

NEUROCYSTICERCOSIS – WORK ABILITY EVALUATION

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*Neurocysticercosis is the term used for human CNS involvement with *T. solium* cysts. Intraparenchymal cerebral cysts usually enlarge slowly, causing minimal or no symptoms, until years or decades after the onset of infection. Clinical manifestations vary from focal or generalized seizures to sensorimotor deficits, intellectual impairment, psychiatric disorders and symptoms of elevated intracranial pressure.*

Work ability was evaluated in 12 patients treated for cysticercosis during 2005 and 2006. In all patient examinations for NCC were conducted in regional health centers, and all were referred to a hospital for further diagnosis and therapy. Diagnosis was made by the following clinical criteria: neurological disorder, CT and / or MRI typical findings, followed by the test for specific antibodies.

We evaluated the period from the first complaints that could be connected with the diagnosis to the moment when diagnosis was made, and severity of symptoms like vertigo, headache, vision disorders and unconsciousness.

Considering neurocysticercosis as a slowly progressing infection of the CNS, with an evolution period of more than several years, and the mean period of unrecognized complaints of 28 months, we suggest that all of neurological or psychiatric complaints in our surroundings, specially where breeding of pigs is widely spread, should be evaluated for cysticercosis.

Key words: cysticercosis, computed tomography, neurocysticercosis, work ability evaluation, zoonoses

INTRODUCTION

Cysticercosis is a tissue infection with larval cysts of the cestode *T. solium*, in which the patient serves as an intermediate host for the parasite. Infection is acquired by consumption of *T. solium* eggs. Prevalence is high wherever *T. solium*

tapeworms are common (i.e. Mexico, Central and South America, the Philippines, and South Asia). Infected subjects normally harbor multiple cysts in many parts of the body. In endemic areas cumulative infection risk increases with age, frequent consumption of pork, and poor inflammation at the site of involvement.

Neurocysticercosis is the term used for human CNS involvement with *T. solium* cysts. Symptomatic disease is related to intracerebral lesions (causing mass effects and / or seizures), intraventricular cysts (causing hydrocephalus), subarachnoidal lesions (causing chronic meningitis) and spinal cord lesions (causing cord compression syndrome meningitis). Intraparenchymal cerebral cysts typically enlarge slowly, causing minimal symptoms until years or decades after onset of infection, when cysts begin to succumb. At that moment cysts begin to swell and leak antigenic material that provokes a severe inflammatory response (cerebritis, meningitis). These processes lead to symptoms of focal or generalized seizures, sensorimotor deficits, intellectual impairment, psychiatric disorders, and symptoms of hydrocephalus. In endemic regions up to 33% of patients with seizures have antibodies to *T. solium*, compared with 2-11% prevalence in the general population. High prevalence is present in all underdeveloped countries where people eat pork and traditional pig husbandry is practiced (King, 1995).

Cysticercosis is a zoonotic parasitic disease, the domestic pig is the intermediate host of *T. solium*, and a source of human infection following consumption of improperly treated infected meat. Man can also become the intermediate host by directly ingesting *T. solium* eggs originated from his own infection. In the gut eggs develop into cysticerci that migrate mostly into the muscles and brain tissue. Neurocysticercosis is therefore a human-to-human infection acquired by the ingestion of *T. solium* eggs shed in the faeces of human parasite carriers. Therefore, it primarily occurs in areas with poor sanitation. *T. solium* carriers are extremely potent sources of infection. Human (neuro) cysticercosis can occur in small outbreaks around immigrant carriers in Western countries (Dirk *et al.*; Roman *et al.*, 2000). Disease is also related to one of the most burning problems in the contemporary society: poverty in marginal rural regions with subsisting animal husbandry, and migration from rural to urban areas or from developing to developed countries.

There are two major aspects in the burden due to *T. solium* cysticercosis. First of all, because of its localisation in the central nervous system, it is estimated to cause an important disease burden, particularly in terms of late-onset epilepsy. As the parasite also requires pigs as intermediate hosts to complete its life cycle, its consequences can also have a potentially large impact in terms of food safety and economical losses.

The clinical relevance of *T. solium* cysticercosis in humans is related mainly to its central nervous system complications, particularly epilepsy (Nikolic, 2006). Although the majority of epilepsy cases belong to the idiopathic/cryptogenic type, a substantial portion of symptomatic epilepsy can be, or could be, attributed to NCC in endemic areas, where is recognized as a common cause of late-onset seizures, accounting for 30-50% of all cases. In some countries of Latin America, in Ecuador for example, approximately 10% of all epilepsy cases, and 25% of

those attributable to a particular identifiable event, are due to NCC (Carpio and Hauser, 2002).

Intracranial calcifications are a typical finding in NCC and in many cases represent the only evidence of the disease. The sensitivity of MRI for the detection of calcified lesions is poor, and thus CT remains the best screening neuroimaging procedure for patients with suspected neurocysticercosis. Currently, MRI is the imaging modality of choice for the evaluation of patients with intraventricular cysticercosis, brainstem cysts and small cysts located over the convexity of cerebral hemispheres. Its better image definition suggests that MRI is superior to CT in the follow-up of patients after therapy. It should be noted, however, that the costs of MRI are high and the equipment is scarcely available in many endemic countries (Del Brutto *et al.*, 2001).

Having in mind different jobs and occupations, as well as the presence of NCC and its consequences on health, we intended to evaluate the work ability in a group of patients treated in the Institute for Infectious and Tropical Diseases, during 2005. and 2006.

MATERIAL AND METHODS

Our study included 12 patients, 4 men and 8 women. They were on average 56.4 years of age. In all patient examinations for NCC were conducted in regional health centers, and all were thereof referred to a hospital for further diagnosis and therapy. Diagnosis was made by clinical criteria: neurological disorder, CT and / or MRI typical findings, following by the test for specific antibodies.

Detection of specific antibodies in the blood. NCC was confirmed by ELISA IgG test in the serum and cerebrospinal fluid. Enzyme immunoassay Novagnost™ (Dade-Behring-Marburg, Germany) was used. Microtiter strip wells were precoated with *Taenia solium* antigens. Specific antibodies present in the sample bind to the immobilised antigens on the microplate. Horseradish peroxidase labelled protein A conjugate binds to antigen-antibody complexes bound to the solid phase. The resulting immune complexes were detected by a colour reaction. The enzyme part of the conjugate converts TMB substrate solution, giving the coloured reaction product. The intensity of colour is proportionate to the amount of anti-*Taenia solium* antibodies in the sample.

Work ability was evaluated by standard criteria for work ability evaluation defined by occupational health regulations.

RESULTS

The studied group was homogenous with respect to age (Table 1), which suggests, owing to the prolonged incubation period, that the infection was contracted at approximately the same life period. The studied group included only one child. Since it was an exception, it would be interesting to follow-up his/her further life and determine the reasons of such rapid cyst degeneration and manifestations of symptoms of perifocal edema, compression, etc.

Table 1. Age distribution of patients

Age	N	%
11 – 20	1	8.33
21 – 30	0	0
31 – 40	0	0
41 – 50	2	16.66
51 – 60	5	41.66
61 – 70	3	25.00
71 – 80	1	8.33
Total	12	100

The statistical data indicate the absence of any significant differences related to sex of affected patients.

Analysis of the results of our study indicated that the studied group was homogenous with respect to age, which suggests, owing to the prolonged incubation period, that the infection is contracted at approximately the same life period. Based on the socio-epidemiological questionnaire, it was evident that the majority of the studied subjects originated from rural areas. The comparison evidenced that our results are consistent with the results of other authors indicating that the rural population, living in less favorable sanitary conditions and at a lower cultural level is more endangered.

The work ability was evaluated for all patients, having in mind the fact that they are mostly employed in the food industry, and that they are directly exposed to other populations. Eight of them were in direct contact with animals (pigs), which suggest that is one important factor in this disease. It was evidenced that the majority of the studied subjects originated from rural areas. The comparison evidenced that our results are consistent with the results of other authors indicating that rural populations, living in less favorable sanitary conditions are at a higher risk of infection.

Frequency and duration of symptoms prior hospitalisation are shown in Table 2.

Table 2. Frequency of duration of symptoms prior hospitalisation

Month	N	%
1 – 12	6	50.00
13 – 24	1	8.33
25 – 36	1	8.33
36	4	33.33
TOTAL	12	100

Typical CT findings in patients suffering from neurocysticercosis are shown on Figures 1 - 3.



Figure 1. Several small amorphous calcifications in the cortex of the left hemisphere in parietal localization

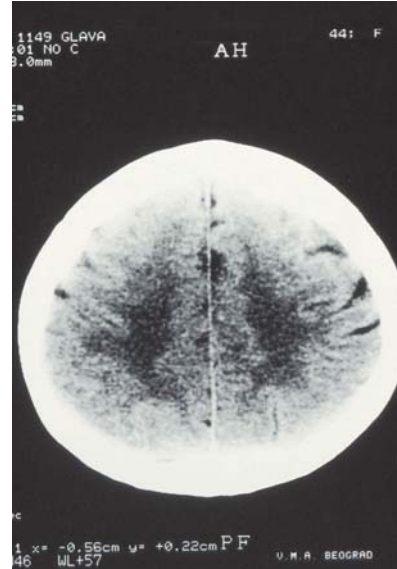


Figure 2. Calcification in the left brain hemisphere

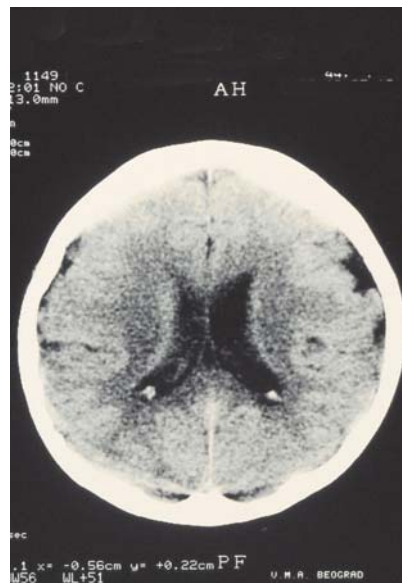


Figure 3. Calcified parasitic cyst in the left brain hemisphere

DISCUSSION

Teniasis is not a disease subject to mandatory reporting, and thus it is not possible to have the insight of its prevalence in Serbia or the percentage of its CNS affection. The data recorded at the Institute of Infections and Topical Diseases over the last twenty years indicate that approximately ten patients are treated for neurocysticercosis per year. In all patients the complaints persisted for months and neurocysticercosis was suspected in a regional health center based on long-lasting complaints and applied imaging methods, primary head CT, which has been the most important diagnostic method.

Positive antibodies (58%) to cysticercosis may contribute to the diagnosis, however they cannot confirm or deny it, and in our study 66.66% were positive which may be attributed to incompatible groups (Dulovic *et al.*, 1996).

Modern neuroimaging techniques, including computed tomography (CT) and magnetic resonance imaging (MRI), have improved the accuracy of diagnosis of neurocysticercosis by providing an objective evidence on the number and topography of lesions, their stage of involution, and degree of inflammatory reaction of the host against parasites (Garcia and Del Brutto, 2000). These imaging methods have largely replaced previous radiological procedures such as plain roentgenograms, pneumoencephalograms, cerebral angiography and myelography, which were once considered helpful diagnostic tools, but currently have only limited importance (Garcia and Del Brutto, 2003). The first reports on CT findings in neurocysticercosis were published in 1977 by Carbajal *et al.* and Bentson *et al.* These pioneer studies were soon followed by a number of studies describing in detail the CT images in the different forms of this disease (Lopez-Hernandez and Garaizar, 1982; McCormick *et al.*, 1982; Mervis and Lotz, 1980; Rodacki *et al.*, 1989).

The clinical presentation of neurocysticercosis varies and depends on the stage, number, size and locations of the cysticercal cysts within the CNS and the host's immune response to the parasite (Dulovic, 1998). Seizures occur in 50 % to 80 % of patients with parenchymal disease (Del Brutto *et al.*, 1991; Del Brutto *et al.*, 1997; Garcia *et al.*, 1993; Garcia *et al.*, 1999; Medina *et al.*, 1990; White Jr A. C., 2000). Due to this high incidence of seizures, neurocysticercosis must always be considered as a part of the differential diagnosis for a new-onset seizure in endemic areas (Del Brutto *et al.*, 1991; Medina *et al.*, 1990) Seizures are thought to occur either from parenchymal irritation because of active inflammation or from gliosis associated with end-stage calcified lesions (White Jr A.C., 2000).

Focal mass effect by parenchymal cysts or reactive edema as the result of an immunologic response to the cyst, may give rise to symptoms of elevated intracranial pressure, most notably headaches, nausea and vomiting.

Computed tomography and magnetic resonance imaging findings in parenchymal neurocysticercosis depend on the stage of development of the parasites. Vesicular (living) cysticerci appear on CT as small and rounded low-density areas that are well demarcated from the surrounding brain parenchyma. These cysts lack perilesional edema and enhancement after contrast medium administration. Most of these lesions have in their interior an eccentric

hyperdense nodule representing the scolex. Sometimes, these parasites are so numerous that the brain resembles a "swiss cheese".

The process of degeneration of parasitic cysts involves a *continuum* that has been categorized by Escobar (1983) in four histopathological stages: viable, colloidal, nodular-granular and calcified. Colloidal cysticerci appear on CT and MRI as undefined lesions surrounded by edema. Most of them show a ring pattern of enhancement after contrast medium administration. Colloidal cysticerci represent the so-called "acute encephalitic phase" of neurocysticercosis in which the host's immune system is actively reacting against the parasite.

Parenchymal brain cysticerci may also appear on CT as nodular hyperdense lesions surrounded by edema after contrast administration (Rajshekhar, 1991).

Calcified cysticerci normally appear on CT as small hyperdense nodules without perilesional edema or abnormal enhancement after contrast medium administration (Figure 3). It has recently been shown that calcified cysticerci may present perilesional edema and contrast enhancement, associated with symptom relapse (Nash *et al.*, 2001).

After full clinical investigation and objective examination, having in mind that the observed patients suffer from brain parasitosis, we can conclude that they are not capable to do jobs at unprotected heights, jobs which include keeping head in unphysiological position, jobs in areas of high concentrations of vapors, gases and all respiratory irritants as well as presence of all risk factors for developing epilepsy and on all workplaces where they can hurt themselves or other workers.

Inflammation markers (CBC and ESR) were undisturbed, which indicates, consistently with the available literature, absence of the prominent inflammatory response to the infection. On one hand, the former is the result of the properties of the parasite itself, i.e., its low antigenic activity, and localization in the tissue which is highly protected from all immune reactions, on the other.

Antibodies are not crucial for making a decision related to the therapy approach, however owing to the fact that they may appear in the cerebrospinal fluid and not in serum, both possibilities must be taken into account in order to obtain as truthful as possible answer.

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NEUROCISTOCERKOZA – EVALUACIJA RADNE SPOSOBNOSTI

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SADRŽAJ

U radu je procenjivana radna sposobnost 12 pacijenata koji su imali cistocercozu sa manifestacijama na centralnom nervnom sistemu. Uzimajući u obzir NCC kao sporo progredirajuću infekciju CNS-a, sa periodom evaluacije od nekoliko godina od prvih tegoba sa glavnim periodom neprepoznatih tegoba u prvih 28 meseci, smatramo da bi sve vrste neuroloških i psihijatrijskih poremećaja, koje se pojavljuju kod ljudi koji su u okruženju životinja (svinja) trebalo detaljno ispitati na NCC.