Normal Pressure Hydrocephalus: Another Treatable 'Dementia'

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Introduction

Normal pressure hydrocephalus (NPH) is mostly encountered in the elderly. A buildup of cerebrospinal fluid within the ventricles leads to their enlargement. This buildup of fluid causes a variety of clinical symptoms, including gait disturbance, urinary incontinence, and dementia-like symptoms. Because NPH is treatable, it is the one cause of "dementia" that is considered reversible. However, since it is still largely under and/or misdiagnosed, a significant number of patients — who otherwise would have been able to maintain a functional lifestyle — end up in nursing homes.

Some studies suggest that up to 6 percent of nursing home residents may have NPH. Clinicians often misdiagnosis the condition due to a number of factors, which include failing to entertain NPH as a diagnosis even when faced with a typical patient, or looking for the typical patient before entertaining NPH as a diagnosis. However, it is crucial to keep this diagnosis in mind and realize that NPH can exist in patients who have only some of the clinical and/or radiological findings. These patients will respond to shunting and should not be denied that option prematurely before a thorough evaluation is performed.

Historical Notes

In 1965, in a series of two papers, Adams and Hakim described a small series of patients with various neurologic symptoms, ventricular enlargement, and "normal" CSF pressures on lumbar punctures. These patients' symptoms improved with shunting. Adams and Hakim called this syndrome normal pressure hydrocephalus to describe a syndrome of progressive dementia and unsteady gait, with dilatation of the ventricular system and CSF pressures below 200 mm. Since then, the syndrome has gained wide recognition and is considered to be an important differential for dementia in the elderly.

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Physiopathology

Most cases of NPH are idiopathic, but others are secondary to an insult to the central nervous system (CNS), resulting in scarring of the subarachnoid spaces and/or the arachnoid villi. This scarring leads to an extraventricular blockage of CSF circulation and/or altered CSF absorption and explains the increased resistance to CSF absorption that is regularly found in cases of NPH. With aging, the brain tissue loses its stiffness and becomes more compliant. As the CSF outflow is reduced, the ventricles will enlarge. The pressure will rise, but to a mild degree. Because of the high compliance of the aging brain, the pressure will stay within the normal range. Although the pressure is considered normal, it is higher than what should be expected in the affected age group of the patient population.

Etiology

Most cases of NPH are idiopathic and no particular etiology can be found. However, it is believed that these cases are secondary to aging of the arachnoid granulations, a process that results in decreased CSF absorption. Minor insults may have gone unnoticed by the patient and accelerated the process by causing inflammation and scarring of the subarachnoid spaces and villi. Etiologies that cause NPH include trauma, subarachnoid hemorrhage, infection, and previous neurosurgical intervention.

Clinical Findings

Gait changes: The gait abnormality is the most common and earliest finding in this syndrome. In patients with NPH, the gait is described as broad-based, slow, and shuffling. The steps are short, the base is widened, and the patient has difficulty raising his or her legs. The gait is sometimes described as magnetic, and the patient also may experience difficulty turning. An alteration of the patient's ability to move smoothly, rather than weakness or true imbalance, is representative of the gait disorder. Occasionally called gait apraxia, the patient often moves as if he or she has forgotten how to walk. An excess of activity in the antigravity muscles is present in NPH and may be the reason that the smooth progression of gait is prevented. There is some similarity between the NPH gait and the Parkinsonian gait, including short stride, slow gait, and difficulty turning. However, there is no cogwheel rigidity, no resting tremor, no drooling, and no response to levodopa in NPH as there is in Parkinson's. In cerebellar ataxia, dysarthria, gaze-evoked nystagmus, and appendicular dysmetria a lso may be present. The presence of gait alteration in NPH is the most significant positive clinical prognosticator.

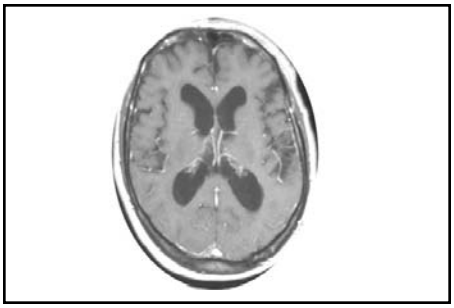

Figure 1. A 78-year-old man with severe magnetic gait and labeled as having Parkinson's Disease. The patient eventually became wheelchair bound. The MRI is read as showing hydrocephalus. The patient was shunted and was walking independently three weeks later.

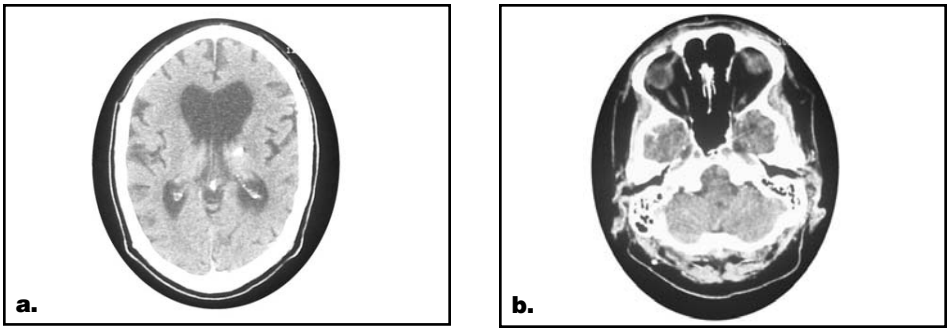

Figure 2. An 80-year-old man with severe gait disturbance, urinary incontinence, and mental status slowing. Patient was seen by numerous specialists and underwent multiple spinal taps without any clinical improvement. Imaging showed enlarged lateral ventricles (2a) and a small IVth ventricle (2b). He was shunted and improved dramatically. Most likely he had acqueductal stenosis, so he did not improve with the spinal taps, although he did have hydrocephalus.

Cognitive deficits: NPH is most commonly characterized by short-term memory alteration. A slowing of mentation and a decreased ability to concentrate are encountered. A variable degree of abulia is manifested by loss of spontaneity and initiative, which have been termed the abulic traits. These can progress to severe abulia. In some cases, agitation, delusions, and hallucinations may be present. In formal mental-status testing, nonverbal performance is more severely affected than verbal performance. True aphasia is not seen. Behavioral disturbances like agitation and depression-like symptoms may be encountered.

Cognitive deficits are the least likely to recover after shunting, especially when such deficits have been severe or prolonged. The differential diagnosis includes Alzheimer's disease, where the magnetic gait is not present. Another differential diagnosis in this age group is vascular dementia, where extensive ischemic changes are seen on MRI. However, there is an association between NPH and cerebrovascular ischemic disease. The latter makes patients more predisposed to NPH.

Urinary disturbances: Urinary disturbances may range from urinary frequency to urgency and, in advanced cases, incontinence. The incontinence may resemble that of frontal syndromes in which the patient may lack the ability to realize the need to urinate. The slow gait also may contribute to incontinence by preventing the patient with urinary urgency from reaching the toilet in time. However, fecal incontinence is rare. It is present in only half the patients and is non-specific, with only a 33 percent predictive value for improvement. The differential diagnosis in this age group includes a variety of disorders, including benign prostatic hypertrophy, pelvic relaxation, and cystitis.

Differential Diagnosis

As previously discussed, the differential diagnosis of NPH includes a variety of diseases leading to senile dementia including Alzheimer's disease, Parkinson's disease, multi-infarct dementia, and depression.

Diagnostic Testing: Imaging Studies

The main challenge faced by radiologists is that NPH occurs in the elderly, and in this patient population, brain atrophy leads to ventricular enlargement (ex-vacuo), without NPH being present. Therefore, radiologists have been trying to determine features on neuroimaging modalities to diagnose NPH.

CT and MRI scans: On CT scan, these features include enlarged temporal horns, enlarged ventricles out of proportion to sulcal enlargement and brain atrophy, and an increased Evans' ratio, which is the ratio of the frontal horns distance to the width of skull measured from the inner calvarial table. On MRI, other features that are sought include transependymal resorption; lack of hippocampal atrophy, which is more specific of Alzheimer's disease; increased CSF flow through the sylvian acqueduct, along with turbulence of CSF flow through the intracerebral channels; and foramina.

However, there has been no single imaging criterion on CT or MRI that has been found to be very reliable in making the diagnosis of NPH. Most of the patients with NPH that we encounter in our practice have CT or MRI reports that state they have "ventricular enlargement within the normal range for that age group."

Cisternogram: Cisternogram is one of the most traditional tests used for diagnosing NPG. It is based on the results of early and more persistent ventricular reflux of radionuclide injected in the lumbar subarachnoid space via a spinal tap. Because of increased resistance to CSF absorption through the arachnoid granulations, the dye is not as readily absorbed at the convexity as in the normal population or the population with cerebral atrophy. Therefore, the dye will reflux early into the ventricular system, where it clears slowly. Although, initially, there was major enthusiasm for this technique, it is far from being an accurate tool to make this diagnosis.

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Normal Pressure Hydrocephalus: Another Treatable 'Dementia' *continued*

Diagnostic Testing: Therapeutic Trials (CSF Diversion)

It is believed that a therapeutic trial of CSF diversion will accurately predict response to shunting and the presence of NPH. Two procedures are generally used: lumbar puncture (LP) and continuous lumbar drainage.

The LP is performed on an outpatient basis, and the patient is seen one to two weeks later. Depending on the duration of follow-up, the family of the patient will often report that the symptoms improved, usually the following day, and then worsened one to two weeks later although not to the same degree as before the LP was performed. We have found that the volume of the tap is not as critical: the CNS will secrete the 20-30cc drained via the LP within an hour. On the other hand, the puncture site in the dura will allow the CSF to leak in the epidural space for a few days. We try to widen this opening and ask our patients to maintain their usual activities after the LP, rather than put them on bed rest for a few hours. The latter is routinely requested in LP's performed for other purposes to avoid post-LP headaches.

For continuous lumbar drainage, the patient is admitted to the hospital. A lumbar drain is inserted and CSF is drained over a period of two to three days. The patient is assessed before the drain is placed. After the drainage period is over, the patient is assessed again for evidence of improved clinical findings.

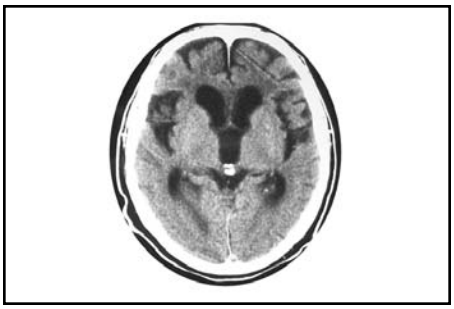

Figure 3. A 78-year-old man with the typical triad. CT was done and was read as " moderate generalized enlargement of the ventricles … mild cortical atrophy … the findings are felt to represent atrophy ..." The patient improved dramatically with CSF drainage.

CSF drainage was found to be 95 percent accurate in predicting response to shunting. However, these tests may miss some patients who have long-standing hydrocephalus or acqueductal stenosis. For this reason, some experts argue that the ultimate therapeutic trial is shunting. Unfortunately, shunting is not an innocuous procedure, and the risk-benefit ratio must be addressed.

Diagnosis

In some cases, the diagnosis of NPH is straightforward, but in others it is more subtle and a heightened index of suspicion is required to refer atypical patients for a neurosurgical evaluation in order to make a more definitive diagnosis. One of the most common problems is that clinicians look for the typical clinical triad and for a radiologic report indicating the presence of hydrocephalus before investigating it further. In my experience, as well as in that of others, I have found numerous patients in which one clinical finding of the triad may predominate or be the only one present; other patients who have a true ventriculomegaly that is missed by the radiologist or read as normal for the age group; and some patients in whom the ventricles are not massively enlarged. Because NPH is one of the few reversible causes of dementia, and because of the major financial and social implications of dementia, it is extremely rewarding to the clinician to diagnose these occasionally challenging patients and restore quality to the remainder of their life expectancy.

In our practice, when we are presented with typical clinical findings, we recommend shunting. When the symptoms are not as typical, then we recommend a therapeutic LP. If the patient improves clinically, than a shunt is placed.

Treatment Options

Medication: Acetazolamide has been found to be effective in treating these patients by reducing CSF secretion. However, I have not been impressed by the results.

Intermittent lumbar punctures: This option is occasionally useful; however, it requires frequent spinal taps, and most often, patients who initially opt for intermittent lumbar punctures end up requesting shunting.

Surgery: CSF diversion via shunting: Lumbar peritoneal/ventriculoperitoneal/ventriculoatrial shunting. Shunting is the most direct and efficacious therapeutic modality of this disease. Unfortunately, it is not without potentially serious morbidity. While there is some morbidity from the actual procedure, the main risk is that of delayed complications, including infection,

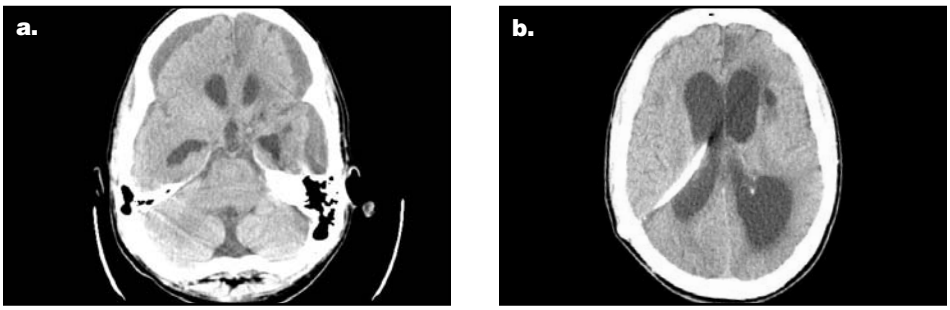

Figure 4a & 4b. An 18-year-old boy injured in a skiing accident developed posttraumatic hydrocephalus. Postshunting he developed subdural collections (4a). The valve setting was increased and the collections resolved spontaneously two weeks later (4b).

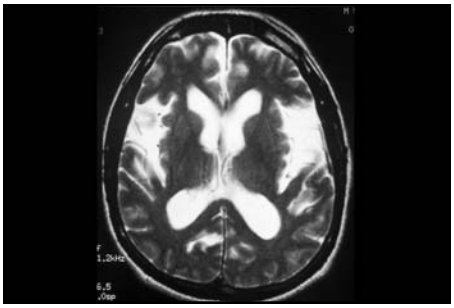

Figure 5. A 50-year-old executive with an extremely intellectually demanding job. He experienced dizziness, foggy thinking, and gait unsteadiness. MRI revealed enlarged ventricles with an enlarged sylvian fissure. He was shunted with a programmable valve set at a pressure of 110 and improved, but not all the way to normal. The valve setting was subsequently reduced to 80, and the symptoms completely resolved.

shunt failure, and the dreaded subdural hematoma from overdrainage. In the elderly population, where the ventricles are enlarged and the brain atrophic, a decrease in ventricular volume from overdrainage will cause the cortical surface to collapse and the bridging veins to stretch. The veins may rupture and bleed into the dead space created by the collapsing brain, resulting in the formation of a subdural hematoma with all of its potentially disastrous consequences. Studies have shown that low-pressure valves have the highest success rate, but they also have the highest rate of complications from overdrainage.

Novelties in the Surgical Treatment of NPH

The use of programmable valves is adding a new dimension to the treatment of NPH. Programmable valves allow surgeons to modify the amount of CSF drained to accommodate the specific needs of the individual patient, rather than using a one-prescription-fits-all approach. Shunts consist of a distal catheter placed within the CNS (ventricles or lumbar subarachnoid space) to drain the CSF, a valve that regulates the amount of fluid drained, and a distal catheter that drains fluids into a body cavity — usually the peritoneal cavity, but less commonly the atrium or the pleural space. Traditional valves have a fixed pressure or flow setting. Although different valves are available, each with a different setting, once the valve is implanted, the pressure setting cannot be changed unless the valve is replaced via open surgery. This limitation is a problem when dealing with patients who experience some, but not maximal, improvement. These patients would benefit from a lower-setting valve; however, the potential for improvement with a lower-setting valve may not justify the risk of another surgery to replace the valve. On the other hand, overdrainage in some patients may lead to a subdural hygroma or hematoma formation, therefore requiring ligating or removing the shunt to stop CSF drainage to prevent these collections from getting larger.

Programmable valves allow adjustment of the drainage settings transcutaneously, using a special magnet, without the need for any invasive intervention. Programmable valves have allowed a more aggressive approach to NPH: in a patient who could benefit from more fluid drainage, the setting is lowered; in the patient who is overdraining, the pressure setting is increased to lessen the amount of fluid drained. While pressure adjustments are not performed routinely on every patient, they can be made to save a patient from revision surgery to replace a higher or lower pressure valve. Also, with the ability to regulate the drainage, the threshold for shunting has become lower.

Summary

NPH represents a true diagnostic challenge, but a rewarding one when the disease is properly diagnosed and treated. It is crucial to keep a high index of suspicion when dealing with patients who might have the disease. The clinician has to use a combination of clinical and radiological findings and drainage interventions to figure out who might benefit from shunting. The advent of programmable shunt technology has been a major advance in NPH treatment and has given physicians more flexibility in treating these patients.

References

1. Adams RD, Fisher CM, Hakim S, et al. Symptomatic occult hydrocephalus with "normal" cerebrospinal fluid pressure. *N Engl J Med.* 1965;273:117–26.