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Clinical Study

Supraciliary keyhole craniotomy for anterior frontal lesions in children

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ABSTRACT

Treatment for anterior frontal space occupying lesions such as epidural hematoma, vascular malformations or brain tumors, have typically involved invasive craniotomies. This method often requires large incisions with wide exposure and may be associated with high morbidity rates. The basis for the "keyhole" method is that a minimally invasive craniotomy is often sufficient for exposing large areas deep in tissue, and may limit exposure and decrease surgically related morbidity while enabling adequate removal and decompression. The supraciliary method includes a cut above the eyebrow and a small craniotomy to uncover the base of the frontal lobe and the orbital roof. We demonstrate our experience with this method. We identified children who were operated via the supraciliary approach between January 2009 and December 2013, and gathered their pre- and post-operative clinical and radiological statistics. Fourteen patients were identified. Pathologies included tumors, abscesses and epidural hematomas. Nine were operated due to epidural hematoma, two due to tumors, two due to brain abscesses, and one for anterior encephalocele. No significant peri-operative or post-operative complications were observed. Long-term follow-up shows that the surgical scars were nearly invisible. The supraciliary approach is a safe, effective and elegant technique for treating lesions in the anterior skull base. The method should be weighed alongside traditional methods on a case-by-case basis.

1. Introduction

Traditionally, approaches to the frontal lobe for treatment of tumors or epidural hematomas have included extensive craniotomies, as were described in detail in the early years of the twentieth century [1]. Such methods require large incisions of the skin, above the hairline, with wide exposure of the bone and brain tissue. This naturally increases the likelihood and severity of complications. The "keyhole" method is gradually becoming the accepted surgical technique for operations of the frontal lobe and represents an excellent alternative to traditional methods [2]. This minimal surgical technique, which involves a small opening of the skull, allows excellent exposure of the anterior portion of the frontal lobe, the orbital roof, and the areas adjacent to the sella turcica, without causing damage to brain tissue or to cranial nerves. Further, this method provides better cosmetic results and significantly reduces the length of surgery compared to traditional methods.

We describe the clinical findings and results of children with lesions of the base of the frontal lobe who were operated on in our department using the supraciliary keyhole approach. We present an illustrative patient with a description of the surgical process and review the benefits and disadvantages of this method in relation to traditional methods for the skull base.

2. Methods

We reviewed the charts of children who underwent surgery of the frontal lobe using minimally invasive methods at our neurosurgical pediatric units at the University Medical Center at Soroka and the Hadassah Ein Kerem Medical Center, Israel. We collected pre-operative statistics, data on the surgical course, and post-operative results. All the patients underwent brain imaging before and after surgery. The surgery included an incision above the eyebrow, extended laterally about 0.5 cm, a single burr hole, and a minimal lateral craniotomy using the "keyhole" method (Fig. 1). After adequate exposure, the dura was opened if needed, and the lesions were removed. The incision above the eyebrow was sewn with a subcutaneous dissolving stitch. After the surgery the children were observed at the pediatric intensive care unit.

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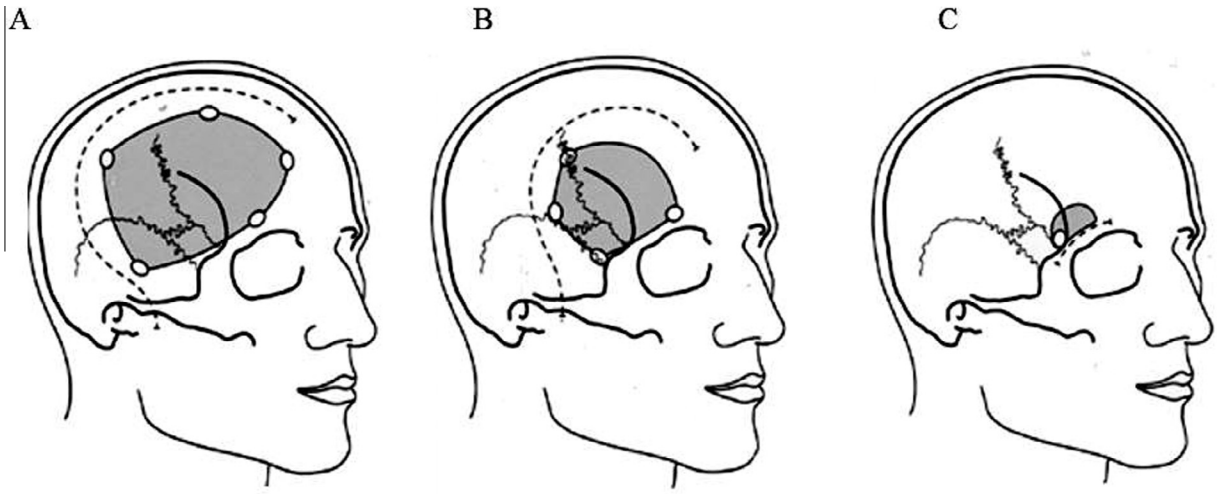

Fig. 1. A schematic illustration of the development of the approach to the anterior skull base. (A) The skin incision and the wide craniotomy described by Dandy [1]. (B) The pterional [13] approach for procedures in this area, as described by Yasargil. (C) The supraorbital method, which includes a minimal incision above the eyebrow and a minimal craniotomy. Despite its small size the incision enables good exposure of the skull base. The schematic illustration is reproduced with permission of the illustrators in Reisch R et al. Ten-year experience with the supraorbital subfrontal approach through an eyebrow skin incision. Neurosurgery 2005;57:242–55 [2].

3. Results

We identified 14 children aged 3–16 years who were operated on using the supraciliary approach for lesions that involved the base of the frontal lobe. Nine had intracranial bleeding and/or fractures after head trauma, two presented with brain tumors, two with brain abscesses, and one child had an anterior encephalocele following a skull base fracture. Nine were operated on the left side of the brain, and five on the right.

Table 1 summarizes demographic and clinical characteristics, and the complications and neurological outcomes of the patients who were operated by the described approach. The nine children who were operated following severe head trauma arrived at the emergency room with a decreased level of consciousness (7–14 on the Glasgow Coma Scale); two of them presented with a dilated pupil. They underwent CT scanning that revealed epidural hematoma with significant pressure on the brain tissue and brain herniation, and were operated urgently for evacuation of the blood clot. Of the two children who were operated following brain tumors, one (Patient 3, Table 1) needed a biopsy to examine a leptomeningeal metastasis originating from a posterior fossa medulloblastoma, which was resected in a previous surgery followed by a neuroaxis radiotherapy. The second (Patient 2, Table 1) underwent repeat partial removal of a glioblastoma multiforme, with a secondary operation in the orbital roof. For both children the operative and post-operative course was uneventful. Both patients died

Table 1
Demographic and clinical data of the children who underwent supraciliary craniotomy

Patient	Age (years)	Sex	Clinical presentation	CT scan/MRI findings	Surgical result	Complications
1	6	F	TBI, GCS 13	Rt. epidural hematoma	No residual	–
2	14	M	Headache, vomiting	Lt intra-axial tumor (GBM)	Subtotal resection	–
3	5	M	Headache	Rt. metastatic medulloblastoma	Biopsy	–
4	11	M	TBI, GCS 11	Rt. epidural hematoma	No residual	–
5	9	F	TBI, GCS 10	Lt. epidural hematoma	No residual	–
6	8	F	TBI, GCS 11	Lt. epidural hematoma	Recurrent epidural hematoma	Lt. frontotemporal craniotomy
7	9	M	TBI, GCS 7 dilated non-reactive pupil	Lt. epidural hematoma	No residual	Split eyebrow
8	16	M	Fever, headache	Lt. epidural abscess	Evacuation of abscess	–
9	7	F	TBI, GCS 14	Lt. epidural hematoma	No residual	–
10	13	M	Fever, headache	Lt. epidural abscess	Evacuation of abscess	–
11	8	F	TBI, GCS 13	Lt. epidural hematoma	No residual	–
12	3	M	TBI, GCS 9	Lt. epidural hematoma	No residual	–
13	5	F	S/P TBI, rhinorrhea	Rt. frontal encephalocele	Resection of encephalocele, intra-cranial dural closure	–
14	6	F	TBI, GCS 8 dilated pupil	Lt. epidural hematoma	No residual	–

F = female, GBM = glioblastoma multiforme, GCS = Glasgow Coma Scale score, Lt. = left, M = male, Rt. = right, S/P = status post, TBI = traumatic brain injury.