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Differences of appearance, life cycle, symptoms, diagnose and treatment mmong Taenia solium, Taenia saginata and Taenia asiatica

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Abstract. Tapeworm belongs to the class Cestoda of the Platyhelminth phylum. In tapeworms, the Taenia solium, Taenia asiatica, Taenia saginata are tapeworm that can infect human and cause taeniasis or other diseases. This essay concludes the basic information of these three kinds of tapeworms including the appearance, life cycle, symptoms, diagnosis, and treatment. In each part it summarizes the similarities and differences among them. The appearance introduces the entire body and gravid proglottid. It compares the length and width in these three kinds of tapeworms, their competence of producing last proglottid, the differences in hooks and the differences in gravid proglottid, which shows general figures of these three kinds of tapeworms. The lifecycle introduces their location and the ways of infection by comparing the differences. In the part of symptoms, the Neurocysticercosis is highlighted and introduce most, and the human immune inhibition is added to complement how human body to confront with tapeworms. In the diagnosis part, microscopical examination, PCR and antibody tests are used to identify the tapeworms. The PCR especially shows the differences of nucleotide sequence and predicted amino acids in tapeworms. For treatment, the similarities and differences in the treatment for different tapeworms are the important contents. Pumpkin seeds and areca nut extract are Chinese medicine, and it shows great power to deworm tapeworms. This essay hopes to get a deeper understanding of tapeworm through the above introduction, so as to promote the prevention and control of tapeworms.

Keywords: tapeworm, Taenia solium, Taenia saginata, Taenia asiatica.

1. Introduction

Taenia solium (TSO), Taenia saginata (TSA), and Taenia asiatica (TAS) are all members of the Cestoda class, which is containing about 5,000 species [1]. Tapeworm infection is spreading worldwide, especially endemic in where sanitation is poor, like Latin America, Africa, and Asia. There is frequently interaction between humans and animals [1]. For the public, it is very meaningful to know the basic information of tapeworm. That is because all three are zoonotic parasites that can cause significant adverse effects on human health and farm production.

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The infection pathway of TSO, TSA, and TAS is similar. They all select humans as their final hosts and animals as their intermediate hosts. Firstly, the tapeworms' eggs in the environment infect animals, like cattle and pigs. Eggs are hatched in the animals' body, and become infective to human after 4-10 weeks [1]. Secondly, when human get the uncooked infected food, cysticerci, the larvae of the tapeworm go into the human body. Cysticerci gradually enlarge and then sexually mature in the human intestine. After sexually mature, the eggs of the tapeworms transferred by feces into environment, like water. Then, they infect animals and finish the life cycle again. For the tapeworms' infections, vomit, fever, headache, are the common symptom, which are always used deworming medicine, operation to treat related diseases. There are lots of articles about TSO, TSA, and TAS. This essay hopes to together the information and get a deeper understanding of tapeworm through the above introduction.

2. Appearance

2.1. Entire body

Tapeworm of the genus Taenia are white or yellowish, with scolex, neck, strobila and reproductive organs. For the entire body, the length and width of tree type of tapeworms are different. According to Table 1, for the entire body TSA are longest and widest, TAS are in the middle and TSO are shortest and thinnest. Moreover, TSA produce most proglottids, while on the average TAS produce least proglottid.

Scolex are divided into three parts, suckers, rostellum, and hooks. All these tapeworms have 4 suckers. Hooks and suckers in scolex in the TSO are all present, while hooks and rostellum rudimentary presented in TAS and absent in TSA. Hooks in TAS are considered as a wart-like formation on the outer skin, and rostellum absent or sunken on the skin [1].

Table 1. Differences among three types of tapeworms [1].

	Taenia solium	**Taenia saginata**	**Taenia asiatica**
Entire body			
Length (m)	1-5	4-12	1-8
Width (mm)	7-10	12-14	9-12
Proglottids	700-1,000	1,000-1,500	200-1,200
Scolex			
Diameter (mm)	0.6-1.0	1.5-2.0	0.2-2.0
Rostellum	+	-	-
Hooks	+	-	-
Gravid proglottid			
Uterus branches	7-11	14-32	12-26
Posterior protuberance	-	+	+
Length (mm)	3.1-10	10-20	4-22
Width (mm)	3.8-8.7	6.5-9.5	3-12
Cysticercus			
Size (mm)	8-15	6-10	0.4-3.5
Hooks in scolex	+	-	Rudimentary
Egg			
Size (mm)	26-34	26-34	16-45

+: Present; -: Absent

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2.2. Gravid proglottid

Mature proglottid of tapeworms are similar, but there are some differences in gravid proglottid among tapeworms. Uterus, posterior protuberance, length, and width are features to distinguish types of tapeworms. The number of branches in uterus of TAS, TSO and TSA are from small to large. Posterior protuberance only appears in TSO. According to Table 1, for the gravid proglottid, TSA are longest, TAS are in the middle and TSO are shortest.

2.3. Cysticerci and eggs

Cysticerci, a visible oval bladder, which are matured from gravid proglottids, have different sizes. Generally, according to table 1, the size of Cysticerci of TSO and TSA are similar, ranging from 6-11mm. However, the size of Cysticerci of TAS only have 0.4-3.5mm, which is much smaller than the other. In addition, the size of larvae of TSA and TSO are much larger than TAS [1].

3. Life cycle

Life cycles of TSA, TSO and TAS have similar. First, their eggs are in the environment and infect animals, like cattle and pigs (Figure 1). Then, cysticerci attach to the intestinal wall after human eating infected meat. After maturation, cysticerci migrate around human body by the blood. Lastly, they lay eggs and eggs actively migrate out of human body.

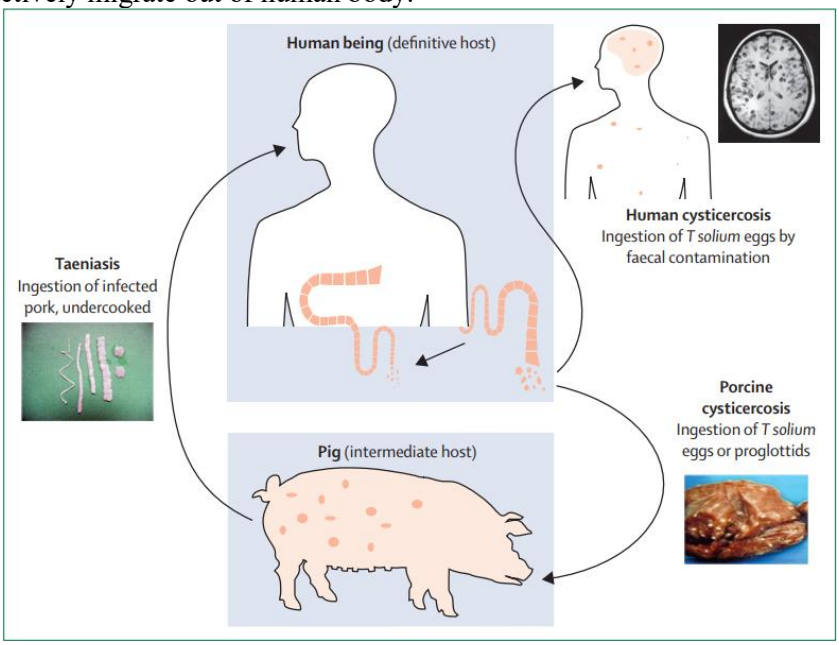


Figure 1. Life cycle of Taenia solium [2].

Although there are a lot of similarities among three tapeworms in the life cycle, the intermediate hosts and migration of tapeworms are different. The eggs of TSO and TSA infect muscle, and respectively choose pigs and cattle as their intermediate hosts and develop into Cysticerci. However, the eggs of TAS infect liver instead of muscle, and always choose pigs' liver to develop. By using hooks, TSO and TAS can attach to the mucosa of duodenum-jejunum in human body. However, because of lacking hooks, TSA cannot attach on intestine and migrate around the human body then out of body by anus. Moreover, Cysticerci of TSO and TAS can cross the blood-brain barrier, while TSA cannot. Therefore, Cysticerci of TAS and TSO can migrate to brain or eyes then lodge in central nervous system (CNS) [2].

4. Symptoms

Tapeworm infection cause a lot of disease, such as nausea, weakness, abdominal pain, and diarrhea. When cysticerci are still alive, it hardly causes inflammation by suppressing or evading the immunity.

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However, lymphocytes, eosinophils, plasma cells, and macrophages make an inflammatory response to degrading or died cyst [1]. Neurocysticercosis (NCC) are the one of the most typical one and the inhibition of immune system may be ignored by human being.

4.1. Neurocysticercosis (NCC)

One of the most special symptoms caused by TSO is neurocysticercosis (NCC). NCC also happened after TAS infection, because cysticerci of TAS can cross the blood-brain carrier, but cysticerci of TSA cannot [1]. Although TAS can cause NCC, but there are few reports about it. Cysticerci of TSO, developing in central nervous system, active immune cells and inflammatory proteins, cause inflammation, impede the cerebrospinal fluid's natural flow and cause fluid accumulation in the brain (Figure 2) [3]. Seizures and edema are the main symptoms of NCC. Although it is not frequently happened, NCC cause cysticercotic encephalitis, especially for young women [4]. It causes intracranial hypertension, due to hydrocephalus [5].

In addition, NCC also cause solitary cysticercus granuloma growth, which are the main reason why patients with NCC have epilepsy. As soon as a cysticercal cyst lodges in the parenchyma of the brain, degradation begins. A few weeks to several years may pass throughout the deteriorating process. In this stage, alive cysticercal cyst transfer into died calcified cyst [6]. Alive cyst is generally asymptomatic, seldom evoke host immune system response. The immune system, on the other hand, responds to the parasite antigen that killed the cyst by triggering an inflammatory response, and driving to a result that results in the formation of the granuloma around the cyst. Granuloma results in hydrocephalus or abnormal enhancement of the leptomeninges, which can lead to epilepsy [1]. In addition, it also results in edema. Given the reputation of the blood-brain barrier, it is hypothesized that edema is brought on by an inflammatory reaction produced by the calcified cyst itself [7].

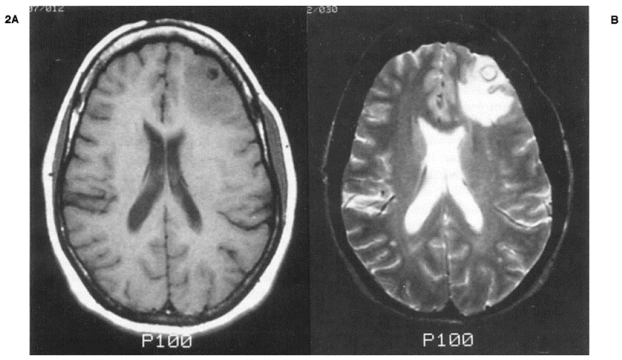


Figure 2. A woman with epilepsy showed a cystic lesion with an eccentric nodule and surrounding edema [8].

4.2. Human immune system inhibition

Cysticerci-produced proteases have the ability to degrade immunoglobulins and interfere cytokine production and growth of lymphocyte[5]. Major host proteins in Taenia cysticercus fluid are albumin and immunoglobulin, which are the major components of serum [5]. In the acidic condition, IgG and hemoglobin in human body are cleaved by the enzyme in Cysticerci. Another enzyme produced by Cysticerci, called Taeniastatin, also inhibit proteinase work. Taeniastatin inhibit C5a-mediated chemotaxis and suppress neutrophil chemotaxis and aggregation [9]. In addition, a protein called annexin B1 are produced by cysticercosis in the early stage. Annexin B1 can bond to eosinophils, and let Ca2+ flow into eosinophils, resulting in apoptosis. It is also shown that it can affect human peripheral blood neutrophils in a proapoptotic way. All the protease inhibitors are mostly produced by TSO, and seldom report showed that TSA and TAS can produced these protease inhibitors.

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5. Diagnosis

5.1. Microscopical examination

It is a traditional way, but the sensibility is not strong. It is very un-likely to distinguish TSA and TSO by observing the larvae of them since their eggs are identical. Unless proglottids are eliminated [10].

5.2. PCR (molecular approaches)

The mitochondrial DNA of TAS, TSA and TSO have been elucidated and can be used for differential diagnosis, molecular characterization and epidemiological investigation using PCR [11].

Estimating 3 kinds of Taenia tapeworm mtDNAs by comparing the differences of predicted amino acids and nucleotide sequence. In terms of the protein-coding sequences, TSO are 4.6% different in 12 protein-coding genes across the entire mtDNA sequence compared to TAS and TSA. Individual differences still exist. The percentage of nucleotide pairwise divergences among human Taenia tapeworms is between 3.0% and 27.9%. The average pairwise similarity of the protein-coding genes between TAS and TSA was nearly 95%. The genes that encode the three cytochrome c oxidase subunits, cytochrome b, 16S rRNA, and tRNAs showed a higher level of conservation. All of TAS's rRNA genes were 5% and 12% respectively different from those of TSA and TSO.

5.3. Antibody test

It is a sensitive and specific way to test and identify the adult tapeworm-specific circulation antibodies in tapeworm carriers by using immunoblot or ELSA. The predictive value of the assay will dramatically decline if the circulating antibodies last for long periods of time after the tapeworm has perished [12].

6. Treatment

Treatment includes common treatments such as the deworming medicine, operations and other methods like cooling and blood transfusion.

The effects and advantages and disadvantages of related deworming medicine are as follows. Praziquantel is very effective. It is widely used in the treatment for taeniasis. There is a possibility, however, of inducing seizures or convulsions in asymptomatic concurrent carriers. Thus, it is used less in the treatment for cysticercosis. Contrarily, clonidine currently is not accessible in many endemic nations, despite its safety and efficiency. Besides, areca nut extract combined with pumpkin seeds is a nice way to treat patients. Treating patients with pumpkin seeds and betel nut extract can significantly reduce the time to complete tapeworm elimination compared with treating patient with pumpkin seeds only (Figure 3). It is shown that it would be able to help the host to expel the paralytic tapeworm to some extent by drinking moderate amounts of magnesium sulfate solution and a large quantity of water since doing so can improve intestinal peristalsis. This is much more relatively accessible [13].

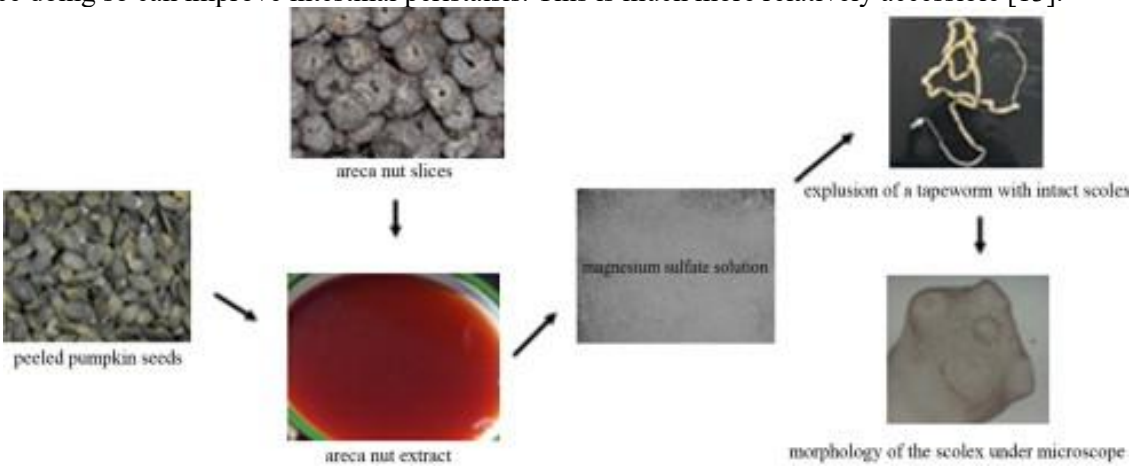


Figure 3. Pumpkin seeds combined with areca nut extract [13].

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The treatment differences are as followed. The treatment for the TSO focuses on the cysticercosis and the neurocysticercosis. It usually uses the pumpkinseed, salicylamide, praziquantel, niclosamid with magnesium sulfate given later, followed by a saline purgative [14]. For the TSA, the different places in treatment aim more in the complications. After the related operation, such as the anti-infective therapy. And there also some new ways to treat like nitazoxanide, intraduodenal 'Gastrografin' injection [15, 16]. Moreover, the treatment for the TAS is quite simple and easy to understand since praziquantel is one choice of medication [17].

7. Conclusion

It is very meaningful for the public to know the basic information of tapeworm. Because tapeworm infection has a very bad effect on people's healthy life and the normal production of the breeding industry. By collecting the existing data on research paper and database, this article summarized the three kinds of tapeworms and gives detailed information, including the regional distribution of the three kinds of tapeworms (T. solium, T. asiatica, T. saginata), the diseases caused by the infection, their respective structural characteristics, including similarities and differences, life cycle, and the diagnosis and treatment methods after infection. Among symptoms, the NCC caused by T. solium is the most serious and fatal. For how to judge whether the patient is infected, there are measures like antibody detection, collaborative examination and PCR. PCR can give the DNA sequence of tapeworm and therefore predict amino acid composition of tapeworm. In addition, for drug selection and treatment, this essay introduces different drug treatments for different tapeworms, as well as some methods in traditional Chinese medicine. This paper hopes to get a deeper understanding of tapeworm through the above introduction, so as to promote the prevention and control of tapeworms.

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