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Abstract

Additive manufacturing of personalized endovascular NiTi implants for intracranial aneurysms

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The shape memory alloy Nickel-Titanium (Nitinol) is a common material used in the field of medical engineering due to its mechanical and functional properties and its biocompatibility [1,2]. Beyond traditional manufacturing processes, Nitinol can be processed with laser powder bed fusion (LPBF) and adapted scan strategies, rather than conventional strategies, yielding small feature sizes, and more homogeneous and finer structures [3,4]. One common application of Nitinol is stents, which are typically manufactured either by braiding or laser cutting techniques. It should be noted that both methods are not suitable for the production of individualized implants. However, in the case of complex aneurysms, the production of individualized solutions is required. A common treatment for complex aneurysms is currently an off-label use of standard stents and flow diverters, but this still requires a significant degree of experience of the attending physician and results in more complications and a lower success rate of the treatment.

This work will demonstrate a novel workflow for the generation of patient-specific Nitinol implants, derived from angiography results with a particular focus on intracranial aneurysms. The workflow employs an automated segmentation of the aneurysms and linked blood vessels based on the angiography scan to simulate the behavior of the aneurysm and various possible implant geometries. Following the selection of the most suitable geometry based on the simulation results, the implant will be manufactured via LPBF and a series of post-processing steps are undertaken to ensure that the requisite properties are met. Concurrently, an appropriate feeding system is developed and incorporated into the simulation. This presentation will demonstrate preliminary results along the workflow chain, as this work is still ongoing.

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