Endoscopic removal of an intraventricular primitive neuroectodermal tumor: retrieval of a free-floating fragment using a urological basket retriever

Case report

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The endoscopic resection of intraventricular tumors represents a unique challenge to the neurological surgeon. These neoplasms are invested deep within the brain parenchyma and are situated among neurologically vital structures. Additionally, the cerebrospinal fluid system presents a dynamic pathway for resected tumors to be mobilized and entrapped in other regions of the brain. In 2011, the authors treated a 3-year-old girl with a third ventricular mass identified on stereotactic brain biopsy as a WHO Grade IV CNS primitive neuroectodermal tumor. After successful neoadjuvant chemotherapy, endoscopic resection was performed. Despite successful resection of the tumor, the operation was complicated by mobilization of the resected tumor and entrapment in the atrial horn of the lateral ventricle. Using a urological stone basket retriever, the authors were able to retrieve the intact tumor without additional complications. The flexibility afforded by the nitinol urological stone basket was useful in the endoscopic removal of a free-floating intraventricular tumor. This device may prove to be useful for other practitioners performing these complicated intraventricular resections.

Key words • nitinol • urological basket • endoscopic • intraventricular tumor • third ventricular tumor • oncology

As experience grows with intracranial endoscopy, surgeons are utilizing this technology to resect certain tumors that were previously approached with open cranial exposures. For the resection of third ventricle colloid cysts, a head-to-head analysis demonstrated decreased operative time and postoperative complications with endoscopic resection compared with microsurgery.9 With an increasing number of tumors resected endoscopically, surgical techniques continue to be refined to address novel scenarios and prevent associated complications.

There are key technical challenges in performing tumor resection using the endoscopic approach. Conventional neuroendoscopy uses rigid endoscopes with 2 working channels for dedicated endoscopic instruments.10 The rigidity of the device can make it difficult for the surgeon in cases requiring tumor resection biopsies.1,2 These drawbacks include visual constraints, limitation on the maximum size of lesion that can be resected, limitation to 2 working channels, and the possible complication of conversion to open craniotomy.1,2,5,6 Nontraditional neurosurgical tools can be important to address some of these technical limitations when complications arise.1,2,5

We report the case of a 3-year-old girl undergoing endoscopic resection of an intraventricular CNS primitive neuroectodermal tumor from the anterior floor of the third ventricle. After careful circumferential dissection, the tumor inadvertently migrated through the foramen of Monro before resting in the atrium of the lateral ventricle. After MRI localization and further endoscopic exploration, a kidney stone retrieval device was used to successfully snare and remove the free-floating tumor. To our knowledge, this is only the second such case reported in the literature.

Exemption status was obtained from the Vanderbilt University Medical Center Institutional Review Board prior to review of all medical records.

Case Report

Presentation and Examination. The patient presented at 32 months of age with headache, nausea, and vomiting lasting approximately 2 weeks. Stereotactic biopsy confirmed the presence of a large intraventricular WHO Grade IV CNS primitive neuroectodermal tumor (Fig. 1A
and B). The patient received a neoadjuvant regimen consisting of 3 cycles of combination vincristine, etoposide, Cytoxan, and cisplatin. This was followed by consolidation chemotherapy with thiotepa and carboplatin. These cycles were administered over a 3-month duration, after which the patient underwent autologous stem cell transplant. This treatment resulted in a significant reduction in tumor burden as noted on MRI, as well as total cessation of symptoms (Fig. 1C and D). After a thorough discussion of treatment options with the family, the decision was made to endoscopically excise the residual intraventricular lesion.

**Operation.** The patient was brought to the operating room and positioned supine, and her previous right-sided midpupillary incision was reopened. An endoscopic introducer was then advanced through the prior bur hole into the right frontal horn of the ventricle. A 22210 20 video endoscope (Karl Storz GmbH) was then advanced into the lateral ventricle through a slightly enlarged foramen of Monro into the third ventricle where a rounded tumor was visualized (Fig. 2). The tumor was located in the infundibular recess and was surrounded by multiple adherent strands of gliotic tissue, which were excised using microendoscopic scissors. Multiple small feeding vessels were immediately visible, and endoscopic bipolar electrocautery was used to coagulate these superficial vessels. We maintained constant irrigation to help assist with clearing blood from the spinal fluid and continued our dissection anteriorly and to the right where the tumor was more adherent to the adjacent tissue. We carefully developed a plane using blunt dissection assisted by bipolar electrocautery. Subsequently, we visualized several small bridging arteries off of the rather large traversing artery. Care was taken not to disrupt this artery itself, and we were able to slowly peel the tumor off of this vessel.

The tumor was relatively large but discrete, and we attempted to free it from surrounding soft tissue. We were eventually able to free the tumor from its anterior vascular pedicle by rolling it more posteriorly. There were more microbridging vessels, which were similarly coagulated. The tumor was eventually completely freed. There was some bleeding at this point, which was irrigated and cauterized with endoscopic bipolar electrocautery. The freed mass moved posteriorly into the third ventricle. We were able to grasp it with our forceps but could not provide adequate traction. As we attempted to remove the freed discrete tumor, we encountered more bleeding from the adjacent choroid plexus.

After hemostasis had been achieved and the field was cleared, we were unable to visualize the tumor even though it had not been removed from the field. We used the angled endoscope to visualize anteriorly where we could confirm that the tumor had been completely resected from its original base. A posterior view to the level of the aqueduct showed no evidence of the tumor, and similarly no tumor was visualized in the third ventricle. The lateral ventricle was also inspected anteriorly and inferiorly with no visualization of the tumor. The possibility of it moving posteriorly in the right lateral ventricle was entertained; however, we were unable to visualize it directly. For this reason, we irrigated the wound thoroughly and achieved hemostasis. The endoscope and introducer were removed, and the scalp flap was returned to position. The galea was reaproximated with inverted 3-0 Vicryl sutures, and the skin edges were reaproximated with running 5-0 Monocryl stitch. We removed the drapes and shampooed the patient’s hair. The patient’s head was removed from the Mayfield head pins, and while anesthetized, she was transferred urgently for MRI of the brain. With T1- and T2-weighted MRI, we were able to visualize the freed tumor attached to the right choroid plexus in the atrium of the lateral ventricle (Fig. 3).

We then returned the patient to the operating room where she was positioned supine on the Mayfield horseshoe headrest. Care was taken not to mobilize the patient

![Fig. 1. A and B: T1-weighted Gd-enhanced slices from an MRI study of the brain demonstrating a solid mass with subependymal spread along the floor of the third ventricle. C and D: The same tumor (arrows) after 3 cycles of chemotherapy demonstrates significant reduction in tumor burden with residual intraventricular neoplasm on the anterior floor of the third ventricle.](image-url)

![Fig. 2. Left: Endoscopic view of intraventricular lesion embedded in gliotic tissue. Right: The gliotic tissue was excised with tumor intact prior to resection from the adjacent brain parenchyma.](image-url)
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greatly during transport. She was carefully padded and secured into position. She was then prepared and draped in usual sterile fashion. We reopened the right frontal incision and retracted the scalp flap. A new endoscopic introducer was advanced posteriorly, and we were then able to access the lateral ventricle in a more posterior approach. There was a fair amount of coagulated blood within the ventricle. We began to remove this using the endoscopic graspers. We identified the choroid plexus extending posteriorly. As we removed more, we could better visualize the location of the tumor.

We brought into the field a Gemini Paired Wire Helical Basket (Boston Scientific) (Fig. 4). This was advanced down the endoscope through the working channel. We were able to deploy this to help initially remove several large pieces of clot and better clear the working environment. This allowed for visualization of the tumor within the atrium of the ventricle. We deployed the net, and we were able to secure the tumor itself and withdraw it with the tumor locked in position. The endoscope, introducer, and tumor were all withdrawn as one unit due to the relatively large tumor size and firm consistency. We inspected and confirmed that the tumor was consistent with what we had previously visualized. Since the tumor was whole, we elected not to reintroduce the introducer and camera for additional visualization.

The wound was thoroughly irrigated with antibiotics containing saline. It was noted prior to removal of the tumor that we did not visualize further bleeding within the ventricle. We observed no hemorrhage through the endoscopic tracts, so we reapproximated the galea with inverted 3-0 Vicryl suture. Skin edges were reapproximated with running 5-0 Monocryl stitch. The drapes were removed, the patient’s hair was shampooed, and bacitracin ointment was applied to the wound. The patient was awakened, extubated, and taken to the recovery room in stable condition.

Postoperative Course. Postoperatively the patient was admitted to the pediatric ICU. She was extubated immediately after surgery, required no pressors, and remained hemodynamically stable. That night, her examination findings returned to baseline; she was awake and alert, her pupils were equal and reactive with good upgaze, her facial excursion was symmetric, and she was moving her arms and legs with symmetric strength and tone. On the 2nd postoperative day, the patient was transferred to the floor. The following day (3rd postoperative day), she was discharged from the hospital at her neurological baseline without a ventriculoperitoneal shunt or reoperation.

Discussion

The endoscopic approach has increasingly been used for the resection of intraventricular lesions and select sellar and pineal region masses. Due to their intraventricular location, the biopsy and/or excision of these masses present a surgical challenge. The rigid endoscope commonly used for these procedures precludes the use of standard rigid tools for tumor extraction. Additionally, these tumors can abut the ventricular system with the potential for translocation to various parts of the brain, complicating the resection as in our case. Coupled with the inherent risks and aforementioned limitations of endoscopic surgery, these operations can present with significant postoperative morbidity if complications arise. As such, there is a need for improved techniques and surgical tools to manage possible complications.

Many authors have advocated various tools and techniques to improve technical efficiency and perioperative morbidity for the endoscopic resection of intraventricular lesions. Souweidane and Luther demonstrated successful tumor resection via the use of an endotracheal suction catheter through an endoscopic approach. In their report, a 6-Fr catheter was used to perform a “pulse aspiration” technique, alternating with blunt dissection to achieve gross-total resection. Notable advantages of this catheter include its transparency, allowing for maximum visibility of adjacent structures, and a beveled tip that improves tumor fenestration for friable tumors. Also in their report,
intraventricular lesions ranging from 0.5 to 1.8 cm in diameter were totally resected without recurrence after 20 months of follow-up. The use of stereotactic and ultrasonic guidance navigation systems during endoscopic approaches have previously been suggested to improve precision.2,20 In a series of 10 patients, the use of an ultrasonic probe in conjunction with stereotactic guidance improved the endoscopic resection of intraventricular tumors.23 In 2005, Harris and colleagues9 devised a stereotactic conduit “ventriculoport” from a commercially available thoracic port to allow for the microsurgical resection of intraventricular lesions. Coupled with CT-guided intraoperative imaging, this technique allowed for increased microsurgical access, decreased brain retraction, and potentially decreased postoperative morbidity.9 The urological stone basket remover was helpful in the removal of a free-floating neoplasm from the atrium of the lateral ventricle after it became lost from the visual field. The utility of this tool in the removal of intraventricular lesions has been presented only once in the literature. Schirmer and Heilman10 described the resection of a colloid cyst located in the third ventricle using a nitinol basket retriever. A large, solid colloid fragment was recovered using the nitinol stone retrieval basket as a flexible wall-guided salvage instrument. This was successfully done through the endoscopic working channel. Similarly, we found that its flexibility was integral during navigation through the ventricle. Additionally, its small size allowed it to be easily accommodated by one of our working ports. The triple-coiled basket is composed of nitinol, a nickel-titanium alloy of considerable durability, malleability, and structural memory.4 The alloy is widely used in urological stone basket removers12 and extensively in various endovascular applications including vascular stents and filters.6,15 The terminal basket easily expands upon deployment to create a porous basket for an 11-mm operating diameter. The relatively large operating head and easy maneuverability allowed for the clearance of debris from the operative field and the retrieval of the tumor.

The localization of the lost fragment was accomplished using emergency MRI. In cases in which intraoperative imaging is limited, localization of a free-floating tumor can be difficult with the potential for further dislocation during transit. We took great care to limit rapid translational motion in our patient to prevent further complications. Factors such as tumor size, presence of ventriculomegaly, or other intracranial processes may possibly affect tumor translocation. To our knowledge there has been no study to assess translational motion on the momentum of intraventricular debris. While in our case we did not use intraoperative MRI to localize the lesion, various reports have documented its usefulness.9,20 In similar cases, this tool could be helpful to limit additional mobility of free-floating lesions which may be possible during transit.

In this example MRI localization demonstrated the position of the errant tumor in the atrium. A more posterior bur hole was created to directly access the tumor in this location, and the nitinol basket was used after traditional piecemeal resection was tried unsuccessfully. Alternatively, a flexible endoscope may have been used for the retrieval, but its efficacy is highly dependent on the operator’s comfort level with this tool.

The risks versus benefits of excising intracranial neoplasms after chemotherapy-mediated volume reduction, especially those of malignant potential, is an interesting topic that warrants further study. From the perspective of the neurooncologist, there may be more risk in leaving a malignant tumor than a benign tumor, although this has not been rigorously proven. Considering the possible intraoperative complications of distant intracranial or even extracranial seeding and ventricular occlusion, it is theoretically possible that primary devascularization of these neoplasms allowing for subsequent regression may be sufficient treatment. Based on current literature, however, it is clearly shown that cytoreductive surgery with adjuvant chemotherapy and stem cell support produces some of the best outcomes in the treatment of intracranial pediatric malignancies.7,14 Recent reports have confirmed the utility of gross-total resection of pediatric tumors subsequent to chemotherapy.24 In this situation, it is not clear what the implications would have been if the errant tumor was left in the ventricle. Numerous malignant tumors in the pediatric population are characterized by an ability to disseminate throughout the subarachnoid space and parasitize blood supply before progressing locally. Moreover, there is also a theoretical fear that the mass might become mobile and lodge in the cerebral aqueduct causing acute hydrocephalus.

Conclusions

In endoscopic neurosurgical operations, there is a need for flexible surgical tools to circumvent the rigidity inherent to commonly used endoscopes. This is of increasing importance in intraventricular tumors invested deeply within the parenchyma around neurologically vital structures. The nitinol stone basket remover has distinct technical advantages when lesions are located within the ventricular system. Its flexibility and design allow for relatively safe and atraumatic capture of free-floating tumors without damage to adjacent tissue. Coupled with intraoperative imaging, this tool can be helpful in complicated endoscopic resections of intraventricular lesions.

Disclosure

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author contributions to the study and manuscript preparation include the following. Conception and design: Zuckerman, Carr, Tomycz. Analysis and interpretation of data: Carr. Drafting the article: Zuckerman, Carr. Critically revising the article: all authors. Reviewed submitted version of manuscript: all authors. Approved the final version of the manuscript on behalf of all authors: Zuckerman. Study supervision: Tomycz, Pearson.

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