Interventional Cardiac MRI

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Introduction

Interventional Cardiac MRI (iCMR) enables MRI-guided minimal invasive cardiac interventions. The combination of real-time cardiac imaging and device tracking results in more precise navigation and improved direct periprocedural feedback. This contributes to more predictable and improved clinical outcomes and offers the prospect of greater effectiveness in various cardiac interventions.

Key words

Cardiac intervention, iCMR, non-Ionizing radiation, real-time cardiac imaging, device tracking.

Main body

In contrast to fluoroscopy or CT-guided interventions, iCMR offers combined excellent visualization of both the inserted instruments and the anatomy of the heart. The high spatial and temporal resolution and the ability to distinguish between different soft tissues offer unique possibilities to monitor and guide cardiovascular therapeutic interventions. And all this can be achieved without the use of X-ray, resulting in a safer environment for both patient and operator.

Clinical implementation of MRI-guided cardiovascular interventions requires specially designed instruments.

To safely perform MRI-guided interventions, it is essential that the instruments and devices used are MRI compatible. Therefore, guidewires, catheters and other devices must be designed to be safe for use in an MRI environment, not to cause substantial image artifacts and not to heat up during scanning.

In addition, the necessary equipment and computers in the MRI room, such as an ablation generator, monitoring systems, displays and communication equipment for the operators, must also be suitable for use near a strong magnetic field.

To track catheters with MRI, two different methods are applied, passive and active device tracking. In passive tracking, the device is tracked based on intrinsic properties that cause a specific image artifact, which can be recognized by the operator. The selection of the correct image planes to track the device must be done manually. In active device tracking, the position of the device is determined automatically based on signals from the coils built into the device. This allows to project the position of the device as a

rendered object in a 3D shell and enables operator-independent accurate tracking of the device .

Although the introduction of iCMR for clinical applications comes with several challenges, including modifications of the scanner infrastructure, the implementation of MRI-compatible equipment, and the training of a multidisciplinary team, a growing number of sites worldwide have started an iCMR program.

Several centers already pioneered MRI-guided hemodynamic measurements and others are focusing on performing MRI-guided electrophysiological procedures.

These MRI-guided interventions can be combined with more conventional MRI imaging of cardiac function and tissue characterization, allowing for more detailed assessment of cardiac pathology and/or direct periprocedural feedback during the intervention.

Multidisciplinary cooperation between cardiology, radiology, anesthesia and med. tech. services is a requirement to enable safe and effective iCMR procedures. If all disciplines are well coordinated and the necessary infrastructure and equipment are available, iCMR offers the prospect to further improve the treatment for cardiovascular patients.

Conclusion

Interventional Cardiac MRI represents a significant advancement in the diagnosis and treatment of cardiovascular diseases. By integrating high-resolution imaging with real-time procedural guidance, iCMR enables detailed visualization of devices and cardiac structures without using ionizing radiation, allowing for more precise navigation and improved peri procural feedbac and therefor more predictable clinical outcomes.

List of supporting educational materials

Link to CMR Pocket guide webpage – PDF downloads currently available in 5 languages

https://www.escardio.org/Sub-specialty-communities/European-Association-of-Cardiovascular-Imaging-(EACVI)/Research-and-Publications/CMR-Pocket-Guides