A novel dissection method using a flexible neuroendoscope for resection of tumors around the aqueduct of Sylvius: A case report

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Abstract

Flexible endoscopes have both a wide range of movement and a wide field of view and are thus widely used for endoscopic third ventriculostomy and biopsy. However, tumor resection using flexible endoscopes has scarcely been reported, likely owing to their single port, which has a diameter of 1.2–2.0 mm. Furthermore, flexible endoscopes do not allow some of the basic neurosurgical manipulations, especially sharp dissection with counter tension. Additionally, the position of the forceps and coagulators is fixed within the endoscope. Here we report a new technique of dissection used on two tumors located in the posterior third ventricle. Technical aspects and potential advantages of this approach are also briefly discussed.

Introduction

Tumors in the posterior third ventricle are rare and clinically challenging to resect owing to their highly internalized position; the third ventricle is surrounded by the midbrain, thalamus, pineal gland, and great vein of Galen. Damaging these structures may lead to several neurological impairments. Further, lesions in these sites can often result in hydrocephalus; the operation for this lesion is necessary to resect tumors and to perform third ventriculostomy for preventing hydrocephalus. Several techniques and tools have been proposed for tumor removal in this region. Recently, endoscopic surgery has developed significantly, and many authors have reported tumor biopsy or resection in this region while performing an endoscopic third ventriculostomy (ETV).[1,2] Endoscopic surgery may be less invasive than microsurgery in resecting deep intraventricular tumors. In many of these reports, a rigid endoscopy with a trans-Monro approach has been used. However, in this method, the foramen of Monro limits the trajectory both anteriorly and posteriorly.[3] Flexible endoscopy has a large range of movement in the ventricles and can easily reach from the tuber cinereum to the aqueduct of Sylvius via a single 10 mm burr hole without burdening the foramen of Monro or other periventricular structures.[3] However, until now, there have been few reports of tumor resection using a flexible endoscope. In the current report, we present a new method of tumor dissection by flexible neuroendoscopy through two illustrative cases.

Operative Procedure

We used a flexible endoscope (VEF-2®, Olympus, Japan), which is 4 mm in diameter, with a 1.5 mm working channel, and 6 mm sheath (NeuroPort MINI®, Olympus). First, we inserted the flexible scope into the frontal horn through a right frontal burr hole, which was located approximately 10-11 cm superior to the nasion (about 1-2 cm anterior to the coronal suture) and 2 cm from the midline (pupil line). This burr hole position is suitable for both third ventriculostomy and manipulation in the aqueduct region. Following observation of the lateral ventricle and anterior part of the third ventricle, the neck of the scope was bent caudally and the aqueduct was inspected. The lesions were resected using 1 mm forceps and a monopolar coagulator. We grasped the tumor with the forceps and twisted it out. If bleeding was minor and the adhesions to the normal structures were minimal, we attempted to resect as much of the tumor as possible. By bending the end of the endoscope with the tip of the forceps or the monopolar coagulator slightly extended from the port, we performed a blunt dissection. An open tip allows a sharper dissection than when the tip is closed. However, performing a closed- tip dissection guarantees a blunt dissection with a lower risk of vascular injury, while allowing a wide range for dissection. After dissecting around the tumor, we grasped and twisted out the residual neck of the tumor. We removed lesions that could not be aspirated with blunt dissection and conventional manipulations. Bleeding was controlled by continuous irrigation with artificial cerebrospinal fluid (Artcereb®, Otsuka Pharmaceutical, Tokyo, Japan). If the amount of bleeding was sufficiently large, we used a high-pressure irrigation system. In the third ventricle, we used the coagulator as little as possible because of the important basal ganglia structures. After tumor removal, we performed ETV to prevent hydrocephalus with an expanding balloon catheter, that is Expanser Balloon Catheter SI ® (Fuji systems, Tokyo, Japan).

Case1

A 38-year-old man presented with headache, nausea, and diplopia. Cerebral magnetic resonance imaging (MRI) revealed triventricular hydrocephalus due to a mass in the aqueduct (fig1A). We completely resected the tumor and performed ETV (fig2) (video1). The postoperative course was uneventful, and his symptoms, including diplopia, disappeared. Gross-total resection of the lesion was confirmed on postoperative MRI (fig1B). Pathological diagnosis was ancient schwannoma, a rare schwannoma variant, which is considered benign. We did not perform adjuvant therapy, but continued performing MRI during follow-up evaluations. At 1-year-follow-up, he showed no neurological deficit and no tumor recurrence was seen.

Case 2

A 78-year-old woman presented with worsening consciousness within a week. After admission, her consciousness rapidly declined from somnolence to coma in a couple days. Cerebral MRI revealed triventriculomegaly and the aqueduct of Sylvius appeared occluded (fig3A). There was a tiny nonenhanced mass in the tectum, and we planned to perform ETV and observe the aqueduct. During surgery, we confirmed a lesion-like cavernous malformation at the tectum, which seemed to have caused the aqueduct occlusion. From several previous MRI series, we could detect that the lesion had gradually grown in a few years. We wondered whether the growing tumor would compress the midbrain in the near future if we performed only third ventriculostomy. Considering the patient’s age, we thought this was the last chance to remove the tumor and to cure her condition; therefore, we subsequently removed the lesion and performed ETV (fig4) (video2). Postoperative MRI showed opening of aqueduct of Sylvius and no residual lesion (fig3B). Following surgery, her consciousness gradually improved, but limb muscle weakness remained. The patient was ultimately transferred to a rehabilitation hospital. At 3-months follow-up, the patient did not show new neurological deficits, including extraocular complication.

Discussion

Tumor resection around the aqueduct of Sylvius is difficult owing to its anatomic position. In microscopic surgery, the approaches typically used for the posterior half of the third ventricle and the pineal region are the occipital trans-tentorial approach, the infratentorial approach, and the transcallosal approach. However, these approaches have some risks, such as hemianopia, eye movement disturbances, and cognitive decline.[4,5] In addition to creating a lesion in the posterior half of the third ventricle, obstructive hydrocephalus often develops, requiring surgery to release or prevent hydrocephalus. During craniotomies, surgeons are often required to drain another ventricle. On the other hand, some reports about tumor resection using neuroendoscopy in this region to facilitate less invasive surgery have been published since Gaab et al. reported gross total removal by an exclusively endoscopic approach.[6,7,8,9] [10] Many of these studies describe tumor resection with ETV using an endoscope from a precoronal burr hole (table1). The results seem to be quite good. However, manipulating the tuber cinereum and the aqueduct with a rigid endoscope simultaneously has potential risk for injuring important structures. The foramen of Monro, which is surrounded by many important structures, such as the fornix, internal capsule, and internal cerebral vein, makes concurrently manipulating these two points difficult and dangerous. The foramen of Monro restricts the movement of the endoscope and other tools used in surgery. Unfortunately, the distance between the human tuber cinereum and the aqueduct is too far to concurrently manipulate a rigid endoscope simultaneously without causing damage.[3,11] The distance between the tuber cinereum and entry to the aqueduct of 10 patients who received ETV and biopsies for tumors in the pineal region in our hospital was 24.81 mm on average, and the angle between tuber cinereum and the foramen of Monro line and the entry of aqueduct-foramen to the Monro line was 50.65°. These anatomical characteristics compel neurosurgeons to enlarge the craniotomy and corticotomy or create a new corridor with another burr hole if the goal is to not only observe, but also to manipulate between the two points. However, these procedures are not always minimally invasive.

Use of flexible endoscopes resolve the problems encountered in this corridor by allowing their tip to bend. Many cases of biopsy in pineal region or posterior third ventricle and concurrent ETV with flexible endoscope have been reported not only in adult tumors, but also in pediatric tumors. These reports showed their procedures were safe with high diagnostic rates.[2,12,13,] However, few reports show that a complete resection of the lesion was achieved using a flexible endoscope alone. This is likely because flexible endoscopes have only one working channel with a diameter of 1.2–2.0 mm and limited available tools (e.g., forceps with a 1.6–1.8 mm head, coagulators). Manipulations with the flexible endoscope are restricted to grasping, twisting, and pulling using forceps, coagulation, and aspiration. It is impossible to dissect sharply with appropriate counter tension using a flexible endoscope.

Feletti et al. reported tumor resection by aspiration of the tumor using a flexible endoscope.[14,15]Although limited to pathologies with limited vascularity and minimal adhesions, Feletti could aspirate the tumors but could not achieve total resection in two-thirds of cases (table1). We think dissection is a critical skill for tumor removal. In the presented cases, we used a 1-mm forceps to grasp, pull, and dissect the tumor by manipulating the distal end of the flexible endoscope. We could not perform counter traction using a second manipulator; therefore, we proceeded with blunt dissection. After dissecting the tumor to some extent, we twisted out the residual attachment of the tumor. By repeating this procedure step by step, we achieved complete resection of the two different pathological tissues. This method enabled to remove a tumor partially buried in the ependyma. During tumor resection, bleeding occurs, mainly owing to laceration of the capillaries or microarteries. Bleeding can hinder visualization of the operative procedures and extend the duration of surgery, but almost all bleeding can be controlled by continuous irrigation with Ringer’s solution or artificial cerebral spinal fluid.[12,15] When we need to perform manipulations under conditions of heavy bleeding, we use a high-pressured irrigation system. This system enables rapid irrigation and controls the bleeding.

Despite the clear advantages of using flexible endoscopy, not all lesions in this location can be removed with this method. Almost all the authors who resect tumors in third ventricle with an endoscope agree that tumor size and vascularity are the major factors limiting this approach. Small tumors with less vascularity and relatively few adhesions to brain tissue are amenable to this kind of resection. Many tumors listed in table 1 are less than 2 cm in diameter (three tumors are slightly larger than 2 cm). Many authors consider that 2 cm diameter is the upper limit of endoscopic trans-Monro approach for third ventricular tumor resection. We agree with this opinion, but we think that another important factor, namely the length of the attachment of the tumor as well as the maximum tumor diameter, should also be considered. The surgeon must move the manipulator to a distance more than the length of the tumor attachment while dissecting the tumor. We also think that tumors with attachment larger than approximately 1 cm in diameter should not be resected (the length of attachment in case 1 was 1.0 cm and that in case 2 was 0.6 cm). The dissection movement is possible only in a very small range in the third ventricle. If the surgeon attempts to resect tumors with bigger attachment by this technique, there may be a great risk of injuring the fornix, internal cerebral vein, and cortex around the port.

Further, highly vascularized tumors, which look like atrioventricular shunts in angiography, should not be operated by this method. For removal of large or highly vascularized tumors, surgeons should use a rigid endoscope or microscope. Small tumors plunging into aqueduct are good indications for our method. Furthermore, manipulating the flexible endoscope safely in the third ventricle requires skill. Surgeons should get used to using flexible endoscopes by using them as often as possible through off-the-job and on-the-job training.

Conclusion

By using a flexible endoscope for tumor dissection, resection of a tumor without a neck, which cannot be removed through aspiration alone, becomes possible. To our knowledge, the presented cases are the first to describe the effectiveness of complete resection of a tumor in the third ventricle using flexible endoscopy.

Figure legends

Fig1 MRI images of case 1

A. A preoperative gadolinium (Gd)-enhanced T1 weighted image. Tumor located in entry of aqueduct and it is not enhanced.

B. A postoperative Gd-enhanced T1 weighted image. The tumor was removed completely, and hydrocephalus got better.

Fig2. Intraoperative views of case 1

A. Overview of the tumor. It had a smooth surface and some vascular, and its neck was wide.

B. The view of dissection with monopolar coagulator. We also used forceps.

C. The view of twisting out the residual neck of the tumor.

D. Final view. We achieved total resection, and aqueduct was open.

Fig3. MRI images of case 2

A. A sagittal image of preoperative Gd-enhanced T1 weighted image.

B. A sagittal image of postoperative T2 weighted image. Tumor was removed, and hydrocephalus improved.

Fig4. Intraoperative views of case 2

A. Overview of the tumor. Tumor was multilobulated and looked like a grape. Cavernous malformation was suspected.

B, C. The view of removing with forceps. Tumor was slightly adhering to normal structure, so we dissected little by little.

D. Final view of the case. Aqueduct was clearly opened.

Video legend

Video 1

Intraoperative video of tumor resection of patient 1 by flexible endoscope.

Video2

Intraoperative video of tumor resection of patient 2 by flexible endoscope

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