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A potential radiotracer for imaging the lungs

Routine patient lung scans in the nuclear medicine department have for decades, employed a radioactive technetium-99m-aggregated-albumin particle injection dose, in conjunction with a ventilation dose of Tc-99m-aerosol in tandem. The lung scans are usually requested for patients with suspected thromboembolism, obstructive pulmonary disease, inhalation injury or when foreign material is present. The occasional disruption in supply of albumin particle formulations to clinics, has prompted researchers to investigate other radiotracers for lung imaging. Gallium-68 is another medical isotope that has become recently popular because of its commercial availability. Many different radiotracers have been prepared in the laboratory, and have combined the Ga-68 isotope with a pharmaceutical ligand. The property of this isotope translates into high quality scans, in which the target organ is intensely displayed over a low background. Such scans allow the physician to diagnose the image information with high accuracy and assurance.

Fig. 1. Whole body positron emission tomography (PET) scan of a rat, taken 20 minutes after it was injected with Ga-68-phytate particles, and it shows high lung uptake.

In this study, a new particle formulation was invented that combined the Ga-68 isotope within a particle matrix comprised of phytic acid units. Phytic acid is a naturally abundant hexaphosphate molecule in the plant kingdom, with a strong affinity for different metal ions including calcium, tin, magnesium, etc.

The methodology to prepare Ga-68-phytate particles was investigated and then the best formulation was characterised for radiochemical purity, radioactive particle size, and the organ distribution in normal rats. A commercially available phytate pharmaceutical product was mixed with Ga-68 chloride solution, calcium ions and air in the original vial, then it was heated at 100^{o}C for 30 minutes. Approximately three quarters of the Ga-68-particles with >95% purity were greater than 5 mm in size, and these remained integral for two hours at room temperature.

Intravenous administration of Ga-68-particles to rats resulted in an average radiotracer uptake after 20 minutes, of more than 92% in the lungs, and less than 5% in the liver plus spleen or in the carcass. The low carcass radioactivity was attributed to minor binding of the isotope to a blood protein that eventually circulated to the salivary glands. It was also rationalised the smaller radioactive particles (<5 mm) grew upon contact with calcium ions in blood, and almost all of the Ga-68-particle population were retained in the pulmonary blood vessels. The Ga-68 scan in Figure 1 clearly showed the lungs, it was superior to a Tc-99m-aggregated-albumin rat scan performed on another occasion. The low uptake by non-target organs did not interfere with the diagnostic quality, and there was pronounced lung uptake against a low background. In advance of human studies, the data so far indicate Ga-68-phytate particles have excellent potential for lung imaging.

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