Evaluation of Flow - Research Promises: What can we expect in the Future?

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Highlights

- Realtime 2D PC MRI for patients with arrhythmia and to measure response to stimuli.
- Ultra-short TE PC MRI for artefact reduction.
- 4D MR Flow for comprehensive hemodynamic assessment.

Target Audience

Those with interest in methodology and clinical applications of 'cutting edge' flow MRI including scientists and physicians, current users of cardiovascular MR, with little or basic knowledge of cardiovascular MR.

Objectives

- To review recent advances in phase contrast MRI methodology.
- To review recent clinical studies with novel PC MRI methodology.
- To provide an overview of potential impact of such novel applications in clinical diagnosis.

Methods

Over recent years, advances in hardware, sequence design, and image reconstruction have facilitated accelerated cardiovascular imaging. Here we will discuss the technical background and research promises of selected new developments in flow sensitive MRI that can potentially have a significant impact on patient care. In particular, the topics of (1) realtime PC MR imaging, (2) ultrashort TE PC MRI and (3) the capture and processing of three-directional velocity encoding over a 3D volume throughout the cardiac cycle, frequently referred to as '4D MR Flow', will be discussed in detail. Acceleration methods such as non-Cartesian sampling (e.g. spiral and radial trajectories) and constrained reconstruction approaches such as kt-SENSE will be reviewed also.

Discussion and Conclusions

The methods discussed here have the potential to significantly change the way flow imaging is clinically conducted as well as expand the indications for velocity sensitive imaging by providing additional functional parameters. These noninvasive measures can possibly enhance diagnosis, therapy planning, and therapy monitoring in a wide range of cardiovascular imaging including all major vascular territories and the ventricles and atria. However, to date these concepts have been mainly investigated in smaller clinical studies and clinical efficacy has to be demonstrated in larger, multi-center trials. Technical limitations currently include the lack of product sequences for realtime and 4D MR Flow acquisition packages as well as intuitive post-processing packages for comprehensive flow analysis, which are crucial for successful clinical adaptation.

References

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