Comparative Evaluation of IVIM-MRI Parameter Extraction Methods in Placental Imaging

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Background

Intravoxel Incoherent Motion (IVIM) is an MRI protocol that quantifies tissue microperfusion via capillary molecular diffusion.

Study's aim: **Comparison of different calculation methods for the IVIM coefficients D*, D, and f in cases of Intrauterine Growth Restriction (IUGR)**, a condition of pathological fetal growth resulting from inadequate blood flow or nutrient supply.

Materials and Methods

IVIM MRI of 9 cases with sonographically confirmed IUGR (GA: 26-36 weeks), using 13 b-values from 0-1000 s/mm² (Philips 3.0T, MULTI Coil, SE sequence with SK-space).

D*, D, and f were calculated using three methods:

I. MR Signal Curve fitting on mean ROI values

Acquired Images

II. Mean ROI values from voxelwise constructed maps

NordicIce

III. Segmented fitting for new maps and voxelwise extraction

MATLAB

○ Comparison of mean D*, D, and f between NordicIce-extracted values.

○ Second independent sampling of parametric maps, using Fiji ImageJ.

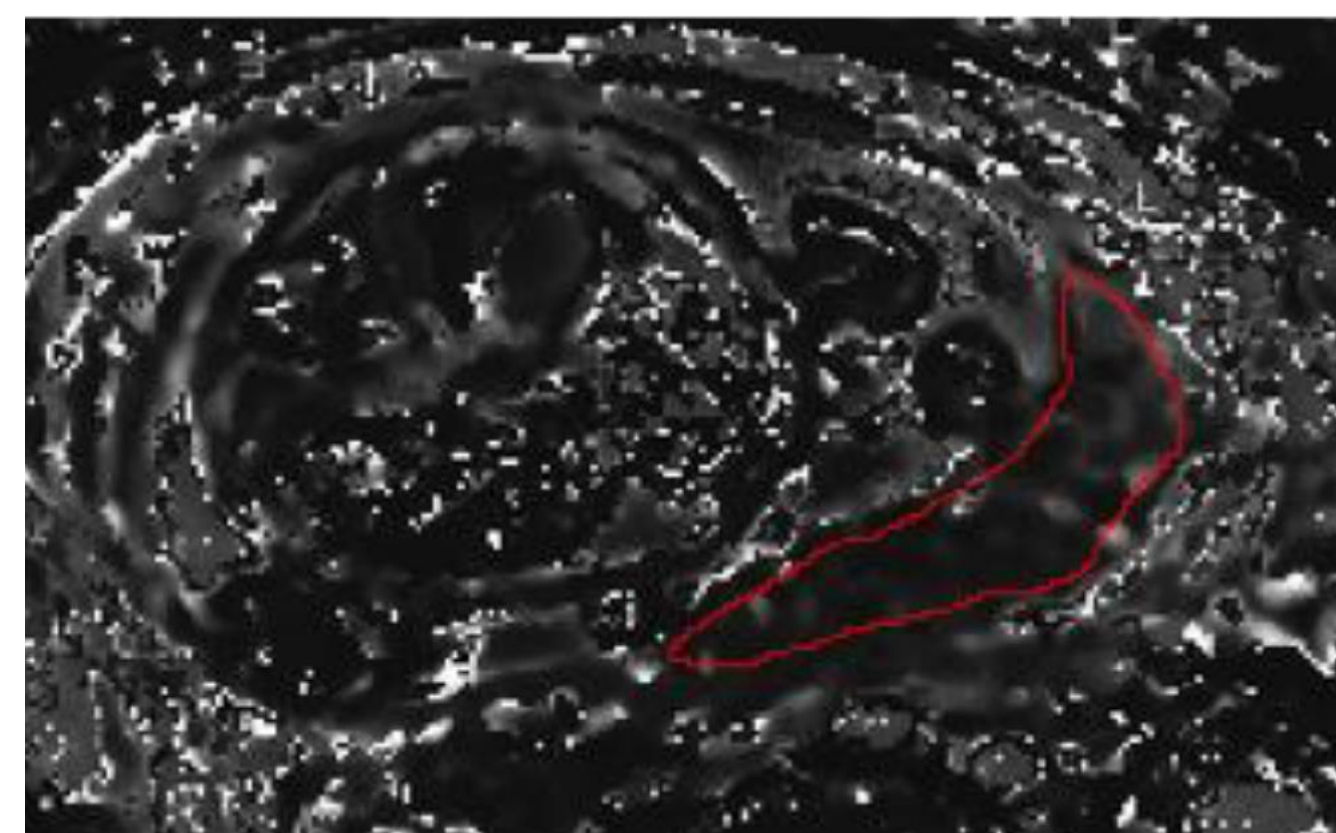○ Statistical analysis using Paired-samples T-test and Wilcoxon Signed Ranks-test.

Fig. 1: Parametric map of D*, NordicIce.

Results

The paired mean values for D*, D, and f from each dataset were compared for each patient separately, revealing significant discrepancies across all methods and a lack of correlation patterns.

This result indicates the significance of the analysis approach within a software as well as the choice of the software itself.
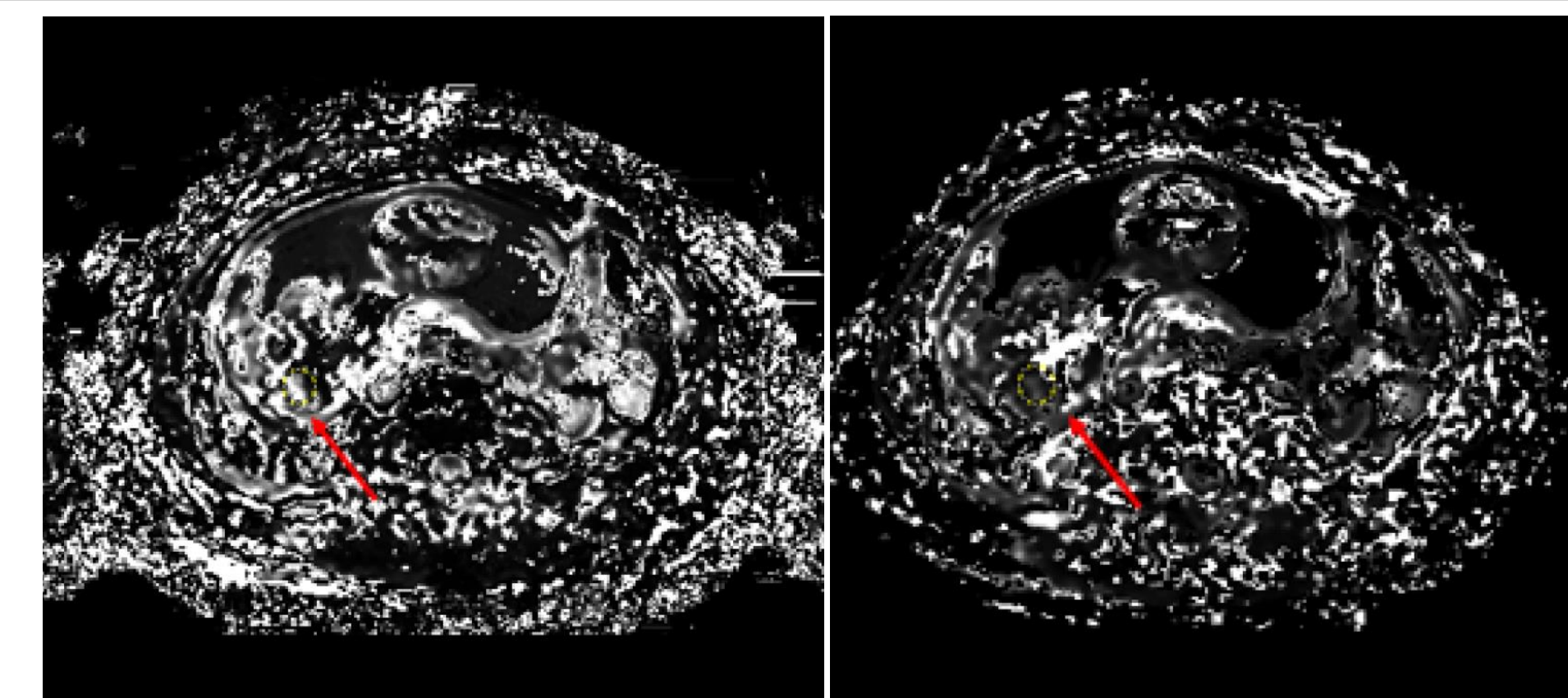

Fig. 2: Parametric map of D*, NordicIce data (left) and MATLAB data (right) followed by second sampling.

Conclusion

✓ The results highlight the importance of model element selection in the application of IVIM.

✓ The current lack of standardization analysis including **model parameter selection, fitting algorithms and data pre-processing** leads to determination inconsistencies for the IVIM parameters.

✓ The findings call for further research on a standardized IVIM protocol that will result in more consistent and reliable outcomes, by significantly aiding diagnosis and disease monitoring.