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Clinical Study

Operative results of keyhole supracerebellar-infratentorial approach to the pineal region

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ABSTRACT

The supracerebellar-infratentorial approach to the pineal region is typically accomplished with a craniotomy that extends to at least the rim of the foramen magnum. Minimally invasive techniques that limit the inferior extent of the craniotomy have been described for this approach but, to our knowledge, no operative results have been published demonstrating the feasibility and safety of such techniques. We present a series of patients who underwent surgical resection of pineal region lesions using the minimally invasive method at our institution. Clinical, radiologic, and operative data were prospectively collected on patients treated for lesions of the pineal region by the senior author from January 2012 to July 2014. Seven patients were identified. The sitting position was employed in each patient. Keyhole craniotomies were limited to a maximum diameter of 2.5 cm. Adequate working corridors were attained, and in no patient was resection limited by the exposure. No neurological or systemic complications were seen in the perioperative and early follow-up periods. In this feasibility study, we demonstrate that it is not necessary to extend a craniotomy inferiorly to the rim of the foramen magnum in order to gain access to the pineal region via relaxation of the cerebellum. The same surgical goals can be safely accomplished with a smaller craniotomy.

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1. Introduction

The supracerebellar-infratentorial (SCIT) approach is a common strategy used to access midline and paramedian lesions located beneath the deep venous system in the pineal-tectal region. Traditionally, a large craniotomy has been used with the SCIT approach due to the limited anatomical pathway afforded while operating in the pineal region, and it is commonly accepted that the craniotomy should be extended inferiorly to at least the rim of the foramen magnum to allow the cerebellum to sag [1–6].

However, we hypothesized that the size of the standard craniotomy could be reduced with the keyhole principle, by which the smallest opening necessary is used to access the requisite anatomy [7,8]. To our knowledge, no operative results have been published demonstrating the feasibility and safety of the keyhole SCIT approach. In this study, we report seven patients in whom we limited the craniectomy to within 2.5 cm of the transverse sinus while employing the SCIT approach to the pineal region. We demonstrate that this method can be safely used to minimize surgical exposure without compromising access to the lesion.

2. Methods

This study was approved by the University of Oklahoma Health Sciences Center Institutional Review Board. We reviewed a prospectively collected database on all patients between January 2012 and May 2014 treated surgically by the senior author with a sitting SCIT approach for lesions of the pineal region. The following data were collected: patient demographics, clinical presentation, diagnosis, operative data, complications, extent of resection and early follow-up information. Diagnosis was determined by histopathologic evaluation by a neuropathologist. Extent of resection was determined by the operating neurosurgeon and the neuroradiologist based on assessment of postoperative imaging.

2.1. Surgical approach

All patients underwent a suboccipital keyhole craniectomy in the sitting position. The neck was flexed with motor and sensory evoked potentials used to ensure that overflexion did not occur. Patients were monitored for air embolus with transesophageal echocardiography. Image guidance with frameless navigation was utilized. For midline lesions, craniectomies just to the side of the

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Table 1
Summary of patients who underwent our keyhole supracerebellar-infratentorial approach to the pineal region

Patient	Age (years)/sex	Clinical presentation	Diagnosis	Approach	Surgical complications	Extent of resection
1	35/F	Syncope, headaches	Pineocytoma	Midline	None	GTR
2	27/M	Disturbed circadian rhythm, abnormal extraocular movement, headaches	Pineal cyst	Midline	None	GTR
3	68/F	Difficulty walking	Falcotentorial and pineal region meningioma	Midline	None	STR
4	43/F	Neurofibromatosis Type II	Falcotentorial and pineal region atypical meningioma	Midline	None	STR
5	48/M	Hemorrhage	Midbrain cavernous malformation	Lateral	None	GTR
6	62/F	Declining neurologic function	Pontine metastasis of lung origin	Lateral	None	NTR
7	37/F	Headaches, nausea/vomiting, encephalopathy	Third ventricular glioblastoma	Midline	None	GTR

F = female, GTR = gross total resection, M = male, NTR = near total resection, STR = subtotal resection.

midline bony keel were planned. For paramedian targets, ipsilateral retrosigmoid craniectomies were planned. A 5 cm vertical incision was made. The soft tissue was dissected and retracted to expose the occipital bone. At this point, a craniectomy located just inferior to the transverse sinus was carefully performed in keyhole fashion using a high speed drill. The largest diameter of the craniectomy was no more than 2.5 cm in all patients. Care was taken to protect the adjacent sinuses. The dura was opened in V-shaped fashion and reflected superiorly to expose the interface between the cerebellum and the tentorium. The supracerebellar veins were cauterized and divided to relax the cerebellum and create a working area. We found that this was successful in causing the cerebellum to sag. Gentle padding was occasionally employed but retractors were not necessary to pull down the cerebellum. The arachnoid overlying the Galenic venous supply was carefully dissected from lateral to medial. The precentral cerebellar vein was cauterized and divided to expose the pineal region, after which the operation was tailored to the specific lesion.

3. Results

Seven patients, five women and two men, underwent surgery for various lesions of the pineal region between June 2012 and May 2014 (Table 1). The median age was 43 years (range: 27–68). The presentations included two pineal lesions, two falcotentorial meningiomas, a third ventricular glioblastoma, a midbrain cavernous malformation, and a pontine metastasis of lung origin. In all patients, despite the use of a mini-craniotomy with limited inferior extent, cerebellar relaxation was sufficient for visualization (Fig. 1). Gross total resection was achieved in four patients, near total resection in one, and subtotal resection in two. Where gross total resection was not accomplished the resection was not limited by exposure but by extension of the lesion into either the straight sinus or the pontine tegmentum, where the risks were deemed to outweigh the benefits of continued resection. No intraoperative complications were experienced. In particular, there was no concern for air embolus in any patient. Short-term follow-up has not demonstrated new neurologic deficits. Each patient's operation is described below.

3.1. Patient 1: Pineocytoma

This patient presented with a history of syncope and headaches and was found to have a pineal lesion (Fig. 2A). After reaching the pineal region, the tumor was approached anteriorly through the third ventricle. The mass was carefully removed from the underlying tectum and posterior commissure using microsurgical dissection. Subsequently, the tumor was followed up to its apex underneath the vein of Galen where it was separated sharply in a single piece. An endoscope was introduced to visualize the recess

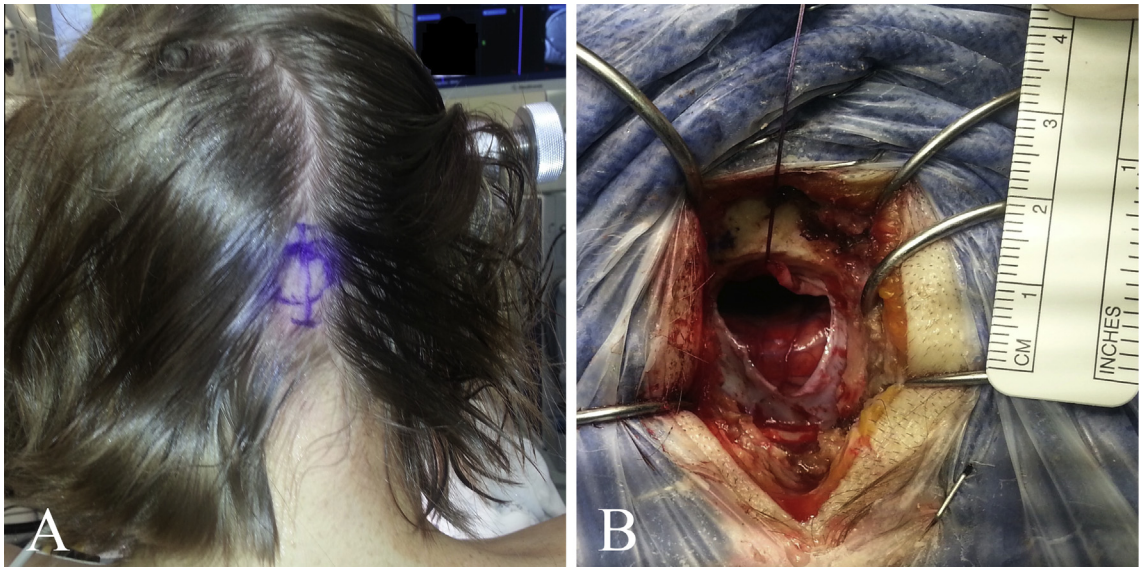

Fig. 1. Planned keyhole craniotomy just inferior to the transverse sinus (A). The cerebellum relaxes in spite of the limited inferior extension (B). (This figure is available in colour at www.sciencedirect.com.)

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