

# Keyhole Craniotomy for Excision of Tumors and Clipping of Aneurysm in Children: An Analysis of Eight Procedures

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Received May 28, 2015; Revised June 05, 2015; Accepted June 08, 2015

**Abstract** With improvement in surgical techniques and introduction of new micro-instruments, keyhole craniotomies are gaining favor in neurosurgery. We evaluated the technical and procedural aspects of the supraorbital keyhole approach for eight pediatric patients undergoing excision of tumor and clipping of aneurysm between 2012-2015. The mean age and weight of the patients were  $10.0 \pm 3.92$  yr and  $23.97 \pm 11.20$  Kg respectively. Surgery was performed from the right side in all patients. The mean length of the incision in our series was  $2.79$  cm  $\pm 0.09$ . Maximum tumor diameter was 50 mm. Gross total resection of the tumor was done in 4 (57.14%) and near total in the remaining 3 patients (42.85%). 2 patients (25%) experienced CSF rhinorrhea and other two patients (25%) suffered transitory diabetes insipidus (8%). There was no mortality in our case series. Out of 8 patients, 6 were followed up to 12 months. Recurrence of tumor was encountered only in 1 (14.28%) patient. We observed that the supraorbital keyhole craniotomy is a useful minimally invasive approach to treat selected anterior fossa tumors and aneurysm of the intracranial vessels.

**Keywords:** supraorbital keyhole craniotomy, minicraniotomy, pediatric neurosurgery

**Cite This Article:** Ali MahadMusallamAl-Mashani, Neeraj Salhotra, Azmat Ali, and Rashid M Khan, "Keyhole Craniotomy for Excision of Tumors and Clipping of Aneurysm in Children: An Analysis of Eight Procedures." *American Journal of Medical Case Reports*, vol. 3, no. 7 (2015): 198-200. doi: 10.12691/ajmcr-3-7-4.

## 1. Introduction

The conventional large craniotomy for excision of brain tumor is often necessitated by lack of diagnostic/ localization techniques, illumination and micro instruments. These craniotomies result in significant postoperative pain, longer period of hospitalization, poor cosmetic appearance, and above all, increased chances of infection. However with better understanding of anatomic corridor, evolution of superior imaging techniques and micro-instruments have lead to the emergence of "Keyhole" craniotomy that is not only cosmetically appealing but results in reduced tissue injury, postoperative pain and shorter hospital stay. Today keyhole craniotomy is usually undertaken in adult patients for excision of brain tumors [1,2,3,4] and aneurysms. [2,5,6] However, there are only few reports in literature on keyhole craniotomy in pediatric patients for tumor excision [7,8] and none for aneurysm. In this case series manuscript we critically analyze and present our experience with keyhole craniotomy in eight pediatric patients undergoing excision of tumor and aneurysm clipping over a three-year period.

## 2. Patients & Methods

After obtaining permission from Ethical Issues Committee to publish the hospital data, we could retrieve data of eight pediatric patients who underwent keyhole surgery under a single neurosurgical unit between 2012-2015. Of these eight patients, six had suprasellar tumor, one hypothalamic hemartoma and one had aneurysm of the bifurcation of the internal carotid artery. The pathological diagnosis of suprasellar tumors was pilocystic astrocytoma in three cases, pilomyxoid astrocytoma in two patients, and a case of craniopharyngioma.

All patients underwent exhaustive clinical examination and imaging workup prior to surgery including a thorough pre-anesthetic assessment. Parents of the patients were explained the advantages and possible complications of the procedure before obtaining written consent.

Patients were positioned supine with the head held in a 3-pin frame. A slight head elevation was maintained throughout the operative procedure. Neuronavigation via Brain LAB<sup>TM</sup> (Vector Vision, Kapellenstrasse 12, Germany) was used in all patients. Incision was made either just above or within the eyebrow to keep it well concealed after healing. The incision length ranged between 2.70-2.90 cm and was marked using a sterile pen and a paper measuring tape. Incision started just outside the supraorbital foramen and extended to the frontal process of the zygomatic bone laterally. A miniaturized craniotomy of approximately 2.5 X 3.0 cm was performed

using a high-speed craniotome. Meticulous care was taken to keep the bony cut flushed with the floor of the orbital roof. This enabled the operating surgeon to get a good access with minimal retraction of the frontal lobe. However in patients where frontal sinus was encountered during the craniotomy, mucosa was exenterated and subsequently filled with bone wax to prevent any CSF leak and/or infection. Subsequently a linear dural incision was made and the surgeon proceeded with decompression of the tumor. Following a complete (four patients) or near gross tumor decompression (three patients) and a good

hemostasis, dura was closed to give a watertight approximation. Drain was not placed in any of our patients.

### 3. Results

The mean age and weight of the patients were  $10.0 \pm 3.92$  yr and  $23.97 \pm 11.20$  Kg respectively. The youngest patient was six years old and lowest weight recorded in an eight years old patient was 3.4 kg. Surgery was performed from the right side in all patients. The mean length of the incision in our series was  $2.79$  cm  $\pm 0.09$  (Table 1).

**Table 1. Clinical characteristics of the patients and surgical procedure with follow up details**

S. No	Age/weight Yrs Kg	Nature of tumor	Location & Size (cm)	Preoperative presentation	Incision length (cm)	Extent of tumor resection	Duration of surgery (hr: min)	Hydrocephalus	Complication	Postoperative status & follow up
1	8 3.8	Pilomyxoid astrocytoma	Suprasellar region 3.0 X 4.0	GCS 15/15, Nystagmus, underweight, titubation	2.75	Subtotal decompression	3: 00	Nil	Postoperative DI, electrolyte imbalance	Nystagmus & titubation improved, GCS 15/15 Till 12 months no tumor recurrence
2	7 21	Craniopharyngioma	Suprasellar region 2.2 X 1.9	Headache, increased thirst, increased urination	2.70	Gross total decompression	2: 35	Nil	Nil	Improvement in all symptoms. Till 12 months no tumor recurrence
3	11 29	Pilocystic astrocytoma	Suprasellar region 2.6 X 2.9	Decreased vision	2.90	Near total decompression	4: 00	Nil	Postoperative developed DI, on replacement therapy of desmopressin & hydrocortisone	Improvement in vision. Till 12 months no tumor recurrence
4	6 20	Hypothalamic hemartoma	Hypothalamic region 2.0 X 2.0	Convulsions	2.75	Subtotal decompression	2: 15	Nil	Nil	Convulsion frequency much reduced. Till 12 months no tumor recurrence and no convulsions.
5	11 35	Pilomyxoid astrocytoma Gr II	Suprasellar region 4.0 X 3.0	Visual disturbances	2.90	Gross total incision	3: 15	Underwent EVD insertion prior to tumor surgery	Nil	Eyesight improved Small tumor recurrence seen 6 months postoperative; received radiotherapy
6	15 31	Pilocystic astrocytoma	Suprasellar region 5.0 X 5.0	Loss of vision	2.75	Gross total decompression	3: 20	Nil	Nil	No follow up after discharge
7	6 18	Pilocystic astrocytoma	Suprasellar region 3.0 X 3.0	Decreased vision	2.90	Gross total decompression	4: 20	Nil	Nil	Improved vision. No follow up after discharge
8	16 34	ICA bifurcation aneurysm	-	Headache & vomiting, GCS 15/15	2.70	Clipping of aneurysm	1: 00	Nil	Nil	Reduced headache intensity & vomiting. GCS 15/15. Patient doing well at 12 months

(ICA= Internal carotid artery, DI= Diabetes insipidus, GCS= Glasgow coma score, EVD= External ventricular drainage, hr: min= hour: minutes).

Gross total resection of the tumor could be achieved in four cases (57.14%), near complete in one patient (14.28%), and subtotal resection in two cases (28.57%). Micranotomy was closed in all cases without a drain. Duration of surgery lasted between one to four hours and twenty minutes. Duration of hospital stay of the patient ranged between eleven to seventeen days.

We encountered CSF rhinorrhea in two patients that was easily controlled. Transient hypoesthesia of the supraorbital region and difficulty in elevating the eyebrow

was noted in nearly all patients. These were temporary and resolved mostly by conservative approach. There was no mortality in this study. The only other added morbidity that we encountered in this series was the development of postoperative diabetes insipidus in two patients who underwent near complete decompression of pilocystic and pilomyxoid astrocytoma. Both responded well to replacement therapy with desmopressin and hydrocortisone. None of the patient developed infection.

Preoperative symptoms of convulsion, visual problems, headache, vomiting, and titubation improved in all patients on follow up at six and twelve months in the postoperative period. Unfortunately two patients of pilocystic astrocytoma did not turn up for follow-up despite reminders.

#### 4. Discussion

In this series of eight patients, we could perform keyhole surgery of tumors and aneurysm successfully without any serious morbidity or mortality. Of the two patients who developed CSF leak; one had a small leak at the incision site and the other had collection under the wound site. It subsided spontaneously in one patient over 24-48 hours while in the other case we had to place a lumbar drain for three days to divert the CSF flow and accelerate the healing process.

The only other morbidity that we noted was the development of diabetes insipidus in two patients. Both had astrocytoma and responded well to replacement therapy with desmopressin and hydrocortisone. We did not encounter any significant added morbidity secondary to the keyhole approach.

The maximum diameter of the tumor resected in adult patients by Wiedemayer et al [4] via keyhole incision measured 30 mm. In contrast, the largest diameter of the tumor in the present series of eight pediatric patients was 50 mm. It was a pilocystic astrocytoma and could be decompressed completely without damaging the pituitary stalk.

The skin incision is generally about 45 mm in adults. [2] The mean incision length in our patients was 27.9 mm. This was sufficient to make bony window of approximately 25 X 30 mm in all our patients to perform a satisfactory surgery. Others have reported nearly similar bony opening measuring 15-20 mm by 25-30 mm [9,10,11].

The operating surgeon may use a neuroendoscope as it provides a close-up wide angled view of the operating site. [4] The neuroendoscope enhances the working angle while operating through a small bone window. However, we did not use this in any of our eight patients, since the endoscopic view is two-dimensional while the operating microscope provides a superior three-dimensional view favoring easier manipulation of the cranial pathology. The operating surgeon in this series and also earlier study [2] preferred operating microscopic (Leica™ MS-1F, Heerbrugg) rather than neuroendoscope for visualization and surgical manipulations during the procedure.

The only patient who underwent clipping of the internal carotid artery aneurysm at its bifurcation was a 16-year old boy weighing 34 kg whose main complaint was headache. The patient was discharged on the eleventh post-operative day with a much-reduced headache and without any new neurological deficits. The patient was

without any symptoms of headache when followed up at six and twelve month's period.

The incidence of gross total and near complete excision of tumor in this case series was nearly identical to that reported by El Shafei [12]. Duration of surgery lasted between one to four hours and twenty minutes in this case series. This was comparable to that reported by Weidemayer et al [4].

Ours is a tertiary hospital with only neurosurgical center in the country with state-of-art facility. We did not achieve shorter hospital stay in our patients undergoing keyhole craniotomy as compared to conventional craniotomy at our center. This is attributed to our policy of ensuring that patient does not have even a remote chance of readmission after discharge as they come from far off places.

In conclusion, the keyhole approach to minicraniotomy has proven to be beneficial in terms of satisfying cosmetic results and no significant morbidity. However, it is essential that the surgeon should have sufficient experience with conventional craniotomy before he/she undertakes keyhole minicraniotomy.

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