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Concentration of Cesium-137 in Human Rib Bone

Abstract. The concentration of fission product cesium-137 in human rib, sampled from various age groups, has been determined by low-level gamma-ray spectrometry. We propose several possible interpretations of the data and point out the possibility that mechanisms of cesium retention may be age-dependent.

The presence of fission-produced cesium-137 in human beings has been extensively studied since it was first reported in 1956 by C. E. Miller and L. D. Marinelli (*1*). C. E. Miller (*2*) reports a value of approximately 30 $\mu\mu$c of Cs^{137} per gram of potassium for adult residents of the Chicago area during the summer of 1961. This figure indicates a level of $\sim 6 \times 10^{-14}$ curie of Cs^{137} per gram of wet tissue weight (135 g of potassium in a 70-kg man) or 1.35×10^{-13} curie per gram of wet muscle assuming that all the Cs^{137} is concentrated in 30 kg of muscle. It has been found from animal experiments (*3*, *4*) that the greater part of the Cs^{137} is in the muscle; however, the work of Nelson *et al.* (*4*) with laboratory mice indicated the concentration of intravenously injected Cs^{137} to be highest in cartilage. Because of the low concentration of potassium in bone mineral, bone has never been considered a likely site of cesium deposition or accumulation. However, in chemical analyses of bone specimens from cadavers, Yamagata *et al.* (*5*) reported the presence of Cs^{137} and proposed that the cesium was located in the marrow rather than in the bone itself.

The experiment considered in this report (*6*) was designed to determine whether Cs^{137} was actually present in bone, and if so, whether a relationship existed between the concentration and the age of the subject. Rib was chosen because the cesium concentration is highest in this bone (*5*) and because rib sections may be easily obtained at autopsy. Seventy rib specimens were obtained through pathologists in the Chicago area, ten specimens from each of the following age groups: 0 to 5, 6 to 10, 11 to 20, 21 to 30, 31 to 40, 41 to 60, and over 60 years of age. Collections were made between April and the end of August, 1961. Hence no radioactivity from the Soviet 1961 tests was involved in this investigation. A short history was obtained with each specimen, and only specimens from victims of accidents or short-term diseases were selected, to avoid possible changes in mineral metabolism which might have occurred from long illness or prolonged therapy. Specimens were individually ashed at 400°C after adhering tissue had been removed, and the ribs were split and mechanically brushed free of marrow. Each sample was scanned for abnormal amounts of radioactivity by means of a scintillation counter. The samples for each age group were pooled, and the composite sample was then counted by means of a sodium iodide crystal (5 in. in diameter and 4 in. thick), in a low-background shield, and a multichannel analyzer. The only gamma emitters detected were cesium-137 and potassium-40, although an effort was made to detect cerium-144 and ruthenium-106. Concentrations of Cs^{137} and K^{40} were obtained by counting standard sources of these radionuclides under identical conditions. The mean value for three measurements of each sample in terms of curies of Cs^{137} per gram of bone ash is plotted in Fig. 1, and the standard deviation is also indicated. Because of the relatively long counting times used for sample and background determinations (900 to 1000 minutes) the probable errors are small.

From the data presented in Fig. 1 we have drawn several tentative conclusions.

1) Cesium-137 is apparently present in rib bone and, in fact, appears to be present in concentrations equal to or somewhat greater than either the whole-body average or the mean concentration in muscle.

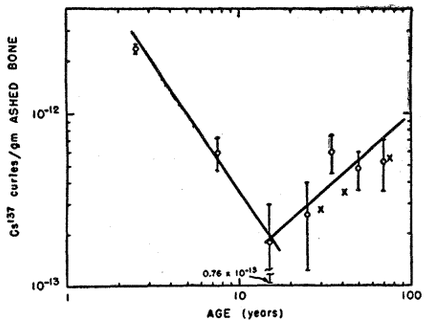

Fig. 1. Cesium-137 in pooled rib samples. (Circles) Values of Anderson and Gustafson (70 specimens); (crosses) values of Yamagata *et al.* (12 specimens).

2) This finding implies that Cs^{137} may be a more important internal emitter, due to its retention in bone, than had previously been thought. Confirmation or refutation of this possibility is essential in view of the resumption of nuclear testing. Suffice it to say that the radiation dose to adult rib bone in 1961 in the Chicago area was greater from Cs^{137} than from strontium-90, to judge by the average Sr^{90} values in adults found by Kulp *et al.* in 1959 (*7*).

3) The decrease in the concentration of Cs^{137} with age up to 15 years seems to follow the pattern of ossification of cartilage, and concentration in this soft tissue may be responsible for the relatively high levels in the 0- to 5-year group, as suggested by the findings of Nelson *et al.* (*4*). Either the cesium is then eliminated as ossification proceeds, or the initial uptake is lower in the older children.

4) The postpubertal rise in cesium concentration also evident in the data of Yamagata *et al.* (*5*) (Fig. 1) cannot at present be explained and requires further investigation.

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