ScientificScholar®
Knowledge is power
Publisher of Scientific Journals

www.surgicalneurologyint.com

Surgical Neurology International

Editor-in-Chief: Nancy E. Epstein, MD, Clinical Professor of Neurological Surgery, School of Medicine, State U. of NY at Stony Brook.

SNI: Trauma

Editor
Jutty Parthiban
Kovai Medical Center and Hospital, Tamil Nadu, India

SNI
Open Access

Technical Notes

Application of the subdural evacuating port system for the drainage of postoperative tension pneumocephalus: A technical note

Omer Doron, Julia R. Schneider, Jason Andre Ellis

Department of Neurosurgery, Lenox Hill Hospital, New York City, New York, United States.

E-mail: *Omer Doron - omerdoronmd@gmail.com; Julia R. Schneider - jschne10@nyit.edu; Jason Andre Ellis - jellis2@northwell.edu

***Corresponding author:**
Omer Doron,
Department of Neurosurgery,
Lenox Hill Hospital, New York City, New York, United States.

omerdoronmd@gmail.com

Received : 28 January 2022
Accepted : 16 April 2022
Published : 20 May 2022

DOI
10.25259/SNI_120_2022

Quick Response Code:

ABSTRACT

Background: Tension pneumocephalus is a neurosurgical emergency requiring prompt intervention. A variety of either temporizing or definitive methods was previously described as part of its management. Here, we report on an off-label use of a bed-side device and the subdural evacuating port system (SEPS)™ for the treatment of tension pneumocephalus.

Methods: The SEPS™ (Medtronic Dublin, Ireland) is a minimally invasive tool that is indicated for the removal of chronic or subacute subdural hematomas and at the patient's bedside. We describe the use of this system to evacuate tension pneumocephalus.

Results: A 44-year-old patient operated in our institution was presented with sudden obtundation 4 days post resection of esthesioneuroblastoma. Imaging confirmed a significant tension pneumocephalus. Immediate bedside decompression using a SEPS bolt placed frontally was performed, achieving rapid evacuation and patient regained consciousness. A definitive skull base reconstruction was done at the operating room at a later stage.

Conclusion: The SEPS™, well-known for evacuation of CSDH, can be potentially used as a bed-side tool to effectively treat mass effect created by tension pneumocephalus. As a readily-available and commercially used device, it can provide a simple and standard toolkit suitable for an emergent temporizing procedure.

Keywords: Brain compression, Burr hole, Craniotomy, Subdural evacuating port system, Tension pneumocephalus

INTRODUCTION

Tension pneumocephalus is a treatable neurosurgical emergency that occurs when air enters through a dural defect and becomes trapped, creating a mass effect.[11,12] The clinical presentation is variable and can include severe restlessness, deteriorating consciousness, focal neurological deficits, cardiac arrest, headache, nausea, vomiting, and seizures.[12,14]

There are two postulated mechanisms leading to the development of pneumocephalus: the "ball- valve" and the "inverted bottle" mechanisms. The former suggests that positive pressure (e.g., sneezing, coughing, Valsalva maneuvers) pulls air intracranially through a cranial defect, and resists outflow leading to tension pneumocephalus.[2,10,16] The latter indicates that drainage of cerebrospinal fluid (CSF) leads to negative intracranial pressure (ICP) that is relieved by the influx

of air through a cranial defect.[8] In cases of pneumocephalus, normobaric oxygenation reduces the volume of intracranial air through accelerated clearance of nitrogen.[8]

CT is the gold standard for the diagnosis of both pneumocephalus and tension pneumocephalus, requiring only 0.55 mL of air for detection.[5] The leading causes of pneumocephalus include trauma, infection, and postoperative (usually after cranial, spinal, or ENT procedures).[9,14] While the etiologies are variable, the pathophysiology is convergent with intracranial air producing mass effect on the brain with elevation of ICPs.[10,11] It has also been posited that direct exposure to high pressure air may be toxic to neurons leading to cerebral edema and other deleterious effects.[15] Therefore, tension pneumocephalus is considered an emergency, requiring immediate neurosurgical intervention.[1,4,10,12]

MATERIALS AND METHODS

The subdural evacuating port system (SEPS)™ (Medtronic Dublin, Ireland) is a minimally invasive tool that is indicated for the removal of chronic or subacute subdural hematomas and hygromas.[6] Due to its minimally invasive nature, the SEPS enables the neurosurgeon to utilize the device at the patient's bedside using local anesthesia and hand-powered drill to make burr hole. The closed system does not require irrigation, aspiration, or a catheter, and the procedure can be completed within a few minutes with a relatively low complication rate.[13]

We report on a case where an off-label use of this system, taking advantage of its rapid and simple bed-side instrumentation, was performed as a temporizing measure for treating an acutely decompensating patient suffering a postoperative tension pneumocephalus.

RESULTS AND CASE PRESENTATION

A 44-year-old man underwent a resection of a large esthesioneuroblastoma in our institution, using a cranial open approach. Four days postoperatively, he was found obtunded, with a sudden impairment in level of consciousness. The patient then undergone an emergent head computed tomography (CT) in the ICU showing a significant bifrontal extradural pneumocephalus compressing the frontal lobes [Figure 1].

A diagnosis of tension pneumocephalus was made and it was decided by the attending neurosurgeon to utilize the SEPS for rapid decompression as the right frontal side was chosen as the insertion point. The patient was immediately prepared and using local anesthetic; a stab incision was made in his right forehead down to the bone. A twist drill burr hole was placed and the SEPS bolt was screwed in. The SEPS JP drain was then attached and placed at self-suction. The entire procedure time took approximately 5 min. Following air drainage into the bag, the patient immediately improved and regained full consciousness. Follow-up CT imaging performed several hours later confirmed excellent brain decompression [Figure 2].

The patient subsequently underwent elective skull base reconstruction to seal the postoperative defect in his anterior cranial base [Figure 3]. He made an excellent recovery and was discharged home.

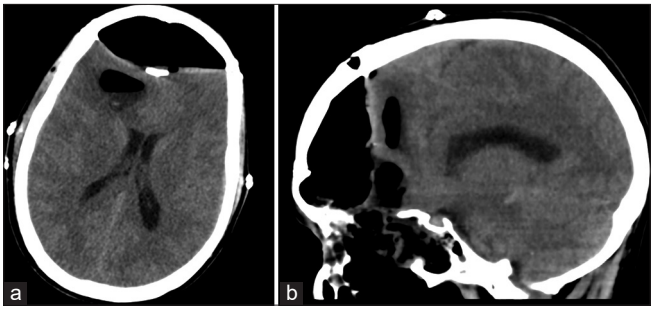

Figure 1: (a) Axial CT shows pneumocephalus with frontal lobe compression, (b) Sagittal view of the same scan.

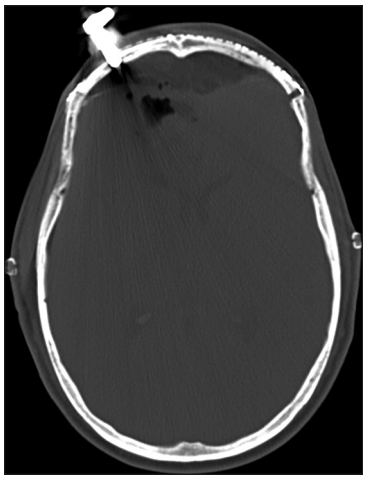

Figure 2: Axial CT shows evacuation of pneumocephalus with subdural bolt drain.

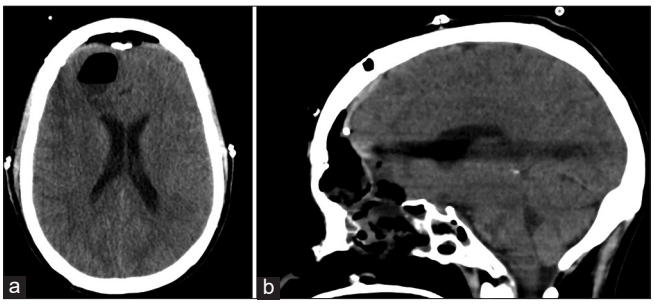

Figure 3: (a) Axial CT after skull base reconstruction to seal postoperative defect in anterior cranial base, (b) Sagittal plane of the same scan.

DISCUSSION

Although rarely under tension, pneumocephalus is a common occurrence after neurosurgical procedures.[2,16] There is no established treatment of pneumocephalus after skull base surgery in the literature; however, the association of pneumocephalus with a skull base defect is similar to that of postoperative CSF leaks and may benefit from similar management.[1] Most collections are small, benign, and respond to conservative therapy (i.e., bed rest and supplemental oxygen); however, space-occupying tension pneumocephalus requires prompt diagnosis and treatment.

This case, to the best of our knowledge, is the first to report on the utilization of the SEPS at the bedside as an emergent temporizing treatment of tension pneumocephalus.

Several temporizing measures for tension pneumocephalus have been described. Bed rest, raising the bed head, hyperosmolar therapy, and abstaining from valsalva-like maneuvers comprise the conservative approaches. Normobaric hyperoxia with 100% inspired oxygen facilitates faster resorption of pneumocephalus and has been described in the literature.[3,7] Due to pulmonary toxicity, this therapy can be offered for a maximal duration of 24–48 h. In an acute ongoing deteriorating patient, therapy has to resort to surgical temporizing measures. These provide rapid decompression of the pneumocephalus and include burr holes, craniotomy, needle aspiration, and an external ventricular drain.[10] These measures either require an operating theater setup or it may take time to assemble the required gear in a bed-side setup. An external ventricular drain may be more invasive in nature and relies on a catheter that has a long shaft compared to a bolt.

The SEPS is indicated for subacute and chronic subdural hematomas and hygromas and has been shown to be effective, safe, and durable for the indicated uses.[13] Compared to the traditional burr hole management, there is no significant difference in mortality or other adverse outcomes.

The kit is composed of a bolt connected to a drain with a closed self-suction system and can be inserted through a 5-mm incision after twist-drilling the skull [Figure 4]. Designed to access and evacuate subdural fluid accumulations into an external suction reservoir, it is also intended to drain air and fluids from the subdural space immediately following craniotomy procedures removing chronic and subacute subdural hematomas.

Therefore, the system is capable of decompressing tension pneumocephalus in a similar manner to evacuating a subdural hematoma through a minimally invasive and quick procedure conducted at the bedside, rather than the operating room.

We believe that a potential advantage of this technique lies both in the rapid, bedside nature of this device, as well as the fact, it is an already assembled kit, which does not require gathering of different instruments, which could be challenging in an emergent ward setup. Importantly, the bolt can be left in place for a few days, allowing ample time for evacuation of air, which can accumulate in significant amounts particularly after skull base surgery.[16] As it lies in the skull and is rigid, it potentially offers better patency over time compared to drains. The capability of the port to remain unclogged along with a high safety profile as a bolt contributes to it being a suitable candidate for use in such cases.

Figure 4: Subdural evacuating port system composed of a bolt connected to a drain with a closed self-suction system.

CONCLUSION

The SEPS™, known for its use in evacuation of CSDH, can be potentially used as a bed-side tool to effectively treat mass effect created by air trapped within the cranium. As a readily-available and off-the shelf device, it can provide a simple and standard toolkit suitable for an emergent temporizing procedure for the treatment of tension pneumocephalus.

Declaration of patient consent

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

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Dabdoub CB, Salas G, Silveira E, Dabdoub CF. Review of the management of pneumocephalus. Surg Neurol Int 2015;6:155.

2. Healy J, Grant M, Melnyk S, Boldt B. Tension pneumocephalus a rare complication of cerebrospinal fluid leak. Radiol Case Rep 2018;14:365-7.
3. Hong B, Biertz F, Raab P, Scheinichen D, Ertl P, Grosshennig A, *et al*. Normobaric hyperoxia for treatment of pneumocephalus after posterior fossa surgery in the semisitting position: A prospective randomized controlled trial. PLoS One 2015;10:e0125710.
4. Hubbard JL, McDonald TJ, Pearson BW, Laws ER Jr. Spontaneous cerebrospinal fluid rhinorrhea: Evolving concepts in diagnosis and surgical management based on the Mayo Clinic experience from 1970 through 1981. Neurosurgery 1985;16:314-21.
5. Karavelioglu E, Eser O, Haktanir A. Pneumocephalus and pneumorrhachis after spinal surgery: Case report and review of the literature. Neurol Med Chir 2014;54:405-7.
6. Kenning TJ, Dalfino JC, German JW, Drazin D, Adamo MA. Analysis of the subdural evacuating port system for the treatment of subacute and chronic subdural hematomas. J Neurosurg 2010;113:1004-10.
7. Klein J. Normobaric pulmonary oxygen toxicity. Anesth Analg 1990;70:195-207.
8. Lunsford LD, Maroon JC, Sheptak PE, Albin MS. Subdural tension pneumocephalus. Report of two cases. J Neurosurg 1979;50:525-7.
9. Markham JW. The clinical features of pneumocephalus based upon a survey of 284 cases with report of 11 additional cases. Acta Neurochir 1967;16:1-78.
10. Pulickal GG, Sitoh YY, Ng WH. Tension pneumocephalus. Singapore Med J 2014;55:e46-8.
11. Satapathy GC, Dash HH. Tension pneumocephalus after neurosurgery in the supine position. Br J Anaesth 2000;84:115-7.
12. Schirmer CM, Heilman CB, Bhardwaj A. Pneumocephalus: Case illustrations and review. Neurocrit Care 2010;13:152-8.
13. Singla A, Jacobsen WP, Yusupov IR, Carter DA. Subdural evacuating port system (SEPS) minimally invasive approach to the management of chronic/subacute subdural hematomas. Clin Neurol Neurosurg 2013;115:425-31.
14. Solomiichuk V, Lebed V, Drizhdov K. Posttraumatic delayed subdural tension pneumocephalus. Surg Neurol Int 2013;4:37.
15. Venkatesh SK, Bhargava V. Clinics in diagnostic imaging (119). Post-traumatic intracerebral pneumatocele. Singapore Med J 2007;48:1055-9; quiz 1060.
16. Yin C, Chen BY. Tension pneumocephalus from skull base surgery: A case report and review of the literature. Surg Neurol Int 2018;9:128.

How to cite this article: Doron O, Schneider JR, Ellis JA. Application of the subdural evacuating port system for the drainage of postoperative tension pneumocephalus: A technical note. Surg Neurol Int 2022;13:204.