Cisternal Scintigraphy

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NOTE: no changes have been made since the version of 2007

1. Introduction

Cisternography is a dynamic investigation to evaluate the displacement, patency, and dispersal of inert radiopharmaceuticals introduced directly into the cerebrospinal fluid (CSF) space, into an intrathecal pump mechanism or into a CSF drain.
The treatment of hydrocephalus is focused on the removal of excess cerebrospinal fluid (CSF). One of the methods used is the placement of a ventriculo-atrial, ventriculo-peritoneal or lumbo-peritoneal shunt. Assessment of the patency of such a drainage system is a major clinical problem. If the drain is patent, activity is seen immediately after the administration of the radiopharmaceutical. The activity will drain both to the ventricles and heart or to the abdominal cavity.

2. Methodology

This guideline is based on available scientific literature on the subject, the previous guideline (Aanbevelingen Nucleaire Geneeskunde 2007), international guidelines from EANM and/or SNMMI if available and applicable to the Dutch situation.

3. Indications

a. Communicating hydrocephalus and in particular normal-pressure hydrocephalus.
b. CSF leakage.
c. Evaluation of a drainage system.
d. Epidural pump function.
e. Assessment of possibility for intrathecal therapy e.g. in CNS lymfomas.

4. Relation to other diagnostic procedures

CT-scanning and MRI provide insight into the anatomy of the brain, the meninges and the CSF space. A CT myelogram, whereby radio opaque contrast is injected into the CSF space, allows for imaging of any sites of leakage. MR myelography, a heavily T2 weighted image, can be used to detect fluid collections such as CSF pooling. This allows for detection of leakage without the need for a lumbar puncture, contrast agent or radioactive isotope, though intrathecal gadolinium is usually preferred. These methods appear to be less sensitive than radionuclide cysternography, though no direct comparative studies are known.

5. Medical information necessary for planning

a. Case history, including neurological symptoms
b. Clinical signs indicating a CSF leak or blocked drainage system
c. Results of previous investigations e.g. CT, MRI, CSF biochemistry

6. Radiopharmaceutical

Tracer:	^{111}In-pentetate (DTPA) for intrathecal use
Nuclide:	Indium-111
Activity:	20 MBq For the evaluation of a drainage system 4 MBq (in a maximum volume of 1 ml)
Administration:	Intrathecally, either through lumbar puncture or into the reservoir in the direction of drainage. No greater volume may be administered than that of the fluid previously drained

Extra care must be taken to prevent radioactive contamination, as these punctures are often not done in the Department of Nuclear Medicine.

7. Radiation safety

a. Pregnancy

Considering the relative low dose, 20 MBq ^{111}In, the benefits of het diagnostics revenues will quickly outweigh the assumed risk to the unborn child. The estimated effective dose to the unborn child is 0,9 mSv. No health detriment to unborn children is reported for doses smaller than 100 mGy, and a dose of 0,5 mSv is acceptable. Less than 1 mSv can be accepted as the dose limit for an unborn child of a worker, is also 1 mSv during the pregnancy.

b. Lactation

According to ICRP 106 there is no need to interrupt breastfeeding.

c. Radiation exposure

The effective dose due to 20 MBq ^{111}In DTPA administered to the patient will be 2,4 mSv.

8. Patient preparation/essentials for procedure

No special preparations. If necessary shave injection site.

Essentials:

a. Lumbar puncture needle.
b. Sterile gloves.
c. For disinfection: iodine, alcohol, sterile gauze.
d. Fine needle.
e. Riser (for pressure measurement).
f. Sterile collection tubes for liquor.
g. Cotton wool or gauze in the case of liquorrhoea.
   Wadding plugs are appropriate during the investigation and for up to 4 h after injection, but not 24 h or longer. They are often lost at night. Large nose wads or gauze, as used in ENT surgery, are therefore preferable.

9. Acquisition and processing

Gamma camera and computer

Energy:	^{111}In setting, 173 and 247 keV
Window:	20%
Collimator:	MEAP

Time:	100.000 counts or 10 min
Upon draining:	over a period of 2 min, frames of 10 sec are recorded with a matrix of 64×64. After 30 min static images of 2 min (anterior and lateral) and a vertex image of 10 min may be made
Computer:	Not required; for digital gamma camera at matrix 128x128 minimum

a. Prior to imaging the skull, check the injection site.
b. In adults images are taken of the skull from anterior, posterior, left and right-lateral as well as vertex views at 4, 24 and 48 h. In children, the same images are taken at 1, 2, 6 and 24 h.
c. If there is a possibility of liquorrhoea, nasal and/or ear plugs are inserted 4 h after injection. These should remain in situ for 24 h. As the wadding is removed, blood is also taken, after which 0,5 ml plasma is counted along with the wadding and blanks. Measurements of nasal or ear plugs after 24 h are appropriate given the occurrence of intermittent liquorrhoea. It is also appropriate, if liquorrhoea is suspected, to carry out abdominal imaging after 24 h.
d. The drain patency investigation is done as follows: During administration, the patient lies supine facing the collimator. The easiest way to immobilize the head is to hold it. After disinfection of the skin above the reservoir, the needle is inserted into the reservoir (liquor). When liquor appears through the needle, it demonstrates the patency of the ventricular portion of the shunt. Next, the CSF pressure is measured and liquor taken for laboratory tests (biochemistry and culture).

A syringe containing ^{111}In-DTPA is affixed to the needle and immediately after the injection, the recording starts. A series of recordings is made at 10 sec per image. After 1 min, if possible, a manual pump technique is used to promote drainage. The entire investigation takes about 2 min. If no drainage can be demonstrated in the first 2 min (even after pumping), then recordings are again made after 30 min.
At this time a vertex recording is also indicated in order to confirm that the radiopharmaceutical has been administered into the reservoir. Depending on the location of the drain, additional images are taken. If there is a lumbo-peritoneal drain, dynamic acquisition is recommended during the first hour. A further recording at 24 h may be useful.

10. Interpretation

a. If a substantial portion of the administered radiopharmaceutical ends up beside the puncture site or has leaked out of it, that will become clearly visible after half an hour. Later the activity will appear into the bladder.
b. Normally the radiopharmaceutical reaches the convexity after approximately 24 h. This process can be delayed as a result of increased volume of the subarachnoid space or delayed resorption.
c. Filling of the ventricles indicates an (often pathological) retrograde movement of the radiopharmaceutical. This so-called reflux into the lateral ventricles is transient, e.g. in cerebral atrophy or in young children, but persists in e.g. a normal-pressure hydrocephalus.
d. Asymmetrical images may arise from adhesions in the subarachnoid space.
e. The reference values with respect to quantities of the radiopharmaceutical found in the nasal plugs, which must be of adequate size and absorbency, are dependent on

the technique used and should be determined for each department. In the literature, several techniques are described.

f. Drain: The erroneous subcutaneous injection of the radiopharmaceutical can create phantom images that simulate a blockage of the distal drain. By making a vertex recording, this pitfall can be avoided.

11. Report

The following should be included in the report:

a. Quality of the injection.
b. Distribution of activity in the subarachnoid space, the basal cisterns, the Sylvii fissures and the interhemispheric fissures at different times.
c. The time and duration of any reflux into the two lateral ventricles.
d. The time at which convexity is achieved and any visible place of liquor leakage.
e. The time and place a ventriculo-peritoneal shunt becomes visible.
f. If drainage is to be assessed: describe the route of the radiopharmaceutical. A patent drain is observed on the frontal recording as spontaneous drainage , first in the direction of the lateral ventricles and then through the distal portion of the drain to the heart. The lateral views do not allow for separate visualisation of these two phenomena, the images overlap. By making images of the thorax or the abdomen, the distal end of the drain becomes visible (if drainage is to the heart, the bladder fills slowly), enabling exclusion / demonstration of a blockage in this section of the drain.

12. Literature

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