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Preface

A primary focus of *Skull Base Surgery: Basic Techniques* is to provide simple, standardized processes for practicing and training physicians that address the complexities encountered by the anatomy of the skull base. A systematic approach to the evaluation, diagnosis, and treatment of skull base pathology is presented in a format that is approachable from all levels of training.

In the last decade, there has been a proliferation of new and innovative surgical techniques to address pathology involving this area. The development of these techniques is a result of the need to address the intricate nature of the skull base and adjacent soft tissues in a comprehensive yet concise manner. As the anatomy of this region is the key to currently available procedures and future developments, *Skull Base Surgery: Basic Techniques* crafts the foundation for both of these time frames. This text illustrates views and details that are critical to the understanding of contemporary and impending approaches.

Skull Base Surgery: Basic Techniques is comprised of sections discussing the preoperative evaluation and management of the patient. Surgical techniques including open, craniofacial approaches and endoscopic techniques are presented. In conjunction with these chapters, study of the imaging required to diagnose and treat patients with lesions in this area is discussed. In the concluding chapters, postoperative evaluation and management approaches as well as supportive procedures and services are presented.

This text is useful to physicians and allied health personnel whose interests include the skull base. All of the contributors have endeavored to exhibit the best of their fields in their discussions and illustrations. The information provided is meant to serve as a point of departure for the learner to facilitate further growth in the knowledge of this area of surgical practice. As such, *Skull Base Surgery: Basic Techniques* illustrates the importance and enjoyment of perpetual learning and discovery.

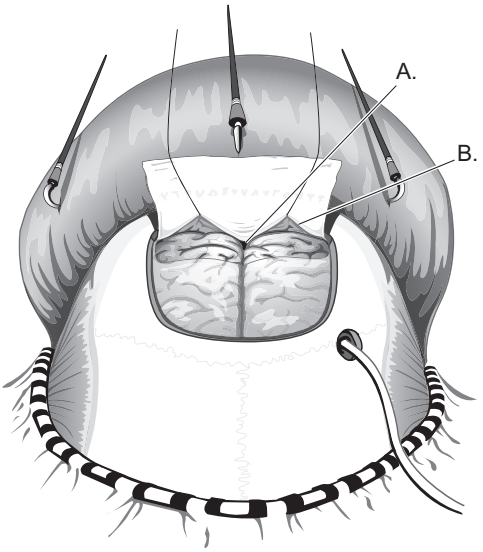

Figure 3–5. Bifrontal dural opening and transection of the superior sagittal sinus (**A**) and falx in preparation for tumor identification and resection. The inferior dural leaflets are reflected toward the orbits (**B**).

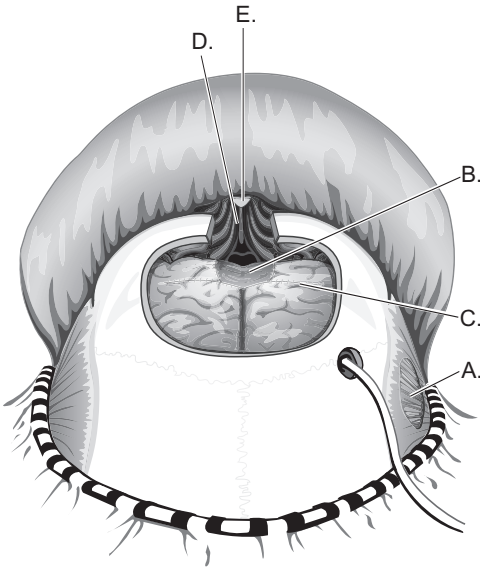

Figure 3–6. Dural repair after removal of intradural tumor. The temporalis fascia is harvested (**A**) and sewn into the dural defect (**B**). The temporalis facia graft may extend up to the frontal convexity depending on the amount of dura removed during tumor resection. The initial bifrontal dural opening (**C**) is also closed at this time. The contents of the nasal cavity (**D**) and remnant of the nasal bone (**E**) are easily seen at this time.

DURAL RECONSTRUCTION

The dura is separated from the orbital roofs medially and the bone along the planum sphenoidale posteriorly. To repair this defect, a graft of superficial temporalis fascia is harvested posterior to the temporalis fat pad, thereby avoiding injury to branches of the facial nerve. This graft is utilized to reconstruct the floor of the anterior fossa and is performed in two layers to prevent communication between the nasal sinuses and the brain while preventing CSF leak. The superficial temporalis graft usually is preferred because it is easily accessible as it has been exposed during the elevation of the galea. A fascia lata graft would be an alternative; however, it is more time consuming and a second incision remote from the surgical field would be required. This graft is sewn to the elevated dural edges with a double armed 4-prolene suture in running fashion. This is the first step of the double layered skull base dural closure. The initial dural opening is usually closed primarily or with a dural substitute in watertight fashion if resection of the lesion has been relatively extensive making re-approximation of native dura impossible (Fig 3–6). The otolaryngology team returns to the field and completes the removal of the nasal and sinus components of tumor.

REMOVAL OF NASAL AND SINUS TUMOR

With the anterior ethmoid cells and the nasal cavity being exposed after removal of the nasoglabellar complex, tumor resection can proceed. This procedure allows intracranial access extending along the posterior planum sphenoidale, anterior clinoid, and tuberculum sellae. The lateral aspect of the exposure is determined by the type and extent of craniotomy that is performed. At this juncture, an intranasal tumor can then be removed from above through the surgical defect by a combination of blunt and sharp dissection.

The goal of surgical intervention is to accomplish a complete resection, if possible. To create the most favorable conditions for removal of tumors in the sinonasal area, surrounding structures must be retracted or removed to view the limits of the tumor. This consists of removing adequate surrounding normal mucosal, cartilaginous, and bony tissue to obtain access to the tumor in a circumferential fashion. Once the tumor is isolated, it then can be removed, preferably in an en bloc fashion. If this is not possible, then it is removed in a piecemeal fashion. A partial or complete septectomy may be performed in addition to a unilateral or bilateral ethmoidectomy. This approach can easily be combined with additional craniofacial approaches as needed. If there is extension into the orbit, an orbital exenteration may be considered. Margins are routinely sent during the operation from the nasal cavity/sinus resection for pathologic review. A positive margin necessitates additional surgical resection unless it is not feasible due to invasion of critical structures such as the cavernous sinus.

Endoscopically assisted procedures may be performed to assist with visualization and surgical resection. This can be performed by viewing the tumor through the exposed surgical defect or from below through the nose. Zero-, thirty-, and seventy-degree endoscopes are routinely utilized. A tower with a monitor, light source, and camera are helpful to allow all surgical personnel to view the procedure.

Once the resection is completed, reconstructive procedures are then performed. If there has been bony destruction, it may require reconstruction for aesthetic reasons as well as to recreate function. If indicated, calvarial bone grafts may be used. This can be accomplished by using the inner table of the craniotomy bone flap provided it does not involve tumor. Using the osteotomes and saws allows for removal based on the appropriate template. Once the graft is harvested, it is secured in place with microplates. Microplates are used to secure the nasoglabellar complex in position. If a large defect is created, for example, from an orbital exenteration, then a pedicled or free tissue transfer may be warranted. The nasoglabellar complex must be freed of any mucosa prior to reconstruction in order to prevent mucocele formation. The mucosa is dissected free and removed with a curette. A drill with a diamond burr is then utilized to polish the area to ensure that it is free of any mucosa. Two nasal trumpets are placed and secured to the septum with 2-0 silk or prolene. This will help to divert any air or pressure from disrupting the reconstruction once the patient is extubated. After tumor removal, the floor of the anterior cranial fossa is reconstructed with a pericranial graft.

PERICRANIAL GRAFT CLOSURE

The pericranial graft is the second stage of the anterior skull base dural closure. This vascularized pedicled flap is outlined on the frontal scalp flap with a 15 blade and harvested with the Metzenbaum scissors (Fig 3–7) It is sewn to the dura posterior to the dural/superficial temporalis graft suture line with 4-0 prolene in running fashion. A two-layered watertight closure is accomplished. The pericranial graft is advantageous because it is a vascularized flap with a significantly greater likelihood of providing a permanent boundary between the nasal cavity and the brain. After copious irrigation, a layer of tissue adhesive is placed between the primary and secondary grafts.

REPLACEMENT OF THE ORBITAL RIM

The holes for the plates were made at the time of the orbital roof removal to optimize cosmesis. Once the pericranial graft is sewn into place and the fibrin glue injected between the primary and

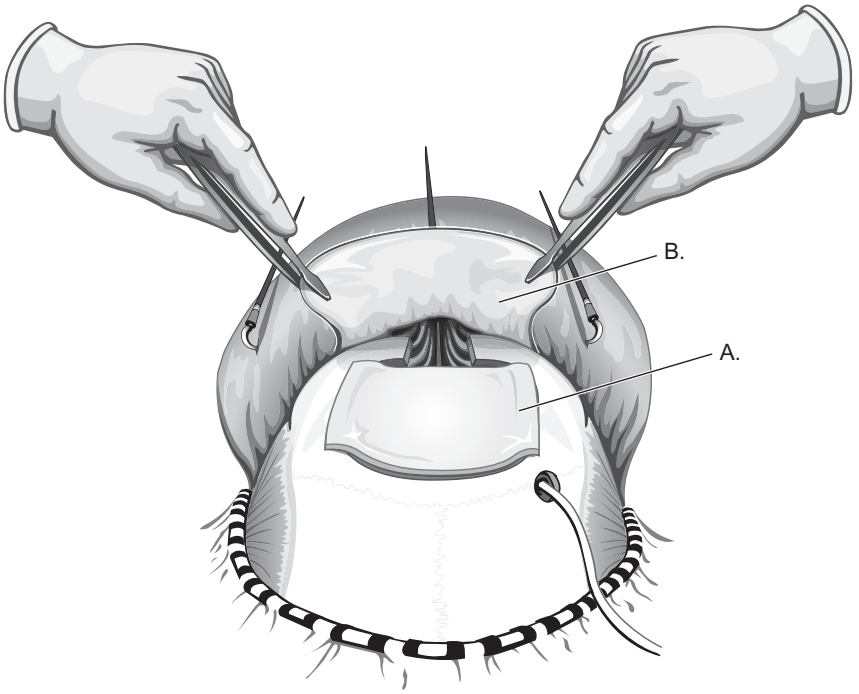

Figure 3–7. The dura is covered with cottonoids (**A**) to protect it during removal of the sinus and nasal cavity components of the tumor. The primary temporalis fascial graft closure of anterior skull base dura is followed by secondary pericranial graft harvest (**B**) and insertion under the skull base defect to reinforce the primary dural closure.

secondary skull base repair grafts, the orbital roof is secured with plates and screws ensuring that the nasion is properly aligned and that there is an even plane along the frontal bar (Fig 3–8). The nasoglabellar complex is placed above the pericranial graft so as to exclude it from the nonsterile contents of the nasal cavity.

REPLACEMENT OF THE CRANIOTOMY/WOUND CLOSURE

This bone flap is secured with plates and screws or a bandeau of titanium mesh after bifrontal dural tack-up sutures have been placed through the bone to eliminate the epidural space. The wound is copiously irrigated with antibiotic impregnated 0.9% normal saline. The external ventricular drain and subgaleal drains are brought out through separate stab incisions posterior to the initial incision and secured with 2-0 silk sutures. The galea is closed with inverted interrupted reabsorbable sutures followed by skin staples. The skin is closed with 3-0 nylon instead of staples if the patient has had radiation already.

POSTOPERATIVE MANAGEMENT

Postoperatively, the patient is admitted to the intensive care unit for observation with frequent neurologic exams, intracranial pressure (ICP) monitoring, and EVD monitoring for a controlled output of 10 to 15 cc per hour of CSF drainage. Postoperative antibiotic prophylaxis is utilized intravenously for 5 to 7 days. A postoperative MRI with and without contrast is

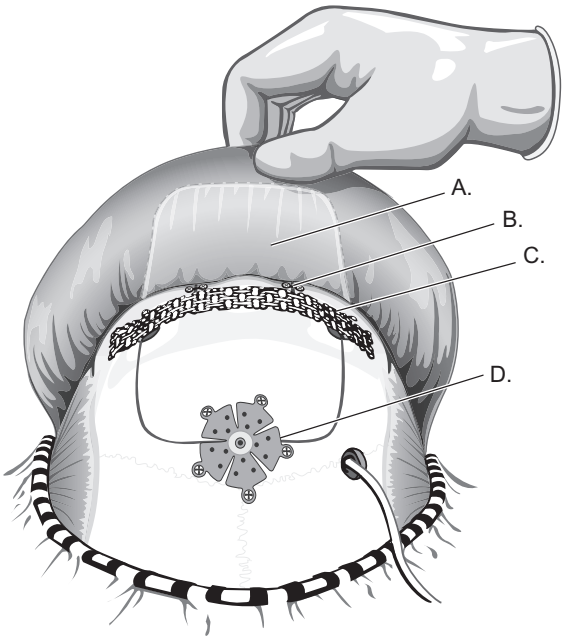

Figure 3–8. The pericranial graft harvest bed (**A**) is still visible. The graft lies below the nasoglabellar bone so as to exclude the devascularized bone from the nasal cavity. Nasoglabellar reconstruction has been accomplished with titanium miniplates and screws (**B**) and a band of titanium mesh (**C**) to secure it to the frontal craniotomy and provide a smooth contour to the bony junction. A large burr hole cover (**D**) can be used to cover the opening over the sagittal sinus.

obtained within 48 hours of surgery. It is unusual to have to treat temporarily increased intracranial pressure in this population of patients. The EVD diverts CSF and thereby gives the skull base dural repair time to heal. A lumbar drain may be used by some surgeons. The disadvantage of lumbar drainage is its inaccuracy in monitoring ICP, should it be required. The EVD typically is clamped on the morning of postop day 3 and removed the following morning if no CSF leak is noted. If a leak is noted, then the drain is re-opened and a CT scan of the brain is performed to evaluate for hydrocephalus or pneumocephalus. The drain in this scenario is opened for another 2 days and then discontinued provided the leak has sealed by then. Reoperation for persistent CSF leak, pneumocephalus, or hydrocephalus is not within the scope of this chapter but must be designed with both otolaryngology and neurosurgery input.

The nasal trumpets that were placed intraoperatively are irrigated and suctioned thought the trumpet to prevent occlusion. This acts to divert air from transgressing the anterior cranial base reconstruction. The nasal trumpets are kept in place for approximately 3 days. Once removed, nasal saline irrigation is continued without subsequent suctioning.

Follow-up after discharge from the hospital includes arrangements for suture removal intranasal debridement. In cases where tumor resection was undertaken, establishment of oncologic therapy follow-up also will be necessary.