Catheter fixation and ligation: a simple technique for ventriculostomy management following endovascular stenting

Report of 3 cases

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The object of this study was to describe a unique method of managing ventriculostomy catheters in patients on antithrombotic therapy following endovascular treatment of ruptured intracranial aneurysms. The authors retrospectively reviewed 3 cases in which a unique method of ventriculostomy management was used to successfully avoid catheter-related hemorrhage while the patient was on dual antiplatelet therapy. In this setting, ventriculostomy catheters are left in place and fixed to the calvarium with titanium straps effectively ligating them. The catheter is divided and the distal end is removed. The proximal end can be directly connected to a distal shunt system during this stage or at a later date if necessary. The method described in this report provided a variety of management options for patients requiring external ventricular drainage for subarachnoid hemorrhage. No patient suffered catheter-related hemorrhage.

This preliminary report demonstrates a safe and effective method for discontinuing external ventricular drainage and/or placing a ventriculoperitoneal shunt in the setting of active coagulopathy or antithrombotic therapy. The technique avoids both the risk of hemorrhage related to catheter removal and reinsertion and the thromboembolic risks associated with the reversal of antithrombotic therapy. Some aneurysm centers have avoided the use of stent-assisted coiling in cases of ruptured aneurysms to circumvent ventriculostomy-related complications; however, the method described herein should allow continued use of this important treatment option in ruptured aneurysm cases. Further investigation in a larger cohort with long-term follow-up is necessary to define the associated risks of infection using this method.

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KEY WORDS • ventriculostomy • subarachnoid hemorrhage • aneurysm • endovascular coiling • endovascular stenting • antiplatelet therapy • vascular disorders

VENTRICULO STOMY is one of the most common procedures performed by neurosurgeons. It is indicated in the monitoring and treatment of patients with acquired or congenital hydrocephalus and is often a life-saving measure. Its most common complications include infection and bleeding. Risks of hemorrhage are increased in the setting of coagulopathy and antiplatelet therapy. Measures are taken to correct the coagulopathy prior to initial ventriculostomy catheter insertion. However, patients who require emergent ventriculostomy for aneurysmal SAH often require intracranial pressure monitoring and CSF drainage for several days to weeks. During this time there is a subset of patients who will require concomitant treatment with antithrombotic therapy following endovascular management of their ruptured aneurysm. This complicates management of the ventriculostomy catheter when its subsequent removal or conversion to a VP shunt is required. Devastating hemorrhages have been reported in this setting and may require emergent surgical evacuation. The risks of reversing the antithrombotic therapy must be balanced against the risk of hemorrhage associated with catheter removal or replacement. Some aneurysm centers have avoided the use of stent-assisted coiling in cases of ruptured aneurysms to avoid ventriculostomy-related complications.

We describe a unique method of managing ventriculostomy catheters in patients who are on antiplatelet therapy, which avoids the hemorrhagic risks of ventriculostomy catheter removal and/or reinsertion, as well as the thromboembolic risks incurred when reversing antithrombotic therapy. The technique was used successfully in 3 patients who required antiplatelet therapy following endovascular treatment of ruptured intracranial aneurysms.
Technique

Initial ventriculostomy catheter insertion is undertaken in the usual fashion using an antibiotic-impregnated catheter and a single dose of prophylactic antibiotics given 30–60 minutes prior to insertion. The catheter is tunneled and secured at a distant exit site (Fig. 1 left). No prophylactic antibiotics are used during external ventricular drainage in the ICU. Ventriculostomies are monitored for infection through daily evaluation of the incision and exit sites, vital signs, and neurological examination. Cerebrospinal fluid analysis is performed for operative planning and as clinically indicated. When appropriate, the catheter is challenged in the standard fashion, and the decision to perform permanent CSF diversion is weighed. If the patient does not require permanent CSF diversion and if catheter removal in the ICU would be undertaken if not for an increased risk of hemorrhage, then the patient is taken to the operating room without the discontinuation or reversal of antithrombotic therapy. Patients are given a single dose of prophylactic antibiotics 30–60 minutes prior to any skin incisions. The previous incision is opened, and the existing ventriculostomy catheter is located and secured to the cranium with 2 dog bone–shaped titanium straps, which functionally ligate the catheter (Fig. 2). It is then divided distally in the subgaleal space. The proximal catheter is left in place with care not to alter its position in any way, and the distal catheter is removed (Fig. 1 right). Bleeding is controlled locally by typical measures, and all incisions are closed in the standard fashion.

Alternatively, if the catheter fails the ventriculostomy challenge or if delayed hydrocephalus develops following the above procedure, then the patient is taken to the operating room for the insertion of a VP shunt. Antithrombotic therapy is not discontinued or reversed. The prior cranial incision is opened, and the existing ventricular catheter is located. Care is taken not to disturb the catheter’s position while it is divided and connected directly to a newly implanted distal shunt system. If the patient has already undergone functional catheter fixation and ligation with titanium straps as described above, the straps are removed and the ventriculostomy catheter is simply connected to the distal system.

Case Reports

Case 1

History and Examination. A 62-year-old woman presented with HH Grade II SAH and hydrocephalus from a ruptured basilar tip aneurysm.

First Operation. She underwent emergent placement of a ventriculostomy catheter, and her aneurysm was endovascularly treated with stent-assisted coiling. She was started on aspirin and clopidogrel to reduce the risk of stroke associated with stent placement. She fared well after this initial treatment, and significant vasospasm did not develop.

Second Operation. Ten days after the ventriculostomy, the catheter tolerated a challenge trial in the ICU. The patient was taken to the operating room where the previous ventriculostomy incision was opened, the catheter divided, and its distal end removed. The proximal end of the catheter was left in its original location and secured to the skull with 2 dog bone–shaped titanium straps, sealing it shut. The incision was closed in the standard fashion. The patient fared well and was discharged home on antiplatelet therapy.

Third Operation. She returned 4 months later with headache and nausea, and enlarged ventricles were demonstrated on a noncontrast CT scan. She was taken to the operating room without discontinuing or reversing her antiplatelet therapy. The previous incision was opened, and the titanium straps were removed. Cerebrospinal fluid flow was spontaneous, and the proximal catheter was connected directly to a newly implanted distal shunt system. She tolerated the procedure well and was discharged on postoperative Day 2. At 10 months following shunt insertion, shunt infection had not developed and her ventricles were decompressed.
Case 2

History and Examination. A 68-year-old woman presented with HH Grade II SAH and hydrocephalus from a ruptured anterior communicating artery aneurysm.

Operation. She underwent placement of an external ventricular drain, and her aneurysm was treated with endovascular coiling. However, a coil herniated into the parent vessel, requiring antiplatelet therapy with aspirin and clopidogrel to prevent distal embolic stroke.

Postoperative Course. The ventriculostomy catheter tolerated a challenge in the ICU. The total duration of externalized ventricular drainage was 17 days. The patient was taken to the operating room on antithrombotic therapy where she underwent removal of her distal catheter leaving the proximal end in place as described above. There was no new hemorrhage on a postoperative CT scan. Ultimately she was discharged to a skilled nursing facility and succumbed to complications of high-grade SAH 3 months later.

Discussion

We report our management strategy for external ventricular drainage in patients requiring antithrombotic therapy following endovascular treatment of aneurysmal SAH. Our technique has proven successful in 3 patients without complications. This pilot study features a method of avoiding the risks in both catheter-related hemorrhage and reversal of antiplatelet therapy.

Ventriculostomy catheter placement is one of the most common procedures performed by neurosurgeons worldwide. It is often life saving for patients who present with acute or compensated chronic hydrocephalus. It allows continuous intracranial pressure monitoring, CSF analysis, and immediate treatment of intracranial hypertension via CSF drainage, which makes it applicable to a diverse range of conditions. In particular, a large number of patients with aneurysmal SAH require a ventriculostomy for acute management of hydrocephalus and/or perioperative brain relaxation. Shunt-dependent hydrocephalus develops in approximately 20% of these patients.4,29 Risk factors for shunt dependence in SAH include poor clinical grade on presentation, thickened clot in the basilar cisterns, and intraventricular hemorrhage.4,28 In some studies, an advanced patient age, symptomatic vasospasm, and radiographic hydrocephalus on admission have also been shown to be statistically significant.4 Definitive treatment of aneurysms is usually undertaken within the first 24 hours of presentation via either endovascular coiling or open microsurgical clipping, with no difference in the risk of shunt dependence.3 However, some aneurysms will require intracranial stenting as an adjunct to endovascular coiling. Extrapolating from the cardiac literature,13 postmortem data,21 and animal data,20 we found that patients are routinely heparinized during this procedure and placed on dual antiplatelet therapy with acetylsalicylic acid and clopidogrel in the perioperative period to reduce thromboembolic complications. This significantly complicates the management of ventricular catheters.

In general the risk of hemorrhage related to ventriculostomy catheter placement is 10%–40%, with less than 1% of these cases becoming symptomatic or requiring surgical evacuation.16,16,19 However, in the setting of SAH and hydrocephalus. Cerebral angiography showed coil compaction.

Operation. She underwent ventriculostomy catheter insertion followed by endovascular stent-assisted coiling requiring postprocedural antiplatelet therapy with aspirin and clopidogrel.

Postoperative Course. The ventriculostomy catheter tolerated a challenge in the ICU. The total duration of externalized ventricular drainage was 17 days. The patient was taken to the operating room on antiplatelet therapy where she underwent removal of her distal catheter leaving the proximal end in place as described above. There was no new hemorrhage on a postoperative CT scan. Ultimately she was discharged to a skilled nursing facility and succumbed to complications of high-grade SAH 3 months later.

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antithrombotic therapy this number is significantly increased. In a small group of patients described by Tu- mialán et al.,6 6 (86%) of 7 patients undergoing stent-assisted coiling experienced hemorrhagic complications associated with ventriculostomy catheter insertion. Three patients in this series died of hemorrhagic complications related to postprocedural ventriculostomy catheter insertion while on dual antiplatelet therapy. As a follow-up to this report, Kung et al.26 retrospectively reviewed data on 131 patients who had undergone ventriculostomy catheter placement in the setting of endovascular coiling with or without stent assistance. They found that the rates of radiographic and symptomatic hemorrhage were significantly higher in the stent group on dual antiplatelet therapy (32% vs 14.7%, p = 0.02; and 8% vs 0.9%, p = 0.03, respectively). Hemorrhages were attributed to placement, removal, or manipulation of the ventriculostomy catheter in 45%, 13%, and 42% of cases, respectively. They credit their lower hemorrhage rate to the early placement of ventriculostomy catheters prior to the initiation of dual antiplatelet therapy. There are no studies documenting the risk of hemorrhage associated with ventriculostomy catheter insertion or removal during concomitant platelet transfusion. The reports mentioned above6,27 confirm the general belief that ventriculostomy-related hemorrhages are increased in the setting of antithrombotic therapy.

The risk of thromboembolic events associated with early discontinuation or reversal of antiplatelet therapy, especially following stent-assisted coiling of aneurysms, is not well defined. In the cardiac literature, discontinuation of dual antiplatelet therapy in the acute and subacute periods following coronary stent placement can have disastrous consequences. Sharma et al.24 reported on 6 of 7 patients whose antiplatelet therapy was withheld for noncardiac surgery within 2 weeks of placing a bare metal stent and who died of presumptive in-stent thrombosis. Kałuza et al.10 reported on 7 myocardial infarctions and 8 deaths in 40 patients who stopped antiplatelet therapy for noncardiac surgery within 14 days of stenting. Larger studies using drug-eluting stents have documented 25%–29% in-stent thrombosis rates with the discontinuation of antiplatelet therapy within the 1st month.8,9 There are no data regarding the risk of in-stent thrombosis or stroke with the aggressive reversal of antiplatelet therapy via platelet transfusion or factor VII administration in the neurosurgical or cardiac literature.

The method we describe in the present report avoids the risk of hemorrhagic complications related to catheter removal and the risk of stroke related to reversing antithrombotic therapy. However, one criticism is that the infection rate may be increased when the proximal end of the existing external ventricular drain is either retained or directly connected to a new distal shunt through the prior incision. A thorough literature search revealed that there are no studies examining the risk of infection in either of these settings. In general, retained proximal shunt cathers rarely become infected, and such infections typically occur outside the perioperative period as a result of secondary bacterial seeding.12,28,31 Conversely, 80% of shunt infections occur within 6 months of surgery, after which infection rates drop precipitously.2,5,7,23,25 Rammos et al.21 retrospectively reviewed a series of 80 patients with hydrocephalus due to SAH who underwent conversion of an external ventricular drain to a VP shunt via an antibiotic-impregnated shunt system through the existing catheter site. The time between insertion of the external ventricular drain and conversion to a VP shunt was 14.1 days (range 3–45 days). No shunt infection developed in any patients by the 2-year follow-up. Additionally, the authors found that early shunting was associated with a reduced infection rate and possibly improved outcomes. Other authors have documented these findings as well.31 Although the current report is limited by a small number of patients, catheter-related infection developed in none of them. Additionally, any increased infection risks with this technique may be offset by the avoidance of prolonged CSF drainage and early shunting. While results of our study are promising, further investigation involving a larger cohort of patients with appropriate long-term follow-up will be necessary to document the infection risk when using this technique.

Some institutions have successfully managed communicating hydrocephalus due to spontaneous SAH in carefully selected patient populations by using lumbar CSF drainage as an alternative to ventricular drainage.14,20 Thoughtful application of this method is appropriate. In the setting of dual antithrombotic therapy following endovascular stenting, similar management challenges may exist.

Conclusions

This preliminary report documents a safe and effective method for discontinuing external ventricular drainage and/or placing a VP shunt in the setting of active coagulopathy or antithrombotic therapy. This technique avoids both the risk of hemorrhage related to catheter removal and reinsertion and the risks associated with the reversal of antithrombotic therapy. Further investigation of this technique in a larger cohort with long-term follow-up is necessary to define the associated risks of infection.

If subsequent studies prove this technique is effective, ventriculostomy-related hemorrhage can be removed from the list of contraindications for the application of stent-assisted coiling of ruptured cerebral aneurysms.

Disclosure

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

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