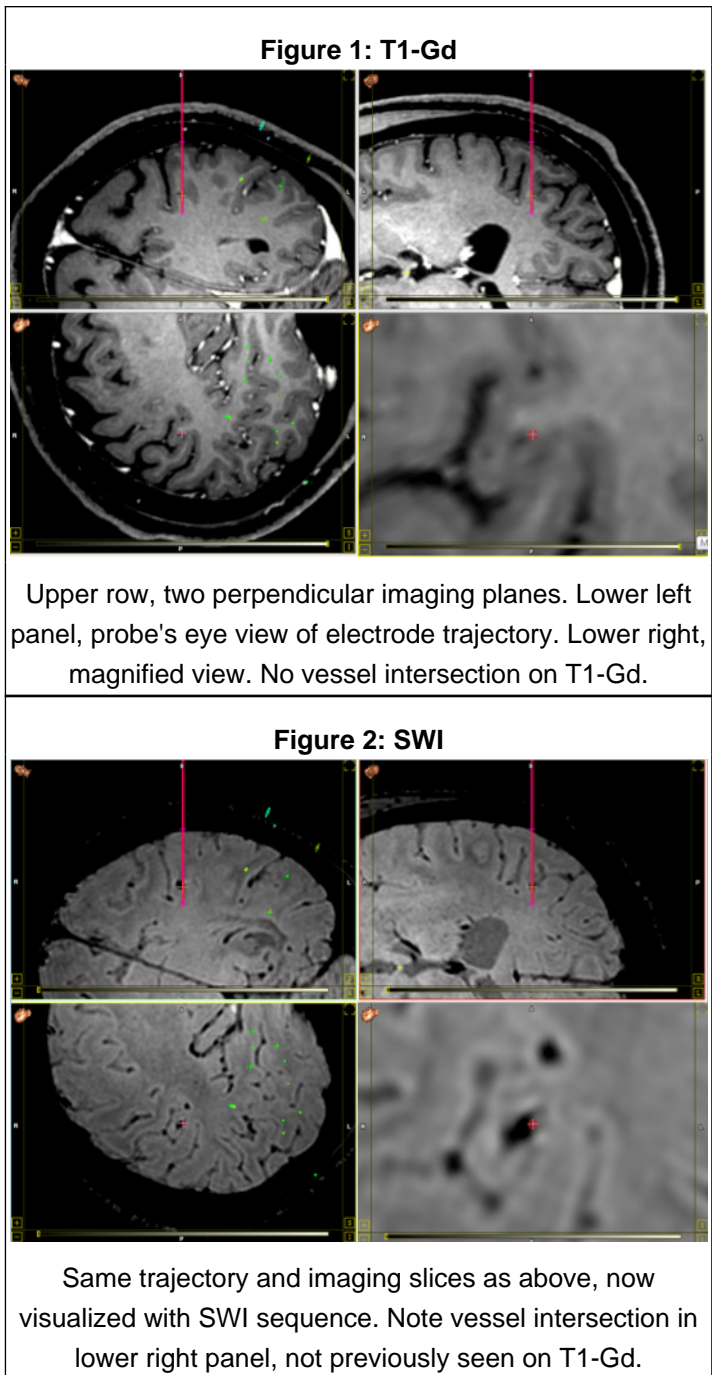


Introduction: Procedures involving stereotactic intracranial electrode implantation, including deep brain stimulation (DBS) and stereoelectroencephalography (SEEG), are increasingly used in the treatment of neurological disorders such as essential tremor, Parkinson's disease, and epilepsy. Along with infection and lead malposition, intracerebral hemorrhage (ICH) is one of the most feared surgical complications, occurring at a rate of 1%-5%. Recently, susceptibility weighted imaging (SWI) has been used alongside traditional T1-weighted gadolinium-enhanced MRI (T1-Gd) for trajectory planning. SWI is known to be particularly sensitive to venous microvasculature. **This study was performed to determine the effect of SWI versus T1-Gd vessel resolution on avoiding hemorrhagic complications during electrode implantation.**

Methods: Fourteen patients undergoing DBS or SEEG electrode placement were implanted with a total of 114 electrodes. All trajectories were planned with pre-operative MR imaging on Waypoint Navigator software, without the use of SWI sequences. Each patient underwent 3D CT or MR imaging post-operatively. Post-operative CT images were co-registered to both pre-operatively acquired T1-Gd and SWI sequences. **Images were analyzed for the presence of electrodes intersecting or passing within 1mm of cerebral vessels on both T1-Gd and SWI sequences.** Among the blood vessels intercepted, each diameter was recorded and a mean value was calculated for SWI and T1-Gd.



Reference: Fenoy AJ, Simpson RK. Risks of common complications in deep brain stimulation surgery: management and avoidance. Journal of neurosurgery. 2014;120:132-139.

Results: **No patients had procedure-related intracerebral hemorrhage on post-operative MRI or CT.** Sixty unique instances of electrodes intercepting cerebral blood vessels were identified on SWI sequences (rate per electrode 52.6%, and average 4.3 interceptions per patient), of which 34 were superficial and 26 were deep in location. Eighteen interceptions were identified on T1-Gd (rate per electrode 15.8%, and average 1.3 interceptions per patient). There was a statistically significant difference in mean diameter of vessel intercepted, measuring $1.50 \pm 0.5 \text{ mm}$ on SWI, and $2.12 \pm 0.7 \text{ mm}$ on T1-Gd images ($p=0.00024$). Addition of electrodes passing within 1mm of cerebral vessels resulted in 104 total instances ("interception plus near miss") on SWI (91.2% per electrode, 7.4 per patient) and 23 such instances on T1-Gd (20.2% per electrode, 1.6 per patient).

Conclusions: **SWI is likely over-sensitive for intracranial electrode trajectory planning.** T1-Gd adequately visualizes larger diameter, superficial vessels, which are more prone to rupture and cause bleeding, whereas SWI improves visualization of smaller cerebral veins. **There were no intracranial hemorrhages despite the high rate of electrode interception or close proximity to cerebral vessels seen on SWI compared to T1-Gd imaging.** We aim to guide neurosurgeons with these evidence-based conclusions in choosing the most appropriate imaging methods when treating patients with DBS and SEEG.