Research proposes new MRI technology for non-invasive assessment of interstitial fluid flow

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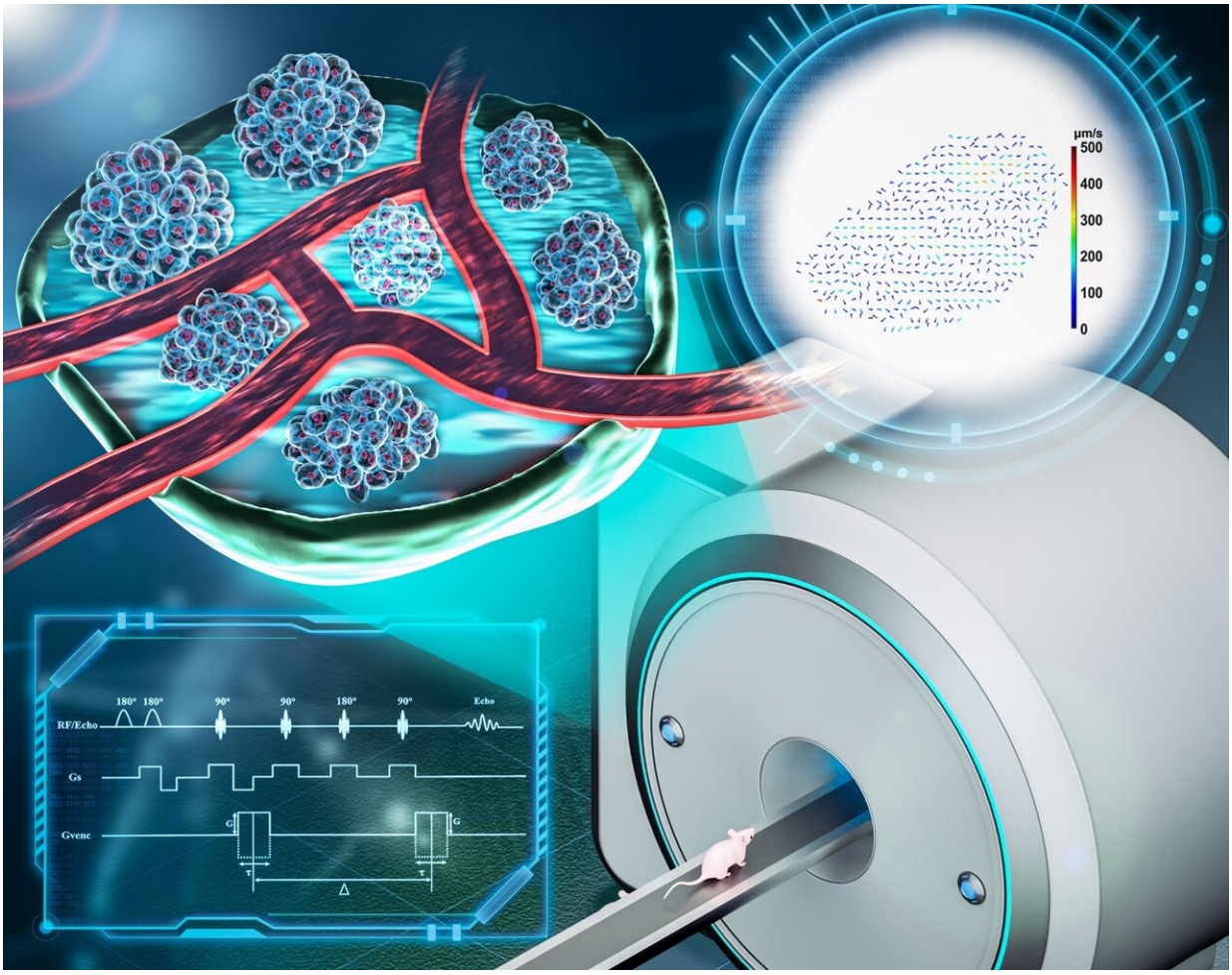

Interstitial flow velocity-MRI has the potential to determine interstitial fluid flow velocity non-invasively and exhibits an intuitive velocity map. Credit: Jun Zhao, Yupeng Cao, Wentao Liu, Dong Han

Interstitial fluid flow is closely related to drug delivery and distribution, playing a crucial role in their therapeutic effects on tumors. However, few non-invasive measurement methods are available for measuring low-velocity biological fluid flow.

In a recent study published in *Magnetic Resonance Letters*, a team of researchers in China proposed a new, non-invasive MRI technology designed specifically for measuring interstitial fluid flow.

"Interstitial fluid flow measuring has always been a challenge for understanding the tumor microenvironment, which drives the development of an applicable characterization method for quantitative description," says the study's corresponding author, Dong Han, a professor at the National Center for Nanoscience and Technology. "Phase-contrast MRI (PC-MRI) is widely used technology for measuring the velocity of rapid flow in biological tissues, such as blood."

The interstitial fluid velocity is four orders of magnitude lower than blood flow. PC-MRI requires considerable gradient intensity and duration if used for slow flow measurements, but high gradient intensity is particularly sensitive to motion and tends to produce motion artifacts during imaging.

In addition, when measuring slow flow velocity, the encoding gradient is large, and the echo time is relatively long. The SNR is significantly lost because the gradient echo is based on T_2* relaxation decay. Therefore, PC-MRI application will be greatly limited.

To address this issue, the researchers combined PC-MRI with an improved stimulation echo sequence (ISTE). Co-corresponding author Wentao Liu, a professor at the same center, explains, "Conventional PC-

MRI usually uses gradient echo, spin echo (SE), and stimulated echo (STE). Compared to the gradient echo, SE uses a 180° focusing pulse to focus the signal in the transverse plane, and its signal is affected by T_2 relaxation, which decays more slowly and has a slightly higher image SNR. STE excites a part of the signal to the longitudinal plane and mitigates part of the T_2 relaxation decay."

However, STE is not superior to SE under any TE condition. Therefore, the researchers proposed ISTE, which refocuses the magnetic moment vectors in the longitudinal plane and yields better SNRs than STE or SE.

Their effort led to an increase in the velocity encoding gradient interval, which can minimize the diffusion sensitivity factor under the same flow velocity measurement sensitivity, thereby reducing the signal loss caused by diffusion and improving the detection accuracy of slow-flow imaging.

The team hopes that their innovative method will contribute to the further understanding of interstitial fluid flow.

More information: Jun Zhao et al, Non-invasive assessment for intratumoural distribution of interstitial fluid flow, *Magnetic Resonance Letters* (2023). DOI: 10.1016/j.mrl.2023.03.001

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