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](image)

Ingested during the consumption of raw or undercooked infected meat (A), the larvae (invisible to the naked eye) are released by chlorohydropeptic 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.

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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). 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: 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 and dose-response 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.

Table 1. Disease characteristics

<table>
<thead>
<tr>
<th>Incubation</th>
<th>Target population</th>
<th>Main symptoms</th>
<th>Frequency (%)</th>
<th>Duration (days)</th>
<th>Complications**</th>
<th>Asymptomatic forms</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-21 days</td>
<td>Anyone who eats raw or undercooked meat</td>
<td>Intense myalgia</td>
<td>70-95</td>
<td>15-20</td>
<td>Neurological complications: hemiparesis, hemiplegia, mental disorders…</td>
<td>Possible with low infestation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High fever</td>
<td>70-95</td>
<td>7-10</td>
<td>Cardiac complications: myocarditis, thromboses…</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Facial oedema</td>
<td>60-90</td>
<td>5-7</td>
<td>Miscarriages…</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Abdominal pain and diarrhoea without blood</td>
<td>10-40</td>
<td>4-6</td>
<td>Deaths (5% in 1985)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rash</td>
<td>15-25</td>
<td>4-6</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Asthenia</td>
<td>30-90</td>
<td>20-40</td>
<td></td>
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</tbody>
</table>

* 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.
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. Accreditation of farms free of *Trichinella* involves long, slow cooking are preferable. Hunters and travellers abroad should be discouraged from eating raw or undercooked meat that has not undergone any controls.

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.

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


Useful links

- National Centre of Reference for *Trichinella*: http://cnrdestrichinella.monsite-orange.fr/
- 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