Readout segmentation

Readout segmentation (RS-EPI) has been suggested as a promising variant to echo-planar imaging (EPI) for high-resolution imaging.

Diffusion tensor imaging tractography is commonly used in neurosurgical practice but is largely limited to the preoperative setting. This is due primarily to image degradation caused by susceptibility artifact when conventional single-shot (SS) echo-planar imaging (EPI) DTI (SS-DTI) is acquired for open cranial, surgical position intraoperative DTI (iDTI). Readout-segmented (RS) EPI DTI (RS-DTI) has been reported to reduce such artifact but has not yet been evaluated in the intraoperative magnetic resonance imaging (iMRI) environment. Elliott et al. evaluated the performance of RS versus SS EPI for DTI of the human brain in the iMRI setting.

Pre- and intraoperative 3-T 3D T1-weighted and 2D multislice RS-iDTI (called RESOLVE [readout segmentation of long variable echo-trains] on the Siemens platform) and SS-iDTI images were acquired in 22 adult patients undergoing intraaxial iMRI resections for suspected low-grade glioma (14; 64%), high-grade glioma (7; 32%), or focal cortical dysplasia. Regional susceptibility artifact, anatomical deviation relative to T1-weighted imaging, and tractographic output for surgically relevant tracts were compared between iDTI sequences as well as the intraoperative tract shifts from preoperative DTI.

RS-iDTI resulted in qualitatively less regional susceptibility artifact (resection cavity, orbitofrontal and anterior temporal cortices) and mean anatomical deviation in regions most prone to susceptibility artifact (RS-iDTI 2.7 ± 0.2 vs SS-iDTI 7.5 ± 0.4 mm) compared to SS-iDTI. Although tract reconstruction success did not significantly differ by DTI method, susceptibility artifact-related tractography failure (of at least 1 surgically relevant tract) occurred for SS-iDTI in 8/22 (36%) patients, and in 5 of these 8 patients RS-iDTI permitted successful reconstruction. Among cases with successful tractography for both sequences, maximal intersequence differences were substantial (mean 9.5 ± 5.7 mm, range -27.1 to 18.7 mm).

Readout segmentation EPI enables higher quality and more accurate DTI for surgically relevant tractography of major white matter tracts in intraoperative, open cranium neurosurgical applications at 3 Tesla [1].

1)
Elliott CA, Danyluk H, Aronyk KE, Au K, Wheatley BM, Gross DW, Sankar T, Beaulieu C. Intraoperative acquisition of DTI in cranial neurosurgery: readout-segmented DTI versus standard single-shot DTI. J Neurosurg. 2019 Aug 16:1-10. doi: 10.3171/2019.5.JNS19890. [Epub ahead of print] PubMed PMID: 31419798.