Pregnancy and Lactation as a Factor of Increased Accumulation of Bone-seeking Radionuclides in Maternal Body: Analysis of the Techa River data
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ABSTRACT
A unique situation on contamination of the Techa River (Southern Urals, Russia) in 1950s by long-lived 90Sr allows investigation of the features of bone-seeking elements (such as Y, Pb, Ba) accumulation in humans. This study is based on information compilation at the Ural Research Center for Radiation Medicine (URCRM, Chelyabinsk, Russia) over a long-term period and includes the results of more than 38,000 in vivo measurements of Sr-body burden for 20,000 persons obtained with a whole body counter SCHR-1. Data on personal medical examinations and residence and family histories. The effect of pregnancy and lactation on accumulation of radionuclides in maternal body is not sufficiently known since the main attention in different studies was paid to accumulation of radionuclides in fetus and infant. Significant changes occur in maternal mineral turnover during pregnancy and lactation due to fetal/infant requirements in minerals. For example, such changes during pregnancy result in increase of Ca and Sr allocation from gastrointestinal tract; Ca and Sr urinary excretion and bone remodeling slightly increase. Total Sr-body burden for 36,000 men from the Techa region significantly shows an increase in accumulation of 90Sr in maternal skeletal during pregnancy and lactation by a factor of 1.5-2 in comparison with non-pregnant, non-lactating (NPAL) women. Such increase is represented as an increase of water and foodstuffs consumption by women mostly increases at lactation (by 25%) then at pregnancy by 5-10%. Another possible reason of additional radionuclide accumulation is a rapid restoration of maternal bone mineral level during pregnancy and lactation coincided with Sr intake. Our study indicates an increase in accumulation of these elements in pregnant/lactating women compared to NPAL women that lead to increased radiotoxic doses and risk for women.

1. Techa River data is a unique source of information on metabolism of bone-seeking elements in humans

Radioactive contamination of a small river Techa in the southern Urals in Russia occurred in 1949–1956 as a result of releases of radioactive materials from the first Russian site for production of plutonium, the Mayak Production Association. About 110 kg of 90Sr were released in the river; 98% of the total activity was discharged in 1950-1951. Ingestion of large amounts of 90Sr by residents of the Techa river-nabes occupied mainly with river water. Extensive radiometric and histochimical investigations of the levels of radioactive contamination of humans and the environment have been performed in this area since mid-1951. In vivo measurements were performed 20–45 years after the maximum 90Sr intake with whole body counter SCHR-1: the contents of 90Sr were determined by measuring the bremsstrahlung of the 90Sr/90Y pair with a planche detector. Minimal detectable amount was equal to 2 kBq. In total more than 30,000 VBC measurements were performed during 1974–1997. Many Techa River-nabes residents were measured several times during this period. The results of VBC measurements were used for different purposes, primarily for estimation of individual doses due to 90Sr.

2. Characteristics of the women under study

The study was performed for the settlement of Muslyumovo located in the mid Techa region (78 km from the release site). Muslyumovo was the most contaminated of the non-evacuated villages, and is often taken as the reference settlement for dosimetric investigations as it had a population of about 3,000 persons and has been studied in detail. Women who lived in Muslyumovo during the whole period of releases and were later measured with whole body counter (WBC) have been selected for the analysis. Persons from the studied group were examined at the URCRM Clinical Department for several times, in relation to their radiation exposure and possible resulting changes in their health status. In particular, the URCRM databases contain information on date of labors, number of children and other relevant data.

The WBC data for women of reproductive age have been analyzed. Those women were pregnant and lactating in the period of maximal 90Sr intake have been of the main interest in our study.

3. Age dependent 90Sr-body burden for Muslyumovo women: results of direct measurements performed in 1977-1980 (30 years after the onset of intake)

4. Comparison of 90Sr accumulation in women who were of different reproductive status in the period of maximal 90Sr intake (1950–1951)

For the analysis, normalized values of Sr-body burden have been used. For this purpose, WBC measurements performed in 1974–1987 have been normalized to a fixed date (1980) using individual or group-average 90Sr elimination rates. Women aged 20-30 years at the beginning of 90Sr intake were considered (n=199). The following groups were selected:
1. Women who gave birth in the period of maximal 90Sr intake (1950-1951)
2. Women who gave birth after the period of maximal 90Sr intake
3. Women who gave birth before the period of 90Sr intake or were childless

4. Comparison of 90Sr accumulation in women who were of different reproductive status in the period of maximal 90Sr intake (1950–1951)

Women who gave birth in the period of maximal 90Sr intake have higher Sr-body burden by a factor of 1.5-2 compared to women who gave birth after or before this period or did not have children.

The reasons for increased 90Sr-body burden are:
1. Increase in 90Sr dietary intake in the period of pregnancy and lactation
2. Increase in Ca/Sr bone turnover rate in pregnancy and lactation
3. Rapid restoration of maternal bone-mineral loss during pregnancy and lactation coincided with 90Sr intake

Conclusions
The increase in 90Sr accumulation in the maternal skeleton during pregnancy and lactation results in higher absorbed dose in the red bone marrow. The increase in the absorbed dose due to child-bearing should be taken into account in assessment of health effects in women. Our results indicate increased risk for pregnant/breastfeeding women due to elevated accumulation of toxic bone-seeking elements, such as Pb, Ba, U.

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Spectrometer for 90Sr in vivo measurements (whole body counter)