PERFUSION MRI OF THE WHOLE LIVER USING 4D THRIVE: FEASIBILITY OF FOCAL LIVER LESION CHARACTERIZATION USING PARAMETRIC MAPS.

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PURPOSE: To prospectively evaluate a newly developed perfusion imaging sequence (4D THRIVE) when imaging the whole liver in high temporal and spatial resolution. The characterization of focal liver lesions using parametric maps is evaluated.

MATERIALS AND METHODS: Fifteen patients suspected for colorectal liver metastases were included. All images were acquired using a 3.0T Achieva X-series scanner (Philips Medical Systems, Best, The Netherlands). For perfusion imaging a Four-Dimensional T1-weighted High Resolution Imaging with Volume Excitation (4D THRIVE) sequence was used. This method is based on a 3D fat-saturated spoiled gradient echo sequence, combined with partial Fourier acquisition, SENSitivity Encoding (SENSE), keyhole and a novel profile sharing technique integrated in the keyhole part to accelerate acquisition. With this sequence it was possible to acquire 4 dynamic scans per breath-hold, 3 keyhole scans of 2 seconds followed by a reference of 10 seconds. One ml/10 kg body weight of gadolinium-BOPTA (MultiHance®, Bracco, Milan, Italy) was injected as a bolus via the cubital vein immediately followed by a bolus of 20ml of physiologic saline (NaCl 0,9%) both at a speed of 3ml/s using a Spectris MR injector (Medrad, Maastricht, The Netherlands). Parametric maps were automatically calculated based on the two-compartment model used by Hoffmann U. et al.[1]. Qualitative and quantitative evaluation (using regions-of-interest including entire focal liver lesions) of the parametric maps was performed for all detected liver lesions. Reference standard comprised surgery with histopathology or follow-up imaging. Rank order analysis (RIDIT analysis; “relative to an identified distribution”) was used for the evaluation of qualitative results and two-tailed student’s t-test for evaluation of quantitative results.

RESULTS: In all cases a complete registration procedure of all dynamic scans to the first one could be performed and parametric maps including the whole liver parenchyma were obtained. In total 29 liver metastases, 17 hemangiomas and 4 focal nodular hyperplasias were evaluated using 4D THRIVE. Qualitative analysis of the parametric maps resulted in significant ($p<0.05$) differences in ring enhancement and lesion heterogeneity comparing liver metastases with benign lesions (hemangiomas and focal nodular hyperplasias). Quantitative analysis of the parametric maps comparing metastases, hemangiomas and focal nodular hyperplasias resulted in non-significant differences of perfusion parameters.

CONCLUSION: This preliminary study shows the potential of 4D THRIVE for imaging the whole liver enabling automated calculation of parametric maps. Qualitative evaluation was accurate for differentiating malignant and benign focal liver lesions. ROI placement including entire focal liver lesions was not useful for quantitative differentiation of malignant and benign focal liver lesions.

REFERENCES: 1. Hoffmann U, Brix G, Knopp M, et al. Pharmacokinetic mapping of the breast: a new method for dynamic MR mammography. *Magn Reson Med*. 1995;33:506-514.

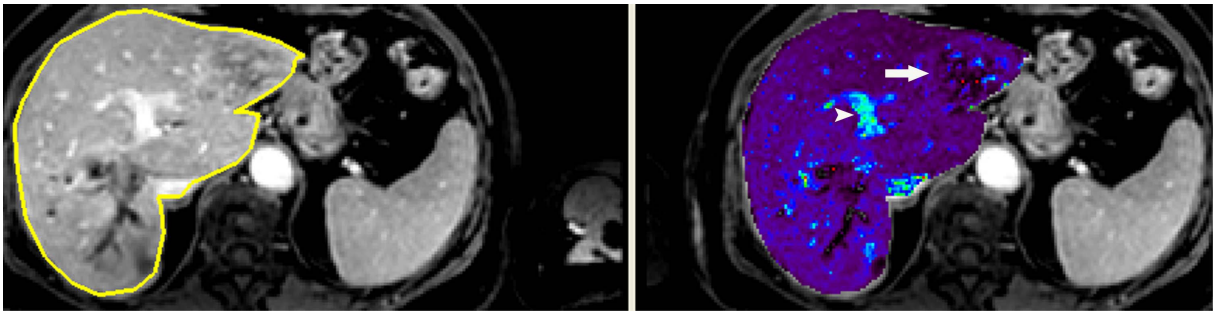

FIGURE 1: A liver metastasis in the left liver lobe is shown. The reference image using 4D THRIVE (on the left) is shown with corresponding automatically calculated parametric map (on the right). The parametric map shows the liver metastasis (white arrow) as a heterogenous lesion with ring enhancement. Portal vein is indicated with white arrowhead.