EPIDEMIOLOGY OF *TAENIA SOLIUM* TAENIASIS/CYSTICERCOSIS IN INDIA AND NEPAL

Vedantam Rajshekhar

Department of Neurological Sciences, Christian Medical College Hospital, Vellore, India

Abstract. The fact that cysticercosis is a major health hazard in India and Nepal is evident from the large number of patients with neurocysticercosis (NCC) managed in hospitals in the two countries in recent years. Unfortunately, population-based epidemiological data on *Taenia solium* taeniasis and cysticercosis are lacking from both countries. Hospital-based data and small population-based studies form the basis of this report.

India: cysticercosis is prevalent in virtually all states of India, the only possible exceptions being Kerala, and Jammu and Kashmir. It is generally believed that the disease is more prevalent in north than south India. NCC accounts for anywhere between 8.7-50% of patients presenting with recent onset of seizure. The peculiarity of the disease in India is the high incidence of patients with the solitary form of the disease, namely solitary cysticercus granuloma (SCG). About 60-70% of all Indian patients with NCC have a SCG. The reasons for the high incidence of SCG vis-à-vis the multilesional form of the NCC (MNCC) are unclear, but may be linked to the low parasite load in the community. The prevalence of taeniasis has been reported to be between 0.5-2%. However, a recent study in a pig-rearing community from the northern state of Uttar Pradesh reported that 17 of 72 (38%) members of that community had evidence of taeniasis. The prevalence of taeniasis is probably higher in northern than southern India. The prevalence of porcine cysticercosis has been studied in pig carcasses in slaughterhouses of north and east India and ranges from 7-12% although a recent study from the pig-rearing community in Uttar Pradesh placed the figure at 26%.

Nepal: even hospital-based data on cysticercosis is lacking from Nepal because of the lack of access to CT scanners for the vast majority of patients. However, several patients from Nepal seek treatment in Indian hospitals and there have been reports of NCC in several Nepalese patients from Indian and other foreign hospitals. Recently, a study of taeniasis in certain ethnic groups of Nepal revealed a prevalence of 10-50%. Porcine cysticercosis rates were estimated to be 14 and 32% by examination of carcasses and lingual palpation of live pigs, respectively.

It is evident from the data presented that cysticercosis is a major public health problem in both countries. Epidemiological data to estimate the magnitude of the problem has to be gathered. These data will help in getting the disease on the public health agenda of both countries. Steps towards control and possible eradication of the disease are needed, as the disease causes not only chronic morbidity, but also contributes to economic losses in an already impoverished population.

INTRODUCTION

Taenia solium taeniasis and cysticercosis are diseases associated with poverty, pork consumption, and poor pig husbandry practices. It is, therefore, not surprising that the prevalence of the disease is high in India and Nepal, both of which are developing countries with large populations below the poverty line. The disease has been known to exist in India for several hundreds of years. A seminal paper on the subject was published by Dixon and Lipscomb in 1961. They carefully studied the disease in 450 British soldiers who served in India, and clarified the latency and other features of the disease in this group of patients. Unfortunately, the disease did not receive the attention due to it in India, and it did not gain prominence as a major cause of neurological morbidity and economic loss. However, only over the last two decades has there been interest in the disease in India and more recently in Nepal. Consequently, there is little epidemiological data on the disease in both countries. Data on the prevalence of taeniasis, human cysticercosis, and porcine cysticercosis in India and Nepal are sparse and are based on hospital-based studies or small community-based investigations.

Correspondence: Vedantam Rajshekhar, Department of Neurological Sciences, Christian Medical College Hospital, Vellore 632004, India.
Fax: 091-416-2232103/2232035
E-mail: rajshekhar@cmcvellore.ac.in

MATERIALS AND METHODS

Data acquisition

The following tools were employed to obtain the epidemiological data on *T solium* taeniasis and cysticercosis in India and Nepal: 1) Medline search using the search words "cysticercosis" and "India" and "Nepal"; and 2) Personal knowledge of published articles on the disease from India and Nepal.

Data presentation

The epidemiological data are presented under the following categories: hospital-based data on human cysticercosis; community-based data on human cysticercosis; community- or hospital-based data on taeniasis; data on porcine cysticercosis.

RESULTS AND DISCUSSION

The above data are summarized in Table 1.

Geographic and demographic profile

Since economic conditions and dietary practices impact directly on the transmission of the disease, knowledge of these features is helpful in understanding the disease dynamics in a given population. It might, therefore, be relevant to discuss briefly the geography and demographics of the populations of India and Nepal before embarking on a discussion of the epidemiology of cysticercosis and taeniasis.

India. India is a subcontinent with a population of over a billion people. The climate is mainly tropical. A vast majority of the population (80%) profess the Hindu religion but this religion is varied in its beliefs and practices in different regions of the country and also between different castes in the same region. Consumption of beef (cow meat) is prohibited by the Hindu religion and although consumption of pork is not prohibited, its consumption is generally restricted to the lower castes. Muslims constitute 14% of the population and they do not consume pork. Sikhs, Jains, Buddhists, and Christians constitute the rest of the population and have differing dietary practices. About 20-30% of the population is strictly vegetarian, but of the rest, only a minority eat meat products on a daily basis. According to a recent World Bank estimate, 29% of the population lives below the poverty line. The literacy rates average about 60%. Toilet facilities are mostly limited to populations in the urban regions (30%) and it is estimated that only a quarter of the population has access to proper, hygienic toilets.

The government provides free healthcare to all, but the facilities in most government hospitals are limited. Some states, such as Tamil Nadu, however, subsidise access to high technology investigations such as CT scanning and have provided CT scan facilities in all district general hospitals. The private healthcare sector is large and provides high quality healthcare, although at a cost. Consequently, almost all major towns in India have one if not more CT scanners (about >800 in all).

Nepal. Nepal is a mountainous country bordering India to the north, with tropical and temperate climates. It has a population of 23 million. The population is predominantly Hindu (>95%). Pork consumption is restricted to the lower castes but recently more members of the upper castes are also eating pork. Beef (buffalo meat) is consumed by several people. Nearly 42% of the population lives below the poverty line and literacy rates average 42%. Toilet facilities are available to less than a third of the population.

There are few CT or MR facilities in the country, and these are restricted mainly to the capital region of Kathmandu.

Hospital-based data on human cysticercosis

Although there are several publications on cysticercosis in humans from India, such publications are lacking from Nepal.

India. There are several publications, from India, on the clinical aspects of neurocysticercosis (NCC) and ocular cysticercosis. This is ample evidence for the widespread occurrence of the disease in India. The disease is prevalent in virtually all states of the country, although the prevalence rates vary significantly between different states (Rajshekhar and Chandy, 2000). There are few reports of patients with cysticercosis from Jammu and Kashmir, a predominantly Muslim state, and Kerala, where educational levels and hygiene standards are probably the highest in the country (Singh *et al*, 2002).

Table 1
Prevalence data on *Taenia solium* taeniasis and cysticercosis in India and Nepal[a].

Country	Human cysticercosis	Taeniasis	Porcine cysticercosis
India	NA	2-38%	7-26%
Nepal	NA	10-50%	14-32%

[a]See text for details on methodologies used to arrive at the prevalence data; NA, not available.

There are certain unique features of the disease in India. The solitary form of the disease (solitary cysticercus granuloma, SCG) is the commonest presentation, and is seen in nearly two-thirds of all patients with NCC. Anywhere between 26-50% of all Indian patients presenting with partial seizures are diagnosed with SCG by CT scan (Wadia *et al*, 1987; Misra *et al*, 1994). Several large studies of patients with seizures have revealed that NCC is a major cause of epilepsy in India. Murthy *et al* (1995), from the south-Indian city of Hyderabad, studied 2,531 patients with seizures and found 262 (10.4%) patients had evidence of NCC. Sawhney *et al* (1995), from the north-Indian city of Chandigarh, found NCC as the cause of seizures in 31% of 158 patients. Kumar *et al* (1990) found that 56% of children with seizures in Lucknow (a north Indian city) had a SCG.

The other unusual feature of the disease is the low proportion of pork eaters amongst Indian patients with NCC. Less than 1-2% of Indian patients with NCC admit to eating pork. More than 95% of Indian patients with NCC are vegetarians or do not consume pork. Serological assays using the enzyme linked immunotransfer blot (EITB) revealed exposure to the disease in 21.5% of 107 neurological patients attending a hospital in Mumbai (Tsang and Garcia, 1999). Singh *et al* (2000) found that 27% of household contacts of children with SCG in Punjab were positive for cysticercal antibodies by EITB.

It is generally noted that human cysticercosis is more prevalent in the northern states of India than the southern states (Singh *et al*, 2002). There could be several explanations for this. Pork consumption might be higher in the north and also general levels of hygiene might be better in the south. Consumption of raw vegetables, as salads, is less prevalent in the south. Salads are eaten with almost every meal in northern India. This could be the source of infection in most patients who do not consume pork (Singh, 1997).

Nepal. Patients from Nepal often seek neurological and neurosurgical treatment outside their country, especially in India. Data from the Christian Medical College Hospital, Vellore, showed that 14 Nepalese patients were diagnosed with the SCG form of NCC in the five years between 1991 and 1995 (Rajshekhar and Chandy, 2000). However, a diagnosis of cysticercosis was made in only 0.01% (4/25,033) of pathological specimens examined at Bir Hospital, Kathmandu, between 1995 and 1997. In Patan Hospital, Lalitpur District, 62 of 23,402 pathological specimens were diagnostic of cysticercosis (Amatya and Kimula, 1999). These low figures are due to the fact that most patients with cysticercosis do not need surgical confirmation. Seven of 8 epileptic Gurkha soldiers (Nepalese) serving with the British Army in Hong Kong were diagnosed with NCC, indicating the prevalence of the disease in parts of Nepal (Heap, 1990).

More recently, Rajbhandari (2000), from Nepal, reported on several Nepalese patients with epilepsy due to NCC and concluded that NCC was the most common cause of symptomatic seizures in Nepalese patients. Shrestha *et al* (1999), from Nepal, reported on patients with ocular cysticercosis.

Community-based cysticercosis data

Community-based studies on the seroprevalence of the disease are generally performed by testing the sera of a defined population group using either ELISA or EITB. This indicates the degree of exposure of a given population to the disease, but does not of itself indicate active disease in an individual.

Unfortunately, there are no community-based prevalence data on cysticercosis from India or Nepal.

Data on taeniasis

Data on the prevalence of taeniasis was obtained to the early 1990s, with examination of stools for ova of *T. solium*, a method known to underdiagnose the problem as it has low sensitivity. This method also cannot distinguish between the ova of *T. solium* and *T. saginata* and can lead to an overestimation of the prevalence of *T. solium* taeniasis in regions where pork and beef tapeworms are prevalent. More recently, estimation of community prevalence of taeniasis has been done using the coproantigen test on stools.

India. In a hospital-based study from Calcutta, 12 of 1,074 (1.11%) stool samples revealed *Taenia* spp infections. In a community-based study, 600 stool samples were examined for the presence of *Taenia* ova and again a prevalence of taeniasis of 2% was noted (Pathak and Gaur, 1989). Examination of stools from patients attending a hospital in northern India revealed that 2% of patients had taeniasis (Mahajan and Malla, 1992). In a study of stool samples from 72 persons in a pig-rearing community in the north Indian state of Uttar Pradesh, an alarming 38% were positive for taeniasis (Prasad *et al*, 2002). All these patients probably had *T. solium* infestation, as most Indians, being Hindus, do not consume beef and therefore were unlikely to harbor *T. saginata*. A study of 2,559 stool samples from the north Indian state of Sikkim revealed a taeniasis prevalence rate of 3.9% (Mitra and Patwari, 1998). As for cysticercosis, it is a generally-held belief

that taeniasis is more prevalent in the north Indian states than in the south Indian states. This is reinforced by the findings of the microbiological study done by Kang *et al* (1998), from Vellore, southern India, on 78 persons from a rural area, whose stools were sampled on alternate days for 30 days; none of the samples yielded *Taenia* eggs.

Nepal. Taeniasis rates range from 10-50% amongst different ethnic groups in the Syangja and Tanahun districts of Nepal (Joshi *et al*, 2003). The rates were higher among the pig rearing community of Magars. These rates for taeniasis are amongst the highest reported anywhere in the world. It is possible that these high numbers are due to the prevalence of *T. saginata* infestation.

Data on porcine cysticercosis

Data on porcine cysticercosis are usually obtained from examination of pork in official slaughterhouses, but this probably underestimates the degree of the problem. Most pigs in India and Nepal, as in other developing regions of the world, are not slaughtered in officially-sanctioned slaughterhouses, but in informal places, including homes. Infected pigs are more likely to be slaughtered in these surroundings than in slaughterhouses for the fear of economic loss. The prevalence of porcine cysticercosis can also be roughly estimated by palpation of the tongue or inspection of the conjuctiva of live pigs for cysts. More recently, prevalences have been estimated using serological tests (ELISA or EITB). The data from India and Nepal have been derived from either inspection of pork or from tongue palpation for cysts.

India. Ratnam *et al* (1983) reported a 7% prevalence of cysticercosis in pig carcasses examined at slaughterhouses in Calcutta (east India). In a study performed in the north Indian state of Uttar Pradesh, between 1980 and 1985, 3,550 pig carcasses were screened for cysticercosis and 9.3% were found to be positive for infection (Pathak and Gaur, 1989). Prasad *et al* (2002) examined 50 pigs that were slaughtered in 3 villages in the north Indian state of Uttar Pradesh and found that 13 (26%) were infected with cysticercosis.

Nepal. Joshi *et al* (2003) estimated the prevalence of porcine cysticercosis as 14% (34/250) by examination of carcasses in Kathmandu and Dharan. They performed lingual examination of live pigs in Syangja District, which yielded a rate of 32% (136 positive/419 examined). They also noted that the pig population in Nepal had risen by 140% in the last two decades of the last century to 900,000, indicating increasing consumption of pork by the Nepalese.

Rising incidence of cysticercosis?

There have been some reports of a rising incidence of cysticercosis in India and Nepal. The lack of epidemiological data makes it difficult to determine whether this observation is true or apparent. The author feels that the rising incidence of cysticercosis is mostly an apparent phenomenon for several reasons. More patients with seizures are being referred for a neuroimaging procedure, such as a CT or MR scan, than 10 or 15 years ago. This leads to a higher rate of detection of cysticercal lesions of the brain. These patients would otherwise have been categorized as having idiopathic epilepsy in the past when imaging was not widely available. Secondly, there is greater awareness of the disease and its radiological manifestations amongst physicians and radiologists. Hence, lesions that would have been labeled "tuberculomas" (especially SCGs) are correctly diagnosed as cysticercal lesions. The author attributes the "rising" incidence of cysticercosis in part to these two factors.

Conclusions

From the data presented above, it is evident that *Taenia solium* taeniasis and cysticercosis are major public health problems in both India and Nepal and also result in loss of revenue to pig rearers. However, good population-based prevalence data are unavailable from both countries. It is obvious that unhealthy pork-rearing practices, where pigs are allowed to feed on human feces, lack of latrines, poor hygiene habits, and lack of meat inspection, have contributed to the establishment and transmission of the disease in both countries. The population has to be educated about the ill effects of these practices and the attention of health authorities in both countries has to be drawn to the magnitude of the problem, to prompt them to initiate measures to control the disease.

REFERENCES

Amatya BM, Kimula Y. Cysticercosis in Nepal: a histopathological study of sixty-two cases. *Am J Surg Pathol* 1999;23:1276-9.

Dixon HB, Lipscomb FM. Cysticercosis: an analysis and follow up of 450 cases. London: Her Majesty's Stationery. *Med Res Counc Spec Rep Ser* 1961; 299:1-58.

Heap BJ. Cerebral cysticercosis as a common cause of epilepsy in Gurkhas in Hong Kong. *J R Army Med Corps* 1990;136:146-9.

Joshi DD, Maharjan M, Johansen MV, Willingham AL,

Sharma M. Improving meat inspection and control in resource-poor communities: the Nepal example. *Acta Trop* 2003;87:119-27.

Kang G, Mathew MS, Rajan DP, *et al*. Prevalence of intestinal parasites in rural southern Indians. *Trop Med Int Health* 1998;3:70-5.

Kumar R, Kumar A, Kohli N, *et al*. Ring or disc-like enhancing lesions in partial epilepsy in India. *J Trop Pediatr* 1990;36:131-4.

Mahajan, RC, Malla N. Parasitic infections of the central nervous system. In: J. Abraham, ed. Progress in clinical neurosciences. Vol. 8. Chennai: Neurolo-gical Society of India, 1992:82-91.

Misra S, Verma R, Lekhra OP, Misra NK. CT observations in partial seizures. *Neurol India* 1994;42:24-7.

Mitra S, Patwari A. Intestinal taeniasis in Sikkim. *J Assoc Phy Ind* 1998;45:124-6.

Murthy JM, Yangala R, Srinivas M. The syndromic classificatin of the International League against epilepsy: a hospital based study from south India. In: Chopra JS, Sawhney IMS, eds. Progress in neurology. New Delhi: Churchill Livingstone, 1995:53-67.

Pathak KM, Gaur SN. Prevalence and economic implications of *Taenia solium* taeniasis and cysticercosis in Uttar Pradesh State of India. *Acta Leiden* 1989;57:197-200.

Prasad KN, Chawla S, Jain D, *et al*. Human and porcine *Taenia solium* infection in rural north India. *Trans R Soc Trop Med Hyg* 2002;96:515-6.

Rajbhandari KC. Clinical profile of epilepsy with neurocysticercosis in Nepal. New Delhi: Proceedings of the Third Congress of Asian Oceanian Epilepsy Organisation, 2000:18.

Rajshekhar V, Chandy MJ. Incidence of solitary cysticercus granulomas. In: Rajshekhar V, Chandy MJ, eds. Solitary cysticercus granuloma: the disappearing lesion. Chennai: Orient Longman, 2000:12-28.

Ratnam S, Khanna PN, Bandyopadhyay AK. Incidence of taeniasis in man. *Indian J Public Health* 1983;27:70-4.

Sawhney IMS, Lekhar OP, Chopra JS. Evaluation of epilepsy management and future guidelines for a developing country. In: Chopra JS, Sawhney IMS, eds. Progress in neurology. New Delhi: BI Churchill Livingstone, 1995:28-37.

Singh G. Neurocysticercosis in South-Central America and the Indian subcontinent. A comparative evaluation. *Arq Neuropsiquiatr* 1997;55:349-56.

Singh G, Prabhakar S, Ito A, Cho SY, Qiu D-C. *Taenia solium* taeniasis and cysticercosis in Asia. In: Singh G, Prabhakar S, eds. *Taenia solium* cysticercosis. From basic to clinical science. Oxon, UK: CABI Publishing, 2002:111-28.

Singh G, Ram S, Kaushal V, *et al*. Risk of seizures and neurocysticercosis in household family contacts of children with single enhancing lesions. *J Neurol Sci* 2000;176:131-5.

Shrestha SP, Henning A, Pradhan D, Parija SC. Subconjuctival and intraocular cysticercosis in Nepal. *Trop Doct* 1999;29:251-3.

Tsang VCW, Garcia HH. Immunoblot diagnostic test (EITB) for *Taenia solium* cysticercosis and its contribution to the definition of this under-recognized but serious public health problem. In: Garcia HH, Martinez SMM, eds. *Taenia solium* taeniasis/cysticercosis. Lima, Peru: Editorial Universo, 1999:245-4.

Wadia RS, Makhale CN, Kelkar AV, Grant KB. Focal epilepsy in India with special reference to lesions showing ring or disc-like enhancement on contrast computed tomography. *J Neurol Neurosurg Psychiatry* 1987;50:1298-301.