

Key Points

1. As it has become clear that the size of tonsillar herniation is not a good indicator of symptomatic Chiari, the use of CSF flow analysis has increased
2. However, some doctors question its usefulness clinically
3. Study assessed whether MRIs could be read for abnormal CSF flow to differentiate between symptomatic and asymptomatic patients with tonsillar herniation
4. Four readers reviewed CSF flow studies of 17 patients who had been evaluated by an experienced neurosurgeon and classified as symptomatic or asymptomatic.
5. Readers used their own criteria to determine abnormal CSF flow
6. Out of 68 total flow studies, 41 were classified as abnormal. However within that group, 27 were classified as symptomatic by the surgeon and 14 as asymptomatic.
7. The sensitivity and specificity of reading the CSF flow studies shows that at this time they can not be used by themselves to identify symptomatic Chiari

Definitions

asymptomatic - not having any symptoms

occipital - referring to the back of the head

sagittal - when referring to an MRI image, a view which splits the body into right and left halves

sensitivity - the ability of a diagnostic test to find a disease when it is actually present

specificity - the ability of a test to exclude a disease when it is not really present

tonsillar ectopia - refers to the

How Useful Is Measuring CSF Flow?

November 30, 2007 -- By now it is clear that the utility of a standard MRI to diagnose symptomatic Chiari is limited. This is because research has shown that a significant percentage of people with tonsillar herniations, even larger than 5mm, do not have Chiari related symptoms. On the flip side, some people with minimal herniations have severe, Chiari like symptoms.

Because of this, the use of phase-contrast MRI to look at the flow of cerebrospinal fluid (CSF) around the cerebellar tonsils has grown in popularity. In the research realm, scientists are working on methods to characterize and quantify CSF flow to aid in Chiari diagnosis. However in doctors' offices flow is examined visually and qualitatively, with no established, uniform criteria for how to interpret the images. Although more and more surgeons are performing flow studies, their usefulness and effectiveness have not been rigorously studied, and some surgeons question their value.

Now, a study out of the University of Wisconsin (Hofkes et al.), and published in the November, 2007 issue of the journal Radiology has shown that CSF flow studies, at least clinically, may provide only part of the solution to diagnosing symptomatic Chiari. Diagnostic tests are generally assessed by their ability to identify the disease in question when it actually exists (sensitivity) and their ability to rule out the disease in question when it is not actually present (specificity). When a test returns a positive result for a disease which is not actually there, it is called a false positive; when it returns a negative result for a disease which is actually there, it is called a false negative. The goal of any diagnostic test is to minimize the number of false positives and negatives and thereby maximize the test's sensitivity and specificity.

The Wisconsin study used medical records to evaluate the ability of CSF flow, as read by radiologists, to differentiate between symptomatic Chiari patients and patients with tonsillar herniation but no symptoms. Specifically, the study included 17 patients, both adults and children, who had been evaluated by an established neurosurgeon for Chiari, because standard MRI had revealed herniations of 5mm or more. Before the CSF flow studies were performed, the neurosurgeon classified each patient as symptomatic or asymptomatic based upon symptoms and a neurological exam. Symptomatic patients exhibited symptoms and signs, such as Valsalva headache, neck pain, nystagmus, etc., consistent with known Chiari symptoms. Any patient who at a later time underwent decompression surgery was also classified as symptomatic.

To assess the diagnostic value of CSF flow, four independent readers retrospectively evaluated the flow studies. It is important to note that they were not given specific criteria to classify abnormal flow, but rather were asked to use their own judgment in determining if the flow was abnormal and likely to contribute to Chiari symptoms. It is also important to note that the readers were not aware of how the patients were classified by the surgeon when they evaluated the MRI tests. Scientifically, this is known as blinding and ensures the readers aren't biased in any way.

Since there were four readers and 17 patients, there were a total of 68 interpretations of CSF flow. Out of these 68 test results, 41 were classified as being abnormal and indicative of Chiari symptoms. However, as classified by the neurosurgeon, only 27 of the flow studies were from symptomatic patients; the remaining 14 studies were actually from asymptomatic patients. This means that in identifying symptomatic patients, the CSF flow analysis matched the surgeon's evaluation 66% of the time.

Similarly, there were a total of 27 results which were classified by the readers as normal and likely to be asymptomatic. In this group, the neurosurgeon had classified 18 as asymptomatic and 9 as symptomatic. This means that in ruling out Chiari, the CSF flow analysis matched the surgeon's evaluation 67% of the time.

To determine the overall sensitivity and specificity of the CSF flow analysis, the individual sensitivity and specificity for each reader was calculated and then averaged together. Overall, the sensitivity of the readers was as high as 75% (for a specific view), meaning that they could correctly identify a symptomatic Chiari patient 3 out of 4 times (see Table 1). However, the specificity for that same view was only 56%, meaning that the readers generated a false positive in almost 1 out of every 2 people.

The authors of this study acknowledge that it is limited by the small number of patients used and by the fact that no specific criteria was established for evaluating the flow studies. However, that is similar to the real world where different doctors are likely to interpret CSF flow based on their own experience and not on a scientifically established standard.

The results of this study indicate that in its current state, while CSF flow may be a useful piece of information, by itself it is not accurate enough to consistently differentiate between people with symptomatic Chiari and asymptomatic tonsillar herniation. However, continued research into quantitative CSF analysis and

cerebellar tonsils extending below, and out of, the skull into the spinal area

tonsillar herniation - refers to the cerebellar tonsils extending below, and out of, the skull into the spinal area

transverse - refers to an MRI view which cuts across the body

Valsalva - straining

cerebellar tonsils - portion of the cerebellum located at the bottom, so named because of their shape

cerebrospinal fluid (CSF) - clear liquid in the brain and spinal cord, acts as a shock absorber

Chiari malformation I - condition where the cerebellar tonsils are displaced out of the skull area into the spinal area, causing compression of brain tissue and disruption of CSF flow

Source

Source: Hofkes SK, Iskandar BJ, Turski PA, Gentry LR, McCue JB, Haughton VM. [Differentiation between symptomatic Chiari I malformation and asymptomatic tonsillar ectopia by using cerebrospinal fluid flow imaging: initial estimate of imaging accuracy.](#) Radiology. 2007 Nov;245(2):532-40. Epub 2007 Sep 21

characterizing flow patterns may in time improve the accuracy, and usefulness, of this test.

Table 1
Sensitivity and Specificity of Qualitative CSF Analysis

	Sensitivity	Specificity
Sagittal View	75%	56%
Transverse View	72%	68%

Note: Criteria for identifying abnormal CSF flow was not determined in advance; each reader used their own criteria

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