

= Spontaneous cerebrospinal fluid leak =

Spontaneous cerebrospinal fluid leak syndrome (SCSFLS) is a medical condition in which the cerebrospinal fluid (CSF) held in and around a human brain and spinal cord leaks out of the surrounding protective sac , the dura , for no apparent reason . The dura , a tough , inflexible tissue , is the outermost of the three layers of the meninges , the system of meninges surrounding the brain and spinal cord .

A spontaneous cerebrospinal fluid leak is one of several types of cerebrospinal fluid leaks and occurs due to the presence of one or more holes in the dura . A spontaneous CSF leak , as opposed to traumatically caused CSF leaks , arises idiopathically . A loss of CSF greater than its rate of production leads to a decreased volume inside the skull known as intracranial hypotension . A CSF leak is most often characterized by orthostatic headaches ? headaches that worsen in a vertical position and improve when lying down . Other symptoms can include neck pain or stiffness , nausea , vomiting , dizziness , fatigue , and a metallic taste in the mouth (indicative of a cranial leak) , among others . A CT scan can identify the site of a cerebrospinal fluid leakage . Once identified , the leak can often be repaired by an epidural blood patch , an injection of the patient 's own blood at the site of the leak , fibrin glue injection or surgery .

SCSFLS afflicts 5 out of every 100 @, @ 000 people . On average , the condition is developed at the age of 42 , and women are twice as likely as men to develop the condition . Some people with SCSFLS chronically leak cerebrospinal fluid despite repeated attempts at patching , leading to long @-@ term disability due to pain . SCSFLS was first described by German neurologist Georg Schaltenbrand in 1938 and by American physician Henry Woltman of the Mayo Clinic in the 1950s .

= = Classification = =

SCSFLS is classified into two main types , cranial leaks and spinal leaks . The vast majority of leaks are spinal . Cranial leaks occur in the head . In some of these cases , CSF can be seen dripping out of the nose , or ear . Spinal leaks occur when one or more holes form in the dura along the spinal cord . Both cranial and spinal spontaneous CSF leaks cause neurological symptoms as well as spontaneous intracranial hypotension , diminished volume and pressure of the cranium . While referred to as intracranial hypotension , the intracranial pressure may be normal , with the underlying issue instead being low @-@ volume CSF . For this reason SCSFLS is referred to as CSF hypovolemia as opposed to CSF hypotension .

= = Signs and symptoms = =

Most people who develop SCSFLS feel a sudden onset of a severe and acute headache . It is a headache usually but not necessarily orthostatic (worse when standing) , typically becoming prominent throughout the day , in which usually the pain is worse when the person is vertical and less severe when horizontal . Orthostatic headaches can be incapacitating ; these ailments often become chronic and can be sufficiently disabling to make those afflicted unable to work . Some patients with CSF leak will develop headaches that begin in the afternoon . This is known as second @-@ half @-@ of @-@ the @-@ day headache . This may be an initial presentation of CSF leak or appear after treatment and likely indicates a slow CSF leak .

Apart from headache , about 50 % of patients experience neck pain or stiffness , nausea , and vomiting . Other symptoms include dizziness and vertigo , facial numbness or weakness , unusually blurry or double vision , neuralgia , fatigue , or a metallic taste in the mouth . Leaking CSF can sometimes be felt or observed as discharge through the nose or ear .

Lack of CSF pressure and volume allows the brain to descend through the foramen magnum , or occipital bone , the large opening at the base of the skull . The lower portion of the brain is believed to stretch or impact one or more cranial nerve complexes , thereby causing a variety of sensory symptoms . Nerves that can be affected and their related symptoms are detailed in the table at right .

= = Causes = =

The two main theories as to the underlying cause of SCSFSL are as a result of a connective tissue disorder or spinal drainage problems .

= = = Connective tissue theory = = =

A spontaneous CSF leak is idiopathic , meaning the cause is unknown . Various scientists and physicians have suggested that this condition may be the result of an underlying connective tissue disorder affecting the spinal dura . It may also run in families and be associated with aortic aneurysms and joint hypermobility . Up to two thirds of those afflicted demonstrate some type of generalized connective tissue disorder . Marfan syndrome , Ehlers @-@ Danlos syndrome and autosomal dominant polycystic kidney disease are the three most common connective tissue disorders associated with SCSFSL .

Roughly 20 % of patients with SCSFSL exhibit features of Marfan syndrome , including tall stature , chest divot (pectus excavatum) , joint hypermobility and arched palate . However these patients do not exhibit any other Marfan syndrome presentations .

= = = Spinal drainage theory = = =

Some other studies have proposed that issues with the spinal venous drainage system may cause a CSF leak . According to this theory , dural holes and intracranial hypotension are symptoms caused by low pressure in the epidural space due to outflow to the heart through the inferior vena cava vein .

= = = Other causes = = =

Patients with a nude (absent) nerve root are at increased risk for developing recurrent CSF leaks . Cranial CSF leaks are as a result of intracranial hypertension in a vast majority of cases . The increased pressure causes a rupture of the cranial dura mater , leading to CSF leak and intracranial hypotension . Lumbar disc herniation has been reported to cause CSF leak in at least one case . Degenerative spinal disc diseases cause a disc to pierce the dura mater , leading to a CSF leak .

Another view of the cause of orthostatic headaches proposes a malformed distribution of craniospinal elasticity as a result of the collapse of the lower spine 's CSF space resulting in the collapse of the dura sac .

= = Pathophysiology = =

Cerebrospinal fluid is produced by the choroid plexus in the ventricles of the brain and contained by the dura and arachnoid layers of the meninges . The brain floats in CSF , which also transports nutrients to the brain and spinal cord . As holes form in the spinal dura mater , CSF leaks out into the surrounding space . The CSF is then absorbed into the spinal epidural venous plexus or soft tissues around the spine . Due to the sterile conditions of the soft tissues around the spine there is no risk of meningitis .

= = Diagnosis = =

The primary place of first complaint to a physician is a hospital emergency room . Up to 94 % of those suffering from SCSFSL are initially misdiagnosed . Incorrect diagnoses include migraines , meningitis , Chiari malformation and psychiatric disorders . The average time from onset of symptoms until definitive diagnosis is 13 months . A study found a 0 % success rate for proper diagnosis in the emergency department .

Diagnosis of CSF leak can be done through various imaging techniques , chemical tests of bodily fluid discharged from a head orifice , or clinical exam . The use of CT , MRI , and assays are the most common types of CSF leak instrumental tests . Many CSF leaks do not show up on imaging and chemical assays , thus such diagnostic tools are not definitive to rule out CSF leaks . A clinician may often depend upon patient history and exam to diagnose , for example : discharge of excessive amount of clear fluid from the nose upon bending over , the increase in headache following a Valsalva maneuver or the reduction of headache when the patient takes a prone position are positive indicators .

Clinical exam is often used means to diagnose CSF leaks . Improved patient response to conservative treatment may further define a positive diagnosis . The lack of clinician awareness of the signs -symptoms and ailments- of a CSF leak is the greatest challenge to proper diagnosis and treatment , in particular : the loss of the orthostatic characteristic of headache and that every chronic CSF leaker will have a unique symptom set that as a whole contributes to the underlying condition , and diagnosis of , a CSF leak .

== = CT == =

Diagnosis of a cerebrospinal fluid leak is performed through a combination of measurement of the CSF pressure and a computed tomography myelogram (CTM) scan of the spinal column for fluid leaks . The opening fluid pressure in the spinal canal is obtained by performing a lumbar puncture , also known as a spinal tap . Once the pressure is measured , radiopaque contrast material is injected into the spinal fluid . The contrast then diffuses out through the dura sac before leaking through dural holes . This allows for a CTM with fluoroscopy to locate and image any sites of dura rupture via contrast seen outside the dura sac in the imagery .

== = MRI == =

Magnetic resonance imaging is less effective than CT at directly imaging sites of CSF leak . MRI studies may show pachymeningeal enhancement (when the dura mater looks thick and inflamed) , sagging of the brain , pituitary enlargement , subdural hygromas , engorgement of cerebral venous sinuses , and other abnormalities . For 20 % of patients , MRIs present as completely normal . There is disagreement over whether MRI should be the study of choice . MRIs performed with the patient seated upright (vs. laying supine) are not better for diagnosing CSF leaks , but are more than twice as effective at diagnosing cerebellar tonsillar ectopia , aka Chiari malformation . Cerebellar tonsillar ectopia shares many of the same symptoms as CSF leak , but originates either congenitally or from trauma , including whiplash strain to the dura .

An alternate method of locating the site of a CSF leak is to use heavily T2 @-@ weighted MR myelography . This has been effective in identifying the sites of a CSF leak without the need for a CT scan , lumbar puncture , and contrast and at locating fluid collections such as CSF pooling . Another highly successful method of locating a CSF leak is intrathecal contrast and MR Myelography .

== = Assay == =

When cranial CSF leak is suspected because of discharge from the nose or ear that is potentially CSF , the fluid can be collected and tested with a beta @-@ 2 transferrin assay . This test can positively identify if the fluid is cerebrospinal fluid .

== = CSF analysis == =

Patients with CSF leak have been noted to have very low or even negative opening pressures . However , patients with confirmed CSF leaks may also demonstrate completely normal opening pressures . In 18 ? 46 % of cases , the CSF pressure is measured within the normal range .

Analysis of spinal fluid may demonstrate lymphocytic pleocytosis and elevated protein content or xanthochromia . This is hypothesized to be due to increased permeability of dilated meningeal blood vessels and a decrease of CSF flow in the lumbar subarachnoid space .

== Clinical presentation ==

The diagnostic criteria for SCSFLS is based on the 2004 International Classification of Headache Disorders , 2nd edn (ICHD @-@ II) (Table 1) (50) criteria . However , the presentation of patients with confirmed diagnosis may be very different from that of the clinical diagnostic criteria and cannot be considered authoritative .

== Treatment ==

Initial measures can include rest , caffeine intake (via coffee or intravenous infusion) , and hydration . Corticosteroids may provide transient relief for some patients . An abdominal binder ? a type of garment that increases intracranial pressure by compressing the abdomen ? can temporarily relieve symptoms for some people .

== Epidural blood patch ==

The treatment of choice for this condition is the surgical application of epidural blood patches , which has a higher success rate than conservative treatments of bed rest and hydration . Through the injection of a person 's own blood into the area of the hole in the dura , an epidural blood patch uses blood 's clotting factors to clot the sites of holes . The volume of autologous blood and number of patch attempts for patients is highly variable . One @-@ quarter to one @-@ third of SCSFLS patients do not have relief of symptoms from epidural blood patching .

== Fibrin glue sealant ==

If blood patches alone do not succeed in closing the dural tears , placement of percutaneous fibrin glue can be used in place of blood patching , raising the effectiveness of forming a clot and arresting CSF leakage .

== Surgical drain technique ==

In extreme cases of intractable CSF leak , a surgical lumbar drain has been used . This procedure is believed to decrease spinal CSF volume while increasing intracranial CSF pressure and volume . This procedure restores normal intracranial CSF volume and pressure while promoting the healing of dural tears by lowering the pressure and volume in the dura . This procedure has led to positive results leading to relief of symptoms for up to one year .

== Neurosurgical repair ==

For patients that do not respond to either epidural blood patching or fibrin glue , neurosurgery is available to directly repair leaking meningeal diverticula . The areas of dura leak can be tied together in a process called ligation and then a metal clip can be placed in order to hold the ligation closed . Alternatively , a small compress called a muscle pledget can be placed over the dura leak and then sealed with gel foam and fibrin glue . Primary suturing is rarely able to repair a CSF leak , and in some patients exploration of the dura may be required to properly locate all sites of CSF leak .

== Prognosis ==

Final outcomes for people with SCSFLS remain poorly studied . Symptoms may resolve in as little

as two weeks , or persist for months . Less commonly , patients may suffer from unremitting symptoms for many years . People with chronic SCSFLS may be disabled and unable to work . Recurrent CSF leak at an alternate site after recent repair is common .

= = = Complications = = =

Several complications can occur as a result of SCSFLS including decreased cranial pressure , brain herniation , infection , blood pressure problems , transient paralysis , and coma . The primary and most serious complication of SCSFLS is spontaneous intracranial hypotension , where pressure in the brain is severely decreased . This complication leads to the hallmark symptom of severe orthostatic headaches .

People with cranial CSF leaks , the rarer form , have a 10 % risk of developing meningitis per year . If cranial leaks last more than seven days , the chances of developing meningitis are significantly higher . Spinal CSF leaks cannot result in meningitis due to the sterile conditions of the leak site . When a CSF leak occurs at the temporal bone surgery becomes necessary in order to prevent infection and repair the leak . Orthostatic hypotension is another complication that occurs due to autonomic dysfunction when blood pressure drops significantly . The autonomic dysfunction is caused by compression of the brainstem , which controls breathing and circulation .

Low CSF volume can cause the cerebellar tonsil position to descend , which can be mistaken for Chiari malformation ; however when the CSF leak is repaired the tonsil position often returns to normal (as seen in upright MRI) in this " pseudo @-@ Chiari " condition . A further , albeit rare , complication of CSF leak is transient quadriplegia due to a sudden and significant loss of CSF . This loss results in hindbrain herniation and causes major compression of the upper cervical spinal cord . The quadriplegia dissipates once the patient lies supine . An extremely rare complication of SCSFLS is third nerve palsy , where the ability to move one 's eyes becomes difficult and interrupted due to compression of the third cranial nerve .

There are documented cases of reversible frontotemporal dementia and coma . Coma due to a CSF leak has been successfully treated by using blood patches and / or fibrin glue and placing the patient in the Trendelenburg position . Empty sella syndrome , a boney structure that surround the pituitary gland , occurs in CSF leak patients .

= = Epidemiology = =

A 1994 community @-@ based study indicated that two out of every 100 @,@ 000 people suffered from SCSFLS , while a 2004 emergency room @-@ based study indicated five per 100 @,@ 000 . SCSFLS generally affects the young and middle aged ; the average age for onset is 42 @.@ 3 years , but onset can range from ages 22 to 61 . In an 11 @-@ year study women were found to be twice as likely to be affected as men .

Studies have shown that SCSFLS runs in families and it is suspected that genetic similarity in families includes weakness in the dura mater , which leads to SCSFLS . Large scale population @-@ based studies have not yet been conducted . While a majority of SCSFLS cases continue to be undiagnosed or misdiagnosed , an actual increase in occurrence is unlikely .

= = History = =

Spontaneous CSF leaks have been described by notable physicians and reported in medical journals dating back to the early 1900s . German neurologist Georg Schaltenbrand reported in 1938 and 1953 what he termed " aliquorrhoea " , a condition marked by very low , unobtainable , or even negative CSF pressures . The symptoms included orthostatic headaches and other features that are now recognized as spontaneous intracranial hypotension . A few decades earlier , the same syndrome had been described in French literature as " hypotension of spinal fluid " and " ventricular collapse " . In 1940 , Henry Woltman of the Mayo Clinic wrote about " headaches associated with decreased intracranial pressure " . The full clinical manifestations of intracranial hypotension and

CSF leaks were described in several publications reported between the 1960s and early 1990s . Modern reports of spontaneous CSF leak have been reported to medical journals since the late 1980s .

= = Research = =

IV Cosyntropin , a corticosteroid that causes the brain to produce additional spinal fluid to replace the volume of the lost CSF and alleviate symptoms , has been used to treat CSF leaks .

In two small studies of two patients and another with one patient suffering from recurrent CSF leaks where repeated blood patches failed to form clots and relieve symptoms , the patients received temporary but complete resolution of symptoms with an epidural saline infusion . The saline infusion temporarily restores the volume necessary for a patient to avoid SIH until the leak can be repaired properly . Intrathecal saline infusion is used in urgent cases such as intractable pain or decreased consciousness .

The gene TGFBR2 has been implicated in several connective tissue disorders including Marfan syndrome , arterial tortuosity , and thoracic aortic aneurysm . A study of patients with SCSFLS demonstrated no mutations in this gene . Minor features of Marfan syndrome has been found in 20 % of CSF leak patients . Abnormal findings of fibrillin @-@ 1 has been documented in these CSF @-@ leak patients , but only one patient demonstrated a fibrillin @-@ 1 defect consistent with Marfan syndrome .