THE SIGNIFICANCE OF CHANGING TRENDS IN TRICHINELLOSIS

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Abstract. Findings during the past two decades have indicated that there are changing trends in trichinellosis in terms of (1) new isolates of *Trichinella*, (2) new sources of meat, including meat of herbivorous animals and of a greater variety of wild animals, (3) increasing number of cases among new ethnic groups in the USA, and (4) the emergence of new foci in Asia. These changes offer new challenges that warrant our attention. The characterization of each of the new isolates of *Trichinella*, particularly with respect to its infectivity, has become critical. Since herbivorous animals have been implicated as the source for human infections, thorough cooking of all animal meat is compulsory. Ethnic groups who continue to prepare their food in traditional manner must be informed of the potential danger of trichinellosis and the need for modification in preparation. The emergence of new foci for human trichinellosis emphasizes the importance of direct communication and interaction on a worldwide basis regarding the parasite and the infection.

INTRODUCTION

Humans become infected with *Trichinella* only when they ingest raw or poorly cooked animal meat containing the larvae. Unfortunately, *Trichinella* has a very wide range of domestic and wild animal hosts with wide geographic distribution, increasing the potential for human infection. In the last two decades, there have been changing trends in trichinellosis in humans that warrant our attention.

MULTIPLE ISOLATES OR *TRICHINELLA*

Until recently, it was assumed that there was only one species of *Trichinella, T. spiralis*. However, an isolate that differed from *T. spiralis* in certain respects was reported and designated *T. nativa* (Britov and Boev, 1972), which had an opaque or "matte" surface as opposed to the translucent white *T. spiralis* and was more resistant to low temperatures (Boev *et al*, 1979). *T. nelsoni*, which had been first obtained from a hyena in Kenya (Nelson and Forrester, 1962), was found to have low infectivity for the rat and domestic pig (Nelson and Mukundi, 1963) and more resistant to high temperatures (Boev *et al*, 1979). Another isolate, *T. pseudospiralis*, obtained from wild animals (Garkavi, 1972), was observed to be smaller than other isolates and lacking a capsule.

In addition to morphological differences, the three isolates were found not to be infective for the domestic pig (Boev *et al*, 1979). The primary hosts for *T. nativa* were carnivores of the Arctic, such as bears and wolves, while those for *T. nelsoni* were the hyena, bush pig and warthog. The principal host for *T. pseudospiralis* was birds, and it is not known to be pathogenic for humans. Breeding experiments revealed that the four isolates, *T. spiralis, T. nativa, T. nelsoni*, and *T. pseudospiralis* failed to interbreed. From these reports, it became apparent that distinct isolates were being observed with respect to morphologic differences, freezing tolerance, interbreeding capacity, and host preference and infectivity. These findings raised a very important question as to whether these isolates were strain variants, subspecies, or separate species.

Attempts to characterize the various isolates by biochemical and immunological means were inconclusive until recently when Pozio and colleagues (unpublished) reported that isoenzyme patterns from 130 isolates of *Trichinella* spp. revealed 8 gene pools. Based on these findings, they proposed that there are at least five species: *T. spiralis, T. nativa, T. nelsoni, Trichinella sp.*, and *T. pseudospiralis*. Zarlenga and Murrell (1989) showed that restriction enzyme fragment lengths of the small rDNA subunit were found

to be significantly different in *T.s. nelsoni, T.s. spiralis* and *T. pseudospiralis. T.s. nativa* was more similar to *T.s. spiralis* than other subspecies as both isolates generated the same 2.2 kDa rDNA band.

SOURCES OF INFECTION

Meat of domestic animals

Since the initiation by various municipalities to prohibit feeding of uncooked garbage and offal to pigs, the incidence of trichinellosis in swine has declined in the United States, but it is still sufficiently high to be a public health concern, as well as an economic burden to American swine industry (Murrell, 1985).

As commercial pork declined as the source for infection, human infections resulting from ingestion of unusual animal meat, such as horse meat, were reported from Italy (Bellani *et al*, 1978), which were later postulated to have occurred as a result of ingestion of an infected rat by a horse (Mantovani *et al*, 1980). Three outbreaks were also reported from France. The first occurred in 1976, the second and third in 1985, all attributed to the consumption of raw horse meat in the form of "steak tartare" (Bouree *et al*, 1989). The outbreak in 976 was traced to horse meat imported from Poland, while the outbreaks in 1985 were traced to horse meat imported from Connecticut and Germany.

An unusually interesting outbreak was reported from northern Germany that was attributed to meat known as "pastyrma" (Bommer *et al*, 1985). A German returning from a visit to Egypt brought back a piece of salted air-dried meat, which he bought as "camel meat". Eight adults who ate the meat as delicacy became infected with *Trichinella*. It was not certain whether the source was indeed camel meat. Another uncertainty of the source was that "pastyrma" is mostly made from beef. If the meat were beef, it may have been adulterated with pork, a situation that has been reported in the USA (CDC 1977; Bailey and Schantz, 1990).

Meat of wild animals

The domestic cycle, involving principally the pig, is not the only source for human trichinellosis. There is also the sylvatic cycle, involving more than 100 species of mammals that can serve as hosts for *Trichinella*. Wild carnivorous or omnivorous animals eat the carrion of dead carnivores as exemplified by the polar bear in which the infection rate has been shown to be high.

In the United States, the percentage of cases due to wild animal meat has increased with bear meat the most commonly incriminated and wild pork second for the period 1982–86 (Bailey and Schantz, 1990). In 1986, an isolated case in Oregon was attributed to the consumption of infected cougar meat (CDC, 1988).

In an outbreak of 10 cases that first occurred in Salluit among the Inuit Eskimos in 1983, there was circumstantial evidence that walrus meat was the source (Viallet *et al*, 1986). Later outbreaks implicated possibly consumption of meat of other northern mammals (MacLean *et al*, 1989).

The importance of game meat is not limited to the North American continent. In the USSR, most human trichinellosis reported in 1981 were traced to the consumption of meat of wild animals, particularly of wild boars (Bessonov, 1981). A clear relationship between the epidemic season of trichinellosis and the hunting season of wild boars and bears has been noted in the USSR, where up to 96% of the reported cases have been due to meat of wild boars and brown bears (Bessonov, 1985).

Analysis of small outbreaks in Spain between 1980 and 1989 revealed that wild boar meat sample contained 12.5 larvae/gram, while the number of larvae was much smaller in pork, 0.001 to 0.33 larvae/gram, emphasizing the increasing importance of game meat as the source of human trichinellosis (Rodriguez-Osorio *et al*, 1990). Germany also reported a recent outbreak in which 58 of 72 persons had clinical manifestations of trichinellosis after ingesting wild boar meat (ISS/WHO/CC, 1988).

INCIDENCE AND TRANSMISSION PATTERNS

The changing trend in the incidence and transmission patterns for trichinellosis has

been most apparent in the United States. In the past, trichinellosis was more common in Americans of German, Italian, and Polish descent due to their culinary preferences for raw or undercooked pork. However, between 1975 and 1984 with the influx of Southeast Asians who prepared their traditional dishes of essentially raw pork usually purchased directly from farms and spiced with condiments, trichinellosis was shown to be 25 times greater in them than for the general US population (Stehr-Green and Schantz, 1986). Of 1,260 cases reported to CDC during this period, 60 (4.8%) were among Southeast Asian immigrants. Thirty-one cases (52%) were Laotians, 24 (40%) were Cambodians, and 3 (5%) were Vietnamese. Earlier in 1971 and 1973, small outbreaks occurred in New York in another group of Southeast Asians, Thais, who had consumed traditionally prepared raw pork dishes (Imperato *et al*, 1974). Recently, two cases in California resulted from consuming "lop", a traditional Laotian dish prepared with rare or slightly boiled pork and spices (CDC, 1987, prepublication).

NEW FOCI

In recent years, Asian countries have been recognized as new foci of trichinellosis where epidemics have been reported from Thailand, Laos, Japan, China, and Hong Kong.

During the period 1962–1983, there were 67 outbreaks with 2,792 cases and 85 deaths in Thailand (Dissamarn and Indrakamhang, 1985). As reported earlier (Khamboonruang *et al*, 1978), the major source was hill-tribe pigs in the form of "lahb" ("larb") or "nahm" ("nhaem"), but meat of other animals, such as wild boar, black bear, dog, jackal, and squirrel have also been responsible (Dissamarn and Indrakamhang, 1985).

In Laos, traditional pork dishes, such as "som-mou", "lap mou", and "lap leuat" were responsible for the outbreak in 1975. The importance of the traditional Thai and Laotian dishes vis-à-vis the United States is that the newly arrived immigrants from these countries have continued to prepare their traditional dishes in the same manner.

Trichinellosis was almost unknown in Japan until the first human outbreak was reported in 1974 among a group of hunters who ate raw bear meat (Yamaguchi, 1978). A second outbreak followed in 1980 in Hokkaido, where raw brown bear meat was served in a local restaurant. The bear meat had been reportedly stored in a refrigerator at –30° C for about four months. A third outbreak in 1981 was also due to the consumption of raw bear meat. Raw meat dishes of various animals, such as horse, deer, pheasant, chicken and marine mammals, are considered as delicacies in Japan, increasing the risk of trichinellosis, although some of these animals are primarily herbivorous.

Interestingly, an outbreak attributed to the consumption of scalded mutton was reported from China. The diagnosis was based on finding encysted larvae of *Trichinella* in the remaining uneaten mutton (WHO/HELM/82.5, 1978). Another outbreak, which included one death, was due to the consumption of raw bear meat.

The first documented outbreak of human trichinellosis in Hong Kong was reported in April 1981 in 20 Gurkha soldiers, who had attended a barbecue and ate pork purchased from local dealers in Sek Kong in the New Territories (Simon *et al*, 1986). The first outbreak among Hong Kong Chinese occurred a year later, involving a four-member family who had ingested inadequately cooked pork (Pun *et al*, 1983). In both outbreaks, the pigs had been imported from southern China.

SIGNIFICANCE OF CHANGING TRENDS

Findings reported during the past two decades have indicated that there are changing trends in trichinellosis in terms of (1) new isolates of *Trichinella*, (2) new sources of meat, including meat of herbivorous animals and of a greater variety of wild animals, (3) increasing number of cases among new ethnic groups in the US, and (4) the emergence of new foci in Asia. These changes offer new challenges that must be met.

The characterization of each of the new isolates of *Trichinella*, particularly with respect to its infectivity, has become critical. For

example, the freezing temperature and time requirement to kill the larvae is different for the Arctic isolate of *Trichinella*, which is quite resistant to freezing temperature. Thus, the present freezing temperature/time recommendation by the US Department of Agriculture may require modification, depending on the isolate.

Since herbivorous animals have been implicated as the source for human trichinellosis, thorough cooking of all animal meat is compulsory, irrespective of whether the animal is carnivorous or herbivorous. Even prior to consumption, measures must be taken on the farm to ensure that herbivorous animals do not have access to infected carcasses in their feed. The wider consumption of meat of wild animals as basic food or as delicacies demands knowledge and judgment on the part of the consumer when ingesting meat of wild animals.

Newly arrived ethnic groups who continue to prepare their food in traditional manner must be informed of the potential danger of trichinellosis and the need for modification in their food preparation to ensure that the larvae are killed. This is a difficult and sensitive issueinasmuch as long-standing traditions must be altered.

The emergence of new foci for human trichinellosis emphasizes the importance and the need for direct communication and interaction on a world-wide basis. Therefore, on behalf of the International Commission on Trichinellosis, I would strongly urge all member countries to submit your epidemiological reports to the Commission every two years in order to share the latest information and to meet the challenges of the changing trends in trichinellosis throughout the world.

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