140-Praseodym: A potential radionuclide for perfusion measurements ?

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Objectives: In research application O-15 water has been used for many years to assess cerebral and myocardial perfusion with PET. Generally, radioisotopes with short half-lifes can be considered to be used as perfusion markers. However, due to the short half-life i.e. 2 min for O-15, this tracers can only be used in PET centers with onsite cyclotron. 140-Praseodym (^{140}Pr, half-life 3.39 min) as daughter radioisotope from 140-Neodym (^{140}Nd, half-life: 3.37 d) can be produced in a generator system and therefore used in PET lacking a nearby cyclotron. Aim of this study was to evaluate the feasibility of ^{140}Pr for perfusion studies in rats using small animal PET scanner.

Methods: ^{140}Pr was derived from a ^{140}Nd/^{140}Pr radionuclide generator as published [1]. ^{140}Nd was produced at the DKFZ Heidelberg cyclotron via ^{139}Pr(p,2n) reaction on Praseodym metal.
3 male SD rats were scanned with the microPET Focus 120 small animal PET scanner. ^{140}Pr was eluted with about 0.5 ml of 10^{-3} M DTPA from the ^{140}Nd/^{140}Pr generator and immediately injected into the jugular vein. Dynamics were started simultaneously with tracer injection of about 5-10 MBq ^{140}Pr-DTPA. 10-min scans were derived from brain and body areas. Additionally, tumor perfusion of one rat bearing DS sarcoma on both hind foot dorsum was imaged.

Results: Imaging of the abdominal area showed that ^{140}Pr-DTPA was rapidely washed out by the kidneys. Time-activity curves of brain and neck regions-of-interests demonstrate that ^{140}Pr-DTPA did not enter the blood-brain barrier (BBB) (Fig. 1). Due to the limited activity the reconstructed images were noisy and perfusion could not properly quantified.

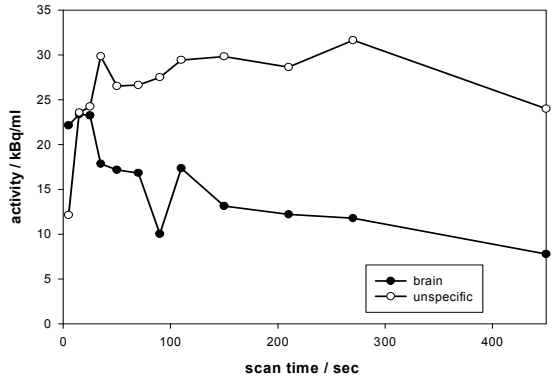

Fig. 1: Time-activity curves of the brain and of the neck and shoulder area (unspecific)

On the other hand, perfusion of the tumor was visible, cf. Fig. 2. TAC are illustrated in Fig. 3.

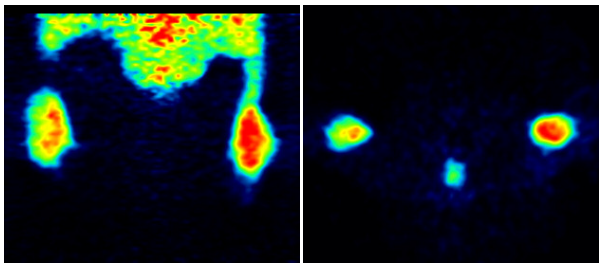

Fig. 2: Coronal (left) and transversal (right) µ-PET sum imaging of ^{140}Pr-DTPA accumulation in a DS-tumor bearing rat

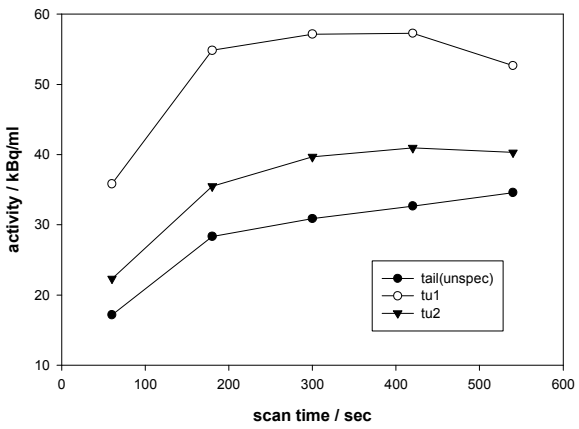

Fig. 3: Time-activity curves for the two tumors and the tail region (unspecific)

Conclusions: ^{140}Pr-DTPA failed to measure brain perfusion as the complex is not passing the BBB. Brain tumor imaging may, however, be an option due to the damaged BBB of the tumors.
Remarkable tumor perfusion in DS sarcoma was detected, demonstrating that ^{140}Pr-DTPA eluted from the ^{140}Nd/^{140}Pr generator indicates regional tumor perfusion. Further perfusion studies with much more ^{140}Pr-DTPA activity resulting in better count statistics are needed to validate these findings.

References

[1] KP Zhernosekov, DV Filosofov, SM Qaim, F Rösch. A ^{140}Nd/^{140}Pr radionuclide generator based on physico-chemical transitions in ^{140}Pr complexes after electron capture decay of ^{140}Nd-DOTA. Radiochim Acta 95 (2007) 319-327