Austin Radiological Association

Nuclear Medicine Procedure

BRAIN DEATH STUDY
Neurolite (Tc-99m Bicisate)
Ceretec (Tc-99m HMPAO)

Overview

- This study is performed to confirm a clinical diagnosis of brain death. Brain-specific or lipophilic tracers which cross the blood-brain barrier (e.g., Tc-99m HMPAO or Tc-99m ECD) are preferred over non-specific or lipophobic tracers (eg,Tc-99m DTPA), which are considered angiographic radionuclides.

Indications

- Diagnosis of brain death.

Examination Time

- 45 minutes.

Patient Preparation

- Place an intravenous line in advance.

Equipment & Energy Windows

- Camera: Rotating gamma camera. Two-headed gamma camera imaging system is preferred.
- Collimator: Low energy, high resolution, parallel hole collimator.
- Energy window: 20% window centered at 140 keV.
- Computer with SPECT software – SPECT/CT with iterative processing.

Radiopharmaceutical, Dose, & Technique of Administration

- Radiopharmaceutical: Tc-99m Bicisate (ECD), or HMPAO (exametazime).
- Dose: 30 mCi (1110 MBq). Pedi dose by NACG chart.
- Technique of administration: Through an existing intravenous line, flush well.

Patient Position & Imaging Field

- Patient position:
  1. Supine with the head in a head holder secured with a Velcro strap.
  2. Flex the head so that the cerebellum is included in the field of view.

- Imaging field: Entire brain including the cerebellum.

Acquisition Protocol

- Time from injection to beginning image acquisition:
  > Immediate for flow. 15-20 minutes post injection for delayed images.

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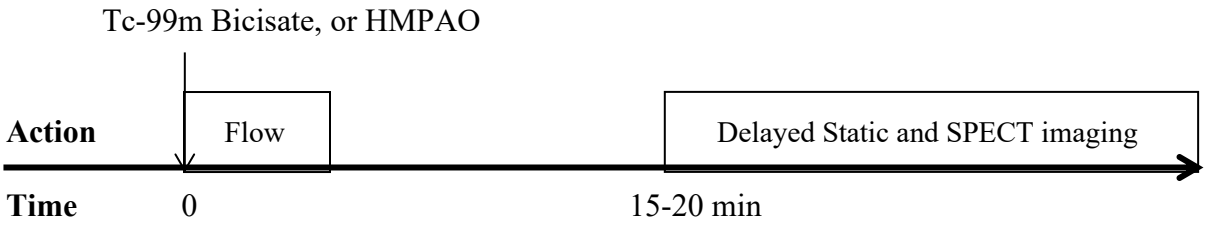
- Image acquisition parameters:

  1. Flow images:
     a. Anterior/Posterior, inject in bolus and acquire 1 second serial dynamic images for at least 60 seconds. For increased spatial resolution frames can be combined into 2 or 3 seconds per frame. Start acquisition before or at the time of injection.

  2. Delayed Static Images
     a. Anterior/Posterior and both Laterals for 5 minutes each.

  3. Optional SPECT or SPECT/CT
     a. Degrees of rotation: 360°.
     b. Number of images: 60 per head
     c. Time per image: Approximately 45 seconds.
     d. Matrix: 128 x 128 pixels.
     e. Zoom 1.78 or 2.0 based on skull size

Protocol Summary Diagram



Data Processing

- Reconstruct SPECT in transverse, sagittal, and coronal images using Flash 3D iterative processing with a Gaussian filter.

- Correct for attenuation using CT transmission map.

- Construct a 3 dimensional surface display of the brain for dynamic viewing (MIP).

Optional Maneuvers

- Diagnosis of brain death:
  - SPECT imaging may be performed if necessary and feasible.
  - Quantification: Activity in the tomograms may be quantitated on a regional basis.
  - Superimposition of perfusion and anatomic images: Images may be superimposed on corresponding magnetic resonance images with computer assistance.

Method for timely correction of Data Analysis and reporting errors and notification of referring parties

- Data Analysis and reporting errors are reported to the interpreting physician and appropriate clinic manager for timely correction and notification of the referring physician via report addendum or STAT call if error is significant.

Principle Radiation Emission Data - Tc-99m

- Physical half-life = 6.01 hours.

Radiation	Mean % per disintegration	Mean energy (keV)
Gamma-2	89.07	140.5

Dosimetry - Tc-99m Bicisate

Organ	rads/20 mCi	mGy/740 MBq
Bladder wall		
2 hour void	2.2	22.0
4.8 hour void	5.4	54.0
Gallbladder wall	1.8	18.0
Large intestine	1.2	12.0
Small intestine	0.7	7.0
Kidneys	0.5	5.4
Brain	0.4	4.0

TABLE 1
Radiation Dosimetry: Adults

Radiopharmaceutical	Administered activity (intravenous)		Largest radiation dose			Effective dose	
	MBq	mCi	Organ	mGy/MBq	rad/mCi	mSv/MBq	rem/mCi
^{99m}Tc-HMPAO (25)	370–1,110	10–30	Kidneys	0.034	0.0126	0.0093	0.034
^{99m}Tc-ECD	370–1,110	10–30	Bladder wall	0.05	0.18	0.0077	0.028

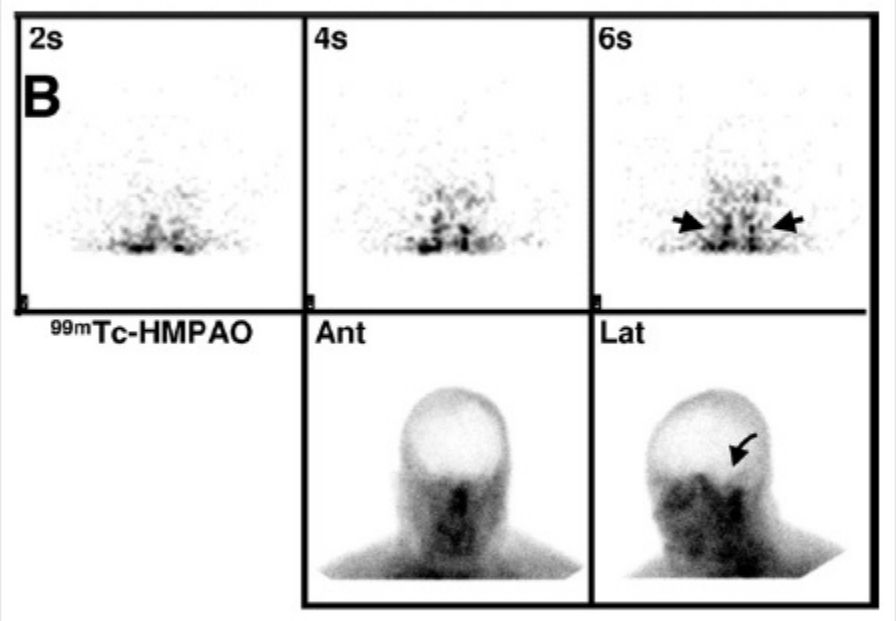
TABLE 2
Radiation Dosimetry: Children (5 Years Old; Normal Renal Function)

Radiopharmaceutical	Administered activity (intravenous)		Minimum dose		Maximum dose		Largest radiation dose			Effective dose	
	MBq/kg	mCi/kg	MBq	mCi	MBq	mCi	Organ	mGy/MBq	rad/mCi	mSv/MBq	rem/mCi
^{99m}Tc-HMPAO	11.1	0.3	185	5	740	20	Thyroid	0.14	0.52	0.027	0.099
^{99m}Tc-ECD	11.1	0.3	185	5	740	20	Bladder wall	0.11	0.41	0.022	0.081

Dose Guidelines

Site	Procedure	Radiopharmaceutical	Dose by Weight	Adult (70kg)	Minimum	Maximum
Brain	• Brain Death	Tc-99m Neurolite (Bicisate ECD)	0.430 mCi/kg	30 mCi	5 mCi	
Brain	• Brain Death	Tc-99m Ceretec (HMPAO)	0.430 mCi/kg	30 mCi	5 mCi	

The below image is an example of a scan positive for brain death using a brain-specific tracer such as Tc-99m HMPAO. In the flow phase, tracer is seen in the common carotid arteries (arrows), confirming an adequate bolus. No intracranial tracer activity is seen, including in the posterior fossa (curved arrow) in the delayed phase.



Images

Zuckier LS and Kolano J. Radionuclide Studies in the Determination of Brain Death: Criteria, Concepts, and Controversies. Semin Nucl Med 2008; 38:262-273. (PubMed link)