

# Imaging of Deep Brain Stimulators and Associated Complications: What the Radiologist Needs to Know

Julia Cameron-Morrison DO, Stephen Tatter MD, Jeffrey Sachs MD



Disclosures: Dr. Tatter participates in research funded by Boston Scientific.

**Objectives:** Case based discussion of imaging of deep brain stimulators (DBS) and associated complications.

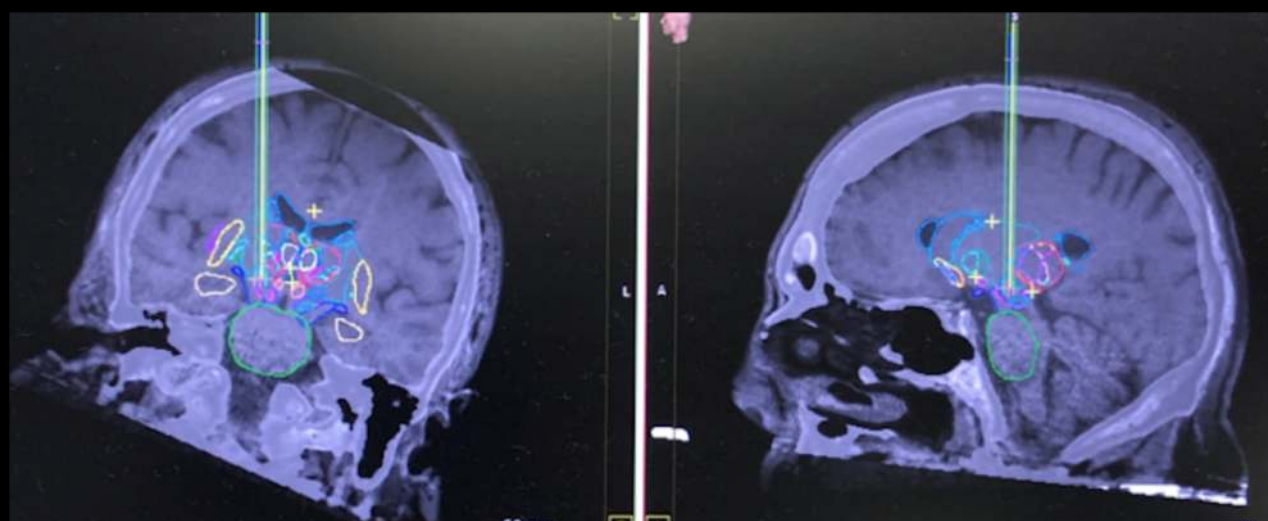
The use of thalamic DBS was initially approved by the FDA in 1997 for treatment of essential tremor and Parkinson disease. Since then multiple additional indications have been approved or are currently under investigation for a wide variety of targets.

Localized targets for Parkinson often include the subthalamic nucleus (STN) and globus pallidus internus (GPi) with the latter more commonly used in individuals with speech, cognitive or mood disturbances. Essential tremor is the second most common indication for placement with targeting of the ventro-intermediate nucleus of the thalamus (VIM).

**Relative contraindications** include non-approved indications and anything that may prevent safe neurosurgical approach; such as severe atrophy, white matter disease or prior infarcts along the expected surgical tract.

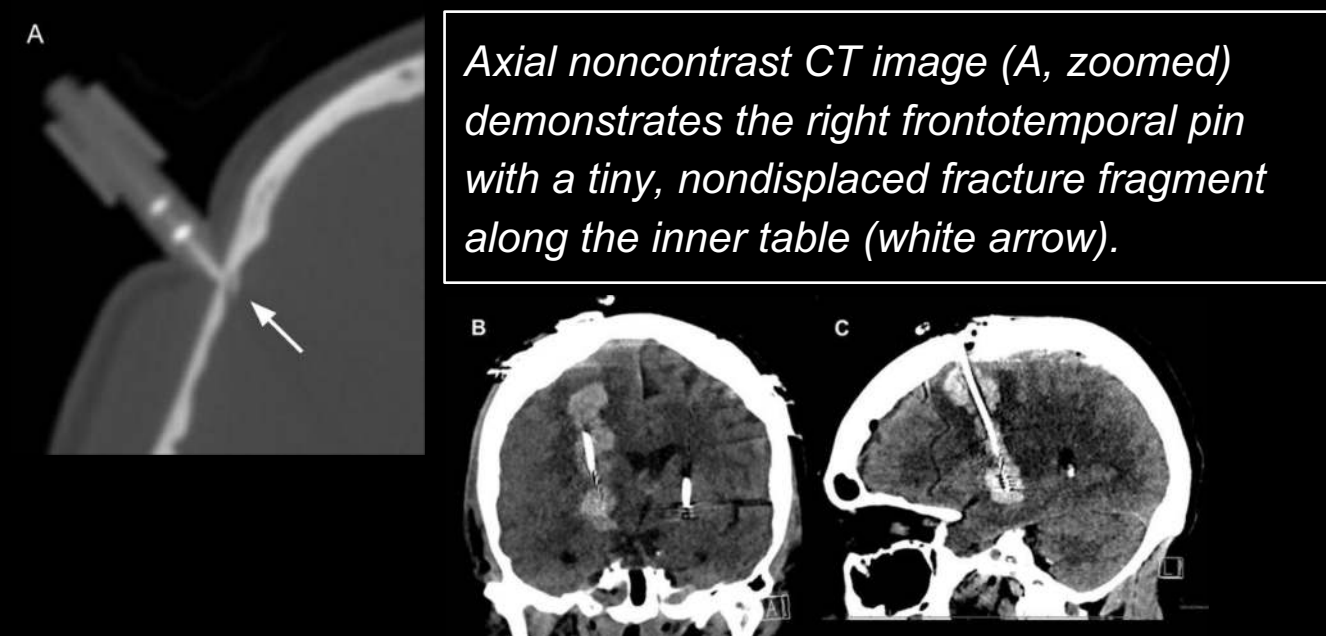
DBS systems are composed of one or more electrode leads implanted at their targeted location with tunneled subcutaneous wires extending to an implanted pulse generator below the collar bone.

**Preoperative imaging** is utilized to assess for relative contraindications and to assist with targeting. Targeting is typically done with stereotactic computed tomography and non-stereotactic preoperative MRI (magnetic resonance imaging) fusion with subsequent overlay of an anatomic imaging atlas via proprietary software (example below). Some structures can be directly targeted by interventional magnetic resonance imaging (iMRI) targeting.



**Postoperative imaging** of all models can be performed via CT. Newer MRI conditional models allow for MR imaging utilizing DBS specific protocols (see manufacturer's guideline).

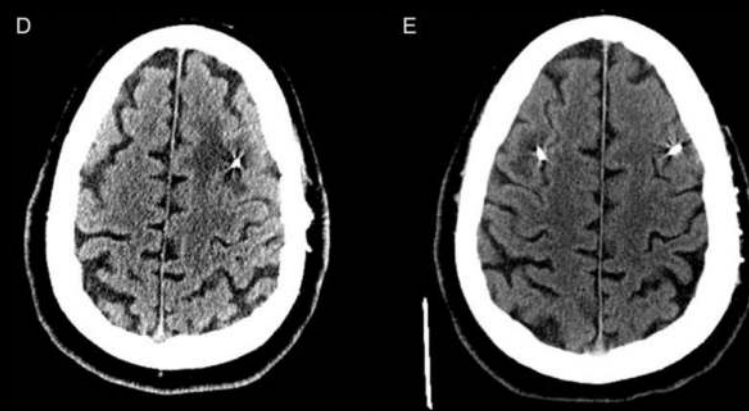
**Complications:** The most common perioperative complications include complications relating to **frame placement, ischemia, and hemorrhage**.



Axial noncontrast CT image (A, zoomed) demonstrates the right frontotemporal pin with a tiny, nondisplaced fracture fragment along the inner table (white arrow).

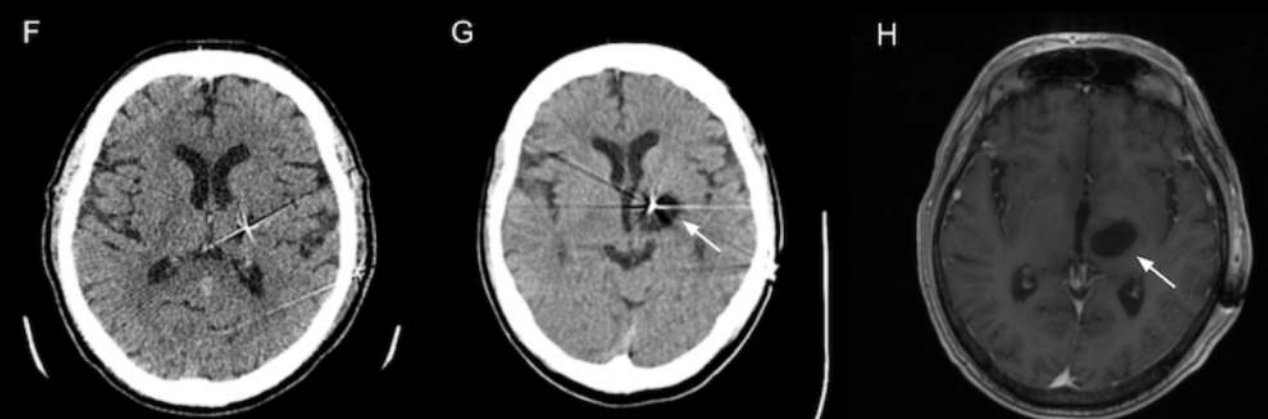
Coronal and Sagittal noncontrast CT (B,C) performed on a different patient two weeks after placement of right DBS lead demonstrate a large delayed intraparenchymal hemorrhage surrounding the lead.

**Peri-lead edema** is more common than once thought; seen in up to 39% of patients as non-infectious, delayed-onset postoperative cerebral edema adjacent to a DBS lead. While infection must be ruled out, in asymptomatic patients this finding will typically resolve without treatment.



Axial noncontrast CT image (D) demonstrate peri-lead edema in an asymptomatic patient four weeks after placement of a left DBS lead. Axial noncontrast CT (E) subsequently performed six months later following placement of the right DBS lead demonstrates resolution of the left perilead edema now with mild perilead edema on the right. The patient remained asymptomatic.

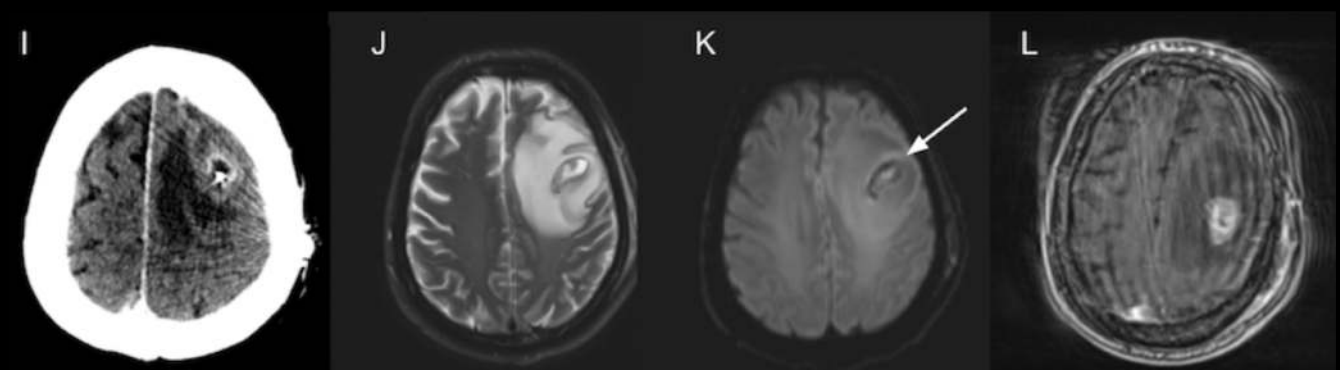
Formation of **intraparenchymal cysts** can occasionally be seen, and is thought to relate to the progression of peri-lead edema. Steroid therapy is the widely accepted therapy for symptomatic patients without evidence for infection. Multiple case reports describe resolution of the cysts following treatment.



Axial noncontrast CT image (F) demonstrates a left DBS lead without surrounding abnormality. Axial noncontrast CT image one year later during routine imaging (G) demonstrates a fluid collection surrounding the lead without mass effect. The electrode was removed with negative cultures. Axial MR T1 post contrast VIBE image (H) demonstrates persistent fluid collection without contrast enhancement consistent with development of a perilead cyst.

Most common late complications relate to the hardware; complications include **infection, lead migration, and lead fractures**.

Infection is the most frequent complication in the first 24 months following surgery. There is a wide range of imaging appearances spanning peri-lead edema to development of frank abscess. Infected leads require hardware removal and treatment with antibiotics with or without further surgical intervention.



Axial postcontrast CT head (I) performed two weeks after placement of a left DBS lead demonstrates peri-lead enhancement and significant edema. Subsequent MR imaging was performed the following day after removal of the DBS electrode. Axial T2 (J), diffusion weighted (K), and T1 SPGR postcontrast (L) images demonstrate peripheral enhancement and central restricted diffusion (arrow), consistent with intraparenchymal abscess formation.