Resection of Intraventricular Tumors in Children by Purely Endoscopic Means

Eveline Teresa Hidalgo[1], Aryan Ali[2], Howard L. Weiner[1], David H. Harter[1]

OBJECTIVE: **Neuroendoscopy is increasingly being used in the management of intraventricular brain tumors. The role of endoscopy in diagnostic biopsy is well established. Expansion of these techniques may allow for definitive resection of intraventricular tumors. We report the feasibility and outcomes of endoscopic resection of select intraventricular tumors in children.**

METHODS: **The clinical characteristics of 11 children with solid intraventricular tumors who underwent tumor resection were reviewed. Twelve procedures were performed.**

RESULTS: **Gross-total resection was achieved in 11 of 12 cases (92%). Maximal tumor diameter ranged from 9 to 26 mm (mean, 16.6 mm). Pathologic results included subependymal giant cell astrocytomas, ependymomas, nongerminomatous germ cell tumors, and pilocytic astrocytomas. Mean follow-up was 35 months (range, 10–109 months). All patients returned to their neurologic baselines after surgery. Local tumor recurrence occurred in 1 patient and distant recurrence in another. In 1 patient, a transitory intraoperative increase of intracranial pressure without clinical implications occurred. There was no permanent morbidity or mortality in this series. Hydrocephalus was present preoperatively in 5 cases and was treated either with tumor removal alone or with an additional endoscopic third ventriculostomy. No patient required a ventriculoperitoneal shunt.**

CONCLUSIONS: **Neuroendoscopic gross-total resection of solid intraventricular tumors is a safe and efficacious procedure in carefully selected pediatric patients.**

INTRODUCTION

Intraventricular tumors account for approximately 6% of all central nervous system tumors in children.[1] These tumors may present technical challenges because of their deep location and proximity to critical neurovascular structures. Microsurgery remains the gold standard for the resection of intraventricular tumors,[2] but endoscopy has become the first-line modality for biopsy and has been shown to be an efficacious and reliable technique providing accurate pathologic specimens.[3] Neuroendoscopic techniques have evolved, and the spectrum of intracranial diseases treatable by contemporary neuroendoscopic means is expanding.[4] Hydrocephalus is common in patients with intraventricular tumors; endoscopic third ventriculostomy (ETV) with concomitant biopsy has been described previously.[3,5] In addition to its role in the treatment of hydrocephalus, endoscopy has demonstrated usefulness in the management of intraventricular brain tumors. The first series reporting gross-total resection (GTR) of intraventricular tumors by an exclusively endoscopic approach was by Gaab and Schroeder in 1998.[6]

Neuroendoscopic GTR of intraventricular tumors has been shown to be an effective surgical approach in carefully selected cases.[7] Most of the neurosurgical literature has focused on endoscopic colloid cyst resection in adults.[4,7–10] GTRs of pediatric intraventricular tumors through an endoscopic approach have been described in case reports[11,12] or as part of series of endoscopic procedures in children.[13]

Given recent advances in neuroendoscopy, we have adopted a purely endoscopic approach for resection of select tumors. For this article, we reviewed the surgical outcomes for patients age 0–18 years who underwent surgery for the treatment of intraventricular brain tumors at New York University Langone Medical Center.

Key words
- neuroendoscopy
- Gross-total resection
- Intraventricular tumor
- Minimally invasive

Abbreviations and Acronyms
CSF: Cerebrospinal fluid
ETV: Endoscopic third ventriculostomy
GTR: Gross-total resection
NGGCT: Nongerminomatous germ cell tumors
SEGA: Subependymal giant cell astrocytoma

From the Departments of [1]Neurosurgery, NYU Division of Pediatric Neurosurgery, New York University School of Medicine, New York; and [2]Shaheed Aso Hospital, Kurdistan, Sulaimaniyah, Qirga, Kaniba, Iraq

To whom correspondence should be addressed: David H. Harter, M.D. [E-mail: David.harter@nyumc.org]

Supplementary digital content available online.

Citation: World Neurosurg. (2016) 87:372-380.
http://dx.doi.org/10.1016/j.wneu.2015.11.052

Journal homepage: www.WORLDNEUROSURGERY.org

Available online: www.sciencedirect.com

METHODS

An institutional review board–approved retrospective chart review of patients who had neuroendoscopic surgery for solid intraventricular tumors by the Division of Pediatric Neurosurgery at New York University Medical Center between 2005 and 2014 was performed. Patients undergoing only a biopsy were excluded; only patients with an attempted GTR were included. This review yielded 11 patients (Table 1).

Independent variables include age, sex, clinical presentation, associated disease, imaging features (localization, size, volume, enhancement, calcification, and ventricular size), pathology, indication of surgery, age at surgery, extent of resection, ETV at surgery, external ventricular drainage (EVD) at surgery, technical information (navigation, suction), complications, recurrence (local or distant), adjuvant therapies, and radiologic and clinical outcome were assessed.

Operative Technique

A computed tomography or magnetic resonance imaging (MRI) scan was obtained after fiducial markers were placed. The data were transferred to the stereotactic work station (Brainlab [Feldkirchen, Germany]), and the trajectory was planned according to tumor localization and patient anatomy. Under general endotracheal anesthesia, patients were positioned supine with the neck flexed. The head was fixed in a Mayfield (Cincinnati, Ohio, USA) or Sugita head frame. Fiducial markers were registered. Superficial landmarks were used to confirm the accuracy of navigation. A linear incision was made at the skin entry point, a burr hole was placed, and the dura and pia opened. Stereotactic guidance was used to cannulate the frontal horn. An endoscopic peel-away (19 French [Braun, Bethlehem, Pennsylvania, USA]) introducer was advanced into the frontal horn. A rigid rod lens endoscope (MINOP rod lens, 0° or 30° Aesculap; Tuttlingen, Germany) was then advanced under direct vision. The endoscope was held by the Mitaka (Park City, Utah, USA) pneumatic arm in select cases. Continuous irrigation at variable rates was maintained throughout the procedure. If an ETV was planned, it was performed before tumor resection either through the same burr hole or through a second at the Kocher point. After identification of the tumor (see Figure 1 for an intraoperative view of a third ventricular ependymoma [case 1]), resection was achieved with grasping forceps, suction with pediatric feeding tube, or endotracheal suction cannula (see Video 1 in the online publication showing resection of an ependymoma in the third ventricle [case 1]). Pathologic specimens were obtained. Bleeding was controlled by irrigation and mono- and bipolar cautery. An antibiotic impregnated BACTISEAL (Codman; Raynham, Massachusetts, USA) ventricular catheter was placed in patients at risk for postoperative hydrocephalus, preoperative neurologic impairment, or significant tumor debris. The EVD was clamped for 48 hours. Closure of the burr hole was performed by insertion of local autologous bone, CranioSculpt (KLS Martin, Jacksonville, Florida, USA), or titanium burr hole covers.

All patients had regular follow-up 4–6 weeks postoperatively, and annually at the Division of Pediatric Neurosurgery, the Pediatric Neuro-Oncology Clinic, or the Comprehensive Epilepsy Center.

Two patients in this series were described previously: one in a case report and one in a video.[14,15]

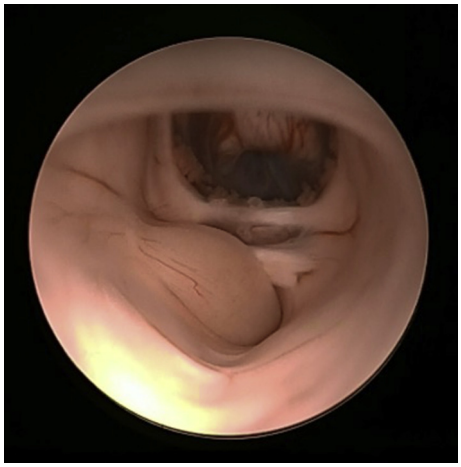

Figure 1. Case 1. Intraoperative view: pedunculated tumor in the third ventricle causing obstruction of the cerebral aqueduct.

RESULTS

Eleven patients underwent 12 surgical procedures for resection of intraventricular tumors. The average age at surgery was 9.8 years (range 8–17 years). There were 5 girls and 6 boys.

Symptoms

Six of 12 patients (50%) presented with headaches as a first symptom, and the additional patients had visual disturbances or visual impairment. Seizures were present at time of diagnosis in all the children with subependymal giant cell astrocytomas (SEGAs).

The indication for surgery was diagnostic and cytoreductive in 6 cases, recurrent tumor in 1 case, and tumor progression based on routine surveillance MRI in 5 cases, all SEGAs.

All patients with SEGAs had tuberous sclerosis.

Imaging

Tumor was located in the wall of the third ventricle in 7/12 (58%) of the cases, and in the wall of the lateral ventricle (caudothalamic groove) in the remaining 5/12 (42%). Maximal diameter varied from 9 to 26 mm (mean, 16.6 mm) and volume varied from 0.24 cm^3 to 3.9 cm^3 (mean, 1.56 cm^3). Calcification was present in 5/12 (42%) cases, all of which were SEGAs. Contrast enhancement was present in 9/12 (75%) cases.

Hydrocephalus

Ventriculomegaly and headache were present in 5/12 patients (42%) at the time of diagnosis. Two patients underwent an ETV at the time of surgery immediately before tumor resection. Two patients with preoperative hydrocephalus had an EVD placed after resection. The EVD was clamped and removed after 24–48 hours. No patient required a ventriculoperitoneal shunt. In all patients undergoing SEGA resection, an EVD was placed and subsequently removed 24–48 hours after surgery.