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# Effect of intravoxel incoherent motion on post mortem diffusion parameters

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## MOTIVATION

- Quantification of different diffusion processes due to varying molecule speed [1,2]
- Understanding of PM IVIM properties
- Validation of temperature dependency of diffusion imaging
- Kurtosis model [1,3]:
  $\frac{S}{S_0} = f \cdot e^{-bD^*} + (1-f) \cdot e^{\left(-bD+(bD)^2 \cdot \frac{K}{6}\right)}$

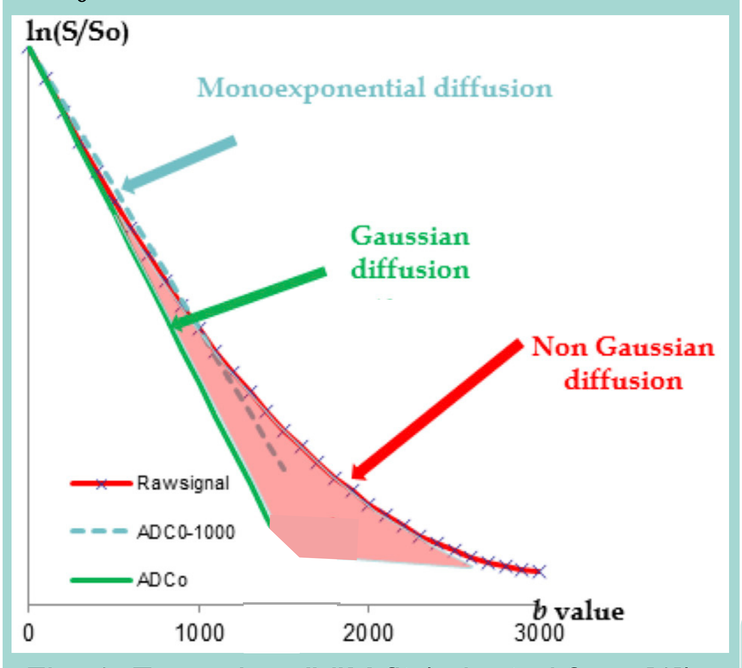


Fig. 1: Exemplary IVIM fit (adapted from [1]).

## ABBREVIATIONS

| | |
|---|---|
| f | Perfusion fraction, fraction of blood microcirculation |
| D* | Pseudodiffusion, collective motion of blood water molecules |
| D | Diffusion, random movement of individual water molecules |
| K | Kurtosis |
| PM | Post mortem |
| IVIM | Intravoxel incoherent motion |
| MRI | Magnetic resonance imaging |
| WM | White matter |
| GM | Gray matter |
| FSL | Functional MRI of the brain software library |
| PMI | Post mortem interval |

## METHODS

- Brain scan of 5 PM and 2 in vivo controls (Tbl. 1)
- $3\,T$ MRI (diffusion-weighted, 16 b-values from $0\ s/mm^2$ to $2500\ s/mm^2$, 6 directions)
- Automatic segmentation into WM and GM with FSL (Fig. 2, [4])
- 2-step kurtosis model with Matlab [1,3,5]

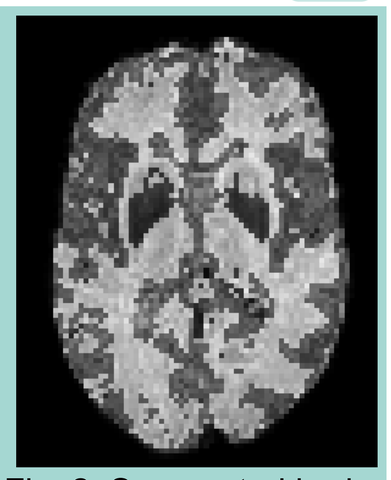

Fig. 2: Segmented brain.

Tbl. 1: Participants overview.

| Subject \ Parameter | Age (y) | Forehead temperature (°C) | PMI (h) | Cooling time (h) |
|---|---|---|---|---|
| PM | 56.6 ± 13.54 | 10.1 ± 4.95 | 27.4 ± 11.14 | 25.6 ± 13.23 |
| Controls | 26.5 ± 4.95 | 31.4 ± 0.57 | - | - |

## RESULTS

- Intra-group agreement, inter-group difference
- PM 3: Higher forehead temperature ($T_{PM\ 3} = 19°C$, $\overline{T_{PM\ 1245}} = 8°C$)

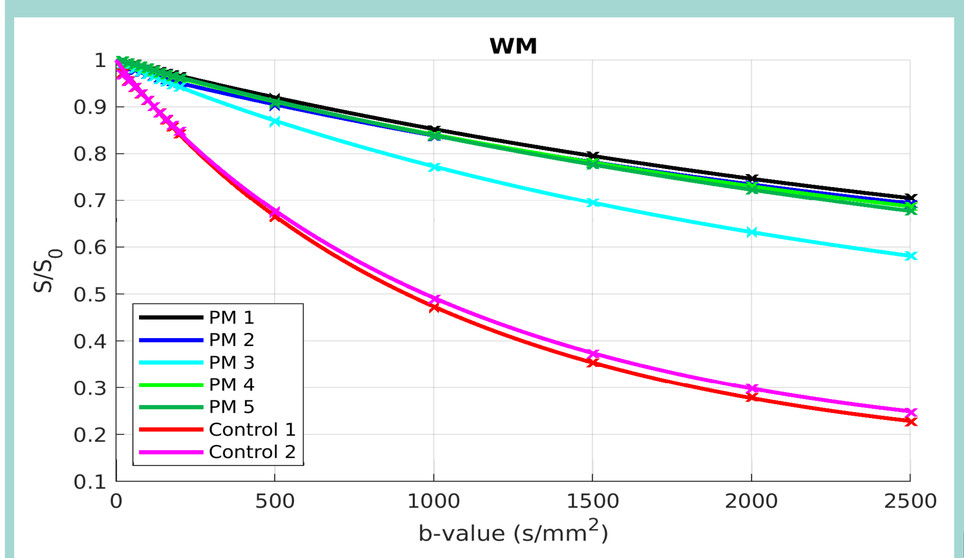


Fig. 3: IVIM fits of WM.

- Diffusion and perfusion fraction lower in PM
- Diffusion and perfusion fraction higher in GM than WM
- Perfusion fraction is not 0 % PM, but similar to WM of controls (see also [6])
- Pseudodiffusion in PM and controls similar
- Cytotoxic edema of PM 2 increases value of pseudodiffusion, especially in WM ($D^*_{PM\ 2} = 20.1 \cdot 10^{-3}\ mm^2/s$, $\overline{D^*_{PM\ 1345}} = 2.5 \cdot 10^{-3}\ mm^2/s$)

Tbl. 2: Calculated coefficients.

| Region \ Coefficient | $f$ (%) | | $D^* \cdot 10^{-3}\ (mm^2/s)$ | | $D \cdot 10^{-4}\ (mm^2/s)$ | |
|---|---|---|---|---|---|---|
| | PM | Controls | PM | Controls | PM | Controls |
| GM | 1.7 ± 0.50 | 11.0 ± 0.45 | 4.6 ± 1.02 | 6.8 ± 0.27 | 3.0 ± 0.69 | 9.3 ± 0.20 |
| WM | 1.1 ± 0.24 | 1.9 ± 0.10 | 5.5 ± 4.15 | 2.4 ± 0.24 | 1.9 ± 0.44 | 8.0 ± 0.30 |

## CONCLUSIONS

- Diffusion and perfusion fraction depend on blood flow and temperature
- Pseudodiffusion depends on capillary throughput in WM which is increased in cytotoxic cerebral edema

**References**

[1] Le Bihan, NeuroImage, 2019, 56-67.
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[4] Jenkinson et al, NeuroImage, 2012, 62:782-90.
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[6] Vieni et al, NeuroImage, 2020, 116228.

**Background Image:** Diffusion of water molecules (blue dots) in intracellular (light mint) and extracellular (white) space.

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