

Status of Certain Elements in Patients with Polycythemia

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Abstract

Background: Polycythemia" (erythrocytosis), is a condition characterized by abnormal increase in circulating red blood cells (RBCs) number resulting in an increased "PCV" (packed cell volume).

Objective: Measure the levels of some trace elements in serum of patients with polycythemia.

Patients and Methods: the study included 70 polycythemia patients (61 males and 9 females), their ages ranged 18-60 years, and 20 apparently healthy, their age and gender matched with the patients as a control group. The levels of (Fe, Zn, Pb and Cd) were measured in both patients and control.

Results: Results obtained from this study showed that the male was affected more than female, male: female ratio (6:1) and the majority of patients were aged <20-29 years. A highly significant increase ($p < 0.01$) in the level of serum iron, Pb, and Cd in polycythemia patients in comparison with healthy control. Results of zinc level in serum showed a highly significant decrease ($p < 0.01$) in the polycythemia patients when compared with control group.

Conclusion: The current study has been shown that males were affected more than females with polycythemia. Also indicate that minerals may play a significant role against a variety of diseases and processes.

Keywords: Polycythemia, Trace element, Pb.

حالة بعض العناصر في مرضى زيادة الدم

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الخلاصة

الخلفية: "زيادة الدم" (زيادة الكريات الحمر) ، هي حالة تتميز بزيادة غير طبيعية في عدد خلايا الدم الحمراء (كريات الدم الحمراء) المتداولة مما يؤدي إلى زيادة "PCV" (حجم الخلية معبأة).
الهدف: لقياس مستويات بعض العناصر النزرة في مصل المرضى الذين يعانون من زيادة الدم .

المرضى وطرق العمل : شملت الدراسة 70 مريضا يعانون من زيادة الدم (61 ذكور و 9 إناث) ، تراوحت أعمارهم 18-60 سنة ، فضلا عن 20 شخصا صحيا كمجموعة سيطرة . تم قياس مستويات (Fe ، Zn ، Cd و Pb) في كل من المرضى ومجموعة السيطرة .

النتائج: أظهرت النتائج التي تم الحصول عليها من هذه الدراسة أن الذكور كانوا أكثر من الإناث بنسبة الذكور: الإناث (6:1) وأن غالبية المرضى تتراوح أعمارهم بين 20-29 عامًا , وكان هناك فرق معنوي عالي ($P<0.01$) في مستوى الحديد في مصل الدم لدى مرضى زيادة الدم بالمقارنة مع مجموعة السيطرة. أظهرت النتائج انخفاضًا كبيرًا في مستوى الزنك في المصل ($P<0.01$) في مرضى زيادة الدم عند مقارنتها مع المجموعة السيطرة ، وارتفاع كبير في مستويات الرصاص والكاديوم في الدم ($P<0.01$) في المرضى عند مقارنتها بمجموعة السيطرة.

الاستنتاج: لقد أظهرت الدراسة الحالية أن الذكور هم أكثر من الإناث عرضة للإصابة بزيادة الدم. واتضح أيضًا أن المعادن قد تلعب دورًا مهمًا في التسبب بمجموعة متنوعة من الأمراض والعمليات الايضية.

الكلمات المفتاحية: زيادة الم , العناصر النزرة , الرصاص.

Introduction

Polycythemia is a condition in which there is an increase in the total number of blood cells, primarily red blood cells in the body. The RBCs over production may be due to a primary process in the bone marrow, or it may be a reaction to chronically low oxygen levels and another condition, health or life style factors can be cause a high red blood cell count. Medical conditions that can cause an increase in red blood cell include hypoxia (low blood oxygen levels) carbon monoxide exposure (usually related to smoking) [1]. Patients may have a true polycythemia (an absolute increase in RCM) or relative polycythemia (a normal RCM and decreased plasma volume) [2].

Apparent (relative) polycythemia refers to raised hematocrit in the presence of a normal red cell mass (RCM). These results from the most factors that cause plasma volume depletion are (severe dehydration, diarrhea, vomiting, diuretics use, hypertension, obesity, etc.) [3].

The absolute polycythemia has been divided into primary and secondary forms. Primary polycythemia when there is an intrinsic problem in the bone marrow, which indicates that the erythrocytosis results from a molecular defect in the hematopoietic progenitor cells, most patients with primary type have polycythemia Vera (PV). Secondary polycythemia where there is an event outside the bone marrow driving erythropoiesis as a result of augmented levels of erythropoietin (EPO) [2]. Secondary polycythemia can be driven by various causes of hypoxia resulting in physiologically increased EPO production. Tissue hypoxia can be caused by congenital defects, such as altered oxygen affinity of Hb from mutations in the α or β globin genes. Acquired defects leads to increased EPO production include chronic hypoxia due to lung

or heart disease, high altitude, tobacco abuse, CO poisoning [4]. The third type, patients who cannot diagnose primary or secondary polycythemia are termed idiopathic polycythemia in which have an elevated RCM of unknown etiology [2]

Trace elements are essential components of biological structures and have important roles in living organisms. They are dietary minerals that are needed in very small amounts for the growth, development and physiology of the body. Some heavy metals are essential trace elements; most of them can be toxic to all forms of life at high levels due to formation of complex compounds within the cell [5]. A large part of these elements exert their toxic effect by generating reactive oxygen species causing oxidative stress. Most of the them are toxic or carcinogenic in nature and pose a threat to human health [6].

Materials and Methods

This study included 70 polycythemia patients (9 females and 61 males) attended to National Blood Transfusion Center in medical city for blood donation aged (18-60) years from October/2018 to February/2019. All patients included in the study had PCV $\geq 55\%$. In addition, 20 apparently healthy age and gender matched individuals were also included as a control group aged (27-58) years whose PCV were between 35% and 42%. They comprised of (11) males and (9) females for control groups.

Determination of Trace Elements

Whole blood was collected from patients (before blood donation) and control, and sera were separated and stored at -20°C until the time of mineral assay. Assessment of inorganic elements (Zn & Pb) was performed by Flam atomic absorption spectrophotometry (FAAS), while (Cd) was performed by graphite furnace atomic absorption spectrophotometry (GFAAS). Serum iron concentration was determined by using colorimetric method.

Statistical analysis

The results were analyzed by Student's t-test using Statistical Package for the Social Sciences (SPSS) version 18. All data were expressed as mean \pm SD. P-value less than 0.05 was considered significant.

Results & Disussion

The results of this study indicate that the majority of patients were males, 61 cases (87.1%) and 9 cases (12.9%) were female with male: female ratio equal to 6:1. While in the control group, 11 cases were male (55%) and 9 cases (45%) were female. Most of patients (42.9%) were in the age group <20-29 years followed by (30%) in the age group 30-39 years and (27.1%) were in the age group 40- ≥50 years, as shown in the table (1).

Table (1): Distribution of patients and control groups according to the age and gender

| | | Patients (n=70) | | Controls (n=20) | |
|--------|----------|-----------------|------|-----------------|------|
| | | No. | % | No. | % |
| Gender | Male | 61 | 87.1 | 11 | 55.0 |
| | Female | 9 | 12.9 | 9 | 45.0 |
| Age | (<20-29) | 30 | 42.9 | 3 | 15.0 |
| | (30-39) | 21 | 30.0 | 9 | 45.0 |
| | (40-≥50) | 19 | 27.1 | 8 | 40.0 |

Most studies denoted that the majority of donors due to increase blood volume were males and few females with their age ranged from (20-29) years, male: female ratio was 19.8:1[7]. Some observed that most polycythemia disease prevalence among women rather than men and age groups range (40-60) years [8, 9] . The explanation for this variation may attribute to the difference in sample.

Table (2): Comparison the mean of serum iron (ug/dl) concentration between patients and control groups.

| | Groups | No. | (Mean± Std.) µg/dl | t-test | P-Value | C.S |
|------------|----------|-----|--------------------------|-------------|---------|----------------|
| Serum iron | Patients | 70 | 116.16± 48.3 | 2. 0.907 | .005 | P<0.01 (HS) |
| | Control | 20 | 84.15± 15.77 | | | |

The results in table (2) showed highly significant difference between polycythemia patients and control in regard to the level of serum iron (116.1 ± 48.3 vs. 84.1 ± 15.7 ug/dl, $p < 0.01$) respectively.

The above results agree with the observation of other studies which reported that cigarette smoking causes minerals disturbances which leads to tissue hypoxia that leads to inadequate oxygenation of blood circulation that results increased EPO which enhance erythropoiesis and increases RCM. This leads to increase in the destroyed red cells number in the normal process

which subsequently increases iron overload. The iron released from red cells when they reach the end of their lifespan and can be reused for production of new erythrocytes [10, 11]. Opposite this findings [12], this study reported that the level of serum iron in polycythemia lower than healthy control.

Table (3): Comparison the mean of serum zinc concentration ($\mu\text{g}/\text{dl}$) between patients and control groups

| | Groups | No. | (Mean \pm Std.) $\mu\text{g}/\text{dl}$ | t-test | P-Value | C.S |
|------------------------|----------|-----|--|--------|---------|----------------|
| Level of Zinc in serum | Patients | 70 | 68.44 \pm 7.39 | 10.357 | 0.000 | P<0.01 (HS) |
| | Control | 20 | 94.45 \pm 16.01 | | | |

The data from table (3) show the mean of serum zinc concentration in patient groups (68.44 \pm 7.39 $\mu\text{g}/\text{dl}$) was highly significant lower than that of the healthy control (94.45 \pm 16.0 $\mu\text{g}/\text{dl}$) ($p<0.01$).

The above results showed the zinc level is decreased in polycythemia patients who agree with another study which donated that the zinc is required in different stages of erythropoiesis in the bone marrow, in addition to iron, folate and vitamin B12 [13]. The zinc function as an antioxidant defense is thought to be the cause of its deficiency [14]. Moreover, other factors could be responsible for the hypozincemia such as, inadequate dietary intake, increased losses from the body and increased uptake of Zn by the cells to be utilized for proliferation, the demand for zinc in the body is increased in erythropoiesis condition [15].

Conversely to these findings, abbas and his colleques [12] observed that significantly higher serum zinc in the polycythemia patients as compared to the control. The reason may be related to the differences in diet habit.

Table (4): Comparison the mean of blood lead and cadmium concentration ($\mu\text{g}/\text{dl}$) between patients and control groups.

| | Groups | No. | (Mean \pm Std.) | t-test | P-Value | C.S |
|---------------------------|----------|-----|--------------------|--------|---------|----------------|
| Level of lead in blood | Patients | 70 | 23.77 \pm 3.89 | 9.545 | 0.000 | P<0.01 (HS) |
| | Control | 20 | 14.95 \pm 3.88 | | | |
| Level of cadmium in blood | Patients | 70 | 0.3004 \pm 0.070 | 11.949 | 0.000 | P<0.01 (HS) |
| | Control | 20 | 0.1865 \pm 0.04 | | | |

Results obtained from table (4), showed a highly significant elevation in the mean blood lead when compared with control group (23.7 ± 3.8 and $14.9 \pm 3.8 \mu\text{g/dl}$) respectively ($p < 0.01$). Also a highly significant elevation in the mean blood cadmium ($0.300 \pm 0.070 \mu\text{g/dl}$) when compared to healthy control ($0.186 \pm 0.04 \mu\text{g/dl}$) ($p < 0.01$).

The elevation of blood cadmium in the patients in the present study may be due to the contaminated food with cadmium, cigarette smoke and pollution from car exhaust. The diet with low essential elements leads to absorbing and consumption of more toxic metals by the body [16]. The possible reason that explains the elevation of blood lead levels may be due to lowering the levels of zinc in patients. The gastrointestinal absorption of lead and sensitivity to its effects are influenced by the sufficiency of essential elements

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