Surgical Neurology International

OPEN ACCESS

For entire Editorial Board visit : http://www.surgicalneurologyint.com

Case Report

Sonographic localization of a nonpalpable shunt: Ultrasound-assisted ventricular shunt tap

Rafael A. Vega, Michael G. Buscher[1], Michael S. Gonzalez[1], Gary W. Tye

Departments of Neurosurgery, and [1]Emergency Medicine, Virginia Commonwealth University, Medical College of Virginia, Richmond, Virginia, USA

E-mail: *Rafael A. Vega - ravega@mcvh-vcu.edu; Michael Buscher - mbuscher@mcvh-vcu.edu; Michael Gonzalez - mgonzalez@mcvh-vcu.edu; Gary W. Tye - gtye@mcvh-vcu.edu
*Corresponding author

Received: 15 June 13 Accepted: 01 July 13 Published: 06 August 13

This article may be cited as:
Vega RA, Buscher MG, Gonzalez MS, Tye GW. Sonographic localization of a nonpalpable shunt: Ultrasound-assisted ventricular shunt tap. Surg Neurol Int 2013;4:101.
Available FREE in open access from: http://www.surgicalneurologyint.com/text.asp?2013/4/1/101/116151

Abstract

Background: Patients frequently present to the emergency department (ED) for evaluation of cerebrospinal fluid (CSF) shunt malfunction, often requiring urgent management. A typical evaluation in the emergency room setting includes a thorough history and physical examination, noncontrasted head computed tomography (CT), shunt series, and occasionally a ventricular shunt tap.

Case Description: We present the case of a 53-year-old male who initially presented to the ED in acute status epilepticus. His history was notable for seizures and multiple craniectomies and cranioplasties with subsequent placement of a ventriculoperitoneal shunt secondary to traumatic brain injury. Imaging in the ED suggested possible shunt failure. No previous imaging was available for comparison, and therefore a ventricular shunt tap was attempted. Initially, the tap could not be performed, as the shunt was not palpable secondary to the thickness of his scalp and location of the reservoir near his complex cranial reconstruction site. We report, for the first time, the utility of emergency ultrasound (EUS) to aid in such an encounter.

Conclusion: EUS revealed the exact location of his shunt reservoir, and therefore enabled the shunt tap, which ultimately led to the discovery of the patient's proximal shunt failure in a setting that may have otherwise been missed. The patient underwent urgent shunt revision with a good outcome.

Key Words: Hydrocephalus, shunt failure, ultrasound guidance, ventricular shunt tap

Access this article online
Website:
www.surgicalneurologyint.com
DOI:
10.4103/2152-7806.116151
Quick Response Code:

INTRODUCTION

Patients frequently present to the emergency department (ED) for evaluation of cerebrospinal fluid (CSF) shunt malfunction, possible causes of which include disconnection, calcification, and migration of the shunt from its intended position and blockage.[17] Shunt failure requires urgent management and often results in the need for revision surgery. Neuroimaging, which includes a shunt series and a noncontrasted computed tomography (CT) scan of the head, are typically obtained to help identify patients in shunt failure. Characteristically, these images demonstrate hydrocephalus. However, these studies can occasionally be inconclusive, as ventricular size does not always change in patients with malfunctioning shunts.[5,18] Another diagnostic modality that is typically utilized for measuring opening pressure and assessing proximal and distal catheter integrity is a ventricular shunt tap.[12,13] In the setting of acute shunt failure, a shunt tap can also be used as a therapeutic temporizing measure to allow for function of a distally occluded shunt.[2,7] However, there are times when a straightforward shunt tap proves challenging, such as encounters in patients with a thick scalp and/or complex cranial reconstruction. Herein, we demonstrate the first report of the utility of emergency ultrasound (EUS) for localization of a nonpalpable shunt reservoir, ultimately enabling a ventricular shunt tap to be performed on a complex patient presenting with signs of shunt failure.

CASE REPORT

A 53-year-old male with a past medical history significant for hypertension, noninsulin-dependent diabetes mellitus, alcohol abuse, seizures, and traumatic brain injury secondary to a fall, necessitating several decompressive craniectomies, bilateral cranioplasties and a left occipital ventriculoperitoneal (VP) shunt (Rickham reservoir), initially presented to an outside institution obtunded and in acute status epilepticus. Seizures were initially generalized tonic-clonic, and then later right-sided convulsions with eye deviation. His seizures were aborted with intravenous lorazepam and fosphenytoin. A head CT was obtained at that time that was suggestive of hydrocephalus, which prompted transfer to our facility.

Upon arrival to our ED the patient was noted to have residual focal right arm and facial twitching, for which he was reloaded with antiepileptic agents. The patient was new to our institution, and no prior imaging was available to aid in determining if he had acute hydrocephalus. A shunt series obtained in the ED showed no signs of discontinuity throughout the shunt system. Therefore, we attempted to perform a VP shunt tap to assess intracranial pressure and determine if he had either proximal or distal shunt failure. Initially, on examination his shunt reservoir was not palpable. This was likely secondary to the large thickness of his scalp and the location of his Rickham reservoir near a burr hole cover and along a raised ridge from his left cranioplasty site [Figure 1].

We utilized the ED's portable ultrasound machine (Edge ® model; SonoSite, Incorporated), typically used in the ED for other procedures, to quickly assist us with imaging through the scalp. Using a 6 cm, 13-6 MHz linear transducer, visualization in both the short-axis and long-axis views allowed for a thorough examination and confirmation of the exact placement of the Rickham reservoir [Figure 2]. The patient was then prepped in the standard fashion, with the Rickham site marked and outlined allowing for the easy placement of our 23-guage butterfly needle into the reservoir site [Figure 3]. Once in place, there was no spontaneous flow. Utilizing a 5-cc syringe, we were only able to obtain a few drops of residual fluid initially from the proximal catheter with 2-3 mL of

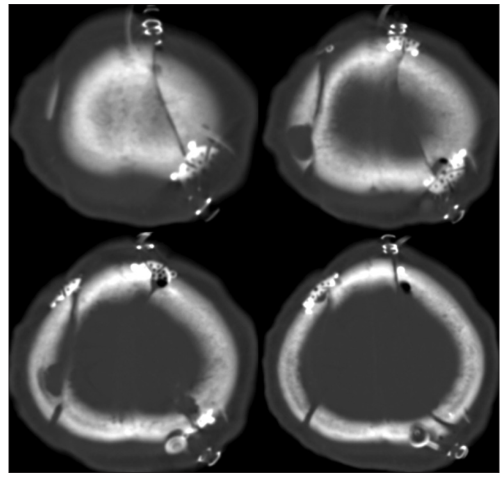

Figure 1: Axial sections from a noncontrast enhanced computed tomographic images of the head (bone window). The complexity of the bilateral cranioplasties can be appreciated in these images. The left occipital Rickham reservoir is located medial to the burr hole cover and ridge from the left cranioplasty

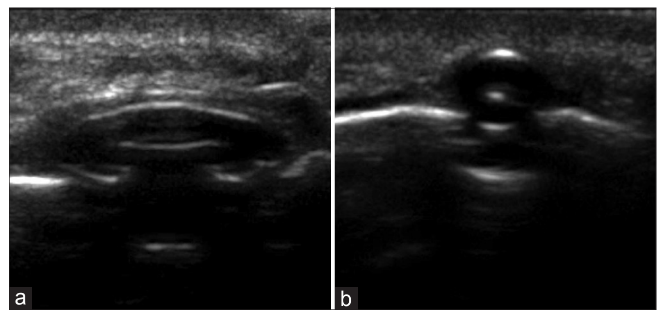

Figure 2: Ultrasound images of the (a) Rickham reservoir and (b) distal catheter tubing

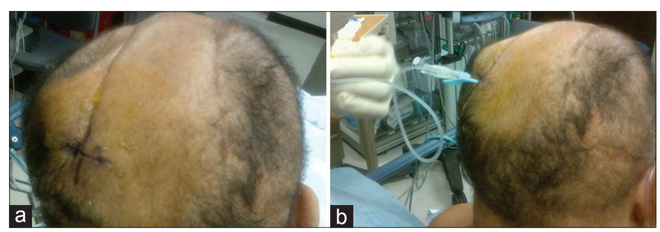

Figure 3: (a) Patient's scalp with markings made in the short- and long-axis, localized with the emergency ultrasound system. (b) Successful cannulation of the reservoir with a 23-guage butterfly needle

negative back pressure, and then no CSF return at all. The result of our ventricular shunt tap suggested proximal shunt failure. The patient was then emergently taken to the operating room (OR) for a shunt revision. In the OR, the left occipital proximal shunt catheter was found to be obstructed, demonstrating shunt failure, which correlated with our shunt tap. In this setting, the decision was made to place a left frontal VP shunt in the standard fashion. Briefly, an incision was made over Kocher's point and a burr hole was placed using a perforator drill. The left frontal catheter was then passed to the appropriate depth and clear CSF return was visualized under high pressure. The distal catheter was then tunneled from the frontal scalp incision to the back part of the previous trauma craniotomy incision, then down towards the neck. The sites were joined with a straight connector along with a medium-low pressure valve. Prior to the connection, distal runoff was checked and found to be appropriate. Postoperatively, the patient did well and was eventually transferred back to his nursing facility.

DISCUSSION

Shunting of the ventricular system for diversion of CSF fluid in patients with hydrocephalus remains the most prominent and accepted treatment of choice.[1,11] It allows for a rapid normalization of intracranial pressure, thus preventing neuronal damage and other detrimental sequelae. Ventricular shunts, however, are also associated with relatively high complication and failure rates, often requiring multiple revisions. Approximately 56-80% of patients will experience at least one episode of malfunction within 10 years, with an annual rate of shunt malfunction estimated to be 5%.[9] Some of the more commonly encountered complications associated with shunt malfunction include, obstruction (proximal, valve, or distal), fracture, disconnection, migration, infection, over-drainage (leading to slit ventricle syndrome, orthostatic hypotension, subdural fluid collections, loculation of the ventricles, acquired Chiari malformation/cerebellar tonsillar herniation), seizures, and pneumocephalus.[17]

Patients frequently present to the ED for evaluation of ventricular shunt malfunction; symptoms most often include headaches, lethargy, nausea, vomiting, irritability, and fever.[7,16] Despite the predominance of these symptoms within this patient population, it is often difficult to correctly diagnose shunt malfunction. The standard evaluation of a patient with suspected shunt malfunction in the ED includes a head CT and radiographic shunt series. Ideally these studies, along with a thorough history and physical examination, are sufficient to diagnose many patients in shunt failure, but it is also important to note that ventricular enlargement is not a sine qua nonindicator of shunt failure.[5,18] Therefore, in these cases, the diagnosis of a patient in shunt failure requires further investigation.

A diagnostic modality that has long been available is the ventricular shunt tap. Although not always utilized, this minimally invasive technique has the ability to measure an opening intracranial pressure and assess proximal and distal catheter function.[13,15] Traditionally, a ventricular shunt tap is considered a simple, effective, and relatively benign method of sampling CSF and identifying obstruction. The tap itself can be performed by placing a sterile needle directly through the scalp and into the reservoir of the shunt system. From this point, it is possible to assess the flow and pressure of the entire VP shunt system, leading to further diagnostic information. Occasionally, it can be difficult to locate the shunt reservoir in practice, especially in the case of a Rickham reservoir, which would impede the diagnostic utility of the ventricular shunt tap. In our case, the reservoir was not palpable secondary to the scalp thickness and further complicated by the location of the shunt reservoir adjacent to the patient's rigid cranioplasty site. At this present time, there is no effective method reported in the literature to manage this type of situation when encountered. Instead of abandoning the shunt tap altogether, the decision was made to utilize the readily available EUS system in our ED to detect the precise location of the Rickham reservoir. We found that this approach facilitated the rapid and accurate placement of our 23-guage butterfly needle to access the reservoir site, and thus assess the function of his VP shunt.

Invasive procedures are frequently performed in the ED. In recent years emergency ultrasonography has become a valuable tool, allowing procedures once guided by physical exam and surface anatomy to be done under ultrasound guidance (dynamic guidance) or ultrasound assistance (static guidance).[6,8] EUS is further utilized to diagnose acute life-threatening conditions and treat emergency medical conditions.[10] There are many aspects of ultrasonography that make it appealing in the acute care setting: Most notably it does not carry the risk of radiation exposure and, when done at the bedside, offers the benefit of real-time results. New applications for this diagnostic modality continue to be described in the literature. In our case, the use of ultrasound can facilitate the rapid evaluation of a complicated and nonpalpable VP shunt reservoir in patients presenting with signs and symptoms concerning for shunt malfunction, ultimately enabling the evaluation and management, in a setting where it would otherwise be too difficult.

The literature continues to be sparse with respect to sonographic evaluation of VP shunts. Previous reports describe the use of Doppler ultrasound to both directly and indirectly evaluate VP shunt function by looking at flow patterns in areas of turbulence.[14] Other studies have focused on measuring cerebral blood flow by using transcranial Doppler ultrasound as a means of extrapolating intracranial pressure.[3] There was also a recent report on the use of EUS to evaluate for VP shunt discontinuity, but the study was limited to confined use in the cervical portion of the distal catheter.[4] There are no current reports in the literature describing the utility of EUS to detect, and ultimately access, a ventricular shunt reservoir in a patient with complicated anatomy.

CONCLUSION

We describe a technique in which the application of EUS enabled our team to determine the precise location of a shunt reservoir in a patient with a complex cranioplasty presenting with signs concerning for shunt malfunction. This simple and fast approach allowed for the accurate guidance of a ventricular shunt tap, in a setting where it may have otherwise been too difficult and consequently missed. Using ultrasound to visualize the site of a ventricular shunt reservoir in real-time has numerous clinical applications, which includes obtaining CSF fluid for analysis of cytology or infection, evaluation of shunt function, the injection of intrathecal medication (antibiotics or chemotherapeutic agents), and as a therapeutic temporizing measure to allow for function of a distally occluded shunt.

REFERENCES

1. Bondurant CP, Jimenez DF. Epidemiology of cerebrospinal fluid shunting. Pediatr Neurosurg 1995;23:254-8.
2. Chan KH, Mann KS. Prolonged therapeutic external ventricular drainage. A prospective study. Neurosurgery 1988;23:436-8.
3. de Oliveira RS, Machado HR. Transcranial color-coded Doppler ultrasonography for evaluation of children with hydrocephalus. Neurosurg Focus 2003;15:ECP3.
4. Hamburg LM, Kessler DO. Rapid evaluation of ventriculoperitoneal shunt function in a pediatric patient using emergency ultrasound. Pediatr Emerg Care 2012;28:726-7.
5. Iskandar BJ, McLaughlin C, Mapstone TB, Grabb PA, Oakes WJ. Pitfalls in the diagnosis of ventricular size. Pediatrics 1998;101:1031-6.
6. Kendall JL, Hoffenberg SR, Smith RS. History of emergency and critical care ultrasound: The evoluation of a new imaging paradigm. Crit Care Med 2005;35:S126-30.
7. Kim TY, Steward G, Voth M, Moynihan JA, Brown L. Signs and symptoms of cerebrospinal fluid shunt malfunction in the pediatric emergency department. Pediatr Emerg Care 2006;22:28-34.
8. Ma OJ, Mateer JR, Blavias M. Emergency Ultrasound, 2nd ed. New York: McGraw Hill; 2008. p. 507.
9. Madikians A, Conway E. Cerebrospinal fluid shunt problems in pediatric patients. Pediatr Ann 1997;26:613-20.
10. Marlin J. Novel applications in pediatric emergency ultrasound. Clin Pediatr Emerg Med 2011;12:53-64.
11. Patwardhan RV, Nanda A. Implanted ventricular shunts in the United States: The billion-dollar-a-year cost of hydrocephalus treatment. Neurosurgery 2005;56:139-45.
12. Piatt JH, Garton HJ. Clinical diagnosis of ventriculoperitoneal shunt failure among children with hydrocephalus. Pediatr Emerg Care 2008;24:201-10.
13. Rocque BG, Lapsiwala S, Iskandar BJ. Ventricular shunt tap as a predictor of proximal shunt malfunction in children: A prospective study. J Neurosurg Pediatr 2008;1:439-43.
14. Sgourous S, John P, Walsh AR, Hockley AD. The value of colour Doppler imaging in assessing flow through ventriculo-peritoneal shunts. Childs Nerv Syst 1996;12:454-9.
15. Sood S, Canady AI, Ham SD. Evaluation of shunt malfunction using shunt site reservoir. Pediatr Neurosurg 2006;42:151-5.
16. Tuli S, Drake J, Lawless J, Wigg M, Lamberti-Pasculli M. Risk factors for repeated cerebrospinal shunt failures in pediatric patients with hydrocephalus. J Neurosurg 2000;92:31-8.
17. Weprin BE, Swift S. Complications in Ventricular Shunts. Tech Neurosurg 2002;7:224-42.
18. Winston KR, Lopez JA, Freeman J. CSF shunt failure with stable normal ventricular size. Pediatr Neurosurg 2006;42:151-5.