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Severe anemia in severe hookworm infection diagnosed by doing endoscopy in our study compared with other studies

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Abstract

Objective: Severe anemia in patients with severe hookworm infection diagnosed by doing endoscopy in our study was compared with other studies.

Methods: A study of 1100 patients who had undergone upper gastro-intestinal endoscopy for a period of four and half years from May 2009 to October 2013 was carried out. In all the patients found to have hookworms in duodenum, investigations were done to know about the presence of severe anaemia. In patients with severe anaemia [haemoglobin <7g/dl or g%] peripheral smear examination was also done in addition to haemoglobin estimation. But in one patient with severe anaemia, various investigations which indicate iron deficiency anaemia were also done namely serum ferritin and serum iron in addition to haemoglobin estimation, mean corpuscular volume or MCV and peripheral smear examination. The results were found as given below.

Results: Out of these 1100 patients, 14 patients found to have hookworms in duodenum were taken into consideration for our study. Out of these14 patients, 2 patients were found to have severe anaemia [haemoglobin <7g/dl or g%] due to severe hookworm infection. The peripheral smear of both the patients showed severe hypochromic anaemia. In one patient with severe anaemia, haemoglobin and mean corpuscular volume or MCV were very low, peripheral smear examination showed microcytic hypochromic anemia and serum ferritin and serum iron were very low which indicate iron deficiency anaemia.

Conclusion: Thus patients having low hemoglobin, low mean corpuscular volume or MCV and microcytic hypochromic RBCs on peripheral smear along with low serum ferritin and low serum iron were labelled as having iron deficiency anaemia. Hence our patient with low haemoglobin (3.2 g%), low mean corpuscular volume or MCV (50.7femolitres or fl), low serum ferritin (1.4 ng/ ml), low serum iron (20 µg /dL) and microcytic hypochromic RBCs on peripheral smear has iron deficiency anaemia.

Keywords: Low hemoglobin, low mean corpuscular volume, low serum ferritin, low serum iron, iron deficiency anaemia

1. Introduction

Severe anaemia is reported to occur in severe hookworm infection in many studies [1, 17]. Severe anemia in patients with severe hookworm infection diagnosed by doing endoscopy in our study was compared with other studies.

2. Materials and Methods

This study was conducted in the department of general surgery, Aarupadai Veedu Medical College and Hospital, Puducherry. A study of 1100 patients who had undergone upper gastro-intestinal endoscopy for a period of four and half years from May 2009 to October 2013 was carried out. In each of these 1100 patients, the first and second part of duodenum were carefully examined to find out the presence of single or multiple hookworms. In all the patients found to have hookworms in duodenum, investigations were done to know about the presence of anaemia. In patients with severe anaemia [haemoglobin <7g/dl or g%] peripheral smear examination was also done in addition to haemoglobin estimation. But in one patient with severe anaemia, various investigations which indicate iron deficiency anaemia were also done namely serum ferritin and serum iron in addition to haemoglobin estimation, mean corpuscular volume or MCV and peripheral smear examination. Anaemia is defined as haemoglobin < 12g/dl or 12g% in women and haemoglobin or < 13g/dl or13g% in men. Mild anaemia is taken as haemoglobin 10to12g/dl or g%, moderate anaemia is taken as haemoglobin 7to10g/dl or g% and severe anaemia is taken as haemoglobin <7g/dl or g%. Normal serum ferritin is18-160 ng/ ml. Normal serum iron is50 to 170 µg/dL. Normal mean corpuscular volume or MCV is 82-92 femolitres or fl.

The results were found as given below.

3. Results

Out of these 1100 patients, 14 patients found to have hookworms in duodenum while doing upper gastro intestinal endoscopy were taken into consideration for our study. Out of these14 patients, 9 patients had anaemia and 2 of these 9 patients were found to have severe anaemia [haemoglobin <7g/dl or g%]. Severe anaemia indicates significant loss of blood which will occur only due to heavy burden of hookworms in severe hookworm infection. The peripheral smear of both the patients showed severe hypochromic anaemia. In one patient with severe anaemia due to severe hookworm infection, various investigations which indicate iron deficiency anaemia were also done namely serum ferritin and serum iron in addition to haemoglobin estimation, mean corpuscular volume or MCV and peripheral smear examination.

3.1 Detailed investigations which indicate iron deficiency anaemia in one patient with severe hookworm infection diagnosed by doing endoscopy in our study.

a. Low serum ferritin

In this patient with severe anaemia due to severe hookworm infection with multiple hookworms in duodenum diagnosed by doing endoscopy, serum ferritin is very low-1.4 ng/ ml [normal range 18-160 ng/ ml].

b. Low serum iron

In this patient with severe anaemia due to severe hookworm infection, serum iron is very low-20 µg /dL [normal range 50 to 170 µg/dL].

c. Low haemoglobin

In this patient with severe anaemia due to severe hookworm infection, haemoglobin is very low-3.2 g% [normal range 12 to 16 g%].

d. Low mean corpuscular volume or MCV

In this patient with severe anaemia due to severe hookworm infection, mean corpuscular volume or MCV is very low and is only 50.7femolitres or fl [normal range 82-92 fl] indicating that the RBCs are very small with small volume and are microcytic.

e. Peripheral smear examination

In this patient with severe anaemia due to severe hookworm infection, peripheral smear examination showed severe microcytic hypochromic anaemia.

Patients having low hemoglobin, low mean corpuscular volume or MCV and microcytic hypochromic RBCs on peripheral smear along with low serum ferritin and low serum iron were labelled as having iron deficiency anaemia. Hence our patient with low haemoglobin (3.2 g%), low mean corpuscular volume or MCV (50.7femolitres or fl), low serum ferritin (1.4 ng/ ml), low serum iron (20 µg /dL) and microcytic hypochromic RBCs on peripheral smear has iron deficiency anaemia.

Multiple hookworms in duodenum in this patient with severe anaemia [haemoglobin 3.2 g%] due to severe hookworm infection diagnosed by doing endoscopy is shown in fig 1, 2, 3.

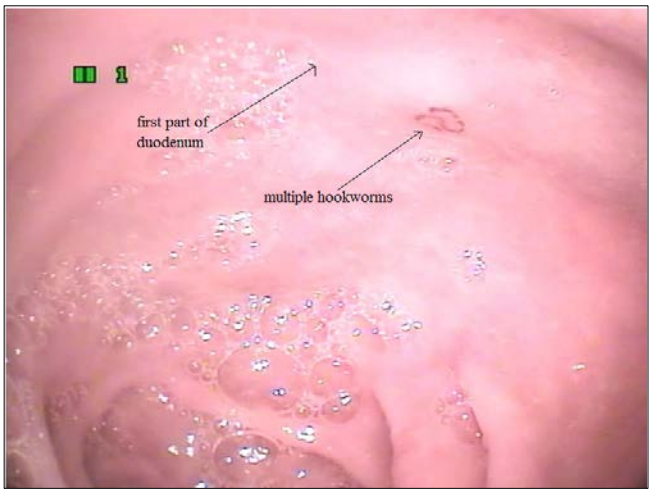

Fig 1: Multiple hookworms in duodenum in a patient with severe anaemia [haemoglobin 3.2 g%] Due to severe hookworm infection

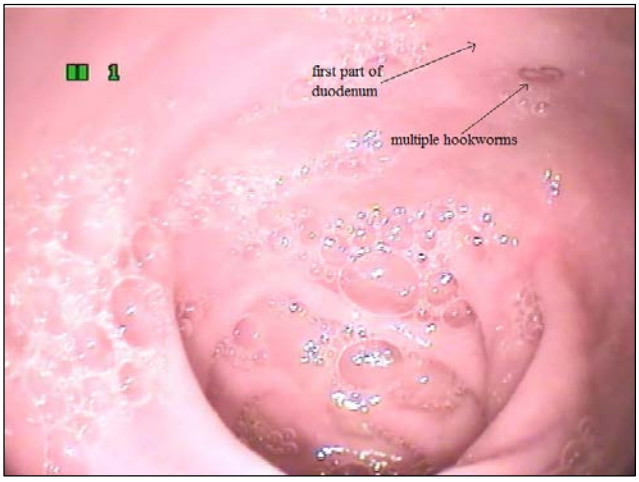

Fig 2: Multiple hookworms in duodenum in the same patient with severe anaemia [haemoglobin 3.2 g%] due to severe hookworm infection [different view]

Fig 3: Multiple hookworms in duodenum in the same patient with severe anaemia [Haemoglobin 3.2 g%] due to severe hookworm infection [different view]

4. Discussion

There are two human- specific hookworms, namely Ancylostoma duodenale and Necator americanus [2]. The most common laboratory finding in hookworm infection is iron deficiency anemia [14]. The degree of anemia depends on hookworm burden and the species, because Ancylostoma duodenale causes more blood loss than Necator americanus [14]. Iron deficiency anemia secondary to loss of iron into the gut is the most significant risk of hookworm infection [13].

4.1 Storage, transport and functional compartments for iron

Iron-containing compounds in the body are one of three types: a) storage forms for iron and b) compounds that serve as transport and c) functional compounds that serve in metabolic or enzymatic functions [18].

a) Ferritin is the primary storage compound for the body's iron.

b) Iron is distributed within the body via transferrin in the plasma, a transport protein that mediates iron exchange between tissues.

c) Hemoglobin constitutes the major fraction of body iron (functional iron) [18].

The normal plasma iron concentration ranges between 50–120 μg/dl.

4.2 Iron deficiency anaemia in adults

Iron deficiency anaemia (IDA) in adults occurs typically due to a gradual decline in the iron content of the body due to a loss of haemoglobin. Hence iron deficiency anaemia is defined as low haemoglobin concentration below the expected values and is also characterised by microcytic anaemia and low serum iron concentration [19]. Blood loss from the gastro-intestinal tract is the common cause of iron deficiency anaemia [19]. Hence hookworm infection which causes blood loss from the gastro-intestinal tract results in iron deficiency anaemia.

Iron deficiency anaemia (IDA) is characterised by low haemoglobin concentration, microcytic anaemia, low serum iron concentration and either an absence of stainable iron in the bone marrow or serum ferritin concentrations less than 12–16 μg/l [19]. Hallberg *et al*. determined the serum ferritin concentration of 203 women aged 38 years who had undergone bone marrow examination. They concluded that a value of serum ferritin <15 μg/l was the best predictor of iron deficiency (confirmed by an absence of stainable iron in the bone marrow) [19].

The subjects having haemoglobin <12gm% were labeled as anaemic as per WHO cut-off values, those having anaemia with mean corpuscular volume or MCV< 78cuμ, serum ferritin < 12ngm/ml and microcytic hypochromic RBCs on peripheral smear were labelled as Iron deficiency anaemia [20].

4.3 Investigations which indicate iron deficiency anemia

The various investigations which indicate iron deficiency anaemia were haemoglobin estimation, mean corpuscular volume or MCV, peripheral smear examination, serum ferritin and serum iron.

a. Low haemoglobin in iron deficiency anemia

Hemoglobin constitutes the major fraction of body iron (functional iron) with a concentration of about 0.5 mg iron/mL blood. 65% of iron in the body is bound up in haemoglobin [18]. Anaemia is defined as the reduction in haemoglobin concentrations below the expected values [WHO, 1972]. Haemoglobin levels were based on the World Health Organisation standards of 13 g/dl for adult males 12 g/dl for adult women and 11 g/dl for pregnant women and preschool children below which were considered to have iron deficiency anemia [18]. In iron deficiency anaemia haemoglobin is low.

b. Low mean corpuscular volume (MCV) in iron deficiency anemia

Normal mean corpuscular volume or MCV is 82-92 femolitres or fl. There is reduced size of red blood cells, so that the mean corpuscular volume (MCV) is lower [microcytic] in iron deficiency anemia. Hence, this is a microcytic anemia.

c. Peripheral smear examination in iron deficiency anemia

Patients with iron deficiency anemia have microcytic hypochromic RBCs on peripheral smear indicating that the RBCs are very small with small volume and are microcytic and RBCs are hypochromic and have low amount of haemoglobin.

d. Low serum ferritin in iron deficiency anemia

Ferritin is the primary storage compound for the body's iron. 30% of iron in the body is stored as ferritin in the spleen, bone marrow and the liver [18]. Normal serum ferritin is18-160 ng/ ml. In iron deficiency anaemia serum ferritin is low.

e. Low serum iron in iron deficiency anemia

Iron is distributed within the body via transferrin in the plasma, a transport protein that mediates iron exchange between tissues. The amount of circulating iron bound to transferrin is reflected by the serum iron level. Normal serum iron is 50 to 170 μg/dL. In iron deficiency anaemia serum iron is low.

4.4 Severe anemia in severe hookworm infection in our study compared with other studies

a. Our study

Patients having low hemoglobin, low mean corpuscular volume or MCV and microcytic hypochromic RBCs on peripheral smear along with low serum ferritin and low serum iron were labelled as having iron deficiency anaemia (19, 20). Hence our patient with severe anaemia due to severe hookworm infection diagnosed by doing endoscopy with low haemoglobin (3.2 g%), low mean corpuscular volume or MCV (50.7femolitres or fl), low serum ferritin (1.4 ng/ ml), low serum iron (20 μg /dL) and microcytic hypochromic RBCs on peripheral smear has iron deficiency anaemia.

b. Other studies

In many other studies also, patients with severe anaemia due to severe hookworm infection diagnosed by doing endoscopy were found to have low hemoglobin (haemoglobin <12g%), low mean corpuscular volume or MCV (mean corpuscular volume or MCV< 78 cuμ or fl) and microcytic hypochromic RBCs on peripheral smear, along with low serum ferritin (serum ferritin < 12ng/ml) and low serum iron (serum iron < 50 μg/dL) indicating iron deficiency anaemia. [1, 2, 6, 14, 15, 17].

1. In the study conducted by Hyun HJ *et al.* [1] in Korea, a 82-yr-old female patient suffered from severe dyspnea and dizziness. Laboratory results revealed: very low hemoglobin 3.4 g/dL (normal12-16 g/dL), low mean corpuscular volume or MCV 74.7 fL (normal 79-95 fL), microcytic and hypochromic RBCs, very low serum iron 9 μg/dL (normal 37-145 μg/dL) and low serum ferritin 10 ng/ mL (normal 18-160 ng/ ml) indicating iron deficiency anaemia. Gastroduodenoscopy observed hyperemic mucosa of the duodenum and discovered numerous moving roundworms on the mucosa. Endoscopy isolated seven of them, which were identified as *Necator americanus*.
2. In the study conducted by Wu KL *et al.* [2] in Taiwan, a 78-year-old man complained of intermittent black color stool passage for 4 months. Laboratory data showed very low hemoglobin of 3.7 g/dL with low mean corpuscular volume: 66.9%, microcytic hypochromic erythrocytes and decreased serum iron indicating iron deficiency anaemia. Upper gastro intestinal endoscopy showed live worms measuring 4-6 mm in length were found in the second portion of the duodenum. They were removed by using the biopsy forceps and these worms were identified as adult hookworms of Necator americanus species.
3. In the study conducted by Lee T.-H *et al.* [6] in Taiwan, a 87-year-old male farmer complained of exertional

dypsnea. Laboratory data showed very low hemoglobin of 3.9 g/dL, low mean corpuscular volume of 72.9 fL (88.3-98.0 fL), very low serum ferritin -3.7 ng/ml(normal 10-130 ng/mL), and very low serum iron -12 μg/dL (normal range 50 to 170 μg/dL) indicating iron deficiency anaemia. Upper gastro intestinal endoscopy showed several thin worms in the gastric antrum and duodenal bulb. The worms were removed by biopsy forceps, and were identified as being *Necator americanus* from their characteristic morphology.

4. In the study conducted by Yan SL *et al.* [14] in China, a 60−year−old male farmer presented with intermittent melena and anemia for 1 month. Laboratory data revealed very low hematocrit of 24.2% (normal: 42- 52%), low mean corpuscular volume of 72/fL (normal: 80-94/fL), low serum ferritin 17.6 ng/mL (normal: 18-160 ng/ ml) and low serum iron 19 μg/dL (normal: 33-167 μg/dL) indicating iron deficiency anaemia. The patient underwent push enteroscopy, demonstrating several reddish worms grazing in the duodenum. Three worms were removed with biopsy forceps and were identified on microscopic examination as hookworm, Necator americanus.
5. In a study conducted by Genta RM *et al.* [15] in *Texas* in a patient with pale skin upper endoscopy was performed. Several small, translucent red-appearing worms measuring between 6 mm and 1 cm in length were seen in the descending duodenum. Laboratory data showed very low hemoglobin of 4.9 g/dL and a very low mean corpuscular volume of 58.1 fL (normal range 88.3-98.0 fL). Hematocrit was very low 16.8% (normal: 42- 52%), serum ferritin was very low-5 ng/ml (normal 10-130 ng/mL) and serum iron was very low-6.0 μg/dL (normal range 50 to 170 μg/dL) indicating severe iron deficiency anaemia.
6. In the study conducted by Bamanikar S *et al.* [17] in *Pune, Maharashtra, India*, a 35-year-old male presented with very low hemoglobin: 4.6 g/dl (normal12-16 g/dL)with microcytic hypochromic erythrocytes, very low hematocrit: 17.5% (normal: 42 -52%), low mean corpuscular volume (MCV): 69.2% (normal 79-95 fl), low serum ferritin 10 ng/ mL (normal 18-160 ng/ ml) and very low serum iron 9 μg/dL (normal 37-145 μg/dL) indicating severe iron deficiency anaemia. Upper gastro intestinal endoscopy showed live worms. They were removed by using the biopsy forceps and these worms were identified as adult hookworms of Ancylostoma duodenale species histologically.

5. Conclusion

1. The patients having low hemoglobin (haemoglobin <12g %), low mean corpuscular volume or MCV (mean corpuscular volume or MCV< 78 cuμ or fl) and microcytic hypochromic RBCs on peripheral smear, along with low serum ferritin (serum ferritin < 12ng/ml) and low serum iron (serum iron < 50 μg/dL) were labelled as having iron deficiency anaemia.
2. In our study and many other studies also, patients with severe hookworm infection diagnosed by doing endoscopy were found to have low hemoglobin, low mean corpuscular volume or MCV and microcytic hypochromic RBCs on peripheral smear, along with low serum ferritin and low serum iron indicating iron deficiency anaemia.
3. Hence, the type of anaemia in patients with severe hookworm infection diagnosed by doing endoscopy in our study and many other studies is iron deficiency anaemia based on the laboratory results of low hemoglobin, low mean corpuscular volume or MCV, microcytic hypochromic RBCs on peripheral smear along with low serum ferritin and low serum iron.
4. Blood loss from the gastro-intestinal tract is the common cause of iron deficiency anaemia. Hence hookworm infection which causes blood loss from the gastro-intestinal tract results in iron deficiency anaemia. Iron deficiency anemia secondary to loss of iron into the gut is the most significant risk of hookworm infection.

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