Journal of Clinical Neuroscience xxx (2017) xxx–xxx

Contents lists available at ScienceDirect

Journal of Clinical Neuroscience

journal homepage: www.elsevier.com/locate/jocn

Tools and techniques

Neuroendoscopic evacuation of intraventricular empyema using a side-cutting aspiration device

Min Lang [a,b], Ghaith Habboub [b], Nina Z. Moore [b], Violette M.R. Recinos [b,c,f], Alireza M. Mohammadi [b,c], Sean Nagel [b], Adarsh Bhimraj [e], Danilo Silva [b,c], Pablo F. Recinos [b,c,d,*]

[a] Case Western Reserve University, School of Medicine, Cleveland, OH, United States
[b] Department of Neurosurgery, Neurological Institute, Cleveland Clinic, Cleveland, OH, United States
[c] Rose Ella Burkhardt Brain Tumor and Neuro-Oncology Center, Neurological Institute, Cleveland Clinic, Cleveland, OH, United States
[d] Section of Rhinology, Sinus, and Skull Base Surgery, Head and Neck Institute, Cleveland Clinic, Cleveland, OH, United States
[e] Section Neurologic Infectious Disease, Cleveland Clinic, Cleveland, OH, United States
[f] Section of Pediatric Neurosurgical Oncology, Cleveland Clinic, Cleveland, OH, United States

ARTICLE INFO

Article history:
Received 20 August 2017
Accepted 29 September 2017
Available online xxxx

Keywords:
Neuroendoscopy
Gram-negative bacteria
Ventriculitis
Intraventricular empyema

ABSTRACT

Pyogenic ventriculitis is a rare but severe post-neurosurgical complication. The infection is often resistant to antibiotic treatment alone. Continuous intraventricular irrigation has been suggested but the technique is cumbersome, increases the risk for secondary infection, and is inadequate in removing adherent purulence. We used a novel neuroendoscopic approach assisted with a side-cutting aspiration device to treat four cases of post-neurosurgical pyogenic ventriculitis. Ventricular empyema was cleared in all patients and three of the four patients had favorable outcomes.

1. Introduction

Pyogenic ventriculitis is a rare but often fatal complication after neurological surgery. With poor antibiotics penetration into the ventricular space and the empyema, medical management alone is often insufficient for treatment. With early diagnosis and appropriate antibiotic treatment, mortality rates can still be as high as 70% [1,2].

Intraventricular irrigation alone is often inadequate in removing adherent pus and debris, resulting in a lack of source control required for effective antibiotic penetration [3,4]. Here, we report the use of a novel neuroendoscopic technique using a side-cutting aspiration device to effectively treat antibiotic nonresponsive cases of pyogenic ventriculitis.

2. Patients and methods

A waiver of patient consent for this retrospective case series was approved by the local Institutional Review Board. Patient characteristics, initial indications for neurosurgery, CSF cultures, length of hospital stay, and final outcomes are presented in Tables 1 and 2. All patients were diagnosed with pyogenic ventriculitis postoperatively through diffusion-weighted magnetic resonance imaging (DWI) (Fig. 1) and positive cerebrospinal fluid (CSF) cultures (Table 1). Empiric intravenous (IV) and subsequent intrathecal (IT) antibiotics were started as soon as possible following initial signs of infection. Targeted antibiotics were started following culture specification. Despite this, *Patients 1, 2, and 3* showed persistent ventriculitis and intraventricular empyema formation. As a final option, neuroendoscopic evacuation of intraventricular empyema was performed using a side-cutting aspiration device (Myriad, NICO Corporation, Indianapolis, Indiana). Neuroendoscopic evacuation was performed much earlier in *Patient 4* due to extensive imaging findings of membranous pus formation in the ventricles and experience with the previous three patients. Mean duration of antibiotics treatment before neuroendoscopic evacuation was 8.5 days ± 6.6 days.

Post-evacuation DWI showed clearance of intraventricular pus and no signs of infarct or injury in all cases (Fig. 1). No growth was observed on daily CSF cultures post-evacuation. 3 of the 4 patients had favorable outcomes (Table 2). Despite clearance of infection (Fig. 1H), *Patient 4* subsequently had a complicated course and died on post-evacuation day 28 due to multi-organ

* Corresponding author at: Minimally Invasive Cranial Base and Pituitary Surgery Program, Rose Ella Burkhardt Brain Tumor & Neuro-Oncology Center, 9500 Euclid Ave., CA-51, Cleveland, OH 44195, United States.
E-mail address: recinop@ccf.org (P.F. Recinos).

https://doi.org/10.1016/j.jocn.2017.09.029
0967-5868/

Table 1
Patient characteristics and course of infection.

Patient No.	Age	Sex	Initial indication for neurosurgery	Time from initial operation to diagnosis of ventriculitis (days)	Site of empyema	CSF culture organism	Antibiotics regimen	Time on antibiotics before evacuation (days)
1	24	M	Recurrent WHO Grade I craniopharyngioma	6	Left lateral ventricle	*ESBL-Klebsiella pneumoniae*	IT colistimethate plus vancomycin and meropenem	15
2	17	M	Recurrent WHO grade II fourth ventricular ependymoma	16	Right lateral ventricle, aqueduct of Sylvius, third ventricle, fourth ventricle	*Klebsiella pneumonia*	IT gentamicin plus vancomycin and meropenem	5
3	35	M	Bone flap replacement s/p hemicraniectomy and cranioplasty for severe traumatic brain injury	7	Lateral, third, and fourth ventricles	*Pseudomonas aeruginosa*	IT gentamicin plus cefepime and vancomycin	13
4	69	M	WHO grade II fourth ventricular ependymoma	8	Left lateral ventricle, fourth ventricle, aqueduct of Sylvius	*Enterobacter cloacae*	IT gentamicin plus vancomycin and meropenem	2

*ESBL = extended spectrum β-lactamase.

Table 2
Hospital course and treatment outcomes.

Patient No.	Hospital stay post-evacuation (days)	Total length of hospital stay (days)	Final outcome
1	25	43	Neurologically intact. Strength and daily functioning fully back to baseline at 1 year follow-up
2	56	82	Neurologically intact, disconjugate gaze, and ataxia with improving ambulation at 1 year follow-up
3	27	42	Back to baseline neurologically. Residual spasticity in the left upper and lower extremities at 9 months follow-up
4	Expired on post-operative day 28	62	Death due to multi-organ failure from ARDS, AKI, septic shock

failure (acute respiratory distress, acute kidney injury, splenic infarct, and hypotensive shock).

3. Illustrative case

3.1. Patient 1

A 24-year-old male with past medical history of recurrent craniopharyngioma, panhypopituitarism, and seizures presented with headache and progressive vision loss in the right eye. The patient had undergone multiple previous craniotomies for subtotal resection of a craniopharyngioma and received radiation treatment outside the United States. His course had been complicated by recurrent infections.

The patient then underwent an expanded endoscopic, endonasal approach for near total resection of the craniopharyngioma. On post-operative day 6, he had an acute neurological decline requiring emergent intubation. Computerized tomography (CT) showed increased ventricular size and the patient had an elevated white blood cell count. He was taken to the operating room for removal of the Ommaya reservoir and right VP shunt, and placement of a right occipital external ventricular drain (EVD). A left frontal external ventricular drain was also placed due to a lack of fluid communication between the lateral ventricles. IT colistimethate, IV vancomycin, and IV meropenem were started. Multiple CSF cultures were positive for extended spectrum β-lactamase producing Klebsiella *pneumonia*e (ESBL-KP). Despite maximal antibiotic treatment, the patient's meningitis remained persistent and DWI of the brain showed evolving ventriculitis with intraventricular abscess in the left occipital horn. As a final option, he underwent burr-hole craniotomy and neuroendoscopic exploration to evacuate the purulent material.

3.2. Surgery (Video 1)

A left occipital burr hole was drilled and a neuronavigation guidance system (Brainlab, Feldkirchen, Germany) was used to reach the left lateral ventricle. The left lateral ventricular system was explored endoscopically using a 0-degree scope. Frank cotton-like purulence was observed adherent to the ventricular walls (Fig. 2). A septostomy was created to connect the lateral ventricles. A side-cutting aspiration device was inserted into an endoscopic port and was used to remove the purulent material utilizing the suctioning and side-cutting capabilities of the device (Fig. 3).

Please cite this article in press as: Lang M et al. Neuroendoscopic evacuation of intraventricular empyema using a side-cutting aspiration device. J Clin Neurosci (2017), https://doi.org/10.1016/j.jocn.2017.09.029