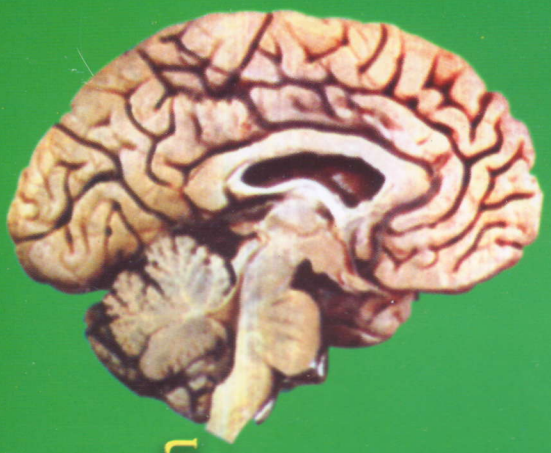
The Egyptian Journal of Neurosurgery



The Official Journal of the Egyptian Society of Neurological Surgeons

Vol. 23 No. 1 January 2008

Idiopathic Normal-Pressure Hydrocephalus; Management and Outcome

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ABSTRACT

Objective: *The response to shunt surgery for idiopathic normal – pressure hydrocephalus (INPH) is variable. This study was designed to evaluate the efficacy of shunt surgery in management of idiopathic normal pressure hydrocephalus.* ***Patients and Methods:*** *This is a prospective study of 20 patients with INPH. This study was done in Neurosurgery departments Cairo university hospitals and Nasser institute hospitals over a period of 2 years, started July 2003. All patients were of probable type of INPH. All patients were subjected to full history, general and full neurological examination. Radiological evaluation was done to all patients including MRI. Patients were classified as having INPH and underwent CSF shunting only if they had: 1) Ventriculomegaly confirmed on CT or MRI scan, 2) presence of two or more clinical features of NPH, 3) no risk factor for secondary NPH , 4) clinical improvement in symptoms after CSF drainage. The patients were managed surgically by V-P shunt medium pressure. Follow-up consisted of clinical evaluation at 3months, 1 year and 2 years after surgery and radiological evaluation as indicated.* ***Results:*** *Twenty patients were included in this study the average age was 58.6 years (range 51 – 69 years). Fourteen patients (70%) were females and six patients (30%) were males. Gait disturbance was a feature for all patients (100%), urinary symptoms were present in 18 (90%) and cognitive decline was present in all patients (100%). On preoperative MRI, ventricular enlargement not attributed to cerebral atrophy were observed in all patients (100%) and evidence of altered brain water content (periventricular signals) were observed in 14 (70%) patients. Fifteen patients (75%) of 20 patients had improvement in at least one INPH symptom at the end of 3 months. Improvement rate for those shunted decreased over the period of 2 years, after 1 year decreasing from 75% to 65% and the end of 2 years the improvement rate was 55%.* ***Conclusion****: CSF shunting is safe and effective for INPH with a shunt response rate of 75%-55% within 2years. The presence of gait impairment as the dominant symptom and shorter duration of symptoms are predictors of symptomatic improvement after shunt surgery. Favorable response to preoperative CSF removal is the most reliable indicator of surgical outcome in patients with INPH.*

INTRODUCTION

The term "normal-pressure hydrocephalus" (NPH) was introduced in the late 1960s by Salomon Hakim in his thesis "some observations on CSF pressure"[14]. In the English-Language literature, NPH was introduced in the landmark article by ***Adams et al.***[1] published in the New England Journal of Medicine in 1965. They are credited with identifying a specific syndrome associated with patients in whom ventricular enlargement occurred in the absence of elevated intracranial pressure and who presented with gait disturbance, dementia, and incontinence. In an article by ***Hakim and Adams***[15] published in 1965, three cases reported described

ventriculomegaly and one idiopathic. Hakim went on to describe the "Classic triad" of gait disturbance incontinence, and dementia, which were improved with removal of cerebrospinal fluid.

Since that time, considerable controversy has evolved as to the appropriate diagnosis and management of the NPH patient, in part because of the "mixing" of idiopathic NPH (INPH) patients (primary NPH) with those with NPH of known cause (secondary NPH), such as trauma, subarachnoid hemorrhage, and stroke[23]. The general assumptions on the underlying pathophysiological mechanism include: (i) altered hydrodynamics of the CSF system, especially an insufficiency in the capacity to absorb CSF; and (ii) a parenchymal, possibly ischemic, process due to impairment of the periventricular blood flow. However, the exact mechanism of the development of the clinical symptoms is not well known[18,26,27]. Brain perfusion studies have revealed decreased regional cerebral blood flow (CBF) in the periventricular region in patients with NPH. The decreased blood flow subsequently improves after shunt surgery[19].

The diagnosis of idiopathic normal-pressure hydrocephalus (INPH) requires convergent evidence from the clinical history, physical examination, and brain imaging[23]. Drainage of cerebrospinal fluid (CSF) via a lumbar tap can be of prognostic value if the response is significant. The prognostic value of this procedure for identifying patients who will benefit from shunt increases as greater amounts of fluid are removed by external lumbar drainage (ELD). The highest sensitivity and specificity are associated with prolonged controlled lumbar drainage[31].

Surgical diversion of cerebrospinal fluid (CSF) is recommended for idiopathic normal-pressure hydrocephalus (INPH) patients in whom there is a favorable risk-to-benefit ratio. Not every patient diagnosed with INPH is a good candidate for shunting. Factors such as coagulation status, immune incompetence, comorbidity, functional status, and advanced age should be considered[29]. This study was designed to evaluate the efficacy of shunt surgery in management of idiopathic normal pressure hydrocephalus.

PATIENTS & METHODS

This is a prospective study of 20 patients with INPH. This study was done in Neurosurgery departments Cairo university hospitals and Nasser institute hospitals over a period of 2 years, started July 2003. All patients were of probable type of INPH. All patients were subjected to full history, general and full neurological examination. Radiological evaluation was done to all patients including MRI.

Supplemental prognostic tests were done to the patients:

[1] Tap test:

It was done to all patients in recumbent position and 50 ml was drained from the patient. The opening pressure was measured and the response to the test was encounted. The opening pressure was in the range of 5-18 mm Hg.

[2] External lumbar drain:

Prolonged ELD was done to 10 patients and a daily (200-300ml) was drained in 3 consecutive days. The response to ELD test is more effective in identifying INPH but it requires hospital admission.

Patients were classified as having INPH and underwent CSF shunting only if they had: 1) Ventriculomegaly confirmed on CT or MRI scan, 2) presence of two or more clinical features of NPH, 3) no risk factor for

secondary NPH (history of subarachnoid hemorrhage, meningitis, encephalitis, concussion, traumatic brain injury, cerebral infarction, venous thrombosis), 4) clinical improvement in symptoms after CSF drainage. The patients were managed surgically by V-P shunt medium pressure.

Outcome assessment:

Follow-up consisted of clinical evaluation at 3months, 1 year and 2 years after surgery and radiological evaluation as indicated. All patients underwent the Mini-Mental state examination[12] at each follow-up visit. Improvement in cognitive function was defined as at least a three–point improvement in the Mini–Mental state examination score and improvement in the patient's cognitive function from either the patient's or family's perspective. Improvement in urinary incontinence was defined as a decrease in incidence of urinary frequency, urgency, or incontinence that was thought by the patient or family to have improved. Improvement in gait was documented by change in detailed clinical evaluation length, base and also was assessed on the basis of the patient's and family's perspective, including documentation of dependence of assistive devices (walker, wheelchair). Symptoms were classified as improved if they resulted in an improvement in the patient's quality of life. To evaluate predictors of outcome, treatment response to CSF drainage was defined as improvement in at least one symptom.

RESULTS

Twenty patients were included in this study the average age was 58.6 years (range 51–69 years). Fourteen patients (70%) were females and six patients (30%) were males.

Gait disturbance was a feature for all patients (100%), occurring for an average of 14 months before presentation (table 1). Urinary incontinence or urgency was present in 18 (90%) patients, occurring for an average of 9 months (table 2). Cognitive decline was present in all patients (100%), occurring for an average 11 months.

On preoperative MRI, ventricular enlargement not attributed to cerebral atrophy was observed in all patients (100%) and evidence of altered brain water content (periventricular signals) was observed in 14 (70%) patients table (3).

Tap test was performed on all patients and resulted in clinical improvement in 16(80%) patients, who were consequently shunted. ELD was performed to 10 patients; including the four who did not improve by tap test; resulted in clinical improvement in 10(100%) patients. ***N.B*** The patients who not improved by prognostic tests were excluded from this study.

Fifteen patients (75%) of 20 patients had improvement in at least one INPH symptom at the end of 3 months. Improvement rate for those shunted decreased over the period of 2 years, after 1 year decreasing from 75% to 65% and the end of 2 years the improvement rate was 55% (Figure 1).

In two patients (10%) the shunting procedure was complicated by subdural hygroma and one (5%) by a subdural hematoma. The hematoma was managed surgically and the two hygroma absorbed spontaneously. In one patient (5%), there was bacterial meningitis which recovered by antibiotics.

Table (1): The commonest gait disturbance variation

	N	%
↓ Step height	16	80%
↓ Step length	13	65%
↓ Speed of walking	12	60%
↑ Trunk sway in walking	14	70%

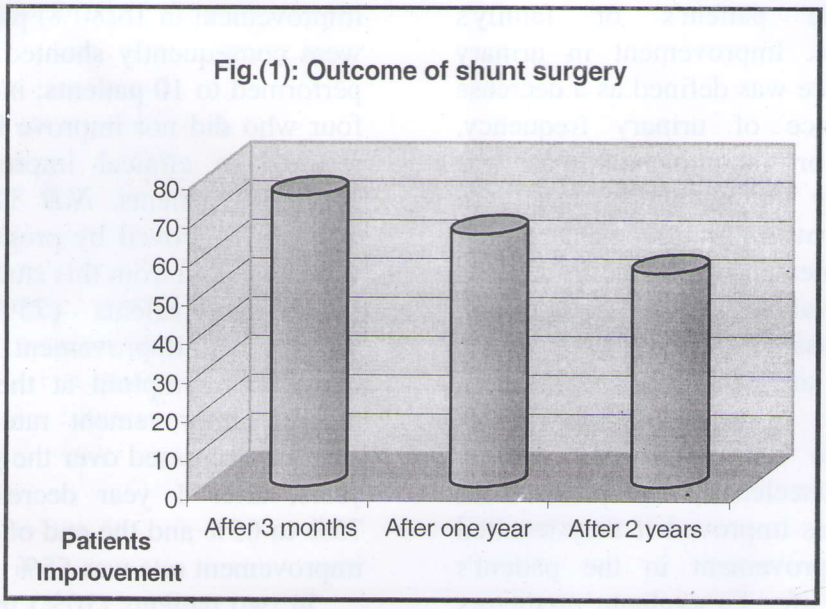
Table 2: Urinary symptoms

	N	%
urinary frequency	7	35%
urinary urgency	9	45%
Urinary incontinence	12	60%

Table 3: Radiological findings

	N	%
• Ventricular enlargement not attributed to cerebral atrophy.	20	100%
• Enlargement of temporal horns.	10	50%
• Evidence of altered brain water content (periventricular signals).	14	70%

Fig.(1): Outcome of shunt surgery



DISCUSSION

Over the past 40 years, there have been numerous reports on the use of CSF shunting for INPH[3,4,10,13,21,29]. These have used a wide range of selection criteria and lengths of follow-up and have varied considerably in the number of patients studied. Consequently, the outcomes also have differed markedly. Much attention has been focused on elucidating clinical or imaging factors that will predict which patients will respond to a shunt. The presence of the complete INPH symptom triad previously was shown to have a low positive–predictive value for shunting response[29]. Two small series showed, as did our series, that when gait disturbance is the primary presenting symptom, high response

rates can be achieved[20,33]. Patients with the most severe white matter disease, or those with the lowest CBF, probably do not respond to shunting because irreversible atrophy has already occurred[7,8].

Diagnostic tools for patients with suspected NPH are numerous[1618,31,34]. The tap test is an important diagnostic test because of its simplicity and less invasive nature[17]. It is generally assumed that of the diagnostic studies, the most reliable result is improvement in clinical symptoms following a lumbar puncture in which CSF is withdrawn[10,25], and Milhorat reported that a favorable response to preoperative CSF removal is the most reliable indicator of surgical outcome in patients with NPH[24]. Analysis of data from several studies has demonstrated that ELD is an accurate test for predicting outcome after ventricular shunting in patients with NPH[17,34]. The results of the present study confirm the accuracy of tap test and ELD in selecting patients for shunt surgery, with an improvement rate of 75% and 65%, after 3 months and 1 year respectively. In the series of Krauss, with the lumbar tap test used as the diagnostic tool provided a similar improvement of 90%[20].

Black reported that the best indicator for shunt responsiveness was patients with the complete triad and achieved a 61.2% rate of improvement and a 35.4% complication rate[2]. Because these data would include patients in the "probable" category, one can appreciate the value of adjunctive testing to predict shunt responsiveness. A subsequent report deals with the value of other tests beyond that of clinical presentation described here and estimates the degree of certainty of achieving a positive response to shunting. These tests include CSF lumbar tap, external lumbar drainage, or CSF resistance studies[31]. We would expect that patients with "probable" INPH would have proportionally more positive adjunctive tests, if implemented, than categories of "possible and unlikely". We also posit that patients with "probable" INPH and a positive adjunctive test will have the highest percentage of favorable responses to shunting compared with the other categories[23,28]. Our series of 20 patients, diagnosed using a rigorous set of four selection criteria that included clinical, radiographic and CSF drainage response, contrasts with early studies such as those of ***Black et al.***[3], ***Vanneste et al.***[29,30] and ***Greenberg et al.***[13], in which only ventricular enlargement and either dementia or gait disturbance were used. The series reported by ***Malm et al.***[22] ***and Larsson et al.***[21], expanded on these basic inclusion criteria by including functional parameters such as improvement with simple CSF tap testing.

Just as the extent and type of selection criteria used to screen patients has varied in the literature, so have the short – term and long – term response rates and length of patient follow-up. The largest series to date by ***Vanneste et al.***[29] enrolled 127 INPH patients and reported only a 31% rate of improvement. The Dutch NPH study[4,6] enrolled 95 patients who were followed for 1 year and observed a 64% rate of improvement, but only a 37% rate of significant improvement. Numerous other small series with 20 to 45 participants[3,13,21,22,33] have shown highly variable response rates ranging from 14 to 89% (with most being less than 50%) with follow – up typically of 1 year of less. A recent Meta – analysis by ***Hebb et al.***[16] of all series reported in the literature found a combined long – term response rate to CSF shunting of 29%. In this study fifteen patients (75%) of 20 patients

had improvement in at least one INPH symptom at the end of 3 months. Improvement rate for those shunted decreased over the period of 2 years, after 1 year decreasing from 75% to 65% and the end of 2 years the improvement rate was 55%.

CSF shunting for the treatment of INPH has long been associated with complications. The Meta – analysis by ***Hebb et al.***[16] showed a mean complication rate of 38% (range, 5-100%), mostly shunt revisions (22%, range, 0-47%), and 6% death or permanent neurological deficit. The Dutch NPH study reported subdural effusions in 53% of shunted patients, two thirds of which spontaneously decreased or resolved[5]. In our series, two patients (10%) were complicated by subdural hygroma and one (5%) by a subdural hematoma. The hematoma was managed surgically and the two hygroma absorbed spontaneously. In one patient (5%), there was bacterial meningitis which recovered by antibiotics.

Hebb stated in his review of 44 articles an overall improvement of 59% after shunting and only 29% of prolonged improvement[16]. Our results may suggest that with some modifications in diagnostic tests as mentioned earlier, and with more rigorous patient selection criteria, these results of shunt surgery can be improved in INPH patients.

CONCLUSION

In this series, shunting is likely to be successful in management of INPH with a 75% to 55% response rate within 2 years. The presence of gait impairment as the dominant symptom and shorter duration of symptoms are predictors of symptomatic improvement after shunt surgery. These data suggest that CSF shunting is a safe and effective intervention that should be offered to appropriately screened patients with INPH. Favorable response to preoperative CSF removal is the most reliable indicator of surgical outcome in patients with INPH.

REFERENCES

1. **Adams RD, Fisher CM, Hakim S, et al.**: Symptomatic occult hydrocephalus with "normal" cerebrospinal-fluid pressure: A treatable syndrome. N Engl Med 273: 117 – 126, 1965.
2. **Black PMcl:** Idiopathic normal pressure hydrocephalus: Results of shunting in 62 patients. J Neurosurg 52: 371–377, 1980.
3. **Black PMcL, Ojemann RG, and Tzouras A:** CSF shunts for dementia, incontinence, and gait disturbance. Clin. Neurosurg. 32: 632-651, 1985.
4. **Boon AJ, Tans JT, Delwel EJ, et al.:** Dutch normal-pressure hydrocephalus study: prediction of outcome after shunting by resistance to outflow of cerebrospinal fluid. J. Neurosurg. 87: 687 – 693, 1997.
5. **Boon AJ, Tans JT, Delwel EJ, et al.:** Dutch normal- pressure hydrocephalus study: Randomized comparison of low – and medium – pressure shunt. J. Neurosurg 88: 490 -495, 1998
6. **Boon AJ, Tans JT, Delwel EJ, et al.:** Dutch normal – pressure hydrocephalus study: the role of cerebrovascular disease. J. Neurosurg. 90: 221 – 226, 1999.
7. **Bradley WG:** Normal pressure hydrocephalus: new concepts on etiology and diagnosis. Am. J. Neuroradiol, 21: 1586-1590, 2000.
8. **Bradley WG:** Normal pressure hydrocephalus and deep white matter ischemia: which is the chicken, and which is the egg? Am

J. Neuroradiol, 22: 1638-1840, 2001.

9. **Conner ES, Foley L and Black PMcL**: Experimental normal–pressure hydrocephalus is accompanied by increased transmantle pressure. J. Neurosurg. 61: 322 – 327, 1984.
10. **Damasceno BP, Carelli EF, Honorato DC, et al.:** The predictive value of cerebrospinal fluid tap – test in normal pressure hydrocephalus. Arq Neuropsiquiatr 55: 179 -185, 1997.
11. **Fisher CM:** Hydrocephalus as a cause of disturbances of gait in the elderly. Neurology 32: 1358–1363, 1982.
12. **Folstein MF, Robins LN, and Helzer JE: :** The Mini-Mental State Examination. Arch Gen Psychiatry 40 : 812, 1983.
13. **Greenberg JO, Shenkin HA, and Adam R.:** Idiopathic normal pressure hydrocephalus – A report of 73 patients. J neurol Neurosurg. Psychiatry 40: 336 – 341, 1977.
14. **Hakim S:** Some observation on CSF pressure: Hydrocephalic syndrome in adults with "normal" CSF pressure. Bogata, Javeriana University School of Medicine (Thesis No. 957), 1964.
15. **Hakim S and Adams RD:** The special clinical problem of symptomatic hydrocephalus with normal cerebrospinal fluid pressure observations on cerebrospinal fluid hydrodynamics. J Neurol Sci 2; 307 – 327, 1965.
16. **Hebb AO and Cusimano MD:** Idiopathic normal pressure hydrocephalus: A systematic review of diagnosis and outcome. Neurosurgery 49: 1166 -1186, 2001.
17. **Ishikawa M:** Guideline committee for idiopathic normal pressure hydrocephalus, Japanese society of Normal pressure Hydrocephalus. Clinical guidelines for idiopathic normal pressure hydrocephalus. Neurol. Med. Chir (Tokyo), 44: 222-223, 2004.
18. **Kahlon B, Sundbarg G and Rehncrona S:** Comparison between the lumbar infusion and CSF tap tests to predict outcome after shunt surgery in suspected normal pressure hydrocephalus. J. Neuro. Neurosurg. Psychiatry, 73: 721 -726, 2002.
19. **K.Killic, A. Czorny, J. Auque, et al.:** Predicting the outcome of shunt surgery in normal pressure hydrocephalus. Journal of clinical Neuroscience 14:729-736, 2007.
20. **Krauss JK, Droste DW, Vach W, et al.:** Cerebrospinal fluid shunting in idiopathic normal – pressure hydrocephalus of the elderly: effect of periventricular and deep white matter lesions. Neurosurgery, 39: 292- 300, 1996.
21. **Larsson A, Wikkelso C, Bilting M, et al.:** Clinical parameters in 74 consecutive patients shunt operated for normal pressure hydrocephalus. Acta Neurol Scand, 84: 475 -482, 1991.
22. **Malm J, Kristensen B, Karlsson T, et al.:** The predictive value of cerebrospinal fluid dynamic tests in patients with idiopathic adult hydrocephalus syndrome. Arch Neurol. 52: 783-789, 1995.
23. **McGirt, Matthew J, Woodworth Graeme, et al.:** Diagnosis, treatment, and analysis of longterm outcomes in Idiopathic Normal Pressure Hydrocephalus. Neurosurgery 57:699-705, 2005.
24. **Milhorat TH.:** Comment. Neurosurgery, 40: 73 -74, 1997.
25. **Mori K:** Management of idiopathic normal–pressure hydrocephalus: a multiinstitutional study conducted in Japan. J. Neurosurg, 95: 970-973, 2001.

26. **Ohata, K and Marmarou A.:** Clearance of brain edema and macromolecules through the cortical extracellular space. J. Neurosurg 77: 387 -396, 1992.
27. **Uhl E, Wrba E, Nehring V, et al.:** Technical note : A new model for quantitative analysis of brain oedema resolution into the ventricles and the subarachnoid space. Acta Neurochir (Wien) 141: 89-92, 1999.
28. **Vanneste JA:** Diagnosis and management of normal – pressure hydrocephalus. J. Neurol. 247: 5–14, 2000.
29. **Vanneste JA, Augustijn P, Dirven C, et al.:** Shunting normal – pressure hydrocephalus: Do the benefits outweigh the risks? A multicenter study and literature review. Neurology 41:54–59, 1992.
30. **Vanneste JA, Augustijn P, Tan WF, et al.:** Shunting normal pressure hydrocephalus: The predictive value of combined clinical and CT data. J. Neurol Neurosurg Psychiatry 56:251, 1993.
31. **Walchenbach R, Geiger E, Thomeer RT, et al.:** The value of temporary external lumbar CSF drainage in predicting the outcome of shunting on normal pressure hydrocephalus. J. Neuro Neurosurg Psychiatry, 72: 503 -506, 2002.
32. **Waldemar G, Schmidt JF, Delecluse F, et al.:** High resolution SPECT with [99m Tc]-d, 1-HMPAO in normal pressure hydrocephalus before and after shunt operation. J. Neurol Neurosurg Psychiatry 56: 655 -664, 1993.
33. **Weiner HL, Constantini S, Cohen H, et al.:** Current treatment of normal–pressure hydrocephalus: Comparison of flow–regulated and differential–pressure shunts valves. Neurosurgery 37: 877–884, 1995.
34. **Williams MA, Razumovsky AY and Hanley DF:** Comparison of PCSF monitoring and controlled CSF drainage diagnose normal pressure hydrocephalus. Acta Neurochir Suppl. 71:328 -330, 1998.