TAENIASIS/CYSTICERCOSIS SITUATION IN NEPAL

Durga Datt Joshi[1], Mahendra Maharjan[1], Maria Vang Johnsen[2], Arve Lee Willingham[3], Yogendra Gaihr[1] and Minu Sharma[1]

[1]National Zoonoses and Food Hygiene Research Center, Tahachal, Kathmandu, Nepal; [2]Danish Bilharziasis Laboratory, Charlottenlund, Denmark; [3]Danish Center for Experimental Parasitology, Frederiksberg, Denmark

Abstract. The zoonotic pork tapeworm, *Taenia solium,* is becoming an increasing problem in Nepal with high prevalences of porcine cysticercosis and human taeniasis/cysticercosis detected in epidemiological studies undertaken in different parts of the country. Pig farming and marketing have increased dramatically in the country in recent years due to increased consumer demand for pork as the country's caste system has become relaxed. Postmortem surveys of pigs at slaughter establishments in Kathmandu and Dharan municipality showed 14% (34/250) of pigs positive for cysticercosis. Antemortem detection of *T. solium* infection of pigs in a Syangja District community indicated 32% (136/419) of pigs positive by lingual examination while 24% (48/201) was serologically positive by Enzyme-linked Immunoelectro Transfer Blot (EITB) and 6% (12/201) showed evidence of old infection or exposure with 42 kDa and 50 kDa. A human helminthological survey in Syangja District in central Nepal indicated a very high prevalence of taeniasis, with 43% positive (77/180), while in Tanahun District 18% were positive (28/152). Taeniasis infection appears directly related to the ethnic groups surveyed and their food habits, literacy rates, and hygiene and sanitation. The prevalence of taeniasis among the ethnic groups surveyed, *ie* Magars, Sarkies, Darai, and Bote, was found to be 50, 28, 10, and 30%, respectively. Magar people are known for rearing pigs and eating much more pork than other ethnic groups, while the Sarkies are the poorest of the ethnic groups and are known to consume rotting cattle carcasses. At this time, the species of *Taenia* infecting these different ethnic groups has not been identified. Human cysticercosis cases were reviewed on the basis of hospital-based data. During the past five years, records from Patan Hospital, Bir Hospital, and Kanti Children's Hospital reported 62, 4, and 11 cysticercosis cases in Kathmandu, respectively. These hospitals had different standards with regard to diagnostic capacity, reporting, and recording systems. At the time of the study, there were only six neurosurgeons and six CAT scanners active in Nepal, all of which, except for one CAT scanner in Dharan, were located in Kathmandu. Neurocysticercosis cases from Nepal are also being diagnosed and treated at hospitals and clinics in India. This preliminary evidence suggests that taeniasis/cysticercosis is a serious and growing problem in Nepal, requiring urgent attention. A proper and thorough risk assessment of the situation involving both the health and agriculture sectors is needed, to determine whether and how the *T. solium* situation in Nepal should be managed.

INTRODUCTION

Taenia solium infection is worldwide and endemic in humans who eat raw or inadequately cooked pork. The disease in humans and pigs is an ancient parasitic disease rooted in developing countries and emerging as a major health problem of global dimensions (Sciutto *et al*, 2000). Infection is common in low socio-economic and poor sanitary areas of central and southern Mexico, and central and southern America. The infection is also present in India, Pakistan, North China, Thailand, and Nepal (Schantz *et al*, 1992). Humans acquire taeniasis infection by eating measly pork. The cysticerci develop into adult tapeworms in the intestine, causing gastrointestinal disorders. Some patients complain of hunger pangs. Anemic conditions may also develop. The infection is comparatively recently diagnosed in Nepal. As major hospitals started to have neurosurgery units, neurocysticercosis as gradually came to be reported, and now it is considered one of the major food-borne parasitic zoonoses (FBPZ) in Nepal.

Taeniasis and cysticercosis are two distinct clinical entities caused by the adults and larvae of *Taenia* spp. Adult *Taenia solium* develops in humans and some species of monkey, while larval cysticercus develops in pigs, humans, and some species of monkey, camels, wild boars, bears, dogs, cats, and other carnivores and rodents. The epidemiological human-pig-human life cycle, however, is most important. The life cycle is dependent upon the link between man and pig in *Taenia solium* infections. In contrast to most zoonotic diseases, humans are essential, linking the epidemiology of taeniasis and cysticercosis. The life cycle of *Taenia solium* involves the two hosts. Humans are the definitive, and pigs are the intermediate, host. The incidence of taeniasis is common in developing countries, including Nepal, where people have a habit

Correspondence: Durga Datt Joshi, National Zoonoses and Food Hygiene Research Center, PO Box: 1885, Tahachal, Kathmandu, Nepal.
Tel: +977-1-270667; Fax: +977-1-272694
E-mal: ddjoshi@healthnet.org.np

of defecating in open fields. The close relationship between humans and pigs in some rural areas, where the pigs live practically in the houses of the owners and feed on kitchen waste and excreta, explains the high prevalence of *Taenia solium* infections in several developing countries, including Nepal.

Cysticercosis is a serious disease, with varied incubation period. Symptoms may appear from 15 days to many years after infection. Humans may harbor from one to several hundred cysticerci, located in various tissues and organs. The location that most often gives rise to medical consultation, is the central nervous system. Localization in the eye and its surrounding tissues is also important. Localization in muscles and subcutaneous connective tissue is generally not manifested clinically, unless it involves a large number of cysticerci. The symptomatology of neurocysticercosis varies with the number of cysticerci and with their location in the central nervous system. In animals, cysticercosis does not usually manifest itself clinically. Experimental infection of pigs with high doses of *T. solium* eggs can produce fever and stiffness of the muscles. Death may occur as a result of degenerative myocarditis. In infected pigs, there may be hypersensitivity of the snout and /or paralysis of the tongue. In general, the normal economic lifespan of the pig is too short (Pedro, 1980) for symptoms to become apparent.

The population dynamics of cysticercosis fundamentally depend on infection rates, which can be high in grazing animal systems. However, the biotic potential of *T. solium* in humans is influenced by environmental and socio-economic factors, including sanitation and personal hygiene. The major risk factor is undoubtedly the presence of a *T. solium* carrier and contributing factors include the conditions under which pigs are kept. Pigs in developing countries are more likely to have cysticercosis lesions due to the environmental conditions in which they are kept and the lack of sanitation facilities for people living in rural areas. Defecation by people on open fields leads to the maintenance of *T. solium* in the environment.

In Nepal, very few research work has been carried out, and very few authentic research articles have been published. The published and unpublished data indicate that the disease has been established in the country, and is developing into a serious public health problem.

MATERIALS AND METHODS

Primary and secondary data about *T. solium* infection that were available in Nepal were collected from hospitals for epidemiological assessment, of the incidence of *T. solium*-induced neurocysticercosis confirmed by biopsy; in Patan Hospital (July 1993-1998), Bir Hospital (1995-1997), and Kanti Children's Hospital (1995-1997). Data were also collected from the master's degree theses carried out in the central Department of Zoology in collaboration with the National Zoonoses and Food Hygiene Research Center. Similarly, the data were presented on the basis of the preliminary report of the porcine cysticercosis study funded by the International Foundation for Science, Sweden. For the assessment of the behavior/environment, education/ecology, and administration/policy, the key informant interviews were held with the meat producers and sellers, health professionals responsible for *T. solium* diagnosis and clinical treatment of human cases of neurocysticercosis in Nepal.

RESULTS

Prevalence of human taeniasis in Syangja district

Between 1990 and 2000, Gairhe (2000) carried out a cross-sectional surveillance study on human intestinal helminthic parasites in Syangja District by direct microscopic examination of stool samples, which showed a prevalence rate of 83% among 180 stool samples. Along with intestinal helminthic infections, the study reported on taeniasis infection only, and/or taeniasis infection combined with other helminthic parasites, with 77 (43%) of 180 samples at different places under the Tindobate Village Development Committee (VDC), Syangja District (Table 1).

Most of the inhabitants in this study area were professional farmers, farming pigs, poultry, and buffalo; fishing was an alternative income source. Because of illiteracy, unhygienic living habits, poor socio-economic conditions, and conservative types of treatment done by traditional healers (Dhami and Jhankri). Many people in these areas were the victims of different types of disease. The study showed that the total literacy rate

Table 1
Prevalence of human taeniasis in Tindobate VDC, Syangja District.

Places names	Total stool samples examined	No. of positive samples (%)
Dansingh	59	40 (68)
Bajakot	63	21 (33)
Kusunde	58	16 (28)
Total	180	77 (43)

was only 37%. About 87% of households did not have a toilet, so they go to the open field or to the forest for the toilet. It was because of their lack of awareness about their health, illiteracy, and probably due to low socio-economic conditions. Almost all pig population have got the access of eating human stool because they were let loose during the day.

Prevalence of taeniasis in Tanahun District

During 1999 and 2000, Thapa (2000) carried out a helminthological survey in Vyash Municipality, Tanahun District, covering four localities, Atreuli, Bote-tar, Baireni, and Dumsi, among Bote and Darai ethnic groups. A total of 152 stool samples were collected from different age and sex groups and examined by fecal smear preparation method. The overall intestinal helminth prevalence rate was 60%, while the taeniasis prevalence rate was 18% (Table 2). In this study, taeniasis was reported as the third most important intestinal helminth parasite, of which the highest prevalence was found in the age group >30 years.

During the questionnaire survey, it was found that in Bote-tar none of the households were using a toilet. All the people in Bote-tar disposed their night soil on the open field, which was an unhygienic practice. By contrast, 10% people of Baireni, 16% of Atreuli, and 72% of Dumsi were using safe latrines. The high percentage of people in Dumsi able to use a toilet was due to the support of the Reiyukai Nepal, Damauli Branch; they did not pay any thing for their own toilet.

Taeniasis infection among different ethnic groups

In Syangja, the basic study was carried out among two ethnic groups (Magars and Sarkies), while in Tanahun District the study was carried among Darai and Bote ethnic groups. The maximum infection rate was observed among the Magar ethnic group *ie* 50% (Table 3). The infection rate was found to be directly related to ethnic group, literacy rate, hygienic and sanitary conditions, etc. The Magar ethnic groups farmed pigs and more frequently consumed pork than other ethnic groups. Sarkies are poor ethnic groups, and are the only ethnic group in Nepal who consume dead cow carcasses perhaps due to their poor economic condition. Bote and Darai ethnic groups are fishermen and consume any type of meat. Hence, the taeniasis reported among the Sarkies ethnic groups might be *Taenia saginata*, including *Taenia solium* which has not yet been identified to species.

Two hundred and fifty different samples of pork meat were collected and examined from Kathmandu Metropolitan City and Dharan Municipality. During the study period, 148 samples from Khichapokhari, 48 from Koteshwor, and 54 from Dharan were carefully examined. Out of the 250 pigs examined, 34 (14%) were positive for porcine cysticercosis. Twenty-two (15%) positive samples were from Khichapokhari, 6 (12%) from Koteshwor, and 6 (11%) from Dharan (Table 4). This result indicates that a higher rate of porcine cysticercosis infection was found from Khichapokhari and the lowest rate of infection was from Dharan.

Table 2
Prevalence of Taeniasis in Vyash Municipality, Tanahun District.

Places names	Total stool samples examined	No. of positive samples (%)
Baireni	27	6 (22)
Bote-tar	35	13 (37)
Atreuli	43	6 (14)
Dumsi	47	3 (6)
Total	152	28 (18)

Table 3
Taeniasis infection among different ethnic groups.

Ethnic groups	Total samples examined	No. of positive samples (%)
Magars	122	61 (50)
Sarkies	58	16 (28)
Darai	90	9 (10)
Bote	62	19 (31)

Table 4
Prevalence of porcine cysticercosis in Kathmandu Metropolitan City and Dharan Municipality.

Place names	Total meat samples tested	No. of positive samples (%)
Kathmandu District		
Khicha pokhari	148	22 (15)
Koteshor	48	6 (12)
Sunsari District		
Dharan	54	6 (11)
Total	250	34 (14)

Porcine cysticercosis among Magar communities of Syangja District

An epidemiological study of porcine cysticercosis was carried out among the Magar ethnic group of the Syangja District during 2000-2001, with the support of the International Foundation for Science, Sweden. The study was linked with a previous study carried out on taeniasis infection. During the study period, a total of 419 pigs was examined for lingual visualization and palpation for cysts. Of the total samples studied, 32.4% were found positive (Table 5). Cysticercocis infection between males and females were statistically analyzed calculating a p-value that showed a significant difference between sexes (p=0.003).

Of 419 live pigs examined, 201 blood samples were collected and sent to the Centers for Disease Control (CDC, Georgia, USA) for enzyme-linked immunoelectrotransfer blot (EITB) analysis. The result showed 24% prevalence while 6% of them were found to be old infections or exposure, with a high prevalence rate (Maharjan, 2002).

Public health problem

During the last five years (1993-1998), 62 clinical patients with cysticercosis were confirmed out of 23,402 biopsy cases detected in Patan Hospital, Lalitpur District, Nepal. Forty cases were from Kathmandu and 22 from outside Kathmandu. Of 62 patients, 38 were female and 24 were male. Most of the patients were from the younger age group (below 30), which is considered a vulnerable age group for infection with *Taenia solium*e eggs (Table 6).

Bir Hospital is a government hospital, centrally located Kathmandu. During the years 1995 to 1997, 4 confirmed cysticercosis cases were reported out of 25,033 major operated cases (Table 7), while 11 confirmed cases were recorded at Kanti Children's Hospital, the only children's hospital in Kathmandu.

DISCUSSION

The most commonly consumed meats in Nepal come from animals that are raised for food. The animals that are used for meat are buffalo, pigs, sheep, goats and chickens. Meat provides protein, vitamins, minerals, and fat necessary for good health and growth. Meat protein contains essential amino acids (protein elements) needed to build and maintain body tissues.

Table 5
Lingual test of pigs in Syangja District, by study area.

Studied areas	Total pigs examined	Positive (%)	Negative (%)
Tindobate	144	54 (37.5)	90 (62.5)
Tulsibhanjyang	71	31 (43.7)	40 (56.3)
Jagatradevi	70	12 (17.1)	58 (82.8)
Walling	134	39 (29.1)	95 (70.9)
Total	419	136 (32.4)	283 (67.5)

Table 6
Cysticercosis cases recorded in Patan Hospital, by age group and gender.

Age groups (years)	Male		Female		Total cases
	Cases	%	Cases	%	
0-9	6	50	6	50	12
10-19	9	50	9	50	18
20-29	6	33	12	67	18
30-39	2	25	6	75	8
40-49	1	20	4	80	5
50-59	0	0	1	100	1
Total	24	39	38	61	62

Table 7
Cysticercosis cases in Bir Hospital.

Year	Major operated cases	Cysticercosis (%)
1995	8,107	1 (0.01)
1996	8,409	1 (0.01)
1997	8,517	2 (0.02)
Total	25,033	4 (0.01)

Red meat is an excellent source of vitamin B complex group. Thiamine (B1) is especially abundant in pork. Thiamine helps to actively maintain the circulatory and nervous systems and also aids the body in storing and releasing energy. Most of the pork comes from pigs around 4 to 7 months old. It has a mild taste. There are certain religious taboos regarding meat consumption, for example, Hindus are not supposed to eat beef; many Jews and Muslims do not eat pork. Depending upon the availability of the animals and cultural habits, meat consumption is different in different countries and various religious communities. In Dharan, the majority of the population belong to Rai, Limbu, and Magar ethnic groups, and due to their socio-economic and cultural conditions, consumption of pork is very high.

The Sarkies and Magars groups of Nepal are among the most backward and illiterate natives of our country. Occupationally, most are farmers and some have small-scale pig and poultry farms. They live conservative lives and still believe and depend on 'Dhami' and 'Jhankri', traditional Nepalese healers. Hence, they are frequently the victims of different types of ailments. The people of these communities usually defecate in open fields, along and around roadsides, and rivers. A proper nightsoil disposal system was totally absent among Sarkies ethnic groups, due to their low socio-economic conditions and illiteracy.

The distribution of *Taenia* spp was 50% among Magars. It has been documented that pigs raised on private farms have a greater risk of ingesting human feces, due to the poor sanitary measures adopted. Pigs on private farms are generally slaughtered without veterinary inspection. In all environments where animal cysticercosis is prevalent, human taeniasis is very likely. Stool test results in Bote and Darai communities showed the prevalence rate of intestinal parasites among the Bote ethnic group was 76%, which was greater than the Darai ethnic group, at 50%. This revealed their poor education, knowledge, poor hygiene and sanitation, low socio-economic condition, and conservative lifestyle.

Serological tests are useful for demonstrating anti-cysticercus antibodies to establish a diagnosis of cysticercosis. Recently, ELISA (enzyme-linked immunosorbent assay) has been routinely employed for serodiagnosis (Verma *et al*, 1986). The diagnosis of neurocysticercosis can, however, be made with marked accuracy by combining clinical signs and history with x-ray, CT-scan or MRI, serological tests, and laboratory examination. Radiological techniques used in the diagnosis of cysticercosis include: plain x-ray of the chest, neck and arms (for calcified cysticerci), and skull x-ray showing multiple elliptiform intracranial calcification or signs of intracranial hypertension (Grisolia and Wiederholt, 1982). Electro-encephalography, cerebral angiography, isotope scanning, pneumo-encephalography and ventriculography have been replaced primarily by CT scanning. This is the safest and most convenient method of detecting space-occupying lesions, particularly in the brain (Rodriguez and Boleaga-Duran, 1982). The interpretation of CT scans, however, may be difficult, and some lesions not revealed by CT examination may be demonstrated by magnetic resonance imaging (MRI) (Rodiek *et al*, 1987; Kramer *et al*, 1989; Suh *et al*, 1989; Suss *et al*, 1989; Chang *et al*, 1991; Davis and Kornfeld, 1991; Ginier and Poirier, 1992; Karla and Sethi, 1992; Mason *et al*, 1992; Isidro-Llorens *et al*, 1993; Rajshekhar *et al*, 1994).

Examination of cerebrospinal fluid (CSF) is important in the diagnosis of cerebral cysticercosis. Usually the pressure is low, but may be elevated (Grisolia and Wiederholt, 1982). Certain immunological tests for CSF are highly significant, although the specificity and sensitivity is very variable, according to the techniques and antigens used. Antigens from *Cysticercus cellulosae*, *Cysticercus bovis* and adult tapeworms have been employed, but cross-reactions with hydatidosis, other tapeworms and schistosomiasis, may present difficulties. Examination of both serum and CSF from the same patient is recommended, since when both specimens were examined, 87% of 212 patients with neurocysticercosis could be diagnosed serologically, but when only CSF was tested, the rate dropped to 67% (Pammenter *et al*, 1987).

Studies were carried out in Columbia, Mexico, and South Africa respectively, testing serum and CSF using an ELISA designed to detect immunoglobulin antibodies against *Cysticercus cellulosae* and *Taenia solium* antigens. These gave 89 and 93% sensivity and

specificity rates, respectively, in Columbia. In Mexico, 87 and 90% were reported for serum testing, with a sensitivity of 87%, and 100% specificity for CSF specimens (Corona *et al*, 1986; Pammenter *et al*, 1987; Ramirez and Pradella, 1987; Tellez-Geron *et al*, 1987). In Peru, a field comparison was made of ELISA, antigen ELISA, and enzyme-linked immuno-electrotransfer blot (EITB) assay. The result showed that the EITB was the best assay available for the diagnosis of cysticercosis in both sera and CSF (Feldman *et al*, 1990; Diaz *et al*, 1992; Moro *et al*, 1992).

Joshi (1991) observed *Taenia* cysts in pig meat slaughtered in Kangeswari, Kathmandu. Bajaj and Satish (1997) reported about cysticercosis and its mode of infection. Although the human intestine is the definitive host, the larval form can also be harbored by humans, dogs, cats, and sheep. When human tissue, is invaded by larvae, it is known as cysticercosis, whereas lodgement in brain is known as neuro-cysticercosis. Such cases are reported from many hospitals in Kathmandu. (Amatya and Kimula, 1999). Sixty-two patients with cysticercosis were confirmed out of 23,402 biopsy cases detected at Patan Hospital, Lalitpur.

Ito *et al* (1998) studied *Echinococcus granulosus* serodiagnosis of human patients by ELISA test, which cross-reacted with *Taenia solium*. This cross-reactivity occurs with any sera from human patients with cysticercosis or other parasitic infestations. Therefore, a differential serodiagnosis for cystic and alveolar echinococcosis, using fractions of *Echinococcus granulosus* cyst fluid (antigen B) and *E. multicularis* protoscolex (EM18), and Western immunoblot serodiagnostic technique has been developed as a confirmatory test.

The review of taeniasis and cysticercosis research in Nepal showed that parasitic infections have existed for many years, but recording them on the basis of research is still in its infancy. The available data on taeniasis, and human and porcine cysticercosis, indicated that the disease is very severe and developing into a serious public health problem.

ACKNOWLEDGEMENTS

The authors are indebted to the Chairmen of project areas VDC Syangja District, Tanahun District, Dharan Municipality, and Kathmandu Metropolitan City for their cooperation during the study. Thanks also to the Directors of Patan Hospital, Bir Hospital, and Kanti Children's Hospital, particularly to Purna Maya Paudel and Rajendra Thapa, for providing data. Part of this study was supported by IFS-Sweden research grant, so the authors highly acknowledge the International Foundation for Science, Sweden, and the DDJ Research Foundation, Kathmandu, Nepal.

REFERENCES

Amatya BM, Kimula Y. Cysticercosis in Nepal. *Am J Surg Pathol* 1999;23:1276-9.

Chang, KH, Lee JH, Han MB, Han MC. The role of contrast-enhanced MR imaging in the diagnosis of neurocysticercosis. *Am J Neuroradiol* 1991;12:509-12.

Corona T, Pascoe D, Gonzalez BD, Abad P, Landa L, Estanol B. Anticysticercus antibodies in serum and cerebrospinal fluid in patients with cerebral cysticercosis. *J Neurol Neurosurg Psychiatr* 1986;49:1044-9.

Davis LE, Kornfeld M. Neurocysticercosis: neurologic, pathogenic, diagnostic and therapeutic aspects. *Eur Neurol* 1991:31:229-40.

Diaz FHH, Garcia RH, Gelman AE, *et al*. Epidemiology of taeniasis and cysticercosis in a Peruvian village. *Am J Epidemiol* 1992;135:875-82.

Feldman M, Plancarte A, Sandoval M, Wilson M, Flisser A. Comparison of two assays (ELISA and EITB) and two samples (saliva and serum) for the diagnosis of neurocysticercosis. *Trans R Soc Trop Med Hyg* 1990;84:559-62.

Gaihre YK. Prevalence of intestinal helminth parasites in general, Ascariasis in detail in Sarkies and Magars Community of Tindobate VDC, Syangja, Nepal. MSc Thesis. 2000.

Ginier BL, Poirier VC. MR imaging of intraventricular cysticercosis. *Am J Neuroradiol* 1992:13:1247-8.

Grisolia JS, Wiederholt WC. CNS cysticercosis. *Arch Neurol* 1982;39:540-4.

Isidro-Llorens A, Dachs F, Vidal J, Sarrias M. Spinal cysticercosis. Case report and review. *Paraplegia* 1993;31:128-30.

Ito A, Liang MA, Schantz PM, *et al*. Serology of echinococosis. *Am J Trop Med Hyg* 1999;60:188-92.

Joshi DD. Current practices of livestock slaughtering and meat marketing in Kathmandu, Lalitpur and Bhaktapur, NZFHRC, Tahachal, Kathmandu, Nepal. 1991.

Karla V, Sethi A. Childhood neurocysticercosis-

epidemiology, diagnosis and course. *Acta Paediatr Jpn* 1992;34:365-70.

Kramer LD, Locke GE, Byrd SE, Daryabagi J. Cerebral cysticercosis: documentation of natural history with CT. *Radiology* 1989;171:459-62.

Maharjan M. Epidemiological study of porcine cysticercosis among Magar community of Syangja district. Final report submitted to International Foundation for Science, Sweden, 2002.

Mason P, Houston S, Gwanzura L. Neurocysticercosis: experience with diagnosis by ELISA serology and computerised tomography in Zimbabwe. *Cent Afr J Med* 1992;38:149-54.

Moro PL, Gilman RH, Wilson M, *et al*. Immunoblot (Western blot) and double diffusion (DD5) tests for hydatid disease cross-react with sera from patients with cysticercosis. *Trans R Soc Trop Med Hyg* 1992;86:422-3.

Pammenter MD, Rossouw EJ, Epstein SR. Diagnosis of neurocysticercosis by enzyme-linked immunosorbent assay. *S Afr Med J* 1987;71:512-4.

Pedro N, Acha BS. Zoonoses and communicable diseases common to man and animals. Washington DC: PAN American Health Organization, 1980:499-504.

Rajshekhar V, Haran RP, Prakash GS, Chandy MJ. Differentiating solitary small cysticercus granulomas and tuberculomas in patients with epilepsy. Clinical and computerized tomographic criteria. *J Neurosurg* 1994;78:402-7.

Ramirez G, Pradilla G. Use of enzyme-linked immunosorbent assay in the diagnosis of cysticercosis. *Arch Neurol* 1987;44:898.

Rodiek SO, Rupp N, von Einsiedel HG. MR and CT patterns of neurocysticercosis. *Fortschr Geb Röntgenstr Nuklearmed* 1987;146:570-7 (In German).

Rodriguez CJ, Boleaga-Duran B. Neuroradiology of human cysticercosis. In: cysticercosis: present state of knowledge and perspectives. 1982:139-62.

Schantz PM, Annc C, Moore JL, *et al*. Neurocysticercosis in an arthodox Jewish community in New York City. *N Engl J Med* 1992;327:629-95.

Sciutto E, Fragoso G, Fleury A, *et al*. *Taenia solium* disease in humans and pigs. *Microbes Infect* 2000;2:1875-90.

Suh DC, Chang KH, Han MH, Lee SR, Han MC, Kim CW. Unusual MR manifestations of Cysticercosis. *Neuroradiology* 1989;31:396-402.

Suss RA, Maravilla KR, Thompson J. MR imaging of intracranial cysticercosis: comparison with CT and anatomopathologic features. *Am J Neuroradiol* 1989;7:235-42.

Tellez-Giron E, Ramos MC, Dufour L, Alvarez P, Montante M. Detection of cysticercus cellulosae antigens in cerebrospinal fluid by dot enzyme-linked immunosorbent assay (dot-ELISA) and standard ELISA. *Am J Trop Med Hyg* 1987;37:169-73.

Thapa R. Prevalence of intestinal helminth parasites in general and *Taenia* sp in detail, particularly in Bote and Darai communities of Vyash Municipality - 5, Kumaltari, Tanahun District of Nepal. Kathmandu Tribhuran: University, 2000. MSc thesis.

Verma TK, Malviya HC, Ahluwalia SS. Serodiagnosis of infection with metacestodes of *Taenia solium* in pigs and taeniasis in man and dogs by indirect haemagglutination assay. *Indian J Anim Sci* 1986; 56:621-7.