

Left frontotemporal craniotomy for sphenoid wing meningioma

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In this case study, the author will present information on meningiomas and an overview of a craniotomy with specific details from a left frontotemporal craniotomy performed on a patient diagnosed with a sphenoid wing meningioma.

TYPES OF INTRACRANIAL TUMORS

Depending on their point of origin, intracranial tumors are classified typically as either primary or secondary.

Primary intracranial tumors originate within the brain, the meninges or the pituitary gland, and occur in approximately 35,000 people per year in the United States.⁶ Primary tumors are classified further into:

- *Intra-axial tumors*, which originate inside the brain parenchyma and include astrocytomas, oligodendrogliomas, ependymomas, medulloblastomas, hemangioblastomas, primary central nervous system lymphomas, germ cell tumors and pineal region tumors; and
- *Extra-axial tumors*, which originate outside the parenchyma and include meningiomas, schwannomas and pituitary adenomas.

Secondary intracranial tumors are metastatic lesions of tumors that originate outside the brain. An estimated 150,000 to 250,000 patients present with this type of tumor annually in the US.⁶

MENINGIOMAS

Meningiomas represent about 20% of all primary intracranial tumors, making them the second most common type of primary brain tumor.^(S)

The majority of meningiomas are benign, slow-growing tumors that develop from arachnoid cap cells that line the inner dura. They typically do not invade surrounding brain tissue, bone or muscle. Instead they compress or displace these structures as they grow, thus increasing intracranial pressure, which can produce noticeable symptoms in the patient. (See Table 1)

Most meningiomas are ovoid in shape, adhere to the dura, feel rubbery to the touch, and are located in the subfrontal region, cerebello-pontine angle, parasagittal region and cerebral convexities.

Table 1. Symptoms commonly associated with intracranial tumors^{5,6}

Compression—While some tumors, including meningiomas, do not invade the brain, they typically compress the brain and any surrounding nerves. Pressure on these nerves usually produces noticeable symptoms in the patient:

- Optic nerve (II)—Loss of vision
- Ocular muscle nerves (III, IV, VI)—Loss of eye movement
- Trigeminal nerve (V)—Facial numbness
- Facial nerve (VII)—Weakness in the face
- Accessory nerve (XI)—Loss of trapezius muscle function
- Hypoglossal nerve (XII)—Loss of tongue movement

Destruction—If a tumor attacks the brain, there may be resulting loss of function in that part of the brain. This type of damage may present as loss of speech, comprehension, sensation, coordination or mental acuity.

Irritation—If the tumor irritates the cerebral cortex, the patient may experience seizures.

Increase in intracranial pressure (ICP)—An increase in ICP can be caused directly by tumor growth and hemorrhage, and indirectly by hydrocephalus. The most commonly reported symptoms are nausea, vomiting, headaches, and a reduction in—or loss of—consciousness. Depending on the tumor's location and rate of growth, these symptoms may occur early on in the tumor's development or may remain mild and/or unnoticeable until the tumor is quite large.

Meningiomas occur most often in adults and primarily in middle-aged women. In some patients, the tumors may be associated with a condition such as meningiomatosis or neurofibromatosis, or a history of radiation therapy in childhood.

Surgery is often the indicated treatment, since gross total resection of the tumor may cure the patient. Total resection usually involves the removal of the tumor, the surrounding dural tissue and any involved skull. However, even when complete removal of these is accomplished, 10% of patients will experience a recurrence within 10 years.⁶

Due to surrounding nerves, blood vessels and other critical structures, complete removal may be difficult or impossible in some cases, leaving the surgeon to decide whether it is better to leave part of the tumor or attempt complete removal and risk neurological damage. For example, the carotid artery and the cranial nerves that enter the cavernous sinus may be inextricably involved with a meningioma that originates in the medial sphenoid wing or petroclival region.⁶

EPIDEMIOLOGY

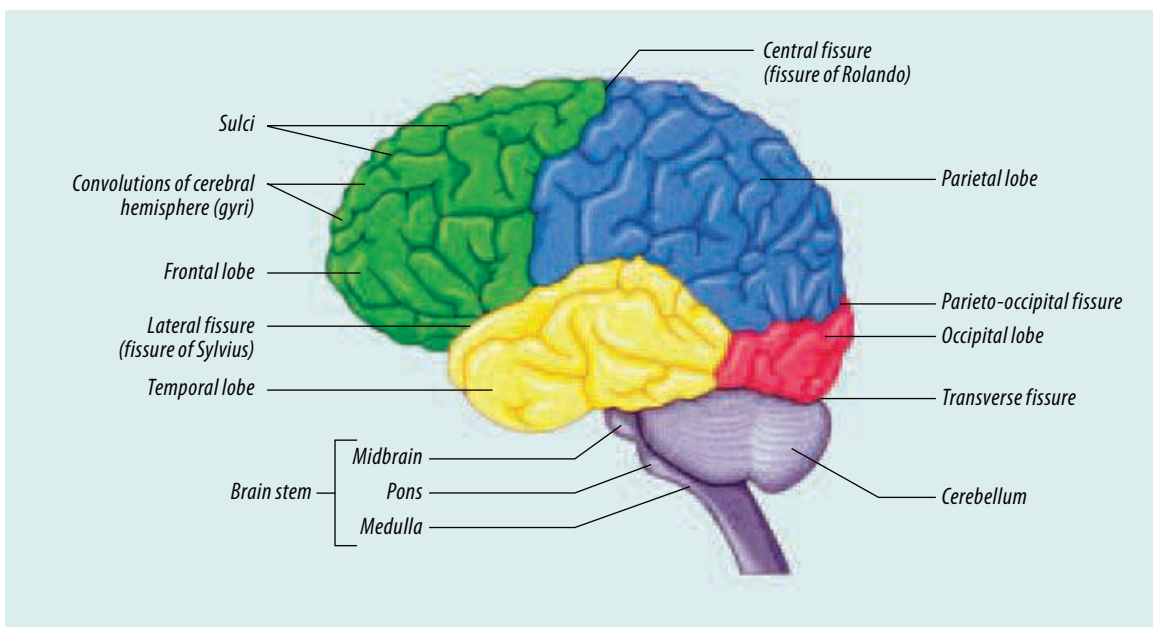
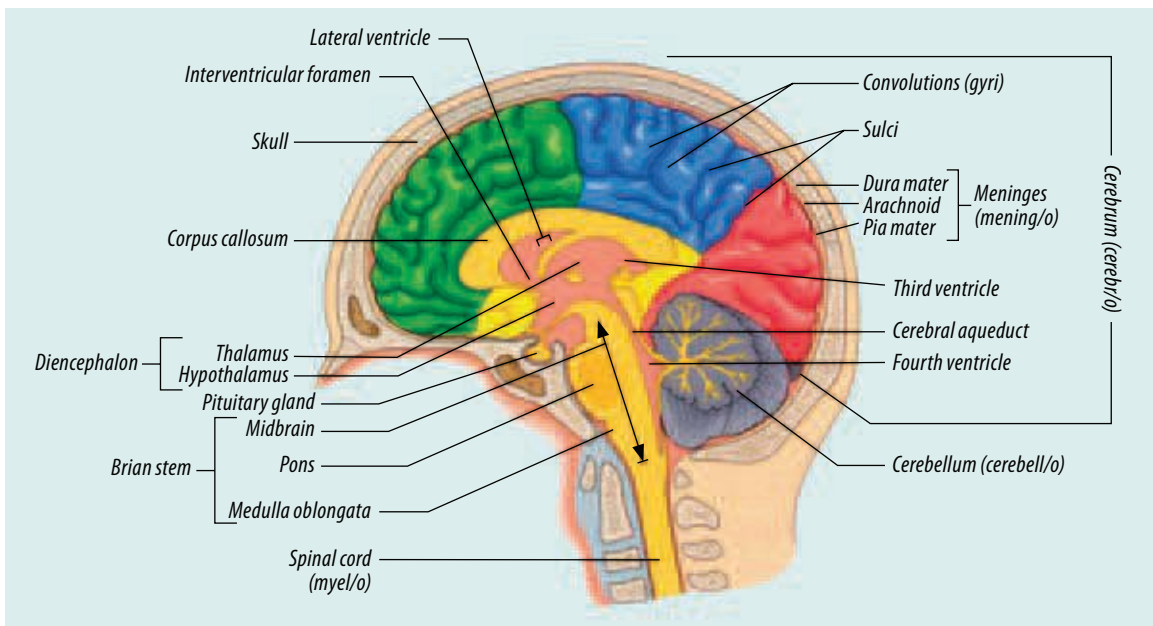
Histologically, benign meningiomas are categorized as:

- Syncytial tumors—or meningotheiomatous meningiomas—in which cell borders are indistinct, because the cell membranes intertwine extensively.
- Transitional tumors composed of plump, polygonal cells.
- Fibroblastic—or fibrous—tumors consisting of interlacing bundles of elongated cells.

A characteristic feature of many meningiomas, especially those in which whorls are prominent, is the presence of psammoma bodies—laminated concretions often found in the pineal body.

DIAGNOSING MENINGIOMAS

A neurological exam is usually the first test given when a patient reports symptoms that suggest a brain tumor. The exam includes checking eye movements, hearing, sensation, muscle strength, sense of smell, and balance and coordination. The physician will also test mental state and memory.



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Traditionally, X-rays of the skull were used, but they have now been replaced by MRI as the gold standard for diagnosing brain tumors. MRI does not use radiation and provides pictures from various angles that enables doctors to construct a three-dimensional image of the tumor. MRI allows visualization, often without the use of contrast agents. It can also detect small tumors, brainstem tumors, low-grade tumors and tumors that are located near bone.

Another diagnostic tool often used is com-

puted tomography (CT), which uses a sophisticated X-ray machine and a computer to create a detailed picture of the body's tissues and structures. It is not as accurate as MRI and can detect only about 50% of low-grade gliomas.

A CT scan helps locate the tumor and can sometimes help determine the type. It can also detect swelling, bleeding and associated conditions. More often, CT is used to check the effectiveness of treatments and to watch for tumor recurrence.



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If there is potential for embolization or if the surgeon needs additional information about the tumor's arterial supply or venous drainage in order to plan the approach, angiography may be performed.

TREATMENT OPTIONS

Treatment options for meningiomas include surgical removal, chemotherapy and radiosurgery.

The primary objective of a craniotomy for excision of a meningioma is to remove or reduce as much of the tumor's bulk as possible. By reducing the tumor's size, other therapies—particularly stereotactic radiosurgery—can be more effective if required.

Whether or not the tumor is symptomatic—as well as the tumor's size, location and degree of involvement with surrounding neurovascular structures—will determine the treatment option selected.

CASE STUDY:

Left frontotemporal craniotomy for resection of a sphenoid wing meningioma

The patient is a 36-year-old female with mild obesity and a history of hyperthyroidism, which was treated with propylthiouracil.

Prior to the diagnosis of sphenoid wing meningioma, the patient reported the following symptoms to her physician: sudden onset of severe headache with nausea and vomiting.

She was treated initially for migraine headache and experienced some improvement.

The patient then underwent a CT scan of the head, which revealed a mass in the frontal lobe. An MRI scan was performed subsequently, and it confirmed the location of the mass on the lateral wing of the sphenoid bone, located at the base of the skull.

The scan also revealed that the meningioma was depressing the optic nerve.

TECHNICAL NOTE

The inner part of the sphenoid bone—the medial sphenoid wing—is closely approximated to several critical neurovascular structures, including the optic nerve, internal carotid artery, cavernous sinus and cranial nerves III–VI.

The outer flared part of the bone—the lateral sphenoid wing—is closely approximated to the frontal temporal lobes and the Sylvian, or lateral, fissure.⁵

The patient's symptoms were interfering with her daily life, so surgery was offered. Due to the risk of hemorrhage and a resulting increase in intracranial pressure or possible stroke, the patient's neurologist advised immediate hospitalization.

PREOPERATIVE PATIENT MONITORING

The patient was hospitalized for three days prior to surgery. While hospitalized, the edema surrounding the tumor and the patient's intracranial pressure were monitored continuously. The patient was given Decadron® to decrease the edema.

While on Decadron, the patient's blood sugar was monitored, because the medication raises blood sugar levels. She was put on a sliding scale of insulin and was monitored every six hours for rising blood sugar levels.

The patient's hyperthyroidism also was treated with medication.

EQUIPMENT, INSTRUMENTATION AND SET-UP FOR CRANIOTOMY

The preparation of the operating room consisted of arranging the furniture and setting up the basic and specialty equipment, supplies and instrumentation.

TECHNICAL NOTE

Planning prior to bringing the patient to the operating room is essential. Equipment placement, special physical needs of the patient, surgical approach, patient position, instrumentation, supplies and availability of necessary medications should all be considered. (See Table 2.)

Make sure all X-rays, MRI and CT scans, arteriograms or plain film studies are in the operating room. Verify readiness of blood products with the blood bank, if blood has been ordered.

Always test drills and saws in advance of need.⁵

PLANNING THE APPROACH

The approach should be planned and executed so as to accomplish four specific goals:

— Adequate exposure to allow extirpation of

the diseased tissue, based on information obtained from physical examination and imaging studies;

- Protect critical structures near the lesion by achieving surgical access beyond the boundaries of the lesion itself to allow for direct visualization and control over the structures of interest;
- The approach should be designed so that at the completion of the extirpative phase, critical barriers between the neurocranium and viscerocranium can be readily and reliably restored;
- The choice of operative approach should reflect consideration for functional and aesthetic reconstruction, and it should include the placement of incisions within natural skin lines that respect aesthetic units of the face.¹

Table 2. Preoperative set-up for craniotomy

EQUIPMENT

Operating microscope and/or loupes, positioning devices (pin fixation device, Mayfield headrest, pillows and chest rolls), monopolar and bipolar electro-surgical units, a power source for the Midas Rex drill, a CUSA ultrasonic aspirator, Mayfield overhead table, two suction sys-

tems, nitrogen source, temperature monitoring device, fiberoptic headlight and light source (optional), autotransfusion machine (optional), ultrasound machine and attachments (optional), and CO₂ or Nd:YAG laser (optional).⁵

INSTRUMENTATION

Craniotomy or basic neurological set, Anspach or Midas Rex power with attachments (or a cranial perforator and

craniotome), and air drill with bits and burs.⁵ In this case study, the surgeon also requested Lorenz cranial plates.

SUPPLIES

A basic pack, basin set, blades (typically #10, #11 and #15), gloves, towels, craniotomy drape, microscope drape, needle magnet and counter, suction tubing (2), hypodermic needles, 4-0 silk and 4-0 braided nylon suture, closure suture (according to surgeon's preference), inner contact gauze and 4X4 dressings, laparotomy sponges, radiopaque sponges, control syringe, bipolar cord attachment to

bipolar bayonet forceps, nerve stimulator, bulb syringes, graduate pitcher, electro-surgical pencil, Telfa pads for specimens, assorted sizes of radiopaque cottonoids, bone wax, cotton balls, MRI-compatible hemostatic clips, scalp clips, Hemovac drain, rubber bands, and ultrasound wand drape (if using ultrasound).⁵

MEDICATIONS

Hemostatic agents (absorbable gelatin sponge and topical thrombin), antibiotic irrigation, and lidocaine 1% with epinephrine to inject into incision site for hemostasis.⁵

Sodium nitroprusside and mannitol with Decadron also may be used.²

POSITIONING, SKIN PREPARATION AND DRAPING

The patient was taken to the operating room in stable condition with an existing IV line and was placed on the operating table in the supine position, taking care to pad any pressure points.

Necessary safety and monitoring devices were applied or inserted, and the anesthesiologist administered general anesthesia with endotracheal intubation.

A Foley catheter was inserted to facilitate drainage of the bladder and to monitor urinary output. The patient's hair was clipped, and the head was shaved.

The Mayfield skeletal fixation device was attached to the operating table, the insertion sites for the pins were prepped by the circulator, and the device was secured to the skull with three sterile fixation pins.

The head was tilted to the patient's right, so that the left malar eminence was at its most prominent point. The headrest and pins were locked into place, and the handle was secured by the surgeon to prevent slippage.

Due to the height and weight of the patient in this case study, optimal positioning was difficult to achieve.

The incision site was marked by the surgeon with indelible marking pen.

TECHNICAL NOTE

Methylene blue is never used, because it produces an inflammatory reaction in nervous tissue.⁵

The skull and portions of the Mayfield head rest were prepped with Betadine®, using caution to ensure that the markings made by the surgeon remained visible.

Following completion of the preparation, four towels were used to square off the planned operative site and were secured in position. A craniotomy drape with a built-in adhesive drape was placed over the towels, and additional drapes were used to cover the remainder of the patient's

body and to isolate the sterile field from the anesthesia provider's area.

The patient received prophylactic antibiotics, mannitol and Decadron to facilitate brain relaxation, and a surgical time-out was performed.

PROCEDURAL OVERVIEW

Following injection with an epinephrine solution to promote vasoconstriction of the blood vessels of the scalp, a curvilinear incision was made with a #10-scalpel blade behind the hairline beginning at one cm superior and anterior to the tragus and continuing toward the midpupillary line and beyond.

Raney clips were applied over the skin edges to control bleeding, and the monopolar electro-surgical unit was used to achieve hemostasis.

TECHNICAL NOTE

Bleeding from the scalp can be profuse. If the surgeon isn't using a Raney clip applicator gun, the surgical technologist will need to load the Raney scalp clips onto applicators quickly as soon as they're received from the surgeon.⁵

The dissection continued through the galea and periosteum, developing a flap to include the temporalis muscle.

TECHNICAL NOTE

At this point, the surgical technologist should be ready to hand the surgeon a small towel clip, rubber band and hemostat for attaching the flap to the drape.⁵

The scalp flap was retracted by folding it back, using caution to maintain the blood supply to the temporalis muscle, and then secured utilizing the rubber band and clamp technique.

Four bur holes were created by the surgeon using a Midas Rex® drill while the assistant cooled the bone and washed away bone fragments with irrigation fluid. The holes were located in the keyhole, frontal, pterion and temporal regions.

Bone wax was applied to the edges of the bur holes to stop bleeding from the cut edges of the bone, and the dura was undermined from the undersurface of the skull around the bur holes.

The Midas Rex drill with the footplate attachment was then used to connect the bur holes, allowing elevation of the free bone flap. The flap was placed in a safe location on the back table.

TECHNICAL NOTE

To identify dural bleeders, the surgical technologist should have an Asepto syringe filled with warm saline ready to pass after the bone flap is turned and the dura is exposed.⁵

The dura was noted to be tense and was incised in a curvilinear fashion and retracted with 4-0 braided nylon suture.

The frontal and temporal retractors were carefully and methodically advanced into the wound, allowing for frontotemporal retraction and allowing CSF fluid to egress and thus facilitate further brain relaxation.

Any bleeding encountered was treated immediately with bipolar coagulation or by placing bits of Gelfoam® soaked in topical thrombin.

The olfactory and optic nerves were protected with neurosurgical sponges at all times.

As the retractors were placed deeper into the wound, the tumor was visualized at the base of the skull. The tumor was pink and whitish in color and was adhered to the dura.

Grossly, it appeared to be a meningioma. Frozen section was not indicated, and a segment of the tumor was obtained and sent to pathology for permanent analysis.

The operating microscope was draped and positioned for use.

TECHNICAL NOTE

If the microscope is not mounted to the ceiling, the circulator may need assistance from the surgical technologist in positioning the microscope correctly.⁵

Microdissection of the tumor was initiated. The CUSA ultrasonic aspirator was also utilized for the tumor dissection.

After the surgeon was completely satisfied that the tumor had been debulked, hemostasis of the skull base was achieved with the bipolar electro-surgical unit and the use of absorbable gelatin sponges.

Following final inspection of the wound, the dura was closed using 4-0 braided nylon suture.

The first sponge, needle and instrument counts were correct, and a central tenting suture was placed.

The free bone flap was then placed back onto the skull and secured using the Lorenz cranial plate and screw set.

The galea and the skin were closed in sequence, and the final counts were correct. A head wrap style dressing was secured, and the patient's head was removed from the Mayfield fixation device.

The patient was transferred to the hospital bed and then transported to the ICU.

TECHNICAL NOTE

Extra caution should be exercised when moving the patient to the hospital bed. There will be multiple monitoring lines, in addition to wound drains and urinary catheter with drainage bag – all of which can be pulled easily.⁵

POSTOPERATIVE MONITORING

Postsurgically, the patient was monitored very closely in the ICU. Monitoring included vital signs, intracranial pressure and neurologic responses.

The steroid medication was continued, and the patient was put on a blood pressure drip medication (Cardizem®) to prevent any increase in blood pressure, which would in turn increase intracranial pressure.

The patient also was given amiodarone intravenously for short-term management of potential cardiac dysrhythmias.

Sequential compression stockings were applied to the patient's legs to promote circulation and reduce the risk of blood clot formation.

The patient remained in the ICU for five days and was then transferred to a lower acuity ward, where she stayed for two days until symptoms and vital signs were stable. The patient's diet progressed from liquids to a normal diet restricted to 2,000 calories per day.

POSTOPERATIVE INSTRUCTIONS FOR PATIENT

The pathology report confirmed that the meningioma was benign.

The patient was advised to be proactive in her ongoing care and vigilant in scheduling annual neurological exams, including CT scans. The patient also was advised to report any symptoms, especially any fluctuation in vision or balance, to her physician immediately.

If the annual CT scans show any irregularities, a follow-up MRI may be indicated. Complete gross excision alone does not rule out recurrences, which could pose a life-threatening situation, due to the location of the tumor.

Due to the patient history's of hyperthyroidism and obesity, the patient was made aware of possible complications and was instructed in preventive measures to take, including lifestyle changes.

PROGNOSIS

Even though the tumor was found to be benign and the surgeon was satisfied that complete tumor debulking had been accomplished, the potential for recurrence still exists.

If the tumor recurs, chemotherapy and/or radiation therapy may be considered as follow-up treatments.

ABOUT THE AUTHOR

Michael Steffy is currently a student in the surgical technology program at Concorde Career College in San Bernardino, California. He will graduate in January 2008, and will take the national CST certification exam in February 2008.

Editor's note: Information in the case study was compiled from the patient's medical records and the surgeon's operative report, with permission from the patient and the surgeon.

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