Abstract:

Release and retention of 212Pb from 224Ra-labeled microparticles

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Objectives: Alpha-particle emitting radionuclides have been subject of medical research due to their high energy and short range of action. This allows for effective and localized cancer therapy. Radium-224 (224Ra), with its convenient half-life of 3.6 days, is a good candidate for use against micro-metastatic disease. Despite attractive properties, the use of 224Ra has been limited to bone-seeking applications due to the difficulty of stably binding 224Ra to targeting antibodies. Alternative delivery systems for 224Ra are of considerable interest. Recently, we have described biocompatible calcium carbonate (CaCO3) microparticles as carriers for 224Ra, designed for local therapy of disseminated cancers in cavitary regions, such as peritoneal carcinomatosis. The aim of this work was to investigate the release of the daughter lead-212 (212Pb) from its parent nuclide 224Ra through the intermediate daughter thoron (220Rn), both to air and liquid volumes. Release and retention properties of 220Rn/212Pb from 224Ra were evaluated in relation to product properties and safety of handling.

Methods: Due to its short physical half-life of 56 s, thoron diffusion was evaluated by measuring its decay product 212Pb with a half-life of 10.64 h and its corresponding radiation emission that is easily detectable with a gamma counter. Thoron release to air was studied from solutions with 224Ra, either as free cation in solution or bound to calcium carbonate (CaCO3) microparticles in a suspension. Additionally, release and retention of daughter 212Pb from suspensions of 224Ra labeled CaCO3 microparticles was evaluated at different particle concentration and suspension volumes.

Results: Release of 220Rn to air appears to be significantly reduced when 224Ra is bound to microparticles as compared to dissolved radium cation. Results shows that from open vials containing small solution volumes, (i.e. 10µl), there is less diffusion (a reduction of 70 % to 95 %) from 224Ra-CaCO3 suspensions compared to free cationic 224Ra solution. The results of measured retention of 212Pb on 224Ra-CaCO3 microparticle indicate that 212Pb released through the diffusion of 220Rn can be re-absorbed on the particles in suspensions.

Conclusions: Preliminary results suggest that 224Ra labeled CaCO3 microparticles have promising properties both in terms of diffusion and retention of progenies. This ensures low amounts of thoron escaping from the tested vials and syringes containing 224Ra-CaCO3 microparticle suspensions, allowing safe handling as long as the product is administered in accordance with safety precautions.