Metabolic assessment of stroked rats using $^{17}O_2$ gas

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Introduction: The identification of acute stroke patients who will benefit from recanalization treatments (thrombolysis or thrombectomy) remains one of the most challenging aspects for stroke neurologists. Due to the narrow therapeutic time window for recanalization many patients are ineligible for treatment. However, accurate imaging of metabolically viable brain tissue could identify patients that may benefit from these treatments outwith the current time window. The only available method for imaging aerobic metabolism is ^{15}O PET, which is simply not practical for routine clinical use. This work makes the first steps in developing a safe approach based on directly imaging aerobic metabolism using $^{17}O_2$ gas, detected via ^{1}H MRI combined with ^{17}O decoupling.

Methods: Fig.1 shows hardware and software development for ^{17}O metabolic MRI.

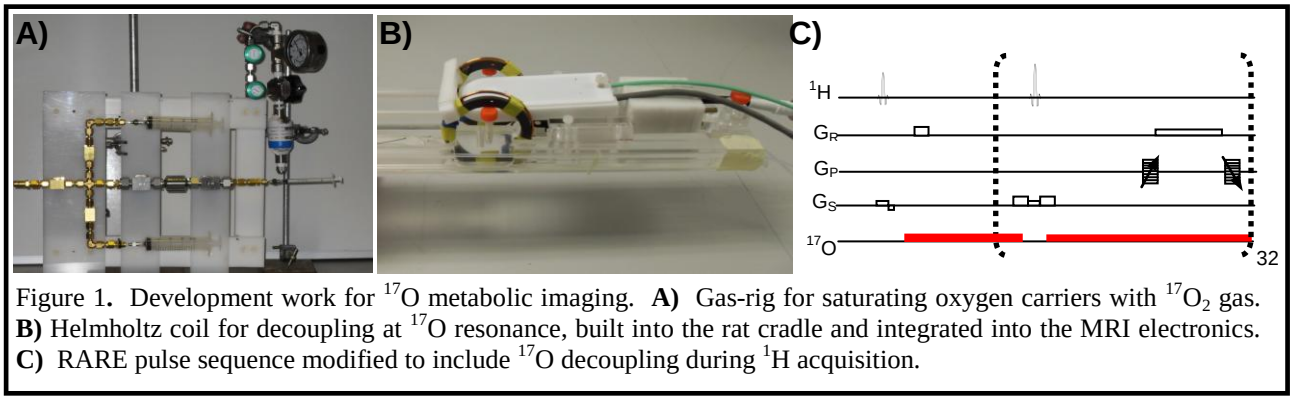
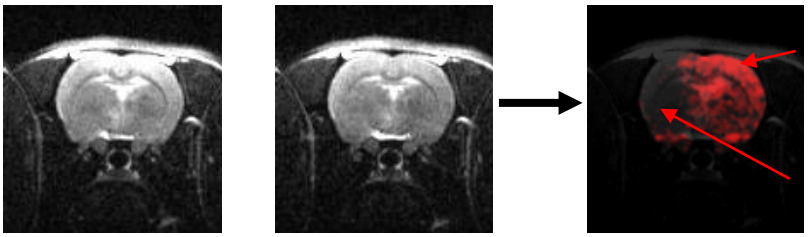


Figure 1. Development work for ^{17}O metabolic imaging. **A)** Gas-rig for saturating oxygen carriers with $^{17}O_2$ gas. **B)** Helmholtz coil for decoupling at ^{17}O resonance, built into the rat cradle and integrated into the MRI electronics. **C)** RARE pulse sequence modified to include ^{17}O decoupling during ^{1}H acquisition.

The metabolic production of $H_2{}^{17}O$ from intravenously delivered $^{17}O_2$ gas is used to directly detect metabolism. Further, the ^{17}O decoupling allows the ^{17}O quadrupole interaction with the bonded ^{1}H to be effectively "switched on" and "switched off" while acquiring the ^{1}H RARE signal using a 300MHz Bruker Biospec.

Results and discussion: MRI of a stroked rat following intravenous injection of $^{17}O_2$ saturated PFC nano-emulsion (Fig.2). (*left image*): T_2 image with decoupling (3 min). (*centre image*): T_2 image without decoupling (3min). (*right image*): Difference image (red overlay), where signal intensity is proportional to the metabolism of $^{17}O_2$ into $H_2{}^{17}O$. The metabolising hemisphere (right) is quite distinct from the non-metabolising stroked hemisphere (left).



T_2 image, with ^{17}O decoupling

T_2 image, without ^{17}O decoupling

Difference image

Figure 2.

Conclusion:We have demonstrated in an in-vivo stroke model the ability to image the aerobic metabolism of $^{17}O_2$ gas, delivered intravenously via an oxygen carrier (PFC nano-emulsion). Further, we demonstrate the use of ^{17}O decoupling during ^{1}H acquisition.