Imaging Techniques for Spinal CSF Leaks

A quick reference guide

The aim of this factsheet is to provide basic information about the different types of imaging techniques used to diagnose and treat a spinal cerebrospinal fluid (CSF) leak. There is no single scan that can rule out a CSF leak and variety of factors influence what scans may be necessary as part of a patient's treatment journey.

Magnetic Resonance Imaging (MRI)

There are three types of MRI scans:

1. **MRI (head or spine)**
2. **Non-Contrast Enhanced MR Myelogram (MRM) (spine)**
3. **Intrathecal Gadolinium Enhanced MR Myelogram (spine)**

An MRI scan of the head can be used to detect signs of intracranial hypotension in the brain, e.g. visual enhancement of the dura surrounding the brain if contrast was used, sagging of the brain. An MRI of the spine can be used to detect signs of a CSF leak, e.g. a collection of CSF outside the dura.

A Non-Contrast Enhanced MR Myelogram of the spine is a special type of MRI scan or 'sequence' which provides high contrast between the 'dark' spinal cord and its nerves and the surrounding 'bright' cerebrospinal fluid, mimicking the appearance of a CT Myelogram.

An Intrathecal Gadolinium Enhanced MR Myelogram of the spine is an MRI scan that requires lumbar puncture with Gadolinium based contrast injected into the thecal sac. The resultant images are not the same as a Non-Contrast Enhanced MR Myelogram and there are pros and cons to both.

Fig 1. MRI scanner

This imaging technique:

- Uses non-ionising radiation.
- May or may not require contrast agents (Gadolinium based) to be injected into a vein.
- Has a long scan time (often 30 min or more).
- Has images that allow for better visualisation of differences in soft tissue compared to CT.
- May not be suitable for some patients – e.g. those fitted with some implants or devices which may not safe due to the strong magnetic fields of an MRI machine.

Computed Tomography (CT)

There are three types of CT scans:

1. **CT (head or spine)**
2. **CT Myelogram (AKA post- myelography CT) (CTM) (spine)**
3. **Dynamic CT Myelogram (DCTM) (spine)**

A CT scan of the head is useful for detecting bleeding on the brain that may raise the suspicion for a CSF leak. It is not as useful as an MRI scan for detecting signs of intracranial hypotension.

CT Myelogram is a CT scan of the spine which requires lumbar puncture with a radiopaque (iodine based) contrast agent injected into the thecal sac. The site of a leak can be found if the contrast has leaked outside of the thecal sac and has not yet mixed too well with the existing extrathecal collection of CSF. Therefore, it's not so good for locating the leak site of very fast leaks or very slow leaks.

Dynamic CT Myelogram is a type of CT myelogram where multiple scans are taken with resultant increase in ionising radiation exposure. The injection of contrast agent may be followed by a saline bolus to increase pressure within the thecal sac and increase the likelihood of locating a leak. The time between introduction of contrast and imaging is very short so this type of scan is good for fast leaks or multiple leaks.

Fig 2. CT scanner

This imaging technique

- Uses ionising radiation.
- May or may not require radiopaque (iodine based) contrast agent to be injected into a vein.
- Has a short scan time.
- Has images that allow for visualisation of smaller structures within the body compared to plain x-ray images.

Fluoroscopic Myelography (spine)

There are two types of myelography:

1. **Myelography (Conventional)**
2. **Digital Subtraction Myelography (DSM)**

Conventional Myelography may be done just prior to a CT Myelogram

Digital Subtraction Myelography (DSM) is carried out in the same way as conventional myelography but better visualisation of leak sites may be obtained for particularly fast leaks if a fluoroscopic technique called 'digital subtraction' is used as well. This involves the pre-contrast image being digitally subtracted from the post-contrast image providing a clearer image of the contrast as it tracks up the spine. Some hospitals may place the patient under general anaesthetic to reduce the potential for movement to affect image quality.

Radionuclide Cisternography

There are two types of imaging:

1. **Planar Radionuclide Cisternography**
2. **SPECT/CT radionuclide imaging**

Planar Radionuclide Cisternography has a radiation dose associated only with the radionuclide.

SPECT/CT images are acquired in two ways. In addition to the SPECT image produced by rotating gamma cameras, a CT image is acquired using the CT component of the SPECT/CT machine. An additional dose arises from this CT scan. The CT image is then overlaid on the SPECT image to improve localisation of the CSF leak.

Fig 3. Fluoroscopic machine

This imaging technique

- Uses ionising radiation produced by a fluoroscopy machine which is a type of x-ray machine.
- Requires lumbar puncture – a radiopaque (iodine based) contrast agent is injected into the thecal sac.
- Allows for real time visualisation of contrast as it leaks from thecal sac.
- Images are such that structures within the body appear overlaid on each other and small detail may be hard to visualise.

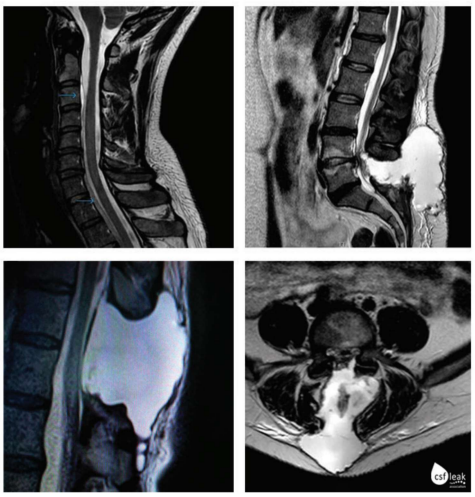
Fig 4. Gamma camera

This imaging technique

- Uses ionising radiation – a radionuclide is injected into the thecal sac via lumbar puncture.
- Images are acquired by scanners called gamma cameras.
- May require multiple image acquisitions over a day or possibly days to produce images that visualise the radionuclide after it has leaked from the thecal sac.
- Has long image acquisition times.
- Has images with poor ability to detect small areas of leaked CSF.

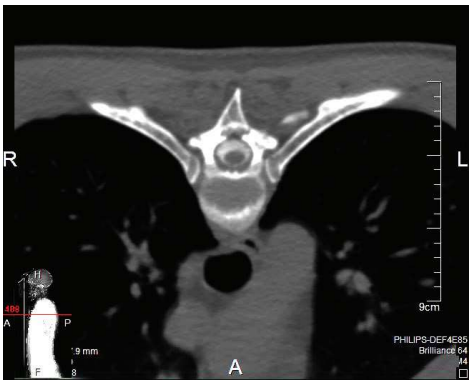
Various scan images

MRI 3T with fat suppression



MRI Intrathecal Gadolinium

CT Myelogram



Digital subtraction Myelogram

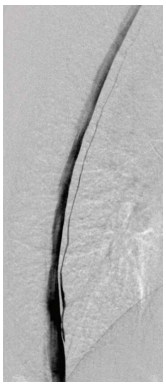


Image courtesy of Wouter I. Schievink

This factsheet forms part of a series of publications about CSF leaks produced by the CSF Leak Association. You can view and download other publications here: www.csfleak.info/publications

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