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Tailoring endoscopic third ventriculostomy for diverse 3rd ventricular floor landscapes

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Endoscopic third ventriculostomy (ETV) offers an effective minimally invasive solution for obstructive hydrocephalus. This video chapter provides insights into patient selection, surgical technique, and post-operative care for ETV. The chapter outlines ETV's evolution and indications, emphasizing meticulous patient selection based on radiological parameters and clinical evaluation. Pre-operative planning ensures procedural precision, with detailed guidance on optimal head positioning and burr hole placement. Under general anesthesia, the ETV technique involves precise ventricular access and stoma creation using channeled neuroendoscopes. Post-operative management focuses on vigilant monitoring and outcome assessment. ETV demonstrates success rates ranging from 70 to 90%, with proper patient selection and pre-operative evaluation associated with better outcomes. This chapter serves as a valuable resource for neurosurgeons navigating hydrocephalus, showcasing ETV's efficacy in select cases.

Keywords: hydrocephalus, endoscopic third ventriculostomy, patient selection, surgical technique, post-operative care

Introduction

An active distension of the ventricular system of the brain resulting from the inadequate passage of CSF from its point of production from the choroid plexus within the cerebral ventricles to its point of absorption into the systemic circulation through the arachnoid granulations (1) (**Figure 1**). Depending on the pathology, the treatment options may vary. Endoscopic third ventriculostomy (ETV) has been a well-known technique for over a century and gained its popularity over the last 3 decades and became one of the primary treatment modalities of internal CSF (cerebrospinal fluid) diversion (2). ETV is a minimally invasive neurosurgical procedure aimed at treating predominantly obstructive hydrocephalus secondary to aqueductal stenosis either congenital or acquired. People have tried this procedure in a few selected cases of communicating hydrocephalus with limited success (3, 4). Conventional ETV (**Video 1**) aimed at creating an alternate CSF pathway through the floor of the third ventricle (tuber cinereum) to the basal cisterns into interpeduncular space using the channeled neuroendoscope. In a few difficult cases, like thickened floor, distorted anatomy of floor of the third ventricle or high arched basilar artery with very limited space in prepontine cisterns, an alternative ETV technique called lamina terminalis ETV (LTETV) can be done using a flexible endoscope (**Video 2**).

This chapter is structured to provide comprehensive insights into the ETV procedure, its indications, technique, and post-operative care.

Selection of cases for ETV

Selecting an ideal case for ETV depends on the patient's age, etiology and previous treatment. Neonatal or early infantile hydrocephalus poses a major challenge and has high failure rates with ETV or shunt surgery. Kulkarni et al. (5, 6) proposed ETV success score to select an appropriate case for ETV with reasonably high success rates of surgery. There are other independent radiological

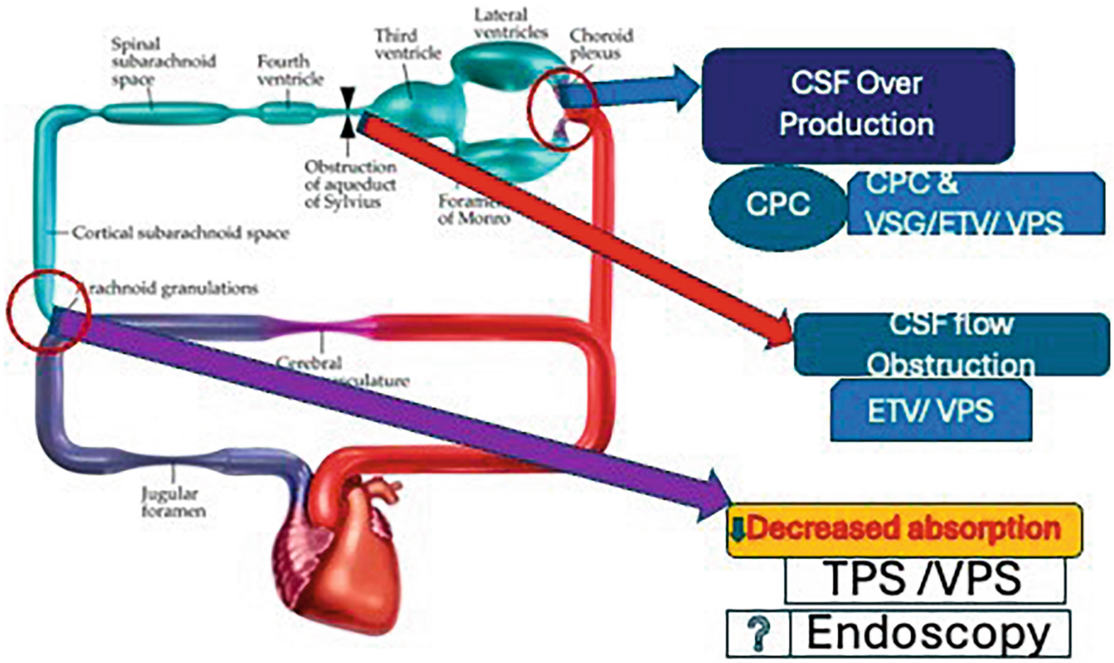

FIGURE 1 | Illustrated diagram showing the normal CSF circulation with possible causes of CSF circulation abnormalities causing hydrocephalus and their modes of management. CPC, choroid plexus coagulation; VSG, ventriculo subgaleal shunt; VPS, ventriculo peritoneal shunt; ETV, endoscopic third ventriculostomy; TPS, thecoperitoneal shunt.

VIDEO 1 | https://youtu.be/G95SH-f_1Gc

VIDEO 2 | https://youtu.be/3C0HIyzW49c

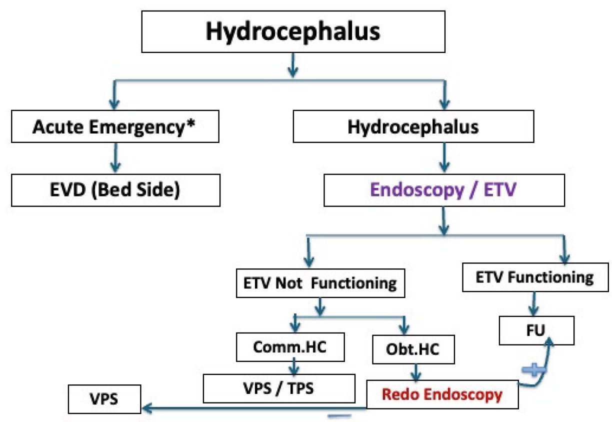

FIGURE 2 | Flow chart showing the hydrocephalus management algorithm and role of ETV in the management of hydrocephalus. EVD, external ventricular drainage; obt. HC, obstructive hydrocephalus; comm. HC, communicating hydrocephalus; FU, follow up.

parameters like the third ventricular bowing sign which will predict the ETV success (7, 8). Down bowing of the third ventricular floor by more than 5 mm has been associated with high success rates. In older children and adults the indications are relatively clear and ETV is the first option in obstructive hydrocephalus. Post-haemorrhagic and post-infective hydrocephalus in pediatric or adult cases are associated with very low success rates with ETV. I follow this flow chart for the selection of different treatment options (**Figure 2**). For this chapter, I will limit myself to ETV and discuss the technical nuances, post-operative complications and outcomes of this technique.

Endoscopic third ventriculostomy (ETV) technique

The procedure is performed under general anaesthesia (GA). Pre-operative evaluation of the imaging is very crucial in planning the head position and placement of the burr hole. The patient is positioned supine with 10–15^0 flexion and the head is turned to the opposite side by 20–30^0 so that it brings the burr hole point to the highest position (9). The exact entry point can be measured on CT or MRI images. The best point is accessed by *two point technique*, where we draw a line connecting the stoma site in the floor of the third ventricle to the midpoint of the foramen Monroe and is extended onto the scalp. This line will be straight and without damage to the fornix one can advance the scope into the third ventricle in sizable dilated foramen Monroe (**Figure 4**). This line has to be adjusted both in sagittal and coronal planes. Usually, this point will match with Kocher's point. Occasionally when one is planning for biopsy along

FIGURE 3 | Figures showing the channeled endoscopes. **(A,C)** Lotta system (Karl Storz) depicting the arrangement of working channels **(B)** Fiber optic flexible neuroendoscope (Karl Storz). **(D)** Flexible video endoscope: Chip on tip new generation flexible endoscope (Karl Storz).

with the ETV in posterior third ventricular lesions, one needs two different burr holes separately for biopsy and ETV (10). To avoid this one can use a single burr hole in the centre of both or use a flexible neuroendoscope to do the biopsy through the standard precoronal burr hole (**Figure 4**). Once the patient is positioned, the head can be strapped to the horseshoe headrest to avoid any movement during the surgery, especially in neonatal and pediatric populations. I routinely use the endoscope holder which is attached to the table on the side of the burr hole. Neuronavigation is used in planning and marking in selected cases with narrow ventricles, small foramen Monroe or multiseptated hydrocephalus. With the navigation, proper entry point, the direction of the trocar and cannula to advance into the ventricle can be planned precisely (11).

The endoscopic equipment is the surgeon's preference and two companies that supply these channel neuro endoscopes are Storz® and Aesculap®. Both these systems have three working channels (**Figure 3**). Two channels are used for instruments and one for irrigation. Once the trocar, cannula assembly is introduced into the lateral ventricle, it's fixed to the holding arm and CSF is collected for analysis. Later the channel endoscope is introduced through the cannula and locked in position. Subsequently, the scope is advanced into the third ventricle through the foramen Monroe. Anatomy is inspected and the stoma point in the floor of the third ventricle is identified anterior to the mamillary bodies. In uncomplicated cases, the floor is thin and transparent where one can inspect the pulsating basilar vessel or its branches. In the case of the opaque floor, one can feel the dorsum Sella with the help of a blunt bipolar electrode and puncture the floor just posterior to that. After the puncture through the floor, the stoma is enlarged using a 2F or 3F Fogarty catheter to achieve a stoma size of approximately 5mm or more. The Fogarty catheter dilatation should be very smooth and the balloon is engaged at the stoma orifice to enlarge it in a better way. It needs a bit of practice and coordination among the surgeon and the assistant. Just below the tuber cinereum, there will be a second layer called the membrane of Lilliquist. Both these layers need to be opened to have an effective functioning stoma (12–14). The endpoint of a successful ETV surgery is

- Adequate size stoma ($\geq$5 mm).
- Flip-flop movement of the membrane at the free edge of the stoma.
- Visible basilar vessels in the prepontine cisterns.

The ventriculostomy process may encounter minimal bleeding through the margins of the stoma in a few cases. This bleeding will stop with the irrigation. As much as possible all kinds of electrocoagulation to be avoided in that area to avoid injury to the perforators or hypothalamic damage. Any amount of blood collected in the ventricle can be irrigated and cleared. In difficult cases and unfavorable

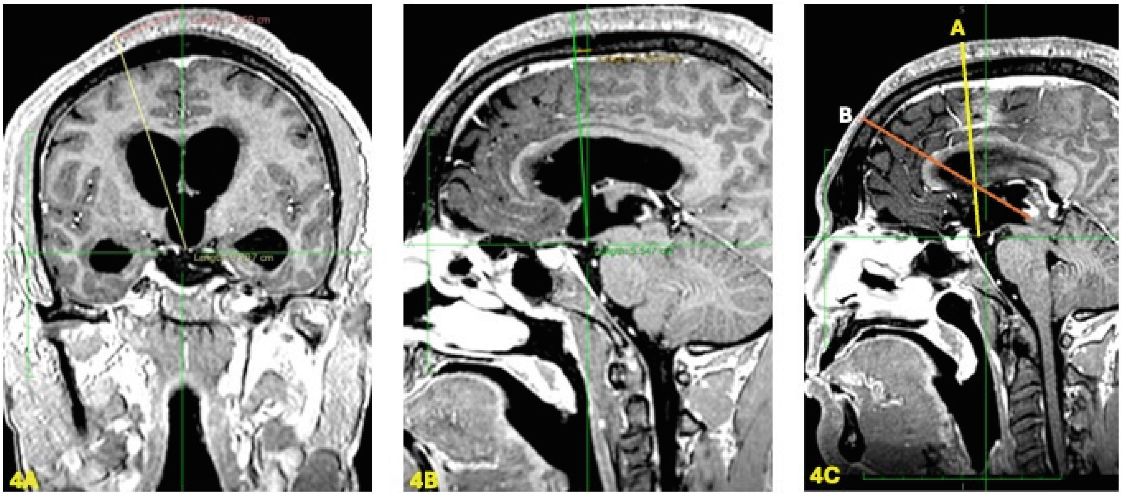

FIGURE 4 | MR images of a hydrocephalus patient showing pre-operative planning marking the entry point in coronal **(A)** and Sagittal **(B)** view for a standard ETV. **(C)** MR image of a patient with posterior third ventricular tumor with hydrocephalus showing different trajectories for the doing ETV and biopsy of the tumor.

VIDEO 3 | https://youtu.be/Fap-ovz1xHk

anatomy at the floor of the third ventricle, one can do the lamina terminalis ETV (LT ETV) using a flexible scope (**Video 2**). In cases of the narrow foramen of Monroe (FM), where it becomes difficult to advance the scope across the FM, a flexible scope can be used to do the conventional ETV (**Video 3**) or the conventional scope be fixed at the FM level and complete the ETV procedure. After securing adequate hemostasis, the scope and cannula are withdrawn. The wound is closed in layers.

Post-operative care

Following extubation, the patient is observed in the ICU for a few hours or a day depending upon the team's preference. Most of these patients can be discharged on the second day in uncomplicated hydrocephalus. Post-operative check CT or MRI is good to have an assessment of the ventricles. Post-operatively infants are monitored with clinical parameters, head circumference and anterior fontanelles. In older children and adults, clinical parameters are to be monitored. In case of any clinical deterioration, brain imaging is warranted. Follow-up MRI brain after 6–8 weeks gives a better appreciation of post-operative radiological changes.

Outcome

In uncomplicated cases, ETV has success rates ranging between 70 and 90%. The results can be ranged between 30 and 90% depending on the pathology and age group. Proper pre-operative evaluation and case selection using ETVSS can aim for high success rates (14). Most of the failures are seen in the first 1–2 months. A successful ETV beyond 5 years has the least chance of failure rates.

Conclusion

Endoscopic third ventriculostomy (ETV) is a minimal invasive CSF diversion procedure in hydrocephalus. It can be performed safely in most of the uncomplicated cases. Lower success rates are seen in the infantile age group below 6 months and post-infective or post-haemorrhagic hydrocephalus. Proper case selection and pre-operative evaluation are associated with better long-term results.

References

1. Yadav Y, Bajaj J, Ratre S, Yadav N, Parihar V, Swamy N, et al. Endoscopic third ventriculostomy – a review. *Neurol India.* (2021) 69:S502–13.
2. Demerdash A, Rocque B, Johnston J, Rozzelle C, Yalcin B, Oskouian R, et al. Endoscopic third ventriculostomy: A historical review. *Br J Neurosurg.* (2017) 31:28–32.
3. Moorthy R, Rajshekhar V. Endoscopic third ventriculostomy for hydrocephalus: A review of indications, outcomes, and complications. *Neurol India.* (2011) 59:848–54.
4. Rekate H. Selecting patients for endoscopic third ventriculostomy. *Neurosurg Clin N Am.* (2004) 15:39–49.
5. Kulkarni A, Drake J, Kestle J, Mallucci C, Sgouros S, Constantini S. Predicting who will benefit from endoscopic third ventriculostomy compared with shunt insertion in childhood hydrocephalus using the ETV success score. *J Neurosurg Pediatr.* (2010) 6:310–5.
6. Kulkarni A, Riva-Cambrin J, Browd S. Use of the ETV success score to explain the variation in reported endoscopic third ventriculostomy success rates among published case series of childhood hydrocephalus. *J Neurosurg Pediatr.* (2011) 7:143–6.
7. Wang Q, Cheng J, Si Z, Li Q, Hui X, Ju Y. Third ventricle floor bowing: A useful measurement to predict endoscopic third ventriculostomy success in infantile hydrocephalus. *Acta Neurochir (Wien).* (2020) 162:31–7.
8. Wang Q, Cheng J, Zhang S, Li Q, Hui X, Ju Y. Prediction of endoscopic third ventriculostomy (ETV) success with preoperative third ventricle floor bowing (TVFB): A supplement to ETV success score. *Neurosurg Rev.* (2020) 43:1575–81.
9. Yadav Y, Parihar V, Pande S, Namdev H, Agarwal M. Endoscopic third ventriculostomy. *J Neurosci Rural Pract.* (2012) 3:163–73.
10. Liebelt B, Chen F, Biroli A, Zhao X, Nakaji P. One- vs two-burr-hole technique for combined endoscopic third ventriculostomy and pineal region biopsy: Volumetric analysis of brain at risk. *Oper Neurosurg (Hagerstown).* (2020) 19:175–80.
11. Alberti O, Riegel T, Hellwig D, Bertalanffy H. Frameless navigation and endoscopy. *J Neurosurg.* (2001) 95:541–3.
12. Brockmeyer D. Techniques of endoscopic third ventriculostomy. *Neurosurg Clin N Am.* (2004) 15:51–9.
13. Farin A, Aryan H, Ozgur B, Parsa A, Levy M. Endoscopic third ventriculostomy. *J Clin Neurosci.* (2006) 13:763–70.
14. Romero L, Ros B, Ibáñez G, Ríus F, González L, Arráez M. Endoscopic third ventriculostomy: Can we predict success during surgery? *Neurosurg Rev.* (2014) 37:89–97.