The Role of Neuroendoscopy in the Treatment of Pineal Region Tumors

Flávio Ramalho Romero¹
Eduardo de Freitas Bertolini²
Adalberto Sestari²
Sérgio Soares Guerrero²
Ramon Barbalha Guerrero²
Modesto Cerione Jr.²

ABSTRACT

Object. The authors report their experience in six patients presenting with pineal tumors and associated hydrocephalus who underwent an endoscopic biopsy procedure and third ventriculostomy (ETV) in a single setting. The purpose of this report is to discuss the role of neuroendoscopic procedures in the management of pineal region tumors.

Methods. A retrospective review of patients undergoing simultaneous ETV and tumor biopsy was undertaken. Neuroendoscopic surgery was first applied for tumor debulking with tissue diagnosis and gross morphological analysis of the tumor and the intraventricular structures, followed by third ventriculostomy. Subsequent procedures were determined on the basis of verified individual tumors.

Results. Over a 2-year interval, 6 patients underwent simultaneous ETV and tumor management. These patients ranged from 6 to 54 years of age (mean 24.3 years). All cases were completed without complications or the need for an additional CSF diversionary procedure within 6 months. The diagnostic yield of the biopsy was 100%. Favorable therapeutic outcomes were obtained in all cases of germinoma and pineoblastoma, with follow-up periods ranging from 6 to 24 months.

Conclusion. The majority of our patients with dilated ventricles were treated satisfactorily with effective neuroendoscopic procedures as the initial procedure, avoiding unnecessary craniotomy and promising excellent therapeutic outcomes.

Keywords: pineal tumor, hydrocephalus, endoscopic third ventriculostomy, biopsy, neuroendoscopy.

SINOPSE

Objeto. Os autores relatam sua experiência em seis pacientes com tumores da região da pineal e hidrocefalia associada que foram submetidos à biópsia por via endoscópica e terceiroventriculostomia (TVE) num mesmo tempo cirúrgico. A proposta deste artigo é discutir o papel da neuroendoscopia em tumores da região da pineal.

Métodos. Foi realizado estudo retrospectivo de pacientes submetidos simultaneamente à TVE e biópsia. A cirurgia neuroendoscópica foi inicialmente direcionada para retirada de fragmentos tumorais para seu diagnóstico, além da avaliação morfológica da lesão e das estruturas ventriculares associadas, seguida por TVE. Procedimentos subsequentes foram avaliados individualmente conforme o diagnóstico histológico.

Resultados. Num período de 2 anos, seis pacientes foram simultaneamente submetidos a TVE e biópsia de lesões da região da Pineal. A faixa etária foi de 6 a 54 anos (média 24.3 anos). Todos foram tratados por trepanação única, sem complicações ou necessidade de procedimento adicional para hidrocefalia. Foi possível diagnóstico histológico em 100% dos casos, já que a biópsia neuroendoscópica oferece material suficiente para diagnóstico, inclusive estudo imunohistoquímico. Radioterapia Estereotática foi realizada em casos com indicação. Prognóstico favorável foi obtido em todos os pacientes com germinomas ou pineoblastoma, com seguimento de 6 a 24 meses.

Conclusões. Todos os pacientes com tumores da região da pineal e dilatação ventricular foram satisfatoriamente tratados inicialmente com procedimento neuroendoscópico, evitando a necessidade de procedimentos mais invasivos desnecessários e com excelente prognóstico.

Palavras-chave: tumor pineal, hidrocefalia, terceiroventriculostomia endoscópica, biópsia, neuroendoscopia.
INTRODUCTION

Management of pineal region tumors has changed considerably during the past quarter of century. Conservative treatment involving shunt therapy and irradiation in the early 1970s evolved into a more aggressive approach with the advent of microneurosurgery. More recently, stereotactic and endoscopic technology has added a new dimension to the management of these tumors. The broad range of treatment modalities for these lesions is due to the diversity of tumor types found in the pineal region as well as the unique location of this structure. The most common presenting signs and symptoms are related to raised ICP because of the numerous vascular structures in the vicinity of the pineal gland. Neither of these procedures, however, specifically addresses the presence of hydrocephalus associated with masses in this area. For these reasons, endoscopy is emerging as the preferred initial management of these lesions. Patients presenting with hydrocephalus and a posterior third ventricular mass can undergo ETV and an endoscopic tumor biopsy procedure in one sitting. Several case reports and short series involving this combined approach to pineal region tumors have been reported.

Optimal treatment for a pineal region tumor may be aggressive resection, radiotherapy, chemotherapy, or a combination based on tumor histology. Obtaining an adequate tissue sample for histological diagnosis is an important aspect of treatment planning. Open craniotomy and microsurgical biopsy sampling can achieve this; however, the risk of permanent associated morbidity approaches 10%. Stereotactic biopsy sampling is a less invasive technique, but sampling error, due to the heterogeneous nature of tumors in the region, has been noted to be a significant problem. Additionally, this procedure can carry significant morbidity because of the numerous vascular structures in the vicinity of the pineal gland. Neither of these procedures, however, specifically addresses the presence of hydrocephalus associated with masses in this area. For these reasons, endoscopy is emerging as the preferred initial management of these lesions. Patients presenting with hydrocephalus and a posterior third ventricular mass can undergo ETV and an endoscopic tumor biopsy procedure in one sitting. Several case reports and short series involving this combined approach to pineal region tumors have been reported.

We present our experience in treating six patients presenting with hydrocephalus and a pineal mass. We specifically discuss the use of endoscopy as an initial treatment modality and elaborate on several aspects evident in our study and in the literature.

METHODS

Between 2009 and 2011, 6 patients with pineal region tumors and associated hydrocephalus presented for surgical treatment. All patients were initially treated endoscopically with simultaneous ETV and tumor management. There were four male and two female patients who ranged in age between 6 and 54 years (mean 24.3 years).

The presenting signs and symptoms are summarized in Table 1. Each patient underwent preoperative computerized tomography (CT) and magnetic resonance imaging (MRI) with and without infusion of contrast material (Fig. 1). The decision to proceed with the endoscopic biopsy procedure as initial treatment was based solely on the presence of a posterior third ventricular mass with dilated ventricles.

Figure 1. Preoperative MRI (Case 4). T1 MR imaging with and without infusion of contrast material and T2 images, respectively, showing lesion in pineal region extending to posterior portion of third ventricle.

A right-sided precoronal incision and burr hole are initially made at the midpupillary line, and an introducer is used to puncture the lateral ventricle. A 7-mm rigid endoscope is inserted through the introducer into the lateral ventricle. The ventricular landmarks including the choroid plexus, thalamostriate and septal veins, and foramen of Monro, are identified. The floor of the third ventricle can often be visualized through the dilated foramen of Monro, and the endoscope is advanced into the third ventricle. The scope is then directed toward the posterior aspect of the third ventricle, and the tumor is visualized (Fig. 2). The standard landmarks in this region are identified. Using biting forceps, two or more biopsy specimens are then obtained from different regions of the mass. Bleeding is controlled using copious irrigation or bipolar cautery. When hemostasis is achieved, the TVE is made using a blunt probe in the usual location anterior to the mammillary bodies and is then widened using a No. 3 French Fogarty balloon catheter. Electrocoagulation is not used during this part of the procedure.

Figure 2. An illustrative case of endoscopic tumor biopsy of a pineal region tumor. Left: Endoscopic view directed into the third ventricle from a left anterior approach. Choroid plexus is seen at the roof of the third ventricle. The tumor mass is situated posterior and inferior to the massa intermedia. Right: Tumor mass is undergoing sampling with cupped forceps.

The study was approved by the Hospital Ethics Committee.
Results

Pathological diagnosis, subsequent treatment, and clinical outcome at last follow up are summarized in Table 1. Histological diagnosis was successfully established in all patients (Table 1). In four patients, biopsy specimens showed germinomas (Table 1). In one patient (Case 3) a diagnosis of pineoblastoma was made after endoscopic biopsy sampling several years previously at an outside institution, and in another patient (Case 5) the biopsy procedure was aborted because the great vascularity of the lesion.

There was no evidence suggestive of tumor dissemination in patients with germinomas, and these patients underwent stereotactic radiosurgery (gamma knife surgery) or frameless stereotactic radiotherapy. Two of these patients also underwent three courses of chemotherapy. All patients had no residual tumor and remained intact neurologically after the treatment.

One patient (Case 5) required subsequent craniotomy for tumor resection. There were no deaths and no significant new postoperative neurological deficits were seen.

Discussion

In 1968, Poppen and Marino\(^7\) reported that pineal region tumors should initially be managed using radiotherapy because of the high mortality rate associated with radical surgery. Until the late 1970’s, this conservative regimen was the standard initial procedure for treating pineal region tumors in North America.\(^2\) In the 1980’s, the approach to pineal region tumors started to shift to extensive radical surgery due to the development of diagnostic neuroimaging and microsurgery.

The use of a variety of surgical techniques to gain access to the pineal region\(^2,22\) was further supported by the advantages presented by microneurosurgery. At the same time, detection of the tumor markers AFP and HCG became available as an aid to the diagnosis and management of these tumors\(^2\) as well as the more specific morphological detection offered by CT\(^9,11,19\) and MR\(^11,19,21\) imaging.

Tumors of the pineal region are rare, comprising less than 11% of all pediatric tumors.\(^6\) In children, approximately 60% of pineal region tumors are of germ cell origin.\(^21\) In these cases, the presence of a-fetoprotein or b-human chorionic gonadotropin in serum or CSF is sufficient to diagnose malignant germ cell tumors without the need for biopsy.\(^11\) When these markers are negative, tissue diagnosis becomes necessary, as different histological tumor types have variable responses to radiation therapy, chemotherapy, aggressive resection, or a combination of these treatment modalities.\(^3,5,10\)

Traditional methods of sampling pineal region masses include microsurgical and stereotactic biopsies. Both approaches result in increased morbidity for a variety of reasons, including the vascularity of the pineal region.\(^22\) Furthermore, recovery and operative time are longer in most cases accomplished via a microsurgical approach.

In 1973, Fukushima, et al.\(^10\) provided the first modern description of the use of an endoscope in the treatment of pineal tumors. Prior to this, the endoscope was mainly used to coagulate the choroid plexus in the treatment of hydrocephalus. In the early 1970s, endoscopic biopsy sampling of pineal lesions was unpopular because surgeons feared inducing uncontrollable bleeding. Since then, adequate techniques have been developed for hemostasis, and the ventriculoscope has been used for

### Table 1: Summary of treatment in six patients with pineal region masses associated with hydrocephalus

| Case | Age/Sex | Presenting Finding | Procedure | Diagnosis | ETV failure | Treatment | Follow-up | Condition | Neurological deficits |
|------|---------|-------------------|------------|-----------|-------------|-----------|-----------|-----------|-----------|----------------------|
| 1    | 14/M    | Headache          | ETV + biopsy | Germimona | no          | RT        | 24m       | estable   | No        |
| 2    | 6/M     | Sonolence         | ETV + biopsy | Germimona | no          | RT+QT     | 18m       | estable   | No        |
| 3    | 32/F    | EOM palsy         | ETV + biopsy | Pineoblastoma | no       | RT+QT     | 12m       | estable   | No        |
| 4    | 21/M    | Headache + sonolence | ETV + biopsy | Germimona | no          | RT        | 9m        | Estable   | No        |
| 5    | 54/F    | Sonolence         | ETV         | Vascular lesion | no      | Surgery   | 6m        | Estable   | No        |
| 6    | 19/M    | Headache          | ETV + biopsy | Germimona | no          | RT        | 6m        | Estable   | No        |

Legend: M: Male; F: Female; ETV: Endoscopic Third-Ventriculostomy; RT: Radiotherapy; QT: Chemotherapy.
various neurosurgical conditions including hydrocephalus, cysts, and tumors.1,2

Currently, in many centers with neurosurgeons who are skilled in endoscopy, patients who present with pineal tumors and hydrocephalus are initially managed endoscopically. Multiple studies have demonstrated its safety, diagnostic efficacy, and lower morbidity and mortality compared with conventional approaches.3-6,8,9,13,22

The goal in the endoscopic management of these patients is to treat hydrocephalus and tissue procurement for diagnosis. In the series reported by Fukushima,7 he obtained biopsy specimens in 21 patients, four of whom harbored pineal region masses. A correct diagnosis, however, was made in only one of the four patients. Nevertheless, in more recent studies, tumor diagnosis has been successful in almost all cases.8-11,13,18-22

There were no significant deficits associated with our endoscopic biopsy procedures. One intraoperative hemorrhage occurred during bipolar coagulation of the tumor surface prior to the biopsy procedure. Since then, we have refrained from using cautery and instead use copious warm irrigation for hemostasis. In reviewing the literature, there were no deaths attributable to the endoscopic procedures. There was a 15% transient morbidity rate involving either hemorrhage or other transient neurological deficit.4,5,7,8,11,13,14,18-20,22

**CONCLUSIONS**

Our data confirm the safety and diagnostic efficacy of simultaneous ETV and biopsy in the early management of a newly diagnosed pineal region mass. Neuroendoscopic procedures have a great advantage in the management of chemo- or radiosensitive tumors, such as germinoma, pineoblastoma, or primitive neuroectodermal tumor. We have also demonstrated that, while it is not yet possible to recommend a set of standard criteria requiring one approach over another, several of our measurements showed trends toward a particular approach. Further evaluation of a larger patient cohort may allow us to make such recommendations.

**REFERENCES**


CORRESPONDING AUTHOR

Flávio Ramalho Romero
Rua Lisboa, 316 – Jd. Paulista
São Paulo – SP – Brazil
Zip code: 05413-000
phone: 11- 3459-4416
e-mail: frromero@ig.com.br / romeroncr@gmail.com