Hydrocephalus in Neurocysticercosis and Other Parasitic and Infectious Diseases

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The cestode species are the most common parasites that affect the central nervous system (CNS). Five different cestode infections of the nervous system are: cysticercosis, from the larva of *Taenia solium* – the most common of them, with more than 50 000 people infected worldwide; hydatidosis (hydatic cyst disease), from the larva of *Echinococcus granulosus*; alveolar cyst disease from the larva of Echinococcus multilocularis; coenurosis, a rarer type, from the larva of Taenia multiceps; and, exceptionally, sparganosis from the larva of *Spirometra mansonoides*. Only the most important ones and those related to hydrocephalus will be discussed here – cysticercosis and hydatidosis. Three other infections are common and may lead to hydrocephalus. They are fungal, viral, and infections by *Mycobacterium tuberculosis*. Other bacterial ventriculitis will not be discussed in this chapter.

Neurocysticercosis

Epidemiology

Cysticercosis infects about 50 million people around the world, 50 000 of whom die each year. It is found, alongside pork tapeworm infestation, in countries with poor hygiene habits. It is rare in most of Europe; in Asia reports are sparse. It occurs frequently in India, the northern coast of Africa, especially Egypt, and among the natives of southern Q 2 Africa. Cysticercosis is rare in the United States of America, but is the leading cause of hydrocephalus and seizures among Hispanic Americans living in Los Angeles and California [4, 59]. Latin America is the area with the highest incidence of cysticercosis – it is referred from Mexico to Argentina and Chile. From all autopsies in Mexico in 1979, 1.9% showed infection by *T. solium*. Colli et al. reported that 2.7% of hospital admissions for neurological diseases in the city of São Paulo in 1986 were due to neurocysticercosis [17]. Admissions in the pediatric age group due to neurocysticercosis comprised 2%-10% of all cases. The habit of repeatedly introducing their fingers into their mouths and easy contact with the soil expose children to a higher risk of massive cestode infections. Statistically, older people are less affected [12, 39].

Cysticercosis affects mostly people with lower living standards. Though a few studies have shown a higher incidence among males, there seems to be no sex preponderance, and as to age, the peak incidence is between 25 and 35 years [52].

Incidence of Hydrocephalus in Neurocysticercosis

In general terms, hydrocephalus is responsible for 15%-30% of clinical manifestations of neurocysticercosis [42]. Neurocysticercosis can be classified into two forms: benign and malignant [25]. In the benign form, the parasites are usually parenchymatous, on the meninges outside the cisterns, or, in a small number of cases, ventricular. Patients are asymptomatic or present with headaches or seizures. Prognosis is good and response to treatment is quick. In the malignant form of the disease, the parasites are located in the subarachnoid space, inside the cisterns or inside the ventricles. Blood vessels are affected. Hydrocephalus is the most common clinical presentation and may be the result of basal arachnoiditis or of the presence of intraventricular cysticerci. Patients may present with myriad symptoms or develop symptoms of increased intracranial pressure. Prognosis is poor and therapeutic response not good. Wei et al. [70] analyzed 1400 cases of cerebral cysticercosis and detected ven-

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triculomegaly in 204 patients (14.5%). Seventy patients had global dilatation of the ventricles and 67 (32.8%) isolated dilatation of the fourth ventricle. In 1984, Apuzzo et al. [4] demonstrated in a series of 45 cases of intraventricular cysticercosis that the fourth ventricle is most commonly affected (24 patients). In 12 cases, the cysticerci were located in the third ventricle, and in 5, inside the lateral ventricles. This series, however, did not show any case of isolated blockage of the temporal horn of the lateral ventricle. Conversely, in our series the presence of cysts completely blocking the temporal horn is somewhat common (Fig. 1). The cysticerci may move from one ventricular cavity to another, a fact that has been verified during ventriculography [4, 15].

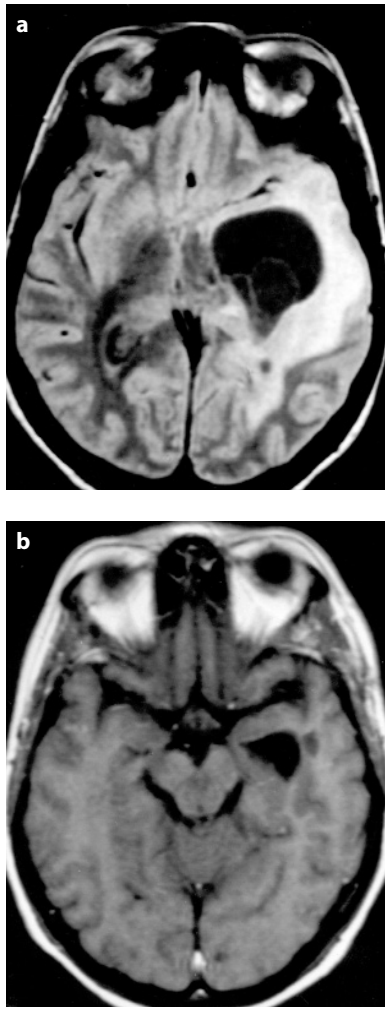

Fig. 1. a Axial FLAIR MRI demonstrating blockage of the temporal horn by cysts. **b** Axial T1-weighted MRI after endoscopic cyst removal

Transmission and Life Cycle of the Parasite

Humans are the only definitive hosts of T. solium, harboring the mature tapeworms in the lumen of the small intestine. Usually, there are only minimal clinical symptoms or even no symptoms at all. The mature T. solium is composed of a head or scolex that contains four suckers and a double crown of hooks, a narrow neck, and a body that is sometimes many meters long and is composed of hermaphroditic proglottids. A few proglottids are released daily from the distal extremity of the tapeworm and eliminated with the host's feces. The host thus delivers proglottids with large numbers of fertile eggs to the exterior, where they contaminate the soil. These eggs are resistant to being dried out and may remain in the soil or water for months. In some cases, the eggs are released inside the intestinal lumen, and these are the eggs released with the host's feces. Around 50% of these eggs are mature and fertile. The usual intermediate host, the pig, becomes infected by ingesting water or food contaminated by human feces. The parasites then take shelter in organs with a high oxygenation and movement level, such as the brain, chewing muscles, tongue, and heart (Fig. 2). By consuming uncooked pork containing the larva (intermediate form), humans acquire tapeworms – the mature form of the parasite (Fig. 2).

Human cysticercosis may result from two mechanisms: autoinfestation and heteroinfestation. In the former, the proglottids may release the fertile eggs inside the host's intestines, leading to internal self-infestation. This is considered one of the ways man can become infected by T. solium. In order to liberate the larvae, the eggs need to be exposed to the stomach acid. Thus, vomiting or antiperistaltic movements of the intestines push proglottids with fertile eggs toward the stomach. These proglottids may, in turn, fragment and release their eggs to the effects of the stomach acids, and suffer, back into the duodenum, intestinal digestion and disintegration of the embryophore and release of the oncosphere. In the small intestine, the larva attaches itself to the intestinal wall using its hooks, and insinuates itself between the epithelial cells of the villi, with the help of cytolytic substances secreted by special glands. It reaches the connective tissue corium and, once the lumen of the capillaries is reached, invades the tissues through the blood vessels. Other facts corroborate this infestation mode, such as the presence in one individual of both cysticerci and the mature tapeworm. A history of tapeworm infection is found in 7%-22% of patients with cysticercosis [59]. External self-infestation occurs when the individuals are

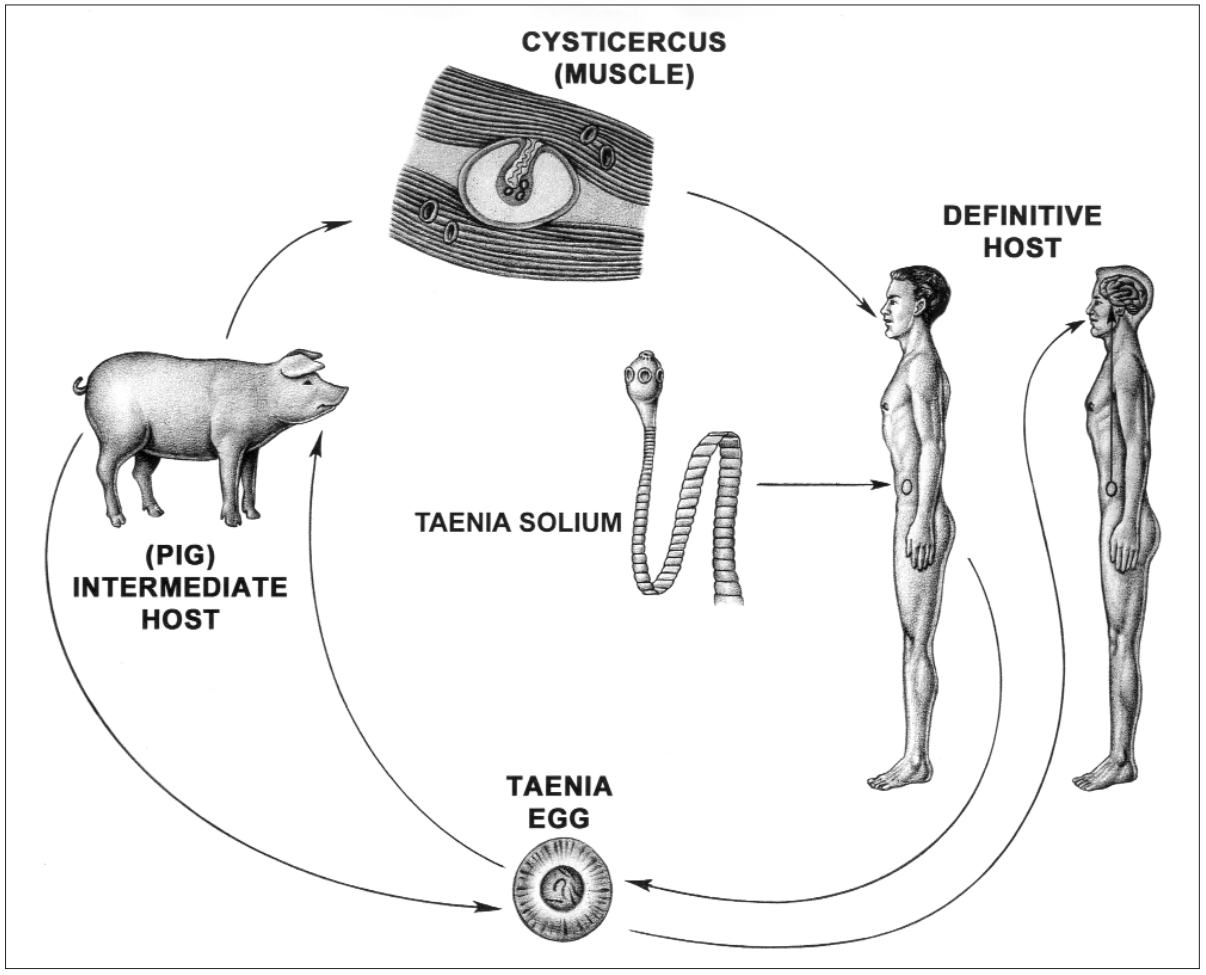

Fig. 2. Life cycle of the parasite

contaminated by their own feces, ingesting eggs or proglottids of their own tapeworm [2].

The mechanisms involved in heteroinfestation include ingestion of water, vegetables, or fruit contaminated by T. solium eggs, either through poor hygiene habits or by soil fertilized with human feces. Usually, consumption of contaminated pork leads to tapeworm infection. However, immune-suppressed individuals may become infected by contaminated pork containing larvae.

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The mature proglottids of the T. solium are eliminated from the intestine with the feces into the environment, degenerate, and release the eggs (embryophores), which harbor the embryo (hexacanth). Once ingested, the egg undergoes the effects of the gastric acids and passes to the intestines where, 24-72 h afterwards, its shell fragments, releasing the oncosphere. The oncosphere, in turn, penetrates the intestinal wall with the help of its hooks, reaches the mesenteric veins and then the blood stream. The stomach is thus the first barrier against this infestation, as only eggs whose shells have resisted the gastric acidity will release their oncosphere in the intestinal alkaline medium. Once liberated in the blood stream, the embryos will be retained in places where the diameter of the vessels is too small or the circulation slow (muscle, retina and brain).

The larval form of T. solium, Cysticercus cellulosae, develops from the embryo. It possesses a head and a neck, invaginated inside a vesicle. The head is similar to that of the adult form and the neck is very small; both are wrapped around themselves. The vesicle is clear, semitransparent, of variable shape, and measures about 10-15 mm; its interior is filled with crystalline fluid. When the cysticercus is located within the cerebral ventricles or in the subarachnoid space around the brainstem, the head and neck may disappear and secondary vesicles may form from its walls, mostly intercon-

nected, taking the aspect of an irregular grape cluster (2-15 cm). This cluster is called Cysticercus racemosus [13, 14].

Pathological Findings in Neurocysticercosis

From one to hundreds of embryos may reach the CNS, where they may survive for 1-30 years in the form of *Cysticercus cellulosae,* or as *Cysticercus racemosus* (its intermediate form) or even as both forms coexisting together. Once settled, the cysticerci, while alive, cause almost no response from the surrounding tissues. The inflammatory response is related to the number of parasites and their state of degeneration, which, in turn, depends essentially on the release of antigens [26]. In many cases, the immune response develops slowly, allowing the parasites to survive for many years inside the host in a state of relative immunological tolerance. In some cases the parasites are rapidly destroyed due to an intense inflammatory reaction. This reaction can elicit concomitant injury to the brain tissue around the cysticerci. Between these two extremes, there is a myriad of immune response levels. Women have been found to present a more intense tissue inflammatory reaction than men [53]. The human leukocyte antigen (HLA) participates in the pathogenesis of cysticercosis. Some cysticerci have HLA molecules adhering to their membranes. The parasites covered with HLA molecules give rise to an inflammatory reaction more intense than that of cysticerci without those molecules adhering to the surface, probably because HLA molecules are modified by the parasite or because the parasite itself produces an HLA-like molecule [20]. Patients with cysticercosis present an elevated HLA-A-28 antigen, while the antigen HLA-DQw2 is decreased, with a relative risk of developing the disease 3.5 times higher in the presence of the antigen HLA-A-28 [21]. These findings suggest that the susceptibility or resistance of an individual to develop cysticercosis may be related in part to genetic characteristics.

The cysticerci are round vesicles of variable size, filled with liquid, constituted by an external layer known as a vesicular membrane and an internal portion called scolex [24]. The scolex presents a structure that is similar to the adult parasite that can be absent in parasites located in the subarachnoid space, especially the basal cisterns, where they group in numerous adherent membranous vesicles, grouped in clusters. Classically, cysticerci with scolex are called *Cysticercus cellulosae* and those without scolex, *Cysticercus racemosus*. Parenchymal cysticerci measure about 1 cm diameter, being located preferentially at the level of the basal ganglia and cerebral cortex due to their increased vascularity.

Once implanted in the CNS, the hexacanth begins its development onto the embryonic form, the cysticercus [24]. In its first stage of development, called the vesicular stage, the membrane is thin and transparent, the fluid is clear, and an invaginated scolex is the norm. The cysticerci can remain in this phase or start a degenerative process as a result of the host's immune response, which may lead to their destruction in three stages. The first stage of this process, when the vesicular fluid becomes cloudy and the scolex shows signs of hyalin degeneration, is called the colloidal stage. Later on, the walls of the cyst become thick and the scolex is transformed into a granular mineralized structure. Lastly, the whole parasite becomes an inert calcified nodule (Fig. 3).

The intensity of the tissue changes around the cysticerci depends on which stage the parasites are in and on their location in the CNS [24]. In the vesicular stage they induce a perilesional inflammatory reaction, composed mainly of lymphocytes, plasma cells, and eosinophils. In the colloidal stage, a dense collagen membrane is formed around the vesicular membrane and the perilesional inflammatory infiltrate may also endanger the parasite. The surrounding brain tissue presents reactive gliosis, which explains one of the most common clinical manifestations of neurocysticercosis, epilepsy [20, 22, 52, 53].

The degeneration is of the hyalin type and is characterized by calcification of the parasite struc-

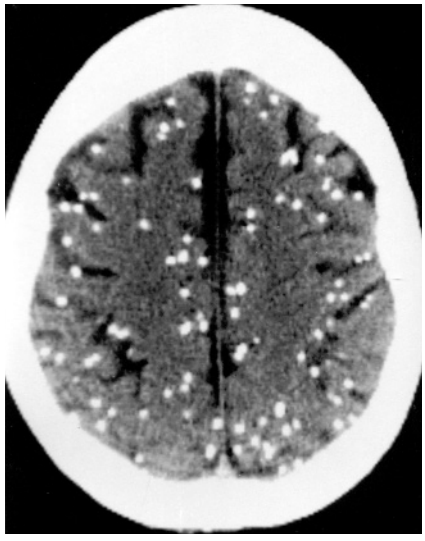

Fig. 3. Unenhanced CT scan demonstrating calcifications as a result of cysticercus degeneration

ture. Glial proliferation develops around the inflammatory reaction, and there may be damage to neighboring neurons and vessels giving rise to ischemic damage to the parenchyma. Rarely, the tissue reaction can diffuse to the brain and meninges. The meningeal cysticerci also give rise to the diffuse formation of a dense exudate in the subarachnoid space composed of collagen fibers, multinucleated giant cells, eosinophils, and hyalinized parasitic membranes, with thickening of the basal meninges. This chronic inflammation is responsible for the development of hydrocephalus in more than half of the cases.

When the cysticercus is located within the ventricular system, it also gives rise to intense perilesional inflammatory reaction (Fig. 4), if they are adherent to the ventricular wall. In these cases, the ependymal cell layer is altered, forming subependymal giant cells that tend to group and protrude into the interior of the ventricular cavities, leading to obstruction to the free flow of cerebrospinal fluid (CSF) at the level of the foramen of Monro or the aqueduct of Sylvius. This process is called granular ependymitis and leads to obstructive hydrocephalus. Hydrocephalus may by asymmetrical if only one foramen of Monro is obstructed. However, the development of granular ependymitis due to a cysticercus may not fix it, allowing it still to move around. This can lead to transient obstruction by the cysticercus.

Intramedullary forms of the disease have been described, mainly at the mid-thoracic level, whereas spinal subarachnoid localizations are more common at the cervical level [7,15].

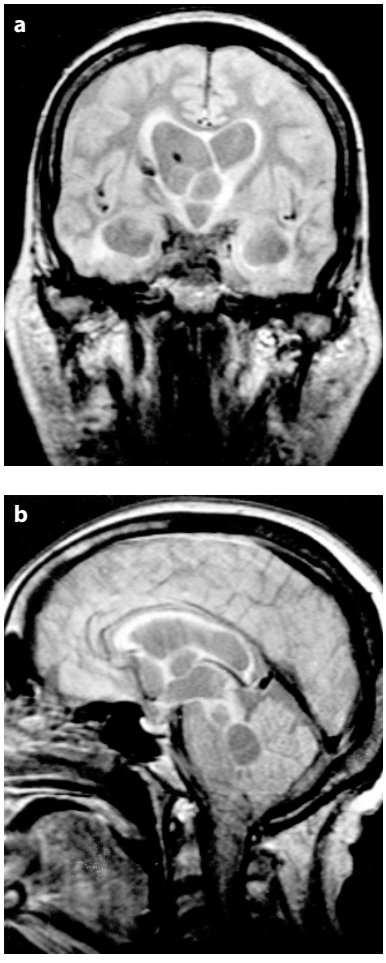

Fig. 4. **a** Coronal and **b** sagittal FLAIR MRI showing intraventricular cysts and ependymal inflammatory reaction

Clinical Manifestations and Diagnosis

With regard to its pathophysiology, neurocysticercosis may present as a high- or low-intensity disease that may be located in the ventricles, parenchyma, meninges, or mixed location. It may manifest as an acute, subacute, or chronic disease, in remission or exacerbation; it may have a simple or complicated clinical evolution, be asymptomatic, symptomatic, or fatal. It may subside with or without treatment; its symptoms may disappear for long periods of time or persist until death. The onset of the symptoms may be insidious or abrupt, and the clinical course is variable and unpredictable. The prognosis is always severe [2].

The clinical presentation may have an insidious beginning and lead to death within a few minutes or in over 30 years' time. The polymorphous nature of the symptoms is characteristic of the disease and is due to a series of factors such as the number, location, form, size, and stage of development of the parasite, the nature of the parasite's action in the host's organism, and the host's individual immunological response [63-66]. In 1988, Zee et al. [84] reported that out of 46 patients with intraventricular cysts, 6 died of hydrocephalus a short time after admission.

Diagnosis may be reached by appropriate clinical observation that includesepidemiological aspects, clinical and neurological examination, along with detailed study of the CSF and imaging studies such as computed tomography (CT) and magnetic resonance imaging (MRI).

Cutaneous cysticercosis may be associated with neurocysticercosis in 65% of the cases. It usually suggests a benign neurocysticercosis. The most common clinical symptoms of the disease are: epilepsy, intracranial hypertension, psychiatric

changes, meningitis, and meningoencephalitis. Occasionally, headache is the only complaint. Although the association of these symptoms is common, isolated epilepsy seems to be the predominant form of presentation. Partial seizures are the most frequent; intractable seizures are rare. Intracranial hypertension is usually severe and tends to occur in association with other symptoms, especially epilepsy. Its treatment is difficult, although once the acute phase has passed, these children frequently present a good recovery. Sequelae may ensue in some cases. Behavioral disturbances such as aggressiveness, agitation, and irritability may also be seen. One should bear in mind the possibility of these children developing a clinical picture of neurological and psychological regression that, when associated with epilepsy, resembles a degenerative disease of the CNS.

The analysis of the disease is the most important aspect of its treatment. Neurocysticercosis can be divided into two major forms: active and inactive. In the active forms of the disease one may have clinical manifestations such as (1) arachnoiditis, (2) hydrocephalus due to meningeal inflammation, (3) parenchymal cysts, (4) cerebral infarction due to vasculitis, (5) mass effect due to large cysts, (6) intraventricular cysts, and (7) spinal cysts. The inactive forms present as (1) parenchymal calcifications and (2) hydrocephalus due to meningeal fibrosis.

Cerebral cysticercosis may be entirely asymptomatic, being demonstrated only at autopsy. In the symptomatic cases the neurological examination is normal in 25% of the total [22]. The initial symptoms that prompt the patient to seek medical help are seizures, meningeal signs, visual disturbances, headaches, and vomiting. Epilepsy may be an isolated symptom for a long time, being called idiopathic epilepsy still to the present day. Neurocysticercosis may lead to an intracranial hypertension syndrome, with headache, vomiting, dizziness, and papilledema. Altered mental status may be a manifestation of the disease, and pure psychotic forms are found in 15% of the cases. Cysticerci on the motor or sensory cortical areas can cause seizures, usually generalized. Chronic focal epilepsy is related to residual calcifications and areas of gliosis that represent the inactive form of the disease.

Meningitis due to neurocysticercosis may show acute or chronic headaches, neck pain, and occasionally fever. In some cases, the typical presentation of increased intracranial pressure can be seen. In other cases, meningitis may progress slowly and with only mild symptoms, leading to communicating hydrocephalus due to basilar arachnoiditis. The pathogenesis of neurocysticercosis is that of a chronic inflammatory process with an irregular period of activation that occurs when cysticerci die and disintegrate, causing antigen release [54,56].

Intraventricular cysticercosis occurs in 11%-17% of the patients, being a potentially lethal form of the disease [85]. The oncospheres probably reach the ventricles through the choroid plexus. They may develop and float freely in the CSF or adhere to the ependyma by a granulomatous reaction. Occlusion of the aqueduct or the foramina of Luschka and Magendie may result in acute obstructive hydrocephalus, sometimes associated with sudden death. Nausea, vomiting, dizziness, headache, diplopia, syncope, and altered state of consciousness are common manifestations of intraventricular cysts.

CSF analysis is one of the most important examinations in the diagnosis of neurocysticercosis, even though the results may be normal in approximately 20%-25% of the cases despite the presence of viable cysticerci. In these cases, an indirect approach to diagnosis is a trial drug therapy. In roughly 75% of the cases, the immunodiagnosis is positive or, at least, there are changes in one or more of the CSF parameters. On the other hand, if the patient's condition permits, close clinical observation with CSF examination, CT, and/or MRI may lead to an unequivocal diagnosis. The definitive diagnosis of neurocysticercosis is based on immunodiagnosis in the CSF and/or on lesions suggestive of this parasitic disease on CT or MRI. The changes in CSF that characterize the syndrome are lymphocytic pleocytosis, increased eosinophilic content, elevated total protein levels, hypoglycorrhachia, and positive immunological reactions in the CSF. Two or more positive tests increase the certainty of the diagnosis. The complement fixation test, one of the first tests utilized for the diagnosis of this disease, is positive in 83% of the cases of active meningeal cysticercosis if there are inflammatory changes of CSF. Conversely, the test sensitivity is only 22% if CSF examination is normal. Another immunoassay used nowadays is the enzyme-linked radioimmunoassay, which has a specificity of 95% and a sensitivity of 87% in cases of active meningeal neurocysticercosis.

Images made by CT scanning vary according to the phase of maturation of the parasite and its location. Viability of the cysticercus usually is determined by contrast enhancement. Neurocysticercosis may show on CT as single, multiple, or racemose vesicles, generally localized in the brain parenchyma. The cysts have well-defined contours, no perilesional edema, and little or no enhancement after contrast administration; colloidal-phase cysts show perilesional edema, have less defined contours, and may present annular contrast enhancement separating the cyst from surrounding cerebral edema.

This tomographic picture was defined as the acute encephalitic phase. Granulomas indicate a degenerating parasite; they may be single or multiple, ordinarily nodular and located on the parenchyma. Calcifications are the most common tomographic findings. They present as minuscule hyperdense lesions not surrounded by edema, that do not change after administration of intravenous contrast; they may be single or multiple, of various sizes, always round, and appear at least 36 months after the start of the degeneration. The presence of diffuse or localized edema without vesicles in the treated patient may indicate the beginning of the evolutive phase, due to an inflammatory reaction, hydrocephalus, increased ventricular size, sometimes in the absence of vesicles, calcifications or granulomas. This is the characteristic pattern of cysticercotic encephalitis, a particularly severe form of neurocysticercosis in which the immune system responds actively and intensely against a massive invasion of the brain parenchyma by cysticerci.

CT findings of subarachnoid neurocysticercosis include hydrocephalus, abnormal enhancement of the basal meninges, and cerebral infarction. Ventricular cysticerci may be isodense in relation to CSF, making their visualization difficult on CT scan. Ventriculography allows precise identification of these cysts [16].

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The MRI characteristics depend on the phase of the disease. Vesicular cysts are seen as round lesions with well-defined contours and a signal intensity similar to CSF in both T1- and T2-weighed images. The scolex is seen as a hyperdense point inside the cystic lesion. The details of the cyst wall and perilesional edema, in addition to the presence of intraventricular cysts, are better visualized. All MRI sequences can identify the vesicles. The degenerating vesicles are recognized by the presence of edema, which appears bright on T2 sequences and is enhanced by contrast material. Granulomas and residual calcifications appear as a signal void. These forms of neurocysticercosis demonstrate one of the most important diagnostic limitations of MRI. MRI easily diagnoses meningeal cysticerci, as they present a signal different from the CSF.

In childhood, the diagnosis through imaging demonstrates two factors that are different from the disease in adults. The first is the number of lesions: only a small group presents with an intact parasite, the vesicle; also, most images are from the acute phase of the disease. Secondly, increased intracranial pressure in infancy is due to cerebral edema from the inflammatory reaction and not to hydrocephalus secondary to ventricular obstruction, the latter being common in adult patients.

Treatment

It is known that neurocysticercosis may be treated surgically or medically. Surgery for removal of cysticerci, employed in only a small and specific number of cases (racemose cisternal cysticerci, ventricular cysticerci), is practically never used in children as these forms of the disease do not ordinarily occur in this age group. Carbamazepine is suggested for the control of epilepsy because of the increased frequency of partial seizures. Del Brutto and Sotelo [20-22] demonstrated that 83% of the patients were drug-free if anticonvulsants were used in conjunction with cysticercocidal drug therapy. Conversely, only 26% of the patients were drug-free when only anticonvulsants were utilized. Increased intracranial pressure is treated specially with dexamethasone, for a long period, 1 month or more, to withdraw slowly. For those few patients who present severe intracranial hypertension that is unresponsive to dexamethasone, mannitol or a lumboperitoneal shunts might be used as a last resort.

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Etiological treatment involves drugs that penetrate the central nervous system and destroy the parasite. Currently two drugs are utilized: praziquantel (PZQ) and albendazole (ABZ). Their use is restricted to patients who exhibit intact forms of the parasite, i.e., vesicles. The simultaneous administration of corticosteroids and cysticercocidal drugs to patients with intraparenchymal lesions is also controversial [20, 21]. ABZ has been the preferred initial cysticercocidal drug, as it is cheaper, has fewer side effects, and is used for a shorter period of time. If the lesions persist, PZQ may be used after 3 months, or the ABZ treatment may be repeated [7, 16]. PZQ is an isoquinoline with strong antiparasitic activity that leads to the disappearance of 60%-70% of intraparenchymal cysts after 15 days of treatment at a dosage of 50 mg/kg per day. ABZ is a benzimidazole with antihelmintic properties, currently the drug of choice for the treatment of neurocysticercosis. It destroys 75%-90% of intraparenchymal cysts when administered for 8 days at a dosage of 15 mg/kg per day. Furthermore, it also acts on the meningeal and intraventricular forms of the disease, due to its good penetration into the subarachnoid space [21]. Despite treatment with PZQ and ABZ, however, a large number of patients will require surgical treatment to treat hydrocephalus or remove isolated cysts (Fig. 5). Patients presenting with compression of cranial nerves, brain tissue, or spinal cord are also amenable to surgery.

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Three mechanisms may produce increased intracranial pressure: diffuse brain edema, hydrocephalus, or mass effect (pseudotumoral form).

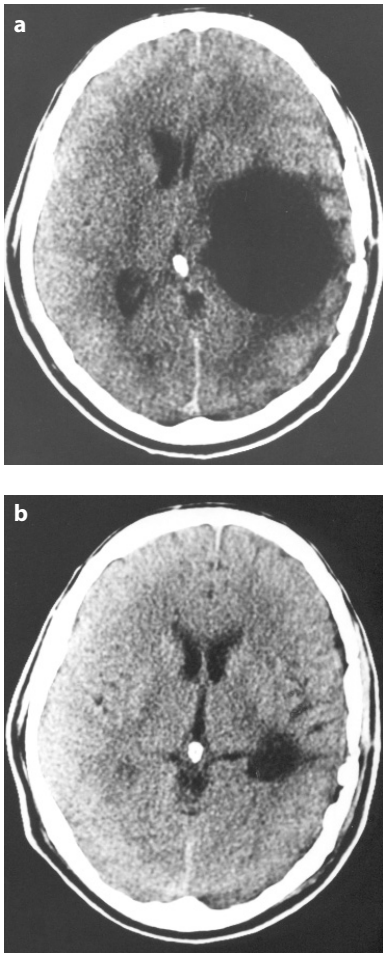


Fig. 5 a, b. Axial CT scans. a Blockage of temporal horn by ependymitis. **a** Postoperative follow-up after endoscopy

Diffuse Brain Edema

This form is found in 2.8% of the cases that present increased intracranial pressure. It is seen in cases of extensive infestation, cysts, inflammatory reaction, and diffuse brain expansion. Treatment is mostly clinical, but in intractable cases lumboperitoneal shunts are indicated. In extreme cases, decompressive craniotomies may be performed in a heroic attempt to save lives.

Pseudotumoral Form

Giant cysts may be located in the brain parenchyma or in the cisterns and are easily identified by imaging studies. If located within the parenchyma, complete removal of the cysts is readily accomplished. However, if the cysticerci lie in the cisterns and their degeneration process has already started, complete removal may be difficult or even impossible.

Hydrocephalus

Hydrocephalus can be identified in 15%-30% of the cases with neurological symptoms [42, 51]. in the majority of cases it derives from chronic basal arachnoiditis or meningeal fibrosis. A small percentage of cases may be due to intraventricular cysts. It is believed that the larvae invade the ventricular system through the choroid plexus. Hydrocephalus corresponds to 90.5% of the cases of intracranial hypertension treated with surgery. Involvement of the ventricular system is ordinarily associated with higher mortality and morbidity rates than is the intraparenchymal form of the disease [4, 7, 42, 60]. There is still no consensus in the literature as to the best kind of treatment. On the whole, there are three types of treatment: drug therapy, which has little or no efficacy in this form of the disease; ventricular shunts; and surgical removal of cysts (Fig. 6).

Hydrocephalus may be produced by mechanical obstruction of the CSF pathways by cysts (Fig. 7), inflammatory reaction caused by cyst degeneration, or an association of both factors. Migration of the cysts within the ventricles may lead to the intermittent headaches that characterize Bruns syndrome. Many authors recommend ventricular shunts as the first or definitive form of treatment [7, 14, 15].

Ventriculoperitoneal shunts are the treatment of choice for those patients who present with inflammatory obstruction of the ventricular system and hydrocephalus. As a rule, the patients exhibit a good recovery. However, mechanical and inflammatory compli-

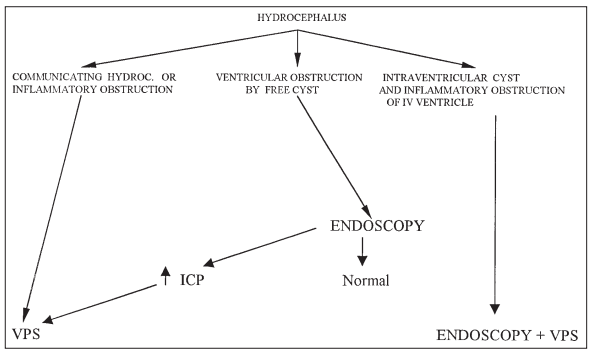


Fig. 6. Treatment algorithm for patients with hydrocephalus

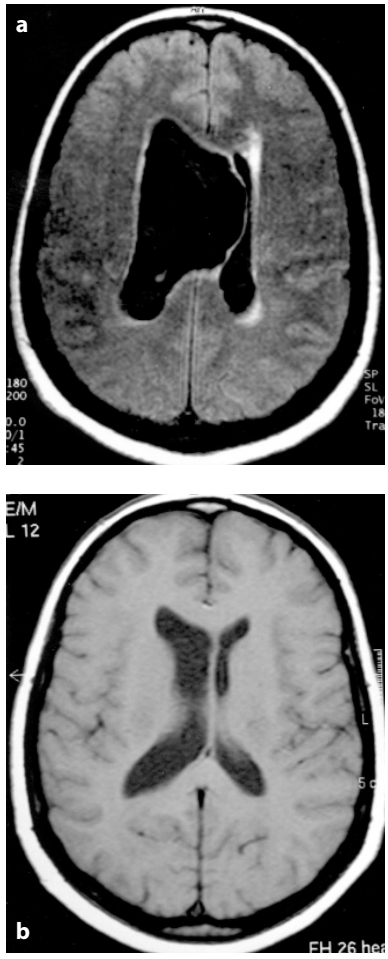


Fig. 7. **a** FLAIR MRI revealing a giant intraventricular cysticercus. **b** Postoperative T1-weighted MRI. **c** Cysticercus cellulosae endoscopically extracted

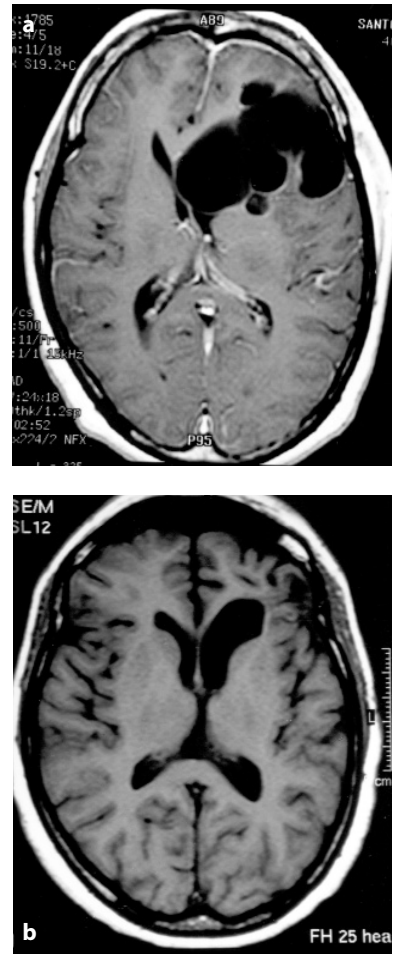


Fig. 8. Axial enhanced T1-weighted MRI. Clusters of cysticerci arising from the sylvian fissure. Note the normal ventricular size. **b** Axial unenhanced T1-weighted MRI, postoperative follow-up after endoscopy

cations are prevalent among these patients, with a high incidence of ventriculitis, meningitis, and obstruction of the catheter by the cyst. Colli et al. [16] report an 82% (46 cases) shunt revision rate in a study of 56 patients with neurocysticercosis treated by ventricular shunts. In those cases in which ependymitis caused ventricular loculation, an endoscopic procedure followed by a ventricular shunt showed good results. Free intraventricular cysts, even those located inside the third and fourth ventricles and basal cisterns, are easily removed by endoscopic procedures. Neurocysticercosis is a chronic inflammatory disease in which there may be communicating and noncommunicating hydrocephalus (Fig. 6).

Cisternal forms with cranial nerve compression (Fig. 8) and spinal forms with spine compression have been described.

Pitfalls in Surgical Treatment

Viable intraventricular cysts may shift position frequently, moving from the lateral ventricles to the third and fourth ventricles. A recent imaging study, preferably one obtained during the immediate preoperative period, should allow detection of any cyst migration and thus help with the surgical strategy, hopefully preventing cysts from being overlooked during surgery.

Endoscopic Treatment

It is estimated that 2.4 million people throughout the world have cysts from neurocysticercosis in the ventricular cavities [42,70]. The cysts' lack of vascularia-

tion and mobility allow easy handling and easy removal in the absence of ependymitis. Large cysts with scolex in their interior need to be completely removed. Even if the cyst ruptures during the procedure, there is no associated ventriculitis. In the event of ependymitis with multiple intraventricular loculations, endoscopy may allow communication between various cavities and placement of a single ventricular shunt system. Endoscopic third ventriculostomy is typically performed when there is a noninflammatory CSF blockage at the level of the aqueduct or fourth ventricle (Fig. 6). Once an inflammatory process at the level of the basal cisterns has occurred, its usefulness is limited. In cases presenting the parenchymal tumoral form of the disease, endoscopy is useful in the removal of cysts and verification of other cysts not detected by imaging studies. In the severe racemose form, in which numerous cysts located within the interpeduncular cistern may present mass effect and symptoms such as altered consciousness, visual and vegetative changes, endoscopic opening of the tuber cinereum can allow removal of these cysts and improvement of the symptoms.

Surgical approach to the lateral or third ventricles through a transcallosal or transcortical-transventricular approaches is recommended for the treatment of intraventricular cysts [4]. The advantages of neuroendoscopy are numerous in comparison to craniotomy. Neal in 1995 [40] reported the removal of a cyst of the posterior portion of the third ventricle, using a combination of rigid and flexible endoscope. Irrigation using positive pressure may be another tool to help mobilize and aspirate the cysts. In our experience, out of 310 patients who underwent endoscopic procedures, in 20 cases (7.4%) it was for treatment of hydrocephalus associated with the disease. Bergsneider et al. [9], while studying ten patients with hydrocephalus due to neurocysticercosis, concluded that endoscopic procedures should be considered as the first treatment option. Only three of their patients required a shunt afterwards.

Outcome of Hydrocephalus Due to Neurocysticercosis

Given that hydrocephalus in neurocysticercosis can be attributed to various mechanisms, it may be said that the outcome will depend on its etiology. Intraventricular cysts can be treated using endoscopic techniques or a direct approach, as for cysts of the fourth ventricle (Fig. 9) or of the periaqueductal re-

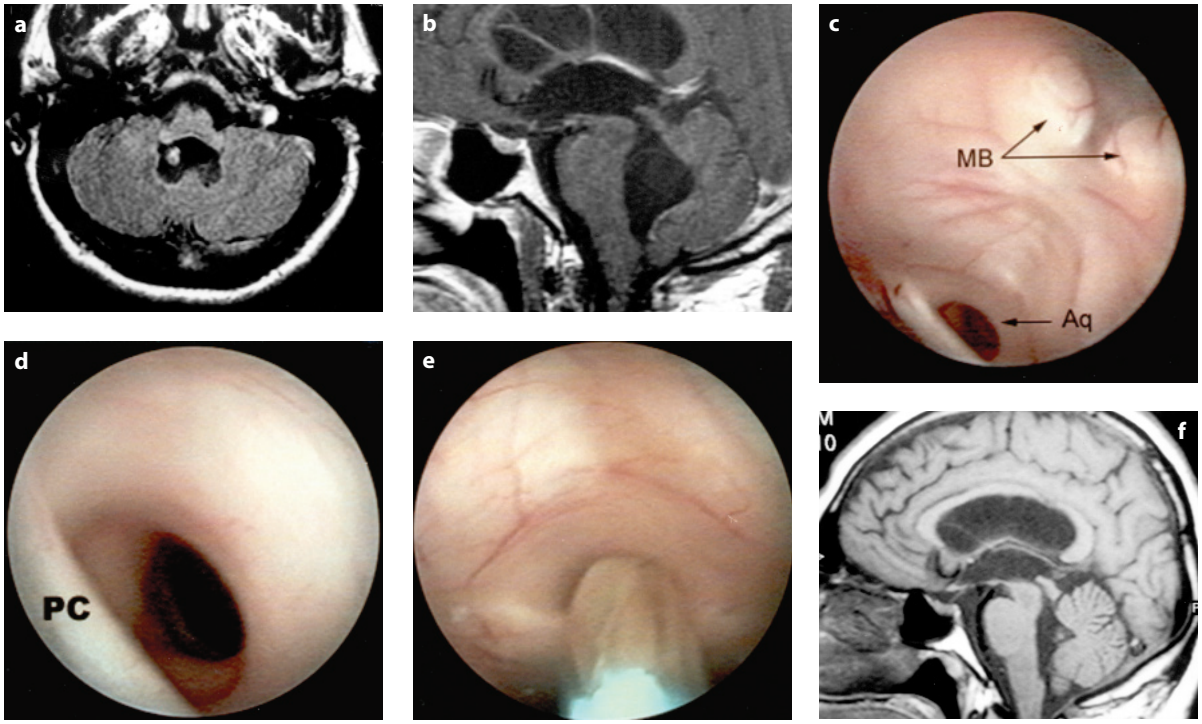
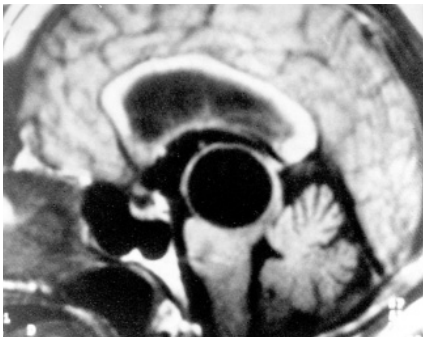


Fig. 9. **a, b** Axial and sagittal T1-weighted MRI. Fourth ventricular cysticercus and scolex. **c, d** Endoscopic views of the floor of the third ventricle. MB, mammillary bodies; Aq, cerebral aqueduct; PC, posterior commissure. Note the cyst appearing inside the fourth ventricle. **e** Endoscopic view of the cysticercus being extracted. **f** Sagittal T1-weighted MRI, 3-month follow-up



Q 10

Fig. 10. Sagittal T1-weighted MRI. Mesencephalic hydatic cyst

gion (Fig. 10). Communicating hydrocephalus resulting from inflammatory blockage of the basal cisterns and treated by ventricular shunts (Fig. 6) may present a higher incidence of complications [13]. Recurrent inflammatory reactions with CSF pleocytosis and increased protein levels due to the rupture of small intraventricular cysts is probably one of the causes of these complications [13]. It is known that drug therapy for neurocysticercosis is far from ideal and for the intraventricular forms of the disease is not efficacious at all [63]. In a series that studied large groups of patients, forms of neurocysticercosis considered hypertensive comprised 20%-36% of the cases [48, 59, 66] and usually resulted in the worst outcome. Stepien [59] reported on 43 patients who presented hydrocephalus. There was improvement in only 12 cases (28%); 29 patients died (67%). In a study from the city of Ribeirão Preto (Brazil) of 500 patients in a period of 23 years [66], 68 (13.6%) underwent some form of CSF shunt diversion or surgical removal of cysts. Out of 74 patients classified as having a pure hypertensive form of the disease, 21 (28.4%) died. Canelas [14] noted that of 63 patients who underwent a surgical procedure, 28(44.4%) died. Takayanagui [64] pointed out that, of his series of 56 patients that presented with signs of increased intracranial pressure, 12 (21.4%) died and 12 developed incapacitating neurological sequelae. Studies concerning the intellectual development of these patients are extremely difficult, as pointed out by Scharf [48], for each patient has a different individual outcome depending on the lesions, the number of parasites, the duration of the infestation, and the immunological response of the host.

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Prophylaxis

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Control of neurocysticercosis demands attention to hygiene habits and environmental sanitation. Widespread medical treatment aimed at eradicating human tapeworm infection would be an alternative control technique. The economic cost of treating a case of tapeworm intestinal infection is 150 times smaller than the cost of the same medication used to treat neurocysticercosis [47]. At the present time there are two kinds of strategies recommended by the World Health Organization: the first, for short term results, is based on widespread treatment of tapeworm infection and foci of transmission; the other, aimed at long-term results, focuses on the development of breeding and inspection techniques for pork, adequate sanitary measures, and actions to detect and treat humans infected by tapeworms [47].

Other Parasitic Diseases Responsible for Hydrocephalus

Histoplasmosis

Histoplasma capsulatum is a dimorphic fungus that exists as a mycelial form at ambient temperature and as a yeast form in mammals. Its distribution is universal, being endemic in certain regions of the United States and Latin America [75]. The fungus exists in the soil of endemic areas, especially in dusty places where the soil contains bat or bird feces, such as for instance a hen house [30]. The initial infection is due to spore inhalation. In endemic areas, almost the entire population is infected and subject to multiple cases of reinfection [72, 76].

Disseminated chronic histoplasmosis is a rare event, its incidence estimated at 1 per 100 000 to 1 per 150 000 infected individuals per year [30]. Symptomatic CNS involvement is believed to occur in 10%-25% of the cases of disseminated histoplasmosis [18, 45, 49, 74].

Shapiro classified the lesions of histoplasmosis of the CNS as follows: (1) miliary granuloma; (2) histoplasmoma; (3) meningitis/ventriculitis, the most frequent CNS presentation, affecting preferentially the skull base meninges; (4) spinal compression [30, 50].

The diagnosis of histoplasmosis is becoming more and more common due to an increase in the number of immunocompromised patients due to AIDS or immunosuppression. Ventriculitis can progress to hydrocephalus, requiring a CSF shunt. In most cases, many shunt revisions are necessary. In other cases, a parenchymal lesion is detected and a biopsy suggested. *Histoplasma capsulatum* should be considered in the differential diagnosis even in cases of communicating idiopathic hydrocephalus (no associated

meningitis or ventriculitis). A common factor among all cases, irrespective of the clinical presentation, is the insidious clinical course, characterized by numerous admissions to the hospital, a number of times because of a shunt revision, with no etiological diagnosis.

The authors have treated eight cases of histoplasmosis, one being in a 12-year-old patient who had already undergone 28 shunt revisions and an erroneous tuberculosis treatment. Another patient had had 16 shunt revisions. After treatment the shunt complications disappeared. One patient underwent an endoscopic third ventriculostomy that obliterated 3 months later.

Another common characteristic shared by these cases are the CSF findings. They are characterized by a modest increase in cell number, usually below ten cells, mostly due to lymphocytic/monocytic infiltrate, and modest hypoglycorrhachia or normal glucose levels; protein content is always related to the phase of the disease. During recurrence episodes, levels are more elevated and protein/cell dissociation is more evident. Intraventricular protein levels are usually above 1 g and may continue to rise even if external ventricular drainage is instituted.

Q 10

The rate of positive results obtained in CSF cultures varies from 25%-to 65%. The best results can be obtained with bone marrow cultures, which have a positivity index of about 75%. Blood cultures are positive in 50%-70% of the cases [46]. The mean time for the results of the cultures is 4 weeks. Serological test results for histoplasmosis are very difficult to interpret. Antibody detection tests in the CSF have a positivity of about 80% and antibody detection in the blood a positivity rate of 92%. However, the rate of false-positive results must also be considered. Cross-reaction rates can reach 50%, especially with tuberculosis and other fungal infections (mainly aspergillosis, blastomycosis, coccidioidomycosis) [73]. In 1986, Wheat et al. [77] proposed studying the histoplasma polysaccharide antigen (HPA) in blood, urine, and CSF. The best positivity rates (91%) are obtained in the urine of patients with disseminated disease. When the disease is restricted to the CNS, positivity falls to 19%. The classical treatment consists of intravenous amphotericin B for 3 weeks and fluconazole for 6 months during the maintenance phase of the treatment. Once treatment is initiated, there is a rapid fall in CSF protein levels, reducing shunt obstruction incidents.

References

1. Abbassioun K, Amirjamshidi A, Moinipoor MT. Hydatic cyst of the pons. Surg Neurol 26:297-300, 1986
2. Acha PN, Szyfres B. Zoonosis enfermedades transmisibles communes de hombre y a los animals. OMS 503:763-774, 1986
3. Agapajev S, Alves-Moreira D, Barriviera B. Neurocysticercosis:treatment with albendazole and destroclorpherinami. Trans R Soc Trop Med Hyg 83:377-83, 1989
4. Apuzzo MLJ, Dobukin WR, Zee C, et al. Surgical considerations in treatment of intraventricular cysticercosis. An analysis of 45 cases. J Neurosurg 60:400-407, 1984
5. Aristotle. Historie des Animaux, vol III, book VIII, para XXI. Paris, Societé d'Editions Les Belles Lettres, pp 48-49, 1969
6. Bamberger DM. Successful treatment of multiple cerebral histoplasmomas with itraconazol. CID 28:915-916, 1999
7. Bandres JC, White AC, Samo T, Murphy EC, Harris RL. Extraparenchymal neurocysticercosis: report of five cases and review of management. Clin Infect Dis 15:799-81, 1992
8. Bérard H, Astoul PH, Frenay C, et al. Histoplasma disséminée à Histoplasma capsulatum avec atteinte cérébrale survenue 13 ans après la primo-infection. Ver Mal Resp 16:829-831, 1999.
9. Bergsneider M, Holly LT, Lee JH, King WA, Frazee JG. Endoscopic management of cysticercal cysts within the lateral and third ventricles. Neurosurg Focus 6(4):article 7, 1999
10. Boppana S, Pass RF, Britt WS. Symptomatic congenital cytomegalovirus infection: neonatal morbidity and mortality. Pediatr Infect Dis J 11:93-99, 1992
11. Boudawara MZ, Jemel H, Ghorbel M, et al. Les kystes hydatiques du tronc cerebral. A propos de deux cas. Neurochirurgie 4:321-324, 1999.
12. Bruck I, Antoniuk SA, Wittig E, Accorsi A. Neurocisticercose na infância: diagnóstico clínico e laboratorial. Arq Neuropsiquiatr 49:43-46, 1991
13. Canelas HM. Neurocisticercose: incidência, diagnóstico e formas clínicas. Arq Neuropsiquiatr 20:1-16, 1962
14. Canelas, HM. Cisticercose do sistema nervoso central. Rev Hosp Clin Fac Med S Paulo 47:75-89, 1963
15. Colli BC, Assirati JA, Machado HR, Santos F, Takayanagui OM. Cysticercosis of the central nervous system II. Spinal cysticercosis. Arq Neuropsiquiatr 52:187-199, 1994
16. Colli BO, Martelli N, Assirati JA, et al. Cysticercosis of the central nervous system I. Arq Neuropsiquiatr 52:166-186, 1994
17. Colli BO, Martelli N, Assirati JA, et al. Results of surgical treatment of neurocysticercosis in 69 cases. J Neurosurg 65:309-315, 1986
18. Cooper RA, Golstein E. Histoplasmosis of the central nervous system. Report of two cases and review of the literature. Am J Med 35:45-47, 1963
19. Davis LE. Fungal infections of the central nervous system. Neurol Clin 4:761-781, 1999
20. Del Brutto OH. Cisticercosis and cerebrovascular disease: a review. J Neurol Neurosurg Psychiatry 55:252-254, 1992
21. Del Brutto OH, Sotelo J. Albendazole therapy for subarachnoid and ventricular cisticercosis: case report. J Neurosurg 72:816-817, 1990
22. Del Brutto OH, Sotelo J. Neurocysticercosis: an update. Rev Infect Dis 10:1075-1087, 1988
23. Enarson DA, Keys TF, Onofrio BM. Central nervous system histoplasmosis with hydrocephalus. Am J Med 64:895-896, 1978
24. Escobar A. The pathology of neurocysticercosis. In: Palacios E, Rodrigues-Carbajal J, Taveras (eds) Cysticercosis of the central nervous system. Charles C. Thomas, Springfield, pp 27-54, 1983
25. Estanol B, Kleriga E, Loyo M, et al. Mechanisms of hydrocephalus in cerebral cysticercosis: implications for therapy. Neurosurgery 13:119-123, 1983

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Q 12

26. Flisser A, Woodhouse H, Larralde L. Human cysticercosis; antigens, antibodies and nonresponders. Clin Exp Immunol 39:27-31, 1980
27. Frenkel, JK. Toxoplasmosis: mechanisms of infection, laboratory diagnosis and management. Curr Top Pathol 54:27-75, 1971
28. Frenkel JK, Friedlander S. Toxoplasmosis. Pathology of neonatal disease. Pathogenesis, diagnosis and treatment. Public Health Service Publication no 141. US Government Printing Office, Washington, DC, 108 pp, 1952
29. Go JL, Kim PE, Ahmadi J, Segall HD, Zee CS. Fungal infections of the central nervous system. Neuroimaging Clin North Am 10:409-425, 2000
30. Goodwin RA, Shapiro JL, Thurman GH, Thurman SS, Des Prez M. Disseminated histoplasmosis: clinical and pathological correlations. Medicine 59:1-33, 1980
31. Gottlieb T, Marriott D. Disseminated histoplasmosis in an AIDS patient. Aust N Z Med 20:621-622, 1990
32. Hanshaw JB, Dudgeon JA (eds) Viral diseases of the fetus and newborn. Saunders, Philadelphia, 1978
33. Karalakulasingam R, Arora KK, Adams G, Serratoni F, Martin DG. Meningoencephalitis caused by Histoplasma capsulatum. Arch Intern Med 136:217-220, 1976.
34. Khamlich A, Belefkih N, Guarzazi A, Chkili T, Bellakhdar F. Le kyste hydatique de la fossa cerebrale postérieure (Revue de la literature à propos de 5 cas). Maroc Med 4:223-233, 1982
35. Knapp S, Turnherr M, Dekan G, et al. A case of HIV-associated cerebral histoplasmosis succesfully treated with fluconazole. Eur J Clin Microbiol Infect Dis 88:658-661, 1999
36. Lambert RS, George RB. Evaluation of enzyme immunoassay as a rapid screening test for histoplasmosis and blastomycosis. Am Rev Respir Dis 136:316-319, 1987
37. LeBourgeois PA. Isolated central nervous system histoplasmosis. Southern Med J 72:1624-1625, 1979
38. Lombardo L, Mateos JH, Estanol B. La cisticercosis cerebral en México. Gac Med Mex 118:1-8, 1982
39. Mitchel WG, Crawford TO. Intraparenchymal cerebral cysticercosis in children: diagnosis and treatment. Pediatrics 82:76-82, 1988
40. Neal JH. An endoscopic approach to cysticercosis cysts of the posterior third ventricle. Neurosurgery 36:1040-1043, 1995
41. O'Doherty DS: Invasion of central nervous system by cysticercosis cellulosae. Georgetown Med Bull 15:128-136, 1961
42. Obrador S. Cysticercosis cerebri. Acta Neurochir 10:320-364, 1962
43. Pratt-Thomas HR, Cannon WM. Systemic infantile toxoplasmosis. Am J Pathol 22:779-795, 1946
44. Rawlinson WD, Packham DR, Gardner FJ, MacLeod C. Histoplasmosis in the acquired immunodeficiency syndrome (AIDS). Aust N Z J Med 19:707-709, 1989
45. Salaki JS, Louria DB, Chmel H. Fungal and yeast infections of the central nervous system. Medicine 63:108-132, 1984
46. Sathapatayavongs B, Batteiger BE, Wheat J, Slama TG, Wass JL. Clinical and laboratory features of disseminated histoplasmosis during two outbreaks. Medicine 62:263-70, 1983
47. Schantz PM. Echinococosiasis (hydatidosis). In: Warren KS, Mahmound AAF (eds) Tropical and geographical medicine. McGraw Hill, New York, pp 487-497, 1984
48. Scharf, D. Neurocysticercosis. Two hundred thirty-eight cases from a California hospital. Arch Neurol 45: 777-780, 1988
49. Schulz DM. Histoplasmosis of the central nervous system. JAMA 151:549-551, 1953
50. Shapiro JL, Lux JJ, Sprofkin BE. Histoplasmosis of the central nervous system. Am J Pathol 31:319-334, 1955
51. Sotelo J, Marin C. Hydrocephalus secondary to cysticercotic arachnoiditis. A long term follow-up review of 92 cases. J Neurosurg 66:686-689, 1987
52. Sotelo J, Escobedo F, Rodrigues J, Torres B, Rubio F. Therapy of parenchymal brain cysticercosis with praziquantel. N Engl J Med 310:1001-1007, 1984
53. Sotelo J, Guerrero V, Rubio F. Neurocysticercosis: a new classification based on active and inactive forms. A study of 753 cases. Arch Intern Med 145:442-445, 1985
54. Spina- França A. Aspectos biológicos da neurocisticercose: alterações do liquido cefalorraquidiano. Arq Neuropsiquiatr São Paulo 20:17-30, 1962
55. Spina-França A, Livramento J A , Machado LR. Cysticercosis of the central nervous system and cerebral fluid: immunodiagnosis of 1573 patients in 63 years (1929-1992). Arq Neuropsiquiatr 51:16-20, 1993
56. Spina-França A. Neurocisticercose e imunologia. J Bras Med 45:7-8, 1983
57. Spina-França A Incidência de neurocisticercose no serviço de neurologia do Hosp. Das Clinicas da FMUSP. Rev Paul Med 43:160-161, 1953
58. Stagno S, Reynolds DW, Huang ES. Congenital cytomegalovirus infection: occurrence in an immune population. N Engl J Med 296:1254-1258, 1977
59. Stepién L Cerebral cysticercosis in Poland: clinical symptoms and operative results in 132 cases. J Neurosurg 19:505-513, 1962
60. Stern WE. Neurosurgical considerations of cysticercosis of the central nervous system. J Neurosurg 55:382-385, 1981
61. Sullivan AA, Benson SM, Ewart AH, et al. Cerebral histoplasmosis in an Australian patient with systemic lupus erythematosus. MJA 169:201-202, 1998
62. Tabbal SD, Harik SI. Cerebral histoplasmosis. N Engl J Med 15:1176, 1999
63. Takayanagui OM. Neurocisticercose II. Avaliação da terapeutica com praziquantel. Arq Neuropsiquiatr São Paulo, 48:11-15, 1990.
64. Takayanagui OM, Castro e Silva AA, Santiago RC, Odashima NS, Terra VC, Takayanagui AMM Notificação compulsória da cisticercose em Ribeirão Preto- SP. Arch Neuropsiquiatr 54:557-564, 1996
65. Takayanagui OM, Jardim E.Therapy for neurocysticercosis: comparison between albendazole and praziquantel. Arch Neurol 49:290-294, 1994
66. Takayanagui OM, Jardim E Aspectos clínicos da neurocisticercose – análise de 500 casos. Arq Neuropsiquiatr São Paulo 41:50-63, 1983
67. Tiraboshi I, Parera IC, Pikielny R, Scattini G, Micheli F. Chronic Histoplasma capsulatum infection of the central nervous system siccessfully treated with fluconazole. Eur Neurol 32:70-73, 1992
68. Tynes BS, Crutcher JC, Utz JP. Histoplasma meningitis. Ann Intern Med 59:615-618, 1963
69. Walpole HT, Gregory DW. Cerebral histoplasmosis. Southern Med J 80:1575-1577, 1987
70. Wei G, Li C, Meng J, Ding M. Cysticercosis of the central nervous system. A clinical study of 1400 cases. Chinese Med J 101:493-500, 1988
71. Weller TH. The cytomegaloviruses: ubiquitous agents with protean clinical manifestations. N Engl J Med 285:203-214, 1971

Q 13

72. Wheat J, French MLV, Batteiger B, Kohler R. Cerebrospinal fluid histoplasma antibodies in central nervous system histoplasmosis. Arch Intern Med 145:1237-1240, 1985
73. Wheat J, French MLV, Kamel S, Tewari RP. Evaluation of cross-reaction in Histoplasma capsulatum serologic tests. J Clin Microbiol 23:493-499, 1986
74. Wheat J. Histoplasmosis – experience during outbreaks in Indianapolis and review of the literature. Medicine 76:339-354, 1997
75. Wheat LJ, Batteiger BE, Sathapatayavongs B. Histoplasma capsulatum infections of the central nervous system – a clinical review. Medicine 69:244-260, 1990
76. Wheat LJ, Kohler RB, Tewari RP, Garten M, French MLV. Significance of Histoplasma antigen in the cerebrospinal fluid of patients with meningitis. Arch Intern Med 149:302-304, 1989
77. Wheat LJ, Kohler RB, Tewari RP. Diagnosis of disseminated histoplasmosis by detection of Histoplasma capsulatum antigen in serum and urine specimens. N Engl J Med 314:83-88, 1989
78. White HH, Fritzlen TJ. Cerebral granuloma caused by Histoplasma capsulatum. J Neurosurg 19:260-264, 1962
79. Wilson CB, Remington JS. What can be done to prevent congenital toxoplasmosis? Am J Obstet Gynecol 138:357-363, 1980
80. Wolf A, Cowen D. Perinatal infections of the nervous central system. J Neuropathol Exp Neurol 18:191-243, 1959
81. Wolf A, Cowen D, Paige BH. Toxoplasmic encephalomyelitis. VI. Clinical diagnosis of infantile or congenital toxoplasmosis. Survival beyond infancy. Arch Neurol Psychiatr 48:689-739, 1942
82. Wong SY, Remington JS. Toxoplasmosis in the setting of AIDS. In: Broder S, Merigan TC, Bolognesi D (eds). Textbook of AIDS medicine. Williams & Wilkins, Baltimore, pp 223-258, 1994
83. Young RF, Gade G, Grinnell V. Surgical treatment for fungal infections in the central nervous system. J Neurosurg 63:371-381, 1985
84. Zee C, Segall HD, Boswell W. MR imaging of neurocysticercosis. J Comput Assist Tomogr 12:927-34, 1988
85. Zee CS, Segal HD, Miller C, et al. Unusual neuroradiological features of intracranial cysticercosis. Radiology 137:397-407, 1980

Questions

[Q 1] **Please confirm this as corresponding author.**

[Q 2] **Please confirm you mean the whole of southern Africa, not just South Africa. "Natives" is a bit of a problematic word - it would be better to find an alternative. Are you referring to all poor black populations, whether urban or not, or just those living a more traditional rural life outside the towns?**

[Q3] **"Usually people are infected by eating contaminated pork; however, immune-suppressed persons may become infected by contaminated pork" - presumably there is supposed to be a difference, since you say 'however' instead of 'and', but what is it? Please clarify.**

[Q 4] **Please confirm "tissue" for "tecidual", which does not exist in English. Occurs again.**

[Q 5] **Please confirm "phase".**

[Q 6] **If you are giving anticonvulsant and cysticercocidal drug therapy, the patients cannot be said to be drug-free. What are you intending to say here? That they *became* drug-free, rather than having chronic drug treatment?**

[Q 7] **"To withdraw slowly" - does this mean "in order for the ICP to go down slowly", or does it mean the dexamethasone is slowly tapered off at the end of treatment?**

[Q 8] **"Despite treatment with" replaces "despite the use of". The sentence now suggests that patients may have to undergo surgery despite having been treated with the drugs, rather than suggesting that, although some patients can be treated with the drugs, others have to undergo surgery. Please confirm the change is correct.**

[Q 9] **What is "clinical"? Medical?**

[Q 10] **Please confirm this is what was meant by "positivity".**

[Q 11] **Please give an abbreviated form of this journal title in accordance with Index Medicus style.**

[Q 12] **Same again, please.**

[Q 13] **Same again, please.**

[Q 14] **Please confirm legend for Fig. 6 (treatment algorithm).**