

Intracranial Hypotension: Spinal leak and CSF-venous fistula

Overview

When cerebrospinal fluid (CSF) leaks from the spine, the brain may sink or sag, causing severe headaches. One type of spinal leak is a CSF-venous fistula. This is an abnormal tunnel that drains CSF directly into nearby veins—like a straw. As CSF continues to drain, there is not enough fluid around the brain. This condition is called intracranial hypotension, meaning low fluid pressure in the head. Treatment options may include a blood patch, surgery, or glue embolization to seal the leak.

Anatomy of the CSF space

To understand spinal leaks, it helps to know how cerebrospinal fluid works. Your brain and spinal cord float in this clear fluid, which cushions and protects them from injury (Fig. 1). CSF is produced inside two large ventricles in the brain. Your body makes 400 to 600 ml of CSF each day, but it can only hold 150 ml at a time. This means your body absorbs and replaces it 3 to 4 times a day.

CSF is held under gentle pressure inside a tough, waterproof sac called the dura, which lines the skull and spinal canal. CSF pressure is higher in the lower spine than in the head. CSF is absorbed into the bloodstream through veins at the top of the head via tiny valves called arachnoid villi. It also drains into veins along the spinal canal and nerve root sleeves. Too much or too little fluid can cause problems.

What is a spinal CSF leak / fistula?

A spinal CSF leak happens when there is a hole or tear in the dura along your spine (Fig. 2). CSF can also leak through a fistula or tunnel, where the dura sac is directly communicating with veins.

When CSF leaks out, the total volume of fluid in the head drops, and so does the pressure.

Intracranial hypotension is a condition that means there is not enough fluid around the brain. As CSF slowly drains, the brain no longer floats freely — it sags against the skull. This often causes debilitating headaches when standing or sitting upright.

What are the symptoms?

The most common symptom of a leak is a **positional (orthostatic) headache** that is worse when standing or sitting upright and feels better

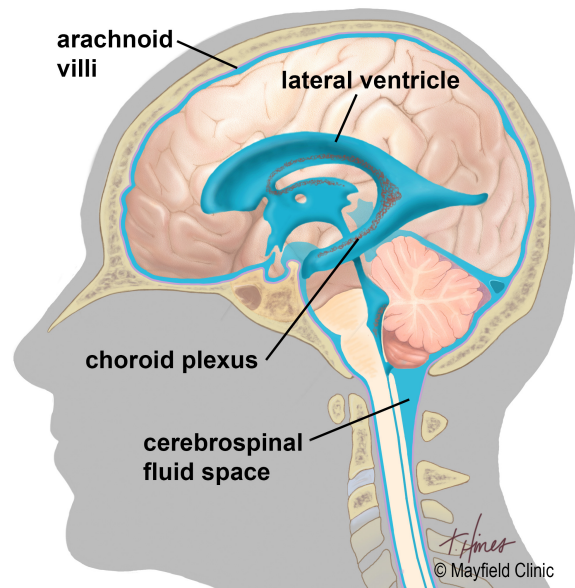


Figure 1. Cerebrospinal fluid (CSF) flows within and around the brain and spinal cord. CSF (teal color) is produced by the choroid plexus inside the ventricles and is constantly being absorbed and replenished.

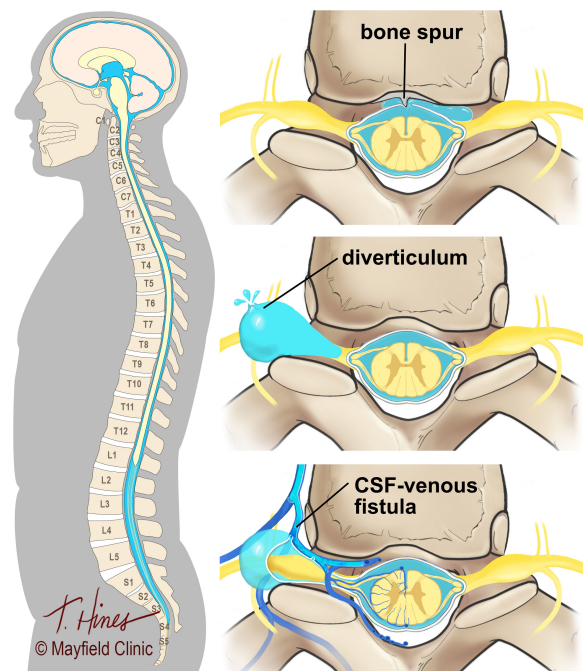


Figure 2. Types of spinal leaks. In the spinal canal, CSF flows around the nerve roots. This is a common location for dura tears from a bone spur, diverticula pouches, and CSF-venous fistulas.

when lying down. While a positional headache is a key clue, it's not the only symptom. The positional aspect can lessen over time, and some people may not notice this pattern at all.

Other symptoms may include:

- Neck pain or stiffness
- Nausea or vomiting
- Muffled hearing or ringing in ears (tinnitus)
- Imbalance, dizziness, or vertigo
- Sensitivity to light or sound
- Trouble thinking or "brain fog"
- Pain between the shoulder blades

Intracranial hypotension can be hard to diagnose because it can look like more common headaches, such as migraines. It can also be difficult to find the exact location of the CSF leak.

What are the causes?

Spinal CSF leaks can happen after an injury or by medical procedures, such as:

- **Lumbar puncture:** a hollow needle inserted into the dura sac to collect CSF for testing or to deliver contrast dye for a myelogram.
- **Epidural injections:** a hollow needle inserted into the space outside the dura to deliver anesthesia that may nick the dura and create a hole.
- **Spine surgery:** a pocket of CSF fluid that may collect after surgery through the dura incision or an unrecognized tear in the dura. This pocket is called a pseudo-meningocele.

Some spinal leaks happen without a clear cause. These are called spontaneous CSF leaks and are often due to an underlying problem, including:

- **Bone spurs:** Sharp bone growths on the spine can poke and tear a hole in the dura.
- **Weak dura:** Some people have weaker connective tissue due to genetic conditions like Ehlers-Danlos or Marfan syndrome.
- **Diverticula:** Small bulging dura pouches that form along the spinal nerve roots.
- **CSF-venous fistula:** A type of leak where CSF drains directly into a vein.

How is a diagnosis made?

Your doctor will start by asking about your medical history, symptoms, past injuries, and any surgery or procedures you have had. If a spinal leak is suspected, imaging tests may be ordered:

Brain MRI: This is often the first test to look for "SEEPS" findings—a set of clues that show if the brain is sagging (Fig. 3):

1. Subdural fluid collections
2. Enhancement of the dura
3. Engorged veins
4. Pituitary enlargement
5. Sagging of the brain

A normal brain MRI does not rule out a leak.

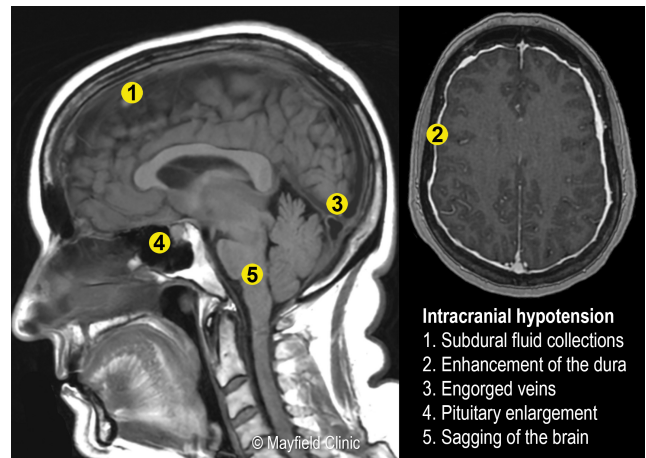


Figure 3. MRI scans of brain sag (left) and enhancement of the dura (right; white edges around brain).

Spinal MRI: This scan can detect fluid pockets from a bone spur or from a ruptured diverticulum.

Some leaks, especially CSF-venous fistulas, can be hard to see. These are called "hidden" or occult leaks because the fluid drains directly into a vein, leaving no puddle or fluid buildup to see on MRI scans. The leak may also happen fast or be intermittent, which makes it harder to find.

Spinal myelogram: Because fistulas can be difficult to detect, high-speed imaging tests can be used to "catch the leak in the act." If a leak is suspected, the next step is to find its exact location with a specialized myelogram.

Dynamic myelography (digital subtraction or CT) uses a contrast dye injected into the spinal CSF space (Fig. 4). It is often done lying on your side to check both the right and left sides of the spine. This may be done on two separate days.

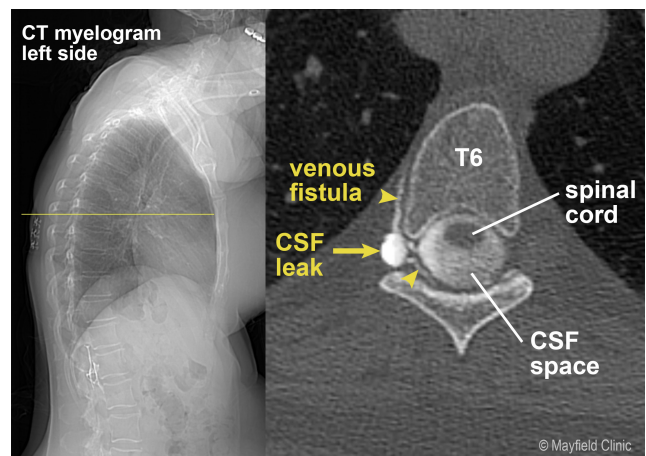


Figure 4. Myelogram of a spinal CSF-venous fistula. The white is contrast dye inside the CSF space (thecal sac) showing the pathway of leak to veins (arrowheads).

What treatments are available?

The goal of treatment is to seal the hole and stop the fluid leak. Your treatment will be tailored to the type of leak you have. Because a fistula is a "tunnel" and not a tear, treatment may be different.

- **Conservative care:** Lying flat, drinking plenty of fluids with caffeine, and pain relievers until the hole heals on its own in several days. This is first-line treatment for post-dural puncture headaches.
- **Epidural blood patch:** A small amount of your own blood is injected into the spinal canal near the leak, but outside the dura. The blood clots and forms a "patch" to seal the hole. A biologic glue (fibrin) may also be injected. A blood patch can be repeated if needed and works best for leaks due to dura holes after a lumbar puncture or surgery. They are less effective for fistulas.
- **Surgery:** An incision is made in your back to open the bony spinal canal (laminectomy) and find the dura tear or fistula. If a large dura tear is found, sutures or a tissue graft is used to seal the hole. If an abnormal vein fistula is found at the nerve root, then it is tied off with a suture. Surgery was once the main treatment for fistulas, but today it may be used if embolization fails to seal the leak.
- **Embolization:** A minimally invasive procedure where a steerable catheter is inserted into the bloodstream. Once the catheter is at the vein, a biologic glue is used to plug the fistula tunnel from the inside.

What happens during embolization?

Endovascular procedures are performed in the angiography suite of the radiology department. It is done outpatient and you go home the same day.

Step 1. prepare the patient

You will lie on the X-ray table and be given either "twilight" sedation or general anesthesia.

Step 2. insert the catheter

The inner thigh and groin area are shaved and cleansed. A local numbing agent is given to minimize discomfort as the skin incision is made. The femoral vein is located, and a hollow needle is inserted (Fig. 5). Next, a long tube made of flexible plastic, called a catheter, is passed through the needle to enter the bloodstream. A special dye, called a contrast agent, is injected into the bloodstream through the catheter. The dye makes the blood vessels visible on the X-ray monitor. Watching the monitor while injecting dye, the doctor carefully guides the catheter from the femoral vein in the leg, up the vena cava, to the azygos vein in the spinal canal.

Step 3. locate the spinal nerve root

When the catheter is placed at the correct spinal level, the doctor injects contrast dye to view the veins near the suspected fistula.

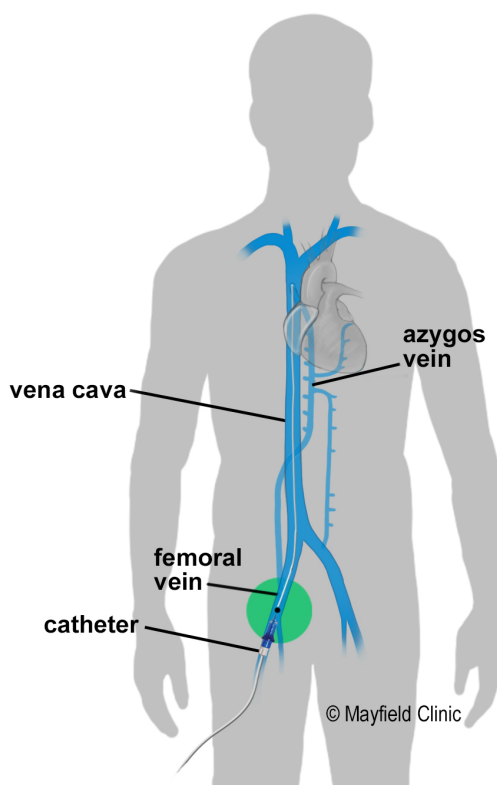


Figure 5. Embolization uses a catheter that is inserted into the femoral vein in the groin. It is then guided up to the azygos vein in the spinal canal.

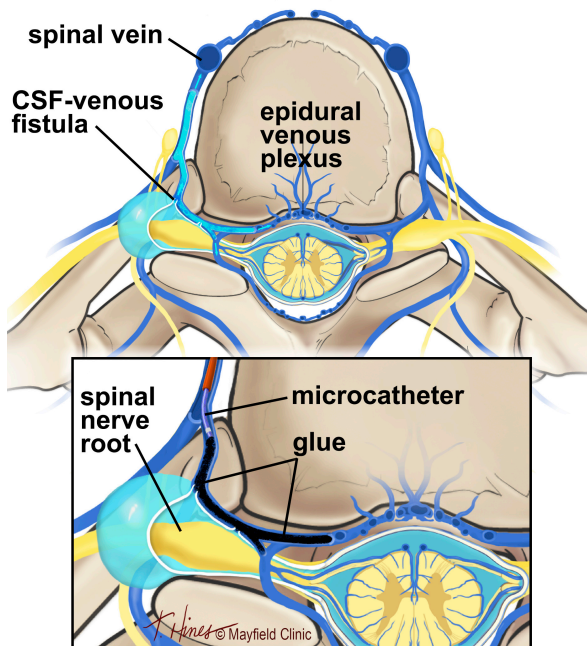


Figure 6. Glue is injected through the catheter into the veins to block the CSF fistula leak.

Step 4: insert the glue

A second smaller catheter, about the size of a string of spaghetti, is advanced through the first catheter. This microcatheter travels through the veins and into the fistula itself. Next, a special biologic glue is pushed through the catheter (Fig. 6).

Step 5: remove the catheter

Once the leak is sealed, the catheter is removed. Pressure is applied to the groin area for about 10 to 15 minutes so that the vein won't bleed.

What happens after embolization?

You are transferred to the recovery area for observation and monitoring as the sedation wears off. Nausea and headaches can occur after the procedure, but medication is available to control these symptoms.

You must remain flat on your back for an hour, keeping the bandaged leg as straight as possible. You may feel mild tenderness at the groin site. Notify the nurse if any pain, swelling, or bleeding occurs at the incision.

You may go home the same day. Someone should stay with you for the next 48 hours.

Recovery

You should take it easy for several weeks after the procedure, with no bending, twisting, or heavy lifting. You may shower as directed by the surgeon but do not take a tub bath or submerge in water for 4 weeks. Incisions should be patted dry with a soft towel to avoid irritation.

Call the surgeon's office if your temperature exceeds 101° F or if the incision begins to separate or show signs of infection, such as redness, swelling, pain, or drainage.

What are the risks?

No procedure is without risk. General complications include bleeding, infection, allergic reaction to contrast dye, and problems with anesthesia.

Local pain: About 30% of patients feel back pain at the level where the fistula was repaired.¹ It is typically not severe and resolves on its own.

Rebound high pressure (Rebound hypertension): This headache occurs in 17-28% of patients and is the most important thing to watch for.¹

- For weeks, months, or years, your body has been losing CSF. Now that the leak is sealed, your body may temporarily have too much CSF.
- This causes a new type of headache. It is typically the opposite of your old headache—it feels **worse when you lie down** and better when you sit up.

- Call the surgeon's office. This is a common and treatable side effect. It is a sign the procedure worked. A medication, called acetazolamide, may be prescribed to help your body adjust.

Glue migration: Small particles of glue may escape the catheter tip and travel to veins in the lung or spine.

Venous perforation: The catheter may puncture the thin-walled epidural venous plexus, causing bleeding. This is rare and does not cause any issues.

What are the results?

In a study of 40 patients who had embolization of their CSF-venous fistula, 90% reported improvement in their symptoms. More than 80% reported being "much better" or "very much better."²

Follow-up brain MRIs showed that the "brain sag" caused by the leak was significantly improved or completely resolved.²

Sources & links

If you have more questions, please contact Mayfield Brain & Spine at 800-325-7787 or 513-221-1100.

Sources

1. Oushy S, Borg N, Brinjikji W. Transvenous embolization of cerebrospinal fluid-venous fistulas: A comprehensive technical video guide. Interv Neuroradiol 11:15910199241264859, 2024
2. Brinjikji W, Garza I, Whealy M, Kisson N, Atkinson JLD, Savastano L, Madhavan A, Cutsforth-Gregory J. Clinical and imaging outcomes of cerebrospinal fluid-venous fistula embolization. J Neurointerv Surg 14(10):953-956, 2022

Links

<https://spinalcsfleak.org>

<https://csfleak.uk/resource/what-is-a-csf-leak>



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