30. Zinc in Plasma

Introduction

Zinc is an essential trace element that is generally non toxic and is essential for normal growth and development, wound healing and immunocompetence. It is also necessary for the activity of more than 70 metalloenzymes, eg carbonic anhydrase, alkaline phosphatase, RNA & DNA polymerases, thymidine kinase and carboxypeptidases.

Zinc is actively absorbed from the gut into epithelial cells, where it is stored as mucosal metallothionen or released into the plasma, where 80% is mainly bound to albumin. It is then transported to the liver, where it is stored by hepatocytes in metallothionen. Zinc is mainly stored in muscle, with bone, liver and plasma forming a small exchangeable pool. Twenty percent of body zinc is found in the skin, nails and hair.

Regulation of zinc absorption is thought to be controlled by the amount of metal free albumin. Zinc absorption decreases in the presence of dietary phytate, high dietary phosphate and excessive calcium. Coffee, dairy products and high fibre bread also reduce zinc absorption. Zinc is mainly excreted in the faeces, with small amounts being lost via the kidneys; urinary zinc increases in nephrosis, postalcoholic hepatic cirrhosis and hepatic porphyria. Increased excretion also occurs in total starvation and on administration of chelation agents. Large amounts of zinc can also be lost in sweat.

Increased zinc intake depresses copper absorption and conversely copper absorption is greatly increased in zinc deficiency. Metabolic interactions occur between zinc and cadmium, zinc and iron, and zinc and chromium. Cadmium and iron uptake are depressed by high zinc levels, while chromium and zinc are metabolised by a common pathway in the intestine and are mutually antagonistic.

In blood approximately 80% of zinc is in the red blood cells. Almost all of this is in carbonic anhydrase. About 3% is found in leucocytes, each leucocyte containing approximately 25 times the amount of zinc as each individual erythrocyte. The rest, approximately 20%, is found in the plasma. In the new-born, erythrocyte zinc levels are about half that of the adult, with levels progressively increasing until about 12 years of age.
Sample requirements

A 5 ml heparinised blood sample is collected into a special trace metal blood collection tube. Copper can be analysed from the same sample. Collection tubes and needles can be supplied by the laboratory. The plasma should be separated from the red cells within 2 hours of collection.

Interpretation

Normal reference range 10.0-17.0 µmol/l (plasma)

Haemolysed samples are unsuitable for plasma zinc estimation because the red cells contain 80% of circulating zinc. Zinc levels in serum are approximately 16% higher than those in plasma due to the release of zinc from platelets during the clotting process.

Plasma zinc levels are thought to follow a circadian pattern, with the highest values occurring in the morning at approximately 10.00 am.

Zinc deficiency

Deficiency causes failure to grow, skin rashes, impaired cell mediated immunity, failure of sexual maturation, taste abnormalities, abnormalities of foetal development and impaired vitamin A metabolism. Low plasma zinc levels have also been associated with chronic skin ulceration, poor wound healing and facial eczema in sheep.

In zinc deficiency a reduction in plasma zinc levels reflects a loss of zinc from the bone and liver, with a consequent increase in the risk for development of metabolic and clinical signs of zinc deficiency. Alkaline phosphatase levels also decrease. Growth retardation is often the first sign of zinc deficiency.

Apart from zinc deficiency, plasma zinc levels decrease after meals and during acute infections. They are also associated with liver disease, malignant tumours, pernicious anaemia or short term fasting. Plasma zinc levels are also lower in late pregnancy. The drop in plasma zinc in these conditions (except fasting) is caused by redistribution to other tissues in response to metabolic need.

Acrodermatitis enteropathica is a genetic disorder of zinc metabolism that manifests as zinc deficiency, with retarded growth, hypogonadism, gastrointestinal disturbances and skin lesions. It appears in early infancy but
with oral zinc therapy a total recovery occurs. There have also been a few cases reports of nonhereditary, temporary zinc deficiency in breast fed infants.

**Industrial exposure**

Zinc is used in galvanising iron and steel, and as an alloy of brass and bronze. Inhalation of zinc oxide fumes produced during welding can cause metal fume fever characterised by nausea, headaches, muscular and joint pain, shortness of breath, thirst and a cough. These symptoms develop 4-12 hours after exposure and last for 1-2 days. Zinc chloride fumes, which are highly corrosive to skin, eyes and mucous membranes, are produced from welding flux, wood preservatives and the manufacture of high quality paper, dyes and deodorants. It is also used in smoke screens.