Synchronous endoscopy and microsurgery: a novel strategy to approach complex ventricular lesions

Report of three cases

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Simultaneous endoscopic and microsurgical (synchronous) approaches represent a new paradigm in the treatment of complex ventricular lesions. This technique is well suited for lesions that involve multiple ventricular or cisternal compartments, have a nonlinear axis, or adhere to critical anatomical or neurovascular structures. Two distinct operative corridors, one endoscopic and the other microsurgical, are used during synchronous approaches to address such lesions, increasing the likelihood of a safe and complete resection.

The authors present the cases of two children and an adult treated via synchronous approaches. All patients had multicompartamental lesions involving the ventricles and/or cisterns. One patient presented with a suprasellar Rathke cyst with a significant third ventricular component, one with a hypothalamic hamartoma having a substantial cisternal component, and the remaining patient with a choroid plexus papilloma in the left lateral ventricle that extended from midbody to the temporal horn.

In the cases of the Rathke cyst and the hamartoma, debulking in the third ventricle and controlled detachment of the lesion from the hypothalamus were undertaken using endoscopy, and simultaneous resection of the suprasellar component was performed through a subfrontal craniotomy. In the case of the choroid plexus papilloma, selective cautery of the choroidal feeding vessels and detachment from the temporal tela choroidea were performed using endoscopy, and the tumor from the ventricular body to the atrium was resected via a craniotomy. In each case the resection concluded with the intersection of endoscopic and microsurgical fields. All three patients had good outcomes.

Endoscopic and microsurgical approaches can be used concurrently to treat multicompartemental ventricular and/or cisternal lesions with good results. The probable advantages of this method are more complete resection and improved safety.

KEY WORDS • endoscopy • microsurgery • pediatric neurosurgery

Complex ventricular lesions include those that involve multiple ventricles and/or cisterns, those with a nonlinear axis, and those that adhere to critical anatomical or neurovascular structures. These lesions can be challenging to resect both endoscopically and microsurgically. The synchronous use of microsurgery and endoscopy via two different trajectories can allow these complex ventricular lesions to be resected safely and effectively while the effectiveness of each modality is maximized. We present three cases in which this new method was used; good results were noted for all.

All patients underwent preoperative brain MR imaging, and thin-cut volumetric images were obtained. These images were transferred to the StealthStation TREON (Medtronic Sofamor Danek, Memphis, TN), and a surface-merge registration to the patient was conducted after the patient was positioned and anesthesia was induced. The patient’s head was positioned as required for the microsurgical approach, and the endoscopist’s route was based on this positioning. Preoperative image guidance was used to plan the endoscopic and microsurgical trajectories. During the procedure anatomical progress was correlated with image guidance.

In each case we used an OPMI Neuro/NC4 surgical microscope (Carl Zeiss MicroImaging, Inc., Thornwood, NY) and a Minop 2.4-mm endoscope within a 6-mm trocar (Aesculap, San Francisco, CA) containing separate working, irrigation, and drainage channels.

Case Reports

Case 1

Examination. This 14-year-old boy presented with a 1-
week history of headaches, which acutely worsened and were accompanied by nausea and vomiting the day of admission. On examination no neurological deficits were noted. Computed tomography scanning of the head revealed a lesion within the left ventricular trigone that extended into the body of the left lateral ventricle as well as into the dilated temporal horn. A homogeneously contrast-enhancing lesion resembling a choroid plexus papilloma, with prominent anterior choroidal feeding vessels in the left temporal horn was demonstrated on MR imaging (Fig. 1).

Operation. A transcalsal microsurgical approach to the body of the lateral ventricle was performed combined with a simultaneous endoscopic approach via a left temporal bur hole to resect the choroid plexus papilloma. The endoscope was used to selectively cauterize the temporal horn component of the tumor and to detach it from the tela choroidea to the level of the atrium. The transcalsal approach enabled debulking of the predominant component of the lesion and removal of the entire mass once its temporal aspect had been detached. A ventricular drain was placed in the left temporal horn. The pathological examination confirmed the diagnosis of an atypical choroid plexus papilloma.

Postoperative Course. Postoperatively, the patient suffered an intraventricular hemorrhage that was managed with extraventricular drainage of cerebrospinal fluid. He also experienced transient expressive aphasia and required neurorehabilitation but was able to return to his high school, where he performed exceptionally well and remained the top student in his mathematics class. Magnetic resonance imaging performed 3 months postoperatively revealed a small focus of tumor in the atrium of the left lateral ventricle (Fig. 2). Images obtained 3 months thereafter indicated slight progression of this lesion, which prompted treatment with the Gamma Knife.

Case 2

Examination. This 11-year-old girl presented with a 1-year history of weight gain, polydipsia, and polyuria. An MR image of the brain revealed a nonenhancing suprasellar lesion with a significant component within the third ventricle (Fig. 3). The mass was determined to be a Rathke cyst.

Operation. The patient underwent a right supraorbital craniotomy combined with a left transcortical tranforaminal endoscopic approach to the third ventricle via the Kocher point to treat the Rathke cyst. We obtained a biopsy sample from the third ventricular component of the lesion with the aid of the endoscope. The supraorbital approach allowed decompression of the cystic suprasellar component and removal of the cyst wall while the infundibulum was preserved. The lamina terminalis was then opened, and endoscopy and microsurgery were combined to debulk the solid component located in the third ventricle. Because the lesion had an easily definable plane with the hypothalamus, we were able to use endoscopic instruments to push the lesion inferiorly into the microsurgical field of view for removal. At the conclusion of resection, light projected by the endo-
Postoperative Course. Postoperatively, the patient’s diabetes insipidus was unchanged and required long-term administration of desmopressin. At discharge from the hospital, thyroid hormone supplementation was not required.

**Case 3**

Examination. This 29-year-old man presented with intractable epilepsy. Magnetic resonance imaging demonstrated a large hypothalamic hamartoma attached to the right wall of the third ventricle extending into the chiasmatic, interpeduncular, and prepontine cisterns (Fig. 5). When the patient was a neonate, he had suffered daily multiple seizures, including grand mal seizures, despite maximal pharmacotherapy and placement of a vagus nerve stimulator. As a result, he was severely developmentally delayed. On examination he was able to follow only very basic commands and was nonverbal.

Operation. A right supraorbital craniotomy was performed in conjunction with a left transcortical, transfornimal endoscopic approach to the third ventricle via the Kocher point. The left-sided endoscopic approach allowed an appropriate trajectory to the interface between the hamartoma and adjacent hypothalamus. Initial biopsy specimens were obtained with the aid of the endoscopic grasping instruments. The Suros variable aspiration tissue resector (Suros Surgical Systems, Inc., Indianapolis, IN), a morcellizing, aspirating endoscopic instrument, was used to debulk the lesion to the base of the third ventricle. Simultaneously, the lesion was accessed microsurgically via a subfrontal approach. The lesion had expanded into the right opticocarotid cistern, and within this corridor the hamartoma was microsurgically debulked. The floor of the third ventricle and the posterior clinoid process demarcated the superior and posterior margins of debulking, respectively (Fig. 6). With very large hypothalamic hamartomas, we have found that disconnection from the hypothalamus, as accomplished through this synchronous approach, is sufficient for seizure control.

Postoperative Course. The patient displayed symptoms of transient diabetes insipidus, which resolved by the 4th postoperative day. In the immediate postoperative period, he...
was seizure free. At the 6-month follow-up examination, the frequency of the patient’s seizures remained substantially reduced, and he currently experiences one grand mal seizure every 3 to 4 weeks.

Discussion

Theoretically, intraventricular tumors are enticing to resect neuroendoscopically. The ventricles provide an anatomical working space for the endoscope, and compared with microsurgery the extent of brain dissection is minimized. Tumor vascularity, consistency, size, and ventricular dilation are all practical considerations that affect the decision to approach a lesion with the aid of an endoscope. Small hypothalamic hamartomas are prototypical lesions to resect endoscopically. They are soft, almost avascular, and usually arise unilaterally from the wall of the third ventricle, a location that is accessed far more easily endoscopically than microsurgically. Most colloid cysts are also amenable to definitive management via endoscopic techniques.\textsuperscript{5,7,8} Large, vascular, or extremely firm lesions are better approached microsurgically.\textsuperscript{5}

Intradural lesions that have a nonlinear axis, that extend into a cistern, or that adhere to critical neurovascular or anatomical structures can be challenging to treat, regardless of whether a microsurgical or endoscopic approach is used. To address these types of lesions, we have developed the concept of synchronous endoscopic and microsurgical techniques. A separate entity from isolated endoscopy and endoscope-assisted techniques, synchronous methods focus on resection of complex ventricular lesions with the goal of superior efficacy, safety, or both. Umemura and colleagues\textsuperscript{9} described a transnasal endoscopic approach in conjunction with a simultaneous craniotomy for the resection of a giant recurrent pituitary adenoma. To our knowledge, the current report is the first in which intraventricular lesions are described as being treated with synchronous approaches.

The simultaneous use of two approaches offers several advantages. Because two surgeons are able to work via two operative approaches concurrently, multicompartamental tumors can be resected during one surgical session. Critical neurovascular or anatomical structures can be approached directly or can be protected by one operative trajectory even if the main corridor of resection involves a second trajectory, reducing the need to perform a blind maneuver. Tumor that is inaccessible from one trajectory can be pushed into the field of view by the other surgeon. With experience, the overall operative time will likely decrease.

For two surgeons to work cooperatively and simultaneously, their physical working spaces must be distinct. Positioning of the microscope and various video monitors must be optimized within the operating room. Doing so may require trial and error and customization in planning the approach to the individual lesion.

When operative trajectories for synchronous approaches are planned, the relative advantages of microsurgery and endoscopy should be maximized. A microsurgical approach is best suited for resecting the bulk of large tumors and for intricate dissection. Endoscopy is best suited for working within the ventricles and areas where cosmesis is a consideration.

In Case 1, the bulk of the choroid plexus papilloma was within the atrium and body of the left lateral ventricle. A component within the left temporal lobe was inaccessible via an interhemispheric approach. The endoscopic approach from the left temporal horn allowed immediate visualization of the choroidal feeding vessels to the lesion while detachment of the papilloma from the tela choroidea was performed. A portion of the temporal component of the tumor was then pushed posteriorly into the microsurgical field of view and removed via the interhemispheric approach. Unfortunately, a small focus of tumor was left within the atrium and required Gamma Knife surgery after the tumor progressed. The patient also suffered a postoperative hemorrhage that was confined primarily to the temporal horn. This hemorrhage did not expand the temporal horn beyond its preoperative size. The splenial callosotomy was probably responsible for the patient’s postoperative aphasia,\textsuperscript{1} which resolved completely over several weeks.

In Case 2, the Rathke cyst had both a cystic component in the suprasellar area and a solid component that extended into the third ventricle. The subfrontal approach allowed decompression of the cyst as well as identification and preservation of the infundibulum. Despite entry into the lamina terminalis, removal of the third ventricular component via the subfrontal approach alone would have been a blind maneuver with potentially devastating consequences to the hypothalamus. Endoscopic visualization from above confirmed that the lesion could be easily separated from the walls of the third ventricle. The third ventricular component was partially resected with endoscopic instruments. The remainder was displaced inferiorly into the microsurgical field of view to allow GTR.

A Rathke cyst is a prototypical lesion for the synchronous use of subfrontal craniotomy with endoscopic access to the third ventricle. We anticipate that the technique will be even more valuable in treating suprasellar craniopharyngiomas that invaginate into the third ventricle. These lesions are notoriously more adherent to the hypothalamus. Several authors have advocated a combined subfrontal– or pterional–transcallosal craniotomy to approach such lesions.\textsuperscript{2} The endoscope can be used in place of the transcallosal approach, providing improved magnification and illumination as well as the potential for decreased approach-related morbidity.

Theoretically, the lesions in Cases 1 and 2 could have been resected using standard microsurgical techniques from a single trajectory. In Case 1, a left superior parietooccipital lobule approach would have provided direct access to the atrium. We rejected this approach because of the lengthy corticectomy and significant brain retraction that would have been required to access the entire tumor. In Case 2, single-trajectory microsurgical approaches via the subfrontal and interhemispheric routes were considered but ultimately rejected. With the former, the interface of the Rathke cyst with the hypothalamus would have been poorly visualized. With the latter, cisternal structures such as the perforating arteries, infundibulum, and optic tracts would have been poorly visualized. In both Cases 1 and 2, the use of synchronous endoscopy and microsurgery improved visualization and enabled safe resection of the lesions.

In Case 3, the goal of the procedure was to disconnect the hamartoma from the hypothalamus rather than to resect the lesion completely. The subfrontal approach enabled debulking of the lesion inferior to the hypothalamus while pre-
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serving critical structures such as the optic tracts, infundibulum, and hypothalamic perforating vessels. The endoscope was used to disconnect the lesion from the medial wall of the right hypothalamus. The transendoscopic Suros variable aspiration tissue resector was essential in performing this disconnection. Using standard endoscopic biopsy forceps, the volume of tissue that can be resected with each grasping action is limited. Resecting large lesions in this manner is extremely tedious. The Suros device can be used to resect and aspirate tissue rapidly in a very controlled manner while applying little traction to adjacent tissue. The Suros device is especially ideal when applied to avascular lesions such as hypothalamic hamartomas. By intersecting the endoscopic and microsurgical operative trajectories in Case 3, complete disconnection was verified.

Conclusions

The synchronous use of endoscopy and microsurgery represents a novel method to approach complex or multicompartamental ventricular lesions. In the appropriate setting, two simultaneous operative trajectories are used in this technique to improve visualization and to protect critical structures. As a result, the operative time may decrease. In this report we have demonstrated a proof of concept of the technique. Further investigation is necessary to determine the appropriate indications for its use. We believe that synchronous techniques will prove most beneficial in approaching lesions involving both the suprasellar cisterns and the third ventricle.

References


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