CISTERNOGRAPHY
(In-111-DTPA)

Overview

- Cisternography depicts the flow of cerebrospinal fluid along normal and abnormal pathways following injection of the tracer into the lumbar intrathecal space.

Indications

- Diagnosis of normal pressure hydrocephalus (1).
- Identification of cerebrospinal fluid (CSF) leaks (2,3).
- Evaluation of lumboperitoneal shunts (4).

Examination Time

- Initial lumbar puncture: 30 minutes.
- Delayed images at 2, 6, and 24 hours: 30 minutes for each set of images. (Delayed images may be needed at 48 hours and 72 hours.)

Patient Preparation

- Informed consent must be obtained for the lumbar puncture.

Equipment & Energy Windows

- Camera: Large field of view gamma camera.
- Collimator: Medium energy, parallel hole.
- Energy windows: 20% windows centered at 171 and 245 keV.

Radiopharmaceutical, Dose, & Technique of Administration

- Radiopharmaceutical: In-111-DTPA (diethylenetriaminepentaacetic acid) (4,5).
- Dose: 1.5 mCi (55.5 MBq).
- Technique of administration:
  1. Intrathecal via lumbar puncture (performed by physician).
  2. 22 gauge or smaller needle preferred to minimize CSF leakage.

3. May use 3 way stopcock so that injection of radiopharmaceutical can be followed by 1-2 mL saline flush.
4. Keep patient horizontal for 2 hours following lumbar puncture to minimize chances of headache from CSF leakage.

Patient Position & Imaging Field

- Patient position:
  1. Supine for ANT and L LAT images.
  2. Prone for 2 hour POST image of lumbar spine.

- Imaging field:
  1. Entire head for all sets of images.
  2. Lumbar spine is added to the 2 hour set of images.

Acquisition Protocol

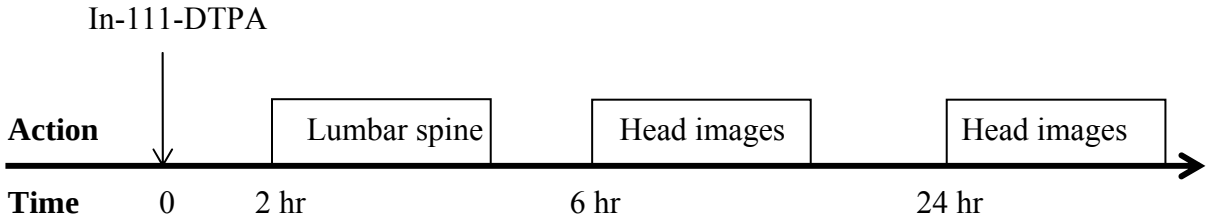
- Acquire a POST lumbar spine image at 2 hours.

- Acquire ANT and L LAT images at 2, 6, and 24 hours.
  1. For the ANT image the orbitomeatal line should be perpendicular to the collimator face.
  2. For the L LAT image the head may be slightly rotated so that the side of the head is flush with the collimator.

- Acquire each image for approximately 200 K counts.

- If at 2 hours there are very few counts coming from the head, show the 2 hour image to the nuclear medicine physician to determine if the injection extravasated outside of the subarachnoid space. If there has been extravasation, the study is usually terminated.

Protocol Summary Diagram



Data Processing

- None (unless nasal pledgets are used, see "Optional Maneuvers").

Optional Maneuvers

- Quantitative diagnosis of CSF rhinorrhea (6):
  1. 2 hours after intrathecal injection of the radiopharmaceutical, anterior and posterior pledgets are placed in each nostril by an ear, nose, & throat physician.
  2. Each pledget is approximately 1 cm square, has an absorptive capacity of 0.5 mL of water, has a string attached to it for retrieval, and has a label on the protruding portion of the string indicating its position, e.g. left-anterior.
  3. 4 hours after placement (6 hours after injection of the radiopharmaceutical), the pledgets are removed.
  4. 5 mL of venous blood is withdrawn into a heparinized tube both at time of placement and at the time of removal of the pledgets.
  5. 0.5 mL of plasma is withdrawn from each blood sample following centrifugation.
  6. The radioactivity in each pledget and each 0.5 mL plasma sample is measured in a well counter using a 150-250 keV energy window.
  7. The results are expressed as the ratio of pledget radioactivity over the average plasma radioactivity (See CSF Leak Worksheet).
  8. Normal pledget to plasma radioactivity ratios do not exceed 1.3 (6).

- When imaging for CSF leaks:
  1. Obtain ANT, POST, L LAT, and R LAT images.
  2. Position the patient in the position that maximizes the leak (2,3):
     a) an absorbent sheet of paper should be placed underneath the patient's nose to catch any radioactive rhinorrhea.
  3. An ANT image of the abdomen may be added to look for swallowed radioactive CSF in the intestine (7).
  4. Tomography may increase the sensitivity of imaging for CSF leaks (8).

- Cisternography may be used to assess the patency of lumboperitoneal shunts (4):
  1. Acquire serial 1 minute digital images of the abdomen in the R LAT projection for the first 20 minutes after injection.
  2. At 2 hours acquire ANT and R LAT images of the abdomen.
  3. At 4 and 24 hours acquire ANT and R LAT images of the abdomen and head.

- Dual isotope SPECT for anatomic localization of leak (9):
  1. Perform routine cisternography with In-111-DTPA.
  2. At 24 hours inject 25 MCi of Tc-99m-MDP.
  3. Acquire SPECT images of the head.

Principle Radiation Emission Data - In-111 (10)

- Physical half-life = 2.83 days.

Radiation	Mean % per disintegration	Mean energy (keV)
Gamma-2	90.2	171.3
Gamma-3	94.0	245.3

Dosimetry - In-111-DTPA (11)

Organ	rads/1.5 mCi	mGy/55.5 MBq
Spinal cord		
Surface	5.0	50.0
Average	1.5	15.0
Brain		
Surface	4.1	41.0
Average	0.4	4.0
Kidneys	0.22	2.2
Bladder wall		
2 hour void	0.21	2.1
4.8 hour void	0.5	5.0
Ovaries		
2 hour void	0.06	0.6
4.8 hour void	0.06	0.6
Testes		
2 hour void	0.04	0.4
4.8 hour void	0.05	0.5
Total body	0.04	0.4

References

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5. Goodwin DA, Chung HS, Finston R, et al: Preparation, physiology, and dosimetry of In-111-labeled radiopharmaceuticals for cisternography. Radiology 108:91-98,1973.
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7. Zu'bi SM, Kirkwood R, Abbasy M, et al: Intestinal activity visualized on radionuclide cisternography in patients with cerebrospinal fluid leak. J Nucl Med 32:151-153, 1991.
8. Lewis DH, Graham MM: Benefit of tomography in the scintigraphic localization of cerebrospinal fluid leak. J Nucl Med 32:2149-2151, 1991.
9. Okizaki A, Shuke N, Aburano T, et al: Detection of cerebrospinal fluid leak by dual-isotope SPECT with In-111 DTPA and Tc-99m HMDP. Clin Nucl Med 26:628-629, 2001.
10. 49-In-111: In MIRD: Radionuclide Data and Decay Schemes, DA Weber, KF Eckerman, AT Dillman, JC Ryman, eds, Society of Nuclear Medicine, New York, 1989, pp 196-197.
11. Pentetate Indium Disodium In-111: Product insert. Medi+Physics, July, 1985.

Normal Findings

> McKusick KA, Malmud LS, Kordela PA, et al: Radionuclide cisternography: Normal values for nasal secretion of intrathecally injected In-111-DTPA. J Nucl Med 14:933-934, 1973.
> James AE, New PFJ, Heinz ER, et al: A cisternographic classification of hydrocephalus. Am J Roentgenol 115:39-49, 1972.

CSF LEAK WORKSHEET

Nuclear Medicine Department

Institution_____

Patient name_____ ID_____

Referring physician_____ Date_____

STEP 1 Determine net counts per 5 minutes (cp5m) for all specimens:

Specimen	Gross (cp5m)		Background (cp5m)		Net (cp5m)
R Ant		-		=	
R Post		-		=	
L Ant		-		=	
L Post		-		=	
2 hr Plasma		-		=	
6 hr Plasma		-		=	
Background					

STEP 2 Calculate the average counts per 5 minutes for the 2 plasma aliquots:

2 hour plasma sample = _____ cp5m
6 hour plasma sample = _____ cp5m
sum = _____ ÷ 2 = _____ cp5m (average)

STEP 3 Calculate the ratio of each pledget to the average plasma value:

Specimen	Net (cp5m)		Ave plasma (cp5m)		Ratio
R Ant		÷		=	
R Post		÷		=	
L Ant		÷		=	
L Post		÷		=	

• Normal ratio ≤ 1.3 •

Technologist_____

NOTES