MRI compatibility of additive manufactured auxetic NiTi parts

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INTRODUCTION: In the context of the SPIRITS project a 3D-printed design of an assistance robot for interventional surgery under Magnetic Resonance Imaging (MRI) is developed[1,2]. It is of the outmost importance that the manufactured components do not affect the image quality[3]. Artefacts in imaging could be caused on one hand by eddy currents due to the numerous loops of the auxetic structure (Fig. 1), and on the other hand by the nickel-containing shape memory alloy NiTi consisting of approx. 50 % Ni, which is ferromagnetic in its elementary form[3].

METHODS: Auxetic structures printed using selective laser melting (SLM) in medical degree pure titanium (strut thickness s = 500 µm) and a NiTi alloy (s = ~600 µm) were compared. Images were acquired with artefact susceptible TRUFI sequences at 3 T (Magnetom Skyra, Siemens Healthineers, Germany)

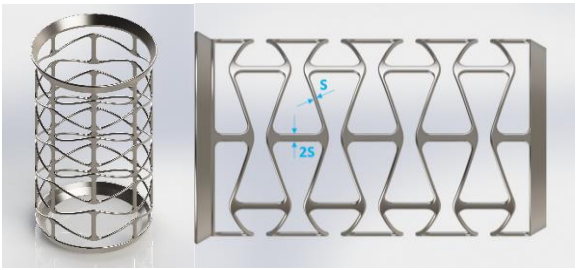

Fig. 1: CAD view of an auxetic structure (ø30 mm, h=50 mm).

RESULTS: All 3D-printed metallic structures could be mapped without any significant side effects such as heating, movement or intense disturbing image artefacts. It was found that NiTi structures lead to slightly larger artefacts than Ti (Fig. 2 and Fig. 3).

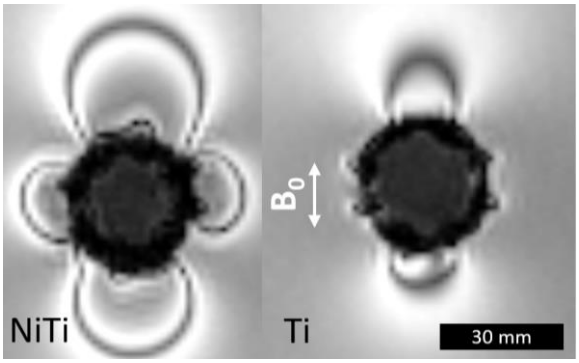

Fig. 2: MRI images of NiTi and Ti structures.

Furthermore, the signal inside both structures is significantly reduced by the induced eddy currents. The observed artefacts are primarily expressed radially in the direction of the main magnetic field B_0.

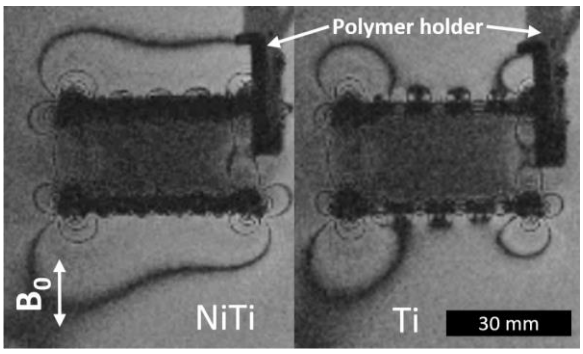

Fig. 3: MRI images of NiTi and Ti structures.

DISCUSSION & CONCLUSION: The observed imaging artefacts can be considered non-problematic due to the region of interest being in axial direction, outside of the auxetic structure. The reason for the major disturbances around the NiTi actuators could be the material difference but also the slightly thicker realization of the structures. Based on the observed behavior, no critical design flaw was identified.

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