jnm / LETTERS TO THE EDITOR

^{203}Pb FOR BONE SCANNING

In their Letter to the Editor, Rao and Goodwin (*1*) reported the potential applicability of ^{203}Pb radionuclide for skeletal imaging. This radionuclide was investigated in many centers in the United States and the radiation dosimetry based on biologic distribution in animals was highly discouraging for the use of ^{203}Pb acetate. The critical organs for ^{203}Pb acetate are the RES (reticuloendothelial system) organs, particularly the spleen. For example, the authors reported the image of a rabbit taken 3 days after intravenous administration of 800 μCi of ^{203}Pb-acetate. Usually a rabbit weighs about 5 kg. Even assuming a maximum weight of 7 kg, the dose administered was 800 μCi. The corresponding tracer dose to a 70-kg human would be 8 mCi. Scanning may have to be done 3 days after administration of ^{203}Pb in order to obtain a high target-to-nontarget ratio and for which the tracer dose administered will be 8 mCi. According to the authors' own calculations the whole body and skeleton would receive an estimated radiation dose of 0.03 and 0.06 rads, respectively, from 100 μCi of ^{203}Pb. For an 8 mCi dose the estimated radiation dose to the whole body would be 2.4 rads and the skeleton receives 4.8 rads.

TABLE 1. NUCLEAR PARAMETERS OF ^{203}Pb

Radiation (i)	Mean number/disint. (η_i)	Mean energy (MeV) ($\bar{E}_i$)	Δ_i $\left(\frac{\text{gm-rad}}{\mu\text{Ci-hr}}\right)$
Electron capture	—	—	*
Gamma—1	0.8077	0.2792	0.4803
K int. con. electrons	0.1316	0.1936	0.0543
L int. con. electrons	0.0397	0.2649	0.0224
M int. con. electrons	0.0124	0.2762	0.0073
Gamma—2	0.0382	0.4013	0.0326
K int. con. electrons	0.0055	0.3158	0.0037
L int. con. electrons	0.0009	0.3870	0.0007
M int. con. electrons	0.0003	0.3984	0.0003
Gamma—3	0.0084	0.6805	0.0122
X-rays: Kα	0.6859	0.0719	0.1053
Kβ	0.1993	0.0840	0.0354
Lα	0.1787	0.0103	0.0039
Lβ	0.1675	0.0122	0.0044
Lγ	0.0225	0.0143	0.0007
Auger			
Electrons: KLL	0.0221	0.0570	0.0027
KLX	0.0127	0.0683	0.0018
KXY	0.0020	0.0796	0.0003
LMM	0.5842	0.0084	0.0104
MXY	1.7681	0.0029	0.0109

* For reference only—does not contribute to dose.

Using the nuclear parameters of ^{203}Pb presented in Table 1, radiation dose estimates to several organs were made. The whole-body dose was 3.09 rads/8 mCi. Assuming a 50% deposition in the skeleton, the skeleton receives 6.74 rads/8 mCi administered dose. Assuming 8% of the injected dose (8 mCi) goes to the liver (*2*), the radiation dose to the liver was estimated to be 6.0 rads. However, when a 70-kg patient receives an 8 mCi dose, the radiation dose to the spleen is high (29.2 rads) even assuming only 5% of the lead acetate goes to this organ.

In the case of a rare-earth metal the activity in the liver, spleen, and kidneys is reduced by approximately 50% with HEDTA chelate compared with a weak chelate such as citrate (*3*). As the radiation dose to the RES organs, particularly spleen, is more than 29 rads with ^{203}Pb acetate, the use of ^{203}Pb HEDTA will not result in a relatively low radiation dose to the patient.

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3. Rosoff B, Siegel E, Williams GL, et al: Distribution and excretion of radioactive rare-earth compounds in mice. *Int J Appl Radiat Isot* 14: 129–135, 1963

THE AUTHORS' REPLY

We appreciate the interest of Syed regarding ^{203}Pb dosimetry. First of all, when we injected 800 μCi in the rabbit to obtain a quick image, we did not mean that a proportionate dose should be given to a patient. We feel that 2 mCi or less would be sufficient to obtain a good scan on a normal patient.

Since Syed has considered an 8-mCi dose to the patient, the resulting absorbed-dose estimates are considerably high.

Second, when a radionuclide with a physical half-life of 2.2 days is considered, the biologic half-life should be taken into account to estimate the absorbed dose. Apparently, Syed did not consider this. If we assume that our biologic distribution data obtained after intravenous administration of ^{203}Pb-acetate in rats are valid for humans, we find 15% of the administered dose has a biologic half-life of 12 hr whereas 30% has 12 days with a total initial uptake of 45% in the bone. Taking this into consideration, we estimated the absorbed dose to the skeleton using the same method followed by Syed to be 0.6 rads/mCi. We also found a biologic half-life of 16 hr for the activity in the liver with an initial uptake of 10% of the administered dose. Then the effective half-life is 12 hr reducing the liver-absorbed dose by a factor of 4 to 0.3 rads/mCi.

The assumption made by Syed that the spleen uptake is at least 5% of the administered dose seems to be unreasonable. Durbin, et al (*1*) have reported less than 1% initial uptake by the spleen and Scott, et al (*2*) have quoted less than 0.5% of the total activity after 1 day. Although our animal data for the spleen are incomplete, we also found much less than 0.5% after 2 days. Therefore, 5% uptake by the spleen appears unlikely unless proven otherwise. Then, taking 1% spleen uptake and assuming no biologic excretion, the absorbed dose can be estimated as 0.8 rads/mCi.

Considering a 2-mCi dose to a 70-kg patient and if our biologic data in rats are valid for humans, the absorbed dose to the skeleton is 1.2 rads, 0.6 rads (T_{eff} = 1.7 days) for the whole body, 0.6 rads for the liver, and about 1.5 rads (T_{eff} is taken as 2.2 days) for the spleen. If the activity in the liver, spleen, and kidneys is reduced by 50% with the use of HEDTA chelate as suggested by Syed, the absorbed dose for these organs will be reduced by another factor of 2. Then these are well within the accepted levels and are less than the doses due to some other radionuclides suggested in the literature for bone scanning.

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ARTHROSCINTIGRAPHY OF KNEE

I wish to comment concerning the article by Drs. Pozderac and Good (Arthroscintigraphy in acute synovial rupture of the knee, *J Nucl Med* 15: 7–9, 1974). First of all, just because the isotope leaks from the knee joint posteriorly does not necessarily mean that a posterior leakage is causing the patient's symptoms. In my experience with arthrography (I personally perform over 900 procedures a year) knee joints in a small percentage of normal people have a tendency to leak spontaneously when the patient exercises. The leakage is in the same area as is seen on the scintigram.

Second, a knee joint may leak posteriorly yet the patient still has deep-vein abnormalities. I have had one such patient in the last year. A venogram would be most helpful in evaluating patients such as the one presented in this article.

Third, it is stated that because of the small volume of radionuclide injected into the joint, pain caused by overdistention of the knee joint as may occur with gas arthrography is avoided and the likelihood of iatrogenic synovial rupture is also reduced. Five cubic centimeters positive contrast material injected into the knee joint should cause no more overdistention and no more likelihood of rupture than the small amount of isotope used. Even when one uses 30 cc of contrast material, it can be easily aspirated after a study (and 30 cc doesn't cause pain).

It is noted that the study was confirmed with an air arthrogram before treatment. Perhaps the air arthrogram was all that was needed although the positive contrast method would be even more accurate.

In summary, it seems more appropriate to study patients such as the one who presented with a positive contrast arthrogram as well as positive contrast venogram.

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