**Title:** Semi-automated workflow with 4D flow CMR to assess left atrial flow dynamics in patients with repaired tetralogy of Fallot

**Background:** Cardiac conditions with abnormal flow patterns lead to changes in cardiac shape and function. Semi-automated 4D flow CMR workflows applying machine learning technologies can streamline the integration of 4D flow imaging into the diagnostic workflow, offering enhanced cardiac assessment.

**Method:** Controls (n=11) and adult patients with repaired tetralogy of Fallot (rToF; n=7) were scanned using 2D cine and 4D Flow CMR imaging. Images were analysed using deep learning based denoising and up sampling, followed by a mask segmentation from biventricular models. Three-dimensional phase contrast magnetic resonance angiography was generated from 4D flow data, and the left heart was automatically segmented using nnU-Net. This allowed examination of flow and function in the left atrium, and comparisons between groups.

**Results:** Right ventricular end-systolic volume (RV ESV), end-diastolic volume (RV EDV) and left atrial volume derived from cine CMR were not significantly different between controls and the rToF group, despite mild to moderate pulmonary regurgitation. However, rToF left atrial dynamics showed a significant difference in patterns of E/A waves, with the A wave peak velocity significantly reduced (rToF 106.1 ml/m2 vs controls: 204.7 ml/m2, p=0.02), correlating with indexed RV ESV (-0.66) and RV EDV (-0.490).

**Conclusion:** Left atrial flow indices may be more sensitive than traditional metrics such as atrial volume. Integrating machine learning-based workflows in cardiac image analyses, especially when combining 4D flow markers, may help with assessment of disease progression.