Parasitology

Blood flukes (Schistosomes)

There are five main species of schistosomes infect human:

1- **S. haematobium**: occurs primarily in the Old World. Nearly all of Africa and portion of Middle East, including Iraq, Saudi Arabia, and Iran which considered as endemic regions.

2- **S. mansoni**: in Africa esp. Egypt, Sudan and Libya, Arabian Peninsula, and Central and South America.

3- **S. japonicum**: is limited to the Far East (China, Indonesia, and Philippines).

4- **S. intercalatum**

5- **S. mekongi**

*S. haematobium, S. mansoni* and *S. japonicum* are the major species that infect human beings. *S. intercalatum* and *S. mekongi* are less common.

**General features of schistosomes from other trematodes**

1-have separated sexes (diecious).

2-adults live in blood vascular system.

3-adult digestive system has no muscular pharynx, but characterized by formation of single intestinal canal by the union of bifurcated intestinal caeca.

4-production of non-operculated eggs (eggs with spine).

5-no redia formation.

6-have forked tailed cercariae (infective stage to man).
7-no metacercariae formation.
8-infect human by penetration of unbroken skin by cercariae.

**Morphology**

Adult worms are elongated and resemble roundworms, apparently as an adaptation to living in blood vessels. The male worm is long and has a cylindrical appearance but it is actually flattened behind the ventral sucker, because it is incurved ventrally to form a gynaecophoric canal in which the longer and more slender female rests and projecting free at each end, but enclosed in the middle.

Both male and female worms are provided with oral and ventral suckers; in the males the ventral sucker is large and powerful. The digestive tract has no pharynx, and the esophagus forks just anterior to the ventral sucker, but the forks reunite in the middle portion of the body to continue as a single tube. The male worm has several testes just behind the ventral sucker. The female has an elongated ovary situated in the fork where the intestinal caeca rejoin. Anterior to the ovary is a straight uterus contains a small number of eggs. Schistosomes live for many years in human.

<table>
<thead>
<tr>
<th></th>
<th><strong>S. haematobium</strong></th>
<th><strong>S. mansoni</strong></th>
<th><strong>S. japonicum</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Adult</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Habitat</strong></td>
<td>vesicle plexus</td>
<td>inf. mesenteric vein</td>
<td>sup. mesenteric vein</td>
</tr>
<tr>
<td></td>
<td>(veins of bladder)</td>
<td>(veins of large intestine)</td>
<td>(veins of small intestine)</td>
</tr>
<tr>
<td>*<em>Size</em>: male</td>
<td>10-14 × 0.9mm</td>
<td>6-12 × 1.1mm</td>
<td>10-20 × 0.5mm</td>
</tr>
<tr>
<td></td>
<td>female 16-20 × 0.</td>
<td>10-20 × 0.16mm</td>
<td>20-30 × 0.3mm</td>
</tr>
<tr>
<td><strong>Integument</strong></td>
<td>with fine tuberculation</td>
<td>with coarse tuberculation</td>
<td>smooth (no tuberculation)</td>
</tr>
<tr>
<td>*<em>Caeca</em></td>
<td>reunite late</td>
<td>reunite early</td>
<td>reunite very late</td>
</tr>
</tbody>
</table>
(united intestine)* short long very short
-Size, arrangement 4-5 6-9 (7) 6-8 (7)
and No. of testes Small small, clustered large , linear
-Position of ovary post. 1/2 ant. 1/2 middle
-Uterus* long with 10-50 short with 1-4 long with 50-200
Ova ova ova

Egg
-Shape oval with terminal oval with lateral round with short
spine spine lateral spine
-Size (µ)* 150 × 62 140 × 61 85 × 60
-Mode of voiding Urine feces feces
-React. to Ziehl Neelsen stain* negative positive positive
Snail (I. H) Bulinus truncatus Biomphalaria Oncomelania

Schistosomas in copula

ملاحظة: علامة * في الجدول تعني للإطلاع فقط
Morphology of both male and female of Scistosoma haematobium, S. mansoni and S. japonicum
Life cycle

Schistosomes have indirect life cycle which involves 2 hosts, the definitive (vertebrate) and the intermediate (invertebrate – snail-). Schistosome eggs are passed in urine (S. haematobium) or feces (S. mansoni and S. japonicum) and contain a fully mature miracidium (1st larval stage). Eggs hatch by rupture if liberated into fresh water. The miracidium that escape swims by cilia in search of an appropriate snail host. If successful, it penetrates the snail. In a susceptible snail, the miracidium loses its outer ciliated epidermal layer and develops into a mother sporocyst (2nd larval stage), then this sporocyst burst out and give rise to many daughter sporocysts (3rd larval stage), then each daughter sporocyst filled with the final larval stages, the cercariae. Thus one miracidium can give rise to thousands of cercariae, all of the same sex.

The cercariae begin to emerge from snail few (4-7) weeks after the snail infection, and they can survive in fresh water for almost 74 hours. When man enters the water, infection takes place by direct penetration of the cercariae through the skin of man, often between the hair follicles, by means of 1-the anterior spines and 2-the cytolytic secretion of the cephalic glands. The tail is shed in the penetration process and immature schistosomes (schistosomula) remain in the subcutaneous tissues for about 2 days then enter peripheral lymphatics or venous vessels. These are carried to the lung and from the lung to the portal vessels (liver
sinusoid) where they begin their growth into adult schistosomes (maturation in the liver sinusoid takes about 6 weeks) which mate and remain in pairs. Two weeks or longer after maturation to adults, the maturing worms commence a migration against the flow of the blood in the portal system to their final location in mesenteric veins (S. mansoni and S. japonicum) or vesicular veins (S. haematobium). Eggs of (S. mansoni and S. japonicum) appear in the stools 25-28 days after the penetration of cercariae and those of S. haematobium in the urine after 54-84 days. The lifespan of the adult worm ranges from 5 to 10 years.

Life cycle of Schistosoma Species
Epidemiology

-The disease (contact with fresh water)
1-Higher in rural area (agricultural population).
2-Sex: more in males than in females (occupational hazard).
3-More common in lower socio-economic communities (bathing and washing clothes).
4-Infection may last years.

-The reservoir host
1-S. haematobium: humans are the only important host.
2-S. mansoni: humans are apparently the only important host, but rodents may carry infection in some areas.
3-S. japonicum: many domestic animals (cats, dogs, cattles, horses and pigs) as well as some wild animals.

-The intermediate host
1-S. haematobium and S. mansoni: aquatic snails
2- S. japonicum: amphibious (semiaquatic) snails.

Control and prevention of schistosomiasis

1-Education of people in endemic areas.
2- Proper disposal of urine and feces.
3- Snail control (chemical and biological eradication).
4- Treatment of infected persons.

It is difficult to control schistosomiasis because:

1- The intermediate host (snail) is difficult to kill by any chemical or biological agents.
2- In some species (S. japonicum), the snails are amphibious (semiaquatic). So, eradication of snails from water is virtually useless.
3- Some species (S. japonicum) have wide range of reservoir hosts (domestic and wild). So, treatment of human cases is virtually useless.

The easiest one to control is S. haematobium because:
1- Snails are aquatic.
2- Lack of reservoir hosts.

**Pathogenesis and clinical features**

The pathogenesis of human schistosomiasis is mainly related to egg deposition and liberation of antigens of adult worms and eggs.

The body structure of the schistosomes seems clearly an adaptation to an intravascular existence. The females leave the male worms to deposit their eggs in small venules close to the lumen of the intestine or bladder. The worms dilate the vessels when they penetrate it for oviposition and withdraw as the eggs are laid, so that the eggs are wedged firmly into the small vessels. Sharp spines on the eggs of *S. mansoni* and *S. haematobium* probably assist in the retention in the blood vessels. An enzyme elaborated by the miracidium diffuses through the egg shell and helps to digest the overlying tissue. The action of this enzyme, together with necrosis of the tissue caused by pressure and the effect of the spine, works to liberate the egg from the tissues into the lumen of the intestine or bladder. Infected persons with schistosomes may be asymptomatic or may manifest a spectrum of disease condition.

**-Clinical manifestations of schistosomiasis:** are divided into schistosome dermatitis, acute schistosomiasis, and chronic schistosomiasis.

**-Schistosome dermatitis (swimmer’s itch)**

Many schistosome cercariae that ordinary infect birds and semiaquatics mammals are capable of penetration into human skin but not of producing a permanent infection. Fresh-water lakes as well as some marine beaches are plagued by the presence of cercariae of the blood flukes of aquatic birds, which cause dermatitis known as swimmer’s itch. Schistosome dermatitis or swimmer's itch is seen mainly when avian cercariae penetrate the skin and are destroyed. This manifestation is not common and milder in human schistosomiasis. Schistosome dermatitis is a sensitization phenomenon, because it occurs in previously exposed persons. The cercariae are destroyed in the epithelial layers of the skin. They
evoke an acute inflammatory response with edema, early infiltration of neutrophils and lymphocytes, and later invasion of eosinophils. A pruritic papular rash occurs within 24 hours after penetration of cercariae, reaching maximal intensity in 2 to 3 days.

-Acute schistosomiasis, or Katayama fever

Acute schistosomiasis, or Katayama fever occurs with the beginning of oviposition, usually 20 to 50 days after primary exposure and infection with *S. mansoni* and *S. japonicum*. It rarely follows infection with *S.haematobium*. Although asymptomatic in endemic areas, acute schistosomiasis is becoming a frequent and major clinical problem in nonimmune individuals from urban regions who are exposed for the first time to a heavy infection in an endemic area. This febrile condition is thought to be a hypersensitivity reaction to schistosomal antigens. Patients complain of a flu like illness with fatigue, headache, arthralgia and night sweats, sometimes with hepatosplenomegaly, cough, dyspnea and chest pain. Acute schistosomiasis is a self-limiting condition and most symptoms resolve without any treatment within 4-6 weeks. Acute disease is more frequently observed in individuals living outside the endemic areas of schistosomiasis, because modulation of the immune response by antigens or idiotypes transferred from mother to child decreases the frequency of this manifestation in subjects living in endemic areas.