Specialty area: *Cardiac MR Today & Tomorrow*

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Highlights: Significant methodological developments have been realized in imaging of the organ systems in the human torso at ultrahigh magnetic fields (7 Tesla or higher) and these improvements are translating into new unique biomedical applications.

Title: *Cardiovascular MR at 7T: Hype or Hope?*

Target Audience: The targeted audience is researchers interested in expanding the boundaries of magnetic resonance (MR) studies in the human torso in general and cardiovascular system in particular, using ultrahigh magnetic fields (7 Tesla and higher) and applications of this technology to study diseases of the organ systems in the torso.

Introduction: Until recently, all the high/ultrahigh field studies were in the brain. To a large extent, this is because the human torso is a particularly challenging target due to the dimensions of the torso relative to the RF wavelength of proton resonance frequency at 7 Tesla and higher magnetic fields. With potential solutions to these problems rapidly emerging as result of methodological and engineering developments, the possibility of unique applications with particular focus on cardiovascular system.

Methods: At the high frequencies of protons at 7 Tesla (i.e. 300 MHz), MRI starts moving into the traveling wave regime. In this regime, the RF penetrates the body as a traveling wave and depending on the boundary conditions imposed by the coil and object geometries, these traveling waves can lead to destructive interferences, causing large regions of signal intensity non-uniformity, and even complete signal loss. The enabling technology to overcome this problem has been the development of parallel transmission, and novel pulse design based on parallel transmission principles.

Results and Discussion: Ultrahigh field MRI in the human torso is in its infancy but presents a tremendous opportunity. The main advantage offered by ultrahigh fields in the torso is the enhanced signal-to-noise ratio (SNR), which can be traded for numerous potential gains, such as higher spatial resolution and/or speed of imaging. The latter is also aided by the fact that spatial encoding using parallel imaging on the receive side also improves significantly when the object dimensions are larger than the RF wave length. Higher resolutions are critically important in numerous biomedical applications. In the heart, it is needed for coronary angiography, plaque imaging, and assessment of vulnerable myocardium. Longer blood T1 also becomes a major asset for imaging perfusion or performing angiography without the use of contrast agents. Notable gains in some of these areas have already been demonstrated. Because of SNR gains, X-nuclei potentially become useful as well. However, the ultrahigh field imaging technologies in the torso still remain suboptimal. The next few years will increasingly bring improvements in the technologies aimed at overcoming the multiple challenges at this field strength and move ultrahigh field torso imaging beyond proof of principle into a position where its benefits can be realized in several clinically driven applications.

Conclusion: In conclusion, it is not hype, there is indeed reason to have much hope but more work is needed and is being carried out in several laboratories with ever improving results!