Cestodes

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Helminths

- Phylum Nematoda (Roundworms) - "Nematodes"
  - Pinworm, Whipworm, Ascaris + VLM, Hookworm + CLM
    - Diabuliasis, River Blindness, Dracunculiasis, etc.

- Phylum Platyhelminthes (Flatworms)
  - Class Cestoidea (segmented flatworms) - "Cestodes"
  - Class Trematoda (non-segmented flatworms) - "Trematodes"

The tapeworms

(Cestodes ==> Non-segmented flatworms)

- *Taenia saginata* (beef tapeworm)
- *Taenia solium* (pork tapeworm) --> Cysticercosis
- *Echinococcus granulosus* (dog tapeworm) --> Hydatid Disease

Taenia saginata

The beef tapeworm

Taenia saginata adult

“Bowl o’ Worms”

“Fields o’ beeves”

© Despommier, master photographer and fly-sherman
"Plate o’ Beef” a la “Wellington”

Cysticercosis - heart of cow

Cestode hosts

*T. saginata*

Definitive Host: Human
Intermediate Host: Cow

Adult *Taenia saginata*

*Taenia saginata* scolex

Proglottid - Sex organs
Gravid Proglottid of *Taenia saginata*

The central uterus of *T. saginata* has more than 12 branches on a side

Embryonated, infectious taeniid eggs

Cannot distinguish species of *Taenia* tapeworms based on morphology of eggs

Pathogenesis:

None

Clinical Disease:

None in humans

Diagnosis:

1. Find eggs or proglottids in stool
2. Identify species based on proglottid morphology, after formalin and India Ink
3. Identify scolex
Drug of Choice

**Praziquantel**

*Mode of Action:*
Increases permeability of flatworm tegument to Ca$^{2+}$ ions,
Causing muscle tetany and worm detachment.

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**Prevention and Control:**

1. Sanitary disposal of human feces

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**Prevention and Control (cont’d):**

2. Prevent cows from coming into contact with human feces, ie good sanitation and physical restraints.

3. Freeze and/or cook all beef until well-done
   Good luck Paris, good luck New York!!
   (No more rare filet mignon or steak tartar)

4. Federal meat inspection programs (muscle exam or serum ELISA specific to larval stage).

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**Taenia solium**
The Pork Tapeworm

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**Still Life With Ham. (Or not?)**

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**Whole cysticercus of Taenia solium**
**Adult *Taenia solium***

**Gravid proglottid *Taenia solium***

**T. Solium Scolex**

**Embryonated, infectious taeniid eggs**

Cannot determine the species of *Taenia* based on egg morphology.
Pathogenesis:
None

Clinical Disease:
None

Diagnosis:
1. Find eggs or proglottids in stool
2. Identify species based on proglottid morphology
3. Identify scolex
4. Stool PCR or ELISA (not readily available)

Drug of Choice:
1. Praziquantel
2. Niclosamide
   - Not absorbed systemically
   - Uncouples cestode oxidative phosphorylation, preventing ATP production.
   - Parasite is then digested by host enzymes.

Prevention and Control:
1. Sanitary disposal of feces

Prevention and Control (cont’d):
2. Sanitary practices on pig farms; separate human feces from pigs.
3. Cooking and/or freezing pork products thoroughly.
4. Federal meat (pork) inspection programs.
5. Treat pigs or vaccinate pigs, using new oncosphere mRNA vaccine, in eradication programs. (WHO Assembly, 2003).
### Cestode hosts

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### Cysticercosis and Neurocysticercosis

- **Multiple Intracerebral Cysts**

### Manifestations of Cysticercosis in Humans

- **Cysticercus floating freely in anterior chamber**
- Cysticercus in brain, on post-mortem pathology
  - Asymptomatic cyst. Actual cause of death, mesothelioma

### Parasite (Cysticercus)
Cysticercosis of eye:
cysticercus near optic nerve, mis-diagnosed as retinoblastoma.

Enucleated globe in cross-section

Radiogram of lower leg with numerous calcified cystercerci of *T. solium*

Subcutaneous Cysts

Neurocysticercosis of the spine

Cerebello-pontine angle cysticercus
This may cause hydrocephalus

MRI sagittal (T1) and axial views (T1 + C)

Neuro-cysticercosis

T1 weighted  T1 with contrast  T2 weighted
Neurocysticercosis

How bad can things get?

Immuno-modulation

- Taeniastatin
  - protease inhibitor
- Paramyocin
  - Inhibits complement
- Other proteases:
  - Degrade Interleukin-12, immunoglobulins and interferon

Intracerebral Calcifications

a GIANT cyst

Single vs multiple cysts
Growing/living cysts vs Calcified/dead cysts
Small vs GIANT Cysts
Seizures,
CSF obstruction
Hydrocephalus,
Arachnoiditis,
Mass effect,
Focal neurologic deficits...

Neurocysticercosis and Taeniasis:
Global Prevalence Map
Clinical Epidemiology of Cysticercosis

- Est. 50 million people with Intestinal Taeniasis, world-wide
- 20% have cysticercosis; at least half will be symptomatic (Sz)
- Leading cause of adult-onset seizures worldwide (~40%)
  - Other causes are trauma, TB, tumors, toxins, other.
- In US: Est. 1000 new cases per year (no mandatory reporting)
  - Immigrants account for >95% annually
  - Travelers account for ~3%
  - Autochthonous transmission: rare

Pathogenesis:

- Space-Occupying lesion
- Local Immunologic Reaction

Clinical Disease:

- Vision impairment / Blindness
- Seizures/Death
- Hydrocephalus/Coma/Death
- Focal Neurologic deficits that depend upon location of mass and area affected.

Diagnosis:

- Must differentiate between cysticercosis and other possible lesions (benign cysts, solid tumors, etc.)
  1. Biopsy whenever possible
  2. Physical (palpation) and X-ray evidence
  3. Enzyme-linked immunoblot serological test, can be as high as 98% sensitive, 100% specific.
  4. MRI

Treatments:

1. Surgical removal of cysticercus when appropriate
2. Steroids (e.g., dexamethasone) during time of neurological symptoms
3. Anticonvulsants (e.g., Dilantin - Phenytoin)
4. Antiparasitic antibiotics: Praziquantel or albendazole + steroids + anticonvulsants for multiple or symptomatic cysticerci, or for inoperable cysts - under study

Echinococcus granulosus
The Dog tapeworm
Hydatid Disease in Humans
Cestode hosts

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Traditional sheep husbandry and farming practices help to maintain the cycle in animals and humans.

Echinococcus Granulosus

Global Prevalence Map

Distribution map of Echinococcus granulosus (black) and E. multilocularis (marked by ‘X’). The latter is now also found in Bokhara (Japan), Alaska and also in the whole of Germany.

Adult of Echinococcus granulosus

Echinococcus Granulosus Adult
cute, n’est-ce pas?
Echinococcus Lifecycle

Radiogram of upper body showing elevation in right lobe of liver due to large hydatid cyst

Distribution of Hydatid cysts

Hydatid cyst of Liver
Visualize:
1. Hydatid Cyst
2. Hydatid Fluid
3. Daughter Cysts

Hydatid cysts removed from human liver

Hydatid cyst of Parietal Lobe
Pulmonary Echinococcus

Liver infected with **hydatid cyst** of *Echinococcus granulosus*

CT Scan

Ultrasound

Petri dish filled with daughter cysts of *Echinococcus granulosus*

Histological section through brood capsules in hydatid cyst of *Echinococcus granulosus*

Hydatid Cyst diagram

Brood capsule with protoscolices of *Echinococcus granulosus*
When intact, hydatid cysts are immunologically and often 
clinically silent, especially in the liver.

In other organs (e.g., brain, lung, bone marrow), 
hydatid cyst is a space-occupying lesion.

It may leak or rupture, seeding/metastasizing adjacent areas.

When hydatid cyst ruptures, allergic reactivity and 
anaphylaxis often ensue. This may be fatal.

Diagnosis:

A. Direct
   1. NO BIOPSY!
   2. CAN remove surgically. Find “hydatid sand” on 
microscopic examination of fluid from 
hydatid cyst

B. Indirect
   1. ELISA-based serology
   2. Imaging: MRI, CAT scan, X-ray, Ultrasound
   3. Accurate case history (ownership of dogs, living 
on a sheep farm, etc.)

Treatment:

• Surgical, whenever possible
  • PAIR Technique for liver lesions
    – (puncture, aspirate, Inject, re-aspirate)
  • Pharmacologic has less than 50% success

Drug of Choice:

Albendazole (for 1-6 months)

Mode of Action:
Prevents microtubule polymerization, blocking glucose absorption, starving worm

Prevention and Control:

• Regularly treat all shepherding dogs with niclosamide. 
  This drug kills the adult parasites (by inhibiting ATPase).

• Avoid feeding hydatid cyst material (sheep offal) to 
dogs.

• Public health education of sheep farmers.
Now that I can’t eat meat or pork,
or play with dogs, cats, or sheep,
what shall I do with my nights off?
I think I’ll have a scotch.

-Abraham