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A Detailed Study Of Five Stages Of Iron Deficiency In Patients With Severe Anaemia Due To Hookworm Infection

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Abstract:
Objective:A detailed study of 5 stages of iron deficiency was done in patients with severe anaemia due to hookworm infection.
Methods: A study of 1307 patients who had undergone upper gastro-intestinal endoscopy for a period of 5yearsand one month from May 2009 to May 2014was carried out.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, peripheral smear examination was also done in addition to haemoglobin estimation . But in one patient with severe anaemia, serum ferritin, transferrin saturation,serum iron,mean corpuscular volume or MCV, mean corpuscular haemoglobin or MCH were also done in addition to haemoglobin estimationand peripheral smear examination. Symptoms and signs of the patient were also noted. The results were found as given below.
Results: In one patient with severe anaemia due to hookworm infection, serum ferritin which indicate first stage of iron deficiency, transferrin saturation and serum iron which indicate second stage ,haemoglobin estimation which indicate third stage,mean corpuscular volume or MCV and mean corpuscular haemoglobin or MCH which indicate fourth stage of iron deficiency were all found to be very low The peripheral smear of the patient showed severe microcytic hypochromic anaemia which also indicate fourth stage of iron deficiency. The patient also had symptoms and signs of iron deficiency such as shortness of breath, weakness, dizziness, and pallor which indicate fifth or very late stage of iron deficiency.
Conclusion: Hence estimation of serum ferritin ,transferrin saturation ,serum iron, haemoglobin, mean corpuscular volume (MCV) and mean corpuscular hemoglobin (MCH) and symptoms and signs of iron deficiency indicate the various stages of iron deficiency in patients with severe anaemia due to hookworm infection.

Keywords:serum ferritin ,transferrin saturation ,serum iron,haemoglobin estimation, mean corpuscular volume , mean corpuscular haemoglobin.

Introduction:

Many studies have also shown the presence of severe anaemia in severe hookworm infection(1 to 17). But so far detailed study of the 5 stages of iron deficiency was not done in patients with severe anaemia due to hookworm infection. Hence a detailed study of the 5 stages of iron deficiency

in patients with severe anaemia due to hookworm infection 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 1307 patients who had under gone upper gastro-intestinal endoscopy for a period of 5years and one month from May 2009 to May 2014 was carried out. 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 or13g% in men. Severe anaemia is taken as haemoglobin<7g/dl or g% . In patients with severe anaemia, peripheral smear examination was also done in addition to haemoglobin estimation . But in one patient with severe anaemia, serum ferritin, transferrin saturation, serum iron, mean corpuscular volume or MCV, mean corpuscular haemoglobin or MCH were also done in addition to haemoglobin estimation and peripheral smear examination. Symptoms and signs of the patient which indicate fifth stage of iron deficiency were also noted. The results were found as given below.

Results:

Outof these 1307 patients, 14 patients found to have hookworms in duodenum were taken into consideration for our study.Outofthese14 patients with hook worm infection, 2 patients were found to have severe anaemia. In one patient with severe anaemia, serum ferritin which indicate first stage of iron deficiency, transferrin saturation and serum iron which indicate second stage ,haemoglobin estimation which indicate third stage,mean corpuscular volume or MCV, mean corpuscular haemoglobin or MCH and peripheral smear examination which indicate fourth stage of iron deficiency were also done . Symptoms and signs of the patient which indicate fifth stage of iron deficiency were also noted. The results were found as given below.

Serum ferritin or storediron [decreased in stage 1 of iron deficiency]

Stage 1of iron deficiency is characterized by decreased iron stores and serum ferritin level falls to < 20 ng/mL.In our patient also, serum ferritin is very low-1.4 ng/ mlindicating exhausted iron stores.

Percent transferrin saturation and serum iron[decreased in stage 2 of iron deficiency]

During stage 2 of iron deficiency, erythropoiesis is impaired. Erythropoiesis is impaired when transferrin saturation falls to < 16%and serum iron falls to < 50 µg/dL (18). In our patient, transferrin saturation is very low and is only 5% and serum iron is very low-20µg /dL indicating severely impaired erythropoiesis. Other studies have also shown very low level of serum iron in patients with severe anaemia due to hookworm infection diagnosed by doing endoscopy(1, 3,4, 5). One study has also shown that decreased serum transferrin saturation (transferrin saturation < 16%)implies an inadequate supply of iron to the marrowin patients with iron deficiency anemia (19).

Stage 3 of iron deficiency (iron deficient anemia with decrease in haemoglobin)

During stage 3of iron deficiency, anemia or reduction in haemoglobin with normal-appearingred blood cells and indices develops. Hookworm infection causes blood loss which results in iron deficiency anemia.In our patient also with severe hookworm infection haemoglobin is very low3.2g%[normal range12-16g%]. Severe anaemia (haemoglobin<7g/dl or g%) is reported to occur in patients with severe anaemia due to hookworm infection diagnosed by doing endoscopy in many studies (1 to 17).

Stage 4 of iron deficiency [Microcytosis and hypochromia]

Our patient had also undergone peripheral smear examination which showed severe microcytic anaemiaand severe hypochromic anaemia.

Microcytosis or low mean red cell volume

In our patient, mean red cell volume or MCV is very low and is only 50.7femolitres or fl[normal range 82-92 fl]. Other studies have also shown that the mean corpuscular volume (MCV) is lower[microcytic] in patients with severe anaemia due to hookworm infection diagnosed by doing endoscopy(1 to 6).

Hypochromiaorlow meancorpuscular haemoglobin

Mean corpuscular haemoglobin or MCH was also very low 15 picograms or pg [normal range 27-32pg] in our patient. Studies have also shown that the mean corpuscular hemoglobin (MCH) is lower[hypochromia] in patients with severe anaemia due to hookworm infection diagnosed by doing endoscopy(1, 2).

Symptoms and signs of iron deficiency[occur in stage 5 of iron deficiency]

Our patient also had symptoms and signs of iron deficiency such as shortness of breath, weakness, dizziness, and pallor which indicate fifth or very late stage of iron deficiency.One study has also shown the occurence of weakness or fatigue and shortness of breath in a patient with severe anaemia due to hookworm infection diagnosed by doing endoscopy(11).

Discussion:

Iron deficiency is the most common micronutrient deficiency in the world.It can affect affect all populations and age groups, but the most vulnerable groups are women and children(18).Hookworm infectionis the most common cause of iron deficiency in developing nations.

Iron deficiency

Iron deficiency develops in stages.

Early stage and late stage of iron deficiency

In the early stage, iron requirement exceeds intake, causing progressive depletion of bone marrow iron stores indicated by decreased serum ferritin level.

During later stages, iron deficiency impairs red blood cells synthesis, ultimately causing anemia indicated by decreased haemoglobin.

Introduction about the various stages of iron deficiency.

The first stage (iron depletion) is characterized by the absence of measurable iron stores indicated by decreased serum ferritin level.

The secondstage (iron deficient eythropoiesis)is characterized by evidence of a restricted iron supply indicated by decreased transferrin saturation and serum iron in the absence of anaemia.

The third stage (iron deficiency anaemia)is characterized by a haemoglobin concentration that falls below the normal threshold for age and sex.

Stage 4of iron deficiency (microcytosis andhypochromia)is characterized bylow mean corpuscular volume and low mean corpuscular haemoglobin.

Stage5 of iron deficiency is characterized by the presence ofsymptoms and signs of iron deficiency.

Detailed discussion about the five stages of iron deficiency.

Stage 1 of iron deficiency (iron depletion with decrease in serum ferritin)

Stage 1of iron deficiency is characterized by decreased bone marrow iron stores and decreased serum ferritin level, but serum iron and haemoglobin remain normal.. Stage 1 is “iron depletion”, at which there is an isolated decrease in serum ferritin levels (20).Serum ferritin concentration is a reliable index of iron stores (1

ng/mL of serum ferritin indicates about 8 mg of storage iron). Serum ferritin does not exhibit diurnal variations as are seen with serum iron levels .Thus serum ferritin level is decreased in all stages of iron deficiency and may be the first indication of developing iron deficiency. Serum ferritin is generally considered the single best test to detect iron deficiency .

Stage 2 of iron deficiency (iron deficient erythropoiesis with decrease in transferrin saturation and serum iron)

Stage 2 is "iron deficient erythropoiesis". (20). At this stage, the supply of iron to the erythroid marrow is inadequate, the serum ferritin level is low (10-20 µg/L), transferrin saturation is decreased (<16%)and serum iron falls to < 50 µg/dL (20).

Stage 3of iron deficiency(iron deficient anemia with decrease in haemoglobin)

Stage 3 is "iron deficient anemia" (IDA), in which hemoglobin levels are subnormal(20). R Stoltzfus, emphasizes that haemoglobin concentration is the key indicator for iron deficiency anemia (IDA) surveillance(21). Hookworm infection produces iron deficiency anaemia and iron deficiency anaemia was defined by low haemoglobin (22to26). Anaemia is defined as the reduction in haemoglobin concentrations below the expected values[WHO,1972] (24).

Stage 4 of iron deficiency [Microcytosis and hypochromia]

During stage 4, microcytosis and hypochromia develop.

Microcyticred blood cellsor RBCs

When the mean red cell volume or mean corpuscular volume[MCV]is lowandis<80 femolitres or fl,the blood is said to be microcytic. Microcyticred blood cells indicate that thered blood cells are very small with small volume.In our patient, mean red cell volume or MCV is very low indicating that the red blood cells are very small with small volume and aremicrocytic.

Hypochromia

Mean corpuscular haemoglobin or MCH is low in hypochromic anaemia.Hypochromicred blood cells indicate that the red blood cells or RBCs have low amount of haemoglobin.Mean corpuscular haemoglobin or MCH is also very low in our patient indicating that the red blood cells or RBCsare hypochromic andhave low amount of haemoglobin.

One study has also shownthat the mean corpuscular volume (MCV) is lower[microcytic] and mean corpuscular hemoglobin (MCH) is lower[hypochromia] in patients withanaemiadue to hookworm infection(22).

Other studies have also shown that the mean corpuscular volume (MCV) is lower[microcytic] and mean corpuscular hemoglobin (MCH) is lower[hypochromia] in patients with iron deficiency anaemia (19,27to 29).

Stage 5 of iron deficiency(symptoms and signs of iron deficiency).

During stage 5, iron deficiency affects tissues, resulting in symptoms and signs.Most symptoms of iron deficiency are due to anemia. Such symptoms include fatigue, loss of stamina, shortness of breath, weakness, dizziness, and pallor. Our patient also had symptoms and signs of iron deficiency which indicate fifth or very late stage of iron deficiency.

Our patient was in fifth or very late stage of iron deficiency

Our patient with severe anaemia due to hookworm infection was in fifth or in late stage of iron deficiency since serum ferritin ,transferrin saturation and serum iron of the patient were extremely low in addition to very low haemoglobin, mean corpuscular volume (MCV) , mean corpuscular hemoglobin (MCH) and severe

microcytic hypochromic anaemia in peripheral smear and sincethe patient also had symptoms and signs of iron deficiency such as shortness of breath, weakness, dizziness, and pallor.

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Conclusion:

1.Low serum ferritin indicates first stage of iron deficiency (iron depletion).

2.Low transferrin saturation and serum iron indicate second stageof iron deficiency(iron deficient eythropoiesis).

3. Low haemoglobin indicates third stageof iron deficiency (iron deficiency anaemia).

4. Low mean corpuscular volume or MCV and low mean corpuscular haemoglobin or MCH indicate fourth stage of iron deficiency (microcytosis andhypochromia).

5.Presence of symptoms and signs of iron deficiency such as shortness of breath, weakness, dizziness, and pallor indicate fifth or very late stage of iron deficiency.

6. Hence our patient with severe anaemia due to hookworm infection wasin fifth or late stage of iron deficiency since serum ferritin ,transferrin saturation ,serum iron, haemoglobin, mean corpuscular volume (MCV) and mean corpuscular hemoglobin (MCH) were extremely low and since the patient also had symptoms and signs of iron deficiency.

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