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Dependence of Biexponential IVIM Parameters on the Number of Slices in the Liver

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Introduction & Motivation

Intravoxel Incoherent Motion (IVIM)

- Method in diffusion-weighted imaging (DWI)
- Considering both tissue diffusivity and blood perfusion
- $S(b) = S_0 \cdot [(1-f)\exp(-bD) + f\exp(-bD^*)]$

Tissue Blood

- Diffusion-weighting factor b, signal S_0 at $b = 0$, diffusion coefficient D, pseudodiffusion coefficient D^* and perfusion fraction f
- IVIVIM allows separation of signal into these two compartments
- IM studies are performed with varying acquisition parameters → Question: Are results comparable?
- Here: Investigation of saturation effects on flowing spins that might occur[1]
- Comparison of data acquisition with few slices and with many slices
- Idea: Measurement with few slices reduces potential saturation effects
- f might be affected most → decrease of f expected for many slices

Materials & Methods

Volunteer Study

- 9 healthy volunteers (2 female, 7 male, age: 21 – 30 years)

Acquisition Parameters

- Field strength: 3T
- Magnetom Prisma, Siemens Healthcare
- TE = 60 ms, TR = 3600 ms
- Slice thickness = 5 mm
- Two sets of b-values (16 and 20 b-values, respectively) ranging from 0 s/mm² to 800 s/mm² were used
- Three orthogonal diffusion directions for every b-value

Measurements

- Divided into two parts: Few and many slices
- Few slices: 4 slices in transversal orientation; 25 mm spacing between slices
- Many slices: 24 – 27 slices (covering the whole liver) in transversal orientation; 1 mm spacing between slices

Evaluation

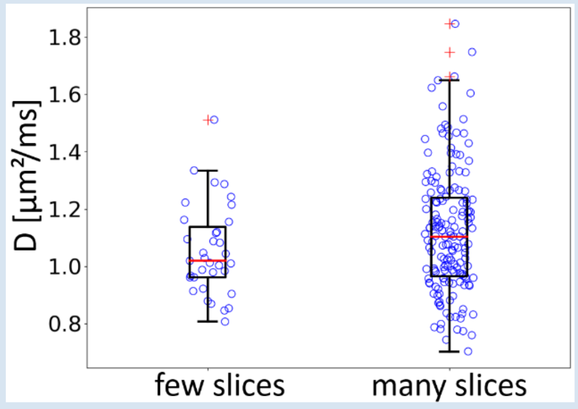
- Region of interest (ROI) was drawn in the liver parenchyma of the right liver lobe for each slice separately → Computation of the median signal of the included voxels
- Biexponential IVIM function was fitted to the median signals from the ROIs (normalised to the signal at $b = 0$) in order to obtain one set of IVIM parameters for each slice
- Assessment of (non) normality of IVIM parameters with Shapiro-Wilk test
- Accordingly, the unpaired t-test (normality) and Mann-Whitney U test (non normality) were applied to assess statistical significance between measurements

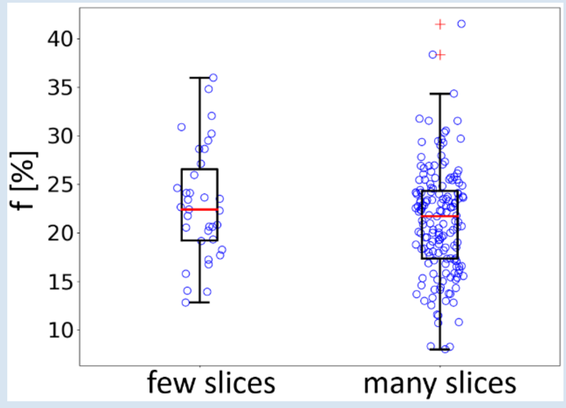
Results

- No statistical significance observed for all three parameters (p_D= 0.09, p_f = 0.09, p_{D^*} = 0.5)

Slice Setting	D [µm²/ms]	f [%]	D^* [µm²/s]
Few Slices	1.02	22.4	38
Many Slices	1.10	21.7	55

Table 1: Median IVIM parameters for the few slice and the many slice setting





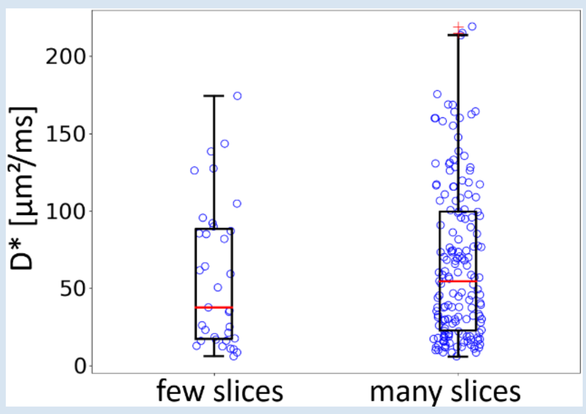


Figure 1: Boxplots of the IVIM parameters for measurements of 4 slices ('few slices') and the many slice setting in transversal orientation ('many slices'). Data points are shown in blue, outliers are marked as red '+'-signs. The red line marks the respective median, the box indicates the interquartile range (IQR) and whiskers indicate all data lying within 1.5 x IQR.

Discussion & Conclusion

- **Saturation effects** only play a **minor role** in IVIM of the liver, which are commonly performed with a similar TR[2]
- Slight **decrease of f** in the many slice setting, but **not significant**
- Blood flow is too fast for blood to get saturated
- **Comparison of IVIM parameters** with different slice settings should be **possible** (at least for TR in the same order of 3600 ms)

References

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2. Riexinger A, Martin J, Wetscherek A, Kuder TA, Uder M, Hensel B, Laun FB. An optimized b-value distribution for triexponential intravoxel incoherent motion (IVIM) in the liver. Magnetic resonance in medicine. 2021;85(4):2095-2108