



Research Article

## DIFFERENTIATION BETWEEN ANCYLOSTOMA DUODENALE AND NECATOR AMERICANUS BY DOING DETAILED MICROSCOPIC STUDY OF HEAD AND MOUTH REGION OF THESE HOOKWORMS

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### ABSTRACT

**Objective:** To differentiate between Ancylostoma duodenale and Necator americanus by doing detailed microscopic study of head and mouth of these hookworms. **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 curved like a hook and hence it is identified as hookworm. **Conclusion:** The eggs of Necator americanus seen in stool examination are 60 to 70µm in length and are virtually indistinguishable from those of Ancylostoma duodenale. Hence detailed microscopic study of head and mouth of these hookworms retrieved out using biopsy forceps while doing upper gastro-intestinal endoscopy can only differentiate between Ancylostoma duodenale and Necator americanus.

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### INTRODUCTION

There are two human-specific hookworms, namely Ancylostoma duodenale and Necator americanus. Hookworm is a common cause of occult gastrointestinal bleeding and anemia especially in the tropical countries. (1 to 13). The degree of anemia depends on hookworm burden and the species, because Ancylostoma duodenale causes more blood loss than Necator americanus.

### MATERIALS AND METHODS

This study was conducted in the department of general surgery, Indira Gandhi Medical College and Research Institute, Pondicherry. 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 curved like a hook and hence it is identified as hookworm. The hookworms found in 6 of these patients were retrieved out using biopsy forceps and immediately sent for microbiological examination to do detailed microscopic study of the head and mouth of these hookworms in order to

differentiate between Ancylostoma duodenale and Necator americanus

1. Out of these 6 patients with hookworms, 4 patients were identified as having Necator americanus since head and mouth of these hookworms have no teeth on the free edge, but have two ventral semilunar cutting plates.
2. Out of these 6 patients with hookworms, 2 patients were identified as having Ancylostoma duodenale since head and mouth of these hookworms have two pairs of sharp-pointed, curved, hook-shaped ventral teeth.
3. Out of these 6 patients with hookworms, 4 patients were identified as having Necator americanus since head and mouth of these hookworms is sharply curved like a hook and is bent dorsally. Necator americanus is identified by the sharp curve at the head and the dorsal bend at the head end.
4. Out of these 6 patients with hookworms, 2 patients were identified as having Ancylostoma duodenale since the sharp curve at the head and the dorsal bend at the head end is not very pronounced as in Necator americanus.

### DISCUSSION

Out of the 6 patients with hookworms retrieved out using biopsy forceps while doing upper gastro-intestinal

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endoscopy, 4 patients were identified as having *Necator americanus* (Fig. 1 to 4) and 2 patients were identified as having *Ancylostoma duodenale* (Fig. 5, 6) by doing detailed microscopic study of head and mouth of these hookworms.

*Ancylostoma duodenale*, the Old World hook worm is a very common nematode parasite in the small intestine of man. Until recently this hookworm is ranked as the most important helminthic infection of man, but it has been brought under control in many countries. *Necator americanus*, the "new world hookworm," is a smaller species than *Ancylostoma duodenale* and is found throughout much of the world.

The average life span of female *Ancylostoma duodenale* is about one year, during which it lays 10,000-20,000 eggs per day during its adult life. The adult *Necator americanus* can live up to 5 years. Female *Necator americanus* is capable of producing 3000-6000 eggs per day.

Differentiation between *Ancylostoma duodenale* and *Necator americanus* is important since *Ancylostoma duodenale* causes more blood loss than *Necator americanus*. *Necator americanus* is a shorter and more slender worm than *Ancylostoma duodenale*. The sudden dorsal bend of the head in *Necator americanus* (Fig. 1) is more distinctive than in *Ancylostoma duodenale*. *Necator americanus* sucks less blood than *Ancylostoma duodenale*. A single *Necator americanus* will take approximately 30 µl of blood daily, while the larger *Ancylostoma duodenale* will take up to 260 µl daily. *Ancylostoma duodenale* females measure 10-13 x 0.6mm, while males measure 8-11 x 0.4mm. The adults of *Necator americanus* are smaller compared with than *Ancylostoma duodenale*. *Necator americanus* ranges from 10 to 12 mm in length for females and 6 to 8 mm for males.

*Necator americanus* is distinguished from its slightly larger *Ancylostoma duodenale* by its semilunar ventral cutting plates (Fig. 2 to 4) at the buccal cavity or mouth compared with *Ancylostoma duodenale*'s two pairs of ventral cutting teeth (Fig. 6) at the buccal cavity or mouth. Ventral surface of *Ancylostoma duodenale* has recurved hook-shaped buccal teeth (Fig. 6). The head is curved and is dorsally bent in both *Ancylostoma duodenale* and *Necator americanus* species but in *Necator americanus* adults it is finer but more pronounced forming a definite "hook" (Fig 1) at the anterior end.



**Fig 1:** showing *Necator americanus* with sharply curved hook like head end, sudden dorsal bend of the head, buccal capsule, buccal cavity and muscular esophagus

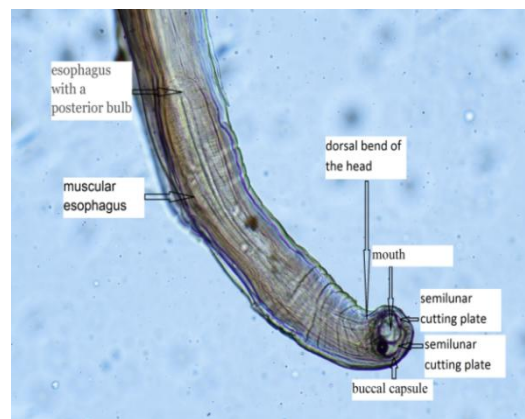
The head end and mouth of the *Necator americanus* is sharply curved giving it a hook like appearance (Fig. 1). The common

name "hookworm" comes from the dorsal bend at the head end (Fig. 2 to 4). The sudden dorsal bend of the head (Fig. 1) is distinctive in *Necator americanus*. The head end (anterior end) is characteristically curved in a direction opposite from that of the rest of the body. Ventral surface of the anterior end grows more rapidly than the dorsal surface, so that the oral end is bent backward like a "hook" (Fig 1) and the mouth thus occupies a dorsal position.



**Fig 2:** showing *Necator americanus* with dorsal bend of the head, buccal capsule, buccal cavity with two semilunar ventral cutting plates and two dorsal conical cutting plates and muscular esophagus

The anterior end or the head of the hookworm has a buccal capsule in the buccal cavity (Fig 2, 4) or mouth (Fig 3, 5). The buccal capsule in the mouth of *Necator americanus* has four cutting plates, two on the ventral and two on the dorsal surfaces. The dorsal portion of the buccal capsule is shorter than the ventral and is supported by two dorsal conical cutting plates in *Necator americanus* (Fig 2, 4). On the ventral side of the buccal capsule, just within the buccal cavity or mouth, are two cutting plates or two pairs of sharp teeth (Fig. 5). Hookworm species are mainly differentiated by their buccal capsule. There are no teeth on the free edge, but the buccal capsule covers two semilunar ventral cutting plates in *Necator americanus*. (Fig. 2 to 4). On the ventral side of the buccal capsule, just within the buccal cavity or mouth, are two pairs of sharp-pointed, curved, hook-shaped ventral teeth (Fig. 5, 6) in *Ancylostoma duodenale*. The dorsal portion of the buccal capsule has two dorsal teeth in *Ancylostoma duodenale* (Fig. 6).



**Fig 3:** showing *Necator americanus* with dorsal bend of the head, buccal capsule, mouth with two semilunar cutting plates and muscular esophagus

Adult hook-worms of *Ancylostoma duodenale* and *Necator americanus* have abuccal capsule with specialized structures to aid in feeding. *Ancylostoma duodenale* has fused ventral teeth (Fig. 6) and *Necator americanus* has two semilunar ventral cutting plates (Fig.2to 4) which are specialized structures to aid in feeding.

Adult hook-worms feed from the blood of the human host. Each *Necator americanus* sucks about 0.03 ml of blood per day while *Ancylostoma duodenale* sucks about 0.26 ml per day. A heavy infestation is dangerous and can produce serious blood loss.



**Fig 4:** showing *Necator americanus* with dorsal bend of the head, buccal capsule, buccal cavity with two semilunar ventral cutting plates and two dorsal conical cutting plates and muscular esophagus

The hookworms are the most dangerous parasitic nematodes because they hold on to the human intestinal villi and suck blood and body fluids of the human host by their muscular esophagus (Fig. 1 to 6), they also cut holes in the human intestinal mucosa and leave bleeding wounds. It causes severe anaemia. In children, where incidence of infection is very great, they retard the physical and mental growth.

**Pathogenicity of *Necator americanus***

The buccal capsule in the mouth or buccal cavity is having two semilunar ventral cutting plates. (Fig.2to 4). *Necator americanus* will attach itself to the human intestinal wall using their buccal capsule in the mouth or buccal cavity and use its cutting plates to cause bleeding. *Necator americanus* feeds from this blood, possibly causing anemia to the human host. *Necator americanus* does not permanently attach itself to the human intestinal wall. This allows movement to new sites for feeding and reproduction within the human host. Previous sites continue to bleed, adding to the host's blood loss.

*Necator americanus* are voracious blood-feeders in the small intestine of humans. In fact, its food consists of intestinal mucous membrane and blood. After feeding it leaves a bleeding wound and moves to another location. Cutting plates in the buccal capsule make small wounds in the human intestinal mucosa and suck up blood and body fluids. *Necator americanus* secrete an anticoagulant preventing blood from clotting, leaving a bleeding wound after feeding. An adult *Necator americanus* worm sucks nearly 0.03 ml of blood per day from the human host causing severe anaemia.

Their preferred site of infestation is in the human upper small intestine, but in very heavy infection (where many thousands

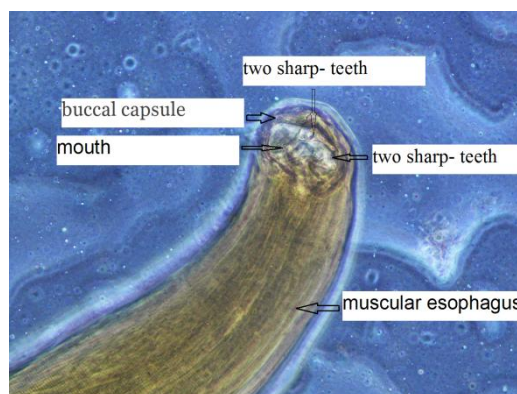
of worms may be present) *Necator americanus* worms may spread down as far as the lower ileum. Blood loss occurs when the *Necator americanus* worms use their cutting apparatus to attach themselves to the human intestinal mucosa and submucosa. This blood loss results in hypochromic, microcytic (iron deficiency) anemia.

**Pathogenicity of *Ancylostoma Duodenale*:**

*Ancylostoma duodenale* is much more injurious than *Necator americanus* to its human host and is harder to expel by means of anthelmintics. Blood loss is higher in *Ancylostoma duodenale* because it is a larger hookworm. It is armed with teeth and it is more migratory, leaving more bleeding points.

The fully grown male *Ancylostoma duodenale* measure about 8-11 mm long and 0.4 to 0.5 mm thick and the female *Ancylostoma duodenale* measure about 10-13 mm long and 0.6 mm thick. The large and conspicuous buccal capsule is lined with a hard substance and is provided with 6 teeth, 4 hook-like on the ventral surface (Fig.6) and 2 knob-like on the dorsal surface (Fig.6). The buccal capsule is provided with two pairs of sharp ventral cutting teeth (Fig.5). *Ancylostoma duodenale* attaches itself and cuts into the intestine of the human host by means of its cutting teeth, and then sucks blood. After feeding it leaves a bleeding wound and moves to another location. An adult *Ancylostoma duodenale* sucks nearly 260 µl of blood in a day from the human host causing severe anaemia.

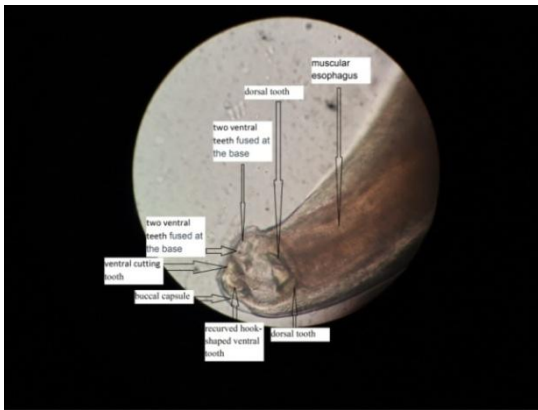
The adult *Ancylostoma duodenale* lives in the small intestine of man, particularly in the jejunum, less often in the duodenum and rarely in the ileum where it sucks blood, lymph, bits of mucous membrane and tissue fluids from the lining of intestinal wall. The adult *Ancylostoma duodenale* worms anchor the wall of the human small intestine by their anterior end. The wounds are afflicted by the sharp ventral teeth (Fig.5, 6) of adult *Ancylostoma duodenale* in the human intestinal wall at the region of attachment. Through these wounds blood comes out and *Ancylostoma duodenale* then sucks the blood by the action of muscular esophagus (Fig.5, 6)).



**Fig 5:** showing *Ancylostoma duodenale* with buccal capsule, mouth with two pairs of sharp teeth and muscular esophagus

Coagulation of the blood is prevented by the production of a secretion from the mouth which has an anticoagulatory property and thus blood is prevented from being coagulated. Both male and female *Ancylostoma duodenale* have two pairs of sharp powerful ventral teeth (Fig.5,6) in the adult forms of the parasite; smaller pair of dorsal teeth are located deeper in the buccal capsule (Fig.6). *Ancylostoma duodenale* worms feed on blood from the walls of the human intestine by

attaching to the intestinal lining via their sharp ventral buccal cavity teeth (Fig.5,6), which they also use to break open small blood vessels so that they can suck the blood from them.



**Fig 6:** showing *Ancylostoma duodenale* with buccal capsule with two ventral teeth fused at the base, ventral cutting tooth, recurved hook-shaped ventral tooth, two dorsal teeth and muscular esophagus

## CONCLUSION

1. *Necator americanus* is a shorter and more slender worm than *Ancylostoma duodenale*. *Necator americanus* ranges from 10 to 12 mm in length for females and 6 to 8 mm for males. *Ancylostoma duodenale* females measure 10-13mm, while males measure 8-11 mm.
2. The sudden dorsal bend of the head in *Necator americanus* is more distinctive than in *Ancylostoma duodenale*. The head is curved and is dorsally bent in both *Ancylostoma duodenale* and *Necator americanus* species but in *Necator americanus* adults it is finer but more pronounced forming a definite "hook" at the anterior end.
3. *Necator americanus* sucks less blood than *Ancylostoma duodenale*. Blood loss is higher in *Ancylostoma duodenale* because it is a larger hookworm. It is armed with teeth and it is more migratory, leaving more bleeding points. Each *Necator americanus* sucks about 0.03 ml of blood per day while *Ancylostoma duodenale* sucks about 0.26 ml per day.
4. The buccal capsule in the mouth of *Necator americanus* has two ventral semilunar cutting plates and two dorsal conical cutting plates. The buccal capsule in the mouth of *Ancylostoma duodenale* has two pairs of sharp-pointed, curved, hook-shaped ventral teeth and two teeth on the dorsal surface.
5. The two large ventral semilunar cutting plates in the mouth of *Necator americanus* and two pairs of sharp ventral teeth in the mouth of *Ancylostoma duodenale* cut into the intestinal lining of humans to suck blood. This leads to blood loss and results in hypochromic, microcytic (iron deficiency) anemia.
6. The average life span of female *Ancylostoma duodenale* is about one year, during which it lays 10,000-20,000 eggs per day during its adult life. The adult *Necator americanus* can live up to 5 years. Female *Necator americanus* is capable of producing 3000-6000 eggs per day.

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