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# Various Investigations Which Help to DifferentateBetween Iron Deficiency And Iron Deficiency Anaemia In Patients With Hookworm Infection Diagnosed by Doing Endoscopy

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***Abstract:***
***Objective****: Anaemia is commonly reported to occur in hookworm infection. Hence a detailed study was done to know about the various investigations which help to differentiate between iron deficiency and iron deficiency anaemia in patients with hookworm infection diagnosed by doing upper gastro-intestinal endoscopy .*
***Methods****: A study of 1307 patients who had undergone upper gastro-intestinal endoscopy for a period of 5 years and one month from May 2009 to May 2014 was carried out.In all the patients found to have hookworms in duodenum,haemoglobin estimation was done to know about the presence or absence of anaemia.But in addition to haemoglobin estimation ,serum ferritin and transferrin saturation are the most important investigations which help to differentiate between iron deficiency and iron deficiency anaemia.In all the patients with hookworm infection with normal haemoglobinwithout anaemia,serum ferritin and transferrin saturation could not be done. In one patient with mild anaemia, mean corpuscular volume or MCV was also done in addition to haemoglobin estimation. But serum ferritin and transferrin saturation could not be done in this patient. But in one patient with severe hookworm infection with multiple hookworms in duodenum,in addition to peripheral smear ,mean corpuscular volume or MCV and haemoglobin estimation, serum ferritin and transferrin saturation were also done.The results were found as given below.*
***Results****: Out of these 1307 patients, 14 patients found to have hookworms in duodenum were taken into consideration for our study. Out of these14 patients,5 patients had normal haemoglobinwithout anaemia.But since serum ferritin and transferrin saturation could not be done in these 5 patients,the status of iron deficiency could not be assessed in these 5patients without anaemia. In one patient with mild anaemia(haemoglobin(11.7g%)due to hookworm infection,mean corpuscular volume or MCV was low.But since serum ferritin and transferrin saturation could not be done in this patient,the status of iron deficiency anaemiacould not be assessed in thispatient .Lowserum ferritin and transferrin saturation along with normal haemoglobin indicate iron deficiency without anaemia.Low serum ferritin and transferrin saturation along with low haemoglobin indicate iron deficiency anaemia.But in one patient with severe hookworm infection with multiple hookworms in duodenum,peripheral smear showed severe microcytic hypochromic anaemia, mean corpuscular volume or MCV was low, haemoglobin was low,serum ferritin and transferrin saturation were found to be very low.Hence this patient could be labelled as having iron deficiency anaemia.*
***Conclusion****: Hence patients with low serum ferritin and transferrin saturation along with low haemoglobincould be labelled as having iron deficiency anaemia.But low serum ferritin and transferrin saturation along with normal haemoglobin indicate iron deficiency without anaemia.*
***Keywords****: serum ferritin and transferrin saturation, haemoglobin, mean corpuscular volume or MCV, peripheral smear, iron deficiency anaemia*

## I. Introduction

Anaemia is commonly reported to occur in hookworm infection(1to 17).Hence a detailed study was done to know about the various investigations which help to differentiate between iron deficiency and iron deficiency anaemia in patients with hookworm infection diagnosed by doing upper gastro- intestinal endoscopy .

## II. Materials and Methods

This study was conducted in the department of general surgery, AarupadaiVeedu Medical College And Hospital, Puducherry. A study of 1307 patients who had undergone upper gastro-intestinal endoscopy for a period of 5 years and one month from May 2009 to May 2014 was carried out.In each of these 1307 patients, the first and second part of duodenum were carefully examined to find out the presence of hookworms. In all the patients found to have hookworms in duodenum,haemoglobin estimation was done to know about the presence or absence of anaemia.But in addition to haemoglobin estimation ,serum ferritin and transferrin saturation are the most important investigations which help to differentiate between iron deficiency and iron deficiency anaemia.In all the patients with hookworm infection with normal haemoglobinwithout anaemia, serum ferritin

and transferrin saturation could not be done. In one patient with mild anaemia,mean corpuscular volume or MCV,mean corpuscular haemoglobin or MCH andmean cell haemoglobin concentration or MCHC were also done in addition to haemoglobinestimation.Butserum ferritin and transferrin saturation could not be done in this patient. But in one patient with severe hookworm infection with multiple hookworms in duodenum,in addition to peripheral smear ,mean corpuscular volume or MCVandhaemoglobin estimation, serum ferritin and transferrin saturation were also done.Anaemia is defined as haemoglobin<12g/dl or 12g%(18,19).Mild anaemia is taken as haemoglobin 10to12g/dl or g%, moderate anaemia is taken as haemoglobin 7to10g/dl or g% and severeanaemia is taken as haemoglobin<7g/dl or g% (20) .The results were found as given below.

## III. Results

Out of these 1307 patients, 14 patients found to have hookworms in duodenum were taken into consideration for our study. Out of these14 patients,5 patients had normal haemoglobinwithout anaemia.

**1.Haemoglobin Values In All The 5 Patients Without Anaemia**

5 patients had normal haemoglobinwithout anaemia. All the 5patients had haemoglobin≥12g%[haemoglobin 18g%, 17.6g%, 16g%, 14g%, 12.8g%].But since serum ferritin and transferrin saturation could not be done in these 5 patients, the status of iron deficiency could not be assessed in these 5 patients without anaemia.

**2. Detailed Investigations In The Patient With Mild AnaemiaDue To Hookworm Infection.**

In one patient with mild anaemia (haemoglobin 11.7g%) due to hookworm infection,mean corpuscular volume or MCV,mean corpuscular haemoglobin or MCH and mean cell haemoglobin concentration or MCHC were also done in addition to haemoglobinestimation.The results were found as given below.

**a.Haemoglobin**

In this patient with mild anaemia due to hookworm infection diagnosed by doing upper gastro-intestinal endoscopy haemoglobin is 11.7g% .

**b.Mean corpuscular volume or MCV**

In this patient, mean corpuscular volume or MCV is 76.5femolitres or fl[normal range 82-92 fl].

**c.Mean corpuscular haemoglobin or MCH**

Mean corpuscular haemoglobin or MCH is 27.9 picograms or pg [normal range 27-32pg] in this patient.

**d.Mean corpuscular haemoglobin concentration or MCHC**

Mean corpuscular haemoglobin concentration or MCHC is 36.6% [normal range 32-36%]in this patient.

In this patient with mild anaemia(haemoglobin (11.7g%)due to hookworm infection,mean corpuscular volume or MCV is low.But since serum ferritin and transferrin saturation could not be done in this patient,the status of iron deficiency anaemiacould not be assessed in this patient .

**3. Detailed Investigations In The Patient With severe Hookworm Infection with Multiple Hookworms In Duodenum.**

But in one patient with severe hookworm infection with multiple hookworms in duodenum,in addition to peripheral smear ,mean corpuscular volume or MCVand haemoglobin estimation, serum ferritin and transferrin saturation were also done.Mean corpuscular haemoglobin or MCH , mean corpuscular haemoglobin concentration or MCHC and serum iron were also done in this patient. The results were found as given below.

**a. Low serum ferritin**

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

**b. Low transferrin saturation**

In this patient with severe hookworm infection with multiple hookworms in duodenum, transferrin saturation is very low and is only 5% and its normal range is 20-50%.

**c. Lowserum iron**

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

**d.Lowhaemoglobin**

In this patient with severe hookworm infection with multiple hookworms in duodenum, haemoglobin is very low-3.2g%[normal range 12to16g%].

**e.Low mean corpuscular volume or MCV**

In this patient with severe hookworm infection with multiple hookworms in duodenum,mean corpuscular volume or MCV is very lowand is only 50.7femolitres or fl[normal range 82-92 fl] indicating that the RBCs are very small with small volume and are microcytic.

**f.Low mean corpuscular haemoglobin or MCH**

In this patient with severe hookworm infection with multiple hookworms in duodenum,mean corpuscular haemoglobin also is very low -15 picograms or pg [normal range 27-32pg] indicating that the RBCs are hypochromic and have low amount of haemoglobin.

**g.Low mean corpuscular haemoglobin concentration or MCHC**

In this patient with severe hookworm infection with multiple hookworms in duodenum, mean corpuscular haemoglobin concentration or MCHC also is low-29.9% [normal range 32-36%].

**h.Peripheral smear examination**

In this patient with severe hookworm infection with multiple hookworms in duodenum, peripheral smear examination showed severe microcytic hypochromic anaemiawith anisopoikilocytosis.

**Anisocytosis**

An abnormal variation in cell volume is called anisocytosis.

**Poikilocytosis**

Irregularly shaped cells is called poikilocytosis.

In this patient with severe hookworm infection with multiple hookworms in duodenum, peripheral smear showed severe microcytic hypochromic anaemia, mean corpuscular volume or MCV was low, haemoglobin was low, serum ferritin and transferrin saturation were found to be very low.Hence this patient could be labelled as having iron deficiency anaemia. In this patient serum iron is also very low.

The following features increase the post-test probability of a diagnosis of iron deficiency anaemia being correct: reduced mean cell haemoglobin, hypochromia (decreased haemoglobin concentration in RBC), increased variation in cell size (Red cell width or RDW),an abnormal variation in cell volume (anisocytosis) irregularly shaped cells (poikilocytosis) and reduced mean cell haemoglobin concentration.

In this patient with severe hookworm infection with multiple hookworms in duodenum also,mean corpuscular haemoglobin is very low, mean corpuscular haemoglobin concentration also is low, peripheral smear showed an abnormal variation in cell volume (anisocytosis) and irregularly shaped cells (poikilocytosis).

## IV. Discussion

**1. Importanceof serum ferritin and transferrin saturation in the diagnosis of iron deficiency anaemia**

**a.Low serum ferritin and transferrin saturation along with low haemoglobin indicate iron deficiency anaemia.**

The patients having anaemia(haemoglobin<12g%) with mean corpuscular volume or MCV< 78 cuµor fl, serum ferritin < 12ng/ml ,transferrin saturation <16% and microcytic hypochromic RBCs on peripheral smear were labelled as having iron deficiency anaemia(21) .

Hence our patientwith severe anaemia with hemoglobin -3.2g%,mean corpuscular volume or MCV 50.7femolitres or fl,serum ferritin 1.4 ng/ ml,transferrin saturation 5%and microcytic hypochromic RBCs on peripheral smear has iron deficiency anaemia.

**b.Low hemoglobin alone without the values of serum ferritin and transferrin saturation cannot be labelled as iron deficiency anaemia.**

Our patient with mild anaemiawith hemoglobin-11.7g%, mean corpuscular volume or MCV-76.5 femolitres or flcannot be labelled as iron deficiency anaemiasince serum ferritin, transferrin saturation and peripheral smear was not done for the patient.Hence low serum ferritin and transferrin saturation along with low haemoglobin,

low mean corpuscular volume or MCV and microcytic hypochromic anaemia in peripheral smear only indicate iron deficiency anaemia.Lowhemoglobin and low mean corpuscular volume or MCV alone without the values of serum ferritin and transferrin saturation cannot be labelled as iron deficiency anaemia.

**2.Differences between iron deficiency and iron deficiency anemia**

Iron deficiency has generally been defined as an absence of iron stores( very low serum ferritin) while iron deficiency anaemiais defined as the absence of iron stores( very low serum ferritin) but with a haemoglobin concentration below a defined threshold.

Iron deficiency is defined as serum ferritin <13 microg/l and iron deficiency anemia as serum ferritin <13 microg/l and haemoglobin<5th percentile in iron replete pregnant women(22). A serum ferritin below 15 – 20 micrograms/L in a person with microcytic anaemia confirms iron deficiency anaemia.

Low serum ferritin and low transferrin saturation with normal haemoglobin, normal mean corpuscular volume[ MCV ] and normocytic normochromic RBCs on peripheral smear indicate iron deficiency without anaemia.

Low serum ferritin and low transferrin saturation with low haemoglobin, low mean corpuscular volume[ MCV ] and microcytic hypochromic RBCs on peripheral smear indicate iron deficiency anaemia .

**a.Iron deficiency without anaemiaor iron deficiency alone or latent iron deficiency**

Iron deficiency without anaemia(ID-A) is generally considered to correspond to a degree of dietary iron deficiency sufficient to deplete ferritin stores and to decrease iron concentrations in some tissues, but not sufficient to reduce hemoglobin to the point of anemia. Patients with normal haemoglobin, but with low serum ferritin were considered as suffering from latent iron deficiency (23).

**b.Iron deficiency with anaemiaor iron deficiency anaemia**

But our patient with severe anaemia had iron deficiency sufficient to deplete ferritin stores and to decrease iron concentrations in some tissues and also had very low hemoglobin(haemoglobin3.2g%) and hence had iron deficiency with anemia or iron deficiency anemia.

Serum ferritin is a surrogate marker of stored iron(23). When serum ferritin is low without low haemoglobin, it is called latent iron deficiency, whereas when there is also low hemoglobin, it is iron deficiency anemia(23).Hence serum ferritin provides the most useful indirect estimate of a person's iron stores in both latent iron deficiency and iron deficiency with anaemia.

**3.Iron deficiency without anaemiaor latent iron deficiency**

The patients without anaemia and having haemoglobin≥12gm%, MCV> 78cuμ or fl, transferrin saturation <16%, ferritin <12ngm/ml and normocytic normochromic RBCs on peripheral smear were categorized as having latent iron deficiency or iron deficiency without anaemia(21) .

Out of the 14 patients with hookworms in duodenum taken into consideration for our study, 5 patients did not have anaemia( haemoglobin≥12g%). But serum ferritin, transferrin saturation, mean corpuscular volume or MCV and peripheral smear were not done for these 5 patients without anaemia. But the patients without anaemia and having haemoglobin≥12g% can be labelled as iron deficiency without anaemiaor latent iron deficiency only if serum ferritin, transferrin saturation,mean corpuscular volume or MCV and peripheral smear were done and only if serum ferritin is< 12ng/ml [normal range 18-160 ng/ ml] and transferrin saturation is<16%[normal range20-50%] and only if mean corpuscular volume or MCVis>78 cuμor fland peripheral smear showed normocytic normochromic RBCs.

Hence none of these 5 patients without anaemia( haemoglobin≥12g%) with hookworms in duodenum taken into consideration for our study can be labelled as having iron deficiency without anaemiaor latent iron deficiency since only haemoglobin was done for these 5 patients and serum ferritin, transferrin saturation,mean corpuscular volume or MCV and peripheral smear could not be done for these 5patients without anaemia.

Hence even in patients without anaemia( haemoglobin≥12g%)serum ferritin, transferrin saturation, mean corpuscular volume or MCV and peripheral smear should be done to diagnose iron deficiency without anaemiaor latent iron deficiency.

## V. Conclusion

1.Thepatients having anaemia (haemoglobin<12g%) with mean corpuscular volume or MCV< 78 cuμor fl, serum ferritin < 12ng/ml, transferrin saturation <16% and microcytic hypochromic RBCs on peripheral smear were labelled as having iron deficiency anaemia.

2.Hence our patient with severe anaemia with low hemoglobin(3.2g%), low mean corpuscular volume or MCV (50.7femolitres or fl),low serum ferritin [1.4 ng/ ml],low transferrin saturation [5%]and microcytic hypochromic RBCs on peripheral smear has iron deficiency anaemia.
3.Lowhemoglobin and low mean corpuscular volume or MCV alone without the values of serum ferritin and transferrin saturation cannot be labelled as iron deficiency anaemia. Hence our patient with mild anaemiawith low hemoglobin( hemoglobin11.7g%), low mean corpuscular volume or MCV (76.5 femolitres or fl)cannot be labelled as havingiron deficiency anaemiasince serum ferritin, transferrin saturation was not done for the patient.
4.Thepatients without anaemia and having haemoglobin≥12g%, MCV> 78 cuμor fl, ferritin <12ng/ml , transferrin saturation <16% and normocytic normochromic RBCs on peripheral smear were categorized as having iron deficiency without anaemiaor latent iron deficiency.
5.Hencenone of the 5patients without anaemia( haemoglobin≥12g%) with hookworms in duodenum in our study can be labelled as having iron deficiency without anaemiaor latent iron deficiency since only haemoglobin was done for these 5 patients and serum ferritin, transferrin saturation, mean corpuscular volume or MCV and peripheral smear could not be done for these 5 patients without anaemia.
6.Hence low serum ferritin and transferrin saturation along with low haemoglobin, low mean corpuscular volume or MCV and microcytic hypochromic anaemia in peripheral smear indicate iron deficiency anaemia.
7.But low serum ferritin and transferrin saturation along with normal haemoglobin, normal mean corpuscular volume or MCV and normocytic normochromic RBCs on peripheral smear indicate iron deficiency without anaemiaor latent iron deficiency.
8.Hence low serum ferritin and transferrin saturation occur both in iron deficiency without anaemia and in iron deficiency anaemia. Low serum ferritin and transferrin saturation along with normal haemoglobin indicate iron deficiency without anaemia. Low serum ferritin and transferrin saturation along with low haemoglobin indicate iron deficiency anaemia.
9.Hence in addition to haemoglobin estimation ,serum ferritin and transferrin saturation are the most important investigations which help to differentiate between iron deficiency without anaemiaor latent iron deficiency and iron deficiency anaemia.

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