ANSWER

Diagnosis: Copper Deficiency

There were frequent cytoplasmic vacuolization in erythroid precursors. This finding *per se* can be observed in copper deficiency and myelodysplastic syndrome (MDS). MDS was not favored, due to the absence of other features of MDS, such as erythroid nuclear irregularity, ring sideroblasts, granulocytic abnormalities or increased blasts. Furthermore, the past history of bariatric surgery predisposes the patient to nutrient deficiencies, including copper.

Upon communication of our suspicion to the clinician, plasma copper and ceruloplasmin were ordered. The patient's plasma copper turned out to be decreased at 61 mcg/dL (reference range: 70-175 mcg/dL) and serum ceruloplasmin was decreased at 13 mg/dL (reference range: 18-36 mg/dL), confirming the diagnosis of copper deficiency.

Copper is the 3rd most abundant trace elements in human body, after zinc and iron. Copper is absorbed in stomach and small intestine. Serum/plasma copper level is insensitive to copper deficiency and is only decreased in severe deficiency cases. In addition, other non-nutritional factors affect copper levels. For example, pregnancy, infection, inflammatory conditions, and oral contraception increase the copper level and corticosteroids lower the copper level. Copper status can also be evaluated by ceruloplasmin and by erythrocyte superoxide dismutase. Copper deficiency is uncommon and can be seen in rare genetic disorders, prolonged malnutrition or starvation, in premature babies, treatment with copper-chelating agents (penicillamine), and excessive zinc supplements. Symptoms of copper deficiency include hypochromic anemia (usually macrocytic), neutropenia, osteoporosis, skin hypopigmentation, ataxia, and neurologic abnormalities. (**Source**: HENRY'S Clinical Diagnosis and Management by Laboratory Methods)