



Research Article

DETAILED MICROSCOPIC STUDY OF THE MORPHOLOGY OF THE REPRODUCTIVE TRACT OF THE MALE NECATOR AMERICANUS (HOOKWORM) BY RETRIEVING OUT THE HOOKWORM WHILE DOING UPPER GASTRO-INTESTINAL ENDOSCOPY

Govindarajalu Ganesan

Department of General surgery, Indira Gandhi Medical College and Research Institute, Puducherry-605009

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ABSTRACT

Objective: To do detailed microscopic study of the morphology of the reproductive tract of the male *Necator americanus* (hookworm) by retrieving out while doing upper gastro-intestinal endoscopy. **Methods:** All patients who had undergone upper gastro-intestinal endoscopy for a period of 2 years (2017 and 2018) were examined for the presence of parasitic worms. **Results:** Out of these patients who had undergone upper gastro-intestinal endoscopy, 20 patients were found to have hookworms in duodenum. The head end and mouth of the hookworm is bent into a curved shape giving it a hook like appearance and hence it is identified as hookworm. **Conclusion:** Hence upper gastro-intestinal endoscopy is a very useful investigation to diagnose hookworm infection.

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INTRODUCTION

Hookworms are the most common parasitic nematodes found in the duodenum of human beings while doing upper gastro-intestinal endoscopy (1to 10).

MATERIALS AND METHODS

This study was conducted in the department of general surgery, Indira Gandhi Medical College and Research Institute, Puducherry. All patients who had undergone upper gastro-intestinal endoscopy for a period of 2 years (2017 and 2018) were examined for the presence of parasitic worms.

RESULTS

Out of these patients who had undergone upper gastro-intestinal endoscopy, 20 patients were found to have hookworms in duodenum. The parasitic worm found in one of these patients was retrieved out using biopsy forceps and immediately sent for microbiological examination to do detailed microscopic study of the morphology of the parasitic worm.

1. The parasitic worm retrieved out using biopsy forceps has a bent head which looks like a hook. Hence the parasitic worm found in this patient was identified as hookworm.
2. The mouth or the buccal cavity of the parasitic worm (hookworm) retrieved out using biopsy forceps has no teeth on the free edge, but has two cutting- plates. *Necator americanus* is distinguished from *Ancylostoma duodenale* by its cutting plates at the buccal cavity

compared with *Ancylostoma duodenale* cutting teeth at the buccal cavity.

3. So the parasitic worm found in this patient was identified as *Necator americanus*.
4. The tail of the parasitic worm found in this patient (hookworm) is broad and expanded due to the presence of broad copulatory bursa. The tail of the male hookworm is broad and expanded due to the presence of broad copulatory bursa. But the tail of the female hookworm is narrow and pointed due to the absence of the copulatory bursa.

So the parasitic worm found in this patient was identified as male hookworm (male *Necator americanus*).

A detailed microscopic study of morphology of adult human-specific hook worms retrieved by doing upper gastro-intestinal endoscopy helps us to differentiate between *Ancylostoma duodenale* and *Necator americanus* which is important since *Ancylostoma duodenale* causes more blood loss than *Necator americanus*. The differentiation between *Ancylostoma duodenale* and *Necator americanus* is not possible by stool examination since only the ova or eggs or rarely the larva of the parasitic worms are seen in stool examination.

DISCUSSION

Necator americanus

The head end and mouth of the hookworm is bent into a curved shape giving it a hook like appearance (Fig. 1). The head of *Necator americanus* is curved and forms a definite "hook" at the anterior end. *Necator americanus* (hookworm) is so named

*Corresponding author: Govindarajalu Ganesan

Department of General surgery, Indira Gandhi Medical College and Research Institute, Puducherry. 605009.

because it has a hooked curved anterior end (Fig.1). The mouth is situated at the anterior end of the hookworm. The mouth region of *Necator americanus* is provided with two cutting plates (Fig. 1) for attaching and lacerating the gut wall of the human host.

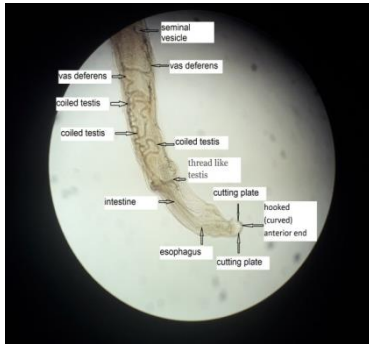


Fig 1 Showing hooked curved anterior end, mouth region with two cutting plates, esophagus, intestine, tubular thread like coiled testis starting near the anterior end of the intestine, vas deferens and elliptical seminal vesicle

The alimentary canal of *Necator americanus* consists of a mouth with cutting plates (Fig. 1), esophagus (Fig. 1), intestine (Fig. 1) and in the male the terminal portion of the intestine along with the ejaculatory duct opens into the cloaca.

Reproductive Organs of male Necator americanus

The male reproductive system of *Necator americanus* has a single continuous tubular thread like coiled testis (Fig.1) starting as a fine tubule near the anterior end of the intestine (Fig. 1) and coiling back and forth along the intestine in the middle of the body. The thread-like testis leads posteriorly and merges into a vas deferens (Fig. 1) or sperm duct. The vas deferens leads to an elongated, swollen, sac-like elliptical seminal vesicle (Fig.1, 3).



Fig 2 Showing tubular coiled testis (magnified view)

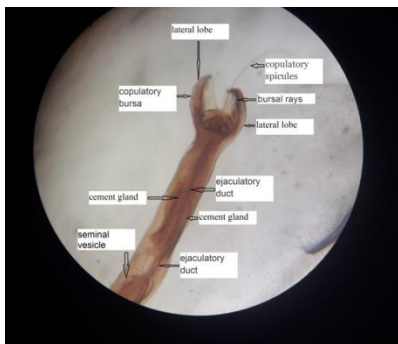


Fig 3 Showing swollen, sac-like seminal vesicle, ejaculatory duct surrounded by the cement gland, copulatory bursa with two lateral lobes, bursal rays and copulatory spicules

The posterior end of seminal vesicle (Fig.3) tapers into the ejaculatory duct (Fig.3). The ejaculatory duct is surrounded by

the cement gland (Fig.3). The ejaculatory duct along with terminal portion of the intestine opens into the cloaca which receives the secretion of cement gland. The secretion of cement gland serves to fasten the male to the female during copulation.

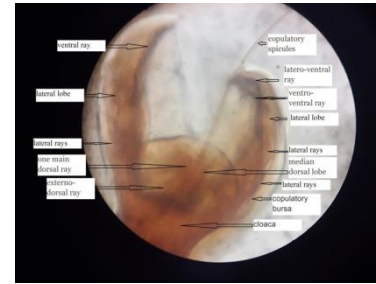


Fig 4 Showing cloaca, broad and expanded copulatory bursa with two broad lateral lobes with an external-dorsal ray, lateral and ventral rays in each lateral lobe and a small median dorsal lobe with one main dorsal ray and copulatory spicules

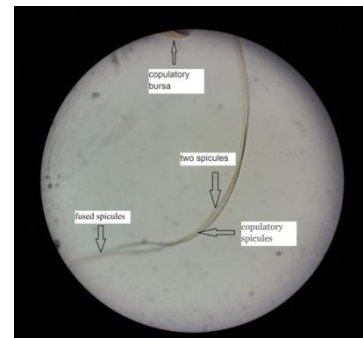


Fig 5 showing two long slender copulatory spicules which are fused distally

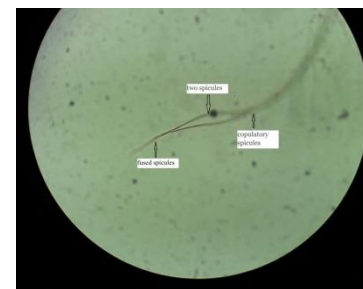


Fig 6 showing two long slender copulatory spicules which are fused distally

The posterior end of the male hookworm (*Necator americanus*) is expanded like an umbrella. This expanded structure at its caudal end is called copulatory bursa (Fig 4) which surrounds the cloaca (Fig 4). All male hookworms (*Necator americanus*) have a pronounced posterior copulatory bursa (Fig 3, 4), consisting of two broad lateral lobes (Fig 3, 4) and a smaller dorsal lobe (Fig 4), all supported by fleshy rays. The copulatory bursa is an umbrella-like expansion of cuticular folds, supported by extensions of the muscular body wall, called as bursal rays (Fig.3). The copulatory bursa (copulatory clamping organ) is used to catch and hold the female *Necator americanus* during mating.

From the cloaca two long delicate slender spicules (Fig.5, 6) extend. They are one millimeter long. Muscles attached to the spicules cause the spicules to protrude from the cloaca. The two protrusible copulatory spicules (Fig. 5, 6) serve as organs of attachment and to dilate the vulva of the female during copulation, directing the sperm into the vagina. The males of *Necator americanus* are characterized by copulatory bursa, which is provided with two long spicules fused distally

(Fig.5,6). Two separate spicules unite (Fig.5,6) to form a single terminal 'fish-hook' barb.

The copulatory bursa has two lateral lobes (Fig 4) with six muscular rays in each, and a small median dorsal lobe (Fig 4) with one main dorsal ray (Fig 4) which is divided only at the tip. The dorsal ray of *Necator americanus* is divided at the distal end into two branches (bidigitate) (Fig 4) (dorsal ray divide into three unequal portions and tridigitate in *Ancylostoma duodenale*). *Necator americanus* adults are distinguished from *Ancylostoma duodenale* by the structure of the dorsal ray and close arrangement of the lateral rays. It can often be used in identifying hookworm species.

The arrangement of rays is remarkably constant and each ray is given a name, the main ray in the dorsal lobe is called a dorsal ray (Fig 4), in each lateral lobe (Fig 4) beginning from the dorsal side the six rays are called externo-dorsal (Fig 4), postero-lateral, medio-lateral, externo-lateral (lateral rays) (Fig 4), latero-ventral ray (Fig 4), ventro-ventral ray (Fig 4). Hence the copulatory bursa is supported by 13 rays. The copulatory bursa and its muscular rays enable the male in sexual contact to grasp firmly the body of the female and properly coapt the sexual parts.

Copulation and Fertilization

Male hookworms (*Necator americanus*) are required to find female hookworms (*Necator americanus*) and inject their sperm into the female's vagina. Female hookworms may produce a pheromone to attract male hookworms. During copulation the male hookworms (*Necator americanus*) coils its posterior end around the female hookworms (*Necator americanus*) in the region of the female genital pore (vulva). In male hookworms there are two copulatory spicules (Fig. 5,6), which are situated immediately in front of the cloaca (Fig 4). Male hookworms use spicules to hold open the genital opening (vulva) on the female hookworms to allow transfer of sperm into the vagina. Sperms are amoeboid-like and lack flagella or cilia. Copulation occurs in the intestine of the human host. The fertilized female hookworms then lay eggs.

Egg Laying

The female hookworms (*Necator americanus*) lays eggs in the intestine of the human host which pass out with faeces. Female *Necator americanus* is capable of producing 3000-6000 eggs per day.

CONCLUSION

1. The head end (anterior end) and mouth of the hookworm is curved giving it a hook like appearance. *Necator americanus* (hookworm) is so named because it has a hooked curved anterior end. The mouth region of *Necator americanus* is provided with two cutting plates for attaching and lacerating the gut wall of the human host.
2. The male reproductive system of *Necator americanus* has a single continuous tubular thread like coiled testis starting as a fine tubule near the anterior end of the intestine and coiling back and forth along the intestine in the middle of the body.
3. The thread-like testis leads posteriorly into a vas deferens. The vas deferens leads to an elliptical, swollen seminal vesicle. The seminal vesicle tapers into the

ejaculatory duct. The ejaculatory duct is surrounded by the cement gland. The ejaculatory duct along with terminal portion of the intestine opens into the cloaca.

4. The posterior end of the male *Necator americanus* (hookworm) is broad and expanded due to the presence of broad copulatory bursa. The copulatory bursa consists of two broad lateral lobes with six muscular rays in each and small median dorsal lobe with one main dorsal ray. The copulatory bursa (copulatory clasping organ) is used to catch and hold the female *Necator americanus* during mating.
5. In male *Necator americanus* two copulatory spicules extend from the cloaca. They serve as organs of attachment and to dilate the vulva of the female during copulation, directing the sperm into the vagina. They are one millimeter long. Muscles attached to the spicules cause the spicules to protrude from the cloaca.
6. The males of *Necator americanus* are provided with two long slender spicules which are fused distally. Two separate spicules unite to form a single terminal 'fish-hook' barb.

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