Cysticercosis of the central nervous system with amyotrophic lateral sclerosis: case report and review of the literature

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SUMMARY A case is described in which the clinical and pathological features of amyotrophic lateral sclerosis (ALS) occurred in a patient with cysticercosis of the central nervous system and associated pachymeningitis of the cervical spinal cord. This is an extremely rare finding. The patient also presented the two symptom complexes more commonly encountered in this condition: focal and generalized epilepsy, and signs of obstructive hydrocephalus. The literature relevant to this case, and to cysticercosis in Great Britain, is briefly reviewed. The case described adds to the concept of motor neurone disease as a syndrome rather than a disease entity of undetermined aetiology.

Chronic adhesive leptomeninitis of the upper cervical spinal cord may be associated with severe muscular atrophy and spastic paraplegia, with histological evidence of degeneration of anterior horn cells and lateral columns, and present with the syndrome of amyotrophic lateral sclerosis (ALS). The essential features of ALS were first described in 1869 by Charcot and Joffroy and, in one of their two cases, a hypertrophic cervical meningitis was found at necropsy.

Racemose cysticercosis of long standing, affecting the cerebral ventricular system and the posterior fossa, is frequently accompanied by fibrous adherent thickening of the basal leptomeninges. If this process is severe and extends to involve the meninges investing the cervical cord, amyotrophy and spastic paresis may occur (Meyer, 1906; Redalié, 1921; Guillain, Pérsson, Bertrand, and Schmide, 1927; Guillain, Bertrand, and Thurel, 1933; López and Feijóo, 1936). These features may be found in combination with the better-known clinical manifestations of intracerebral cysticercosis—namely, epilepsy and symptoms of raised intracranial pressure.

A clinicopathological study of a patient is presented to illustrate these facts.

CASE REPORT

A 53 year old man, an ex-soldier, was admitted to hospital in June 1966. He had been stationed in India (1934–1943). In 1937 he was treated for pork tapeworm (Taenia solium) infestation. Seven years later he had a generalized fit, after which focal motor attacks in the right arm and occasional grand mal attacks occurred. In 1949 a diagnosis of epilepsy secondary to cysticercosis was made and he was invalided out of the Army. Subsequently, the spasms in the right arm became painful, and he noticed that his right hand was clumsy. Mild weakness of the hand and astereognosis were found.

In February 1965 he began to have frequent severe occipital headaches. The pain radiated to his forehead and could be produced by moving his neck. He experienced bouts of vomiting, an episode of intractable hiccup, and noticed unsteadiness on walking. In June 1966, there was ataxia of all limbs, spastic paresis of the right arm and leg, and astereognosis and apraxia in the right hand. Radiographs showed calcified intracranial cysts and cysts in the intercostal and pelvic girdle muscles. Myodil ventriculography demonstrated a dilated fourth ventricle with obstruction to its outlets. A diagnosis of posterior fossa neoplasm, or racemose cysticercosis was made.

At exploration of the posterior fossa (Professor Valentine Logue) a thick-walled cyst measuring 4 cm by 5 cm was encountered. This was partially removed, leaving the anterior portion which was closely adherent to the brain-stem and was seen to extend down to the C1 spinal cord segment. A free flow of cerebrospinal fluid was established. Microscopical examination of the tissue showed a racemose cysticercosis cyst (Dr. M. el Batata).

In February 1967 he became confused. Recurrence of the obstructive hydrocephalus was demonstrated.
by air ventriculography, and insertion of a Pudenz ventriculocaval shunt resulted in considerable improvement in his general and mental state. Shortly after this, he started to suffer from pain in his shoulders, radiating to his hands, and associated with paraesthesiae in the fingers, and similar, less intense pain and paraesthesiae of the legs. After a left ventricular tap, contralateral hemiparesis and hemianesthesia developed due to a capsular haemorrhage.

Neurological examination two months later showed nystagmus on right lateral gaze and a residual right facial weakness. There was symmetrical muscular wasting in the arms, mainly of forearm and hand muscles, with normal tone. Fine movement and coordination were impaired. He could not sit up without assistance due to weakness of the trunk muscles. Stereognosis and two-point discrimination were impaired. In the legs, spastic paraparesis with adductor spasm was severe. He became cachectic and died in May 1968.

LABORATORY FINDINGS In June 1966 routine biochemical, haematological, and serological tests were normal. The erythrocyte sedimentation rate (ESR) was 5 mm in one hour. Ventricular fluid contained 13 mg protein/100 ml. Nine months later, the ESR was 36 mm in one hour; ventricular fluid protein was 171 mg/100 ml with a cell count of 4,000 red cells and 45 white cells per mm$^3$.

PATHOLOGICAL STUDIES Post mortem examination was performed 24 hours after death. The body was that of a small emaciated man. There was broncho-pneumonia and a left pleural effusion.

CENTRAL NERVOUS SYSTEM The cerebral convexities appeared normal on external examination. Dense adhesions bound the cerebellum to the dura mater of the posterior fossa, and a thick mass of fibrous tissue was adherent to the anterior rim of the foramen magnum and encircled the brain-stem. The entire basal surface of the brain was covered by a thick grey membrane, dense over the medial structures, and this gross adhesive leptomeningitis extended from the interpeduncular cistern, over the brain-stem, into the spinal canal. The ventriculocaval shunt was patent. Coronal sections of the fixed brain showed small lateral ventricles. Four calcified cysts, 0.3 to 0.4 cm in diameter, were found in the cerebrum. One cyst was in the left superior frontal gyrus, and three were in sulci. Microscopical examination of these lesions showed a central necrotic zone and a surrounding band of eosinophilic acellular material containing small lamellated foci of calcification. A narrow band of gliosis surrounded the frontal lesion. There was a linear necrotic zone in the left internal capsule.

The fibrous tissue on the ventral aspect of the brain-stem incorporated the vertebral and basilar arteries, and many large and small cysts with yellow gelatinous contents were applied to the lateral surfaces of pons and medulla (Figs. 1 and 2). These were seen microscopically to be composed of a central folded mass of acellular eosinophilic and Schiff-positive material surrounded by a cellular zone, composed of polymorph-leucocytes, lymphocytes, macrophages, and very large multinucleate giant cells which were closely applied to the cyst wall. The contiguous meninges showed an intense inflammatory cellular exudate, and a few arterioles with severe endarteritis, although in general this was not a common feature.

Sections of cerebellum and pons showed a dilated fourth ventricle, a granular ependymal lining, and softening of surrounding white matter (Fig. 1). Sections of the spinal cord showed marked fibrous thickening of the dura mater, arachnoid, and pial membranes of the cervical segments and, to a lesser degree, of the thoracic leptomeninges. The fibrous tissue encircled emerging dorsal nerve roots (Fig. 3). Microscopically, a little collagen, derived from the thickened pial membrane encroached on the peripheral substance of the spinal cord. There was concentric fibrosis of many small pial arteries and associated pallor of the peripheral cord substance in the myelin preparations. The anterior spinal artery appeared normal. The intrinsic spinal cord vessels showed concentric mural fibrosis. Inflammatory cell cuffing was not present. The number of anterior horn cells was decreased at all levels, and was always most severely reduced in the medial zones. Many of the remaining cells were either pale and shrunken, or large and distended with lipochrome pigment. There were several extremely large neurones with one to three vacuoles in the cytoplasm. Gliosis in the anterior horns was generally moderate. In myelin preparations of cervical, thoracic, and lumbar cord segments there was bilateral pallor of the pyramidal tracts and the ventral nerve roots in the cervical segments were wasted (Fig. 3).

Severe neurogenic atrophy was seen in sections of the small muscles of the hand, thenar, forearm muscles, hamstrings, quadriceps femoris, and tibialis anterior muscles (Fig. 4). Calcified cysts were demonstrated in shoulder girdle and proximal thigh muscles. Other organs examined showed no relevant changes.

DISCUSSION

The case presented had three clinical syndromes which correlated with the neuropathological findings. Focal and generalized epilepsy was due to calcified encysted larvae in the cerebrum. Symptoms of raised intracranial pressure and nerve root irritation resulted from basal leptomeningitis and obstruction of the outlet foramina.
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FIG. 1. Cerebellum and brain-stem. The fourth ventricle is enlarged. The surrounding parenchyma shows necrosis. Note the grossly thickened leptomeninges (arrow).

FIG. 2. Medulla. There is a degenerate larval cyst (arrow) and an intense inflammatory reaction around it. Fibrous tissue incorporates nerve roots and vessels. Nissl ×6.5.
FIG. 3. Spinal cord—cervical. Marked thickening of dura mater, arachnoid, and pia mater. Myelin loss is most marked in the direct and indirect corticospinal tracts. There is atrophy of the ventral roots (arrows). Haematoxylin—van Gieson × 8.

FIG. 4. Longitudinal section through tibialis anterior muscle. There is group atrophy of muscle fibres indicating denervation atrophy. H and E, × 100.
of the fourth ventricle. Finally, there was amyotrophic lateral sclerosis, secondary to pachymeningitis of the cervical spinal cord.

Meningeal fibrosis, accompanying the racemose form of cysticercosis, is frequently mentioned in the literature, particularly from South America and Poland (López and Feijóo, 1936; Stepien and Chorobski, 1949; Arana and Asenjo, 1945; Stepien, 1962). Some reports of spinal cord involvement deal with the rare finding of an intramedullary cyst (Cabies, Vallenas, and Landa, 1959; Dixon and Lipscomb, 1961; Hesketh, 1965). These reports are mostly from neurosurgeons.

In a comprehensive review of all aspects of cysticercosis in man, particularly in relation to the incidence in Great Britain, Dixon and Lipscomb (1961) analysed 450 cases. In 49 in which the disease was demonstrated at necropsy, nine had ventricular obstruction with associated intracranial hypertension. Lesions in the spinal cord were found in two cases, one with a cyst in the cord substance, and one with a meningeal reaction.

Bickerstaff, Cloake, Hughes, and Smith (1952) reviewed the pathology of the racemose form of cysticercosis, and Bickerstaff, Small, and Woolf (1956) detailed the pathological findings in the posterior fossa. More recently Treles, Palomino, and Cáceres (1967) published a general and critical review of the histopathology of cerebral cysticercosis. These authors, and Martinez (1961), have studied the fine structure of the cyst membrane, in the basal, racemose form, and concluded that the metabolites of the parasite exert an influence on the host tissue by leakage through a digestive pore. Treles et al. (1967) emphasize the importance of the inflammatory reaction, which amounts to a true encephalitis, and above all the predominant vascular lesions.

The histopathology of the basal meningeal reaction in the present case corresponded very closely with the description of Treles, notably in the occurrence of large giant cells seen exclusively in the inner lamina of inflammatory cells surrounding the degenerate larval remains, and also in that, while there was prominent vascular involvement, true endarteritis was exceptional. This does not exclude the possibility of mild ischaemic changes or more severe sequela of vascular insufficiency in the vicinity of the affected vessels.

In 1925 Purdon Martin coined the term 'amyotrophic meningo-encephalitis' to describe the pathology of spinal progressive muscular atrophy associated with syphilis, and in his cases the vascular abnormalities were by contrast, widespread, severe and typically obliterative. In the disease under discussion, the relative importance of toxic, immunological, and ischaemic factors, in producing changes in the spinal cord, and the resulting clinical manifestations, cannot be completely determined. However, the degree of vascular involvement in the investing membranes and spinal cord substance suggests that ischaemia may at least in part have contributed to the neuronal destruction and resulting amyotrophy.

The rarity of the combination of calcified cerebral cysts and the racemose larvae is reflected in the retrospective statistical survey made by Barrientos, Schirmer, Schenone, Aranda, Concha, and Rojas (1967). In their review of 5,132 necropsies at Santiago Psychiatric Hospital there were 31 examples of hydatid disease and 39 cases of cysticercosis, of which 36 were cerebral, and of the latter 23 were cystic, 11 racemose, and only two combined both forms. No mention was made of pathological changes in the spinal cord.

Reports which include paraparesis, or the symptomatology of ALS in cysticercosis of the nervous system are rare (López and Feijóo, 1936; Dixon and Lipscomb, 1961; Martinez, 1961). Full necropsy reports which include examination of the spinal cord are extremely uncommon, and none is recent. Meyer (1906) reported a case of ALS combined with multiple cysts of cysticercosis in the brain. The spinal cord was examined and there was a severe cervical pachymeningitis. He emphasized a perivascular inflammatory reaction, and attributed the neural changes to vascular insufficiency. The French authors Redalié (1921) and Guillain et al. (1927, 1933) described cases with similar pathological changes including degenerative features in the neurones and fasciculi of the spinal cord.

With regard to surgical treatment, Dixon and Lipscomb (1961) concluded that decompression for intracranial hypertension due to obstruction to the cerebrospinal fluid was rarely successful, but one case is quoted (case 279) in which removal of a large arachnoid cyst from the cisterna magna resulted in marked improvement for four years, after which the patient's condition deteriorated progressively. It is of interest that no case has been recorded in the literature, or could be found on review of the
records of the Royal Army Medical College, of a patient having had a ventriculocaval shunt in obstructive hydrocephalus due to cysticercous leptomeningitis. In the present case the patient's symptoms of raised pressure were successfully alleviated by means of the Pudenz ventriculocaval shunt procedure. Kassis, Nathanson, and Tinsley (1967) suggest that a shunt is contraindicated because of the possibility of haematogenous spread of the cysts. No evidence of this was revealed in this case.

In Great Britain most cases of this disease have occurred in soldiers or their relatives who have lived in India. This applied particularly to the period preceding 1930, when stricter hygienic measures were instituted in the affected parts of India. Dixon and Smithers (1935), continuing the original research on cysticercosis started by Colonel W. P. (later Lieutenant-General Sir William) MacArthur (1933, 1934), made a comprehensive survey, including the historical and literary references, of the occurrence and measures of prevention of *Taenia solium* infestation in man. They reported on a series of cases in British families between 1892 and 1934. Dixon and Lipscomb (1961) continued and enlarged on this study. Many of the patients included in their analysis have been the subjects of further reports and references to these are given in their report. The condition was also relatively common in persons of Polish origin who came to this country during or shortly after the second World War. In Bickerstaff's review of five cases, two patients were Polish, one was Ukrainian, and two were English.

At present, *Taenia solium* infestation is still common in many countries, and with the facility of modern travel occasional cases may be expected to occur sporadically in any part of the world. In 1968 and in 1970, biopsy material from posterior fossa leptomeninges, taken from two patients in the National Hospitals for Nervous Diseases, London, was found microscopically in each case to contain fragments of the racemose form of cysticercosis. Both these patients came from Greece (Professor W. Blackwood, personal communication).

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