The kinetics of copper pyruvaldehyde bis(N-methylthiosemicarbazone): A blood flow tracer for positron emission tomography

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Cost is one of the biggest obstacles to the wide spread acceptance of positron emission tomography (PET). Copper pyruvaldehyde bis(N-methylthiosemicarbazone) (Cu-PTSM), a trapped blood flow tracer, helps overcome this obstacle, as it can be radiolabelled with Cu-62 from a Zn-62/Cu-62 generator. The primary goal of this work is to measure the kinetics of Cu-PTSM in vivo.

Since Zn-62 was not available, Cu-60 (23 min half-life) was produced via Ni-60(p,n)Cu-60, by proton irradiation of natural nickel. After irradiation, the nickel target was electrochemically dissolved. The copper was separated from the nickel solution using solvent extraction into dithizone and ion exchange chromatography followed by chelation into Cu-PTSM.

The use of Cu-60 for PET posed several problems. Copper-60 emits other prompt gammas in addition to the positron. The effects of these gammas on quantitative PET were studied and found to be insignificant due to their lack of spatial correlation with the annihilation photons. Second, proton irradiation of natural nickel produces other radioisotopes of copper, which required using a an off line coincidence pair to assay the injected positron activity and to decay correct the PET data.

The kinetics of Cu-PTSM were studied in the blood, the myocardium and the brain. In all organs, the uptake of Cu-PTSM was rapid and irreversible. The half time for the trapping of Cu-PTSM in the blood was about 1 minute. Comparison between the uptake of Cu-PTSM and radioactive microspheres in the canine myocardium showed that the uptake of Cu-PTSM is a linear function of flow for flows up to 4 ml/min/g. PET images of the human myocardium using Cu-PTSM and ammonia are very similar, with the Cu-PTSM images having slightly more noise. In the brain, a comparison of Cu-PTSM uptake with flow as measured using F-18-fluoromethane suggests that the PS product for Cu-PTSM in the brain is about 40 mls/min/100g.