

2017 BASIC RECOGNIZING AND EVALUATING LOW PRESSURE HEADACHE SYNDROMES

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Headache is the most common symptom associated with changes of intracranial pressure—whether high or low. The pressure in the intracranial cavity is controlled by the contents (the brain, blood, cerebrospinal fluid, and ventricles) enclosed in a rigid structure, the skull. Any increase in one, be it a mass in the brain, increased blood volume, increased CSF or increased size in the ventricle will result in the rise of intracranial pressure. Headache is the most common symptom of a rise in pressure. Similarly, if the intracranial pressure falls or cerebrospinal fluid is reduced below a certain level, headache will be the result. Headache due to high or low intracranial pressure can complicate headache diagnosis. Treatment of the underlying condition (low or high pressure) results in better outcome. How can you learn to recognize these syndromes?

CASE DESCRIPTION: A 32 year old car salesman lifted weights every morning before work. One morning he developed a headache that improved with lying supine and worsened being upright. The headache progressed to be associated with nausea, vomiting, arm numbness, vertigo. A complete neurological examination was normal. MR imaging showed a “sagging hind brain”, meningeal enhancement with gadolinium. A lumbar puncture showed an unobtainable pressure. A search for a “leak” showed several dilated nerve sheaths in the lumbar region on MR, but no specific abnormality appeared. A radionuclide scan was normal. A blood patch brought relief for one day and the headache recurred. Three subsequent patches brought temporary relief, but the headaches recurred after 1-2 days in each case. Finally, a CT myelogram showed a leak at the T-5 area. A directed blood patch brought relief.

Definition of terms

Low pressure headaches are known as: spontaneous low pressure headache, low CSF volume headaches, hypotensive headache, orthostatic headache, CSF hypovolemia, CSF volume depletion, spontaneous CSF leaks, and intracranial hypotension. The ICHD-3 beta version as: Headache attributed to spontaneous intracranial hypotension headache.

Definition by ICHD: 7.2 Headache attributed to low cerebrospinal fluid pressure (see ICHD 3rd edition beta version Cephalgia 2013; 33(9): 629-808)

Description: an orthostatic headache associated with low CSF pressure (secondary or spontaneous) and usually seen with neck pain, tinnitus, changes in hearing, photophobia or nausea. This type of headache resolves when there is successful closure of the CSF leak.

Diagnostic criteria:

- A. Any headache fulfilling criterion C
- B. Low CSF pressure (<60 mm CSF) and/or evidence of CSF leakage on imaging
- C. Headache has developed in temporal relation to low CSF pressure or CSF leakage, or led to its discovery
- D. Not better accounted for by another diagnosis.

The comment made is this headache is “usually but not invariably orthostatic.” That is, the headache will worsen when sitting or standing and is improved after lying flat. There are two types of low cerebrospinal fluid headache: post-dural puncture (7.2.1) and Headache attributed to spontaneous intracranial hypotension (7.2.3).

The differential diagnosis of a low pressure headache (positional headache) includes: postural orthostatic tachycardia syndrome (POTS), post-coital headache, post Chiari malformation surgery, large dural sac, colloid cyst of the third ventricle.

Headache associated with low intracranial pressure has been known for many years. First, described first in 1938 and later in 1953 by Schaltenbrand as “aliquorrhoea”, spontaneous intracranial hypotension has since then been frequently recognized. Schaltenbrand’s observation that it is really a low fluid state and not necessarily a low pressure state has been echoed recently by Mokri (Mokri, 1999;1997). Schaltenbrand remarked that the symptoms of aliquorrhoea are the same as the syndrome of increased pressure: patients complain of severe headache, neck pain, nausea, buzzing in the ear, but the optic discs are not swollen, the headache is worse on standing and on lumbar puncture, the puncture is “dry”. Dr. Mokri recommends we use the term “**CSF hypovolemia**” instead of intracranial hypotension, although the latter term is widely used in publications and discussions.

Low pressure headache is a frequent accompaniment of lumbar puncture, but it can also occur spontaneously. “**Primary intracranial hypotension**” is used to denote the spontaneous form without an antecedent cause, whereas secondary intracranial hypotension is used to signify intracranial hypotension related to a known cause, like a lumbar puncture or intracranial shunt over drainage.

The most common cause of a low pressure headache is a **post-lumbar puncture headache**. Prevention of the headache after lumbar puncture includes using a small-gauge needle, using a round holed needle as opposed to a bevel edge, and luck.

Headache characteristics

The characteristic feature is that the headache is very severe while the patient is upright and virtually disappears in recumbence. The headache may be frontal or occipital, and neck pain is frequently present. The pain can be excruciating or mild. However, other symptoms also occur including neck stiffness, vertigo, nausea, hearing changes, facial numbness, changes in taste, and imbalance occur. Visual symptoms such as blurred vision, photophobia, visual field constriction, diplopia (from unilateral or bilateral 6th nerve palsy) have been reported. Headaches in general are made worse by coughing sneezing, straining and exertion. Headaches are frequently misdiagnosed as migraine, sinusitis, tension type headache.

Also, it is important to explore the risk factors for development of intracranial hypotension include: the presence of a shunt, lumbar puncture, head trauma, sports (water sports; weight lifting, golf), severe coughing from an upper respiratory infection (vigorous coughing), any minor trauma, chiropractor manipulation, motor vehicle accident, and even fishing (throwing forceful movements of casting) and yoga. The development of CSF leaks may also be more common in people with connective tissue problems such as Marfan’s syndrome or Ehlers-Danlos syndrome.

The neurological examination is frequently normal. A slow pulse rate (“vagus pulse”) can be present. However, if one suspects this type of headache, look carefully for downbeat nystagmus on lateral gaze or subtle phoria or tropia. On the general examination look for hyper flexibility (wrist, fingers, elbows, knees)

The imaging characteristics help make the diagnosis. MRI shows a sagging brain including cerebellar tonsillar herniation, optic nerve and chiasmal downward displacement, and striking meningeal enhancement. The diffuse meningeal enhancement seen on MRI, reported just over 10 years ago, has become one of the key diagnostic imaging features. Since meningeal enhancement alone, however, can be a sign of other conditions causing headache (meningitis, meningeal carcinomatosis, neurosarcoidosis, subarachnoid hemorrhage), look for the other findings. The other clear feature is the descent of the brain and brain stem, including: cerebellar tonsillar herniation, reduced size of the pre-pontine cistern, inferior descent of the optic chiasm, and descent of the iter (or the aqueduct opening). Ventricular size is on the smaller size in some and reverts to normal after normalization of pressure. Enlargement of the pituitary gland has also been shown. Engorgement of the venous plexus and spinal veins also occurs.

The spinal fluid pressure in this syndrome does not have to be invariably low. In Mokri’s series, less than half of his 26 patients had pressures of 40 mm or less with one-fourth of patients having 41-90, and another quarter having near normal pressures (70-130). So having a normal opening pressure does not rule out the diagnosis. This is why Mokri believes that the decrease in the amount of fluid is most important not the absolute pressure reading; what is low pressure for one person may be normal for another. Some have found that pressure doesn’t correlate at all with the imaging findings (Kranz et al)

The cerebrospinal fluid may show some lymphocytic pleocytosis with over one-half of his patients having more than 5 WBC; and over 20-40 in almost one half. CSF protein was also variably elevated over 70 mg/dl (Mokri). Mokri has divided spontaneous intracranial hypotension into 4 syndromes:

- 1) Classic form: Headache, with diffuse pachymeningeal gadolinium enhancement, and variable degrees of the following: sagging brain, subdural fluid collection, and low CSF pressure.
- 2) Normal pressure form: Headache, diffuse pachymeningeal enhancement, and variable sagging brain or subdural fluid collection, and normal CSF pressure.
- 3) Normal meninges form: Headache, with sagging brain, low or normal CSF pressure, absent meningeal enhancement on MR.
- 4) Acephalgic form: low CSF pressure, meningeal enhancement, absent headache.

Diagnosis of the site of leak is sometimes easy, but more often can be a challenge. Spinal MR is probably most often used initially to see the site of the CSF leak, looking for meningeal diverticula or Tarlov cysts. Interestingly, the site of the leak in patients with spontaneous leaks is most frequently in the thoracic, then lumbar, cervical region. Radionuclide cisternography may also be helpful. This diagnostic procedure is used in several ways. One is to diagnose that a leak is present. Here radioisotope cisternography show decreased activity over the brain, and early detection of the isotope in the urinary bladder. In addition pledgets may be used in the nose to detect a cribiform plate leak. Furthermore, cisternography can also be used to show where a leak is occurring when imaging is made of the cervical, thoracic and lumbar spine.

CT myelography/MR myelography appears to be the most sensitive test to detect the leaking site in difficult cases. In some institutions, CT myelography has been the procedure of choice in difficult to find CSF leaks. The difficulty with this procedure is that it requires myelography, and CT imaging from the base of the skull down to the lumbar sacral regions. Sometimes even this procedure can be difficult to interpret such as when the fluid is leaking within a "gutter of the epidural space. MR gadolinium myelography has also been used. In addition, recently surgeons from Bern reported microscopic vertical rents in the dura caused by microspurs from the intervertebral disc (Beck et al 2016)

Schievink has described basically 3 types of leaks that can be detected: the meningeal/ dural tear, usually anterior but can be posterior (this is the one we all look for in our myelography) in about 25%; the meningeal diverticulum (Tarlov cysts (40%) and complicated dural sac cysts (about 4%) that may not leak but harbor enough CSF to cause headache and symptoms), and the CSF venous fistula (2.5%). Schievink 2016)

Treatment of intracranial hypotension headache is usually closure of the leaking site. The most common treatment is epidural blood patches. Sometimes blind lumbar blood patches are successful; however, directed blood patch to the leaking site is most successful. More than one blood patch is common. Some have recommended that localization of the spinal leak is not necessary unless a patient fails two large volume (20-30 mL) blood patches in the lumbar area followed by 10 minutes of 30 degree lowering of the head. (Dillon) Unsuccessful blood patches occur in leaks that are too large, tears that are far lateral along nerve root sleeves, or leaks that cause "pseudocyst formation" which are walled off from the epidural space and do not allow for successful blood patching.

Epidural saline infusions have been used too, usually requiring hospitalization. Complications for its use are risk of infection from an indwelling catheter and pneumocephalus.

Surgical treatment of meningeal diverticula (Tarlov cyst) is also possible. This involves ligation of diverticula and epidural (blood, muscle, fibrin glue) packing of the involved site.

Medical treatment is occasionally successful including IV fluids, corticosteroids, fluid and ephedrine (Mokri). Simple fluid hydration in post-lumbar puncture headache along with bed rest has been known for years. Other treatments include caffeine sodium benzoate, corticosteroids, abdominal binder, continuous saline infusion have been used successfully for some, especially post lumbar-puncture headache. Other more theoretical and unproven agents which increase CSF production include: cholinergic agonists (carbachol, prostigmine), sympathetic agonists (albuteral), phosphodiesterase inhibitors (theobromine, caffeine, theophylline) or promote CSF secretion include: caffeine sodium benzoate.(Absher)

Pathophysiology of the “low pressure” headache

The cause of the headache is interesting. First, it is known that it is the decrease in the CSF volume that seems most important, not the absolute pressure. Kunkle et al showed that headache occurred when 10% of the estimated volume of CSF was removed. Further, the pain is thought to be due to the actual descent of the brain causing stretching of cerebral veins causing traction and pain.

Complications of intracranial hypotension include subdural hematoma, actually recognized as early as Schaltenbrand, occur because of the traction on the cerebral veins which tend to engorge because of the lack of CSF. The incidence of this complication is unknown. Furthermore, stupor associated with a central herniation syndrome can also occur.

When do you suspect a headache is due to intracranial hypotension? Headaches with a positional component to them, or headaches associated with neck pain that increase with cough and improve with recumbence should raise a suspicion of a low pressure headache. Proceed with evaluation of the headache with a MR looking for characteristic findings including the dural meningeal enhancement with gadolinium, the sagging brain. Treatment of the headache is treatment of the cause of the low CSF pressure. When dural blood patch fails consider CT myelogram and localization of the leak.

Pressure whether high or low can cause headaches. Although not difficult to diagnose in their typical forms, high or low pressure headaches can be confusing and challenging in terms of headache management. Knowing the clinical features, radiological features can greatly add to our diagnostic ability. Treating the underlying abnormality most often brings the patient more relief. Therefore, all physicians who take care of patients with headaches should be able to recognize these “pressure headache” types.

References

- Absher JR. Spontaneous cerebrospinal fluid drainage headache. *The Neurologist* 1996; 2: 219-229.
- Ahn JS, Akincioglu C, Gulka I, Coome G. Spontaneous low cerebrospinal fluid pressure headache: an emergency medicine perspective. *CJEM*. 2013 Jan;15(1):53-8.
- Aldrets JA. Persistent post-dural puncture headache treated with epidural infusion of dextrin. *Headache* 1994; 34: 265-267.
- Beck J, Ulrich CT, Fung C, Fichtner J, Seidel K, Fiechter M, Hsieh K, Murek M, Bervini D, Meier N, Mono ML, Mordasini P, Hewer E, Z'Graggen WJ, Gralla J, Raabe A. Diskogenic microspurs as a major cause of intractable spontaneous intracranial hypotension. *Neurology*. 2016 Sep 20;87(12):1220-6.
- Capizzano AA, Lai L, Kim J, Rizzo M, Gray L, Smoot MK, Moritani T. Atypical Presentations of Intracranial Hypotension: Comparison with Classic Spontaneous Intracranial Hypotension. *AJNR Am J Neuroradiol*. 2016 Jul;37(7):1256-61.
- Chung SJ, Kim JS, Lee MC. Syndrome of cerebral spinal fluid hypovolemia. Clinical and imaging feature and outcome. *Neurology* 2000; 55: 1321-1327.
- Dillon WP, Fishman RA. Some lessons learned about the diagnosis and treatment of spontaneous intracranial hypotension. *AJNR* 1998; 19: 1001-1002.
- Ford CD, Ford DC, Koenigsberg MD. A simple treatment of post-lumbar-puncture headache. *J Emerg Med* 1989; 7: 29-31.
- Gibson BE, Wedel DJ, Faust RJ, Petersen RC. Continuous epidural saline infusion for the treatment of low CSF pressure headache. *Anesthesiology* 1988; 68: 789-791.
- Horton JC, Fishman RA. Neurovisual findings in the syndrome of spontaneous intracranial hypotension from dural cerebrospinal fluid leak. *Ophthalmology* 1994; 101: 244-251.
- Kranz PG, Amrhein TJ, Schievink WI, Karikari IO, Gray L. The "Hyperdense Paraspinal Vein" Sign: A Marker of CSF-Venous Fistula. *AJNR Am J Neuroradiol*. 2016 Jul;37(7):1379-81.
- Kranz PG, Tanpitukpongse TP, Choudhury KR, Amrhein TJ, Gray L. Imaging Signs in Spontaneous Intracranial Hypotension: Prevalence and Relationship to CSF Pressure. *AJNR Am J Neuroradiol*. 2016 Jul;37(7):1374-8.
- Kunkle, EC, Ray BS, Wolff HG. Experimental studies on headache: analysis of the headache associated with changes in intracranial pressure. *Arch Neurol Psych* 1943; 49: 323-358.
- Marcellis J, Silberstein SD. Spontaneous low cerebrospinal fluid pressure headache. *Headache* 1990; 30: 192-196.

- Mokri B. Spontaneous cerebrospinal fluid leaks: from intracranial hypotension to cerebrospinal fluid hypovolemia—evolution of a concept. *Mayo Clin Proc* 1999; 74: 1113-1123.
- Mokri B, Piepgras DG, Miller GM. Syndrome of orthostatic headaches and diffuse pachymeningeal gadolinium enhancement. *May Clin Proc* 1997; 72: 400-413.
- Mokri B, Krueger BR, Miller GM, Piepgras DG. Meningeal gadolinium enhancement in low pressure headaches (abstract). *Ann Neurol* 1991; 30: 294-295.
- Mokri B. Spontaneous Intracranial Hypotension. *Continuum (Minneap Minn)*. 2015 Aug;21(4 Headache):1086-108.
- Mokri B. Spontaneous low pressure, low CSF volume headaches: spontaneous CSF leaks. *Headache*. 2013 Jul-Aug;53(7):1034-53.
- Pattichis AA, Slee M. CSF hypotension: A review of its manifestations, investigation and management. *J Clin Neurosci*. 2016 Aug 4. pii: S0967-5868(16)30434-9.
- Pleasure SJ, Abosch A, Friedman J, Ko NU, Barbaro N, Dillon W, Fishman RA, Poncelet An. Spontaneous intracranial hypotension resulting in stupor caused by diencephalic compression. *Neurology* 1998; 50: 1854-1857.
- Sable SG, Ramadan NM. Meningeal enhancement and low CSF pressure headache: an MRI study. *Cephalalgia* 1991; 11: 275-276.
- Spears RC. Low-pressure/spinal fluid leak headache. *Curr Pain Headache Rep*. 2014 Jun;18(6):425.
- Rando TA, Fishman RA. Spontaneous intracranial hypotension: report of two cases and review of the literature. *Neurology* 1992; 42: 481-487.
- Schaltenbrand G. Normal and pathological physiology of the cerebrospinal fluid circulation. *Lancet* 1953; 1:805-808.
- Schievink WI, Deline CR. Headache secondary to intracranial hypotension. *Curr Pain Headache Rep*. 2014 Nov;18(11):457.
- Schievink WI, Moser FG, Maya MM. CSF-venous fistula in spontaneous intracranial hypotension. *Neurology*. 2014 Jul 29;83(5):472-3.
- Schievink WI, Maya MM, Jean-Pierre S, Nuño M, Prasad RS, Moser FG. A classification system of spontaneous spinal CSF leaks. *Neurology*. 2016 Aug 16;87(7):673-9.
- Tanaka Y, Tosaka M, Fujimaki H, Honda F, Yoshimoto Y. Sex- and Age-Related Differences in the Clinical and Neuroimaging Characteristics of Patients With Spontaneous Intracranial Hypotension: A Records Review. *Headache*. 2016 Sep;56(8):1310-6.
- Tyagi A. Management of spontaneous intracranial hypotension. *Pract Neurol*. 2016 Apr;16(2):87-8..