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Free-running 3D anatomical and flow MRI using Synchronization of Neighboring Acquisitions by Physiological Signals (SyNAPS)

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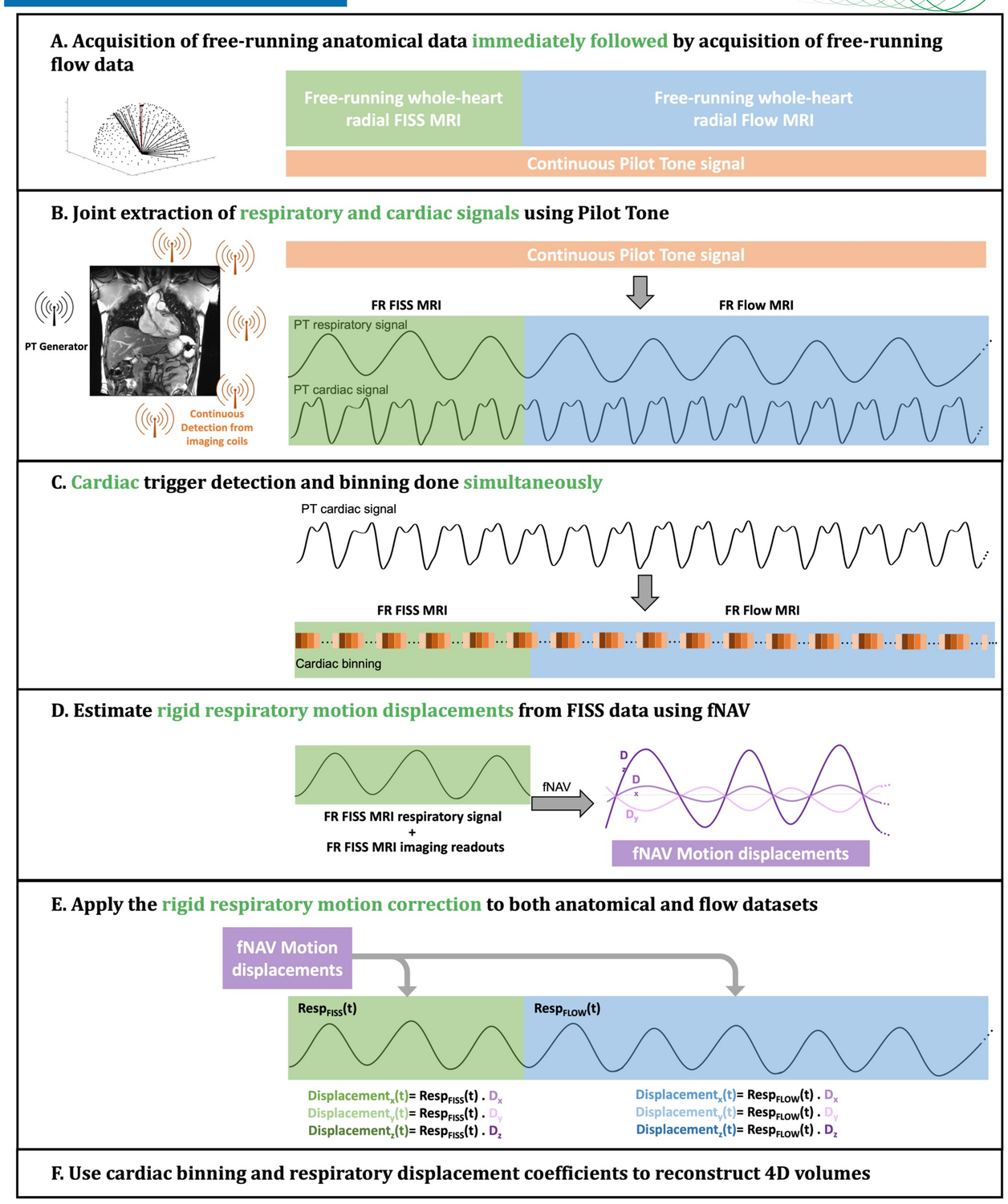
BACKGROUND

The free-running framework was developed for fully self-gated whole-heart MRI [1] and has been extended to angiography [2], flow [3,4], T1 [5] and fat fraction [6] mapping. Each of these branches benefit from a simplified workflow and predictable scan times without the need for ECG gating or respiratory navigation. However, self-gating, which extracts cardiac and respiratory motion signals from the data themselves, has been shown to have unpredictable shifts relative to known physiological markers (i.e. R-wave, end-expiratory position), precluding a comprehensive analysis of different free-running branches in the same exam, or requiring additional manual spatial and temporal synchronization of the resulting images [1].

METHODS [7-9]

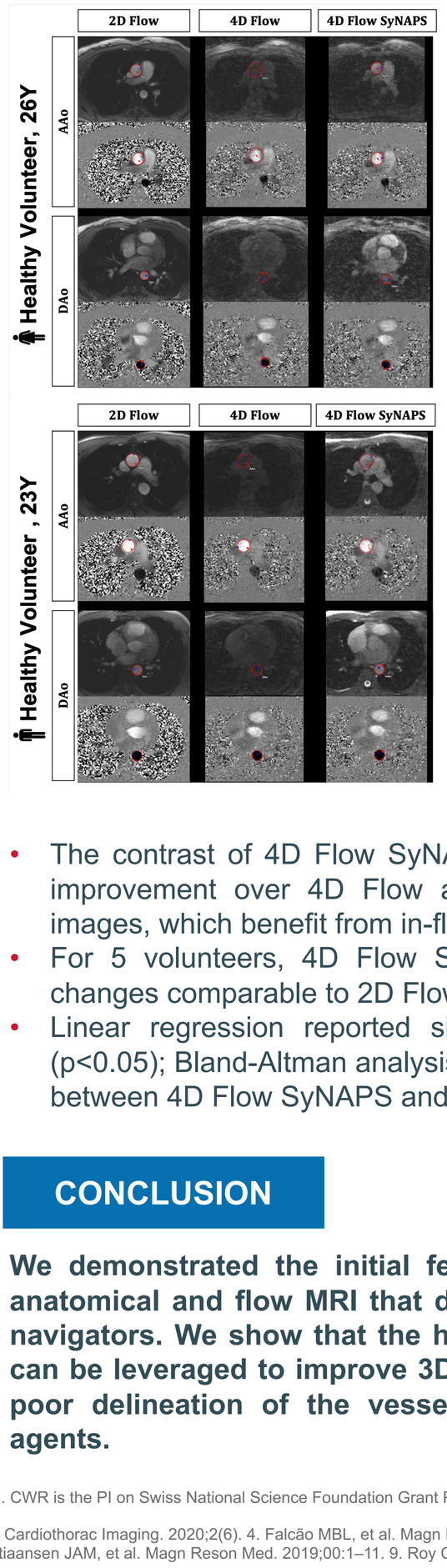
FREE-RUNNING

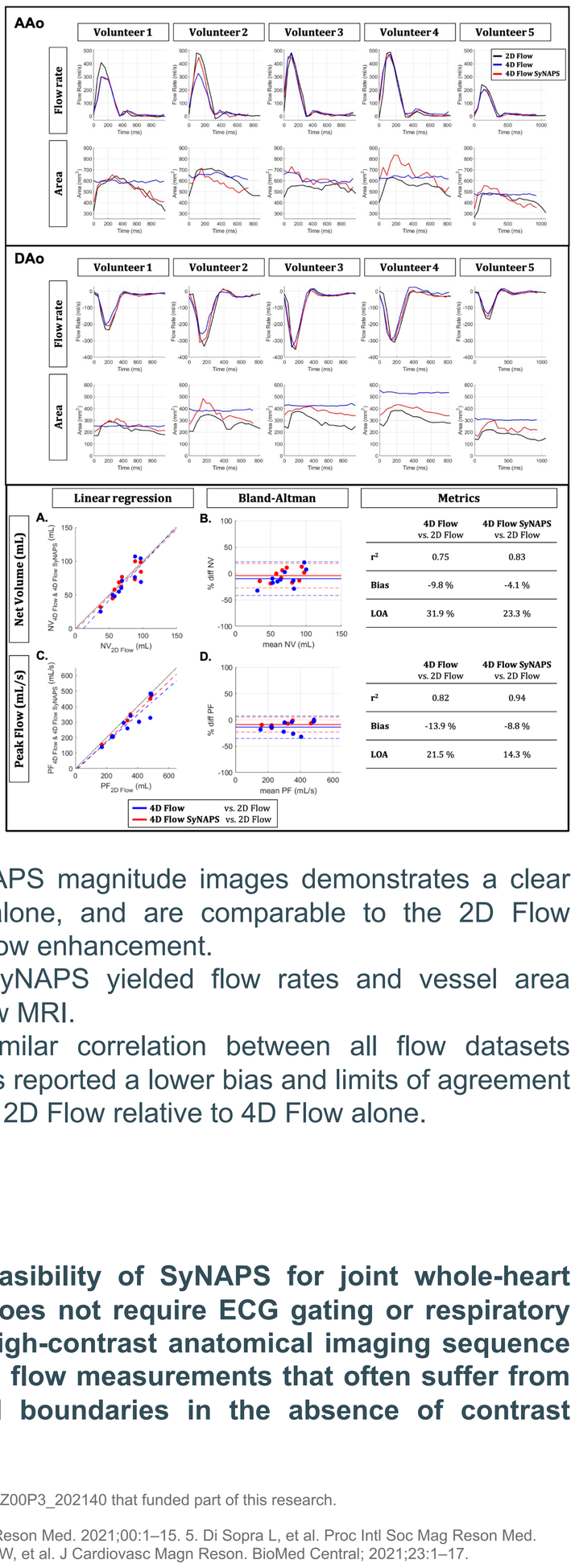


AIMS

We introduce a novel method for combining multiple free-running MRI acquisitions together, through the use of cardiac and respiratory signal extraction with Pilot Tone navigation called Synchronization of Neighboring Acquisitions by Physiological Signals (SyNAPS). We demonstrate the initial feasibility and utility of SyNAPS on a setup for joint reconstruction of back-to-back dynamic anatomical and flow MRI acquisitions, here named 4D flow SyNAPS.

RESULTS





- The contrast of 4D Flow SyNAPS magnitude images demonstrates a clear improvement over 4D Flow alone, and are comparable to the 2D Flow images, which benefit from in-flow enhancement.
- For 5 volunteers, 4D Flow SyNAPS yielded flow rates and vessel area changes comparable to 2D Flow MRI.
- Linear regression reported similar correlation between all flow datasets ($p<0.05$); Bland-Altman analysis reported a lower bias and limits of agreement between 4D Flow SyNAPS and 2D Flow relative to 4D Flow alone.

CONCLUSION

We demonstrated the initial feasibility of SyNAPS for joint whole-heart anatomical and flow MRI that does not require ECG gating or respiratory navigators. We show that the high-contrast anatomical imaging sequence can be leveraged to improve 3D flow measurements that often suffer from poor delineation of the vessel boundaries in the absence of contrast agents.

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