



Trichinella spp.

Trichinella spp. (trichina)
Worm
Roundworm
Parasite

Characteristics and sources of *Trichinella* spp.

Main microbiological characteristics

Trichinella is a roundworm parasite belonging to the class of Nematodes. The worm is found in its infective larval form mainly in mammalian striated muscle fibre (especially in omnivores and carnivores). Mammals become contaminated by ingesting infected muscle. The parasite's life cycle is summarised in Figure 1.

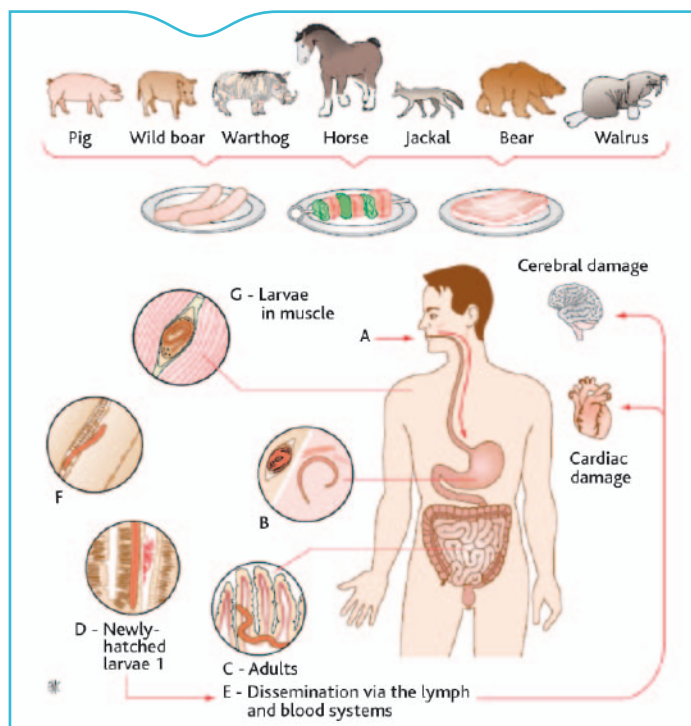
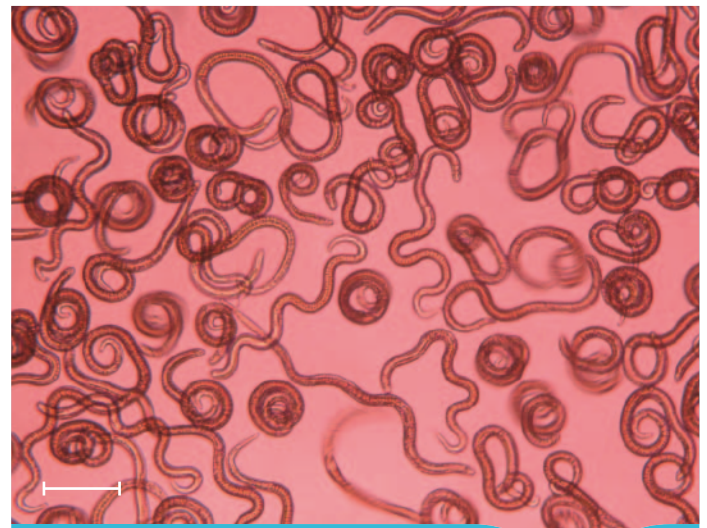


Figure 1. Life cycle of *Trichinella* in humans and main sources of contamination⁽¹⁾



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animal trichinellosis, ANSES Maisons-Alfort

Ingested during the consumption of raw or undercooked infected meat (A), the larvae (invisible to the naked eye) are released by chlorhydropeptic gastric digestion (B). They then penetrate the intestinal epithelium and reach adulthood in 48 hours (C). After mating, females lay their L1 larvae and are then quickly expelled. These newborn L1 larvae migrate throughout the body via the lymphatic and blood systems (D) which, in cases with complications, can result in damage to the brain and heart (E). They then reach their final niche: the muscle fibre (F) which becomes the feeder cell. These larvae grow and become infective in two weeks and most species then become encapsulated (G). They remain viable for years (source Encyclopédie Médico-Chirurgicale, EMC).

Trichinella is a pathogen for humans whose degree of pathogenicity is directly linked to the species (different prolificacy in females) and to the initial infectious dose. Only eight species are currently recognised. Five of these become encapsulated in muscle: *Trichinella spiralis*, *T. nativa*, *T. britovi*, *T. murrelli* and *T. nelsoni*. All these species are known to be pathogenic to humans. Three species are "non-encapsulated": *T. pseudospiralis*, *T. papuae* and *T. zimbabwensis*. These species are easily identifiable by simple molecular biology techniques. *T. spiralis* is considered the most pathogenic species.

(1) This figure was published in EMC Maladies Infectieuses, [8-517-A-10], A. De Bruyne, I. Vallée, T. Ancelle, I. Brochériou, A. Bonafé, P. Boireau, J. Dupouy-Camet, Trichinellosis, pp. 1-19. Copyright Elsevier, 2010.

Sources of the hazard

All meat from mammals other than ruminants is likely to harbour *Trichinella*. The main source of the hazard is the consumption of raw or undercooked pork or wild boar meat. In the past, horse meat has been responsible for human cases in France and Italy. The flesh of carnivorous birds and reptiles (crocodiles, etc.) can also be infected. Some cases have been reported following the consumption of turtle meat.

Transmission routes

Transmission to humans is exclusively *via* food. Consumption of raw or undercooked meat is the main exposure factor.

Recommendations for primary production

- Susceptible livestock (pigs) should be considered according to the type of farming (Regulation (EC) No 2075/2005⁽²⁾). Pigs reared outdoors are at risk of contamination through consumption of dead wild animals (foxes, wild boars, rodents). These pigs therefore undergo a mandatory trichinellosis diagnosis at slaughter.
- Intensive indoor pig farms must be protected: the buildings housing animals must prevent the intrusion of wild animals (including birds) and food containers must be impervious.

Human foodborne illness

Nature of the disease

In humans, several days after infection, the development of adult trichina in the intestine causes abdominal pain and diarrhoea without blood. The migration of newly-hatched larvae into the circulation results in high fever and allergic reactions (facial oedema, rash, etc.). The penetration of larvae in muscle cells causes intense myalgia (muscle pain). There is a significant increase in polynuclear eosinophils and increased levels of serum muscle enzymes. This febrile and myalgic phase lasts around ten days and then disappears spontaneously, leaving a lasting asthenia, often with chronic myalgia (Table 1).

Susceptible population groups⁽³⁾: elderly people, those with a massive infective load or those who were diagnosed late may develop neurological or cardiac complications that can be fatal. In pregnant women, the parasite can cause miscarriage.

Dose-effect⁽⁴⁾ and dose-response⁽⁵⁾ relationships

The minimum dose likely to cause symptoms in humans is estimated at between 70 and 300 larvae, but this dose varies depending on the species of trichina, the receptivity of the subject and the method of meat preparation.

Epidemiology

The incidence of trichinellosis is still low in France. Between 2000 and 2009, 60 confirmed cases were reported to the French National Centre of Reference (NCR), or six cases per year on average. Thirty-one cases were acquired abroad. In total, 25 cases were linked to consumption of wild boar meat (France), 23 cases to bear meat (Canada), five cases to warthog (Senegal), four cases to pork (Laos), one case to jackal (Algeria) and two cases to an unidentified source. Twenty-two of the 60 cases involved hospitalisation for periods of 1-15 days. No fatal cases have been observed since 1985.

Between 1975 and 1998, eight outbreaks linked to consumption of horse meat affected at least 2,316 people.

The three species of indigenous trichina (*T. spiralis*, *T. britovi* and incidentally *T. pseudospiralis*) circulate mainly in wildlife (wild boar, foxes).

The Parasitology Laboratory at the Cochin Hospital (Paris) is mandated by the French Institute for Public Health Surveillance (InVS) with the surveillance of human cases and is the NCR. Trichinellosis is not specifically a notifiable disease but it nevertheless falls within the scope of notifiable foodborne illness outbreaks.

Role of food

Main foods to consider

In France, indigenous cases are related to the ingestion of uncontrolled raw or undercooked wild boar meat. Imported cases are mainly related to the consumption of game meat (bear, warthog, etc.).

Globally, the main source of human cases remains pork meat, especially in areas where family breeding is practised, which is not controlled by veterinary services.

(2) Commission Regulation (EC) no. 2075/2005 of 5 December 2005 laying down specific rules on official controls for *Trichinella* in meat.

(3) Susceptible population group: people with a higher than average probability of developing symptoms of the disease, or severe forms of the disease, after exposure to a foodborne hazard [definition used for the ANSES data sheets].

(4) The relationship between the dose (the amount of microbial cells ingested during a meal) and the effect on an individual.

(5) For a given effect, the relationship between the dose and the response, i.e., the probability of this effect appearing in the population.

Table 1. Disease characteristics

| Incubation | Target population | Main symptoms | Frequency (%) | Duration (days) | Complications** | Asymptomatic forms |
|--|---|--|---------------|-----------------|--|-------------------------------|
| 5-21 days depending on species and infective dose* | Anyone who eats raw or undercooked meat | intense myalgia | 70-95 | 15-20 | Neurological complications: hemiparesis, hemiplegia, mental disorders... Cardiac complications: myocarditis, thromboses... Miscarriages Deaths (5‰ in 1985) | Possible with low infestation |
| | | high fever | 70-95 | 7-10 | | |
| | | facial oedema | 60-90 | 5-7 | | |
| | | abdominal pain and diarrhoea without blood | 10-40 | 4-6 | | |
| | | rash | 15-25 | 4-6 | | |
| | | asthenia | 30-90 | 20-40 | | |

* The higher the infective dose, the shorter the incubation period and the more severe the disease. ** The frequency of complications (1 to 20% of cases) is reduced by early treatment.

Inactivation treatments in industrial environments

| Heat | Cold |
|--|---|
| The larvae are destroyed instantly by heat at 71°C, in 3 minutes at 58°C (core temperature of cooked meat) and in 4 hours at 51°C | <i>Trichinella spiralis</i> is destroyed in half an hour at -37°C, in 22 hours at -32°C, in 48 hours at -26°C and in 82 hours at -21°C. For other <i>Trichinella</i> species, these conditions may not be sufficient to kill the parasites (e.g. <i>T. nativa</i> can withstand months at -30°C in polar bear muscle) |
| Curing/Smoking | Irradiation |
| Inactivation occurs where $a_w \leq 0.92$ and is combined with a pH < 5.3 When the salt content is < 4%, the efficacy of salting depends on the duration of the salt ripening process and the pH The larvae can withstand curing and smoking | Irradiation at 0.3 kGy inactivates the larvae of <i>Trichinella</i> |
| High pressure | Disinfection of contaminated surfaces |
| There are no official data recognised by the International Commission on Trichinellosis or by European regulations | Contaminated utensils can be disinfected by heat (hot water $\geq 70^\circ\text{C}$ for at least 5 min) or bleach (0.65% concentration of a.c.* for 2 h or 0.01 a.c. for 3 h). Non-corrosive surfaces can be decontaminated with bleach at 2.6% a.c. for 5 min |

* Active chlorine.

Monitoring in food

Surveillance system in France

The introduction of the new European regulation (Regulation (EC) No. 2075/2005) concerning the control of zoonoses, led in 2006 to major changes in the control of pork meat. Individual inspection of pigs is the rule unless the farm or farming system is considered free of *Trichinella*. Breeders are still systematically inspected, together with all outdoor pigs and any farms not designated as "disease-free". Accreditation of farms free of *Trichinella* is issued by the veterinary services on the basis of regular farm visits. The definition of a disease-free farm is provided in the legislation. Currently there are no farms in France that have been declared disease-free. To summarise, any contact with wildlife should be avoided. Food sources are monitored and controlled, farms are enclosed and buildings are sealed to avoid intrusion by wildlife.

Wild boar should be systematically controlled according to one of the methods described in European Directive 92/45/EEC⁽⁶⁾ if the meat is to be sold.

The legislation also requires screening for trichina in all imported or indigenous horses slaughtered in France. Imported meat is subject to systematic inspection at the point of slaughter. Meat which has not been inspected after slaughter must be frozen before sale. However, the limitations of inactivation treatments using cold should be taken into consideration (some species being resistant to freezing).

The ANSES Parasitology Laboratory (UMR BIPAR, Maisons-Alfort) is responsible for surveillance of animal cases and training of personnel involved in mandatory inspections of pigs, wild boars and horses. It is the National Reference Laboratory for animal trichinellosis.

Surveillance system in the rest of the world

Trichinellosis is one of the zoonoses monitored by the World Organisation for Animal Health (OIE). An annual report provides an estimate, for each country, of the incidence of the disease in animals (OIE website: <http://www.oie.int/en/>).

Validated methods available for detecting the hazard in foods

Artificial digestion is the standard method described in Annex I, Chapter I of Regulation (EC) No. 2075/2005. This is a microscopic examination of artificial digesta obtained by the combined action of heat, hydrochloric acid and pepsin. Sensitivity is from 0.1 to 1 larva/g depending on the amount of meat analysed.

Recommendations to operators

Operators' attention should be drawn to:

- the limitations of freezing, which may not be effective in inactivating certain species of the parasite;
- the obligation to obtain an official diagnosis for the meat;
- the ban on the sale of raw meat from non-inspected animals;
- the efficacy on the parasites of heat treatments in meat, subject to a temperature and duration that are adapted to the thickness of the piece.

Domestic hygiene

Domestic freezing does not ensure the inactivation of the parasite.

Recommendations to consumers

- Do not eat wild boar meat that has not undergone an official inspection. If in doubt, cook meat thoroughly: recipes involving long, slow cooking are preferable.
- Hunters and travellers abroad should be discouraged from eating raw or undercooked meat that has not undergone any controls.

References and links

General references

- Trichinelloses. A. De Bruyne, I. Vallée, T. Ancelle, I. Brochériou, A. Bonafé, P. Boireau, J. Dupouy-Camet. EMC (Elsevier Masson SAS, Paris), Maladies infectieuses, 8-517-A-10, 2006.
- La trichinellose: un risque parasitaire persistant en France. A. de Bruyne, N. Delanos-Grégoire, T. Ancelle, J. Dupouy-Camet, Spectra Biologie, 2006, 153, 24-28 available from: http://spectrabiology.com/Documents/SB153_24-28.pdf
- FAO/WHO/OIE GUIDELINES FOR THE MANAGEMENT OF TRICHINELLOSIS coordinated by Darwin Murrell & Jean Dupouy-Camet with the participation of E. Pozio, R. Gamble, F. Bruschi, K. Noeckler, C. Kapel & P. Boireau. May be downloaded from: <ftp://ftp.fao.org/docrep/fao/011/a0227e/a0227e.pdf>

Useful links

- National Centre of Reference for *Trichinella*: <http://cnrdestrichinella.monsite-orange.fr/>
- National Reference Laboratory for foodborne parasites: animal trichinelloses. <http://bipar.vet-alfort.fr/thematiques/891/lmr/lmr.html>
- European Union Reference Laboratory for Parasites: <http://www.iss.it/crlp/index.php>
- International Commission on Trichinellosis (ICT): <http://www.med.unipi.it/ict/welcome.htm>

(6) Council Directive 92/45/EEC of 16 June 1992 on public health and animal health problems relating to the killing of wild game and the placing on the market of wild-game meat.