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Iron Profile status and its Usefulness in the Assessment of Iron Deficiencies in Selected Population

Sheikh Matinuddin, *Junaid Mahmood Alam, Sheikh Khalid Mahmood, Mahwish Amin

Department of Clinical Biochemistry Laboratory services, Liaquat National Hospital and Medical College, Karachi-74800. Pakistan

Abstract Iron deficiency and the resultant anemia is the most common form of clinical condition. Iron is an essential component of the hemoglobin molecule: without iron the bone marrow is unable to produce hemoglobin. The purpose of the study was to determine the gender-wise distribution of the sensitivity, specificity and iron profile status of patients from selected population suspected of or diagnosed with anemia and iron deficiencies. The subjects were patients from age group < 3 years to 50 years. A total of 991 patients were included in the study with 487 males and 504 females for the period January 2012 to Dec 2016. The males and females are further classified into infants with age < 3 yrs, children with age between 4 and 11 years and adult between age group 20 to 50 years. The iron profile status showed that in male infants 10.8% exhibit low iron levels, 11.49% low ferritin and 13.55% elevated TIBC levels. Similarly the iron profile status was evaluated in females and it was noted that 17.85% female infant showed low iron levels, 17.06% low ferritin levels, and 19.04% elevated TIBC concentrations. Somewhat similar pattern was noted in female children as well where 15.67% showed low iron and 16.26% exhibited low ferritin levels with compensatory high levels of TIBC in 16.46% (n = 83) female children. It was concluded that infants and children were noted to be more affected with low iron, low ferritin and compensatory high TIBC levels. The sensitivity and specificity of ferritin is more than 80% and 90%, respectively, followed by % transferring levels.

Keywords Iron profile, iron deficiencies

1. Introduction

Iron deficiency and the resultant anemia is the most common form of anemia. Iron is an essential component of the hemoglobin molecule: without iron the bone marrow is unable to produce hemoglobin. The red cell count falls and those which do enter circulation are smaller than normal (microcytic) and lacking in hemoglobin, hence they are pale (hypochromic). Similarly serum ferritin concentration is now well established tool for the assessment of body iron stores in healthy individuals [1-3]. It has been successfully applied to nutritional surveys of people in Western countries including Canada and the United States in 70s [1-5]. It is also emphasized that the deficiency of iron may be *absolute* (there is no iron available for the production of hemoglobin - this is true iron deficiency anemia) or *relative* (the iron is present in storage in the marrow but other reasons prevent its incorporation into red blood cells). It is documented that the serum ferritin concentration is declined in iron deficiency anemia and is elevated in iron loading disorders [5-8]. However the clinical application of its measurement has been limited by the previous finding that common conditions such as cirrhosis, chronic inflammation and hematologic malignant conditions increase its concentration out of proportion to the size of body iron stores [1, 2-6]. The judicious inference of the

imprecise effects on the efficacy of measuring the serum iron profile, including iron, ferritin total iron binding capacity (TIBC) and % transferrin concentrations to detect iron deficiency and related anemia have not been evaluated in correlations. However, major impact could not been determined due to non-availability of larger groups including of infants, children, adults of both genders.

The purpose of the study described in this paper was to determine, under general conditions in a tertiary care hospital, the gender-wise distribution of the sensitivity, specificity and iron profile status of patients from selected population suspected of or diagnosed with anemia and iron deficiencies.

2. Materials and Methods

2.1. Selection of subjects: The subjects were patients from age group < 3 years to 50 years. A total of 991 patients were included in the study with 487 males and 504 females for the period January 2012 to Dec 2016.

3.2. Analysis: Hemoglobin was determined by automated Sysmex analyzer (USA), whereas ferritin and iron were analyzed by chemistry analyzer Hitachi 912, Cobas c501 and Modular Cobas 6000. TIBC was determined by semi-automated method (Randox-Monza), were as transferrin was calculated using the formula, 100x iron/TIBC [5].

2.3. Analysis of data: The analysis of data to assess the usefulness of measuring the iron profile components such as serum ferritin concentration to predict the presence or absence of body iron stores was calculated according to the method and protocols established previously [1]. It calculates the sensitivity, specificity and efficiency and predictive value of ferritin, iron and % transferrin in comparison with the others expressing the fractions as percentages.

3. Results

Results are summarized in Table 1 and 2. In total patients (n = 991) selected, n = 487 (49.14%) are males, n = 504 (50.85%) females. The males and females are further classified into infants with age < 3 yrs, children with age between 4 and 11 years and adult between age group 20 to 50 years. The iron profile status showed that in male infants 10.8% exhibit low iron levels, 11.49% low ferritin and 13.55 elevated TIBC levels. Similarly the iron profile status was evaluated in females and it was noted that 17.85% female infant showed low iron levels, 17.06% low ferritin levels, and 19.04% elevated TIBC concentrations. Somewhat similar pattern was noted in female children as well where 15.67% showed low iron and 16.26% exhibited low ferritin levels with compensatory high levels of TIBC in 16.46% (n = 83) female children. Normal iron values were 1-3 years in females, 25-101 microgram/dl, males 29-91 microgram/dl; adults, Females, 37-145 microgram/dl and males, 59-158 microgram/dl. Reference values of TIBC concentrations in infants are 100-400 microgram/dl, adult 250-425 microgram/dl. Ferritin levels in normal children and adults are; children 3 months to 16 years, 20-200 ng/ml, adult females, 15-150 ng/ml and males 30-400 ng/ml.

Table 1: Iron profile status (Iron, Ferritin, TIBC, % transferrin) in selected population (n = 991; Males = 487, females = 504)

Population	**number**	**Iron**			**Ferritin**			**TIBC**			**% Transferrin**		
Males	N	↓	↑	**N**	↓	↑	**N**	↓	↑	**N**	↓	↑	**N**
Infants (< 3 years)	146	53	16	77	56	19	70	38	66	41	46	5	77
Children (4- 11 yrs)	159	41	22	96	20	33	91	26	50	83	20	10	129
Adults (20-50 yrs)	182	21	29	132	10	29	143	13	26	140	10	16	122
Females	N												
Infants (< 3 yrs)	141	90	20	31	86	28	27	29	96	16	98	21	22
Children (4-11 yrs)	162	79	22	39	82	21	41	26	83	19	83	18	22
Adults (20-50 yrs)	201	65	39	97	59	31	110	41	82	60	39	20	141

Note: Total number of patients n = 991, Males = 487; females = 504. ↓ = Low levels; ↑ = high levels, **N** = normal levels

Table 2: Sensitivity, specificity and efficiency of ferritin, iron, transferring values in selected population

Components	Sensitivity %	Specificity %	Efficiency %
Iron levels	81	20	41
Ferritin	83	94	90
Transferrin %	80	59	46
Iron + ferritin	80	41	50
% transferring + ferritin	86	52	62

Note: The data calculated according to Mazza et al., 1978 [1]

4. Discussion

Ferritin plays a significant role in the absorption, storage, and release of iron. As the storage form of iron, ferritin remains in the body tissues until it is needed for erythropoiesis [www. Mayo Clinics labs, 2013, 1-6]. When needed, the iron molecules are released from the apo-ferritin shell and bind to transferrin, the circulating plasma protein that transports iron to the erythropoietic cells. A low serum ferritin value is thought to be the best laboratory indicator of iron depletion. Virtually all patients with low serum iron and low ferritin have iron deficiency. Serum ferritin is clinically useful in distinguishing between iron-deficiency anemia (serum ferritin levels diminished) and "anemia of chronic disease" (serum ferritin levels usually normal or elevated) [1, 7-11]. Serum ferritin is a good screening test in separating erythrocyte microcytosis due to iron deficiency (low values) from microcytosis related to thalassemia minor (normal or high values). An iron-depletion state with a decreased serum ferritin value is quite common among menstruating and reproductively active females and in children [11-16]. Ferritin is an acute phase reactant. A normal serum ferritin value, therefore, cannot be used to exclude iron deficiency if a hepatic, malignant, or inflammatory condition is present. A high serum ferritin value is seen in hemochromatosis and other iron-overload states, as well as acute hepatitis, Gaucher disease, malignancies, and chronic inflammatory disorders.

Regarding TIBC, iron and % transferrin [www. Mayo Clinics Labs, 2013, 17-21], ingested iron is absorbed primarily from the intestinal tract and is temporarily stored in the mucosal cells as Fe(III)-ferritin. Ferritin provides a soluble protein shell to encapsulate a complex of insoluble ferric hydroxide-ferric phosphate. On demand, iron is released into the blood by mechanisms that are not clearly understood, to be transported as Fe(III)-transferrin. Transferrin is the primary plasma iron transport protein, which binds iron strongly at physiological pH. Transferrin is generally only 25% to 30% saturated with iron. The additional amount of iron that can be bound is the unsaturated iron-binding capacity (UIBC) [1, 12, 16, 22]. The total iron binding capacity (TIBC) can be indirectly determined using the sum of the serum iron and UIBC. Knowing the molecular weight of the transferrin and that each molecule of transferrin can bind 2 atoms of iron, TIBC and transferrin concentration is inter-convertible.

It is known fact that the average amount of iron in the average adult male is 4gm and in the average adult female 2.5gm. The normal North American diet contains approximately 15-20mg of iron per day. Most is present in meat and green vegetables; approximately 1.0mg is absorbed each day and just about an equal amount is lost in feces and sweat [14, 15, 17, 22]. As a result, the average adult's iron intake is in delicate balance, but is of little consequence as there is slightly more iron absorbed than lost and a store of iron is gradually accumulated. If, for some reason, the rate of iron loss increases, these stores can be depleted and an absolute iron deficiency develops. Such a deficiency requires large doses of supplemental iron to resupply the body stores and sufficient monitoring to prevent iron overload. The known and documented causes of iron deficiency includes, diet - uncommon except in children, failure to absorb, increased utilization (for example pregnancy, adolescent growth), atransferrinemia , failure to utilize (for example lead poisoning, chronic diseases) and blood loss [18-23]. Chronic blood loss is the most common cause of iron deficiency anemia. It must be remembered that anemia in iron deficiency develops slowly. The type and severity of the anemia varies with time. The development stages are, depletion of iron stores, decreased ferritin levels, no anemia, increased transferrin levels, no anemia, fall in serum iron, no anemia, development of normocytic, normochromic anemia and development of microcytic, hypochromic anemia [23-25].

5. Conclusion

In conclusion, the present study described the iron profile status in 991 patients of both genders. Infants and children were noted to be more affected with low iron, low ferritin and high TIBC levels. The sensitivity and specificity of ferritin is more than 80% and 90%, respectively, followed by 80% and more than 50% that of transferring levels.

References

1. Mazza, J., Barr, R. M., McDonald, J.W.D, Valberg, L.S. (1978) Usefulness of serum ferritin concentration in the detection of iron deficiency in a general hospital. Can Med Ass. J., 119: 884-886.
2. Bhatti, A.S., Mahida, V.I., Gupte, S.C. (2007). Iron status of Hindu brahmin, Jain and Muslim communities in Surat, Gujarat. Indian J Hematol Blood Transfus. 23(3-4):82-7.
3. Wells, A.M., Haub, M.D., Fluckey, J., Williams, D.K., Chernoff, R., Campbell, W.W. (2003) Comparisons of vegetarian and beef-containing diets on hematological indexes and iron stores during a period of resistive training in older men. J Am Diet Assoc. 103(5):594-601.
4. Laskowska-Klita, T., Chełchowska, M., Ambroszkiewicz, J., Gajewska, J., Klemarczyk, W. (2011). The effect of vegetarian diet on selected essential nutrients in children. Med Wieku Rozwoj. 2011; 15(3):318-25.
5. Djalali, M., Neyestani, T.R., Bateni, J., Siassi, F. (2006) The effect of repeated blood donations on the iron status of Iranian blood donors attending the Iranian blood transfusion organization. Int J Vitam Nutr Res. 76(3):132-7.
6. Snyder, A.C., Dvorak, L.L., Roepke, J.B. (1989) Influence of dietary iron source on measures of iron status among female runners. Med Sci Sports Exerc. 21(1):7-10.
7. Milman, N., Ingerslev, J., Graudal, N. (1990). Serum ferritin and iron status in a population of 'healthy' 85-year-old individuals. Scand J Clin Lab Invest. 50(1):77-83.
8. Peter, F., Wang, S. (1981) Serum iron and total iron-binding capacity compared with serum ferritin in assessment of iron deficiency. Clin Chem. 27(2):276-9.
9. Zorgati, M.M., Hafsia, R., Bahlous, A., Bahri, S., Ben-Ammar, S. (2009). [Soluble tranferrin receptor in the biological diagnosis of iron deficiency. Report of 24 cases]. Tunis Med. 87(12):818-23. French.
10. Ambroszkiewicz, J., Klemarczyk, W., Gajewska, J., Chełchowska, M., Rowicka, G., Ołtarzewski, M., Laskowska-Klita, T. (2011). Serum concentration of adipocytokines in prepubertal vegetarian and omnivorous children. Med Wieku Rozwoj. 15(3): 326-34.
11. Ho, C.H. (2002) The diagnostic role of serum transferrin receptor in patients with various anemia. Zhonghua Yi Xue Za Zhi (Taipei). 65(2):55-60.
12. Chung, M., Moorthy, D., Hadar, N., Salvi, P., Iovin, R.C., Lau, J. (2012). Biomarkers for Assessing and Managing Iron Deficiency Anemia in Late-Stage Chronic Kidney Disease [Internet]. Rockville (MD): Agency for Healthcare Research and Quality (US); 2012 Oct.
13. Naghii, M.R, Mofid, M. (2007) Impact of daily consumption of iron fortified ready-to-eat cereal and pumpkin seed kernels (Cucurbita pepo) on serum iron in adult women. Biofactors. 30(1):19-26.
14. Hanif, E., Ayyub, M., Anwar, M., Ali, W., Bashir, M.. (2005) Evaluation of serum transferrin receptor concentration in diagnosing and differentiating iron deficiency anaemia from anaemia of chronic disorders. J Pak Med Assoc. 55(1):13-6.
15. Kapur, G., Patwari, A.K., Narayan, S., Anand, V.K. (2003). Iron supplementation in children with celiac disease. Indian J Pediatr. 70(12):955-8.
16. Milman, N., Cohn, J. (1984). Serum iron, serum transferrin and transferrin saturation in healthy children without iron deficiency. Eur J Pediatr. 143(2):96-8.
17. Kuvibidila, S., Yu, L., Warrier, R.P., Ode, D., Mbele, V.. (1994). Usefulness of serum ferritin levels in the assessment of iron status in non-pregnant Zairean women of childbearing age. J Trop Med Hyg. 97(3):171-9.

18. Madanat, F., El-Khateeb, M., Tarawaneh, M, Hijazi, S.. (1984) Serum ferritin in evaluation of iron status in children. Acta Haematol. 71(2):111-5.
19. Chełchowska, M., Laskowska-Klita, T., Leibschang, J. (2007) [Concentration of ferritin, transferrin and iron as a markers of iron deficiency in healthy women in reproductive age]. Pol Merkur Lekarski. 22(127):25-7. Polish.
20. Genc, S., Erten, N., Karan, M.A., Besisik, S.K., Saka, B., Tascioglu, C., Sivas, A.(2004) Soluble transferrin receptor and soluble transferrin receptor-ferritin index for evaluation of the iron status in elderly patients Tohoku J Exp Med. 202(2):135-42.
21. Angeles, Vázquez López M., Molinos, F.L., Carmona, M.L., Morales, A.C., Muñoz Vico, F.J., Muñoz, J.L., Muñoz, Hoyos. A. (2006). Serum transferrin receptor in children: usefulness for determinating the nature of anemia in infection. J Pediatr Hematol Oncol. 28(12):809-15.
22. Singh, U., Sinha nee Mehrotra, S., Gupta, H.P., Natu, S.M., Deo, S., Bagchi, S. (2011) Once a week (200 mg) elemental iron: an effective option for prophylaxis in non-anaemic pregnant women. J Indian Med Assoc. 109(9):654-6.
23. Gupta, S., Uppal, B., Pawar, B. (2009) Is soluble transferrin receptor a good marker of iron deficiency anemia in chronic kidney disease patients? Indian J Nephrol. 1 9(3):96-100.
24. Sarkate, P., Patil, A., Parulekar, S., Rege, N.N., Samant, B.D., Lokhande, J., Gupta, A., Kulkarni, K. (2007). A randomised double-blind study comparing sodium feredetate with ferrous fumarate in anaemia in pregnancy. J Indian Med Assoc. 105(5):278, 280-1, 284.
25. Kapur, G., Patwari, A.K, Narayan, S., Anand, V.K. (2003) Iron supplementation in children with celiac disease. Indian J Pediatr. 70(12):955-8.