Key Points

1. Cine MRI is commonly used to visualize CSF flow across the foramen magnum
2. Study used a different imaging technique to examine CSF flow in 17 CM/CM patients over a 24 hour period
3. Radioactive substance was injected into the CSF and then images taken periodically
4. Identified three different types of flow, rapid, delayed, and blocked
5. Also rated patients before and after surgery using a modified disability scale
6. The blocked flow group experienced the most improvement, based on the scores, after surgery
7. This type of imaging is not practical for everyday use

Definitions

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

cerebellum - part of the brain located at the bottom of the skull, near the opening to the spinal area; important for muscle control, movement, and balance

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

Chiari malformation - 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

cine MRI - type of MRI which can show the flow of CSF

cranial nerve - one of 12 pairs of nerves that originate in the brain as opposed to the spinal cord

craniectomy - surgical technique where part of the skull is removed

cranium - the skull

Studying CSF Flow To Predict Surgical Outcome

There is little doubt that the MRI, and its cousin the cine MRI, are the imaging tools of choice in diagnosing Chiari and syringomyelia. However, a group of researchers from the Sanjay Gandhi Postgraduate Institute of Medical Sciences in India, led by Dr. Arora, recently used a different technique to closely examine patterns of cerebrospinal fluid flow in a group of patients with Chiari and syringomyelia. They published their findings in the February, 2004 issue of the journal Acta Neurochirurgica.

Radionuclide cisternography involves injecting a tracer agent into the CSF system. As the tracer agent disperses, images taken at different times clearly show the where the tracer is, and thus reveal how the CSF is flowing. The research team used just such a technique on 17 patients they treated between 2000 - 2002.

The patient group included 13 men and 4 women with an average age 26. Each person had both a demonstrable Chiari and syrinx, and had endured their symptoms for between 2 months and 15 years. In addition to the radionuclide cisternography, each person also underwent standard X-rays and MRI's. As a group, the patients exhibited signs of pain, motor weakness, sensory disturbances, cranial nerve compression, cerebellar compression, and other symptoms typical of CM/SM (see Table 1).

Prior to treatment, each person was given a disability score using a modified scoring system. The researchers began with a system developed to measure disability due to spinal disease and added components specific to Chiari and SM. The final system had 8 categories: sensory, paresis, gait, urinary/bowel, muscle control in the arms/legs, neck pain, respiratory problems, and cranial nerve signs. The first four categories were scored 1-5, with a 5 representing no disability, and a 1 representing total disability. The latter categories were scored similarly, but with a range of 1-3. When combined, the total possible score, which represented no disability, was 32.

Also before surgery, each patient underwent the radionuclide cisternography. The tracer was injected into the lumbar region and an image was taken immediately after. Follow-up images were taken 1, 2, 4, 6, and 24 hours after the injection.

From these images, the researchers identified three categories of CSF flow, which they termed: rapid, delayed, and blocked. In the rapid group, which consisted of 7 patients, the tracer element quickly moved up the spinal cord and crossed the foramen magnum into the brain region in less than an hour. Here it quickly dispersed as it would in a healthy person.

In the delayed group, which also consisted of 7 patients, the tracer crossed the foramen magnum in the usual amount of time, but then it was delayed and took nearly 24 hours to disperse throughout the brain area. Finally, in the blocked group, which consisted of 3 patients, the tracer never crossed the foramen magnum, indicating that the CSF flow was completely blocked by the Chiari malformation.

All the patients underwent decompression surgery and then were reevaluated at follow-up (3 months to 1 year after surgery) using the disability scoring system. In addition, 10 patients underwent the radionuclide cisternography for a second time and 11 patients underwent a standard MRI.

Before the surgery, the patients in the rapid flow group had the highest average score on the disability scale (27 out of 32), meaning they were the least affected by the CM/SM (see Table 2). Both the delayed and blocked group of patients had lower scores, with the blocked group suffering the most (20 out of 32).

After surgery, the groups scored at about the same level, however the improvement in the blocked group was dramatically higher than the delayed and the rapid group. In fact, the patients in the rapid group only improved on average by 0.7 from before surgery, compared to an average increase of 8.3 in the blocked group.

The follow-up radionuclide cisternography showed that all 10 patients who took the test demonstrated normal CSF flow (they would be categorized as rapid). In addition, the MRI's showed that the syrinxes collapsed in 4 of the patients. It is also interesting to note that, as many previous studies have found, the amount of tonsillar herniation did not relate to either the type of CSF flow or the disability score before or after surgery.

In comments published in the same journal, Dr. Klekamp, a widely recognized syringomyelia expert, points out that this study highlights that patients with CM/SM are not all the same and that this imaging technique identified three distinct types of flow. He also points out, however, that he would not classify the rapid group as having normal flow, since the Chiari malformation essentially guarantees an abnormal flow.

While the radionuclide cisternography is a useful research technique, it is probably not practical for clinical

decompression surgery - general term used for any of several surgical techniques employed to create more space around a Chiari malformation and to relieve compression

dura - tough, outer covering of the brain and spinal cord

duraplasty - surgical technique where the dura is opened and expanded by sewing a patch into it

foramen magnum - large opening at the base of the skull, through which the spinal cord passes and joins with the brain

gait - the act of walking

laminectomy - surgical technique where part of a vertebra is removed

lumbar - lower part of the spine

magnetic resonance imaging (MRI) - diagnostic device which uses a strong magnetic field to create images of the body's internal parts

radionuclide cisternography - imaging technique where a radioactive tracer is injected into the CSF system; time-lapse images can then show how the CSF flows

spinal cord - thick cord of nerve tissue which extends from the brain down through the spinal column, and from which nerves branch off to different parts of the body

syringomyelia (SM) - neurological condition where a fluid filled cyst forms in the spinal cord

syrinx - fluid filled cyst in the spinal cord

tonsillar herniation - descent of the cerebellar tonsils into the spinal area; often measure in mm

tracer - a substance, often radioactive, which is injected into a system so that images can be taken which reveal a process in that system

Source

Source: Arora P, Pradhan PK, Behari S, Banerji D, Das BK, Chhabra DK, Jain VK. Chiari I malformation related syringomyelia: radionuclide cisternography as a predictor of

purposes given its invasiveness. The MRI - both static and cine - will likely remain the imaging workhorse in the world of Chiari for the foreseeable future. Still, it is interesting that this study revealed a group of people for whom the surgery did not significantly improve things, and the patients in the group were the ones who were the best off before surgery.

Table 1
Clinical Signs & Symptoms Before Surgery

Category	# of Patients Total = 17
Pain	13
Motor Problems	17
Sensory Problems	13
Brain Stem, Cranial Nerve	5
Cerebellar	7
Autonomic	6
Neck Movement	7

Table 2
Average Disability Score By CSF Flow Category, Pre and Post Surgery

Flow Group	# of Patients	PreOp Disability Score	PostOp Disability Score
Rapid	7	27.0	27.7
Delay	7	23.1	27.3
Block	3	20.3	28.6

Note: *Disability score based on a modified Klekamp scale; maximum score=32 which represents no disability*

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outcome. Acta Neurochir (Wien).
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