


Age-dependent cerebrospinal fluid-tissue water exchange detected by non-invasive magnetization transfer indirect spin labeling MRI

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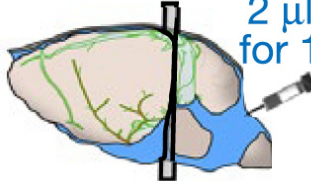

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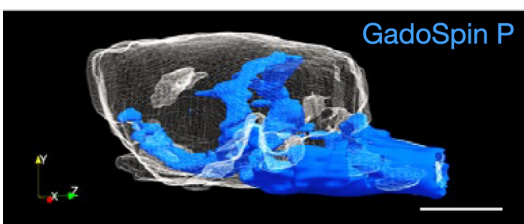
CSF circulation by MRI is mainly achieved by Gd agents

GadoSpin P
intracisternal infusion

$2 \mu\text{l min}^{-1}$
for 15 min

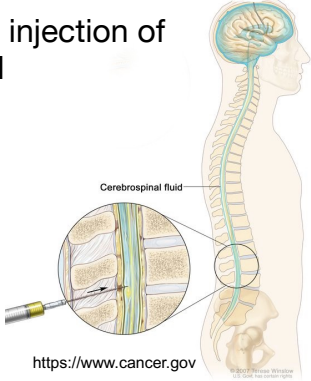


T1-weighted FLASH 3D



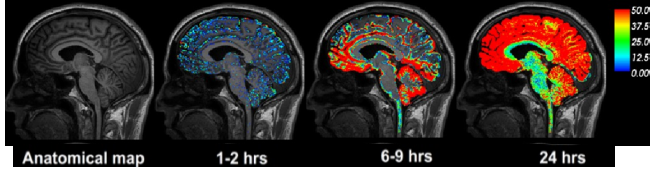
Ahn, J.H., *Nature* 2019; 572, 62-66.

Intrathecal injection of gadobutrol



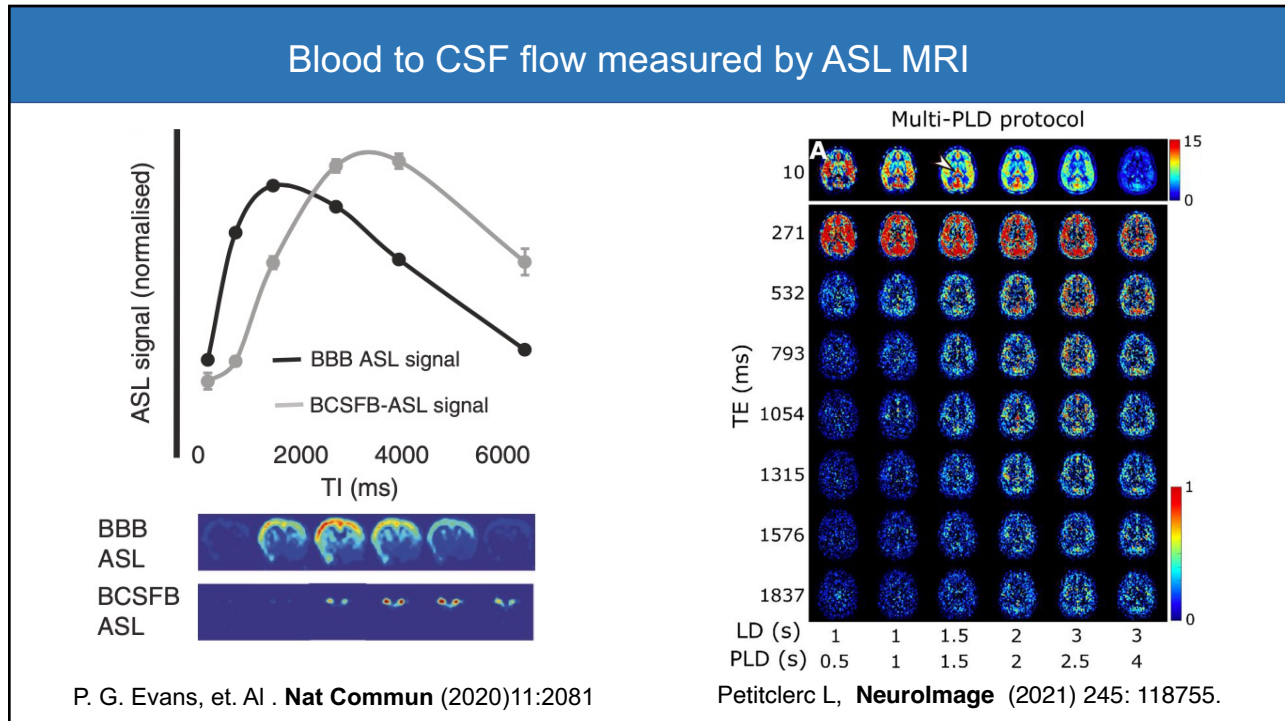
Cerebrospinal fluid

<https://www.cancer.gov>

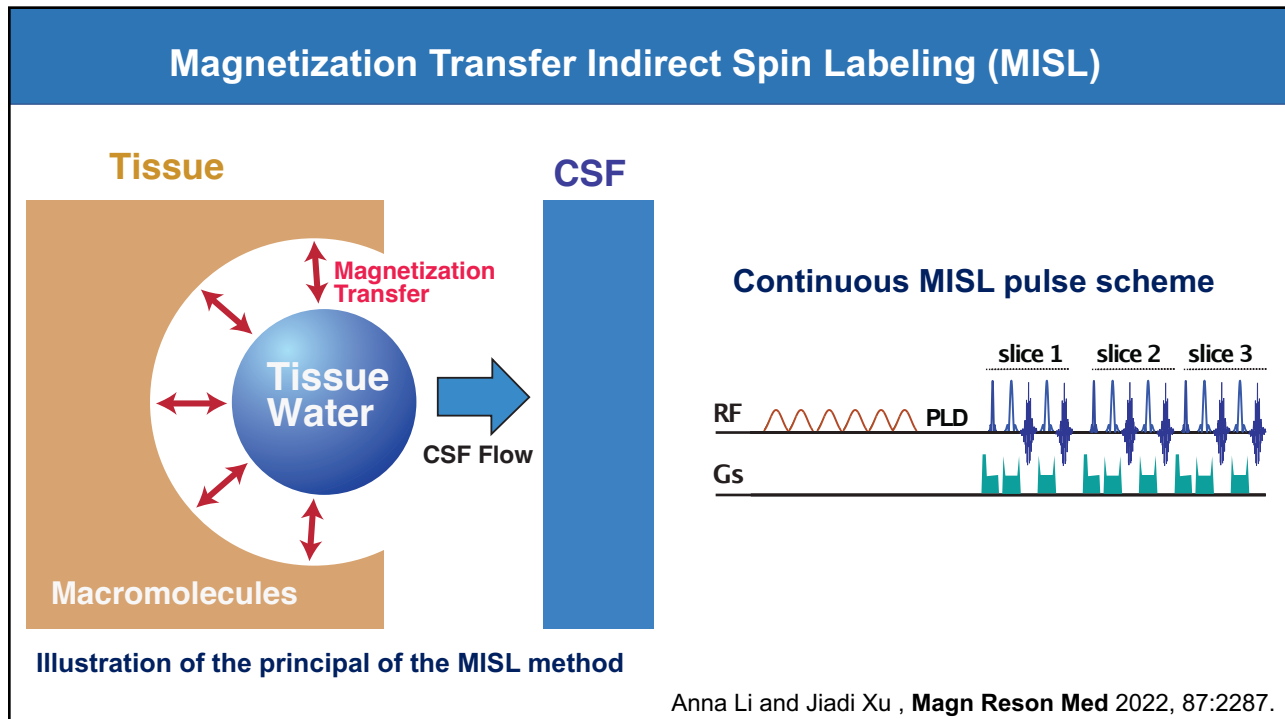


Geir Ringstad, *JCI Insight* 2018; 3:e121537.

2



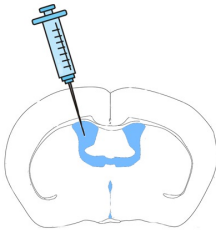
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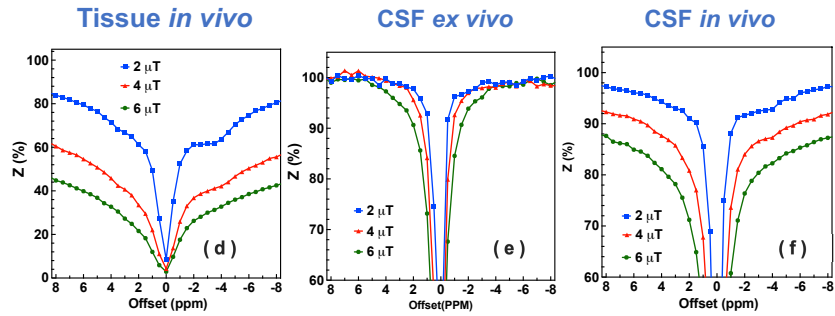
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Validation of the MISL with extracted CSF

CSF drawn from cerebroventricle



Z spectrum of



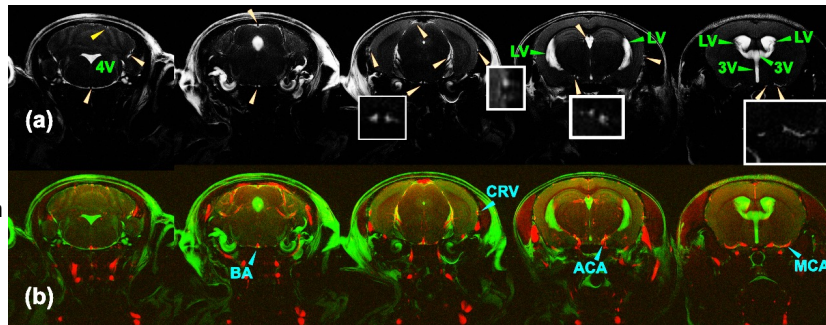
Anna Li and Jiadi Xu , *Magn Reson Med* 2022, 87:2287.

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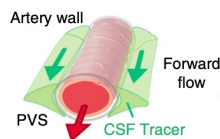
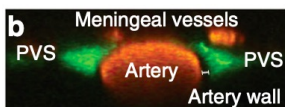
Ventricle and perivascular space (PVS) distribution

High-resolution MRI images

Angiography maps overlapped with the high-resolution MRI images



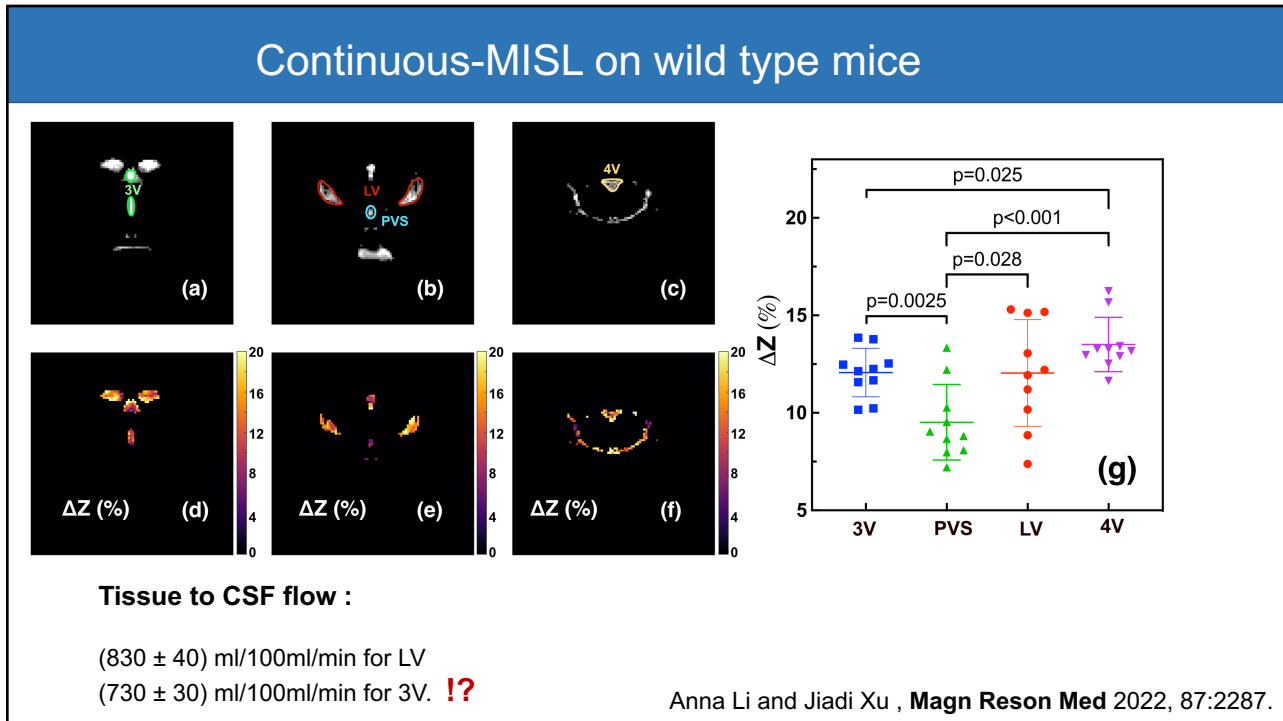
Anna Li and Jiadi Xu , *Magn Reson Med* 2022, 87:2287.



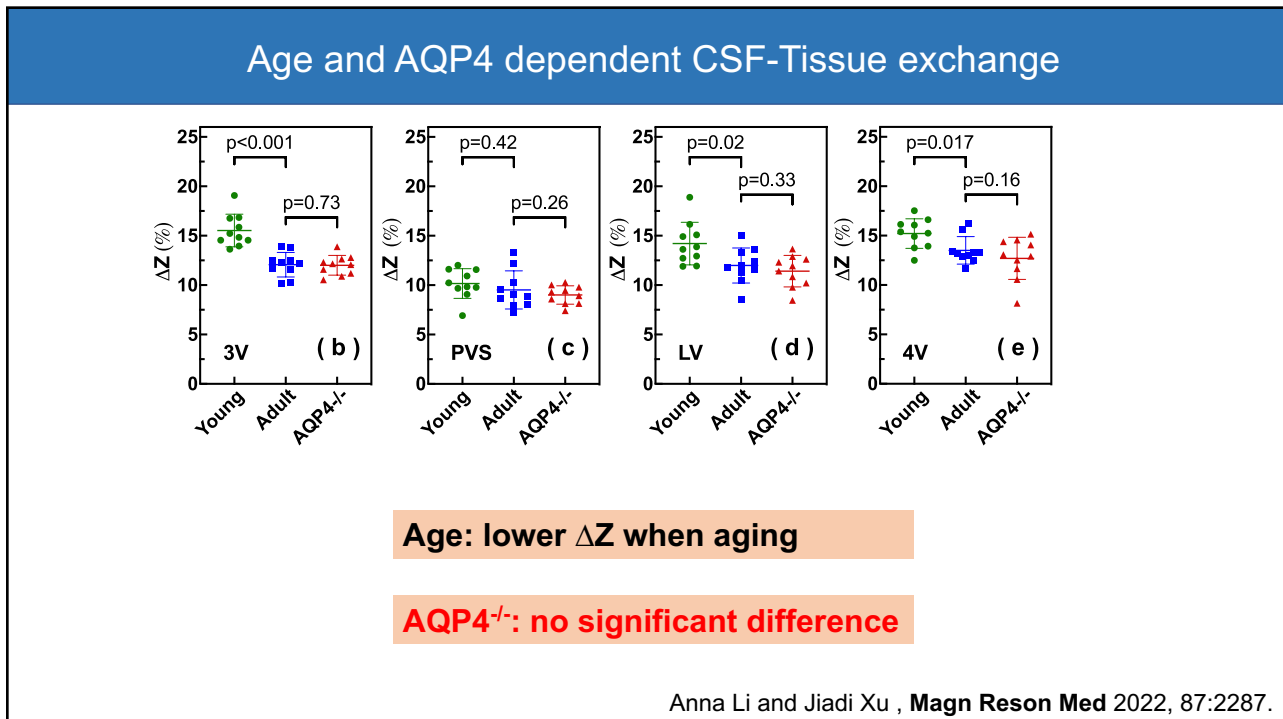
Same finding: PVS is two triangular channels!

Mestre H, *Nat Commun* 2018;9(1):4878.

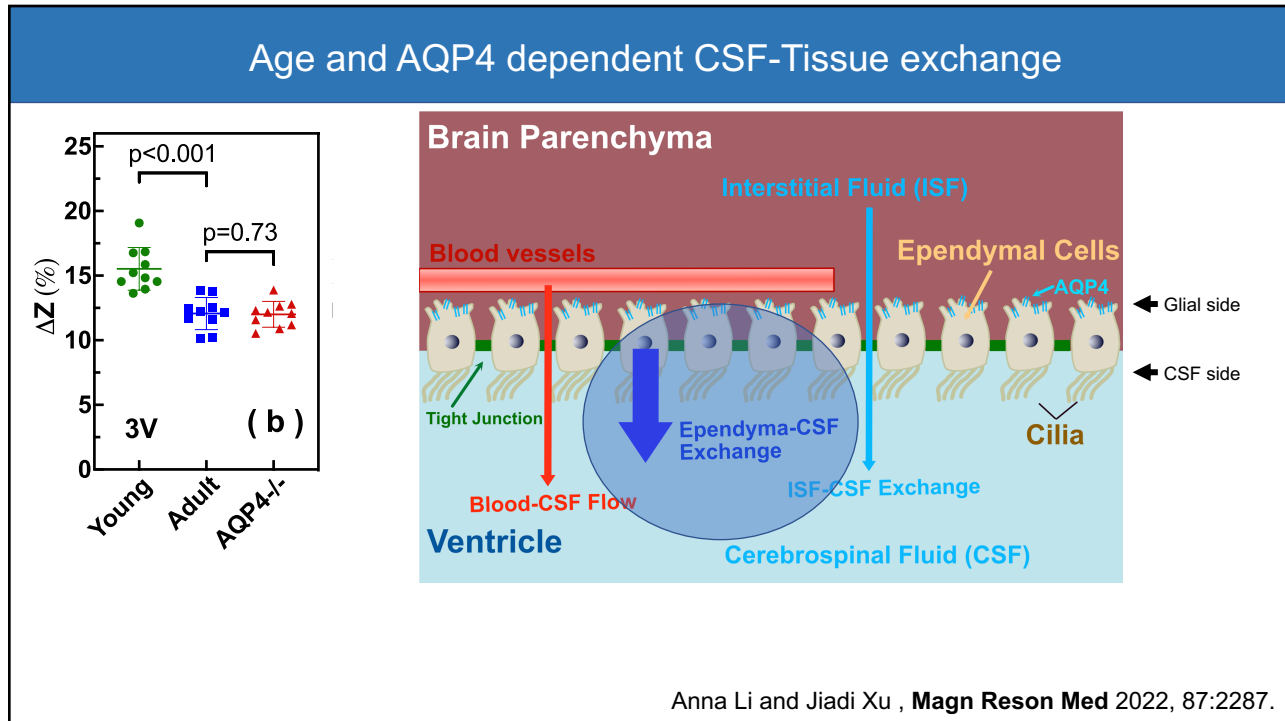
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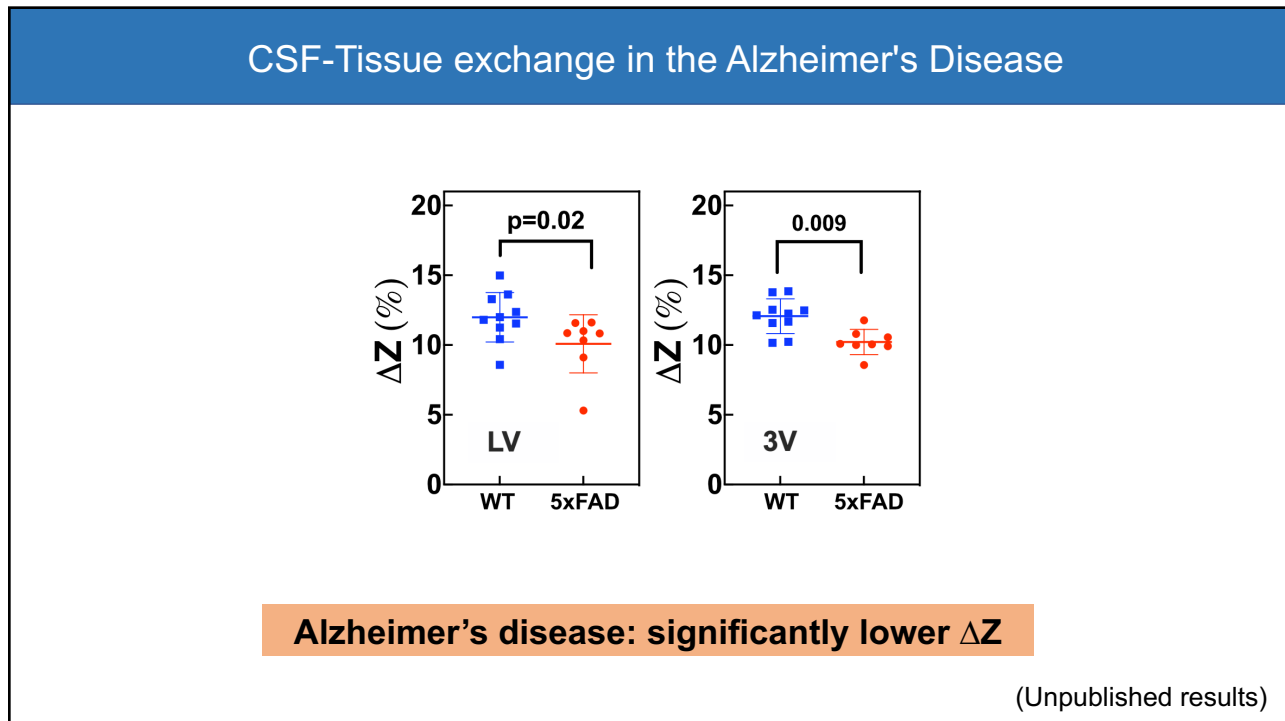
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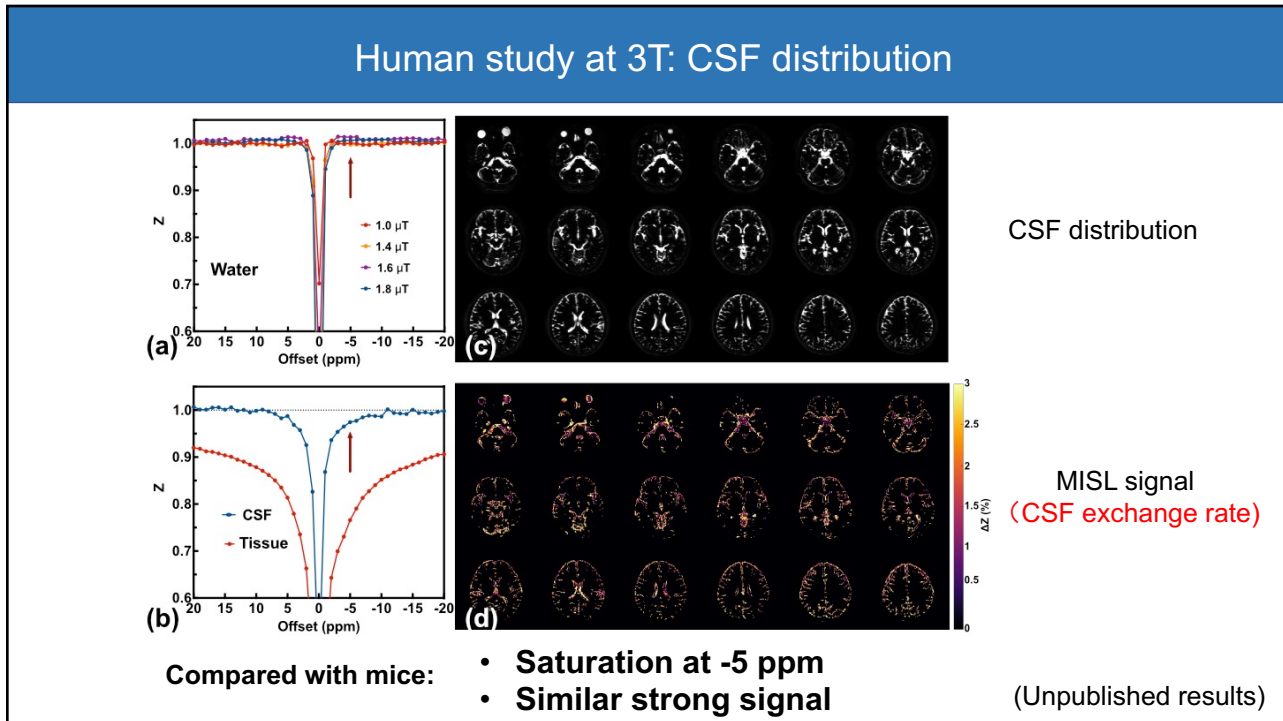
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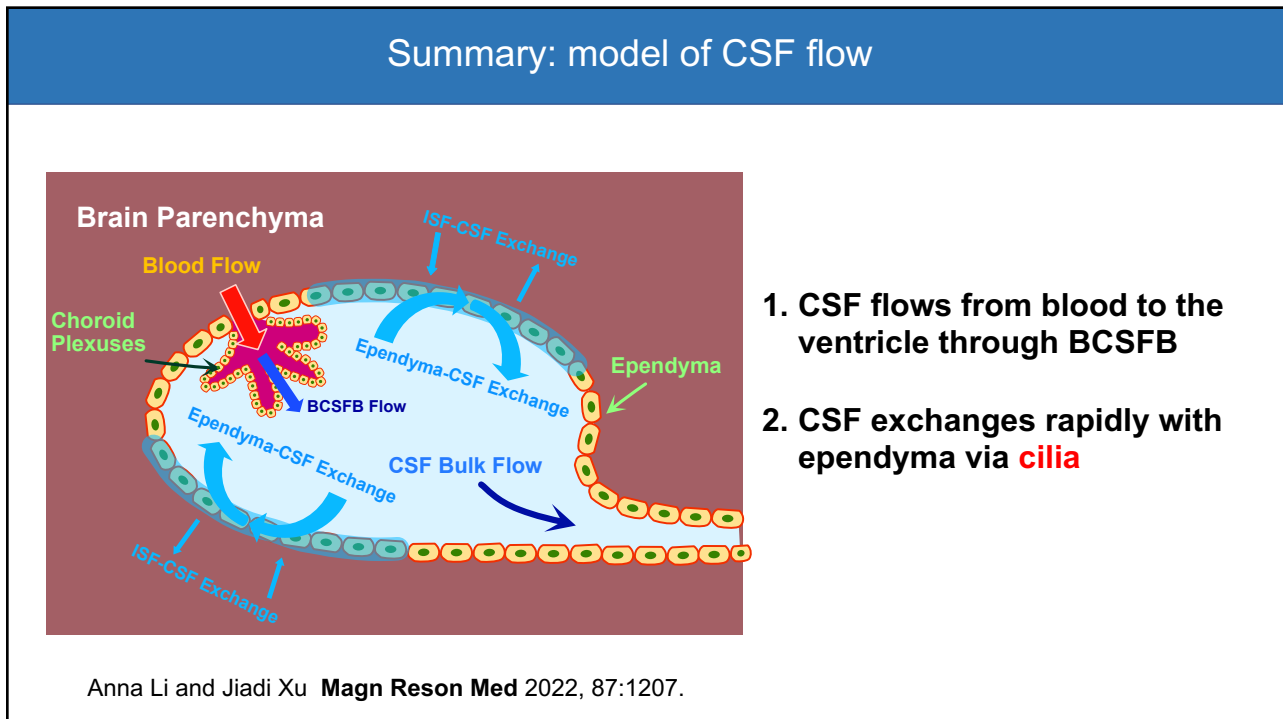
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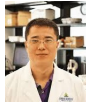
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