Chromium and Diabetes Mellitus

- the functional importance of chromium for regulating the sugar metabolism –

By Prof. Joachim Schmidt

Chromium is an essential trace element which has to be supplied to the body regularly in the diet. Chromium occurs in nature in various valences, with only the trivalent form (chromium III) being of significance with respect to nutritional medicine. Tetravalent chromium (chromium IV) is rapidly reduced in the organism to form chromium III. Hexavalent chromium (chromium VI) is of no interest physiologically, but of significance in terms of toxicology. The following remarks refer to the form which is nutritionally significant, i.e. chromium III.

The physiological importance of chromium III is based primarily on its significance for the glucose and lipid metabolism, especially the effects of insulin. Chromium is required to develop the effect of insulin and sensitizes at the same time the ß-cells of the pancreas, thereby promoting the supply of insulin. It has long been known that chromium deficiency reduces glucose tolerance and causes disruption to glucose utilisation. This has been observed above all in patients with parenteral nutrition and an insufficient supply of chromium. Chromium supplementation resulted in the elimination of such disruption in these cases.

Insulin requires chrome in order to fully develop its effect. We can imagine this as follows:
The increase in the glucose level in the blood, e.g. after the intake of food, results in the release of insulin from the pancreas. This insulin binds to the insulin receptors, which are activated as a result, resulting in the uptake and utilisation of the glucose. The binding of insulin and activation of the insulin receptor requires the availability of chromium in the form of a low-molecular Cr-binding substance known as chromodulin, which was also called glucose tolerance factor. Chromodulin also binds to the insulin receptor and activates the insulin receptor tyrosine kinase. The activity of this enzyme is dependent on its chromium content. Chromodulin also inhibits phosphotyrosine phosphatase, as a result of which the insulin sensitivity of the insulin receptor is increased. Furthermore, experimental findings indicate an increase in the number of receptors, insulin internalisation and ß-cell sensitivity through chromium. In terms of the physiological metabolism, this means that chromium in its biologically active form increases the effectiveness of insulin and improves insulin sensitivity. This forms the basis for the importance of chromium for patients with diabetes mellitus.

The effectiveness of chromium supplements in diabetes mellitus has been investigated in several clinical studies. In the majority of cases, supplementation with

200 to 400 (1000) µg/day of chromium III as chloride or picolinate was found to improve the parameters of the glucose and/or lipid metabolism. The findings indicate that the effectiveness of the chromium supplementation depends on the initial chromium status. Therapeutic effects were mainly found in studies involving patients with a marginal or poor chromium status.
An analysis of all studies performed between 1966 and May 2002 with type II diabetics confirms the importance of chromium in the supportive treatment of type II diabetes. The efficacy of chromium (III) has also been shown in patients with type I diabetes. The administration of 200 µg Cr/day resulted in a reduction in the circulating insulin quantity by 30% and stabilised blood sugar control. In several studies it has also been possible to show a reduction in the cholesterol and triglyceride levels.
The positive effects of chromium treatment therefore comprise a reduction in the blood sugar, insulin, cholesterol and triglyceride levels, as well as a reduced demand for blood sugar-lowering medications. When taken as a whole, the data confirms the safety and the therapeutic value of chromium substitution in the treatment of diabetes mellitus.

The chromium requirement of healthy individuals (recommended daily intake in Germany, Austria and Switzerland) is 30 to 100 µg/day. Chromium-rich foods are meat (especially liver and kidneys), mushrooms, shellfish, fish, eggs, nuts, whole grain bread, cheese, yeast and beer. Fruit and vegetables contain relatively little chromium. Normal chromium concentrations in the serum are stated as being 0.05-0.84 µg/l (=1-10 nmol/l), and 0.5-3.9 µg/l (=10-15 nmol/l) in the whole blood.
The consequences of chromium deficiency are primarily disturbed insulin effects. Insulin resistance develops, with the resulting functional consequences. Furthermore, patients suffer from lipid metabolism disorders with an increase in their cholesterol and triglyceride values. These disorders occur if the daily chromium intake is less than 20 µg.
In order to diagnose the chromium status, it is advisable to determine the chromium content of the whole blood - or even better the leucocytes - although the meaningfulness is very limited due to possible redistributions. Various authors therefore consider a marginal deficiency to be a situation in which glucose tolerance can be improved by chromium substitution.
Risk groups for chromium deficiency are patients with diabetes mellitus and metabolic syndrome. There is an increased demand for chromium in the case of infections, stress and high physical exertion (e.g. competitive sports). In these individuals the daily intake of 200 µg of chromium is recommended. This cannot be achieved by diet alone. The average Cr intake in the diet lies within the range of around 50 µg/day. For this reason it is recommended that risk groups should receive additional chromium substitution.

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