Endoscope-Assisted Microsurgical Resection for Pineal Region Tumors: Preliminary Experience

Ye Gu¹, Xiaobiao Zhang¹,²,*, Yong Yu¹, Fan Hu¹,², Wenlong Xu¹, Tao Xie¹ and Chongjing Sun¹

¹Department of Neurosurgery, Zhongshan Hospital, Fudan University, Shanghai, China
²Shanghai Key Lab of Medical Image Computing and Computer Assisted Intervention, Shanghai, China

Abstract: Objective: To determine the value of assisted-endoscope in infratentorial supracerebellar approach with microsurgical technique for patients with pineal region tumors.

Methods: seven patients with pineal region tumors underwent infratentorial supracerebellar approach for removing the neoplasms. Endoscope was utilized not only intraoperatively in extirpating tumors and removing iatrogenic clot but also preoperatively or postoperatively for the third ventriculostomy (a neurosurgical procedure).

Results: Gross total resection was achieved in all cases. Pathological diagnosis was germinoma in 2 cases, germinoma mixed with embryonal carcinoma in 2 cases, and malignant teratoma, mature teratoma and pineocytoma in 1 case for each. Endoscopic third ventriculostomy was carried out in 3 cases preoperatively due to acute increased intracranial pressure and 1 case postoperatively due to delayed hydrocephalus. All patients had good early outcomes. Follow-up studies were performed in 10 to 69 months after operations: 5 patients lived a normal life, 1 patient reported recurrence, 1 patient lost to follow-up study.

Conclusions: Resection for the pineal region tumors is very difficult, but appropriate surgical approach with meticulous microsurgical procedure assisted by endoscope may improve prognosis. Our data demonstrated that endoscope is valuable in ascertaining total tumor removal, evaluating bleeding after resection and removing clot from the third ventricle, and performing third ventriculostomy for obstructive hydrocephalus.

Keywords: Endoscope, Pineal region, Tumor, Infratentorial supracerebellar approach.

INTRODUCTION

Pineal region tumors are characterized by histological heterogeneity and deep-seated location adjacent to vital neurovascular structures [1, 2]. The management of pineal region tumors are based on pathological diagnosis [3-6]. With benign lesions, surgery alone is sufficient while in malignant lesions radiotherapy and chemotherapy are required after operations. The surgical intervention plays essential role in deciding the therapeutic strategies, since the pathological diagnosis is obtained by biopsy or tumor removal. However, the surgical treatment is often hindered by the deep location of the tumors and its close relationship to the surrounding vital neurovascular structures. The stereotactic biopsy or endoscopic biopsy takes the risk of intractable bleeding while gaining too limited tissue to ensuring the accurate pathological outcome [7]. Recently, Endoscopic techniques have been applied not only in pineal region tumor biopsy and third ventriculostomy but also in assist microsurgery for pineal tumor resection [8, 9].

We report our preliminary experience in removing pineal region tumors using endoscope-assisted microsurgery.

METHODS AND MATERIALS

From November 2006 to Jun 2012, 7 patients (5 males and 2 females) with pineal region tumor, aged from 14 to 68 years old (average 27.1 years old) underwent surgical treatment in Zhongshan Hospital of Fudan University. Among these patients, 1 accepted ventriculoperitoneal shunting in another hospital before admission. Preoperative evaluation included computer tomography (CT), magnetic resonance imaging (MRI) and cerebrospinal fluid (CSF) and serum measurement of Alpha-fetoprotein (AFP), β-human chorionic gonadotropin (β-HCG) and carcinoembryonic antigen (CEA) levels. Preoperative clinical manifestations, described in Table 1, included headache, dizziness, visual disturbance (visual loss, diplopia and paralysis of upgaze), and ataxia.

If necessary, an endoscope system (Karl Storz, Tuttingen, Germany) for endoscopic third ventriculostomy (ETV) was utilized. The endoscope procedure was performed as described previously [10] with slight modifications. A burr hole was made in the right frontal region, 1 cm anterior to the coronal suture and 3 cm lateral to midline.
A 0 and 30-degree, 18-cm long, and 4-mm wide rigid endoscope (Karl Storz, Tuttlingen, Germany) was used. For the infratentorial supracerebellar approach, the patient was put in a lateral oblique position with the thorax elevated 15 degrees to enhance venous drainage and the neck was slightly flexed to enhance the surgeon’s trajectory to the tumor. The head was fixed with three-pin Mayfield fixation. After antiseptic preparation, a straight midline incision about 8-10 cm was made. The bone flap was about 4 cm size, which extended over transverse sinus and included the torcular region. The dura was opened in V-shaped fashion with the base margin up to transverse sinus. After fixed the dura with suturing, surgical process was performed by microsurgical technique. Some bridging veins between the tentorium and the superior surface of the cerebellum can be sacrificed without any adverse effect in order to open the quadrigeminal region. Access was gained to the supracerebellar—infratentorial corridor. The thickened and opaque arachnoid membrane over the quadrigeminal cistern in the presence of tumors was opened by microdissection techniques to expose the precentral cerebellar vein. The precentral cerebellar vein was sacrificed with impunity to further exposure of the pineal region. The superior and lateral margins of the tumor can be dissected from surrounding velum interpositum, pulvinar and walls of the third ventricle. In such way, the tumor was extirpated totally. The endoscope was employed constantly. The dura was sutured in watertight manner and the bone flap was repositioned.

A CT was performed on postoperative day 1 to evaluate the degree of tumor resection and to detect postoperative bleeding. Follow-up MRI was performed at 1, 3 and 6 months postoperatively and then yearly. Postoperative brain and spine MRI was required in patients with malignant tumors.

**RESULTS**

The endoscope was used for acquiring panoramic visualization of the tumor, checking the absence of any residual tumor and for removing the iatrogenic clot probably bringing postoperative obstructive hydrocephalus (Figures 1-2). In this series, all patients achieved total tumor removal with the endoscope-assisted microsurgical techniques (Figure 3). Pathological diagnosis was germinoma in 2 cases, germinoma mixed with embryonal carcinoma in 2 cases, and each malignant teratoma, mature teratoma and pineocytoma in 1 case. Endoscopic third ventriculostomy was carried out in patient 5, 6 and 7 preoperatively due to acute increased intracranial pressure (Figure 4) and in patient 3 postoperatively due to delayed hydrocephalus. 5 patients accepted radiotherapy postoperatively according to the pathological diagnoses. The symptoms including dizziness, headache and ataxia were all released and visual disturbance were improved after surgery. The transient diabetes insipidus was reported in patient 5 and the desmopressin was required. All patients had good early outcomes. The follow-up studies were

<table>
<thead>
<tr>
<th>case</th>
<th>age</th>
<th>sex</th>
<th>Clinical findings</th>
<th>Tumor markers*</th>
<th>Previous surgery</th>
<th>ETV</th>
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<td>None</td>
<td>Mature teratoma</td>
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<td>Visual disturbance</td>
<td>AFP†</td>
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<td>Preoperative</td>
<td>Malignant Teratoma</td>
<td>Radiotherapy</td>
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<td>68</td>
<td>F</td>
<td>Ataxia</td>
<td>Normal</td>
<td>No</td>
<td>Preoperative</td>
<td>Pineocytoma</td>
<td>None</td>
<td>None; live a normal life now</td>
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ETV: endoscopic third ventriculostomy; F/U: Follow-up, mo: months, VPS: ventriculoperitoneal shunting, a: visual disturbance included visual loss, diplopia and paralysis of upgaze, b: tumor markers measurement included serum and cerebrospinal fluid.

**Table 1: Patients’ Data**

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Figure 1: Intraoperative endoscopic view from patient 6 after microsurgery. The figure showed the structure inside the third ventricle after microsurgery. There is no residual tumor and the stoma of previous ETV was found clearly. A: the intraventricular structures was observed consequently after tumor removal; B: When advancing endoscope, the storm was found. F=fornix, AC=anterior commissure, LT=lamina terminalis, C=chiasma, CR=chiasmatic recess, S=stoma, TB=tumor bed.

Figure 2: Intraoperative endoscopic view from patient 5 after microsurgery. The pictures showed the structures inside the third ventricle and absence of residual tumor. A: the remote view; B and C: the close view. ITC=interthalamic commissure (collapsed), F=fornix, AC=anterior commissure, CP=choroid plexus, FM=foramen Monro.

Figure 3: MR images from patient 6 demonstrated the total tumor removal. A and B: Preoperative MR images; C and D: postoperative MR images.

performed in 10 to 69 months (mean 47.8 months, patient 1 was not included). 5 patients lived a normal life, 1 patient reported recurrence, 1 patient lost to follow-up study. Patient 1 with a mixed germ cell tumor (germinoma mixed with embryonal carcinoma) reported tumor recurrence 18 month after surgery but lost to follow-up study then. Patient 3 reported delayed hydrocephalus 2 months after operation and accepted an ETV, and at the 36th month he reported visual impairment, the MRI examination demonstrated tumor recurrence in the sellar region and he was referred for a second radiotherapy. The detail was also concluded in Table 1.
DISCUSSION

Cushing and Dandy are pioneers whom trying to remove pineal region tumors but achieved unfavorable prognosis [11, 12]. The early publication of successful expatriation of a pineal region tumor was reported by Krause via an infratentorial cerebellar approach [13]. However, the surgery for pineal region tumors did not spread widely and the successful reports were few. The introduction of the operating microscope and the advent of microsurgical instruments and technique heralded the modern era of radical surgery for pineal region tumors. Stein [14] and Poppen [15] respectively modified infratentorial and supratentorial approach with microsurgical technique. In the last decade, endoscopic extended endonasal approach surgery has been proved to be an alternative minimally invasive surgery for lesions in anterior skull base and suprasellar region for the sake of panoramic view and direct manipulation brought by endoscope [16-18]. Accordingly, applications of endoscope in posterior skull base may also benefit from the better surgical visualization of endoscope. Endoscope-assisted technique had been reported feasible to obtain an unsurpassed view of pineal region and even ventricle from posterior perspective in an anatomic study with infratentorial supracerebellar approach [19].

Although the multimodal therapeutic strategies have been built for the pineal region tumors, there is a growing appreciation for the value of aggressive tumor removal for improving the prognosis of patients. Total resection is acutely curative for benign tumors, while radical debulking is thought to improve the outcome and response to adjuvant therapy in malignant tumors [20]. The pineal region has been accessed primarily via three surgical routes: the infratentorial–supracerebellar, the occipital transtentorial, and the posterior transcallosal interhemispheric approach [4, 6, 20]. The infratentorial–supracerebellar approach, which allows for adequate exposure of lesions located in the pineal region and the posterior part of the third ventricle, was advocated by Krause [13] in 1926 and more recently popularized by Stein [14]. The main advantage of infratentorial–supracerebellar approach is essentially extra-axial route to the pineal region and the posterior compartment of third ventricle located underneath the major deep veins, which diminishes the chance for important neurovascular compromise. However, the disadvantage of this approach is a narrow operative field because of the presence of the tentorium, which produces restricted visualization at both lateral and superior corners [21]. The endoscope can provide supplemental visualization than microscope. In this series, though adequate exposures required for tumor extirpation were obtained under microscope, wider visualization provided by endoscope further confirmed the absence of residual tumor.

To review the articles of endoscope-assisted microsurgery for pineal region, we found two papers. Cardia et al. [19] reported an anatomic study of endoscope-assisted infratentorial-supracerebellar approach to the third ventricle though the pineal region. The pineal region was examined in 10 human cadaveric heads. The vital neurovascular structures achieved complete view. However, this study did not illustrate where the extra region the endoscope was provided compare to microscopic approach alone. Our clinical outcome confirmed their anatomic study. Broggi M et al. [9] reported their experience on resecting pineocytomas with the endoscope-assisted technique via an interhemispheric transtentorial retrosplenial approach. The series included 15 cases of patients with pineocytomas, which all achieved total tumor removal. During the operative procedures, endoscope was able to detect residual tumor located either behind the Vein of Galen or attached to the undersurface of the corpus callosum and guide the residual tumor resection. The main advantage of their approach is essentially large extra-axial route above the tentorium to gain extensive view of the entire pineal region, which facilitating the view of deep venous structures and ipsilateral dorsal and lateral extension. However, for large lesions the splenium may need to be split [6, 9]. Our data demonstrated that endoscope-assisted
microsurgical techniques using in the infratentorial approach was feasible in resecting the pineal region tumor as well.

Preoperative hydrocephalus was frequently encountered in patients with a pineal region tumor owing to the compression or obstruction of sylvian aqueduct. Postoperative hydrocephalus was also reported due to the intraoperative hemorrhage into the resected tumor bed and adhesion [22]. In the past, ventriculoperitoneal shunting was advocated in resolving pre- and postoperative hydrocephalus. However, it was reported to carry the risk of infection, dissemination of tumor cells and shunting failure [23]. In recent two decades, ETV has been gradually considered to be a valid alternative to ventriculoperitoneal shunting in patients with obstructive hydrocephalus for its minimal invasive access and acceptable reliability [24, 25], it was employed both in preoperative and postoperative hydrocephalus. The success rate of ETV is high (70–94%) [26-28].

The value of endoscope in our series may be conclude as 1) To check if there is any residual tumor and remove it under monitoring of endoscope based on the extra visualization beyond the microscope; 2) To remove the clot from intraoperative hemorrhage into the resected tumor bed and sylvian aqueduct entry, which may decrease the rate of postoperative obstructive hydrocephalus; 3) Applications in preoperative and postoperative endoscopic third ventriculostomy to treat hydrocephalus. Owing to the limited similar studies, the randomized controlled trial could not be conducted. The long-term results of the importance of endoscope-assisted microsurgical techniques should be identified in the further study.

CONCLUSION

Although surgical managements for the pineal region tumors are very challenging, suitable surgical approach with meticulous endoscope-assisted microsurgical procedure may improve outcomes. Our data demonstrated that application of endoscope is valuable in assuring total tumor removal, eliminating intraoperative clot within the third ventricle to prevent obstructing the sylvian aqueduct and employing in third ventriculostomy for both preoperative and postoperative hydrocephalus.

REFERENCE


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