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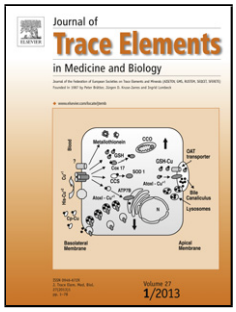

Title: Kinetics and tissue distribution of bismuth, tin and lead after implantation of miniature shotgun alloy pellets in rats

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Kinetics and tissue distribution of bismuth, tin and lead after implantation of miniature shotgun alloy pellets in rats

Running title: Kinetics and distribution of bismuth in rats

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ABSTRACT

Introduction: Shotgun pellets containing bismuth (Bi) as substitute for lead (Pb) are increasingly being used due to environmental concerns. Information on toxicokinetics of Bi is lacking for the assessment of humans accidentally shot by Bi-containing shotgun alloy pellets.
Methods: Male Wistar rats were exposed to miniature alloy pellets containing Bi, tin (Sn) and minor amounts of Pb by implantation in muscle tissues of the hind legs.
Results: The concentrations of Bi in whole blood and urine increased up to 53 weeks after implantation. The highest concentrations of Sn in whole blood were observed three weeks after implantation, then declining to background levels 53 weeks after implantation. Lead in whole blood increased up to 13 weeks of exposure, and declined for the remaining observation period. Bismuth and Sn accumulated mainly in kidney, but also in liver, testicle and brain. Analytical field emission scanning electron microscopy of post-implant pellets showed depletion of Pb towards the pellet surface. Oxygen and chlorine accumulated in Sn rich lamellas in areas next to the pellet surface. The distribution of Bi remained visually unaffected as compared to pre-implant pellets.
Conclusion The concentration of Bi increased during the whole observation period in blood, urine, kidney, brain, testicle and liver. The decline in the concentrations of Pb and Sn in blood and urine after reaching the peak concentration may be related to alterations in the chemical composition and element distribution of the implanted alloy pellets.

Keywords: bismuth, tin, shotgun pellets, intramuscular implantation

INTRODUCTION

We determined bismuth (Bi) in whole blood (B-Bi) and urine (U-Bi) in a hunter accidentally wounded by shotgun alloy pellets containing Bi, tin (Sn) and minor amounts of lead (Pb). Many fragments could not be removed by surgery. Measurements showed the highest B-Bi concentration of 15.7 µg/L three months after the accident declining slowly to 4 µg/L 36 months later. A median B-Bi concentration of 0.001 µg/L in non-occupationally exposed humans has been reported [1], suggesting a substantial systemic uptake of Bi in the hunter. As no scientific publications were found on Bi toxicokinetic and dose related effects in humans wounded by Bi-containing shotgun alloy pellets, clinical assessment of the patient was hampered.
Bismuth is mainly used in the production of chemicals, in alloys, as an additive in casting and in cosmetics [2]. It is also used for treatment of medical conditions, and in particular for gastrointestinal disorders [3]. The use of Bi as a substitute for Pb in shot shell ammunition is