ORIGINAL ARTICLE

A Simple Technique of Cerebrospinal Fluid Leak Prevention Following Endoscopic Third Ventriculostomy: A Technical Note

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■ BACKGROUND: **There are a variety of complications of endoscopic third ventriculostomy (ETV) that have been described in the literature. Cerebrospinal fluid leak is one of the common complications that need to be addressed properly and timely management plays a crucial role in prevention of meningitis/encephalitis.**

■ OBJECTIVE: **To share our experience of using autologous bone (from burr hole) debris and "BloodSTOP" absorbable hemostatic agent as an effective tool in cerebrospinal fluid leak prevention.**

■ METHODS: **We have observed 14 individuals who have undergone an ETV procedure using the abovementioned multilayered technique of burr hole closure at our institution in 2024.**

■ RESULTS: **A watertight dural closure is a mandatory step in every case of neurosurgical procedure. But when primary dural closure is not possible in endoscopic intraventricular surgeries, there is a way out using more affordable hemostatic materials like BloodSTOP. There are plenty of strategies in surgical closure technique, including pericranial graft, dural allografts and synthetic substitutes, and various sealants but no single consensus on the best practice regarding dural closure. TachoSil is a hemostatic agent consisting of human fibrinogen and thrombin coated onto an equine collagen sponge and has proven efficacy as a sealant for easy repair of encephalocele, incidental spinal durotomy, transsphenoidal surgery, and intradural cranial and spinal lesions.**

■ CONCLUSIONS: **We report the use of a simple novel, sutureless BloodSTOP sandwich dural closure technique for post ETV dural defects, which has proven efficacy in our study when watertight primary dural closure is not technically feasible.**

INTRODUCTION

Endoscopic third ventriculostomy (ETV) is a neurosurgical procedure involving the perforation of the floor of the third ventricle and the Liliequist membrane to establish communication between the intraventricular cerebrospinal fluid (CSF) pathways and the basal cisterns. It has been widely recognized as an effective and minimally invasive treatment for obstructive hydrocephalus (OH).

Since Jason Mixter (1880–1958) first introduced third ventriculostomy for the treatment of non-OH using an ureteroscope in 1923, ETV has evolved into a reliable and efficient procedure, particularly in cases requiring urgent intervention for hydrocephalus.[1]

While there is ongoing debate regarding its limitations in certain age groups, ETV has demonstrated a high success rate—approximately 86% in children older than 1 year. Poor outcomes have primarily been associated with a history of intraventricular

Key words
- CSF leak
- ETV
- Obstructive hydrocephalus

Abbreviations and Acronyms
CSF: Cerebrospinal fluid
ETV: Endoscopic third ventriculostomy
OH: Obstructive hydrocephalus

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hemorrhage or neuroinfection, both of which are considered potential predictors of procedural failure.[2] Pediatric patients undergoing ETV before the age of 6 months have shown a significantly higher risk of treatment failure.[3]

One of the frequent complications following ETV is CSF leakage. Despite careful surgical technique, postoperative CSF leakage and pseudomeningocele formation remain clinically significant challenges. These complications may lead to prolonged hospitalization, need for rehospitalization, and reoperation. Moreover, literature has reported fatal sequelae of CSF leakage, including wound infection, meningitis, and encephalitis.[4] CSF leakage is often considered a marker of ETV failure, with reported incidence rates ranging between 1.7% and 5.2%. A recent literature review reported the average postoperative CSF leak rate in ETV to be approximately 1.61%.[5]

As a general principle, watertight dural closure is essential in all intraventricular surgical procedures, and the use of biological augmentation materials is widely recommended to support this goal. However, achieving primary dural closure may be technically challenging in certain scenarios—such as incisions made through a burr hole during ETV, in cases of dural inelasticity, or when the incision is located near venous sinuses.

In this context, we present a simple, sutureless technique for dural reconstruction using an absorbable hemostatic agent composed of etherified carboxymethyl cellulose. Applied in a sandwich-like configuration as both an inlay and onlay, this material provides effective coverage and sealing of small dural defects.

METHODS

This study included 14 patients admitted through our outpatient department with OH caused by aqueductal stenosis, pineal region tumors, or cysts, who underwent surgical treatment between January 2024 and December 2024. The study protocol was approved by the Institutional Review Board of the Republican Scientific-Practical Medical Center of Neurosurgery. No external funding was received for this research. A retrospective review was conducted of all ETV procedures performed by the senior authors during the study period.

Patient data were collected from the electronic medical record system “Technomed,” including inpatient charts, clinical notes, operative reports, and surgical supply documentation. Inclusion criteria comprised patients who underwent ETV either as a primary surgical intervention or as a preliminary palliative treatment.

Primary outcomes assessed were postoperative CSF leakage, symptomatic pseudomeningocele, need for additional CSF diversion procedures, postoperative infection, and revision surgery.

Postoperative CSF leakage was defined as the discharge of clear fluid (presumed CSF) through the surgical incision site, with or without associated clinical symptoms. Symptomatic postoperative pseudomeningocele was defined as a fluid collection in the subgaleal or subcutaneous space near the incision site, confirmed on postoperative imaging (magnetic resonance imaging or computed tomography) and documented in the radiologist’s report. Clinical correlation included local swelling at the operative site, with or without associated signs of intracranial hypertension, such as headache, nausea, or vomiting.

Technique

In each case of ETV, after ETV is finished, we suggest meticulous irrigation using warm saline to ensure complete hemostasis along the endoscopic corridor. Once hemostasis is confirmed, a firmly packed, ball-shaped piece of Surgicel Fibrillar is placed at the site, followed by the inlaying of 3 layers of etherified carboxymethyl cellulose material (BloodSTOP, LifeScience Plus), extending beyond the margins of the dural defect.

Subsequently, dry strips of BloodSTOP are applied as an outer protective layer over the dura, covering the circumference of both the burr hole and the dural opening. Using a delicate instrument such as a Penfield Number 3 dissector, the BloodSTOP is carefully tucked beneath the bony margins, allowing it to extend beyond the edges of the burr hole (Figure 1).

Then, applying gentle finger pressure over hemostat, provides it to adhere, slight irrigation with warm saline solution facilitates complete adhesion to the dura, which usually demands approximately 30 seconds.

It is important to use completely dry instruments when placing BloodSTOP as an onlay or inlay material, due to its strong adhesive properties. Focal pressure and repeated irrigation may be necessary at sites where BloodSTOP does not adhere adequately.

We suggest to perform Valsalva maneuver to reassure the absence of CSF egress from the dural closure. The cranial bone dust is then filled in the burr hole and 2 layers of BloodSTOP layed over bone dust to keep it in its bed firmly. Galea is reapproximated and sutured. Closure of skin incision is performed in the usual fashion.

RESULTS

A total of 14 patients (8 females and 6 males) underwent ETV during the study period (Table 1). The mean age was 34.0 ± 20.38 years, with a male-to-female ratio of 0.75:1, indicating a slight predominance of female patients.

The surgical indications for ETV included intra-axial pineal region tumors ($n = 6$), aqueductal stenosis ($n = 6$), an arachnoid

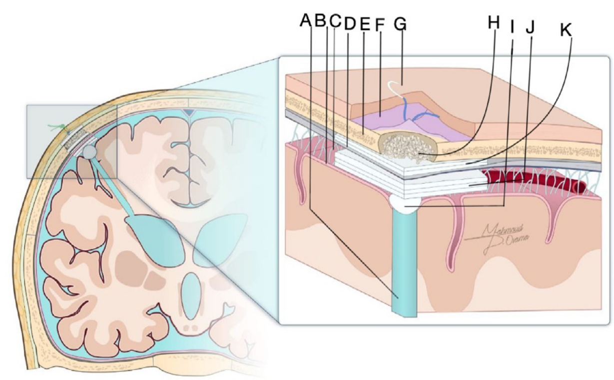

Figure 1. Schematic illustration of sandwich technique using hemostatic material BloodSTOP and bone dust. (**A**) Endoscopic pathway. (**B**) Pia mater. (**C**) Arachnoid layer. (**D**) Dura mater. (**E**) Frontal bone. (**F**) Suturing galea aponeurotica. (**G**) Skin. (**H**) Burr hole filled with its own bone dust. (**I**) Surgicel Fibrillar in ball-shaped form. (**J**) Inner layer of BloodSTOP. (**K**) Outer layer of BloodSTOP (illustration by Dr. Mahmoud Osama).

Table 1. General Information About Patients' Data

Patient	Gender	Age	Diagnosis	Surgery	Days in Hospital
1	F	27	Aqueductal stenosis. OH	ETV	5
2	M	22	Aqueductal stenosis. OH	ETV	6
3	M	28	Aqueductal stenosis. OH	ETV	5
4	M	19	Pineal region tumor. OH	ETV	6
5	M	7	Pineal region tumor. OH	ETV	6
6	F	47	Aqueductal stenosis. OH	ETV	7
7	F	64	Aqueductal stenosis. OH	ETV	5
8	M	46	Pineal region tumor. OH	ETV	5
9	M	54	Pineal region tumor. OH	ETV	7
10	F	9	Cerebellar vermis and IV ventricle tumor. OH	ETV	6
11	F	28	Aqueductal stenosis. OH	ETV	7
12	F	74	Pineal region tumor. OH	ETV	6
13	F	21	Arachnoidal cyst of the third ventricle. OH	ETV	7
14	F	26	Pineal region tumor. OH	ETV	6

F, female; OH, obstructive hydrocephalus; ETV, endoscopic third ventriculostomy; M, male; IV, intravenous.

cyst of the third ventricle ($n = 1$), and a tumor involving the cerebellar vermis and fourth ventricle ($n = 1$). In all cases, ETV was performed as a palliative procedure aimed at relieving symptoms of acute OH.

No cases of postoperative CSF leakage were observed clinically, and postoperative imaging revealed no evidence of pseudomeningocele at the incision site in any patient.

DISCUSSION

Watertight dural closure remains a fundamental step in all intraventricular neurosurgical procedures. However, in certain cases—particularly endoscopic intraventricular surgeries—achieving primary dural closure can be technically challenging. In such scenarios, the use of hemostatic materials such as BloodSTOP or TachoSil offers a practical and effective alternative.

Various strategies for dural closure have been described in the literature, including pericranial grafts, dural allografts, synthetic substitutes, and a range of sealants. Despite these numerous approaches, there remains no consensus on the optimal method for dural closure. TachoSil, a hemostatic agent composed of human fibrinogen and thrombin coated onto an equine collagen sponge, has demonstrated efficacy in sealing small dural defects, including those encountered in encephaloceles, spinal durotomies, transsphenoidal surgery, and other cranial and spinal intradural procedures.[6]

BloodSTOP, another hemostatic agent used in our practice, has proven to be a safe and cost-effective option for sealing small dural defects, such as those encountered in ETV. Some authors advocate for additional external reinforcement—such as the application of a tight bandage—particularly in pediatric patients, where the dura is thin and the galea is structurally weak.[6]

Nevertheless, we acknowledge that our technique has not been applied to large dural defects, such as those encountered in craniotomies. In such cases, we continue to consider pericranial autografts as the most reliable substitute for native dura mater. Other techniques, such as the "mushroom" or "T-plug" method using absorbable gelatin sponge to occlude the endoscopic tract, have also shown favorable results in preventing CSF leakage.[3,7,8]

To date, we have not encountered any comparative studies indicating that BloodSTOP is inferior to other dural closure methods. Fibrin-based adhesives form a strong bond with the dura and offer a reliable barrier without requiring sutures. However, the use of a single hemostatic agent like BloodSTOP may be advantageous in limited-resource settings, offering cost-effectiveness without compromising safety or efficacy.

In the present study, we report the safe and effective use of a novel, sutureless BloodSTOP sandwich technique for closing small dural defects following ETV. The combined inlay-onlay application of BloodSTOP provides a reliable protective layer capable of withstanding intracranial hydrostatic pressure.

Limitations

This technique may not be equally applicable in all patient populations. Specifically, its feasibility in cases where the skull is thin—such as in infants—or in patients with osteoporotic bone is uncertain. In such scenarios, achieving sufficient sub-bone anchoring of the hemostatic material may be technically challenging, potentially limiting the effectiveness of the closure and increasing the risk of CSF leakage. This represents a potential limitation of the technique that warrants further investigation in broader patient cohorts.

CONCLUSIONS

We present a simple, sutureless dural closure technique using the BloodSTOP sandwich method for small dural defects following ETV. This technique demonstrated safety and efficacy in our patient series when primary watertight dural closure was not feasible. While we recognize that traditional primary dural suturing remains the gold standard, our approach offers a practical and cost-effective alternative, particularly in minimally invasive procedures and resource-constrained settings.

CRediT AUTHORSHIP CONTRIBUTION STATEMENT

Dilshod Mukhammadvalievich Mamadaliev: Conceptualization, Data curation, Formal analysis, Writing — original draft. **Ulugbek Asadullaev:** Data curation, Formal analysis. **Gayrat Maratovich Kariev:** Formal analysis, Investigation. **Mahmoud Osama:** Investigation, Methodology. **Jakhongir Yakubov:** Resources, Software. **Dilshod Naimovich Khodjimetov:** Resources, Software. **Tohir Makhmudovich Akhmediev:** Software, Visualization. **Maruf Makhsudovich Matmusaev:** Supervision, Validation, Visualization. **Bipin Chaurasia:** Supervision, Validation, Visualization, Writing — review & editing.

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