Neuroendoscopic approach to brain tumors
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Abstract
Objective: Although standard microsurgical approach is the established techniques to many brain tumor surgery, however, endoscopic brain tumor surgery is becoming the technique of choice to some skull base tumors and intraventricular tumors. The purpose of this study was to evaluate the efficacy of brain tumor surgery by endoscopic approach. In this paper, we like to share our experience regarding the management of patients with brain tumors by endoscopic approach. Methods: 12 cases of brain tumor patients were treated by endoscopic approach first time ever in Bangladesh. A total of 12 strictly endoscopic interventions were performed. Total tumor resections, partial resections, biopsies and endoscopic third ventriculostomies (ETV) were performed. Results: Endoscopically complete tumor resection was possible in five cases with eventless and quick postoperative recovery. Tumor biopsy or partial resection from the midbrain, thalamus, pineal region and intraventricular space through a single burr hole technique was possible without any postoperative neurological deficit. The hydrocephalus-related symptoms resolved in all of the 10 patients with cerebrospinal fluid pathway obstruction. One patient died on 5th postoperative day. Conclusions: In our preliminary experience, the endoscopic brain tumors surgery was found minimal invasive technique and superior to conventional microscopic surgery in terms of operative mortality and morbidity. Endoscopic third ventriculostomy (ETV) is the unique technique to manage tumor associated obstructive hydrocephalus rather than ventriculoperitoneal (VP) shunt.

Introduction
Surgical management of brain tumor is still a challenging issue to the neurosurgeons. Skull base tumors (e.g. pituitary tumors), thalamic, midbrain and pineal region tumors, tumors in the cerebellopontine angle and tumors in the ventricles of the brain present a challenging management scenario for the neurosurgeon. This is primarily because of the site of the lesions and critical neuroanatomic structures such as optic apparatus, hypothalamus, pituitary gland, fornices and midbrain, cranial nerves, vessels and other brainstem structure situated adjacent to the abnormality. Direct standard microsurgical approach (craniotomies) still not so appreciable to remove these tumors and sometimes fraught with severe complications. In the recent decades neuroendoscopy as a minimal invasive procedure is becoming the powerful tool to approach to many brain tumors -because of less invasiveness, magnification and illumination best offered by neuroendoscope in comparison to operating microscope. In this context, as we started neuroendoscopic brain tumor surgery for the first time ever in Bangladesh, we would like to present a few cases of brain tumor treated with purely neuroendoscopic approach. We will discuss how neuroendoscope have influenced our approach to the treatment of brain tumor involving critical neural structures.

Materials and methods
Between May 2006 and July 2007, 12 patients with brain tumor were selected for endoscopic approach. The selection criteria mainly depended on tumor location, and size of the tumor. Average age at presentation was 22 years of age (range: 12 years to 42 years) and the male-to-female ratio was 2:1 (eight male and four female). The lesions included two pituitary giant macroadenoma, two lateral

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ventricular tumor (astrocytoma), one case of the colloid cyst of the third ventricle, three cases of thalamic tumor (astrocytoma), one craniopharyngioma (primarily intra-axial with exophytic extension into the third ventricle), three midbrain lesions (astrocytoma) and one pontine glioma with exophytic extension into the prepontine cistern and third ventricle. Total tumor resections, partial resections, tumor biopsies and endoscopic third ventriculostomies were performed. A total of 12 strictly endoscopic interventions were performed. Each patient’s presenting symptoms, radiographic findings, treatment, histopathology, adjuvant treatments, outcome, and complications were recorded. Particular attention was paid to the role of the endoscope in the patients’ surgical treatment.

Tumors located within the ventricular system were approached through a single standard burr hole (14 mm size) at frontal region - 3 cm off the midline just anterior to the coronal suture. The endoscope is introduced via a right/left frontal burr hole, and navigated around the ventricles, looking for anatomy of the ventricular system, and pathologies within the ventricles. Ventriculoscopy is invaluable for exploration of the ventricular system and thus approach to intraventricular tumor, tumors in the midbrain, thalamus and pineal region. Tumors located in the skull base (e.g. pituitary tumor) were approached through nostrils (right or left or both) without any incision in the nasal mucosa (Figure 1).

Pure endoscopic tumor surgery, where the endoscope is the sole means of visualization and instruments are passed down a working channel, is used when the tumor is totally intraventricular, less than 2 cm in size and relatively avascular and cystic intraventricular lesions. The colloid cyst is the perfect example of the purely endoscopic application (Fig. 2). Endoscope controlled microsurgery, where the endoscope is the sole means of visualization but instruments are passed alongside the scope, not through working channels, is another technique that can be used to remove intraventricular tumors that are too large or too vascular for the purely endoscopic technique. Endoscope assisted open surgery is a technique whereby the endoscope simply allows the surgeon to visualize anatomic and pathological structures that cannot be seen well with the operating microscope (e.g. endoscopic endonasal pituitary tumor surgery, endoscopic assisted microvascular decompression).

Results
Endoscopically complete resection had been done in five cases (two pituitary macroadenoma, one thalamic tumor and one intraventricular tumor and one colloid cyst). The postoperative recovery was uneventful in all these cases. The extent of tumor removal was confirmed by postoperative magnetic resonance imaging (MRI) (Fig. 2 & 3, 4 & 5). Partial tumor resection was done in five cases and biopsy was taken from the two midbrain lesions. Complications observed in the series included infection in one case, transient CSF leakage through ventriculosity wound in one case and one perioperative death (patient with pontine lesion with exophytic extension into the prepontine cistern and third ventricle). Radiotherapy was given in appropriate cases. Two patients of midbrain glioma have had tumor progression.

Discussion
Over the past several decades, articles have appeared discussing the merits of endoscopically assisted tumor biopsy and resection. In 1968 a surgeon wrote on using the endoscope during stereotactic tumor biopsy. In 1980 a series of articles was
published discussing techniques for endoscopically resecting intraparenchymal tumors. A physician has reported on successfully biopsying 50 brain tumors using a stereotactically guided endoscope with a 0% mortality or morbidity. It is his feeling that the endoscope enables him to better control post biopsy bleeding and to insure a complete evacuation of any associated cyst.

The endoscopic approaches to the tumors within the cerebral ventricles and in the structures surrounding the ventricles are advantageous in terms of patient morbidity and mortality. Although very few comparative conclusions can be drawn regarding the advantages of endoscopy over standard microsurgical techniques, there are several scenarios in which endoscopy is clearly invaluable. Examples are ventriculoscopic identification of tumor dissemination, endoscopic third ventriculostomy for secondary noncommunicating hydrocephalus and purely endoscopic removal of colloid cysts and other suitable intraventricular tumors.

Colloid cysts of the third ventricle are the lesions most amenable to purely endoscopic removal. Lewis et al. presented a series of 15 patients harboring colloid cysts; with shorter operative times and hospital stays and faster returns to work in those patients treated endoscopically versus those who underwent transcallosal resection. The series published by Abdou and Choen, King et al. and Rodziewicz et al. also demonstrated effective resections with low morbidity. In a series from Decq et al., with upto 28 months of follow-up, 1 of 15 patients had a cyst recurrence at 1 year. We had a single case of colloid cyst removed by endoscopic technique through a single burr hole. Patient did not need any postoperative ICU support and became ambulant after 24 hours of surgery and discharged from hospital after 48 hours of operation (Figure 2). Postoperative follow up MRI shows complete disappearance of the tumor.

Surgical approach to the solid intraventricular tumors, tumors of the midbrain, thalamus and pineal region with exophytic extension into the ventricles also a great challenge to the neurosurgeons. Open microsurgical approaches to these lesions were not encouraging - because of more invasiveness of the procedure which is related to the higher morbidity and unacceptable mortality. Endoscopic approach to the lesions of these critical structures approach appears to be more safe and patients friendly as it is minimally invasive procedure and provide very quick recovery without any significant postoperative complications. In our study, we completely removed two intraventricular solid tumors very successfully- without any perioperative complications (Figure 3). Subtotal tumor resection and biopsy from midbrain tumors was also uneventful.
Most of the patient with intraventricular tumor has associated obstructive hydrocephalus which may need additional CSF diversion surgery. Previously all such cases were managed by ventriculoperitoneal (VP) shunt prior to definitive microsurgery. However, recent trend is different - because with endoscopic approach both the intraventricular tumor and associated hydrocephalus can be managed in a single sitting with a standard burr hole. In this series we performed 10 endoscopic third ventriculostomy (ETV) procedures simultaneously while performing tumor resection, or tumor biopsy. This is particularly very convenient to the patients - because they do not need any VP shunt surgery prior to tumor surgery.

The use of endoscopes for inspection of the ventricular system (ventriculoscopy), tumor resection, tumor biopsy and endoscopic third ventriculostomy (ETV) is well documented in the literature. In the case of ventriculoscopy, diagnosis and treatment may change with the additional information provided as compared with imaging studies alone. Likewise, for masses with an intraventricular component, endoscopic biopsy is a straightforward procedure to obtain a tissue diagnosis. Endoscopic third ventriculostomy, depending on the underlying cause of hydrocephalus, has obvious allure, as opposed to shunting, with the inherent complications of shunting.

With the improved illumination, magnification and field of view offered by the endoscope, the progression of endoscopic techniques to intraventricular tumor removal and endoscopically assisted microsurgical resection was predictable. While operating via endoscope we experienced - very clear anatomical details within the ventricular system and also details about pathology and structure involved by the lesion with the panoramic view of endoscope.

Pituitary adenomas are slow growing tumors that constitute about 10-15% of all intracranial neoplasms. They can produce compression symptoms when enlarged or give rise to hormonal disturbances. These tumors are often diagnosed late or remain undiagnosed. Radiology (MRI) is the best tool for diagnosis along with hormonal assays. These tumors can be treated medically, surgically or with radiotherapy. In 1912, Cushing was the first to describe the transseptal transphenoidal approach to the pituitary tumors. Since the late 1970, the transphenoid approach has been the preferred procedure for removal of these tumors. With the advent of endoscopic surgery the endoscopes have now been applied to access these tumors with favorable result. The better magnification and illumination provided by the endoscopes has helped in precise delineation of the tumor and has ensured completeness of tumor removal. It has also greatly reduced the postoperative morbidity.

The conventional surgical methods (open craniotomy or transspenoidal approach) for removal of pituitary adenomas involves incisions on the scalp or incisions under the upper lip (sublabial approach) or in the nostril respectively. Transphenoidal approach requires the use of postoperative nasal packing. Endoscopic endonasal approach not only eliminates the need for incision or nasal packing but heightens the surgeon's visualization of pituitary tumors. Replacing the operating microscope, the endoscope provides the surgeon with a panoramic view of the pituitary gland and surrounding structures. It can also provide a very close view of the pituitary gland and tumor interface. Patients are generally sent home the day after surgery. De Divitis E. described that the increased exposure, magnification and flexibility of the endoscope combined with the absence of skin incisions, brain retraction and cranial nerve dissection is an advantage of the endoscopic endonasal transphenoidal approach that cannot be denied.

In this series we performed complete resection of two pituitary tumors endoscopically (fig. 4 & 5). We experienced very quick and uneventful postoperative recovery in both the cases. Endoscopic approaches to these skull base lesion is simply straightforward and superior to
standard microsurgical approach in respect to postoperative morbidity and mortality.

Figure 4: (a) Pituitary macroadenoma (b) Tumor is removed by Endonasal endoscopic approach. Patient on the following day of surgery (c) Postoperative MRI showing complete removal of tumor

Figure 5: (a) Functioning pituitary macroadenoma (b) Acromegalic patient (c) Tumor is removed by Endonasal endoscopic approach. Patient on the following days of surgery (d) Postoperative MRI

Conclusions
Now-a-days neuroendoscopy is becoming the essential tools for management of many intracranial space occupying lesions (ICSOLs). It may help in the re-establishment of cerebrospinal fluid pathways, enhance tumor removal, assess the extent of tumor removal and totally replace the microscope in some cases. Factors that influence the ability of a surgeon to perform a complete endoscopic resection include tumor size, composition and vascularity. Based on our results, we believe that endoscopic techniques should be considered in the treatment of selected pituitary tumors and selected intraventricular lesions and some other selected intracranial space occupying lesions like arachnoid cysts. The procedure requires careful patient selection, the use of refined endoscopic instrumentation and a disciplined surgical technique.

References