Endoscopic Assisted Microsurgical Resection of Lateral Ventricular Choroid Plexus Papillomas in Children

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ABSTRACT

Background: Choroid plexus tumors arise mainly in children. Their blood supply is from the choroidal arteries in the form of a pedicle. These tumors represent surgical challenge owing to their vascularity and the relatively low blood volume especially in infants, necessitating early control of the vascular pedicle. Endoscopic assisted microsurgery had proven beneficial in resecting many intra-ventricular masses. Objective: The aim of this study was to evaluate the endoscopic assisted microsurgical resection of choroid plexus papillomas focusing on clinical outcome, extent of resection, the extent of cortical incision and the need for brain retraction.

Patients and Methods: Sixteen choroid plexus papillomas in fifteen children with widely dilated ventricles were operated upon between 2007 and 2014. All cases had an initial attempt of endoscopic coagulation and detachment of the vascular pedicle followed by microsurgical excision of the mass. The extent of the cortical incision and the need to use self-retaining brain retractors were documented. Clinical outcome was assessed in the early postoperative period and after one month. Magnetic resonance imaging was performed three months postoperatively for all patients.

Results: Endoscopic coagulation and detachment was achieved completely in fourteen tumors and partially in one tumor. Failure of coagulation in the remaining tumor was due to its huge size and failure to mobilize it. Total excision was achieved in all cases. Two patients developed transient weakness and one patient developed postoperative seizures. Hydrocephalus needed insertion of a ventriculo-peritoneal shunt in twelve patients. Smaller cortical incisions were performed and no self-retaining brain retractors were needed in cases with complete endoscopic coagulation.

Conclusion: Endoscopic coagulation and detachment of the vascular pedicle followed by microsurgical resection of choroid plexus papillomas provides adequate and safe tumor resection with smaller cortical incisions and minimal brain retraction.

INTRODUCTION

Choroid plexus papillomas are rare intracranial tumors that originate mainly inside the ventricular system, representing 2 to 4% of pediatric intracranial tumors and 0.5% of intracranial tumors in adults. In children, most of these tumors are located within the lateral ventricles. They may occur at any age but the peak incidence is during the first two years of life particularly the first year. These tumors are highly vascular obtaining their blood supply from the anterior and posterior choroidal arteries through a vascular pedicle. Surgical resection of these tumors is usually performed by microsurgical techniques which are considered the gold standard for management of intraventricular tumors. Early adequate devascularization of these tumors through obliteration of their vascular pedicle is of paramount importance to avoid massive and even fatal blood loss.

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This may be difficult to achieve as the vascular pedicle is usually on the opposite side of the surgical approach. The use of the endoscope in management of intraventricular lesions especially colloid cyst has been frequently reported, being employed to perform fenestration, third ventriculostomy, tumor biopsy, and even tumor excision in selected cases. The endoscope provides better illumination and visualization without the degree of tissue retraction needed by the microscope. It is best used for management of small and relatively avascular tumors with soft or cystic consistency. Although choroid plexus papillomas are not the best candidates for endoscopic excision, few authors reported successful endoscopic excision of these tumors. Despite the use of the endoscope for coagulation of the choroid plexus in cases of hydrocephalus for many years, using the endoscope to interrupt the vascular pedicle of choroid plexus tumors prior to microscopic resection had not been frequently reported.

The aim of this study was to evaluate the endoscopic assisted microsurgical resection of these tumors focusing on the clinical outcome, the extent of
resection, the extent of cortical incision, and the need for brain retraction. The main role of the endoscope was to coagulate and detach the vascular pedicle before microsurgical tumor excision.

PATIENTS AND METHODS

This study was performed on fifteen children with sixteen choroid plexus papillomas (one patient had bilateral papilloma) and dilated ventricles operated upon during the period between 2007 and 2014 in Cairo University Hospitals. Patients with choroid plexus papillomas and ventriculomegaly, with or without VP shunt, were included in this study. Patients with choroid plexus carcinomas were excluded. All patients were subjected to history taking (from the parents) and detailed neurological examination. History taking focused on manifestations of increased intracranial tension, occurrence of fits, neurological deficits especially motor weakness and progressive head enlargement in infants. Examination stressed on assessment of head circumference and anterior fontanelle in infants, examination of motor power, gait affection and fundus examination in older children. Magnetic resonance imaging (MRI) with intravenous contrast injection was performed for all patients. Assessment of vascular supply was based on MRI which showed the signal void of the feeding arteries. Conventional angiography and computed tomography angiography (CTA) were not needed in any patient.

All patients were operated upon through the transcortical superior parietal lobule approach in the supine position. Complete excision was the aim of surgery in all patients. After performing the craniotomy and opening the dura, the endoscope was introduced (Hopkins 0 angle scope for navigation and Gaab Neuroscope 6 degrees with working channel). The endoscope was mainly used to reach and coagulate the vascular pedicle of the tumor as an initial step before attacking the tumor. An attempt of vascular pedicle coagulation was performed to interrupt the tumor blood supply using bipolar coagulation followed by detachment of the tumor from the vascular pedicle. At this point, the endoscope was removed and the operating microscope was introduced. Corticectomy was increased around the track of the endoscope. Tumor dissection and resection proceeded using the microsurgical techniques, being much easier after tumor devascularization. After tumor excision, an external ventricular drain (EVD) was inserted in all patients for a period of three to seven days. The dura was closed watertight with the subdural space filled with warm lactated ringer solution before final closure of the dura. The extent of cortical incision and the need to use self-retaining brain retractors was documented for each patient.

All patients were admitted to the postoperative neurosurgical intensive care unit. Clinical assessment was performed in the immediate postoperative period. Any deterioration in the conscious level or the presence of any unexplained neurological deficit was immediately investigated by computed tomography (CT) of the brain. The patients were kept lying on the side of the surgery for the first few days following surgery to decrease the accumulation of fluid in the subdural space. Regular assessment of the clinical condition and the EVD function was performed. Follow up CT was routinely performed on the second postoperative day unless it was needed earlier. The maximum duration for the use of EVD was one week, after which it was either removed, or a VP shunt was inserted. Clinical outcome was assessed and documented at one month postoperatively, and follow up MRI was performed three months postoperatively.

RESULTS

The study included ten males and five females (male to female ratio 2:1) with age ranging between seven months and twelve years (mean age: 3.25 years). The clinical manifestations included increased head circumference (HC) in four infants and manifestations of increased intracranial tension (ICT) in eleven patients. Table (1) shows the epidemiology and the clinical manifestations of patients. All tumors were located mainly in the trigone with extension into the occipital horn in three patients, and into the occipital horn and body of the lateral ventricle in one patient. Six patients had left sided tumors, eight patients had right sided tumors, and one patient had bilateral tumors being larger on the left side (Fig. 1). The maximum tumor diameter ranged between 1.5 cm and 7 cm, with mean maximum tumor diameter of 3.72 cm. All patients had ventriculomegaly including two patients with VP shunt inserted preoperatively.

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Table 1: The epidemiology and the clinical manifestations
Complete endoscopic coagulation of the vascular pedicle was achieved in fourteen out of sixteen tumors (87.5%), in addition to another tumor with partial coagulation (6.25%). Failure of endoscopic coagulation resulted from the inability to reach the vascular pedicle due to huge tumor that could not be mobilized allowing no access to the pedicle. The length of the cortical incision ranged between 2.5 cm and 3.5 cm except in the two patients with failed and incomplete vascular pedicle coagulation where the cortical incision measured 5 cm. Self-retaining brain retractors were not used in the fourteen tumors with complete coagulation and detachment of the vascular pedicle. Four patients below two years of age needed blood transfusion. Total tumor excision was achieved in all patients (100%).

There was no mortality in this series. Two patients developed postoperative weakness which was transient with no permanent deficit in any. Postoperative seizures occurred in one patient only. Permanent CSF diversion through VP shunt insertion was needed in twelve out of fifteen patients (80%) including two patients with preoperative VP shunt insertion. In the remaining three patients, the EVD was removed with no VP shunt required. Postoperative subdural hygroma developed in all patients. In asymptomatic cases, the hygroma was managed conservatively without the need for drainage or shunt insertion in any of the patient. Postoperative MRI performed after three months verified total tumor excision in all patients with partial or complete resolution of subdural hygromas (Fig. 2). Pathological examination verified choroid plexus papilloma in all patients. Mean follow up period was 3.5 years.

Fig. 1a&b: a: Preoperative CT and b: Intraoperative photo of the case with bilateral tumors

Fig. 2 a-d: a&b: Preoperative coronal and axial MRI with contrast. c: Early postoperative CT. d: Postoperative MRI after 3 months of one of the patients
DISCUSSION

Surgical management of intraventricular tumors represents a technical challenge to the neurosurgeon. The deep location within the brain, the need to go through vital neural structures to access them, and tumor consistency and vascularity represent obstacles to safe complete resection of these lesions. Dealing with choroid plexus tumors with their extensive vascularity and the hidden location of the tumor vascular pedicle adds to the difficulty of surgical resection. Surgery for these tumors would become much easier after devascularization, making early access to the vascular pedicle and its interruption an important operative step. Although this step can be performed using the microscope, this requires a considerable amount of brain retraction in most of the cases with increased incidence of complications. An alternative to early surgical interruption of the vascular pedicle is the preoperative embolization of these tumors to obliterate its blood supply and decrease blood loss. Concerns regarding radiation exposure and risks related to the vascular access, especially in the young age, were raised making many surgeons proceed to surgery without embolization. Failure to interrupt the vascular pedicle by embolization or early during surgery may result in significant blood loss.

The role of the endoscope in surgery for intraventricular tumors has been widely accepted being used for excision of some tumors, biopsy of others, and performing septostomy or ventriculostomy. Tumor criteria ideal for endoscopic resection include small size preferably less than 2 cm, cystic consistency, and low vascularity. Removal of highly vascular choroid plexus tumors using the endoscope would seem to be hazardous, especially for larger tumors (mean maximal tumor diameter in this series was 3.72 cm). In a review of forty articles including six hundred and sixty eight papers, tumor diameter in this series was 3.72 cm. In a review of forty articles including six hundred and sixty eight papers, tumor diameter in this series was 3.72 cm. In a review of forty articles including six hundred and sixty eight papers, tumor diameter in this series was 3.72 cm. In a review of forty articles including six hundred and sixty eight papers, tumor diameter in this series was 3.72 cm. In a review of forty articles including sixty and sixty eight purely endoscopic tumor resection, there were only two cases of choroid plexus papillomas, which clearly shows the limited experience with the endoscope for resection of these masses. However, using the endoscope to reach the vascular pedicle and coagulate it before proceeding to tumor excision would seem to be a reasonable approach based on the previous use of endoscopes to coagulate the choroid plexus in hydrocephalic patients. Moreover, Moftakhar et al reported endoscopic assisted resection of a choroid plexus vascular malformation where they used the endoscope to disconnect the lesion from its vascular supply and venous drainage before excision, which is similar to the concept adopted in this series. The endoscope allows performing this crucial step with smaller cortical incisions and minimal amount of brain retraction in most of the cases.

The endoscope is introduced in a trajectory that allows best tackling of the pedicle and not the mass itself. Once the pedicle is reached, endoscopic coagulation can be performed followed by tumor detachment from the vascular pedicle. Following devascularization, resection of choroid plexus papillomas is similar to resection of other intraventricular tumors. In this study, the vascular pedicle could not be reached in one patient (6.25%), and complete coagulation of the vascular pedicle was not possible in another patient (6.25%). Failure to perform this step resulted in greater extension of the cortical incision and the need to use brain self-retaining retractors.

There was no mortality or permanent major morbidity in this series, which is similar to the results of Kennedy et al, and slightly better than the results reported by Safaee et al who had no mortality and a single permanent neurological deficit among twenty four patients (4.2%). Other series reported mortalities that were mainly due to bleeding. Postoperative seizures occurred in 6.7% of the patients which is close to the 8% incidence of seizures following transcortical approach to intraventricular tumors reported by Milligan and Meyer, and much lower than the 25% incidence mentioned in the literature.

This series included only patients with ventriculomegaly which is considered a favorable factor for neuroendoscopic procedures, although others gave evidence that endoscopy is equally feasible in the absence of ventriculomegaly. Most of the patients (80%) required CSF diversion by VP shunt. This is much higher than the reported incidence of persistent hydrocephalus requiring shunting following tumor excision which ranged between 24 and 50%. Kennedy et al reported nine infants with choroid plexus papillomas who were operated upon and did not require CSF diversion in any patient. Some authors inserted EVD in their patients and concluded that this effectively lowered the need for permanent CSF diversion. Although the external ventricular drainage was used in all patients, this did not effectively lower the incidence of shunt insertion in this series.

Asymptomatic subdural hygroma occurred in all patients; however none of the patients needed surgical intervention. The development of large symptomatic or asymptomatic subdural fluid collection is common following these surgeries. Several authors discussed this complication reporting its incidence between 14.3% and up to 100%. The modified “brain patch” technique has been suggested to avoid this complication.

Total excision was achieved in 100% of patients which is similar to the results of many authors. Other authors reported lower rates of gross total excision ranging between 83.3% and 96%. Dudley et
al reviewed the data of two hundred and two children with choroid plexus tumors and found gross total excision in only 63.6% of cases with choroid plexus papilloma.27

CONCLUSION

Early interruption of the tumor blood supply is a crucial step in the surgical excision of choroid plexus tumors. This can be achieved by the endoscope, in most of the patients, minimizing the cortical incisions and avoiding the need for self-retaining brain retractors. Endoscopic assisted microsurgical resection of choroid plexus tumors provides adequate and safe tumor resection, with smaller cortical incisions and minimal brain retraction.

Disclosure:
The authors have no personal, financial or institutional interest in any of the drugs, materials, or devices described in this article.

REFERENCES