

# Normal-Pressure Hydrocephalus (NPH)

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- described by Hakim and then by Adams in 1965.
- highest PREVALENCE in **late middle-aged and elderly** groups (rare in patients < 60 years).
- accounts for **5% of demented patients** in older age group.

GAIT APRAXIA + DEMENTIA + INCONTINENCE  
with normal CSF pressure and dilated ventricles

## PATHOPHYSIOLOGY

NPH - **communicating hydrocephalus** with *increased resistance to CSF outflow* (at **subarachnoid space** or **arachnoid villi**) and **normal ICP** (absence of headache & papilledema).

- normal ICP is maintained as result of apparent compensations.
- *ICP is not always normal* - transient ICP elevation may increase ventricular size and new fluid balance is reached with normal pressure but with higher force, based on Pascal's law of pressure in fluids.

Causes of subarachnoid space-arachnoid villi obstruction / scarring:

- 1) SAH
- 2) meningitis
- 3) head trauma
- 4) CSF protein↑

N.B. large number of patients **do not have identifiable cause**.

## CLINICAL FEATURES

- **older patient** with insidious **PROGRESSIVE TRIAD** (in order of appearance):

N.B. patients may appear *mildly parkinsonian*, but their tremor, if present, is postural, not resting.

1. **GAIT APRAXIA\*** (90%) – most frequent first symptom: slow, unsteady, wide based gait; **“magnetic gait”** (short steps + difficulty picking feet off ground); difficult turning (takes several steps)
  - legs are bradykinetic (vs. Alzheimer disease – normal gait).
  - disturbances in stance with tendency to lean forward and imbalance exacerbated by eye closure.
  - normal motor force, tone, and reflexes  
upper motor neuron signs or lower limb weakness may be indicative of cervical myelopathy and lumbar canal stenosis, respectively!
  - **discrepancy between during walking and simulated walking** (this gait dyspraxia eliminates pyramidal lesion) - can move legs well and imitate walking while in chair, but becomes awkward and severely impaired as soon as attempts to walk.
  - difficulty in handwriting and dressing.

- differentiation from parkinsonism:
  - Parkinson's patients are able to increase their stride length and walking cadence with aid of external cueing such as counting; vs. patients with NPH have gait apraxia that does not respond to such aids.
  - patients with NPH mobilize with relatively preserved arm swing
- 2. **DEMENTIA** (mild ÷ moderate) – *subcortical frontal dysexecutive syndrome*: reduced attention, memory loss, difficulty planning, slowness in thought, apathy
  - aphasia is uncommon
  - pathophysiologic mechanism - *compromised microcirculation*, due to increased intraparenchymal pressure (PET shows widespread glucose utilization defects in subcortical and cortical regions).
- 3. **URINARY INCONTINENCE\***

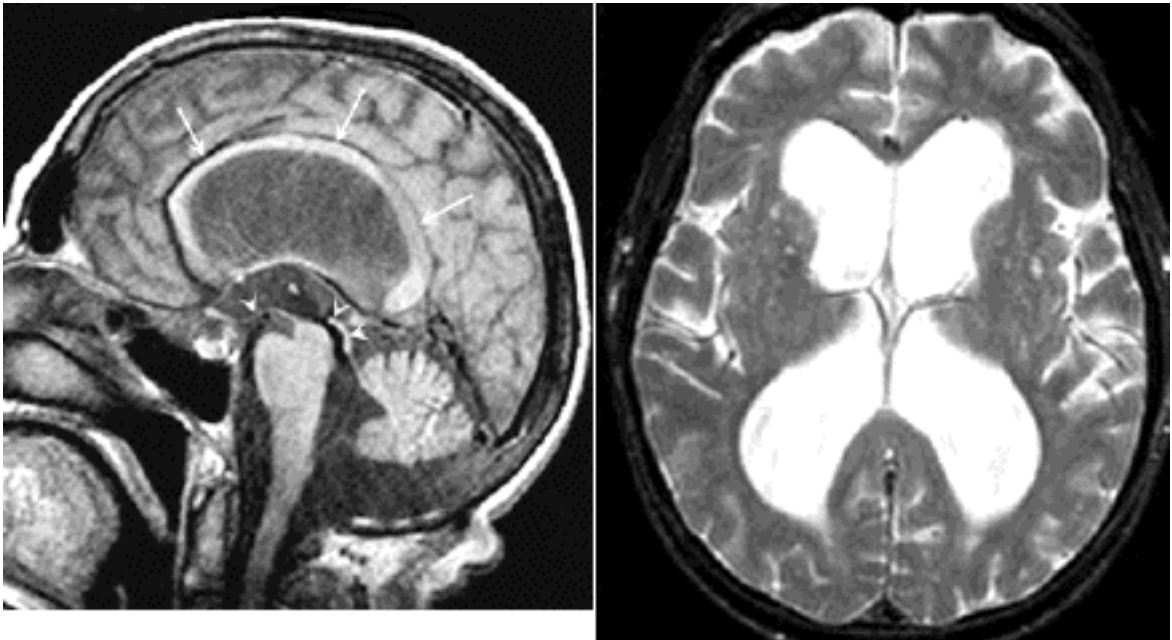
\*relate to *stretched fibers* innervating legs and sphincters that project through *vicinity of frontal horns* of ventricular system.

In addition, other symptoms have been reported: lethargy, apathy, impaired wakefulness, visuospatial disturbances.

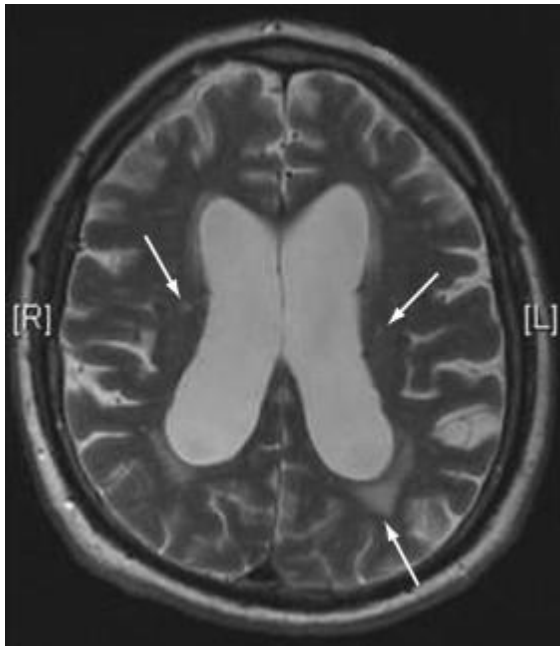
## DIAGNOSIS

**CT / MRI** - **hydrocephalus with little or no cortical atrophy** (vs. Alzheimer disease):  
 ventricular *anterior horns* measure > 30% of diameter of cranial cavity  
 (i.e. Evans' index >0.3)  
 ventricular *inferior horns* are > 2 mm.

- A. T1-MRI - dilatation of lateral ventricle, stretching of corpus callosum (*arrows*), depression of 3<sup>rd</sup> ventricle floor (*single arrowhead*), enlargement of aqueduct (*double arrowheads*).
- B. T2-MRI - dilatation of lateral ventricles.



Ventriculomegaly, periventricular lucency (*inferior arrow*), and white matter hyperintensities (*superior arrow*):



**ICP monitoring** - intermittent pressure B-waves (decreased brain compliance), particularly during REM sleep; slowly increase ventricular size and lead to ischemic damage.

**SPECT-acetazolamide challenge** - decreased periventricular perfusion that is not altered by acetazolamide.

Three supplementary tests:

*Current guidelines recommend that all patients suspected of having idiopathic NPH be considered for supplementary tests with one or more of the three methods*

1. **Lumbar puncture “tap test”** – high-normal CSF pressure, normal CSF composition

**Removal of 40-50 ml CSF** → transient clinical improvement in cognitive & gait dysfunction!\*

\* 73-100% positive predictive value to indicate better prognosis with shunting

2. **Measures of CSF outflow resistance** - thought to reflect CSF absorption pathways.
  - fluid is injected into CSF space (e.g. ventricles or lumbar sac) either by bolus or infusion.
  - CSF outflow resistance can then be calculated with pressure-volume study and used to assess CSF circulation for signs of disturbance.
    - In Dutch NPH study, **outflow resistance > 18 mm Hg/mL/min** had specificity of 87% and sensitivity of 46%.
  - can also be performed through preimplanted ventricular reservoir device.
3. **Prolonged external lumbar drainage** (in excess of 300 mL) – highest sensitivity (50-80%), specificity (80%), and positive predictive value (80-100%).

Historical tests:

**Radioisotope cisternography** (not particularly specific) - isotope injected intrathecally:

**normal** - isotope is seen around brain convexity within 48 hours;

**NPH** - isotope reflux into ventricles and stasis beyond 48 hours.

## DIFFERENTIAL DIAGNOSIS

N.B. bilateral multiple lacunar strokes (état lacunaire) can give all three symptoms!!! see p. Vas3 >>

### GAIT DISTURBANCE

#### *Vascular*

- Cerebrovascular disease
- Stroke
- Multi-infarct dementia
- Binswanger's disease

#### *Neurodegenerative*

- Parkinson's disease
- Alzheimer's disease
- Progressive supranuclear palsy
- Frontotemporal dementia

#### *Miscellaneous*

- Peripheral neuropathy
- Cervical myelopathy
- Lumbar canal stenosis
- Diabetic neuropathy
- Autonomic dysregulation
- Spinal neoplasm

### DEMENTIA

#### *Vascular*

- Cerebrovascular disease
- Stroke
- Multi-infarct dementia
- Binswanger's disease
- CADASIL (cerebral autosomal dominant arteriopathy, subcortical infarcts, and leukoencephalopathy)

#### *Neurodegenerative*

- Parkinson's disease
- Alzheimer's disease
- Progressive supranuclear palsy
- Frontotemporal dementia
- Corticobasal degeneration

### URINARY INCONTINENCE

#### *Structural*

- Bladder outflow obstruction
- Benign prostatic hypertrophy

#### *Bladder innervation*

- Autonomic dysregulation
- Lumbar canal stenosis

#### *Miscellaneous*

- Medications—anticholinergics, diuretics

## TREATMENT

1. **ACETAZOLAMIDE** or **DIGOXIN** to decrease CSF production.
2. **VENTRICULAR SHUNTING**; patient selection criteria:
  - 1) mild dementia of < 2 years' duration

- 2) typical gait and urinary dysfunction
- 3) rapid CSF flow in 4<sup>th</sup> ventricle and cerebral aqueduct (seen as accentuated signal loss on heavily T2-weighted images).
- 4) no MRI evidence for multi-infarct state\*
  - \* deep white matter T2 hyperintensities (marker of comorbidity); some studies showed inverse correlation with shunt responsiveness; other studies found no correlation

N.B. only 60-80% patients experience long-term benefit (gait improves more than memory).

3. Alternative methods of shunting:

- a) **lumboperitoneal shunting** - significantly greater likelihood of *need for shunt revision* and greater overall charges to the health care system.
- b) **ETV** - success rates generally reported around 70% (i.e. efficacy similar to that of VPS)
- c) **lumbar subcutaneous shunt** proposed by Mendelow's group.

BIBLIOGRAPHY see p. S50