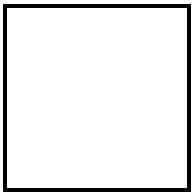
Journal of the Institute of Medicine 2001; **23**: 1 –12 Original Article



Epidemiological status of taenia/cysticercosis in pigs and human in Nepal

D.D. Joshi[1] **Purna Maya Poudyal**[1]
M. Jimba[2] **P.N.Mishra**[3]
Lucy Neave[1] **M. Maharjan**[1]

ABSTRACT

Two hundred and fifty slaughtered pigs for meat purpose, in various localities of Kathmandu Metropolitan City and Dharan Municipality were examined for *Taenia* cysts during January 1997 to April 1998. A surveillance study was also carried out with butchers, meat sellers, farmers and pork consumers to study the awareness of taeniasis/cysticercosis.

Data was collected from the hospitals to determine the status of taeniasis/cysticercosis infection in humans. Out of 250 slaughtered pigs examined, thirty-four (13.6%) were found positive for cysticercosis. The sexwise prevalence rate of infection was 8.77% in male pigs and 24.05% in female pigs. The result reveals that females are infected more than the males. Out of 196 slaughtered pigs examined in Kathmandu, 28 (14.28%) were found positive, whereas in Dharan, out of 54, 6 (11.11%) were found positive. The result further reveals that the number of infected pigs is higher in Kathmandu than Dharan. It is due to the importation of infected pigs to Kathmandu both from rural areas of Nepal and India. The results show that pork consumption is risky from a public health point of view. In environments where animal cysticercosis is prevalent, human taeniasis/cysticercosis is likely to be present.

Prevalence of *Taenia solium* infection in pigs was therefore observed and recorded for the first time in Dharan Municipality and Kathmandu Metropolitan Municipality in Nepal.

Human cysticercosis cases were also studied. Out of 23,402 human biopsy cases recorded from Patan Hospital alone during July 1993 - Feb 1998, sixty-two patients were confirmed to have cysticercosis infection. Out of 62 taeniasis/cysticercosis patients, 40 cases were from Kathmandu and 22 were from outside Kathmandu. Among the 62 infected patients, 38 were females while 24 were males. The result reveals that

[1] National Zoonoses and Food Hygiene Research Cente, Tahachal, Kathmandu, Nepal.
[2] School & Community Health Project (SCHP), HMG/JICA/JMA
[3] Zoology Department, Tribhuvan University Kirtipur, Kathmandu, Nepal.

the infection rate is higher in Kathmandu than outside Kathmandu. Sexwise data again reveal that females are infected more frequently than males.

The surveillance study findings reveal that taeniasis and cysticercosis are prevalent in Kathmandu and Dharan due to various factors, viz,
uncontrolled slaughtering, lack of a meat inspection program, lack of awareness about meat borne diseases, unhygienic conditions of slaughtering places due to lack of slaughter houses, environmental pollution etc.

The incidence of human taeniasis/cysticercosis could be controlled by raising pigs under hygienic condition and improving the environmental quality in the pig slaughtering abattoirs under the supervision of medical and veterinary technicians. An effective veterinary public health activities should immediately be established in all 56 municipalities of the country for meat inspection and construction of slaughter houses.

Keywords: taeniasis/cysticercosis; biopsy; scanning.

EPIDEMIOLOGICAL PATTERN

Taenia solium infection is world wide and endemic in the human population where people eat raw or inadequately cooked pork. The 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).

Contributing factors include the conditions under which pigs are kept. Pigs in developing countries are more likely to
have cystcercosis lesions due to the environmental conditions in which they are kept and the lack of sanitation facilities for people living in rural areas. Defaecation by people on open fields leads to maintenance of *T. solium* in the environment.

HUMANS

Cysticercosis is a serious disease. The incubation period varies considerably. Symptoms may appear from 15 days to many years after the time of infection. Man may harbour from one to several hundred cysticerci located in various tissues and organs. The location which most often gives rise to medical consultation is the central nervous system (neurocysticercosis). 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. In such cases there is muscular pain, cramps and fatigue. The symptomatology of neurocysticercosis varies with the number of cysticerci and with their location in the central nervous system.
The most frequent locations of the cysticerci are the meninges, cerebral cortex, ventricles and less frequently the parenchyma.
The symptoms generally appear several years after the infection, when death of
the larva causes inflammatory toxic
reactions. These symptoms are often not well

defined and may resemble those of a cerebral tumor, basal meningitis, encephalitis, intracranial hypertension, and hysteria. The most prominent symptom is that of epileptiform attacks which recur at irregular intervals. In 742 cysticercosis cases studied in Guatamala, the most prominent symptoms were throbbing headache, visual disturbance, vomiting etc. (Hernandez and Romero, 1979).

Taeniasis is often subclinical and is only revealed by faecal examination. In clinical cases, the most common symptomatology consists of abdominal pain, nausea, debility, weight loss, flatulence, and diarrhoea or constipation.

ANIMALS

Cysticercosis does not usually manifest itself clinically. Experimental infection of pig with high dose of *T. solium* egg can produce fever and stiffness of 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.

DIAGNOSTIC APPROACH OF TAENIASIS / CYSTICERCOSIS

Humans

Diagnosis of *T. solium* intestinal taeniasis is made by demonstration of eggs and proglottids of *T. solium* in the faeces. The eggs of *T. solium* and *T. saginata* are morphologically indistinguishable. *T. solium* can be differentiated from *T. saginata* by examination of the gravid proglottids occasionally found in the faeces. The presence of few lateral branches in uterus on each side, the presence of vaginal sphincter and the absence of an accessory lobe of ovary, are the diagnostic features of the mature proglottids of *T. solium*. Demonstration of the scolex armed with rostellum is the most reliable feature to identify *T. solium.* Cysticercosis is conventionally diagnosed by radiological examination of the skull and extremities which show the presence of small calcified areas. The diagnosis is supported by other tests such as electroencephalogram (EEG). Computerised tomography (CT) Scan, brain scan and arteriography which confirm the presence of different space occupying lesions in various sites.

The serological tests are useful for the demonstration of anti-cysticercus antibodies to establish the diagnosis of cysticercosis. Recently the ELISA (enzyme-linked immunosorbent assay) has been routinely employed for serodiagnosis (Verma et. al. 1986). The diagnosis of neurocysticercosis can, however be made with a marked accuracy by combining clinical signs and history with x-ray, CT 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).

Electroencephalography, cerebral angiography, Isotope scanning, Pneumoencephalography 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 Carbajal 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) (Suss et. al. 1986, Rodiek et. al., 1987, Kramer et. al., 1989, Suh et. al., 1989, Chang et. al. 1991, Davis and Kornfeld, 1991, Ginier and Poirier, 1992, Karla and Sethi, 1992, Mason et. al. 1992, Rajshekhar et. al., 1993, Isidro-Llorens et. al. 1993).

Examination of cerebro spinal 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 of these tests 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 give difficulties. The 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).

Much recent work has been done using an enzyme-linked immunosorbent assay (ELISA) with cysticercus cellulosae and *Taenia solium* antigens on both serum and CSF specimens with improved results.

Work was 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, Ramirez and Pradella, 1987, Tellez-Geron et. al., 1987, Pammenter et. al., 1987). In Peru, a field comparison was made of an ELISA, an antigen ELISA, and an enzyme-linked immunoelectrotransfer blot (EITB) assay. The result showed that the EITB is the best assay available for the diagnosis of cysticercosis in both sera and CSF (Diaz et. al., 1992, Feldman et. al. 1990, Moro et. al., 1992).

Animals

Diagnosis of cysticercosis in animals is made by routine inspection of the meat. The serological tests are yet to be standardised and evaluated for the routine serodiagnosis of cysticercosis in pigs.

TAENIASIS/CYSTICERCOSIS RESEARCH IN NEPAL

Joshi (1973 & 1991) observed *Taenia cysts* in pig meat slaughtered in Kangeswari, Kathmandu. (Bajaj, Satish K. 1997) reported about the cysticercosis and its mode of infection. Although the human intestine is the definitive host, the larval form can also harboured by human, dogs, cats and sheep too. When human tissue is invaded by larvae, it is known as cysticercosis whereas lodgement in brain is known as neurocysticercosis. Such cases are reported from many hospitals of Kathmandu. (Amatya BM and Kimula Y 1988) Sixty two patients with cysticercosis were confirmed out of 23,402 biopsy cases detected at Patan hospital, Lalitpur.

Akiro, 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 a human patient with cysticercosis or other parasitic infestation. 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 serodiagnosis technique has been developed as a confirmatory test.

PREVENTION AND CONTROL

An important factor in the prevention of the human disease is improving the level of environmental conditions and the personal hygiene in the rural areas. This is intimately related to economic development and education. Health education should be continued about the dangers of eating raw or undercooked meat. Meat should be thoroughly cooked. Since cysticerci are killed at temperature of 45-50° C, but can survive in large piece of meat if the centre is inadequately cooked. Temperature of -100 to -7.8° C for four days kill the cysts, but survival occurs for up to 70 days at 0° C. Cysticerci can be successfully destroyed by freezing infected pork for a minimum of 10 days.

OBJECTIVE OF THE STUDY

1. To study the incidence of Taeniasis / Cysticercosis in pigs slaughtered for meat.
2. To determine the magnitude of public health infection by Cysticercosis / Taeniasis.
3. To formulate a control plan for Taeniasis / Cysticercosis which is a serious public health problem.

METHODOLOGY

Two hundred and fifty samples, of different pork collected from various local slaughtering area and markets in Kathmandu Metropolitan city and Dharan Municipality, Sunsari district, Nepal, were examined during January 1997 to April 1998.

Study Area, Population and Sampling

The prevalence of Taeniasis/ Cysticercosis in pigs slaughtered for meat consumption was studied in different pig population from various local slaughtering areas in Kathmandu Metropolitan and Dharan Municipality. The study was performed in various abattoir of Kathmandu Metropolitan and Dharan Municipality. Khichapokhari,

Dhoka Tole, Dhalkhu and Koteshwor were the areas of study in Kathmandu, whearas Deshi line, Putali line and Narayan Chowk were the study areas in Dharan Municipality. In other words the study was confined in Kathmandu Metropolitan and Dharan Municipality.

During January 1997 to April 1998, two hundred and fifty samples were examined. Out of two hundred and fifty, one hundred and forty-eight from Khichapokhari, forty-eight from Koteshwor and fifty-four from Dharan were studied for the cyst of *Taenia solium.*

Out of two hundred and fifty pork samples collected from various localities, thirty-four samples were found positive (Taenia cysts). Taenia cysts were generally obtained from the muscles of neck, shoulder and tongue regions. In some cases, the *Taenia* cysts were found in all parts of the body.

Surveillance Study

The survey was conducted among the butchers, meat sellers and consumers within the study areas. The study was done by means of interviews, and field observation with the help of questionnaires. Prior to the survey work, the questions were pretested on butchers and meat sellers and checked on consumers and farmers (Poudyal 1998). A total of 26 butchers and meat sellers in Kathmandu and Dharan Municipalities were surveyed, (16 from Kathmandu and 10 from Dharan). The slaughtering spots and meat stalls were also observed carefully and on spot photographs were taken. A total of 15 farmers who usually consume pork and rear pigs in Dharan Municipality, were surveyed. The fifteen farmers/consumers were interviewed as to whether they were aware of the status of taeniasis/cysticercosis or not. The environment and sanitary systems of pig farmings were observed carefully and on the spot photographs were taken (Poudyal 1998).

Data Collection and analysis

Data from examined pigs slaughtered in the study area was collected. *Taenia* cyst samples were brought to the laboratory and carefully examined. This data provided the information on slaughtering conditions, waste disposal, knowledge about environment pollution, cold storage, knowledge about meat borne disease, especially taeniasis/cysticercosis. Data from farmers/consumers was listed. This provided information on types of meat consuming habits, knowledge about meat borne disease, taeniasis/cysticercosis, grazing and feeding practices of pigs and awareness about environment pollution and hygiene.

Data of public health infection was collected from hospital records as given below :

1. a) General surgery cases including taeniasis/cysticercosis in Patan hospital from July 1993 to February 1998.
   b) Age and gender distribution of cysticercosis cases.
2. Cysticercosis/taeniasis cases in Bir hospital during the year 1995-1997.
3. Taeniasis/cysticercosis cases in Kanti Children hospital during 1993-1997.

4. Taeniasis cases in B.P. Koirala Institute of Health Sciences, Dharan (Parija 1997).

Laboratory Procedures

Pig muscles collected from different abattoirs were examined for *Taenia* cysts. The affected parts were sliced and cysts were collected for examination. The collected *Taenia* cyst samples with muscles were preserved in a clean plastic bottle with 90% alcohol and brought to the laboratory. In the Laboratory the *Taenia* cysts were carefully exposed on a clean metal tray. The attached muscles were dissected out with the help of blunt forceps and scissors. The cysts were immediately placed into plastic sample bottles containing sufficient ethanol.

Data collected from the field was computerized at the office of National Zoonoses & Food Hygiene Research Centre (NZFHRC), Tahachal, Kathmandu, Nepal.

RESULTS

The survey conducted among the butchers and meat sellers who usually slaughter and sell meat in two different places viz. Kathmandu Metropolitan and Dharan Municipality and results are presented in table I and figure 1 graph. Out of 21 places surveyed 13 were in Kathmandu and 8 in Dharan, Sunsari District.

Table I : Total Number of slaughtering and meat selling places surveyed

Regular Slaughtering and Meat Selling Place	No. of Place
1. Kathmandu	
a) Dhoka Tole	1
b) Dhalkhu	2
c) Khichapokhari	7
d) Koteshwor	3
2. Dharan	
a) Deshi line	4
b) Putali line	1
c) Narayan Chowk	3
Total = >	21

Prevalence of Taeniasis/cysticercosis in Pigs is presented in Table II.

Table II: Prevalence of pig cysticercosis in Kathmandu Metropolis and Dharan Municipality.

Name of Place	*Total meat sample collected*	*No. of sample tested positive*	Percentage
1. Kathmandu			
a. Khichapokhari	148	22	14.86
b. Koteshwor	48	6	12.5
2. Sunsari			
a. Dharan	54	6	11.11
Total	250	34	13.6

Fig. 1

Two hundred and fifty different samples of pork collected from Kathmandu Metropolis and Dharan Municipality were examined. During the study period one hundred and forty-eight samples from Khichapokhari, forty-eight from Koteshwor and fifty-four from Dharan were carefully examined. Out of the two hundred and fifty-pigs examined, thirty-four (13.6%) were found positive for taeniasis/cysticercosis. Twenty-two (14.86%) positive samples were from Khichapokhari, six (12.5%) samples were from Koteshwor and six (11.11%) were from Dharan. This result indicates that a higher rate of taeniasis/cysticercosis infection was found from Khichapokhari and the lowest rate of infection was found from Dharan.

Socio-Economic, Public Health and Religious Factors

The taeniasis infection was found to be very common among people who consume barbequed pork. Such habit of consuming barbequed pork was found to be prevalent among the special ethnic communities like Magar, Rai, Tamang and Limbu. The tendency of consuming barbequed pork was found increasing in the younger generation of other ethnic groups viz, Newar, Chhetry and Brahman etc.

Public Health Problem

Human cysticercosis, an infection caused by larvae of *Taenia solium*, is a major public health problem in many developing countries including Nepal.

(a) During the last five years (July 1993 - Feb 1998) sixty-two patients with cysticercosis were confirmed out of 23,402 biopsy cases detected in Patan Hospital, Lalitpur. Forty cases were from Kathmandu and 22 from outside Kathmandu. Out of 62 patients 38 patients were female and 24 patients were male. Most of the patients were from the younger age group, below 30, which is considered a vulnerable age group for being infected with the egg of *Taenia solium* (See table III).

Table III: Age and gender distribution of cysticercosis cases in Patan Hospital.

Age groups (Years)	*Total Cases*	*Male*		*Female*	
		Cases	*%*	*Cases*	*%*

0 - 9	12	6	50	6	50
10 - 19	18	9	50	9	50
20 - 29	18	6	33.3	12	66.6
30 - 39	8	2	25	6	75
40 - 49	5	1	20	4	80
50 - 59	1	0	0	1	100
Total	62	24	38.70	38	61.29

(b) Out of 25,033 operated patients only four cysticercosis cases were recorded in the registers of the Bir Hospital during the period 1995-1997 (See table 4).

Table IV: Cysticercosis Cases in Bir Hospital

Year	*Major operated cases*	*Cysticercosis*	*%*
1995	8107	1	0.01
1996	8409	1	0.01
1997	8517	2	0.02
Total = >	25033	4	0.01

According to Dr. Upendra Devkota a renowned neuro-surgeon cysticercosis infection cases as registered in the Bir Hospital should be more, as in a week he examines more than 12-14 cases in the hospital alone. In his clinic there are atleast 50 cases in a week. This reveals that the rate of taeniasis infection is very high in Kathmandu.

(c) During the period 1993-1997, 26,156 patients were operated on in Kanti Children Hospital in Maharajgunj. Among these operated cases eleven cases were positive in cysticercosis (See table 5).

Table V: Cysticercosis Cases in Kanti Children Hospital in Maharajgunj

Year	*Major operated cases*	*Cysticercosis*	*%*
1993	6122	NA	-
1994	6454	1	0.01
1995	5745	2	0.03
1996	5701	3	0.05
1997	2134	5	0.23
Total = >	26156	11	0.04

(d) Out of 4445 stool samples examined over a period of July 1994 to 4th March 1996, *Taenia* species was found to be positive in four stool samples only. This is the statement communicated by Dr. Parija (1997), a Professor and Head Department of Microbiology of B.P. Koirala Institute of Health Science, Dharan.

DISCUSSION

The most commonly consumed meats in Nepal come from animals that are raised for food. The animals that are used for the purpose of 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. 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 religions 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, majority of the population belong to Rai, Limbu and Magar and due to their socio-economic and cultural conditions, consumption of pork is very high.

In Kathmandu the majority of the population consume pork for making different types of dishes. The demand for pork is increasing in small restaurants and larger hotels in Kathmandu. The survey conducted on meat consumption revealed that 200 to 250 pigs were required daily for consumption in Kathmandu.

Infected meat is responsible for zoonotic disease outbreaks in human beings. Pigs are the intermediate hosts of the cestode parasite *Taenia solium* in which the metacestode stages develop in different parts of the muscle forming cysticercus cellulosae. *Taenia solium* is transmitted by eating raw or insufficiently cooked pork which contains infected cysticercus larva. Human beings may also become the host of the larval form of *Taenia solium* by the ingestion of food or water contaminated directly by human excreta or indirectly by flies.

The main objective of the present study was to investigate the prevalence of taeniasis/cysticercosis in pigs with special relation to public health significance. Most of the pigs are reared in the villages. This survey was conducted among the farmers/consumers, butchers, sellers and by field observation. Human consumption of pork was studied by collecting pork samples and distributing questionnaires. Two hundred and fifty pork samples were collected from Kathmandu and Dharan. Out of two hundred and fifty pork samples examined, thirty-four (13.6%) samples were found positive. The result showed that the highest rate of taeniasis / cysticercosis infection was noted in Khichapokhari (14.86%). It is all due to the import of infected pigs both from rural areas of Nepal and India. The result reveals that there is a high risk to public health because the study showed 13.6% of pigs slaughtered for human consumption were infected with taeniasis/cysticercosis. It reveals that adequate control measures viz; improving the quality of environmental condition and personal hygiene in rural areas should be implemented to fight against taeniasis/cysticercosis. This is intimately related to economic development and education. Health education should be continued and the danger of eating raw or undercooked meat should be explained. Meat

inspection in different slaughtering places should be strictly established as soon as possible.

RECOMMENDATIONS

1. To prevent uncontrolled slaughtering of the pigs there should be provision of animal slaughter house and meat inspection.
2. Community health education must be introduced and health education should be imparted effectively to the abattoir workers, butchers, meat sellers, meat consumers and villagers who also slaughter pigs and other animals (Poudyal 1999).
3. Regular and active surveillance, to know the prevalence and incidence of taeniasis and cysticercosis in both definitive and intermediate hosts should be carried out.
4. Veterinarians or meat inspectors should inspect carcasses and ensure the correct disposal of infected offals.
5. A system should be introduced to consume only the approved type of meat and unmarked or un approved meat should be disposed in a hygienic way.
6. Educational advertisements through various mass media (Television, Radio, Newspaper) must be done regularly for mass awareness about meat borne diseases and the subsequent hazards caused by such diseases.
7. Animal husbandary practices should prevent pigs from having access to human faeces.
8. Pork should be thoroughly cooked, since cysticerci are killed only at temperatures of 45-50° C, but can survive in large piece of meat if the centre is inadequately cooked. Temperature of -100 to -7.8° C for four days kills the cysts, but survival occurs for up to 70 days at 0° C.

REFERENCES

1. Akiro Ito, Liang MA, Peter M. Schantz, Bruno Gottstein, Yue-Han Liu, Jun-Jie Chai, Samik, Abdel-Hafez, Nazmne altintas, Durga D. Joshi, Marshall W. Lightowlers, Zbigniew S. Pawlowske (1998) serology of Echinococosis Am J. Trop. Med. Hyg. 1999; **60** (2): 188-192.
2. Amatya BM, Kimula Y: cysticercosis in Nepal. Am J Surg Pathol 1998 (in press).
3. Bajaj, Satish K (1997) Neurocysticercosis: An alarming national health problem. The Kathamndu Post Tuesday, December 30, 1997.
4. Chang, K.H; Lee, J.H; Han, M.B. and Han, M.C. (1991) The role of contrast-enhanced MR imaging in the diagnosis of neurocysticercosis. Am. J. Neuroradiol. 12:509-12.
5. Corona, T; Pascoe, D; Gonzalez - Barranco, D, Abad, P; Landa, L. and Estanol, B. (1986) Anticysticercous antibodies in serum and cerebrospinal fluid in patients with cerebral cysticercosis. J. Neurol. Neurosurg. Psychiatr. 49: 1044-1049.
6. Davis, L.E. and Kornfeld, M. (1991) Neurocysticercosis : neurologic, pathogenic, diagnostic and therapeutic aspects. Eur. Neurol, 31: 229-240.
7. Diaz, F.H.H. Garcia, R.H. Gelman, A.E. Gonzales, M. Castro, V.C.W. Trang, J.B. Pitcher, L.E. Vasquez, M. Lescano, et. al. (1992) : Epidemiology of Taeniasis and cysticercosis in a Peruvian village. American Journal of Epidemiol. 135(8) : 875-882.
8. Diaz, J.F; Verasteque, M; Gilman, R.H; Tsang, V.C; Pilcher, J.B; Gallo, C; Garcia, H.H; Torres, P; Montenegro, T. and Miranda, E. (1992) Immunodiagnosis of human cysticercosis (*Taenia solium)* : a field comparison of an antibody - enzyme-linked.
9. Feldman, M; Plancarte, A; Sandoval, M; Wilson, M. and Flisser, A. (1990) Comparison of two assays (EIA and EITB) and two samples (Saliva and Serum) for the diagnosis of neurocysticercosis. Trns. R. Soc. Trop. Med. Hyg. 84: 559-562.
10. Ginier, B.L. and Poirier, V.C. (1992) MR imaging of interaventricular cysticercosis. Am. J. Neuroradiol. 13: 1247-1248.

11. Grisolia, J.S. and Wiederholt, W.C. (1982) CNS cysticercosis Arch. Neurol. 39: 540-544.

12. Hernandez, L.A; and A.C. Romero (1979) Characteristicas clinico-epidemiologicas de la cisticercosis humana in Guatemala. Bol oifc sanit Panam (in press).

13. Immunosorbent assay (ELISA), an antigen - ELISA, and an enzyme - linked immunoelectro transfer blot (EITB) assay in Peru. Thy cysticercosis working group in Peru (CWG). Am. J. Trop. Med. Hyg. 46 : 610-615.

14. Isidro-Llorens, A; achs, F; Vidal, J. and Sarrias, M. (1993) Spinal cysticercosis. Case report and review.

15. Joshi D.D. (1973) Veterinary Public Health Hazards in Nepal. Published by Mrs. K.D. Joshi, Kathmandu, Nepal.

16. Joshi D.D. (1991) Current practices of livestock slaughtering and meat marketing in Kathmandu, Lalitpur and Bhaktapur, NZFHRC, Tahachal, Kathmandu, Nepal.

17. Karla, V. and Sethi, A. (1992) Childhood neurocysticercosis - epidemiology, diagnosis and course. Acta Paediatr. Jpn. 34: 365-370.

18. Kramer, L.D; Locke, G.E; Byrd, S.E. and Daryabagi, J. (1989) Crebral cysticercosis: documentation of natural history with CT. Radiology 171: 459-462.

19. Mason, P; Houston, S. and Gwanzura, L. (1992) Neurocysticercosis : experience with diagnosis by ELISA serology and computerised tomography in Zimbabwe Cent. Afr. J. Med. 38: 149-154.

20. Moro, P.L; Gilman, R.H; Wilson, M; Schantz, P.M; Verastegui, M; Garcia, H.H. and Miranda, E. (1992) 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. 86: 422-423.

21. Pammenter, M.D; Rossouw, E.J. and Epstein, S.R. (1987) Diagnosis of neurocysticercosis by enzyme-linked immunosorbent assay. S. Afr. Med. J. 71: 512-514.

22. Parija S.C. (1997) : Human stool samples examined data over a period of July 1994. 4th March, 1996. B. P.
Koirala Institutes of Health Sciences, Dharan, Nepal.

23. Poudyal, Purna M (1999) : Taenia solium, a major health problem in our country Published in Kathmandu Post April 27, 1999

24. Poudyal, Purna M (1998) : Prevalence of Taenia solium in Pigs and its Public Health Importance in Kathmandu Metropolitan City and Dharan Municipality, Sunsari District of Nepal. A Dissertation Presented To The Central Department Of Zoology Tribhuvan University

25. Pedro, N. Acha, Boris Szyfres (1980) : Zoonoses and Communicable diseases common to man and animals. PAN American Health Organization, WHO, Washington DC 1980, 499-504.

26. Rajshekhar, V; Haran, R.P; Prakash, G.S. and Chandy, M.J. (1993) Differentiating solitary small cysticercus granulomas and tuberculomas in patients with epilepsy. Clinical and computerized tomographic criteria. J. Neurosurg. 78: 402-407.

27. Ramirez, G. and Pradilla, G. (1987) Use of enzyme-linked immunosorbent assay in the diagnosis of cysticercosis. Arch. Neurol. 44: 898.

28. Rodiek, S.O; Rupp, N. (1987) CT patterns of cysticercosis. ROFO 146: 570-577.

29. Rodriguez - Carbajal, J. and Boleaga-Duran, B. (1982) Neuroradiology of human cysticercosis. In: cysticercosis : present state of knowledge and perspectives, pp. 139-162.

30. Schantz, Peter M., Annc C. Moore, Jose L. Munoz, Barry J. Hartman, John A. Schaefer, Alan M, Aron, Deborach Persaud, Elsa Sarti, Marianna Wilson and Ana Flisser 1992 : Neurocysticercosis in an arthodox Jewish community in New York City, N. Engl. J. Med. 327 (10) : 629-695.

31. Suh, D.C; Chang, K.H; Han, M.H; Lee, S.R; Han, M.C. and Kim, C.W. (1989) Unusual MR Manifestations of Cysticercosis. Neuroradiology 31: 396-402.

32. Suss, R.A; Maravilla, K.R. and Thompson, J. (1986). MR imaging of intracranial cysticercosis: Comparison with CT and anatomopathologic features. Am. J. Neuroradiol. 7: 235-242.

33. Tellez-Giron, E; Ramos, M.C; Dufour, L; Alvarez, P. and Montante, M. (1987) Detection of cysticercus cellulosae antigens in cerebrospinal fluid by dot enzyme -linked immunosorbent assay (dot-ELISA) and standard ELISA. Am. J. Trop. Med. Hyg. 37: 169-173.

34. Verma, T.K. H.C. Malviya and S.S. Ahluwalia (1986) Serodiognosis of infection with metacestodes of *Taenia solium* in pigs and taeniasis in man and dogs by indirect haemagglutination assay, Indian Journal of Animal Science, 56(6) 621-627.