Original Article

Chromium Content in the Human Hip Joint Tissues*

Barbara Brodziak-Dopierała[1,#], Jerzy Kwapuliński[2], Krzysztof Sobczyk[3], and Danuta Wiechuła[1]

1. School of Pharmacy with the Division of Laboratory Medicine, Department of Toxicology, Medical University of Silesia, 4 Jagiellonska, Str. 41-200 Sosnowiec, Poland; 2. Institute of Occupational Medicine and Environmental Health, 13 Kościelna, Str. 41-200 Sosnowiec, Poland; 3. Municipal Hospital, Department of Traumatic Surgery, May-1 Str. 41-100 Siemianowice Slaskie, Poland

Abstract

Objective Chromium has many important functions in the human body. For the osseous tissue, its role has not been clearly defined. This study was aimed at determining chromium content in hip joint tissues.

Methods A total of 91 hip joint samples were taken in this study, including 66 from females and 25 from males. The sample tissues were separated according to their anatomical parts. The chromium content was determined by the AAS method. The statistical analysis was performed with U Mann-Whitney's non-parametric test, $P \leq 0.05$.

Results The overall chromium content in tissues of the hip joint in the study subjects was as follows: 5.73 μg/g in the articular cartilage, 5.33 μg/g in the cortical bone, 17.86 μg/g in the cancellous bone, 5.95 μg/g in the fragment of the cancellous bone from the intertrochanteric region, and 1.28 μg/g in the joint capsule. The chromium contents were observed in 2 group patients, it was 7.04 μg/g in people with osteoarthritis and 12.59 μg/g in people with fractures.

Conclusion The observed chromium content was highest in the cancellous bone and the lowest in the joint capsule. Chromium content was significantly different between the people with hip joint osteoarthritis and the people with femoral neck fractures.

Key words: Chromium; Femur head; Hip joint; Cortical bone; Cancellous bone

Biomed Environ Sci, 2015; 28(2): 89-96 *doi: 10.3967/bes2015.011* *ISSN: 0895-3988*

www.besjournal.com (full text) *CN: 11-2816/Q* *Copyright ©2015 by China CDC*

INTRODUCTION

Chromium is counted among trace elements that are obligatory for the energy metabolism of humans and animals[1]. It affects the metabolism of glucose and lipids. It is a component of the glucose tolerance factor (GTF)[1]. Moreover, it has influence on certain enzymes that regulate the synthesis of cholesterol[2-3]. When absorbed by blood, chromium binds to globulin. Bound to transferrin it is transported to tissues[4]. Chromium contained in blood is absorbed into the bone quite quickly. It also accumulates in the spleen, liver and kidneys[4-6].

Chromium is subject to the process of exchanges between the plasma and the surface of bones[6]. Like lead, though with much lower efficiency, it can be introduced into the bone structure during bone remodelling processes[7]. Bones are an important reservoir of chromium after

*This work was financed by the Medical University of Silesia in Katowice (contract No. KNW-1-124/K/4/0).

#Corresponding should be addressed to Barbara Brodziak-Dopierała, Tel: 48323641633, Fax: 48323641631, E-mail: bbrodziak@sum.edu.pl

Biographical note of the first author: Barbara Brodziak-Dopierala, female, born in 1975, PhD, majoring in heavy metals in biological samples.

its oral or intraperitoneal administration[8-9].

Weber[10] conducted long-term degradation studies of soluble chromate-51 in rats and found that radioactive chromium administered orally was mainly accumulated in the area of epiphysis of long bones. O'Flaherty[7,11] published a research on chromium as an essential and toxic metal and model of chromium kinetics in rats. The distribution of radioactive chromium compounds was considered similar to Ca45 or Sr89 which have a high affinity for bones[11].

Berry et al.[12] showed that prosthesis-released chromium can be a reason for the extensive osteolysis around a cementless knee prosthesis. In such a situation, chromium may induce a lower level of activity of osteoblasts which may result in prosthesis loosening[13].

Chromium alloys are applied in various types of orthopedic prostheses and implants[14-15]. However, over time these alloys corrode and soluble chromium ions (VI) are released. Toxicity of these metal ions contributes to hypersensitivity reactions, neurological disorders and bone diseases[14]. Accumulation of chromium in the skeleton may interfere with bone formation and resorption by modulating key enzymes which are involved in these processes[11]. Based on experiments on rats, Sankaramaqnivel et al.[16] presented a hypothesis that chromium disturbs the bone remodelling process. Chromium exerts its influence on bones by modulating biochemical parameters of bone: alkaline phosphatase (ALP), tartrate-resistant acid phosphatase (TRAP), calcium and phosphorus. A significant accumulation of chromium and reduction of the alkaline phosphatase activity in the skeleton were observed in this study. This resulted in changes in the bone formation rate[16].

Some reports show that chromium added to mixtures of ceramic prostheses stimulates bone remodelling as shown by the increased cellular activity (osteoblastic cells) and bone resorption. As a result, the implant may grow into the surrounding tissues[14-15,17].

It has been demonstrated that chromium ions can be added to the hydroxyapatite crystal during mineralization and affect the parameters of the crystal lattice and the size of the crystals. The bone tissue around the metallic implants containing chromium may be changed[14,18]. Studies using the electron spin resonance (ESR) suggested that chromium is associated with the organic constituent of the calcified tissues[19].

It can be concluded that the adult rats' exposure to $K_2Cr_2O_7$ in their prenatal and postnatal periods impairs their growth and decreases the mineral density of bones[20]. The study showed that $K_2Cr_2O_7$ changes biochemical parameters related to the bone tissue and histopathological parameters of the femur[20].

Chromium has been determined as a component of cigarette tobacco with the concentration ranging from 0.4 to 10.0 μg/g[21]. Antilla et al.[22] observed that average lung tissue levels of chromium was 6.4 μg/g in smokers and 2.2 μg/g in nonsmoking referents[22]. The pulmonary metal concentrations were compared with smoking history, pulmonary emphysema, age, and occupation[22]. The mean chromium concentrations for the non-smokers, smokers, and ex-smokers were 1.3, 4.3, and 4.8 μg/g dry wet, respectively. The pulmonary chromium content increased with age and smoking time, but showed no connection with occupation[23].

The content of elements in bones is dependent on several factors, including age, sex, place of residence, health status, smoking, or diet pattern[1,2,6,9,24-27]. After reaching the peak bone mass, calcium loss is observed with age. Moreover, accumulation of heavy metals derived from environmental and occupational exposures occurs[1,28]. The difference in bone mass between women and men is quite significant, therefore sex is an important factor to influence the content of trace elements in bones[29]. At the same age, bone mass in women is lesser than bone mass in men[28]. Women show a greater tendency to develop osteoporosis, especially in the postmenopausal period, which is confirmed by many long-term studies[30]. Additional factors that may have influences on the content of elements in bones of women are pregnancy and lactation[30]. Food components, depending on their origin, may provide the human body with essential substances but also elements that can accumulate in bones[29].

The role of chromium in bone metabolism has not been fully understood yet. Therefore, it is advisable to trace the changes in chromium content in chosen elements of the hip joint which was removed in arthroplasty. Chromium content was determined in tissues of patients (female, male) with different disease status, due to which joint replacement had been conducted, and in smokers and non-smokers. The novelty of this study was to determine the chromium content in both the bone

Download English Version:

https://daneshyari.com/en/article/4195861

Download Persian Version:

https://daneshyari.com/article/4195861

Daneshyari.com