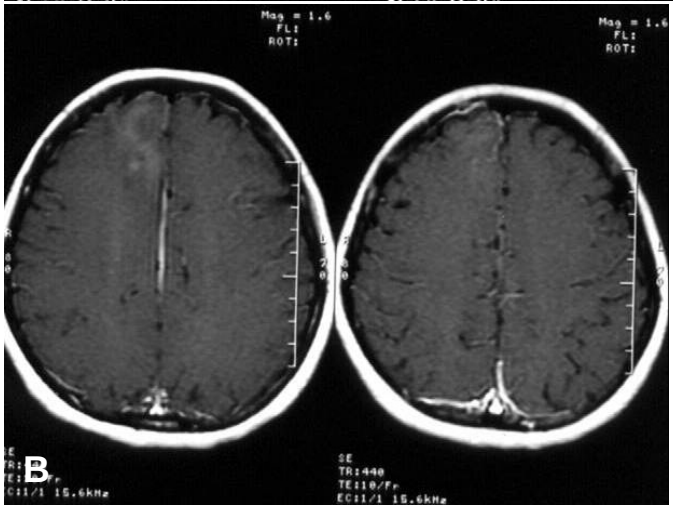


Fig. 3.1.5A and B: 37-year-old man with cerebral schistosomiasis and 1-week history of headache and fever.
A: Unenhanced axial T2-weightedand MR. Patchy heterogeneous edema in right frontal lobe.



B: Enhanced axial T1-weighted MR. Patchy enhancement with small enhanced nodules. Adjacent leptomeningeal enhancement is also seen.

3.2 Typical signs

The most consistent image findings of cerebral schistosomiasis were variable enhancing lesions mainly comprising multiple various enhancing nodules with perilesional edema on enhanced CT and MRI, and central linear enhancement, peripheral vascular enhancement and adjacent leptomeningeal enhancement on enhanced MRI (Table 3.2).

Table 3.2: Typical signs of cerebral schistosomiasis in 24 patients

CT-Scan with contrast substance	
Multiple various enhancing nodules with perilesional edema	Fig.3.2.1, Fig.3.1.1C, Fig.3.1.2C, Fig.3.1.3C
MRI with contrast substance	
Multiple various enhancing nodules with central linear enhancement, peripheral vascular enhancement and adjacent leptomeningeal enhancement	Fig.3.2.2, Fig.3.2.3, Fig.3.1.1D

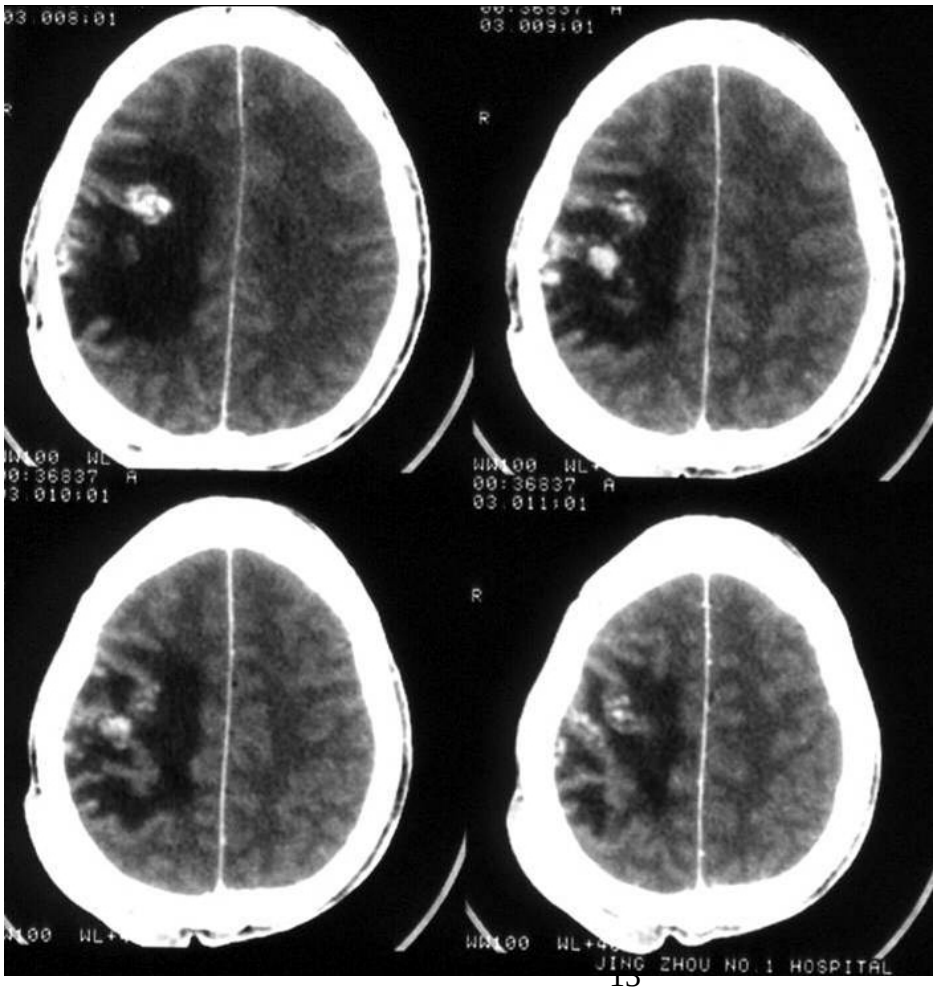


Fig. 3.2.1: 21-year-old man with cerebral schistosomiasis and 1-week history of headache and seizure.

Enhanced axial CT images shows multiple intensely enhancing small nodules with perilesional edema.

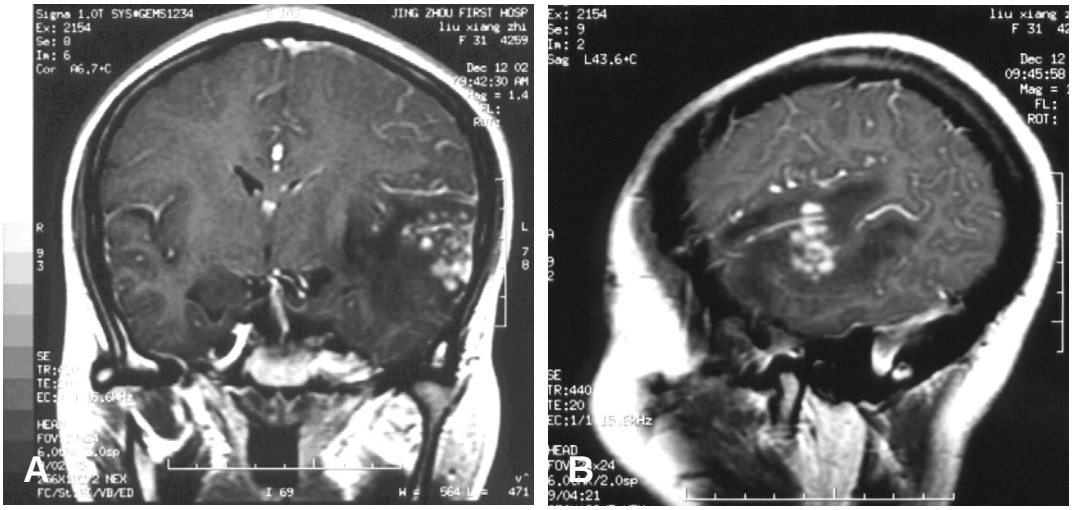


Fig. 3.2.2A and B: 31-year-old woman with cerebral schistosomiasis and 1-week history of headache and seizure.

Enhanced coronal (A) and sagittal (B) T1-weighted MR images show multiple intensely enhancing small nodules. Central linear enhancement, peripheral vascular enhancement and adjacent leptomeningeal enhancement are also seen.

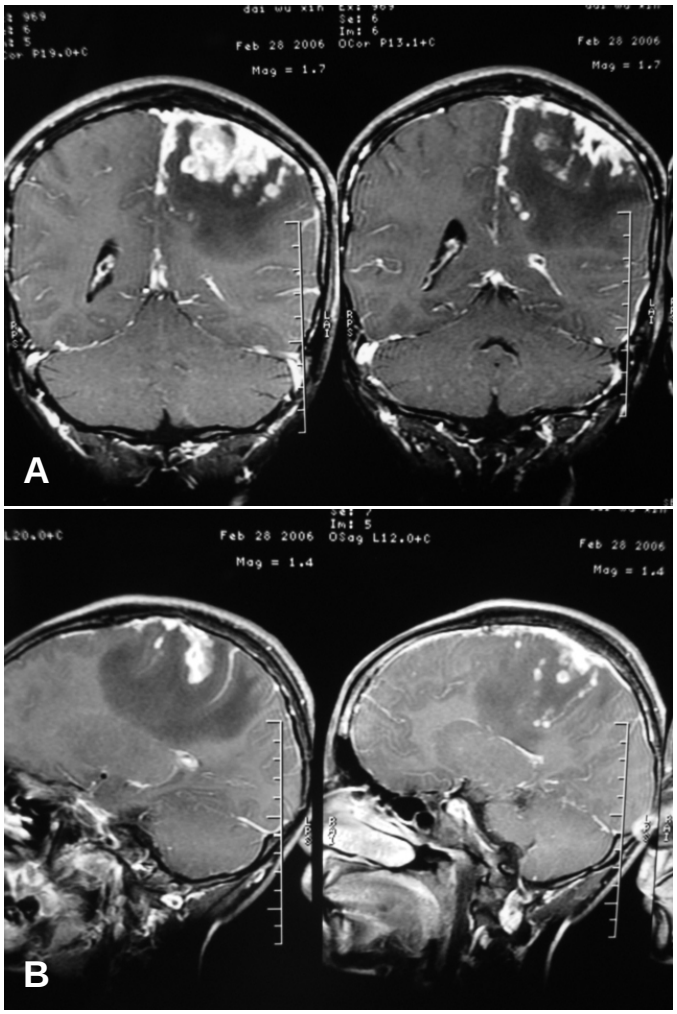


Fig. 3.2.3A and B: 18-year-old man with cerebral schistosomiasis and 3-week history of headache, fever and vomiting.

A and B: Enhanced coronal (A) and sagittal (B) T1-weighted MR images show multiple spotty, nodular, mottled, and ring-like heterogeneous contrast enhancements with adjacent leptomeningeal nodular enhancement, central linear enhancement and vascular enhancement .

3.3 Imaging, changes after therapy

Antischistosomal therapy may lead to reversal of pathologic lesions, even complete resolution (Fig. 3.3.1). In rare circumstance, surgery treatment was indispensable. Microscopically, various egg granulomas, mainly chronic schistosomiasis granulomas, could be seen (Fig. 3.3.2).

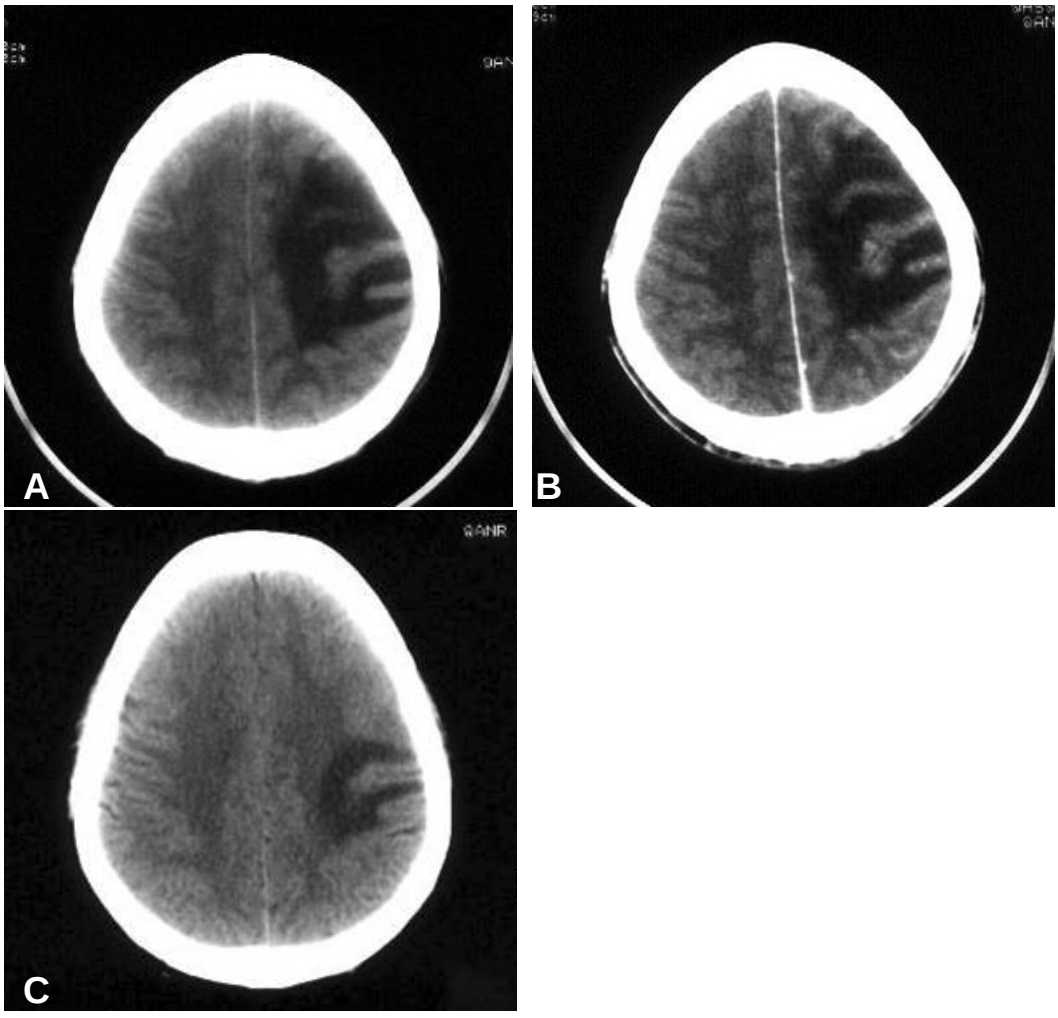


Fig. 3.3.1A-C: 31-year-old man with cerebral schistosomiasis and 3-week history of headache and right limb jerking.

A and B: Axial CT image show nodule, mass or gyrus swelling with prominent edema and mass effect in left parietal lobe.

C: 1 month after treatment, a scan corresponding to A shows partial resolution of the lesion.

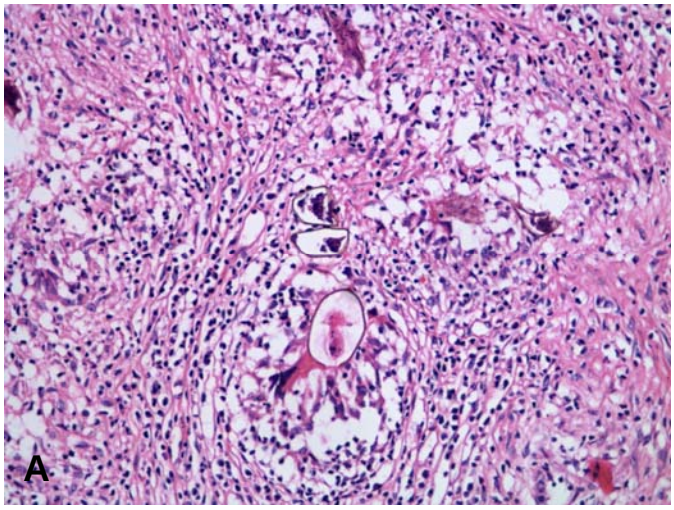
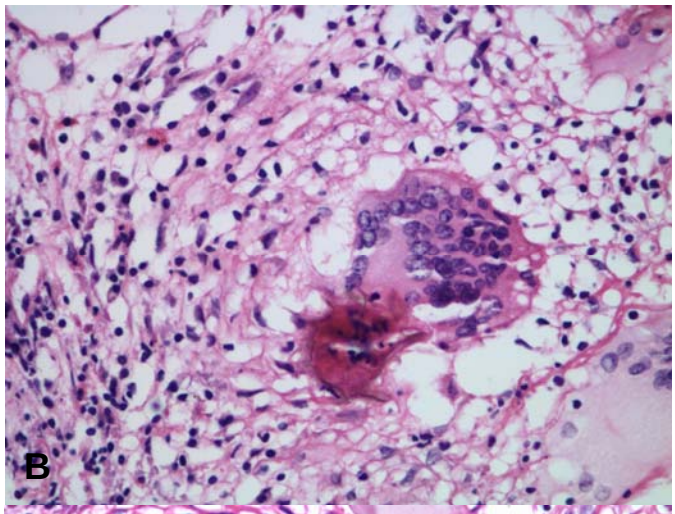


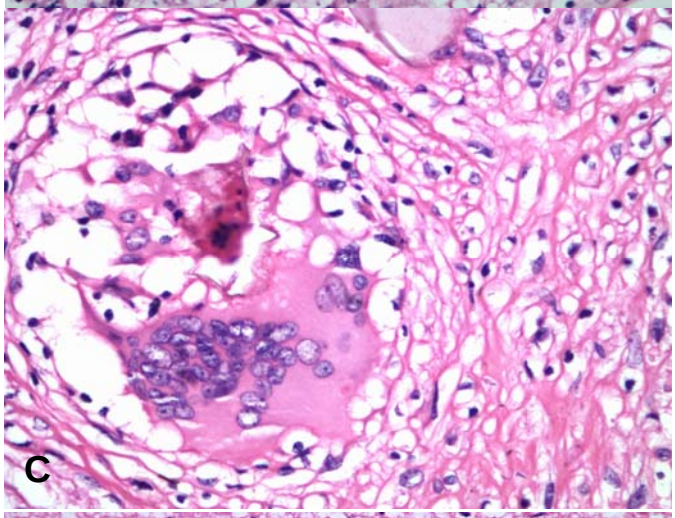
Fig. 3.3.2A-D: Histology of cerebral schistosomiasis.

A: Multiple granuloma formation around (characteristic) Schistosoma japonicum egg.

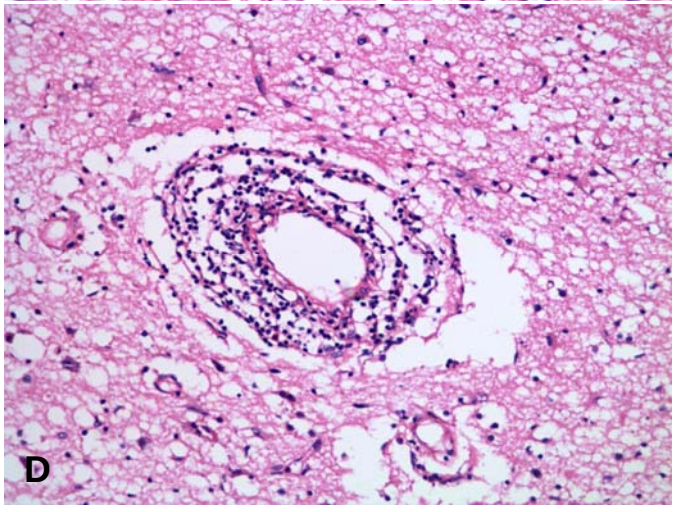
HE, 200.



B: Miliary pseudotubercles, surrounded by well-developed epithelioid, giant cells and fibrosis.
HE, 200.



C: Fibrosis, schistosomiasis granulomas， surrounded by layers of fibroblast and collagenous fibrosis.
HE, 400.



D: Vasculitis.
HE, 200.

3.4 Imaging, changes follow-up

In imaging follow up, some of patients with cerebral schistosomiasis could show cortical atrophy (Fig. 3.4) or central atrophy. Some of them might show normal by CT and MRI due to complete resolution of cerebral schistosomiasis.

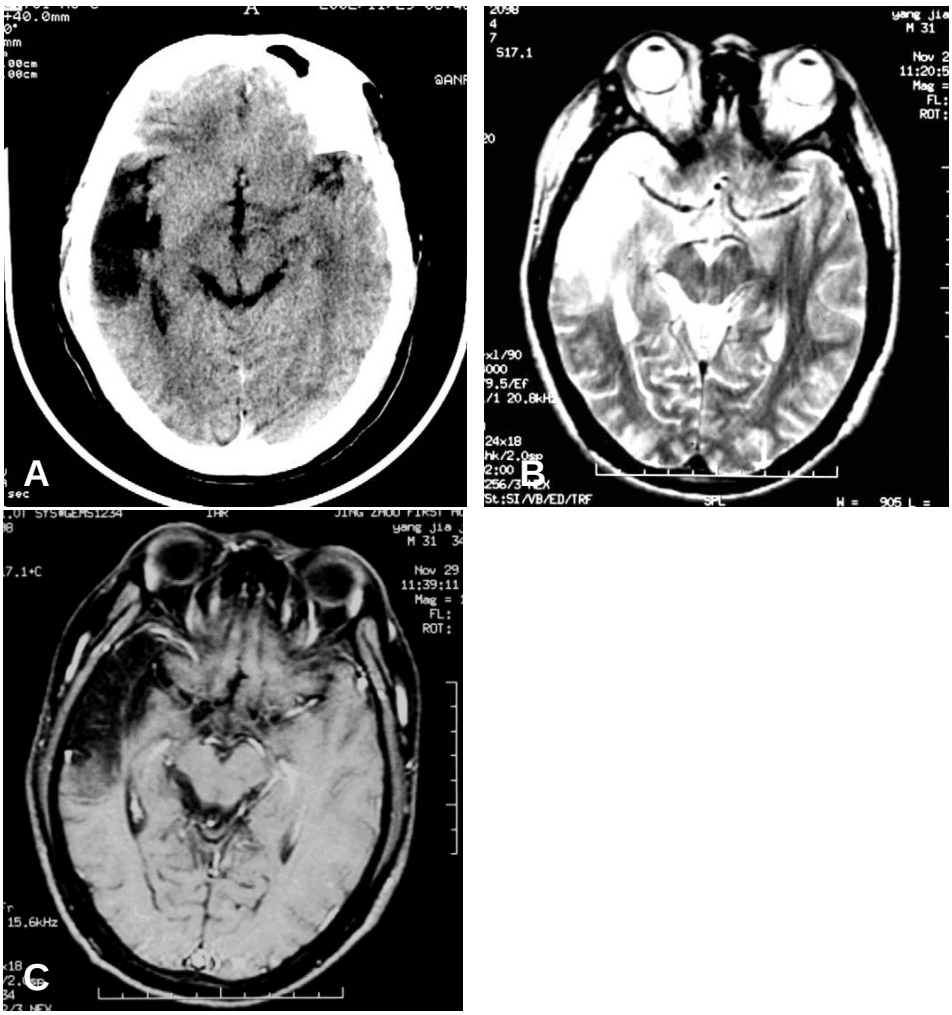


Fig. 3.4A-C: 31-year-old man with cerebral s chistosomiasis atrophy for 8 years.

A: Axial enhanced CT

B: Axial T2-weighted MR

C: Axial enhanced T1-weighted MR

The images show cystic formation or necrosis and cortical atrophy in left parietal lobe.

3.5 Differential diagnosis

In the differential diagnosis of cerebral schistosomiasis, image findings should be differentiated from those of other space-occupying lesions. These lesions include malignant diseases such as glioma or metastasis, cerebral tuberculosis, cerebral cysticercosis, brain abscess and acute viral encephalitis. Variable enhancement could be present in these lesions, however, the lesion of cerebral schistosomiasis is predominantly located at cortical and subcortical areas, mainly comprising multiple intensely nodular enhancements.

3.5.1 Glioma

In China, glioma is the common primary brain tumor in adults. The imaging finding of glioma is an expansive, infiltrative space occupying lesion, with hemorrhage, cyst formation or necrosis, mass effect, perilesional edema and heterogeneous enhancement, predominantly located at white matter areas (Fig 3.5.1.1, and Fig 3.5.1.2).

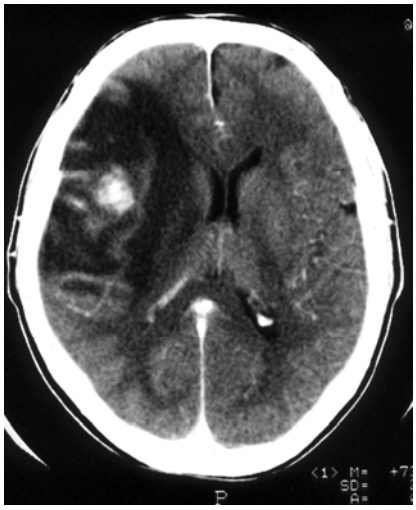


Fig 3.5.1.1: 64 year-old man with glioma

Enhanced axial CT image show intensely enhancing mass with significant perilesional edema and mass effect, no small nodules in periphery.

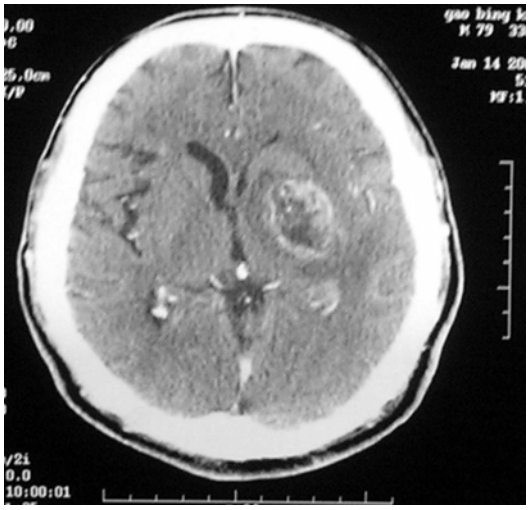


Fig 3.5.1.2: 76 year-old man with glioma

Enhanced axial CT image show heterogeneous intensely enhanced mass with mild perilesional edema.

3.5.2 Cerebral tuberculosis

In China, cerebral tuberculosis is the most dangerous form of tuberculosis. The pathologies were tuberculoma, hydrocephalus, basal cistern exudation, cerebral embolism, brain atrophy, miliary nodules, tuberculous abscesses and etc. miliary nodules and tuberculous abscesses present as ring or nodular enhancing lesion with mild edema (Fig 3.5.2.1). Basal cistern exudation is the common change and the main image in early stage patients showing basal cistern enhancement (Fig 3.5.2.2). Manifold lesions occurred in late stage patients, occasionally complicated with calcification (Fig 3.5.2.3).

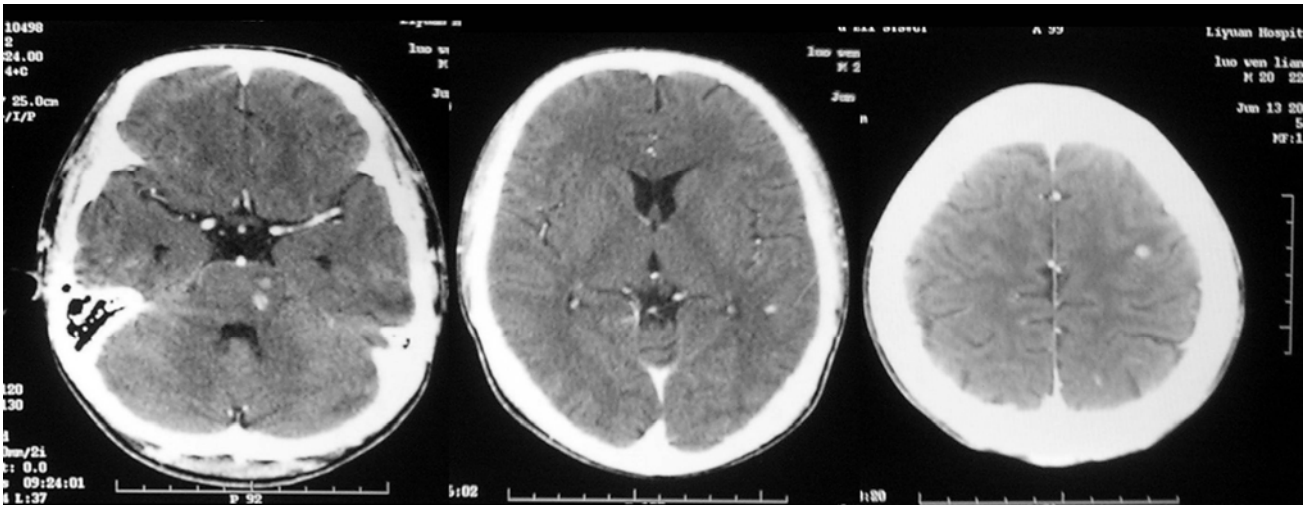


Fig 3.5.2.1: 20 year-old man with cerebral miliary tuberculosis

Enhanced axial CT shows multiple intensely enhancing nodules with little perilesional edema.

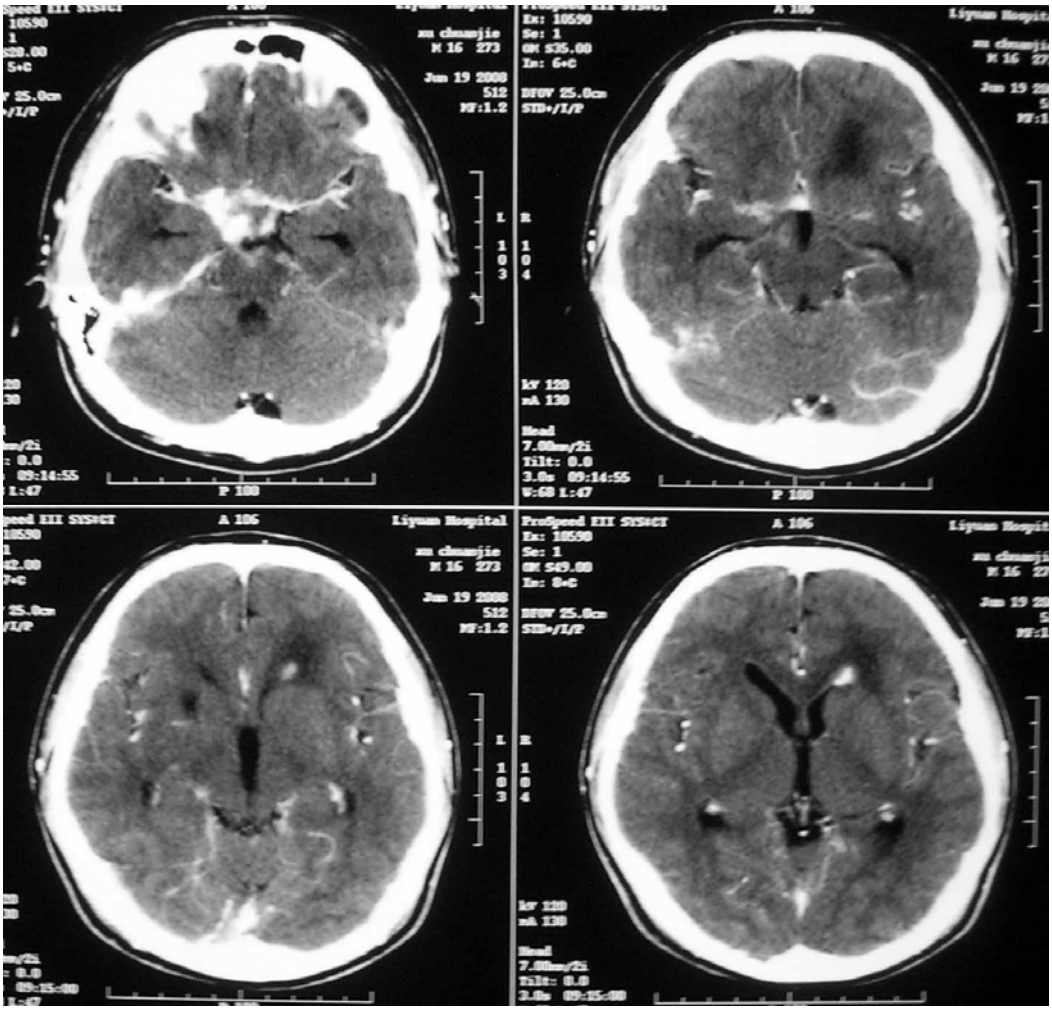


Fig 3.5.2.2: 16 year-old man with cerebral tuberculosis

Enhanced axial CT shows suprasellar cistern enhancement (arrow) and intensely enhancing nodule with little perilesional edema.

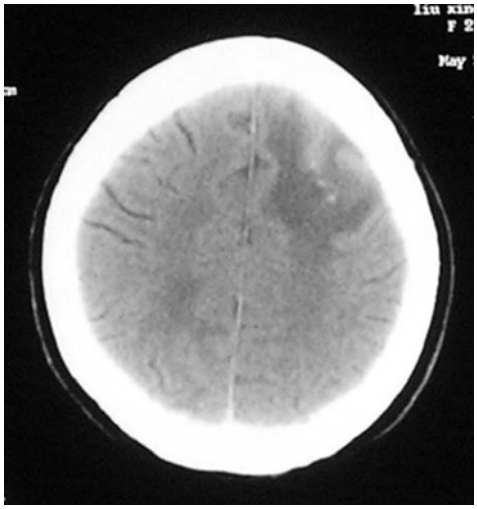


Fig. 3.5.2.3: 21 year-old woman with cerebral tuberculosis

Unenhanced axial CT images show gyrus swelling with edema and calcification.

3.5.3 Cerebral cysticercosis

The diagnosis of cerebral cysticercosis could be established by CT and MRI with the findings of calcifications and hypodense, enhanced, and annular enhanced nodules. The characteristic appearances are punctuate eccentric high-density structure suggestive of scolex and rounded cystic lesions (Fig 3.5.3.1). The characteristic findings along with subcutaneous nodules are virtually diagnostic of cerebral cysticercosis(Fig 3.5.3.2).

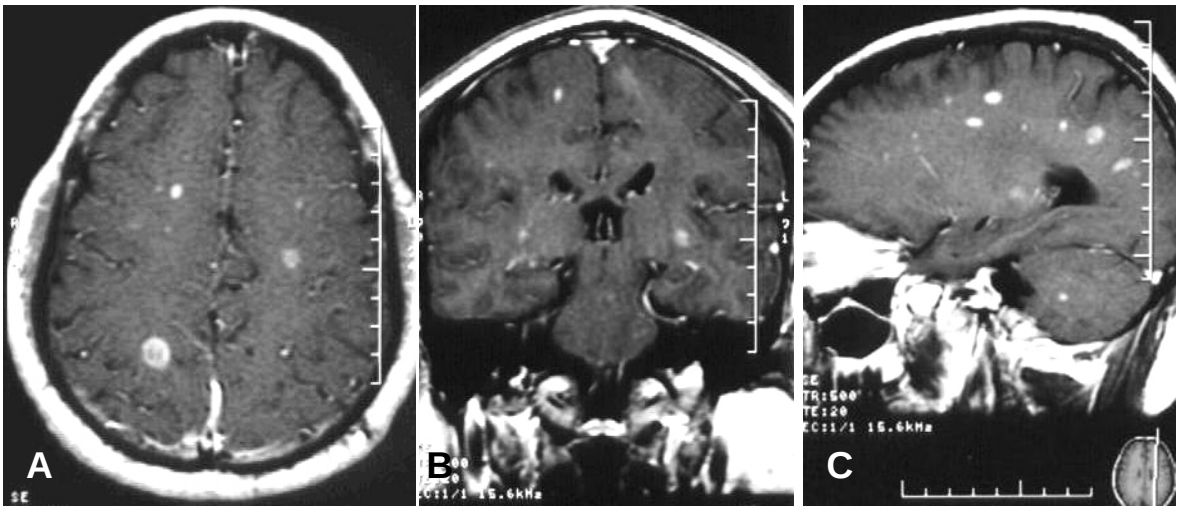


Fig 3.5.3.1A-C: 21 year-old woman with cerebral cysticercosis

Enhanced MR images show multiple ring and nodular enhancement.

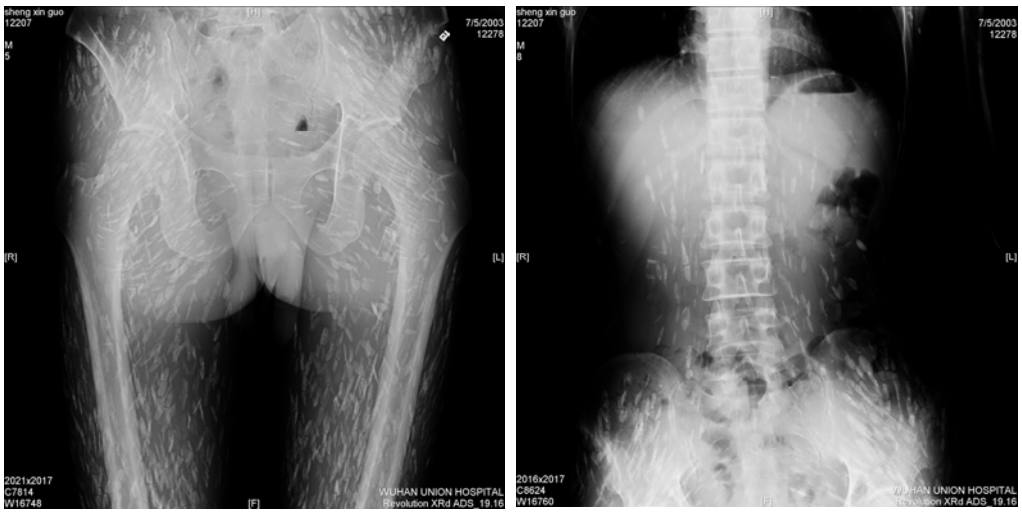


Fig 3.5.3.2: 23 year-old man with cysticercosis

Radiographies show multiple high-dense nodules spread along the muscles.

3.5.4 Brain abscess

Early in the course, abscess appears as a low-density, irregular zone that does not enhance in the presence of intravenous contrast (early cerebritis). Classically, as the disease progresses, a distinctive "ring enhancement" appears on contrast-enhanced CT and MRI(Fig 3.5.4), as the abscess wall thickens.

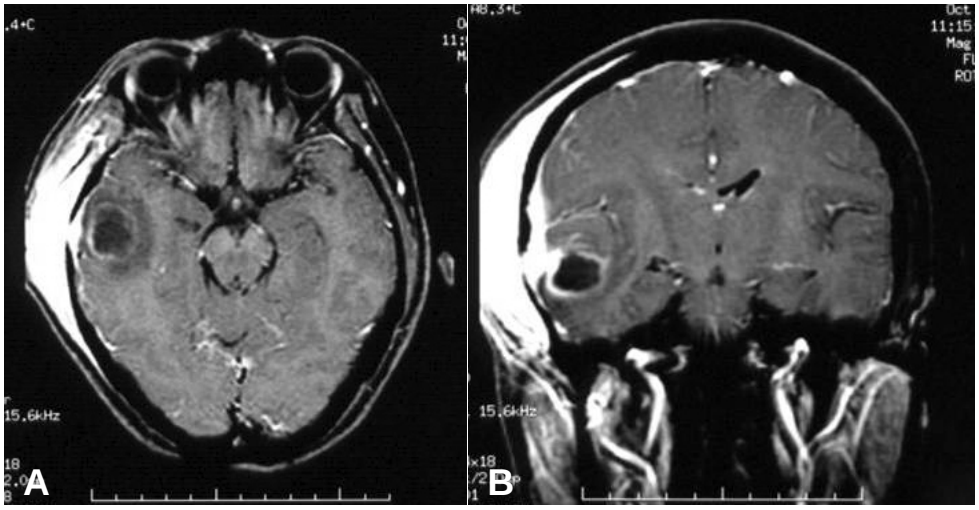


Fig 3.5.4A and B: 40 year-old woman with brain abscess

Enhanced MR images show a ring enhancement with edema.

3.5.5 Acute viral encephalitis

In general, acute viral encephalitis is usually diagnosed on the basis of clinical features and laboratory examinations, especially cerebrospinal fluid findings. CT and MRI images show multiple patchy areas of focal abnormality, usually no parenchymal enhancement, rarely with spotty, gyral or leptomeningeal enhancement, depending on the degree and severity of inflammation (Fig 3.5.5). In some cases, brain imaging studies may help the diagnosis. Herpes simplex encephalitis and Japanese encephalitis are endemic in some regions of china. The former characteristically involves the insular, temporal lobe and limbic system. The latter characteristically involves the thalamus.

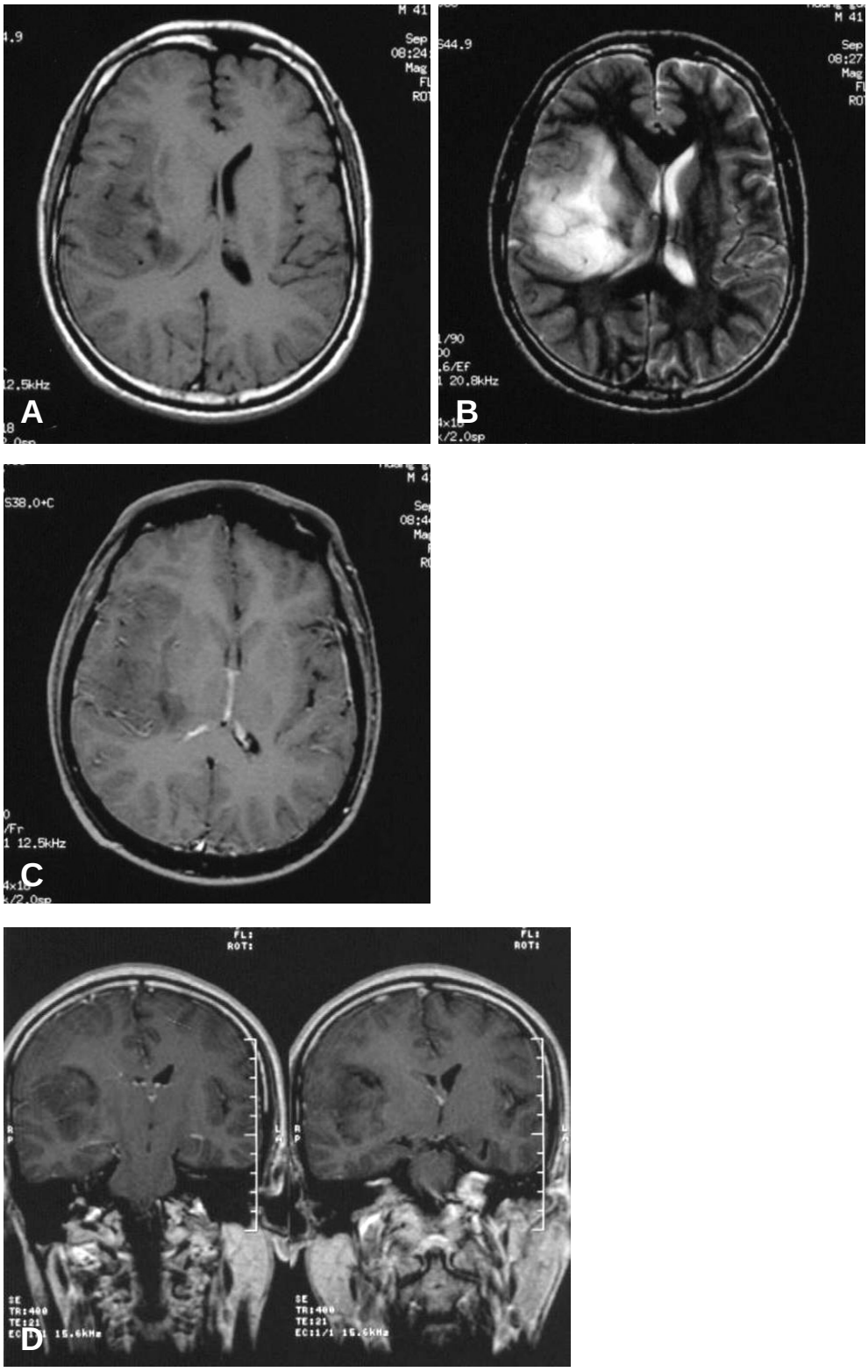


Fig 3.5.5A-D: 41 year-old man with acute viral encephalitis

A and B: Unenhanced MR shows hypointense lesion on T1WI and hyperintense on T2WI.

C and D: Enhanced MR shows slightly spotty enhancement with edema and mass effect.

3.5.6 Metastasis

On findings of multiple, enhancing solid lesions at the gray matter–white matter junction and prominent surrounding edema in a patient with known primary cancer, a diagnosis of metastases may be confidently made (Fig 3.5.6).

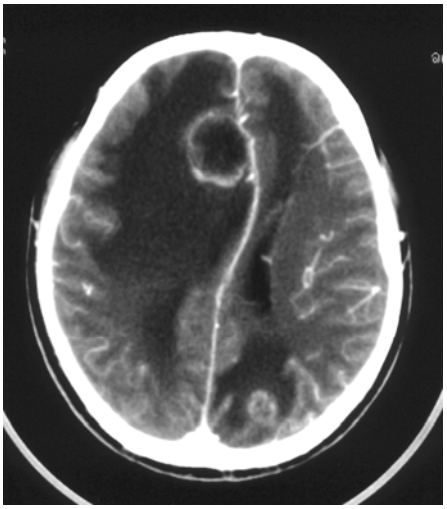


Fig 3.5.6: 64 year-old man with metastatic lung cancer in brain

Enhanced CT shows multiple ring enhancing nodules and mass with significant edema, located at subcortical area.

4 Discussion

4.1 Imaging findings and diagnostic features

In China, the research on imaging of cerebral schistosomiasis has been made for about 20 years (Wang et al 1988, Mao et al 1989). Neuroimaging (CT and MRI) play a key role in the diagnosis and differential diagnosis. Some studies indicate that MRI is far superior to CT in the sensitivity and accuracy of the diagnosis (Lei et al 2003). The advantage of MRI has also been confirmed in our study. The leptomeningeal or vascular enhancement has been demonstrated on gadolinium-enhanced MRI images; they have not been visible in CT. Nevertheless, some studies suggested that CT delaying enhancement (for about 5~10 minutes) and thin-slice scan could improve the accuracy of the diagnosis (Wu et al 2002).

Among the 25 patients with cerebral schistosomiasis in this series, 24 were inpatients, 1 patient had cerebral atrophy interpretated as residual change after years with cerebral schistosomiasis (Sun et al 1999). On review of the images of the 24 patients, variable and significant signs were presented. On unenhanced CT and MRI scans, edema was the prominent feature, sometimes with the signs of gyrus swelling, nodule, or mass; this could be seen in other diseases and is considered unspecific. On enhanced CT and MRI scans, variable enhancing lesions mainly comprising multiple small nodular enhancements with edema could be seen in almost all cases; these have been reported as characteristic features of CT and MRI findings (Zhu et al 2000). Some other features were also important in the diagnosis of cerebral schistosomiasis caused by S. japonicum. They were cortical and subcortical location, adjacent multiple lobes involvement, variable enhancement pattern such as diffuse, spotty, nodular, mass or ring, central linear enhancement, peripheral vascular enhancement and adjacent leptomeningeal enhancement.

As shown in the cases demonstrating the differential diagnosis, some other cerebral infections and tumor could present signs similar to those of cerebral schistosomiasis, which were nodular, ring, mass enhancement with edema, even adjacent leptomeningeal enhancement in cerebral infections; they could look like cerebral schistosomiasis. However, not all the findings were detected in the patients with other cerebral diseases due to different pathologic basis.

Some reports on image findings of cerebral schistosomiasis caused by S. mansoni have also documented nodular and linear enhancement as the characteristic features (Sanelli et al 2001, Betting et al 2005). These findings were suggested to be the common appearance to cerebral

schistosomiasis caused by both endemic S. japonicum and imported cases of S. mansoni (Liu et al 2008). With the limited reports available, we still noted the differences between the lesions caused by S. japonicum and those caused by S. mansoni and S. haematobium. Neuroimaging (CT and MRI) of cerebral schistosomiasis caused S. mansoni usually showed a tumoral lesion with mass effect and heterogeneous contrast enhancement mainly at the cerebellum and more rarely at the thalamus and the temporoparietal, occipital, and frontal regions (Mackenzie et al 1998, Pittella et al 1996). Subacute intracerebral hematoma and one cystic lesion have been documented in a patient with cerebral schistosomiasis caused by S. haematobium (Preidler et al 1996), which did not present in our cases. Cerebral schistosomiasis caused by S. mansoni and S. haematobium also rarely presented significant edema, peripheral vascular enhancement and adjacent leptomeningeal enhancement.

We suggest that the characteristic imaging features of cerebral schistosomiasis caused by S. japonicum should include variable enhancing lesions mainly comprising multiple intensely enhancing nodules, perilesional edema, central linear enhancement, peripheral vascular enhancement and adjacent leptomeningeal enhancement. These findings were different from those of other cerebral infections (such as neurocysticercosis, tuberculosis, viral encephalitis or abscess), tumor, and cerebral schistosomiasis caused by S. mansoni and S. haematobium; so we suggest that when these findings are observed, a diagnosis of cerebral schistosomiasis caused by S. japonicum should be considered.

4.2 Diagnosis and differential diagnosis

Although the definitive diagnosis of cerebral schistosomiasis is based on the visualization of eggs or adult worms in intracranial tissue at histological examination, a presumptive diagnosis can be established on the epidemiologic history in combination with positive laboratory results， image findings and the patient’s recovery after antiparasitic chemotherapy. Hence, in patients with a combination of neurologic symptoms, positive exposure, and serology or stool samples positive for schistosomiasis, and the comprehensive review of neuroimaging appearances, it may be possible to make a prospective diagnosis.

However, diagnosis could be difficult, as clinical findings are nonspecific and laboratory changes such as eosinophilia and evidence of schistosome ova in stool may or may not be present. The exclusion of other causes of neurologic disease should be considered. In this circumstance, the trial therapy with antischistosomiasis drugs would be helpful.

4.3 Image findings - therapy planning and the follow up

Generally, excellent treatment responses for acute cases can be achieved with antiparasitic drugs and corticosteroids (Yi 1988). In some circumstance, surgery treatment was indispensable. Image findings would be useful for the choice of therapy planning.

If chemotherapy is applied early enough, Antischistosomal therapy may lead to the reversal of pathologic lesions, even to complete resolution (Wu et al 1997, Dong et al 2004); in cerebral schistosomiasis in our series, this has been observed for the image findings of spotty, nodular or ring enhancement being interpreted as cerebral schistosomisis granuloma and indicating an early course of the disease.

Furthermore, different enhancement patterns could induce different treatment responses. Complete resolution would usually be achieved with chemotherapy in the cases showing multiple small spotty, nodular, ring enhancement. A high dose chemotherapy or even surgery would be mandatory in the cases with mixed nodular, mass enhancement, which could disappeare slowly.

Appropriate management of patients with cerebral schistosomiasis must take into consideration of the extent of disease, intensity of infection and complication including epilepsy; the own observations are concordant with the literature (Zhou et al 2008, Zhang et al 2002).

A scarred schistosomal granuloma could be remain in the brain for a long time. Chronic intractable epilepsy would result from these lesions. Surgical intervention are indicated on and planned with the image findings (Lei et al 2008); these are

(1) presence of an intracranial expanding lesion with mass effect

(2) inflammatory edema in the brain, obstruction of CSF circulation or emergence of brain hernia.

In this study, the surgery was performed also in patients with intracranial multiple nodular or mass with mass effect and recurrent epilepsy. The result was satisfying.

Image follow up is important for the patients with cerebral schistosomisis. Imaging contributes to evaluate the effect of antischistosomal therapy, to indicate surgery, to assess the prognosis, and to exclude other disease.

5 Conclusions

In 24 patients with cerebral schistosomiasis, we found variable and significant manifestations. On unenhanced CT and MRI scans, edema was the prominent feature, sometimes with gyrus swelling, nodule, or mass. On enhanced CT and MRI scans, variable enhancing lesions could be seen, which mainly comprised multiple small nodular enhancements combined with edema; they were located in cortical and subcortical areas, most often in multiple lobes. Central linear enhancement, peripheral vascular enhancement and adjacent leptomeningeal enhancement were also present.

The analysis of the own findings suggests that the characteristic imaging features of cerebral infection with S. japonicum are variable enhancing lesions, mainly comprising multiple intensely enhancing nodules with perilesional edema, sometimes with central linear enhancement, peripheral vascular enhancement and adjacent leptomeningeal enhancement.

When these findings were present in patients, a diagnosis could be established with a combination of neurologic symptoms, positive exposure, and serology or stool samples positive for schistosomiasis. Other cerebral infections and tumor could and must be excluded. The findings in diagnostic imaging are important to the therapy planning and follow up.

6 Summary:

OBJECTIVE: To describe the image findings of cerebral schistosomiasis in Hubei Province, China, and to evaluate the typical findings and its contribution to the therapy planning and follow up.

MATERIALS AND METHOD: This is a retrospective series of 25 clinically (17 patients) and pathologically（8 patients） diagnosed patients, identified at 2 hospitals in endemic areas of China. The images were reviewed and compared with those of other cerebral space-occupying diseases.

RESULTS: Variable and significant manifestations were presented in the cases with cerebral schistosomiasis. On unenhanced CT and MRI scans, edema was the prominent feature, sometimes with gyrus swelling, nodule, or mass. On enhanced CT and MRI scans, variable enhancing lesions mainly comprising multiple small nodular enhancements with edema could be seen, which were located at cortical and subcortical areas of adjacent multiple lobes. Central linear enhancement, peripheral vascular enhancement and adjacent leptomeningeal enhancement were also presented.

The characteristic imaging features of cerebral infection with S. japonicum include variable enhancing lesions mainly comprising multiple intensely enhancing nodules, perilesional edema, central linear enhancement, peripheral vascular enhancement and adjacent leptomeningeal enhancement.

CONCLUSION: Cerebral Schistosomiasis presents a wide variety of CT and MRI features. The characteristic findings are variable enhancing lesions mainly comprising multiple intensely enhancing nodules at the cortical or subcortical areas with perilesional edema, mass effect, central linear enhancement, vascular enhancement and adjacent leptomeningeal enhancement. The characteristic imaging features might be useful for diagnosis and distinguishing from some other cerebral infections and tumor. Furthermore, the image findings are important to the therapy planning and the follow up.

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