



Journal homepage: [www.mcmed.us/journal/ijacr](http://www.mcmed.us/journal/ijacr)

## A DETAILED STUDY OF VARIOUS INVESTIGATIONS WHICH INDICATE IRON DEFICIENCY IN PATIENTS WITH SEVERE ANAEMIA DUE TO HOOKWORM INFECTION DIAGNOSED BY DOING ENDOSCOPY

**Govindarajalu Ganesan**

Associate Professor, Dept. of General Surgery, Indira Gandhi Medical College and Research Institute, Puducherry, 605009.

Corresponding Author:- **Govindarajalu Ganesan**  
E-mail: [drgganesan@gmail.com](mailto:drgganesan@gmail.com)

<p><b>Article Info</b></p> <p><i>Received 15/04/2016</i> <i>Revised 27/05/2016</i> <i>Accepted 06/06/2016</i></p> <p><b>Key words:</b> Iron deficiency, Serum ferritin , Transferrin saturation , Serum iron</p>	<p><b>ABSTRACT</b></p> <p>Severe anaemia is reported to occur in severe hookworm infection. But so far detailed study of various investigations which indicate iron deficiency in patients with severe anaemia due to hookworm infection diagnosed by doing upper gastro intestinal endoscopy was not done. Hence a detailed study of various investigations which indicate iron deficiency in patients with severe anaemia due to hookworm infection diagnosed by doing upper gastro intestinal endoscopy was done. A study of 1259 patients who had undergone upper gastro-intestinal endoscopy for a period of 5 years from May 2009 to April 2014 was carried out. In each of these 1259 patients, the first and second part of duodenum was carefully examined to find out the presence of 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 &lt;7g/dl or g%] peripheral smear examination was done. But in one patient with severe anaemia, various investigations which indicate iron deficiency namely serum ferritin, transferrin saturation, serum iron and total iron binding capacity [TIBC] were also done. The results were found as given below. Of these 1259 patients, 14 patients found to have hookworms in duodenum were taken into consideration for our study. Of these 14 patients, 9 patients had anaemia and 2 of these 9 patients were found to have severe anaemia [haemoglobin&lt;7g/dl or g%]. In one patient with severe anaemia serum ferritin, transferrin saturation and serum iron were very low which indicate iron deficiency. Hence low serum ferritin, low transferrin saturation and serum iron indicate iron deficiency in patients with severe anaemia due to hookworm infection diagnosed by doing upper gastro intestinal endoscopy.</p>
--	--

### INTRODUCTION

Severe anaemia is reported to occur in severe hookworm infection. But so far detailed study of various investigations which indicate iron deficiency was not done in patients with severe anaemia due to hookworm infection diagnosed by doing upper gastro intestinal endoscopy. Hence a detailed study of various investigations which indicate iron deficiency in patients with severe anaemia due to hookworm infection diagnosed by doing upper gastro intestinal was done.

### MATERIALS AND METHODS

This study was conducted in the department of general surgery, Aarupadai Veedu Medical College and Hospital, Puducherry. A study of 1259 patients who had undergone upper gastro-intestinal endoscopy for a period of 5 years from May 2009 to April 2014 was carried out. In each of these 1259 patients, the first and second part of duodenum was 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. Anaemia is defined as haemoglobin < 12g/dl or 12g% in women and haemoglobin < 13g/dl or 13g% in men. Severe anaemia is taken as haemoglobin <7g/dl or g%. 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 namely serum ferritin, transferrin saturation, serum iron and total iron binding capacity [TIBC] were also done. The results were found as given below.

## RESULTS

Of these 1259 patients, 14 patients found to have hookworms in duodenum were taken into consideration for our study. Of these 14 patients, 9 patients had anaemia and 2 of these 9 patients were found to have severe anaemia [haemoglobin <7g/dl or g%]. The peripheral smear of both the patients showed severe hypochromic anaemia. In one patient with severe anaemia [haemoglobin <7g/dl or g%] due to hookworm infection serum ferritin, transferrin saturation and serum iron which indicate iron deficiency were also done. The results were found as given below.

### Detailed investigations which indicate iron deficiency in the patient with severe anaemia due to hookworm infection

The various investigations which indicate iron deficiency were done in the patient with severe anaemia [haemoglobin <7g/dl or g%] due to hookworm infection namely serum ferritin, transferrin saturation, serum iron and total iron binding capacity [TIBC].

#### 1. Serum ferritin

##### a. Serum ferritin [decreased in iron deficiency]

Decreased serum ferritin is the earliest indicator of iron deficiency. In patients with severe anaemia due to hookworm infection, serum ferritin concentration is typically less than 12–15 µg/l. In our patient also with severe anaemia due to hookworm infection, serum ferritin is very low-1.4 ng/ ml [normal range 18-160 ng/ ml].

##### b. Serum ferritin [stored iron].

The total amount or the total distribution of iron in the human body is 50mg and 38mg per kg body weight in an average adult man and woman respectively living in a developing country. Out of this total amount of iron the total stored iron in the human body is 13mg and 5mg per kg body weight for a man and woman respectively. Serum ferritin reflects true iron stores in uncomplicated iron deficiency and fluctuates less due to short-term variations than serum iron levels and total iron binding capacity (TIBC). Ferritin concentration of <12–15 µg/l is taken to indicate deficient iron stores.

#### c. Decreased serum ferritin in hookworm infection .

Low level of serum ferritin indicates exhausted and low iron stores due to depletion of iron resulting from loss of blood in severe hookworm infection. In patients with severe anaemia due to hookworm infection, serum ferritin concentration is typically less than 12–15 µg/l. The stored iron [ferritin] directly regulates iron absorption in the gut and the iron content of the blood indirectly. The control of the stored iron levels is the key to understand how the body adapts to the presence of blood feeding hookworms. Since serum ferritin level measures the total stored iron, serum ferritin level is extremely important to assess the iron status in hookworm infection.

## 2. Transferrin saturation

### a. Percent transferrin saturation [decreased in iron deficiency]

Serum ferritin measures the stored iron, but only transferrin binds the iron ions or ferric ions and is essential if stored iron is to be moved and used. Each molecule of transferrin binds with similar affinity two molecules of iron. The extent to which sites on transferrin molecules are filled by iron ions is known as percent transferrin saturation. Amount of iron in the plasma or serum is assessed by estimating the percentage of the two binding sites on all transferrin molecules that are occupied, called the percentage transferrin saturation and its normal range is 20-50%. In our patient, transferrin saturation is very low and is only 5%. In addition to serum ferritin concentration, measurement of transferrin saturation is another very important indicator of iron deficiency and deteriorating iron status.

### b. Transferrin [iron transport]

Transferrin is the specific transport protein for iron in the plasma pool, and each molecule binds with similar affinity two molecules of iron. About 0.1% of total body iron is circulating in bound form to transferrin. Iron absorbed from intestinal mucosal cells is transferred to transferrin, an iron-transport protein synthesized in the liver. Most absorbed iron is utilized in bone marrow for erythropoiesis. Transferrin saturation identifies iron-deficient erythropoiesis. The concentration of the transport protein transferrin reflects iron status only when iron stores are exhausted and when the plasma iron concentration is <40–60 µg/dl, so it does not diagnose iron deficiency prior to ineffective erythropoiesis.

## 3. Serum iron level [decreased in iron deficiency]

In addition to serum ferritin concentration and transferrin saturation, measurement of serum iron level is also the other important indicator of iron deficiency. Serum iron measures the iron molecules that are bound to transferrin and circulating in the blood. But in our patient, serum iron is very low-20 µg /dL [normal range 50 to 170 µg/dL] which indicates that only very low amount of iron



molecules are bound to transferrin and are circulating in the blood of our patient.

#### **4. Total iron binding capacity or TIBC [ normal or increased in iron deficiency]**

Total iron binding capacity or TIBC is normal or somewhat increased in people with iron deficiency. Measurement of the total amount of transferrin is called total iron binding capacity [TIBC] which is however normal in our patient with severe anaemia due to hookworm infection diagnosed by doing endoscopy- 434 µg/dl [normal range 240-450µg/dL].

These three tests- serum iron, percent transferrin saturation and total iron binding capacity are generally done at the same time to diagnose iron deficiency. Transferrin saturation is calculated from serum iron and total iron binding capacity (transferrin saturation= serum iron/ total iron binding capacity or SI/TIBC). In iron deficiency the serum iron will be decreased, while the serum total iron binding capacity is somewhat increased, so that the percent transferrin saturation is much lower than normal-perhaps only 5 to 10%.

## **DISCUSSION**

### **Iron deficiency**

Iron deficiency has generally been defined as an absence of iron stores (very low serum ferritin). Iron deficiency was defined as serum ferritin <13 microg/l. Low serum ferritin , normal or somewhat increased total iron binding capacity, low serum iron and transferrin saturation indicate iron deficiency in patients with severe anaemia due to hookworm infection diagnosed by doing upper gastro intestinal endoscopy .

### **Investigations which indicate iron deficiency**

#### **a. Low serum ferritin**

Studies have shown very low level of serum ferritin in patients with severe anaemia due to hookworm infection diagnosed by doing endoscopy. In a study conducted by Hyun HJ et al (2010) [1] in Korea, serum ferritin was very low-10 ng/ mL (normal 10-130 ng/mL) in a female patient with severe anaemia due to hookworm infection diagnosed by doing upper gastro intestinal endoscopy. In a study conducted by Genta RM et al (1991) [2] in *Texas*, serum ferritin was very low-8 ng/ mL in a male patient with severe anaemia due to hookworm infection diagnosed by doing upper gastro intestinal endoscopy. In a study conducted by Yan SL et al (2007) [3] serum ferritin was very low-17.6 ng/mL (normal: 21.8-274.6 ng/mL) in a patient with severe anaemia due to hookworm infection diagnosed by push enteroscopy. Low level of serum ferritin indicates iron deficiency resulting from loss of blood in hookworm infection. In a study conducted by Crompton DW et al (1993) [4], serum ferritin was low in 42 patients with iron deficiency due to hookworm infection. In a study conducted by Watthanakulpanich D et al (2011) in Thailand [5], serum

ferritin was low in 42 patients with iron deficiency due to severe hookworm infection. Low level of serum ferritin indicates exhausted and low iron stores due to depletion of iron resulting from loss of blood. One study has also shown decreased serum ferritin in patients with iron deficiency due to depletion of iron stores. In a study conducted by Sikosana PL et al (1998) [6] in Zimbabwe, serum ferritin was low in patients with iron deficiency due to depletion of iron stores. One study has also shown decreased serum ferritin in pregnant women with iron deficiency. In a study conducted by Tiwari, M et al (2013) [7] in pregnant Indian women, serum ferritin was low in 30 cases suggesting iron deficiency. One study has also shown decreased serum ferritin in young elite water polo players with iron deficiency. In a study conducted by Dopsaj V et al (2008) [8] in Serbia, serum ferritin was low in 2 young elite water polo players with iron deficiency.

#### **b. Normal or somewhat increased total iron binding capacity [TIBC]**

Studies have shown normal or somewhat increased level of total iron binding capacity [TIBC] in patients with severe anaemia due to hookworm infection diagnosed by doing endoscopy. In a study conducted by Hyun HJ et al (2010) in Korea, total iron-binding capacity was normal -318 mcg/dL (normal 228-428 mcg/dL) in a female patient with severe anaemia due to hookworm infection diagnosed by doing upper gastro intestinal endoscopy. In a study conducted by Yan SL et al (2007), total iron-binding capacity was normal -356 mcg/dL (normal: 259-402 mcg/dL) in a patient with severe anaemia due to hookworm infection diagnosed by doing upper gastro intestinal endoscopy. In a study conducted by Genta RM et al (1991) in *Texas*, total iron-binding capacity was somewhat increased -559 mcg/dL (normal 240-450 mcg/dL) in a male patient with severe anaemia due to hookworm infection diagnosed by doing upper gastro intestinal endoscopy.

#### **c. Low serum iron**

Studies have also shown very low level of serum iron in patients with severe anaemia due to hookworm infection diagnosed by doing endoscopy. In a study conducted by Hyun HJ et al (2010) in Korea, serum iron was very low- 9 µg/dL (normal 37-145 µg/dL) in a female patient with severe anaemia due to hookworm infection diagnosed by doing upper gastro intestinal endoscopy. In a study conducted by Genta RM et al (1991) in *Texas*, serum iron was very low-18 µg/dL (normal range 50 to 170 µg/dL) in a male patient with severe anaemia due to hookworm infection diagnosed by doing upper gastro intestinal endoscopy. In a study conducted by Yan SL et al (2007), serum iron was very low-19mcg/ dL (normal: 33-167mcg/dL) in a patient with severe anaemia due to hookworm infection diagnosed by push enteroscopy. In a study conducted by Wu KL et al (2002) [9] in Taiwan, serum iron was decreased in a male patient with severe



anaemia due to hookworm infection diagnosed by doing upper gastro intestinal endoscopy.

#### d. Low transferrin saturation

Iron deficiency results in a reduction in serum iron (SI) levels, an elevation in transferrin (total iron-binding capacity [TIBC]) levels, and hence a net reduction in transferrin saturation (transferrin saturation= serum iron/ total iron binding capacity or SI/TIBC). In a study conducted by Dopsaj V et al (2008) [8] in Serbia, transferrin saturation was decreased (< 16%) in iron deficiency. In a study conducted by Crompton DW et al (1993) transferrin saturation was low in 16 patients with iron deficiency due to hookworm infection. One study has also shown decreased transferrin saturation (transferrin saturation < 16%) in patients with iron deficiency. In a study conducted by Dopsaj V et al (2008) [8] in Serbia, transferrin saturation was low- 8.33% (normal range is 20-50%) in 2 young elite water polo players with iron deficiency.

#### CONCLUSION

Hence low serum ferritin, low transferrin saturation and low serum iron indicate iron deficiency in

patients with severe anaemia due to hookworm infection diagnosed by doing upper gastro intestinal endoscopy.

#### ACKNOWLEDGEMENT

The author sincerely thanks the staff nurses A.K.Selvi and Nithya for their immense help rendered to the author while conducting this work. The author acknowledges the immense help received from the scholars whose articles are cited and included in references of this manuscript. The author is also grateful to authors / editors / publishers of all those articles, journals and books from where the literature for this article has been reviewed and discussed.

#### CONFLICT OF INTEREST:

The authors declare that they have no conflict of interest.

#### STATEMENT OF HUMAN AND ANIMAL RIGHTS

All procedures performed in human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This article does not contain any studies with animals performed by any of the authors.

#### REFERENCES

1. Hyun HJ, Kim EM, Park SY, Jung JO, Chai JY, Hong ST. (2010). A case of severe anemia by *Necator americanus* infection in Korea. *J Korean Med Sci*, 25(12), 1802-4.
2. Genta RM, Woods KL. (1991). Endoscopic diagnosis of hookworm infection. *Gastrointest Endosc*, 37(4), 476-8
3. Yan SL, Chu YC. (2007). Hookworm infestation of the small intestine. *Endoscopy*, 39, E162±163
4. Crompton DW, Whitehead RR. (1993). Hookworm infections and human iron metabolism. *Parasitology*, 107, S137-45.
5. Watthanakulpanich D, Maipanich W, Pubampen S, Sa-Nguankiat S, Pooudouang S, Chantaranipapong Y, Homsuwan N, Nawa Y, Waikagul J (2011). Impact of hookworm deworming on anemia and nutritional status among children in Thailand. *Southeast Asian J Trop Med Public Health*, 42(4), 782-92.
6. Sikosana PL, Bhebhe S, Katuli S. (1998). A prevalence survey of iron deficiency and iron deficiency anaemia in pregnant and lactating women, adult males and pre-school children in Zimbabwe. *Cent Afr J Med*, 44(12), 297-305
7. Tiwari M, Kotwal J, Kotwal A, Mishra P, Dutta V & Chopra S. (2013). Correlation of haemoglobin and red cell indices with serum ferritin in Indian women in second and third trimester of pregnancy. *Medical Journal Armed Forces India*, 69(1), 31-36.
8. Dopsaj V, Šumarac Z, Novaković N & Dopsaj M. (2008). Determination of parameters of iron status in evaluation of anemia in elite young Serbian water polo players. *Serbian Journal of Sports Sciences*, 2(1-4), 91-99.
9. Wu KL, Chuah SK, Hsu CC, Chiu KW, Chiu YC, Changchien CS. (2002). Endoscopic Diagnosis of Hookworm Disease of the Duodenum, a Case Report. *J Intern Med Taiwan*, 13, 27-30.

