Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.JournalofSurgicalResearch.com

Shunting for hydrocephalus: analysis of techniques and failure patterns

Fares Nigim, MD,[a] *Jonathan F. Critchlow, MD,*[b] *Benjamin E. Schneider, MD,*[b] *Clark Chen, MD, PhD,*[a] *and Ekkehard M. Kasper, MD, PhD*[a,*]

[a] *Department of Neurosurgery, Harvard Medical School, Boston, Massachusetts*
[b] *Department of Surgery, Beth Israel Deaconess Medical Center, Boston, Massachusetts*

ARTICLE INFO

Article history:
Received 4 January 2014
Received in revised form
17 March 2014
Accepted 25 March 2014
Available online 1 April 2014

Keywords:
Ventriculoperitoneal shunt (VPS)
Laparoscopic technique (Lap technique)
Normal pressure hydrocephalus (NPH)
Cerebrospinal fluid (CSF)

ABSTRACT

Background: Hydrocephalus is characterized by ventricular dilatation because of progressive accumulation of cerebrospinal fluid. Normal pressure hydrocephalus (NPH) affects a subset of patients representing a reversible clinical triad of gait disturbance, urinary incontinence, and dementia with normal cerebrospinal fluid pressure and composition. Various shunting procedures have been used for treatment, but techniques and outcomes remain under debate. The objective of this study was to evaluate the clinical outcomes of 232 patients with and without NPH after the first-time Ventriculoperitoneal shunt placement and assessed patterns of failure between December 2004 and December 2012.

Results: Mean age was 54.7 y in non-NPH and 71.9 y in NPH patients. We used open technique in 34.3% and laparoscopic technique in 65.7% of NPH patients and 32.7% and 67.3% of the non-NPH patients, respectively. A total of 36 of 232 patients displayed shunt failure, 16.4% in NPH and 15.2% in non-NPH patients. Twenty-three of 155 patients failed after laparoscopic and 13 of 77 failed after open placement. Proximal shunt failure was more frequent in the non-NPH cohort. Distal failures accounted for 13 of 232 cases, and the difference between laparoscopic (six of 155) and open failures (seven of 77) was profound, but not between NPH- and non-NPH patients.

Conclusions: Shunt failures are related to the placement method. Non-NPH patients showed more proximal failures. NPH patients showed fewer proximal failures. Less distal failures were observed after laparoscopic ventriculoperitoneal shunt placement without significant differences between NPH and non-NPH patients. Beyond this, laparoscopic surgery carries distinct advantages such as shorter operating room times and hospital stays, which should translate into less use of pain medications, earlier mobilization, and a lower incidence of ileus.

1. Introduction

Ventriculoperitoneal shunting (VPS) is the mainstay for the treatment of hydrocephalus and remains a frequently performed procedure in general neurosurgical practice. Among all patients with hydrocephalus, there are various etiologies leading to ventricular dilatation and neurologic decline, ultimately requiring a cerebrospinal fluid (CSF) diversion procedure. However, these implanted devices may fail over time.

* *Corresponding author*. Department of Surgery, Beth Israel Medical Center and Department of Neurosurgery, Harvard Medical School, 110 Francis Street Suite 3B, Boston, MA 02215. Tel.: +1 617 632 7246; fax: + 1 617 632 0949.
E-mail address: ekasper@bidmc.harvard.edu (E.M. Kasper).
0022-4804/$ – see front matter © 2014 Elsevier Inc. All rights reserved.
http://dx.doi.org/10.1016/j.jss.2014.03.075

We investigated a cohort of elderly normal pressure hydrocephalus (NPH) patients against the background of a large suitable reference cohort of other hydrocephalus patients also requiring a VPS, and we report comparative data regarding surgical outcomes and shunt survival in these patients and investigate respective shunt failure patterns. NPH patients differ from the other cohort of patients with, for example, posthemorrhagic hydrocephalus, hydrocephalus in the setting of metastatic disease, hydrocephalus in the presence of a central nervous system tumor, or pseudotumor cerebri, and so forth. In at least two important aspects: First, NPH patients are generally older and second, the CSF or NPH patients is considered to be normal, which means unaltered by any increase in protein or cells, for example, after infection, intracranial hemorrhage, or in the presence of tumors.

The hypothesis that can be addressed with this study are as follows: (1) Patients with NPH may show a higher VPS failure rate, as older patients are more likely to suffer from comorbidities (e.g., those resulting in abdominal surgery and adhesions causing distal catheter obstruction); (2) NPH patients have a CSF composition that differs from the CSF of hydrocephalic patients with other etiologies, and hence they may show a different failure rate and pattern [1]; (3) We wanted to see whether laparoscopic placement of VPS may translate into a lower failure rate as assumed by other laparoscopic studies or show a different pattern of VPS failures over time.

This data set is suitable to corroborate the validity and safety of the laparoscopic and open VPS procedures and looks at the longevity of the first-time shunts placed. We furthermore look in detail into the observed cases of VPS failures by assessing both location and possible causes.

Among the large number of patients requiring a shunt for various indications is a more homogenous patient group with NPH. This cohort is of particular interest, because NPH is one of the few treatable conditions of cognitive decline among other symptoms and affects as many as 3%–6% of patients with dementia [2–9]. The syndrome was first described by Hakim and Adams [10] in 1965 and included gait apraxia, imbalance, progressive memory loss, urinary incontinence, and normal CSF composition and pressure on lumbar puncture. Currently, there is no effective medical treatment for neurocognitive decline from hydrocephalus in NPH, and drugs such as acetazolamide or osmotic diuretics have been found not to work reliably. Ventricular shunting is the only treatment to provide a lasting benefit.

Success after shunting is reflected in a lasting remission of symptoms in these patients with a normal life expectancy. This requires long-term follow-up and regular patient assessment, as well as management of potential shunt complications via revisions.

There is an ongoing debate as to whether the benefits outweigh the risk in shunting in NPH patients, because NPH affects predominantly the elderly population who often suffer from significant comorbidities (e.g., cardiovascular disease, diabetes mellitus, chronic obstructive pulmonary disease, and so forth) [11–13]. We therefore set out to look at shunting in these NPH patients and analyzed their complication rate and failure patterns in comparison with a large cohort of other patients undergoing first-time VPS placement for different etiologies. To this end, longitudinal observation and assessment of these patients is essential. Several authors have thus far reported good outcomes with follow-up periods mostly ranging from 3 mo to 2 y [14–17]. To date, one of the seminal studies reported was done by Savolainen *et al.* [18] who followed 25 patients for 5 y. However, only a small number of studies has elucidated the long-term effects of shunting and few report on the associated surgical morbidities [19–23].

Here, we report our surgical experience and outcome in patients undergoing surgery for NPH in comparison with patients requiring shunt placement for different etiologies.

Shunt failures do occur rather frequently as reported in the present literature, and we wanted to see, whether these may be possibly related to the placement method chosen. We therefore compared metrics from patients who underwent VPS via the conventional open surgical approach to data from patients who had laparoscopic VPS surgery, and we followed these patients longitudinally to find a significant difference in shunt failure rates and pattern when comparing the two cohorts and the two techniques investigated.

2. Material and methods

This is an institutional review board (IRB No. 2011P-000101/4 and 2013P-000253/1)-approved retrospective cohort study of a prospectively collected data set of consecutive adult patients who underwent first-time insertion of a VPS for various etiologies of hydrocephalus. The study cohort consisted of patients treated at Beth Israel Deaconess Medical Center between December 2004 and December 2012.

New VPS placement was strictly defined as insertion of a proximal cerebral catheter, a new valve, and new distal placement of a peritoneal catheter. To avoid contamination of data, any shunt revisions and previously shunt-treated patients, who underwent complete shunt removal (for infection or other indication) and who later underwent placement of a new VPS, were also excluded. Distal catheters were placed either via a standard small open laparotomy or via a laparoscopic technique using two or three access ports.

The decision what technique to use was based on (1) past medical history of the individual patient (e.g., prior abdominal surgery), (2) patients body habitus, or (3) the neurosurgeon's preference and experience with both techniques.

Independent variables investigated in this study included demographics (e.g., age and gender), indication for surgery, and past medical history (e.g., comorbidities and previous abdominal operations). For all patients, we carefully examined the preoperative imaging (head computed tomography or magnetic resonance imaging scan when available), the description of the operative encounter (open or laparoscopic and intraoperative findings), and the specifics of the implanted valve type as well as clinical notes and radiographic studies during the entire follow-up period for each patient. Dependent variables analyzed included operative time, length of hospital stay, findings on postoperative head computed tomography scan (obtained immediately and 4–8 wk after surgery and annually thereafter to assess early as well as delayed postoperative complications), occurrence of any