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Abstract

Milisecond Magnetic Particle Imaging of a 3D printed patient-specific cerebral aneurysm phantom with flow diverter stent

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Undetected, asymptomatic brain aneurysms include the high risk of progressive expansion [1], followed by rupture, hemorrhage and finally death in approximately 80% of the cases. Therefore, imaging techniques to assess the state of aneurysms and the success of the treatment of aneurysms are of high relevance. For this purpose, we manufactured vessel structure phantoms by 3D silicon printing. The vessel structure phantom contains straight and curved sections as well as an aneurysm and was created using MRI-data sets of patient-specific cerebral aneurysms. By Magnetic Particle Imaging (MPI), an ambitious biomedical imaging modality with high temporal and spatial resolution using magnetic nanoparticles (MNP) as tracer, we studied the flow characteristics of MNP in 3D printed phantoms using a preclinical MPI system (MPI 25/20 FF, Bruker Biospin, GER) equipped with an additional gradiometric receive-only coil. By MPI, we were able to resolve the transport and residence of MNP in the different parts of the vessel structure phantom with millisecond resolution. To assess the success of treating aneurysms with flow diverter stents, we compared flow MPI measurements in a 3D-printed artery without a flow diverter stent with images in a treated artery with a flow diverter stent inside the vessel. Our results provide valuable information on the capabilities and prospects of MPI imaging of vascular structures and the detection and quantification of flow changes in untreated and treated aneurysms for future in vivo applications. 3D printing allowed us to bridge the gap between imaging using a preclinical MPI system and patient-specific cerebral aneurysms.

AUTHOR'S STATEMENT

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this work. Informed consent: Informed consent has been obtained from all individuals included in this study. Ethical approval: The research related to human use complies with all the relevant national regulations, institutional policies and was performed in accordance with the tenets of the Helsinki Declaration, and has been approved by the authors' institutional review board or equivalent committee.

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