



Original Article

Ventriculo-atrial shunt. Comparison of an ultrasound-guided peel-away technique versus conventional technique in the management of normal pressure hydrocephalus: A retrospective cohort

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ABSTRACT

Background: Normal pressure hydrocephalus (NPH) is a common neurodegenerative syndrome among the elderly characterized by ventriculomegaly and the classic triad of symmetric gait disturbance, cognitive decline and urinary incontinence. To date, the only effective treatment is a cerebrospinal fluid shunting procedure that can either be ventriculo-atrial, ventriculo-peritoneal, or lumbo-peritoneal shunt. The conventional ventriculo-atrial shunt uses venodissection, whereas the peel-away is a percutaneous ultrasound (US)-guided technique that shows some advantages over conventional technique. We sought to compare perioperative complication rates, mean operating time and clinical outcomes for both techniques in NPH patients at our institution.

Methods: A retrospective cohort-type analytical study was conducted, using clinical record data of patients diagnosed with NPH and treated at our center from January 2009 to September 2019. Parameters to be compared include: Perioperative complication rates, intraoperative bleeding, mortality, and mean operating time. Perioperative complication rates are those device-related such as shunt infection, dysfunction, and those associated with the procedure. Complications are further classified in immediate (occurring during the first inpatient stay), early (within the first 30 days of surgery), and late (after day 30 of surgery).

Results: A total of 123 patients underwent ventriculo-atrial shunt. Eighty-two patients (67%) underwent conventional venodissection technique and 41 patients (33%) underwent a peel-away technique. Immediate complications were 3 (3.6%) and 0 for conventional and peel-away groups, respectively. Early complications were 0 and 1 (2.4%) for conventional and peel-away groups, respectively. Late complications were 5 (6.1%) and 2 (4.9%) for conventional and peel-away groups, respectively. Mean operating time was lower in the peel-away group ($P = 0.0000$) and mortality was 0 for both groups.

Conclusion: Ventriculo-atrial shunt is an effective procedure for patients with NPH. When comparing the conventional venodissection technique with a percutaneous US-guided peel-away technique, the latter offers advantages such as shorter operating time and lower perioperative complication rates.

Keywords: Cerebrospinal fluid, Normal pressure hydrocephalus, Peel-away, Venodissection, Ventriculo-atrial shunt

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INTRODUCTION

Normal pressure hydrocephalus syndrome (NPH), first described by Salomón Hakim in 1965, is the most common form of chronic hydrocephalus. NPH is characterized by the paradoxical phenomenon of ventriculomegaly, a classic triad of symmetric gait disturbance, cognitive decline, and urinary incontinence with normal intracranial pressure.^[1] The only effective treatment is a cerebrospinal fluid (CSF) shunting procedure that can either be a ventriculo-atrial shunt (VAS), ventriculo-peritoneal (VPS), or lumbo-peritoneal (LPS). VAS is the original technique, but the conventional technique uses venodissection so it was abandoned by most surgeons due to high intraoperative complication rates.^[24] Since 1981, some groups adopted a Seldinger-type ultrasound-guided (US-guided) percutaneous technique using a disposable peel-away sheathed catheter that offers certain advantages.^[3]

This peel-away technique has proven to be a precise, rapid, and safe procedure.^[10] At our NPH center of excellence, we have implemented VAS with peel-away as the procedure of choice since 2017 which in this specific population has not shown a higher incidence of complications compared to VPS.^[11] Our experience shows that peel-away technique is advantageous versus conventional venodissection because there is lower incidence of perioperative complication rates and significant reduction in mean operating time. This study summarizes our experience using a peel-away technique in NPH patients at our institution.

MATERIALS AND METHODS

A retrospective cohort-type analytical study was performed using data from medical records of patients diagnosed with NPH and treated at our institutional NPH center of excellence from January 2009 to September 2019. Patients underwent either conventional VAS or peel-away VAS and perioperative complications, intraoperative bleeding, mean operating time, and mortality were documented to compare outcomes in both groups.

Perioperative complications are classified in immediate (during the first inpatient stay), early (within the first 30 postoperative days), and late (after day 30). Complications are mainly device-related: infection, shunt dysfunction, and surgery-associated mortality.

RESULTS

A total of 123 patients underwent VAS, of these patients, 82 (67%) were operated using a conventional technique and 41 (33%) were operated using a peel-away technique. Immediate complications were reported in three patients (3.6%) and 0 in the conventional and peel-away groups, respectively. Early complications were 0 and 1 (2.4%) for

conventional and peel-away groups, respectively. Late complications were 5 (6.1%) and 2 (4.9%) for conventional and peel-away groups, respectively.

Mean operating time was 178.32 and 100.39 min for conventional and peel-away groups, respectively ($P = 0.0000$). Surgery-associated mortality was 0 for both groups. Regarding intraoperative bleeding, data were not easily obtained because in most records, the term “scant bleeding” was used, possibly representing a potential confounding bias for this parameter. All relevant data are summarized in [Table 1] and [Figure 1].

DISCUSSION

Despite the enormous amount of research on NPH, still today the exact etiology of the disorder eludes us. To date, the only effective treatment is a CSF shunting procedure with a success rate ranging from 60% to 80% depending on the series. These differences are mainly due to divergent methodology, diagnostic criteria, selection criteria for shunting procedure,

Table 1: Cohort demographic data.

Variable	Peel away (%)		Venodissection (%)		P-value
Total patients (n:123)	41	33	82	66.67	
Females	17	41.46	40	48.78	
Males	24	58.54	42	51.22	
Duration (min.)	100.39		187.32		0.0000
Bleeding (ml.)	61.82		46.52		
Complications					
Immediate	0	0.00	3	3.60	0.215
Early	1	2.44	0	0.00	0.156
Late	2	4.80	5	6.10	0.783
Mortality	0	0.00	0	0.00	

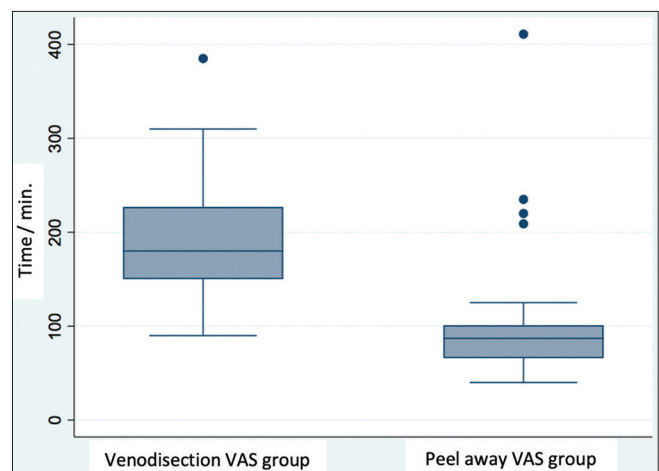


Figure 1: Box plot analysis of operating time for conventional and peel-away ventriculo-atrial shunt groups.

and thresholds for clinical improvement, hence is important to diagnose those patients who benefit from a shunt device. CSF shunting has proven to improve at least one of the classic triad components in most patients. Some authors report subjective improvement in 96% of cases with objective improvement in gait tests in 83% of cases.^[10] However, surgery carries a risk of infection, bleeding, device-related complications which include: infection (the most common), obstruction, dysfunction, overdrainage and underdrainage, migration, visceral perforation, and even death.^[10,25]

VAS was originally described by Nulsen and Spitz in 1952 and later improved by Hakim due to a physiological rationale. VPS was described by Scott in 1955.^[15] VAS was the preferred technique, but was eventually superseded by VPS and LPS because the conventional venodissection technique had a high rate of intraoperative complications that included vascular rupture, thromboembolic complications, and infection. Nonetheless, the most frequent complications, as in all other techniques, are infection with common skin flora and device-related complications (obstruction, dysfunction, and overdrainage) that require revision.^[2]

VPS is the most common technique, but incidence of peritoneal cavity complications range from 5% to 47% and VPS is contraindicated in certain patients (infection, neoplasm or recurrent idiopathic ascites, and among others).^[15,18] In a 4-year follow-up, less than half of patients with a VPS have a functional device, most require revision or even replacement in the short and mid-term.^[4] Reasons for device dysfunction are varied: shunt infection, obstruction, catheter fracture, catheter migration to adjacent viscera with subsequent inflammation and adhesions in the abdominal cavity, peritoneal scarring, pseudo-cyst, abscess, malposition, hernia, and ascites.^[15] It is widely known that some non-modifiable risk factors as age are related to a higher incidence of shunt dysfunction; however, when stratified by hydrocephalus type, NPH patients have the lowest incidence of device revisions.^[22] In NPH patients, it is the degree in severity of preoperative symptoms that has been associated with clinical outcome after surgery and likelihood of device revision during the follow-up. It is established that early diagnosis and timely treatment increase the possibilities of dementia regression and adequate response to surgery.^[19]

With the advent of Seldinger-type percutaneous techniques, perioperative complications and mean operating time are significantly reduced.^[3,12] Different authors have systematically reported their case series with lower operating times and significant reduction in perioperative complications.^[5] Kock-Jensen *et al.* first used a disposable sheathed vascular catheter traditionally used in electrophysiology procedures which proved a faster and safe technique of distal catheter insertion with minimal vascular manipulation.^[16] In 1995, Decq *et al.* described a modified technique in which they avoid placing a

connector between catheters in a series of 22 patients. Again, operating time was noticeably reduced and only two minor complications were encountered. After the 1st year of follow-up, all patients had improved their clinical condition.^[6]

In 2006, Słowiński *et al.* reported a series of 169 patients followed during 64 months. Among intraoperative complications, they report: carotid artery puncture (5%) and pneumothorax (3.3%). Complications during the first 6 postoperative months include: surgical site infection (3.3%), distal catheter malposition (5%), and catheter disconnection (1.7%). Late complications included: distal catheter infection (3.3%), occlusion (6.7%), and disconnection (1.7%).^[23] In 2007, Ellegaard *et al.* used US to guide venous puncture in 26 patients. He reported no artery puncture or pneumothorax and infection rate of 7.6%.^[8]

It is accepted that when choosing VAS, a US-guided peel-away technique with constant cardiac monitoring should be used and distal catheter position should be confirmed with fluoroscopy.^[7,10,20] Recently, Kim *et al.* compared complication rates in patients undergoing VAS versus patients operated with a VPS. Patients in whom a VPS was contraindicated, underwent VAS and report that incidence of complications of VAS is not higher than VPS.^[9,11,13,14,17] The important aspect when considering VAS is proper placement of the distal catheter and that is why venopuncture should be US-guided and electrocardiographic monitoring as well as fluoroscopy should be used to confirm final catheter position. The concern with VAS is thromboembolic complications because they have a high mortality and morbidity, but their prevalence is <1%.^[11,21]

In our cohort, perioperative complications and operating times were lower in the peel-away group. Only one patient from the peel-away group had an early complication versus 0 in the conventional group. This patient developed bacterial meningitis which was optimally treated without any further complications and has no relation with the type of technique but probably with flawed antisepsis during the procedure. Surgery-associated mortality was 0 for both groups. This cohort proves once again that peel-away technique is a safe method with low complication rates (comparable to that reported previously in the literature) and that is a viable option for patients that cannot undergo a VPS. All the available data warrant a randomized controlled trial to evaluate both procedures and eventually examine superiority or at least non-inferiority. For the time being, VAS remains an excellent treatment of choice for patients with NPH in experienced hands.

CONCLUSION

VAS using a Seldinger-type US-guided technique with a disposable sheathed peel-away vascular catheter under constant electrocardiographic monitoring and confirming

distal catheter position with fluoroscopy, is a procedure that offers advantages like shorter operating time and lower perioperative complication rates for patients with NPH.

Declaration of patient consent

Patient's consent not required as patients identity is not disclosed or compromised.

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Conflicts of interest

There are no conflicts of interest.

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