Diagnostic Tests for Brain Structure and Function

Susan E. Hunter-Joerns, MD

Abstract

Presents an overview of radiological tools for neurodiagnostics and summarizes the strengths and weaknesses of each procedure in the diagnosis of the brain.

CLINICAL REVIEWS

CT and MRI scans are the tests most often used to look at brain structure. They each have relative strengths and weaknesses in imaging as well as advantages and disadvantages such as cost and allergic reactions. Their relative merits are summarized below.

CT Scan:

Uses ionizing radiation or x-rays to make the image; average exposures are equivalent to about 10 chest x-rays for one brain scan. Costs range from $400 to $1200 for the films. The radiology interpretation averages $100 to $400. The IV contrast agent used is similar to IVP dye and can frequently cause allergic reactions with occasional anaphylaxis. The contrast agent is cleared renally and can worsen or initiate renal insufficiency, especially in diabetic patients. The equipment is spacious, well tolerated and usually does not need premedication.

CT is the first choice for:

Early stroke evaluation, trauma, bleeding in or around brain, visualizing skull bones, calcified tumors such as meningiomas, poorly cooperative patients (children, intoxicated, claustrophobic).

CT sees poorly:

Brainstem and posterior fossa, tiny lesions from multiple sclerosis.

CT with contrast for:

Vascular malformations, aneurysms, inflammation, tumors.

CT contraindicated with:

1st trimester pregnancy, relative contraindication in rest of pregnancy.

2205 N Jordan Ave
Juneau AK 99801
(907) 790-3224

MRI Scan:

MRI uses a varying magnetic field to create the image with no exposure to radiation. Film cost ranges from $600 to $1200. Radiology costs range from $100 to $400. The contrast IV is a paramagnetic agent that is radically different from the CT contrast medium, and while renally cleared, rarely causes allergic reactions or renal insufficiency. The majority of MRIs have only a small clearance between the machine and the patient and frequently provoke claustrophobia. Claustrophobic reactions are often countered by premedication with Xanax (0.5mg 1-2 hours before the scan). The scan requires 20 to 60 minutes to arrange and image the patient, whereas the CT scan takes from 5 to 10 minutes to perform. The MRI has sharper definition between the gray and white matter in the brain and better anatomical localization than the CT scan. Most MRIs can also do Magnetic Resonance Angiography (MRA). This is a method of imaging just the vascular system in the brain *without* the use of contrast.

MRI is the first choice for:

Brainstem, posterior fossa, multiple sclerosis, tumors, metastatic lesions, small vessel strokes, edema, small lesions.

MRI sees poorly:

Bone, meningiomas, subarachnoid bleed, subdural hematomas.

MRI contrast for:

Tumors, metastatic growths, any vascular malformation, aneurysms, inflammation, encephalitis.

MRI contraindicated with:

Patients who can't remain still, pacemakers, implanted defibrillators, metallic cardiac valves, carotid clamps, aneurysm clips, Holter monitor, insulin pump, implantable pain pump, TENS machine, metal in eye, cochlear implants, some penile prosthesis, credit cards (demagnetizes them), Electrical bone growth stimulators, some MRIs do not have equipment for EKG monitoring or ventilator patients.

MRI will work with:

Pregnancy (better not in first trimester unless an emergency), Harrington rods, intraocular lens implant, sternotomy wires, Omaya reservoir, hip replacement, knee replacement, ventriculo-peritoneal shunt, some newer aneurysm clips, claustrophobia (premedicate, or use newer "open MRI" equipment).

OTHER METHODS SOMETIMES HELPFUL IN DIAGNOSING BRAIN ABNORMALITIES

EEG (Electroencephlagram)

An EEG is the best indicator for possible seizures, but many seizure patients have normal EEGs. It can help with encephalitis and dementia evaluation, but is not usually helpful with headaches.

Carotid Ultrasound

Carotid ultrasound provides a non-invasive view of the *extra*-cranial portion of the carotid and vertebral arteries. Plaque, degree of stenosis, reversal of flow, and occlusions can be detected.

Transcranial Doppler

Transcranial doppler is a non-invasive way of looking at the *intra*-cranial portions of the vertebral and basilar arteries as well as the Circle of Willis.

Cerebral Angiography

Cerebral angiography is the best method of imaging the cerebral blood vessels. A catheter is inserted in the groin and threaded to arteries in the neck. The dye used is the same as the CT contrast with the risk of renal insufficiency and allergic reactions. This is an approximately $2000 invasive procedure and carries a 1% to 3% risk of stroke or other major side effect.

SPECT (Single Photon Emission Computed Tomography)

This is a radiolabeled isotope injection that gives a measure of cerebral blood perfusion. This is a rough measure of metabolic activity. SPECT gives poor spatial resolution and therefore a less accurate anatomical picture. It was the first test that measured functional activity rather than just imaged structures.

PET (Positron Emission Tomography)

PET scans measure metabolic activity in the brain. They have improved resolution over the SPECT scan but still are not as clear as the MRI. The PET scan is expensive and only available in large centers. It requires a cyclotron to make the positron labeled tracers. Both PET and SPECT can help locate high or low metabolic areas that can occur with seizures, strokes or tumors. It can also locate functional areas in the brain (such as the part used in math computation).

Evoked Responses

Visual evoked responses are a method of testing the retroorbital optic nerve. This is used frequently in multiple sclerosis patients to document a second or asymptomatic lesion. Brainstem evoked responses evaluate the auditory pathway from cochlea to midbrain, and are also useful in the diagnosis of multiple sclerosis.

One rule for all the methods described is that the wording on the report changes depending on the person interpreting the image. "White matter changes" is often identical to "small spots of increased T_2 activity" and "small vessel ischemic changes." *Look at the films yourself!*

BIOGRAPHY

Susan Hunter-Joerns, MD, is a neurologist in private practice in Juneau, AK. Dr Hunter-Joerns received her medical degree from the University of Texas Health Sciences Center at San Antonio, TX and her Neurology residency at Audie Murphy VA Hospital in San Antonio, TX. She is board certified in Neurology.

HELPFUL READING

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