

Status of Some Minerals in Patients with Polycythemia using Colorimetric Method

Ahsan K. Abbas*
 Mohammed S. Al-Sayab **
 Mayssa J. Majeed *

Bsc, PhD
 BSc, PhD
 BSc, Msc

Summary:

Background: Polycythemia (or polycythaemia or erythrocytosis) is a condition in which there is a net increase in the total number of blood cells, primarily red blood cells, in the body. The overproduction of red blood cells may be due to a primary process in the bone marrow (a so-called myeloproliferative syndrome), or it may be a reaction to chronically low oxygen levels or, rarely, a malignancy. Minerals are the building blocks of our bodies. They are required for body structure, fluid balance, protein structures and to produce hormones. They are the key for the health of every body system and function. They act as co-factors, catalysts or inhibitors of all enzymes in the body.

Patients and Methods: Blood Calcium, iron & Magnesium concentrations was determined by using colorimetric method, while Potassium, Copper & Zinc concentration was determined by using flame atomic absorption spectrometry method.

Results: Obtained results showed that the level of Potassium, Calcium and zinc in polycythemic subjects were significantly higher than that of healthy subjects ($p < 0.05$), while serum iron, Copper in polycythemic subjects were significantly lower than that of healthy subjects. Magnesium level shows no significant difference between two studied groups.

Conclusion: Recent research indicates that minerals may play a significant role against a variety of degenerative diseases and processes.

Keywords: Polycythemia, Minerals, Sialic acid, calcium, iron, potassium, Copper, Zinc.

Fac Med Baghdad
 2010, Vol. 52, No. 1
 Received: May, 2009
 Accepted: Aug, 2009

Introduction:

Polycythemia Vera, or "PCV" for short, is a disorder of the bone marrow in which too many Red Blood Cells (RBC's) are produced. There are other types of Polycythemia will be discussed. PCV is not actually "cancer", since the Red Blood Cells that are overproduced do not go on to divide themselves. Rather, it is a "myeloproliferative disorder", which simply means that too many NORMAL Red Blood Cells are being made. A problem with any myeloproliferative disorder is that the bone marrow loses "equilibrium" and does not make necessary cells in the proper ratios. This impacts all the cells normally produced by the bone marrow (1, 2). The blood contains the mineral elements in two forms:

1. Those in colloid state suitable for cellular appropriation and thus not suited for elimination by the kidneys.
2. The mineral cellular wastes, which are dissolved in the plasma and destined for elimination. Trace minerals do not exist by themselves but in relationship to one another. Too much of one trace Element can lead to imbalances in others resulting in disease, rather than the absence of disease. Most trace Elements need to be in ionic form to be well-absorbed in

the intestine (3, 4). Electrolyte imbalance causes a variety of symptoms that can be severe. Electrolyte imbalance is commonly caused by loss of body fluids through prolonged vomiting, diarrhea, sweating or high fever. The most serious forms of electrolyte imbalance in cancer patients include high blood calcium levels. Electrolyte imbalance is commonly caused by loss of body fluids through prolonged vomiting, diarrhea, sweating, or high fever. All of these may be side effects of chemotherapy treatment. The kidneys play a critical role in regulating electrolytes. They control the levels of chloride in your blood and "flush out" potassium, magnesium and sodium. Therefore, a disturbance in blood levels of these electrolytes may be related to kidney function (5, 6).

Patients and Methods:

A total of 50 subjects were included in this study: 25 subjects are polycythemic patients; their age ranged between 35-50 years with a mean of (43 years). The other is normal healthy individuals their age was between 20-50 years with a mean of (36 years). Colorimetric Method was used for the measurement of calcium, Iron and magnesium concentrations, while flame atomic absorption spectrometry method was used for the measurement of serum potassium, copper & zinc level.

* Department of Physiological Chemistry, College of Medicine, University of Baghdad.

** Department of Chemistry, College of Dentistry, University of Baghdad

Results:

The characteristics of healthy subjects and polycythemic subjects are shown in table 1.

Table 1: basal characteristics of healthy subjects and polycythemic subjects:

Studied parameters	healthy subjects (mean $\pm$ SD)	polycythemic subjects (mean $\pm$ SD)
K mEq/L	4.6 $\pm$ 2.2	6.8 $\pm$ 2.2*
Ca mg/dl	8.9 $\pm$ 1.8	10.2 $\pm$ 1.8*
Fe mEq/L	2.6 $\pm$ 1.9	1.3 $\pm$ 1*
Mg mEq/L	3 $\pm$ 0.9	2.9 $\pm$ 1
Zn mEq/L	8.9 $\pm$ 2.9	13 $\pm$ 3.2*
Cu mEq/L	2.0 $\pm$ 0.8	0.88 $\pm$ 0.35*

Values are expressed as a mean $\pm$ SD, *P<0.05

This table shows that the level of serum Potassium, Calcium and Zinc in polycythemic subjects were significant higher than that of healthy subjects (p<0.05)

Serum iron& Copper in polycythemic subjects were significantly lower than that of healthy subjects (p<0.05).

Magnesium concentration shows no significant difference between polycythemic and healthy subjects.

Discussion:

The study is presented the content of physiologically active erythrocytic microelements (iron, copper, manganese, calcium, potassium and zinc) in erythrocytes of the peripheral venous blood in patients with polycythemia vera. Potassium is the major intracellular cation in the blood. It, along with sodium, helps to maintain osmotic balance and also involved in acid-base balance (7, 8). with many polycythemia complications, the blood become more acidic (due to hypertension) and potassium leaks of the body cells(9), as well as, in polycythemia, there are many more blood cells than normal, and these cells are high in potassium within them(10).increasing acidity of the blood, bursting of blood cells together increase blood potassium level(11).A common cause of mild or transient hypercalcemia is dehydration, because when there is less fluid in blood, the human bodies' blood become acidic, our bodies have no choice but to leech calcium out of our bones to neutralize the acid. Calcium concentrations rise in the blood (12, 13) as shown in tab. Magnesium should be evaluated in any animal with hypercalcemia (14) "During stress response, calcium ions rush inside the cell, and this alters the internal Mg: Ca, ratio. This change in ratio exhibits wide effects because, while magnesium and calcium are very similar in their chemistry, biologically these two elements function and react very differently. Magnesium and calcium are two sides of a physiological coin: they are antagonistic to one another yet come as a team." In the normal unstressed state, cellular Mg: Ca ratio is high. If this cannot be maintained due to lack of adequate body magnesium or an overwhelming amount of

body calcium, the ratio may not be able to maintain or return itself to its healthy nonstressed ratio. In such a case, the stress response, in the absence of an appropriate trigger, can occur. This can be seen when nutritional magnesium deficits cause high blood pressure or increase blood stickiness (platelet aggregation). Additionally, since a low Mg: Ca ratio can increase adrenaline secretion as well as cells' response to adrenaline, a too low magnesium state can keep the stress response from subsiding in a timely way. Even worse, when body magnesium becomes drastically low, this becomes a stress trigger in itself, alarming the body into further stress response with out enough magnesium to back it up, resulting in a low magnesium-high stress crisis that can end in sudden death (15, 16, 17, and 18). Low level of iron can be related that marrow contains more than the normal number of cells as a result of the overexpansion of the blood forming cells and is lacking iron, which has been used up making the additional red cell (19, 20).Copper is required in the production of hemoglobin, the vital component of red blood cells that picks up oxygen from the lungs and expressly carries it to cells of the body that require it. Consider that each red blood cell contains 200 million molecules of hemoglobin. Each molecule of hemoglobin is made up of an iron-containing part called heme and a protein part called globin, hence the name hemoglobin. There are about 35 trillion red blood cells in an average person's bloodstream. Consider that a red blood cell dies after 120 days, meaning our red bone marrow must produce 2,400,000 cells per second to maintain normal blood levels; one can better appreciate the impact of copper deficiency in hemoglobin production (21, 22, 23, and 24). The low pH in the stomach causes the formation of soluble zinc salts. These are absorbed from the duodenum and rapidly distributed to the liver, kidneys, prostate, muscles, bones, and pancreas. Zinc salts have direct irritant and corrosive effects on tissue, interfere with the metabolism of other ions such as copper, calcium, and iron, and inhibit erythrocyte production and function (25, 26). In summary, It was found that in polycythemia vera the calcium, potassium, iron copper and zinc in erythrocytes showed disturbances. These changes indicate the neoplastic character of proliferation of bone marrow in polycythemia vera. The changes are of compensatory-adaptative character and reflect the state of homeostasis in polycythemia vera.

References:

1. Passamonti F, Malabarba L, Orlandi E, Baratè C, Canevari A, Brusamolino E, Bonfichi M, Arcaini L, Caberlon S, Pascutto C, Lazzarino M (2003). "Polycythemia vera in young patients: a study on the long-term risk of thrombosis, myelofibrosis and leukemia". *Haematologica* 88 (1): 13-8.
2. MICHAEL RUBINKAM (2008). "Cancer cluster confirmed in northeast Pennsylvania.
3. Achenbach, C., Daying, H., Schweikart, P. et al. (1991): Unterschiedliche Effekte von Mg, Ca, Mn und Nifedipin auf den Na/Ca-Austausch während des Aktionspotentials der Herzmuskelzelle. *Int. Symposium Edinburgh New approaches in the Pathophysiology and Treatment of Cardiovascular Disease*.
4. Rose, Burton David; Post, Theodore (2001). *Clinical Physiology of Acid-Base and Electrolyte Disorders* (5th ed.). New York: McGraw-Hill. pp. 888-930. ISBN 0-07-134682-1
5. Kasper, Dennis L.; Harrison, Tinsley Randolph; Braunwald, Eugene; Fauci, Anthony S.; Hauser, Stephen L; Longo, Dan L.; Jameson, J. N. St C. (2005). *Harrison's Principles of Internal Medicine* (16th ed.). New York: McGraw-Hill. pp. 258-261. ISBN 0-07-140235-7
6. Alexander G. Schauss (2007): *Minerals and Human Health The Rationale for Optimal and Balanced Trace Element Levels*. Nutrients. Alan R. Liss, p. 2.
7. John M. Russell (2000) . "Sodium-Potassium-Chloride Cotransport". *Physiol. Rev.* 80: 211-276.
8. Michiels J (1997). "Erythromelalgia and vascular complications in polycythemia vera". *Semin Thromb Hemost* 23 (5): 441-54. doi:10.1055/s-2007-996121.
9. Thurmes PJ, Steensma DP (July 2006). "Elevated serum erythropoietin levels in patients with Budd-Chiari syndrome secondary to polycythemia vera: clinical implications for the role of JAK2 mutation analysis". *Eur. J. Haematol.* 77 (1): 57.
10. O'DONNELL, M. E., J. D. BRANDT, AND F. R. E. CURRY. Na-K-Cl cotransport regulates intracellular volume and monolayer permeability of trabecular meshwork cells. *Am. J. Physiol.* 268 (Cell Physiol. 37): C1067-C1074, 1995.
11. O'DONNELL, M. E. Endothelial cell sodium-potassium-chloride cotransport. Evidence of regulation by Ca²⁺ and protein kinase C. *J. Biol. Chem.* 266: 11559-11566, 2000.
12. O'NEILL, W. C., AND J. F. STEINBERG. Functional coupling of Na⁺-K⁺-2Cl⁻ cotransport and Ca²⁺-dependent K⁺ channels in vascular endothelial cells. *Am. J. Physiol.* 267 (Cell Physiol. 36): C267-C274, 2002.
13. Elisaf M, Milionis H, Siamopoulos K. Hypomagnesemic hypokalemia and hypocalcemia: Clinical and laboratory characteristics. *Mineral Electrolyte Metab* 1997;23:105-12.
14. Feillet-Coudray C, Coudray C, Tressol JC, Pepin D, Mazur A, Abrams SA. Exchangeable magnesium pool masses in healthy women: effects of magnesium supplementation. *Am J Clin Nutr* 2002;75:72-8.
15. DePalma J. Magnesium Replacement Therapy. *Am Fam Phys* 1990;42:173-6.
16. Rodríguez-Moran M and Guerrero-Romero F. Oral magnesium supplementation improves insulin sensitivity and metabolic control in type 2 diabetic subjects. *Diabetes Care* 2003;26:1147-52.
17. Ascherio A, Rimm EB, Hernan MA, Giovannucci EL, Kawachi I, Stampfer MJ, Willett WC. Intake of potassium, magnesium, calcium, and fiber and risk of stroke among US men. *Circulation* 1998;98:1198-204.
18. Vulpe CD, Kuo YM, Murphy TL, et al. Hephaestin, a ceruloplasmin homologue implicated in intestinal iron transport, is defective in the *sla* mouse. *Nat Genet.* 1999;21(2):195-199.
19. Yip R. Significance of an abnormally low or high hemoglobin concentration during pregnancy: special consideration of iron nutrition. *Am J Clin Nutr.* 2000;72(1 Suppl):272S-279S.
20. Food and Nutrition Board, Institute of Medicine. Iron. Dietary reference intakes for vitamin A, vitamin K, boron, chromium, copper, iodine, iron, manganese, molybdenum, nickel, silicon, vanadium, and zinc. Washington D.C.: National Academy Press; 2001:290-393. (National Academy Press)
21. Hein MS. Copper deficiency anemia and nephrosis in zinc-toxicity: a case report. *SD J Med.* 2003;56:143-7.
22. Danks DM. Copper deficiency in humans. *Annu Rev Nutr.* 1995;8:235-57. doi: 10.1146/annurev.nu.08.070188.001315.
23. Schumann K, Classen HG, Dieter HH, König J, Multhaup G, Rukgauer M, Summer KH, Bernhardt J, Biesalski HK (2002). Hohenheim consensus workshop: copper. *Eur J Clin Nutr.* 56:469-83. doi: 10.1038/sj.ejcn.1601315.
24. Simmer K; Pearson T C; Wheeler M J; Thompson R P (2003) . Zinc status in polycythaemia. *European journal of haematology* ;38(5):433
25. Michiels J (1997). "Erythromelalgia and vascular complications in polycythemia vera". *Semin Thromb Hemost* 23 (5): 441-54.
26. Rosner F, Goefien PC (2006). Erythrocyte and plasma zinc and magnesium levels in health and disease. *J Lab Clin Med* 19; 72:213-219.