Chapter 101 – Surgical Approaches to the Infratemporal Fossa

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The anatomy of the infratemporal fossa (ITF), otherwise known as the *pterygoid fossa,* is confusing for both neurosurgeons and head and neck surgeons. Although its anatomic description varies, the most accepted boundaries are shown in Table 101-1.

The first report in the English literature of a surgical approach to the ITF is attributed to Fairbanks-Barbosa, who in 1961 described his approach for advanced tumors of the maxillary antrum.[1] Subsequently, others reported different surgical techniques or modifications of the Fairbanks-Barbosa approach (Table 101-2).[1–8]

Table 101-1 -- ANATOMIC BOUNDARIES OF THE INFRATEMPORAL FOSSA

	Superior	Medial	Lateral	Anterior	Posterior
Bone	Greater wing of the sphenoid, temporal bone	Lateral pterygoid plate, pterygopalatine fissure	Mandible Zygoma		Articular tubercle of the temporal bone, glenoid fossa and condyle, styloid process
Muscle		Superior constrictor, pharyngobasilar fascia	Masseter temporalis	Lateral and medial pterygoid, masseter	Prevertebral fascia
Foramina	Carotid canal Jugular foramen Foramen ovale Foramen spinosum Foramen lacerum Soft tissue Muscles				
Nerves	Foramen ovale (V3), jugular foramen (pars nervosa)				IX-XI Sympathetic plexus
Vessels	Internal carotid artery	Internal maxillary artery			Internal carotid artery
	Internal jugular vein	Pterygoid venous plexus			Jugular vein
Other			Parotid		

Table 101-2 -- SURGICAL APPROACHES TO THE INFRATEMPORAL FOSSA: HISTORICAL BACKGROUND

Authors[*]	Year	Technique
Fairbanks-Barbosa[1]	1961	Extracranial resection of advanced tumors of the antrum
Terz et al.[2]	1969	Craniofacial resection of tumors of the SNT with invasion of the ITF
Fisch[3]	1979	ITF approaches for tumors of the upper aerodigestive tract or intracranial tumors invading the ITF
Biller et al.[4]	1981	Median mandibulotomy
Sekhars et al.[5]	1987	Subtemporal-preauricular approach
Cocke et al.[6]	1990	Extended maxillotomy/maxillectomy approach
Janecka et al.	1990	Facial translocation approach
Catalano and Biller[8]	1993	Vascularized facial translocation

ITF, infratemporal fossa; SNT, sinonasal tract.

* Many other authors have contributed immensely to the advancement of surgery of the ITF. This table is intended to present an overview of what we consider novel approaches and is by no means comprehensive.

PATIENT SELECTION

Tumors may arise in the ITF or may invade it by direct extension from the upper aerodigestive tract, the parotid gland, the temporal bone, the skull base, or the cranial cavity. It is fundamental that the origin and extension of the tumor be established to offer the patient the most effective treatment.

Selection of the surgical approach depends on the characteristics of the patient, the biologic behavior of the tumor, and the experience of the surgeon. In most instances, these tumors require a multidisciplinary approach to properly stage, diagnose, and extirpate the tumor and to provide an acceptable cosmetic and functional reconstruction.

Clinical Evaluation

The history and physical examination must emphasize neurologic deficits, especially those resulting from dysfunction of the cranial nerves. These deficits are an important consideration in the development of a surgical plan, as well as postoperative care, because they have a significant impact on recovery and functional rehabilitation of the patient. As a result of the location of these tumors, considerable growth may occur before obvious clinical findings develop and the patient seeks medical care. The initial symptoms are diverse and are usually secondary to dysfunction of the masticatory muscles or cranial nerve deficits.

Symptoms and signs that are attributable to deficits of the trigeminal nerve are frequently evident. Pain may be present in the distribution of any of the divisions of the trigeminal nerve and may be exacerbated by jaw movement, jaw clenching, or head position. Sensory losses characterized by hypoesthesia or paresthesia of the divisions of the trigeminal may be present, and the pattern of deficits provides clues to the location and extent of the tumor. Pain may be referred to the ear because of sensory innervation of the external auditory canal (EAC).

Physical examination focuses on sensory and motor deficits. In addition to assessing cutaneous sensation, corneal sensation is tested with a cotton swab. In the presence of a concomitant facial nerve palsy, protective measures to prevent corneal injury may need to be instituted preoperatively or postoperatively. Trigeminal motor function is assessed by palpation of the masticatory muscles (masseter and temporalis) during jaw clenching. Deviation of the jaw laterally with jaw opening reflects dysfunction of the pterygoid musculature. Trismus may be due to mechanical restriction of the jaw as a result of infiltration of tumor into the pterygoid muscles or temporomandibular joint (TMJ), or it can be due to pain. The extent and cause of the trismus are important considerations in the perioperative management of the airway. Trismus secondary to pain will disappear with general anesthesia and allow safe oral endotracheal intubation. Awake nasotracheal intubation may be performed in patients with constant trismus if it is anticipated that surgery will correct the trismus. Otherwise, awake tracheostomy should be performed at the beginning of surgery.

Facial nerve deficits may be manifested as facial weakness, epiphora, hyperacusis, hyperkinesis, and dysgeusia. The motor function of all divisions of the facial nerve is assessed. It is important to remember, however, that significant involvement of the facial nerve by tumor may occur before any facial weakness is clinically apparent. Deficits of the facial nerve or first division of the trigeminal nerve (V1), or both, may result in corneal exposure. Insertion of a gold weight in the upper eyelid or tightening of the lower lid may be necessary to protect the cornea and prevent future complications.

Hearing loss may be either conductive or sensorineural. Conductive hearing loss is usually a result of eustachian tube dysfunction with accumulation of fluid in the middle ear space. Sensorineural hearing loss may result from tumor involvement of the temporal bone or posterior cranial fossa. The presence of hearing loss may be helpful in localizing the tumor, especially when it is observed in combination with other cranial nerve deficits. Because hearing loss impairs effective communication with the patient during the perioperative period, the use of a hearing aid or other amplification device may be required for communication. It should be anticipated that extensive surgery involving the infratemporal skull base will result in a conductive hearing loss that may compound a previous sensorineural hearing loss.

Deficits of the lower cranial nerves (IX, X, XI, and XII) are seen with tumors that arise high in the parapharyngeal space near the jugular foramen. Patients may exhibit varying degrees of hypernasal speech, nasal regurgitation, dysphagia, aspiration, and dysphonia. Findings on physical examination include decreased elevation of the palate, decreased mobility of the tongue with deviation to the involved side on protrusion, pooling of secretions in the hypopharynx, decreased supraglottic sensation, ipsilateral vocal cord paralysis, and decreased prominence and strength of the sternocleidomastoid and trapezius muscles. In patients with incomplete lower cranial nerve deficits, surgical therapy can be expected to increase nerve dysfunction with resultant increased risks of dysphagia and aspiration. Consequently, a tracheostomy is often necessary in the perioperative period. Laryngeal framework surgery (thyroplasty) may be considered at the same time to improve glottic closure and decrease the risk of aspiration. Strong consideration should also be given to placement of a gastrostomy (percutaneous or open) to facilitate postoperative feeding and decrease the risk of aspiration. Palatal dysfunction may be ameliorated by a palatal lift prosthesis to push the soft palate against the posterior pharyngeal wall. Alternatively, a pharyngeal flap or surgical fixation of the palate to the pharyngeal wall (palatopexy) may be necessary.

Because of the relative inaccessibility of the infratemporal space to physical examination, radiologic imaging is an essential part of the evaluation. Both computed tomography (CT) and magnetic resonance imaging (MRI) provide valuable information and are performed with a standard skull base protocol. CT scanning provides adequate resolution of most tumors and is superior for demonstrating enlargement of neural foramina or erosion of bone. For most tumors involving the ITF, MRI provides better resolution of soft tissue planes and tumor invasion along neural and vascular structures (Fig. 101-1). CT and MRI are often complementary in the evaluation of cranial base tumors.

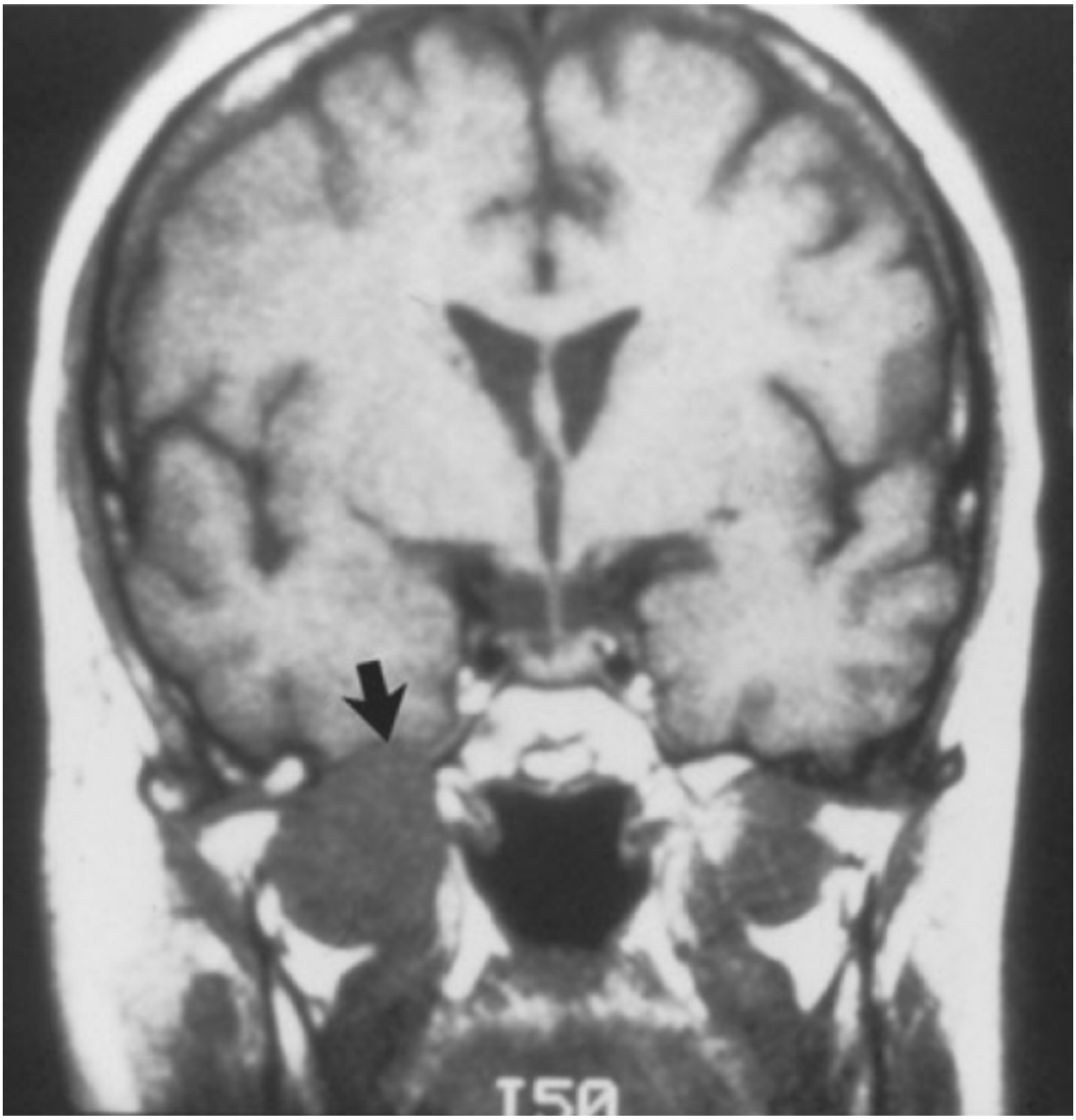


Figure 101-1 Magnetic resonance image demonstrating a neurilemmoma arising from the mandibular division of the trigeminal nerve *(arrow)*. Although there is intracranial extension of the tumor, it is extradural. Tumors in this location may reach a large size before they are visible or palpable on physical examination. Such tumors may cause facial numbness, pain, or difficulty with mastication.

A critical question in the evaluation of tumors in this area is the relationship of the neoplasm to the internal carotid artery (ICA). Magnetic resonance angiography (MRA) may be used in selected cases to provide a noninvasive assessment of the ITF and intracranial vasculature. If preoperative embolization of the tumor is warranted, as is the case for many juvenile angiofibromas, paragangliomas, or other highly vascularized tumors, angiography is preferable to MRA because the tumor can be embolized during the initial angiogram (Fig. 101-2). In addition to yielding information about tumor vascularity and involvement of the ICA, angiography provides important information on the intracranial circulation and collateral blood supply. Neither study is adequate, however, to reliably assess the adequacy of collateral intracranial circulation in the event that manipulation or sacrifice of the ICA is necessary. Whenever manipulation of the ICA is likely, evaluation of collateral cerebral blood flow with angiography–balloon occlusion–xenon computed tomography (ABOX-CT) is recommended (Fig. 101-3).

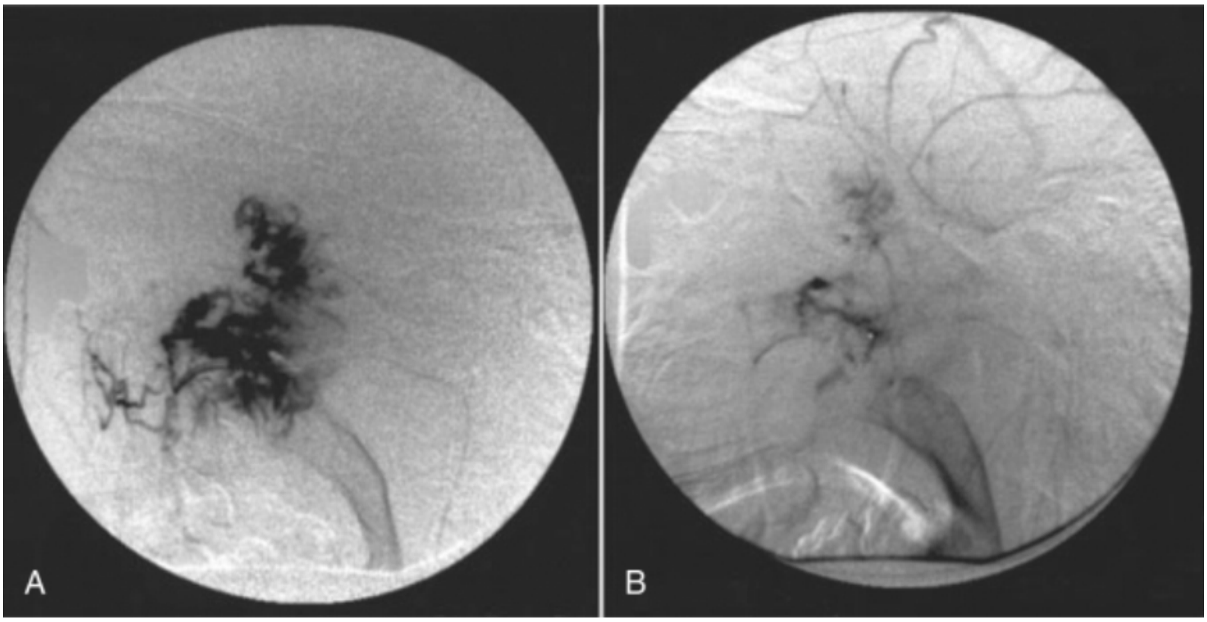


Figure 101-2 Angiography of the left internal maxillary artery in a patient with an angiofibroma demonstrates an extensive tumor blush (**A**) that is markedly decreased after embolization (**B**).

Figure 101-3 Magnetic resonance image demonstrating a neoplasm of the right infratemporal skull base that is encasing the petrous portion of the internal carotid artery (ICA) *(arrow).* Preoperative evaluation of collateral cerebral blood flow with angiography–balloon occlusion–xenon computed tomography is recommended because of the increased risk of injury to the ICA with attempted removal of this tumor.

Briefly, ABOX-CT consists of the introduction of a nondetachable balloon into the ICA. The balloon is inflated for 15 minutes, and the awake patient is monitored for sensory, motor, or higher cortical function deficits. The balloon is deflated and the patient is transferred to a standard CT suite. The balloon is then reinflated and a mixture of 32% xenon and 68% oxygen is administered to the patient via facial mask for 4 minutes. The CT scan will demonstrate the distribution of xenon within cerebral tissue, which reflects blood flow (Fig. 101-4). This study provides a quantitative assessment of millimeters of blood flow per minute per 100 g of brain tissue. This test accurately predicts patients at risk for a cerebrovascular accident when blood flow through the ICA is compromised (Table 101-3).[9] It should be recognized that patients can still suffer ischemic brain injury despite negative ABOX-CT findings because of embolic phenomena or the loss of collateral vessels, which are not assessed by balloon occlusion testing. For these reasons, every attempt is made to preserve or reconstruct the ICA when feasible. Other techniques that provide similar information regarding collateral cerebral blood flow include single-photon emission computed tomography (SPECT) with balloon occlusion and transcranial Doppler monitoring.

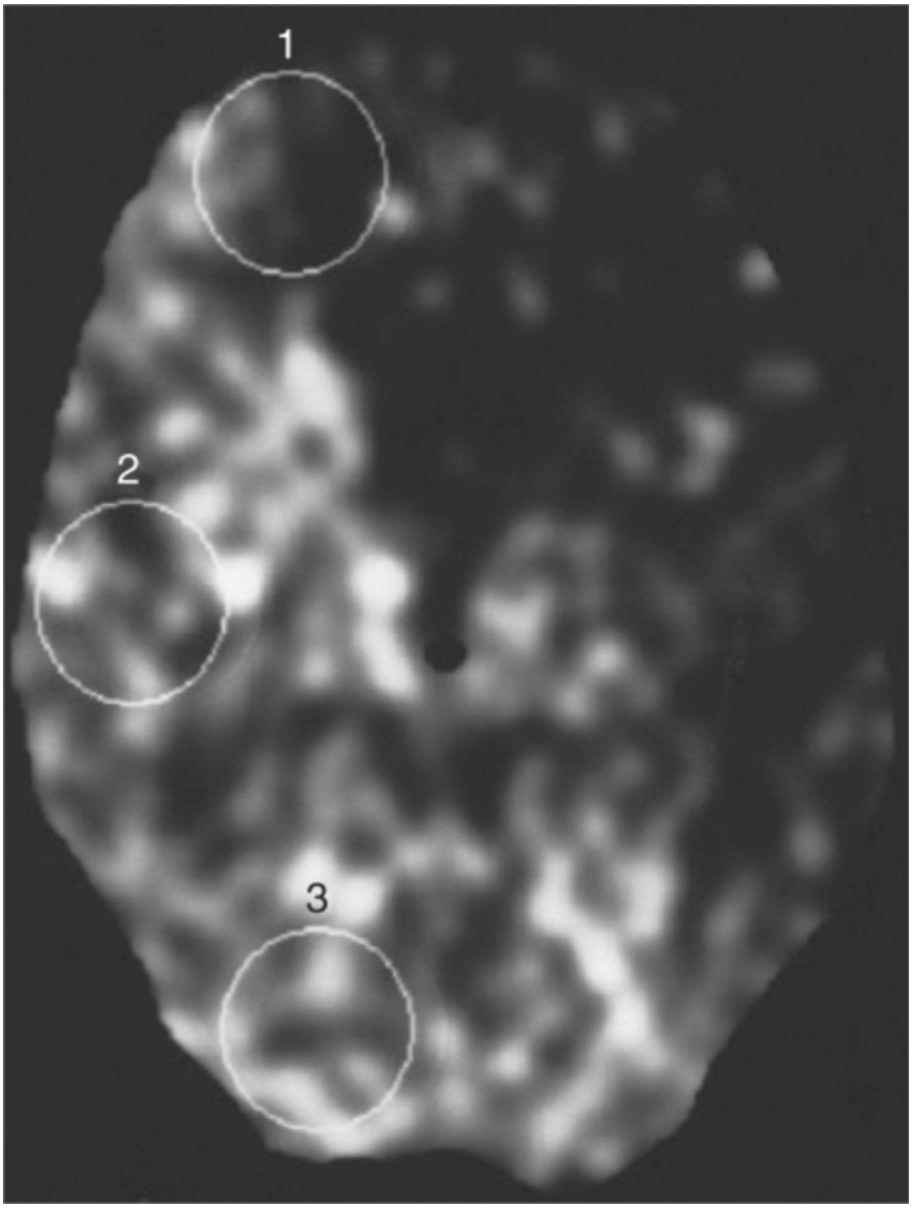


Figure 101-4 After balloon occlusion of the left internal carotid artery (ICA), a significant reduction in blood flow was noted in the distribution of the left anterior and middle cerebral arteries (1-3). This patient is at high risk for development of a stroke after permanent occlusion of the left ICA.

Table 101-3 -- XENON COMPUTED TOMOGRAPHY

Cerebral Blood Flow (mL/min/100 g Tissue)	Risk	Implication
<20	High	Patient will not tolerate occlusion of the internal carotid artery
21-35	Moderate	Patient will tolerate occlusion under controlled circumstances; reconstruction is recommended
>35	Low	Carotid may be sacrificed

Biopsy

Histologic confirmation is mandatory before subjecting the patient to any major extirpative surgery. Tissue is usually obtained by incisional or punch biopsy. Occa sionally, fine-needle aspiration biopsy under CT or MRI guidance is required for tumors arising in deep locations. Biopsy of many cranial base tumors can be performed with minimally invasive endoscopic approaches through the paranasal sinuses.

The surgeon should consider the possibility of metastasis to the cranial base when the tumor appears to originate from the bone and is in an unusual location. In such cases, a thorough history and physical examination will usually provide evidence of a primarytumor elsewhere (breast, prostate, lung, or gastrointestinal system). Although the cost-effectiveness of an extensive search in asymptomatic patients is questionable, a screening test such as a mammogram or serum prostate-specific antigen level may be revealing. The search for a primary tumor or other metastases should be intensified when a biopsy reveals an adenocarcinoma that is not originating from a major salivary gland. “Intestinal-type” adenocarcinomas of the nasopharynx, in particular, can be confusing and may necessitate thorough evaluation of the lower gastrointestinal tract.

Metastatic Workup

The extent of the evaluation to rule out regional or distant metastasis is dictated by the suspected histologic type and stage of the tumor. CT or MRI of the neck is considered more sensitive than physical examination for the detection of regional metastases. Patients with tumors showing a predilection for hematogenous metastasis (sarcomas, melanoma) should undergo a CT scan of the chest and abdomen and a bone scan. A positron emission tomographic (PET) scintigram may aid in identifying both the primary and metastatic tumors. A lumbar puncture for cerebrospinal fluid (CSF) cytology is reserved for patients with tumors invading the dura or with symptoms of “drop metastasis” to the spinal cord. Consultation with an experienced neurosurgeon is recommended for tumors invading the skull base or for tumors that require resection of the skull base for margins.

Reconstructive/Rehabilitation Considerations

Finally, the reconstructive requirements of oncologic surgery should be anticipated. In most cases, a temporalis muscle transposition flap is adequate to separate the cranial cavity from the upper aerodigestive tract and obliterate the dead space. Nevertheless, the use of microvascular free flaps such as the rectus abdominis flap (for soft tissue defects), latissimus dorsi flap (for myocutaneous or massive defects), or iliac and scapular composite flaps (for defects requiring bone reconstruction) is recommended when the temporalis muscle or its blood supply will be sacrificed, when the patient requires complex resection involving composite tissue flaps with skin or bone, or when the extirpative surgery produces a massive soft tissue defect and dead space.

Attention should also be directed to functional and cosmetic deficits created by the tumor and surgery. Facial rehabilitation may be achieved during the primary surgery. When a temporary facial palsy is anticipated,corneal protection with lubricants or a temporary lateral tarsorrhaphy is generally adequate. When grafting of the facial nerve is necessary and a longer period of recovery of facial nerve function is expected, implantation of a gold weight into the upper eyelid is performed. If reconstruction of the facial nerve is not feasible, static fascial slings or muscle transpositions are appropriate. Lower cranial nerve deficits may be ameliorated by laryngeal framework surgery, tracheotomy, or laryngotracheal separation.

PREOPERATIVE PLANNING

The patient is premedicated with a short-acting benzodiazepine. Narcotics may be used in the absence of elevated intracranial pressure. Preoperative steroids are administered if manipulation of the brain or motor cranial nerves is anticipated. H_2-blockers or proton pump inhibitors are given perioperatively to decrease the incidence of gastroesophageal reflux and stress ulcers. If retraction of the temporal lobe is necessary, prophylactic anticonvulsants are administered during surgery and in the postoperative period.

Preoperatively, the patient's blood is typed and cross-matched for 4 to 6 units of packed red blood cells or cryoprecipitate. A Cell Saver/autotransfusion device may be used when the tumor is benign and there is no contamination by flora of the upper aerodigestive tract.

Perioperative antibiotic prophylaxis that provides coverage against the flora of the skin and upper aerodigestive tract and exhibits good penetration of the blood-brain barrier is administered 2 hours before surgery and continued for 48 hours after the surgery is completed. The use of a broad-spectrum cephalosporin with good CSF penetration (e.g., ceftriaxone) appears to be as effective as multiple antibiotic regimens.

The patient is taken to the operating room, and all standard monitoring electrodes and lines are placed and secured (Table 101-4). The choice of anesthetic agent depends on the extent of intracranial dissection and the potential for brain injury, systemic hemodynamics, the need for monitoring of cortical and brain stem functions (e.g., brain stem evoked response, somatosensory evoked potentials, electroencephalography), and the need for cranial nerve monitoring (7th and 10th through 12th cranial nerves). Somatosensory evoked potential monitoring using the median nerve is indicated whenever surgical manipulation of the ICA is anticipated.

Table 101-4 -- STANDARD ANESTHETIC MONITORING

Electrocardiogram
Pulse oximeter
Capnometer

Arterial line
Central venous catheter[*]

* In selected cases, a pulmonary artery catheter may be necessary.

When changes in head position during surgery are anticipated, the endotracheal tube is secured with a circumdental or circum-mandibular wire ligature (no. 26 stainless steel wire). The operating table is positioned perpendicular and away from the anesthetic equipment. If significant brain retraction or intradural dissection is expected, a spinal drain is placed and secured with sutures and adhesive dressing (e.g., Tegaderm, Op-Site). Other measures to diminish intracranial pressure, such as hyperventilation, osmotic diuresis, or steroids, are used as needed throughout surgery. A nasogastric tube and Foley catheter are passed and secured after adequate placement is corroborated. Antiembolic sequential compression stockings are mandatory to diminish the risk for deep venous thrombosis. Heparin is not recommended because of the potential for increased intracranial bleeding.

The head of the patient is positioned on a Mayfield horseshoe head holder or, if necessary for intracranial neurovascular work, on Mayfield pins. When the horseshoe is used, it is important that additional “egg crate” foam padding be used, because scalp ischemia may result from the hard rubber pads during prolonged surgery. The head should be positioned in slight extension to provide access to the neck for proximal control of the ICA. Monitoring electrodes are carefully placed and secured with sutures or staples. A baseline recording is obtained for intraoperative reference. Tarsorrhaphy sutures are placed for protection of the eyes. Ribbon gauze or pledgets soaked in oxymetazoline (0.05%) solution may be inserted intranasally at this time for additional hemostasis if communication with the nasal cavity is anticipated. The proposed incision lines are infiltrated with local anesthetic containing epinephrine (1:200,000). The hair is parted with a comb and held in place with staples. Standard skin preparation with povidone-iodine (Betadine) solution is performed.

SURGICAL TECHNIQUE

Preauricular (Subtemporal) Approach

This approach is suited for tumors arising in the ITF and intracranial tumors arising in boundaries of the anterior temporal bone or greater wing of the sphenoid bone and extending into the ITF.[10–13] The preauricular approach does not allow safe resection of any portions of the tympanic bone or control of the infratemporal facial nerve or jugular bulb.

A hemicoronal or bicoronal incision across the vertex of the scalp and posterior to the hairline is extended through the subcutaneous tissue, galea, and pericranium over the cranium (Fig. 101-5A). In the temporal area, the incision extends down to the deep layer of the temporal fascia overlying the temporalis muscle. Ipsilateral to the tumor, the incision is extended into the preauricular area. A separate incision may be made in the neck for proximal control of the carotid arteries (see Fig 101-5B).

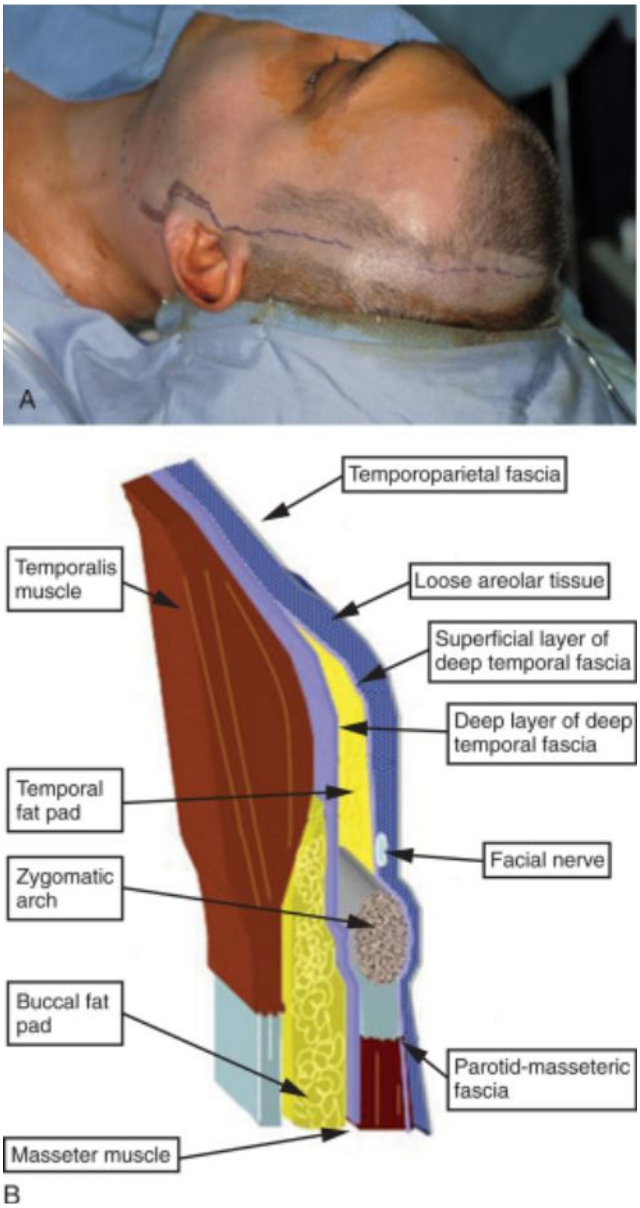


Figure 101-5 **A,** A hemicoronal scalp incision is made posterior to the hairline in the temporal area and extended along a preauricular skin crease, similar to a parotidectomy incision. It may be continued into the upper cervical region, or a separate cervical incision may be made for exposure of the vessels and nerves. **B,** The different tissue planes of the temporal area are illustrated. The frontal branch of the facial nerve is found in the superficial layer of the deep temporal fascia. Safe dissection must occur deep to this plane.

The scalp flap is elevated anteriorly in a subpericranial plane to separate attachments of the pericraniumto the deep layer of the temporal fascia at the margin of the temporalis muscle down to the level of the superior orbital rim. The anterior branches of the superficial temporal artery are preserved to ensure adequate blood supply to the scalp flap. The scalp flap is easily elevated from the deep temporal fascia with a broad periosteal elevator. Approximately 1 to 2 cm above the zygoma the fascia splits into superficial and deep layers that attach to the lateral and medial surfaces of the zygomatic arch, respectively. This creates a triangular space filled with adipose tissue. The superficial layer of the deep temporal fascia is incised obliquely above the level of the superior orbital rim toward the zygomatic root. Dissection is then carried deep to this plane, and the superficial layer of the deep temporal fascia and the adipose tissue are elevated off the zygomatic arch and reflected anteriorly with the flap. The orbitozygomatic complex is exposed by subperiosteal dissection. This maneuver protects the frontal branches of the facial nerve that are superficial to the superficial layer of the deep temporal fascia (Fig. 101-6). Periosteum is elevated from the lateral surface of the zygomatic arch and malar eminence. The periorbita is elevated from the lateral orbit with a Freer or Adson elevator to expose the area from the roof of the orbit to the inferior orbital fissure. It is helpful to separate the masseteric fascia from the overlying parotid gland with a broad periosteal elevator before detaching the masseter muscle from the zygomatic arch (Fig. 101-7). The masseteric fascia is transected at its insertion into the zygomatic arch, and the periosteal elevator is then used to separate it from the muscle while leaving it attached to the deep surface of the parotid.

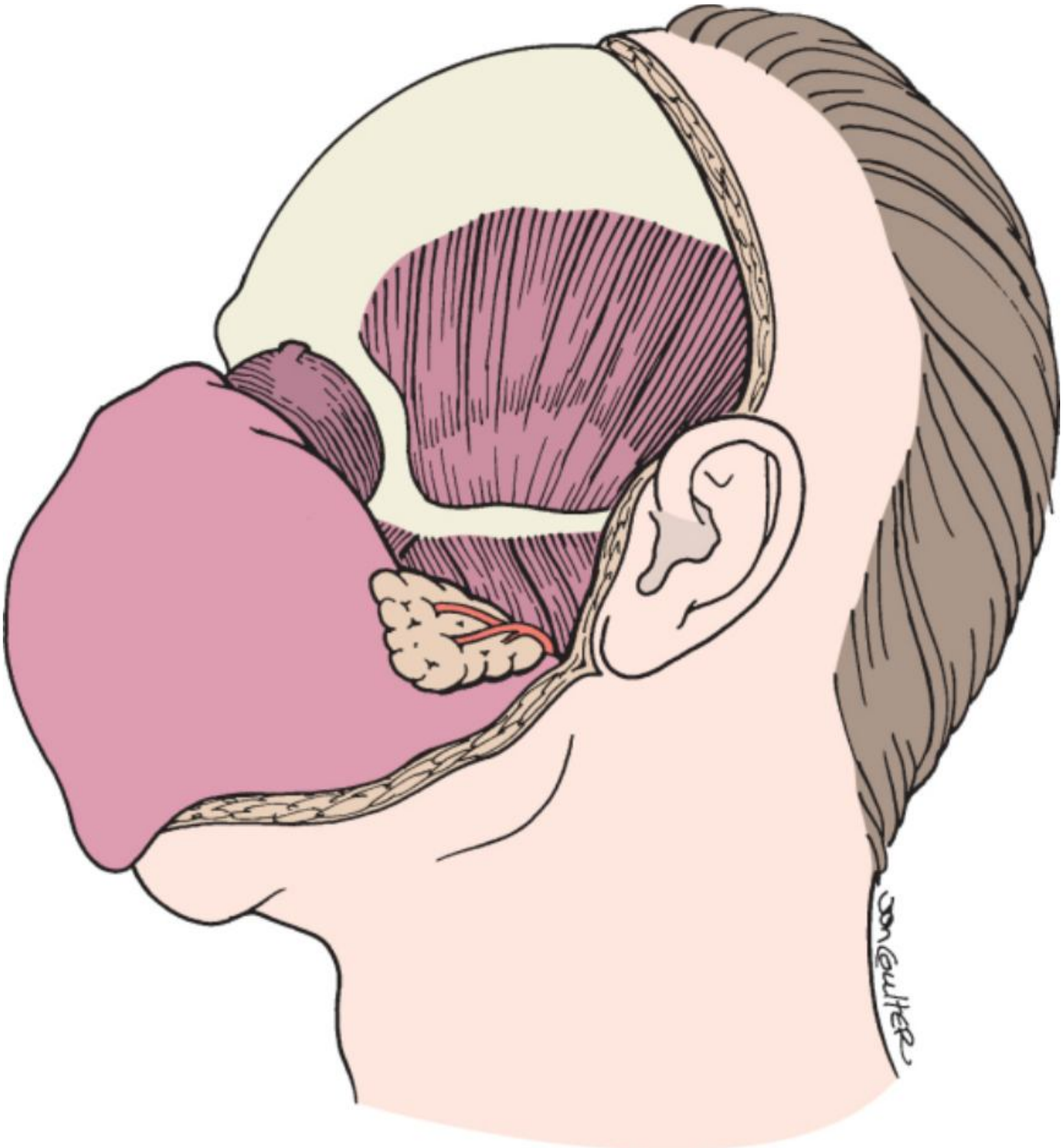


Figure 101-6 The scalp flap is elevated from the underlying cranium, deep temporal fascia, lateral orbital rim and zygomatic arch, and masseteric fascia. The plane of dissection is deep to the parotid gland and the temporal branches of the facial nerve.
(Redrawn from Sekhar LN, Janecka IP [eds]: Surgery of Cranial Base Tumors. New York, Raven Press, 1993.)

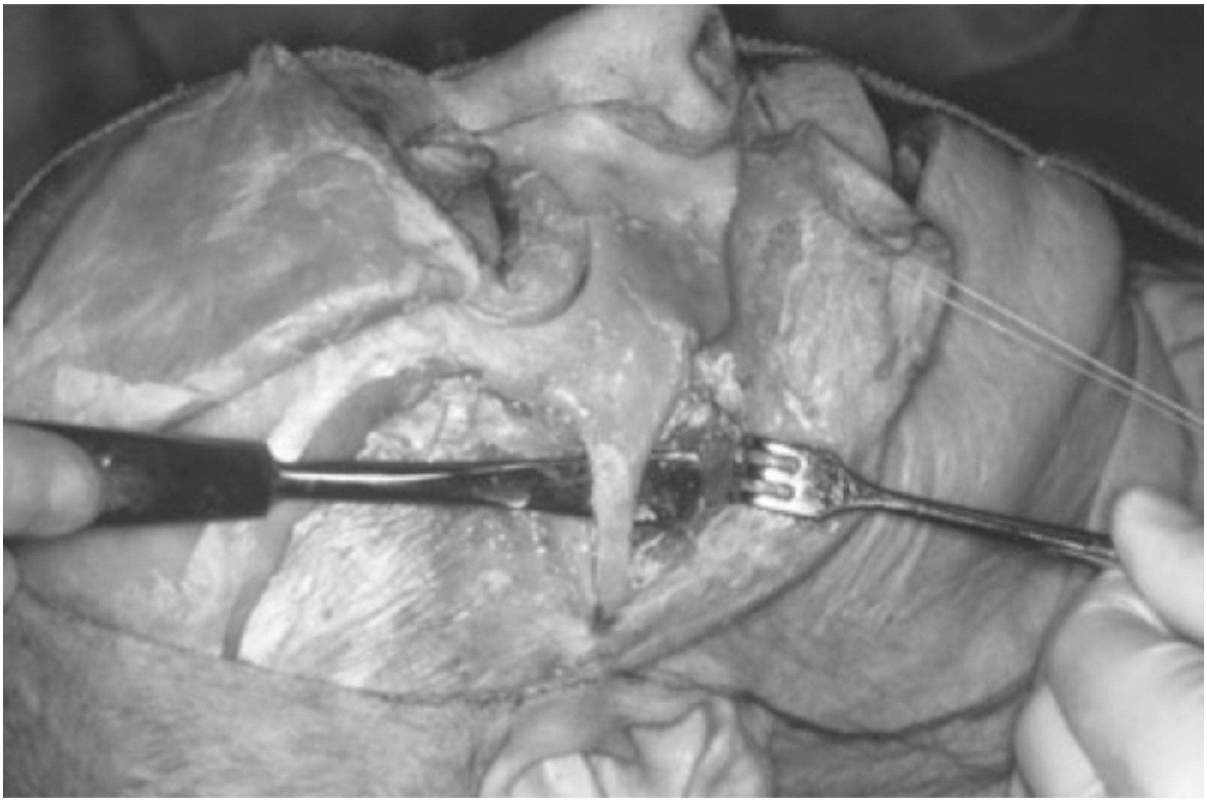


Figure 101-7 In this cadaver dissection, the masseteric fascia and other fascial attachments to the zygomatic arch are separated after elevation of the facial soft tissues from the superficial surface of the masseteric fascia. This frees the zygomatic arch for performance of the osteotomy.

All soft tissue anterior to the temporal bone can be transected to the level of thefacial nerve pedicle to increase the arc of rotation of the flap. The facial nerve is identified and preserved with a standard technique (see Chapter 62). It is helpful to leave a pedicle of soft tissue around the facial nerve trunk to prevent excessive traction injury to the facial nerve with retraction of the facial flap. The attachments of the temporalis and masseter muscles to the zygomatic arch are transected with electrocautery. Using the caudal limb of the incision, the sternocleidomastoid muscle is dissected laterally and the carotid sheath is exposed. The internal, common, and external carotid arteries, as well as the internal jugular vein, are exposed, dissected, and controlled. Cranial nerves X through XII are identified and preserved. Vessel loops are placed around the structures and secured with hemoclips rather than hemostats to avoid inadvertent traction on a hemostat (Fig. 101-8).

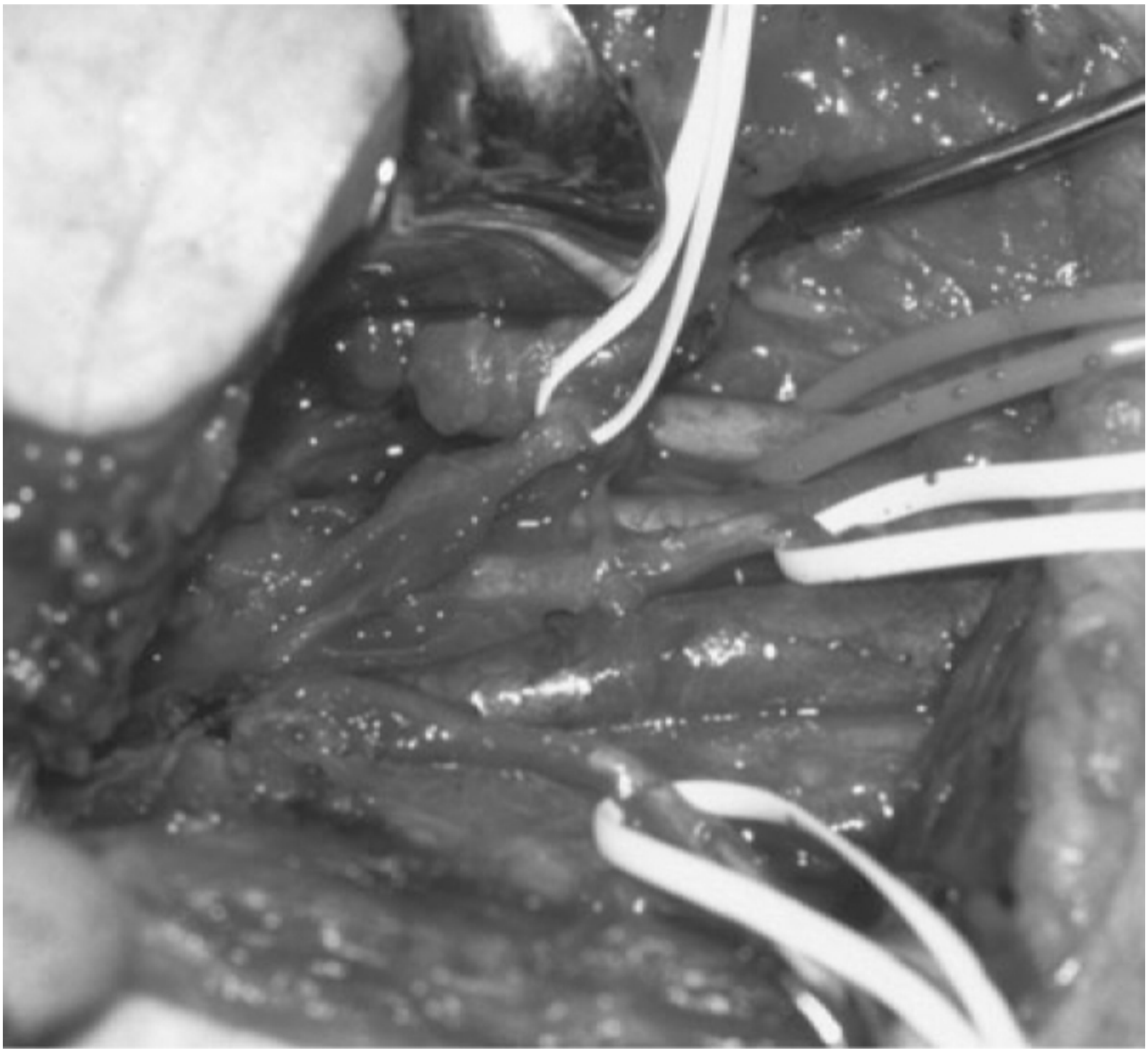


Figure 101-8 The nerves and vessels of the right upper cervical region have been isolated in this patient (left superior). White vessel loops are placed around the hypoglossal, vagus, and spinal accessory nerves. A dark vessel loop is placed around the internal carotid artery.

The attachments of the temporalis muscle to the pericranium are transected with electrocautery, and the muscle is elevated off the temporal fossa. If the muscle will be returned to its original position at the completion of surgery, a few millimeters of fascia may be left attached to the cranium at the margin of the muscle to facilitate suturing of the muscle. The temporal muscle is then reflected inferiorly until the infratemporal crest is fully visualized. Bleeding from underlying bone is usually encountered and controlled by the application of bone wax. Care should be exercised when dissecting on the deep surface of the temporalis muscle near its attachment to the mandible because the blood supply to the muscle (deep temporal arteries from the internal maxillary artery) may be injured. Dissection of soft tissue from the infratemporal skull base is associated with troublesome bleeding from the pterygoid plexus. It can be controlled with bipolar electrocautery and the application of hemostatic materials. A subtemporal craniectomy is performed at this time to aid in identification and exposure of the neural and vascular foramina. The coronoid process can be fractured or removed to increase the inferior arc of rotation of the temporal muscle. It is important to protect the soft tissue at the sigmoid notch to prevent accidental injury to the internal maxillary artery at the point where it travels on the medial surface of the mandibular ramus.

The orbitozygomatic bone graft is freed by osteotomies at the zygomatic root posteriorly, the zygomaticofrontal suture superiorly, and the zygomaticomaxillary buttress at the level of the zygomaticofacial nerve medially (Figs. 101-9 and 101-10). A reciprocating saw is used to make beveled and V-shaped bone cuts to maximize exposure and facilitate replacement of the bone graft at the completion of surgery. If there is tumor involvement of the orbit, the bone cut through the lateral wall of the orbit may include only the orbital rim to avoid violation of the tumor. For lesions that do not involve the temporal bone or petrous portion of the ICA, this approach provides adequate exposure to the infratemporal skull base. If dissection of the ICA throughout its petrous portion is necessary, the glenoid fossa is removed as part of the bone graft. It is first necessary to perform a temporal craniotomy for exposure of the superior aspect of the glenoid fossa (Fig. 101-11). The capsule of the TMJ is dissected free from the fossa and displaced inferiorly. If possible, the capsule and meniscus are preserved. If additional exposure is necessary, the mandibular condyle can be transected at the level of the sigmoid notch and removed (Fig. 101-12). Using a reciprocating saw, a V-shaped cut is then made through the bone of the glenoid fossa to incorporate approximately the lateral two thirds of the glenoid fossa (Fig. 101-13). This avoids potential injury to the ICA, which is located medial to the glenoid fossa (Fig. 101-14). If the bone cut is made too posteriorly, there is risk of injury to the cochlea. This modification provides better stability for the mandibular condyle after reconstruction.

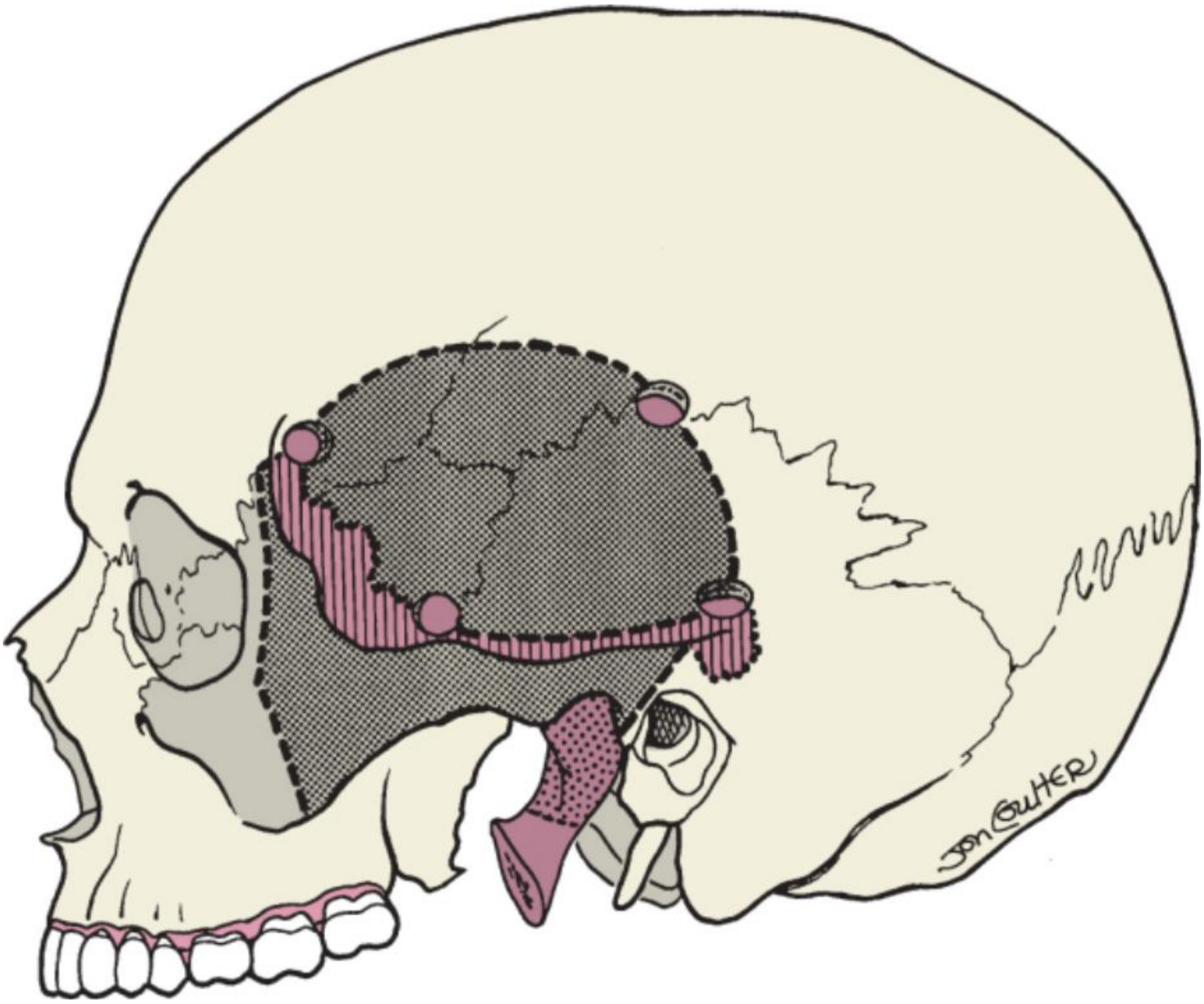


Figure 101-9 The areas of bone removal are noted *(dark stippled area)*. A temporal craniotomy is performed in conjunction with an orbitozygomatic osteotomy. This illustration demonstrates transection of the zygomatic arch anterior to its posterior attachment and preservation of the lateral orbital rim. Additional exposure of the infratemporal skull base may be achieved by removal of the subtemporal cranium *(striped area)* and resection of the mandibular condyle *(light stippled area)*.

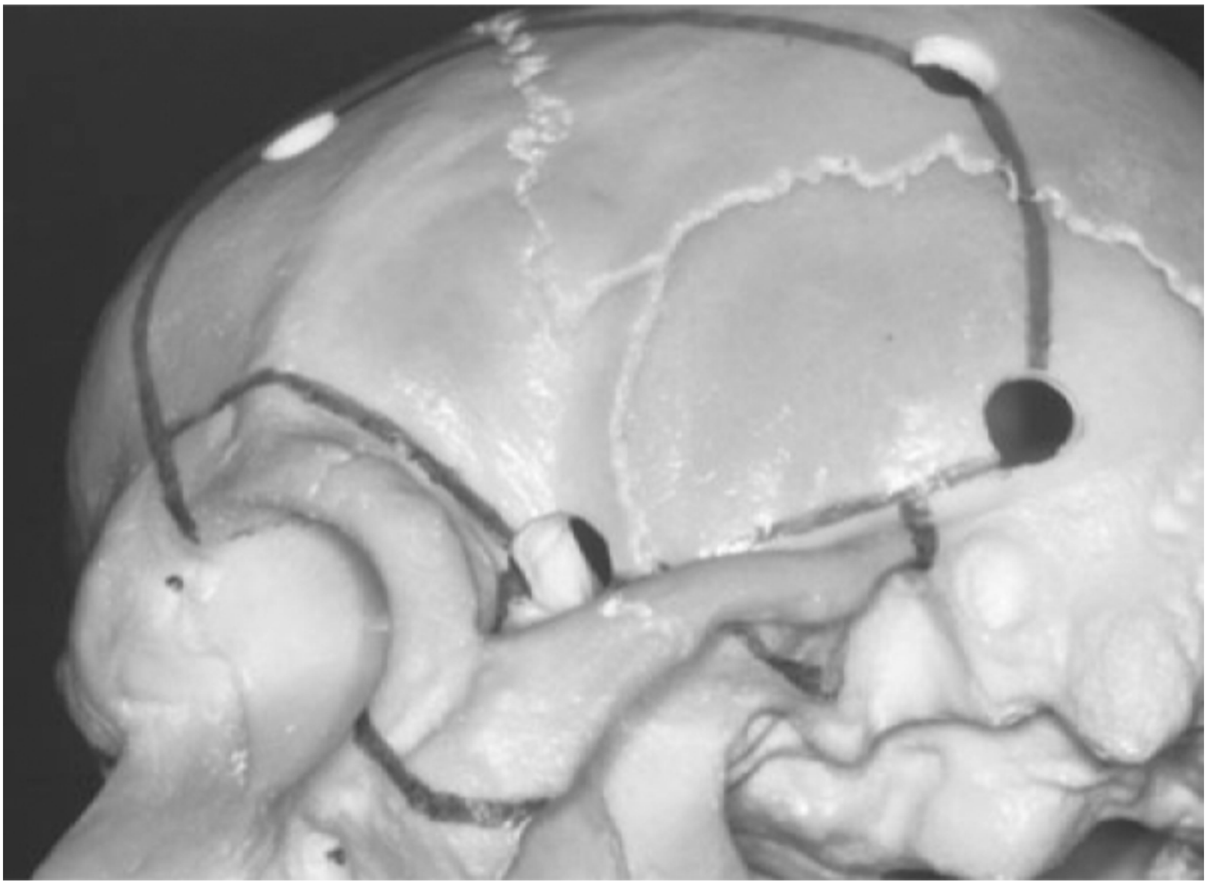


Figure 101-10 In this plastic model of a skull, the lines for the craniotomy and orbitozygomatic osteotomy are marked. If it is not necessary to remove the glenoid fossa, the zygomatic arch is transected posteriorly at its attachment to the cranium.

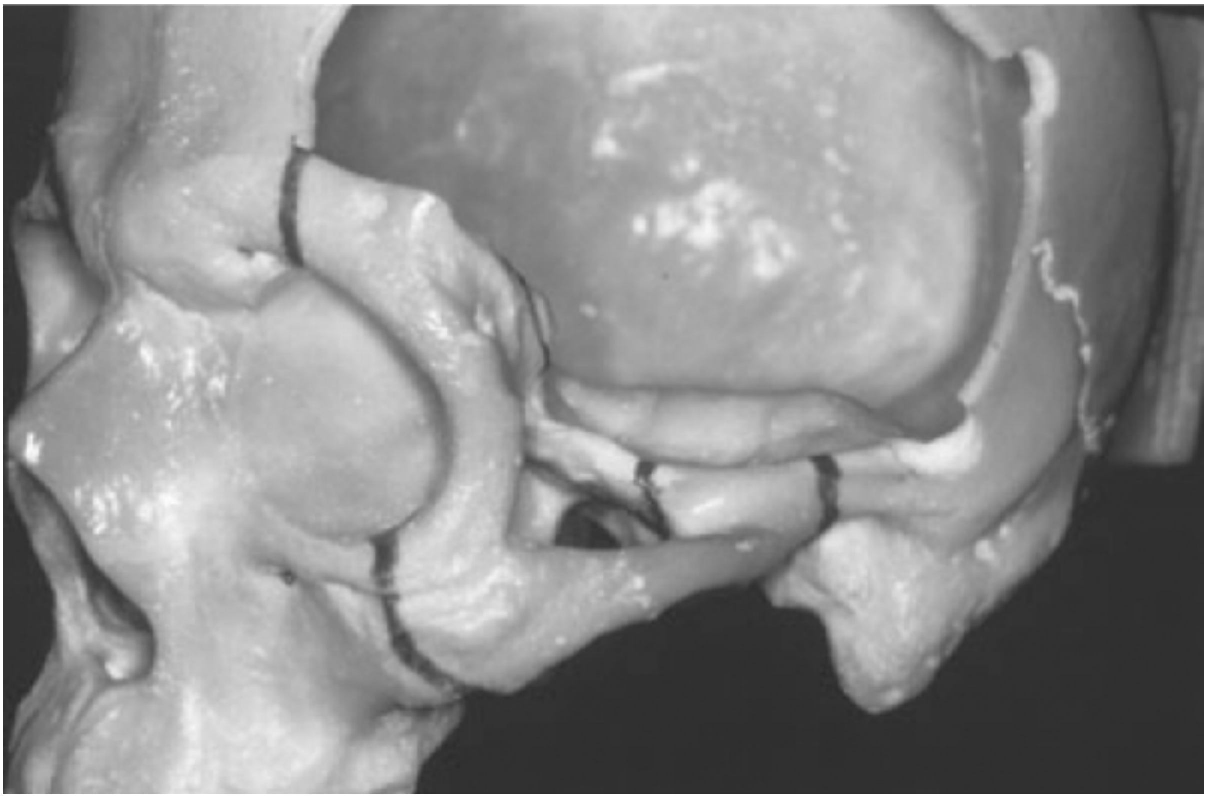


Figure 101-11 A temporal craniotomy has been performed to provide adequate exposure for osteotomies through the glenoid fossa and orbital walls.

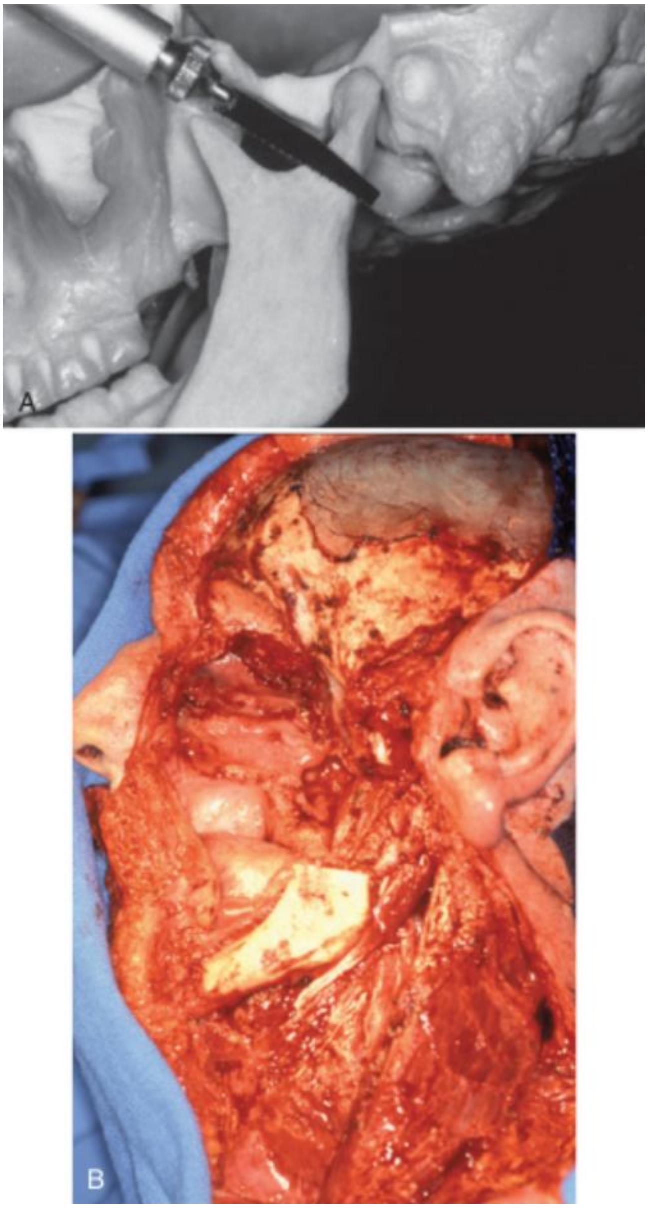


Figure 101-12 **A,** An osteotomy of the mandibular condyle is performed with a reciprocating saw to provide additional exposure. **B,** Removal of the coronoid process in conjunction with the condyle provides further exposure and facilitates rotation of the temporalis muscle.

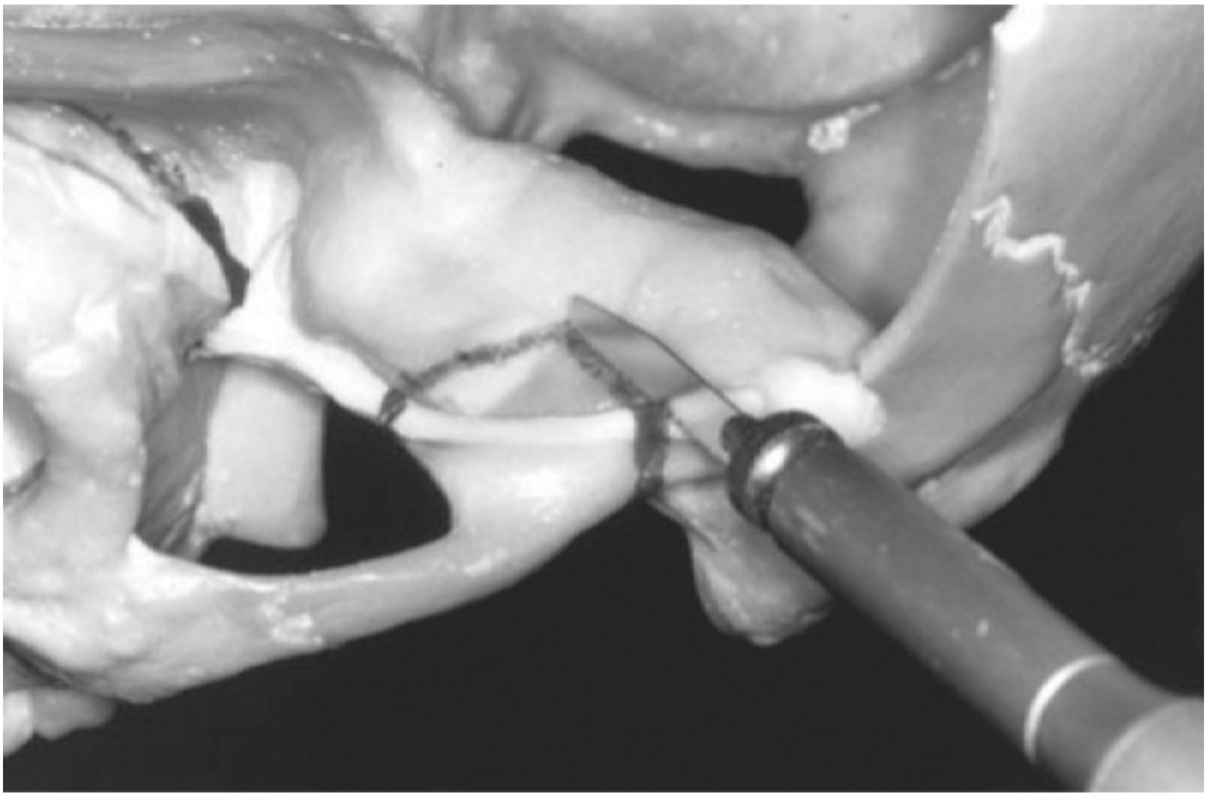


Figure 101-13 The lateral two thirds of the glenoid fossa is removed by performing osteotomies with a reciprocating saw. Care is taken to avoid injury to the internal carotid artery medially and the cochlea posteriorly.

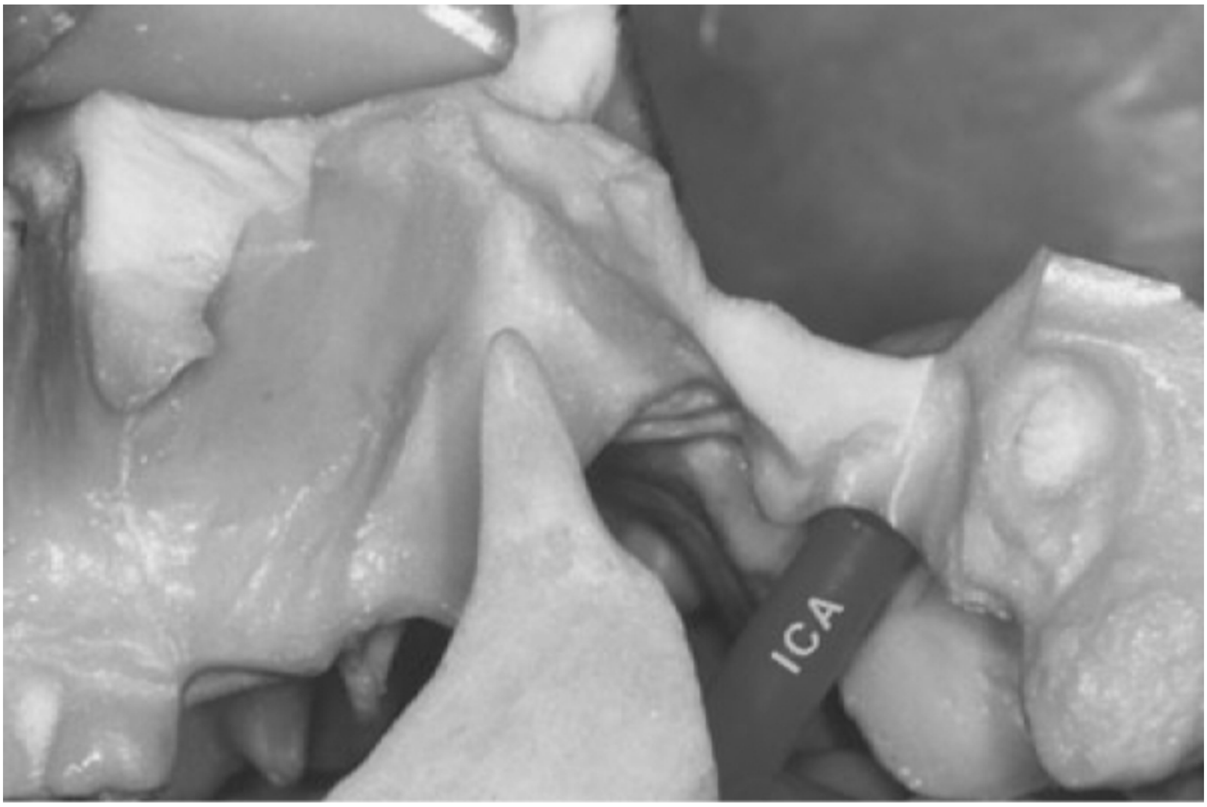


Figure 101-14 The location of the internal carotid artery (plastic tube) is noted in this model to be medial to the mandible and the glenoid fossa.

Elevation of the periorbita from the lateral and inferior walls of the orbit is necessary to identify the inferior orbital fissure and complete the orbitozygomatic osteotomies (Fig. 101-15). The tip of the reciprocating saw is placed in the most lateral aspect of the inferior orbital fissure along the orbital floor, and an osteotomy through the malar eminence is performed (Fig. 101-16). This separates the zygoma from the lateralwall of the maxilla. On occasion, violation of the maxillary sinus may occur, especially if the maxilla is well pneumatized. If this happens, the mucosal remnant attached to the zygoma is removed. Adequate closure of the maxillary defect is achieved after replacement of the orbitozygomatic bone segment at the completion of surgery. It is not necessary to strip the mucosa from the remainder of the sinus. Using both intracranial and extracranial approaches, osteotomies are made through the superior and lateral orbital walls to completely free the orbitozygomatic bone segment (Fig. 101-17). This provides excellent access to the infratemporal skull base, orbital apex, and lateral maxilla (Fig. 101-18).

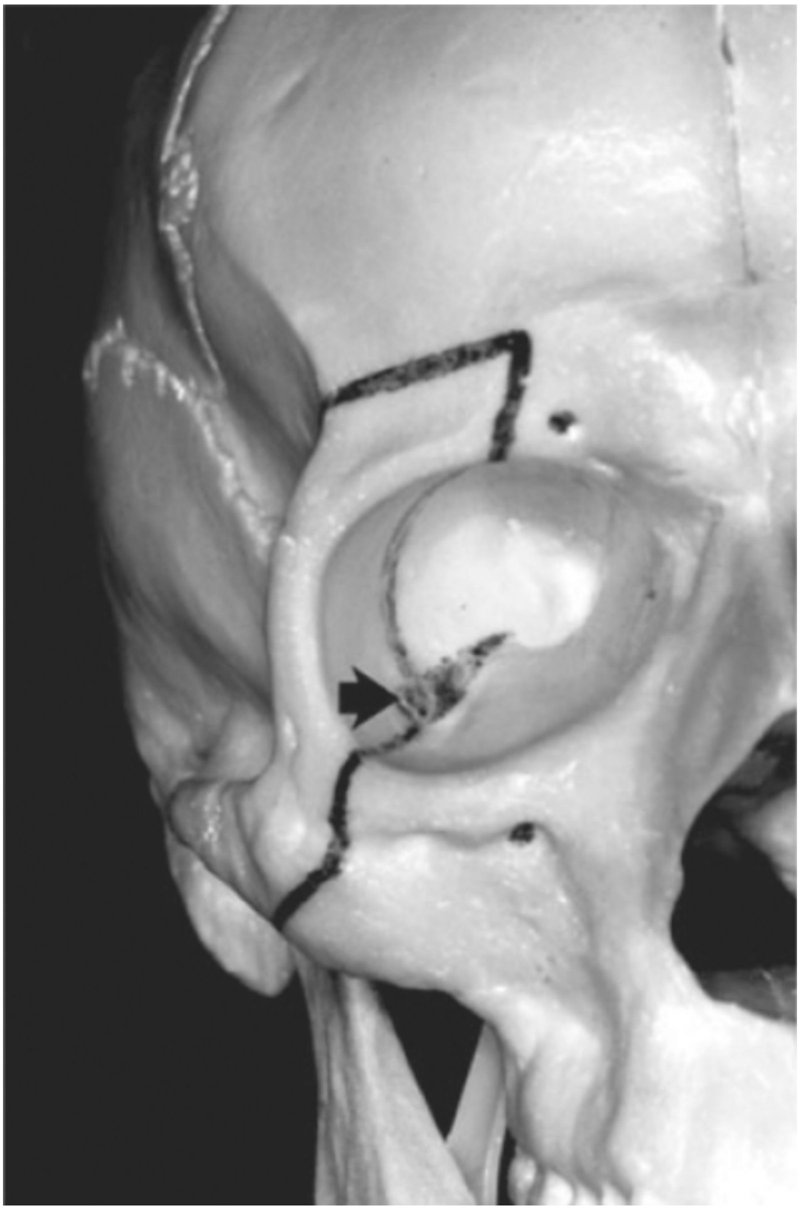


Figure 101-15 The osteotomies communicate with the lateral aspect of the inferior orbital fissure *(arrow)*.

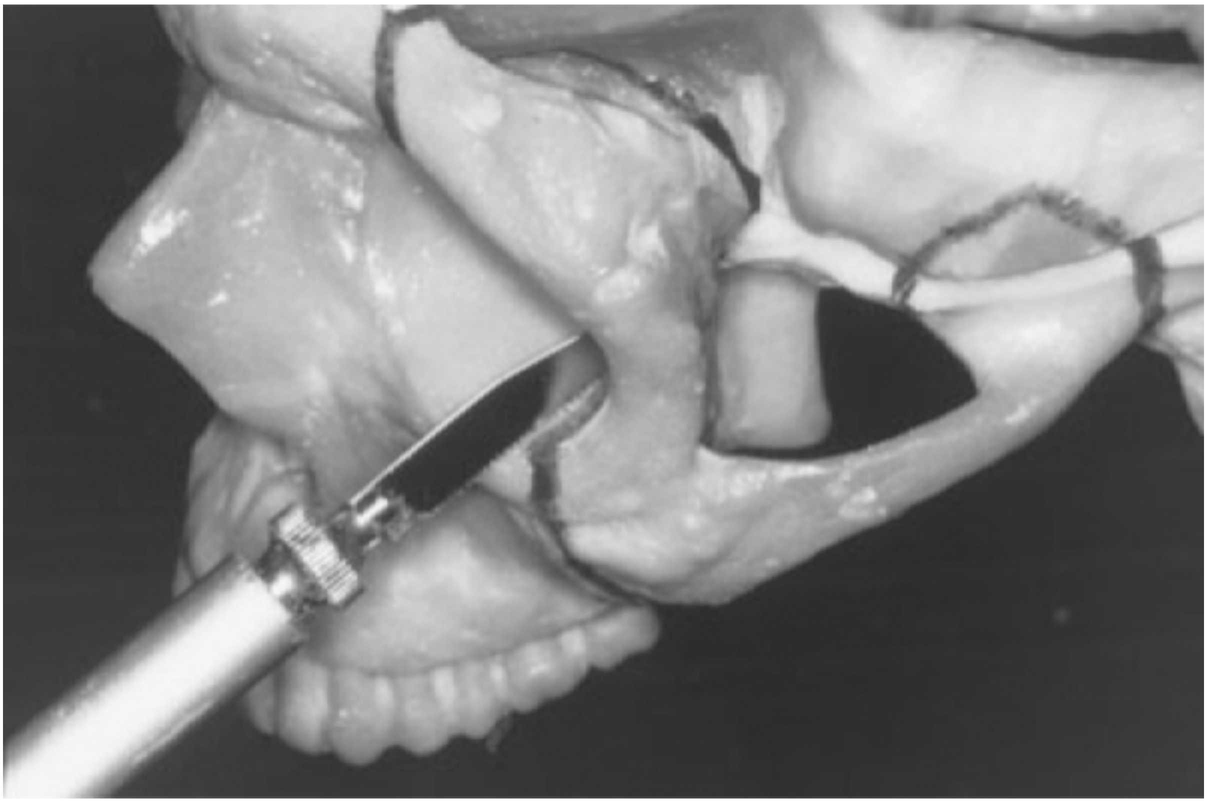


Figure 101-16 An osteotomy is made from the inferior orbital fissure across the malar eminence and lateral to the maxilla.

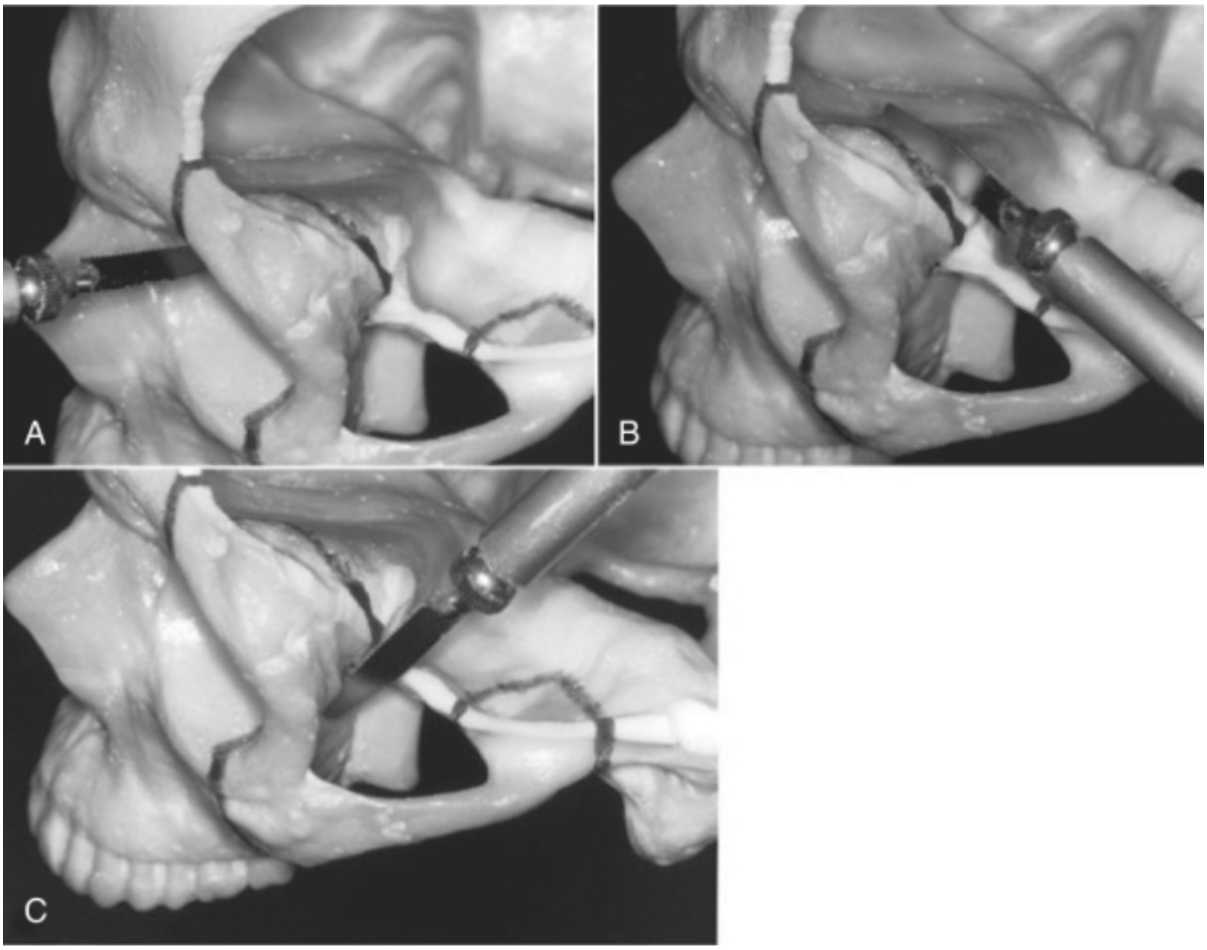


Figure 101-17 With the use of intracranial and extracranial approaches, osteotomies of the superior orbital roof **(A** and **B)** and lateral orbital wall **(C)** are performed.

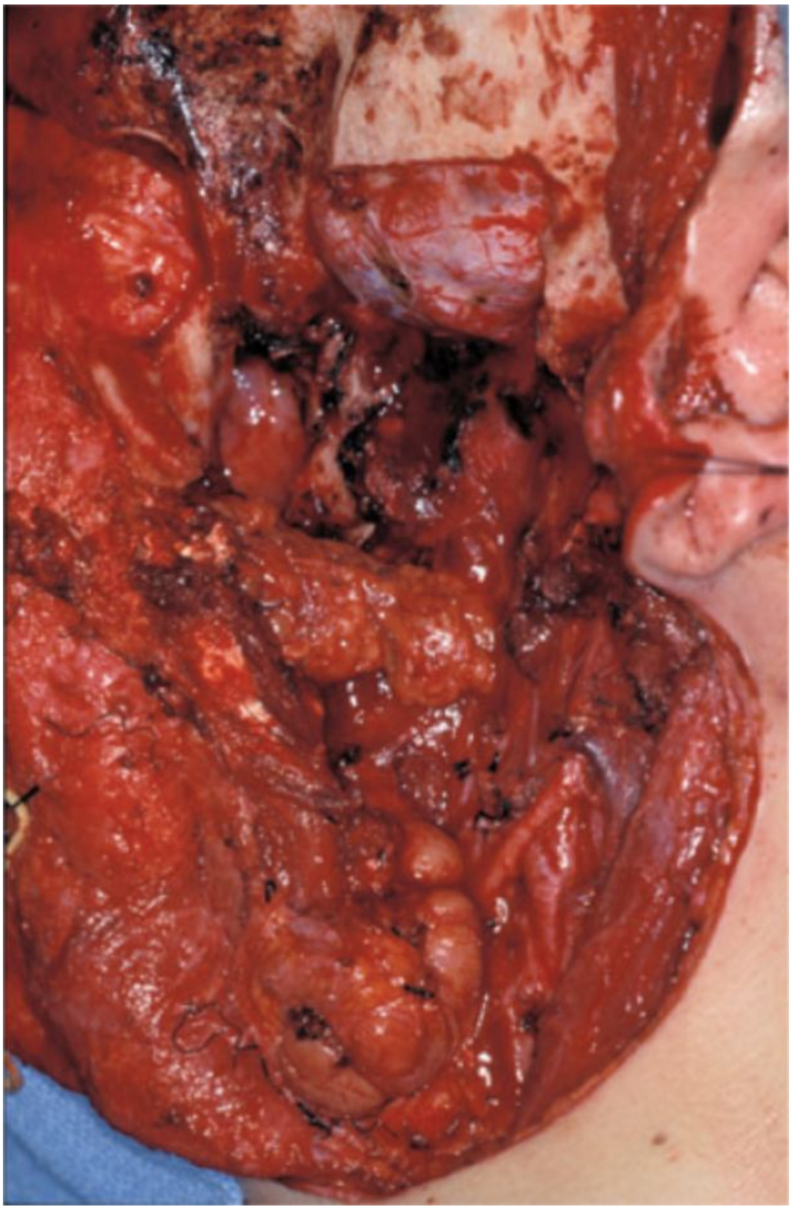


Figure 101-18 Extent of exposure after a temporal craniotomy and orbitozygomatic osteotomy.

Several anatomic relationships are useful for identification of infratemporal skull base structures (Fig. 101-19). After completion of the temporal craniotomy, additional bone is removed from the inferior margin of the defect with rongeurs (see Fig. 101-9). The origin of the lateral pterygoid plate from the skull base is identified anteriorly. The curve of the lateral pterygoid plate is followed posteriorly to identify the foramen ovale, foramen spinosum, and the spine of the sphenoid bone. These structures lie in a straight line and are all lateral to the ICA. The middle meningeal artery is cauterized with bipolar electrocautery and transected. Bleeding from venous communications through the foramenovale may be controlled with Surgicel packing. If complete dissection of the petrous portion of the ICA is required, it is usually necessary to transect the mandibular division of the trigeminal nerve at the foramen ovale for additional exposure (Fig. 101-20). The lateral aspect of the sphenoid sinus may be accessed by removal of bone between the second and third divisions of the trigeminal nerve (Fig. 101-21). Extirpation of the tumor can now proceed, including the involved soft tissue and bone (Fig. 101-22). For tumors invading the mandible, partial mandibulectomy is essential to obtain negative margins. In the pediatric age group, the distance from the body of the mandible to the infratemporal skull base is greatly foreshortened. Adequate exposure of the infratemporal skull base can often be achieved from a transcervical approach with superior displacement of the facial nerve (Fig. 101-23).

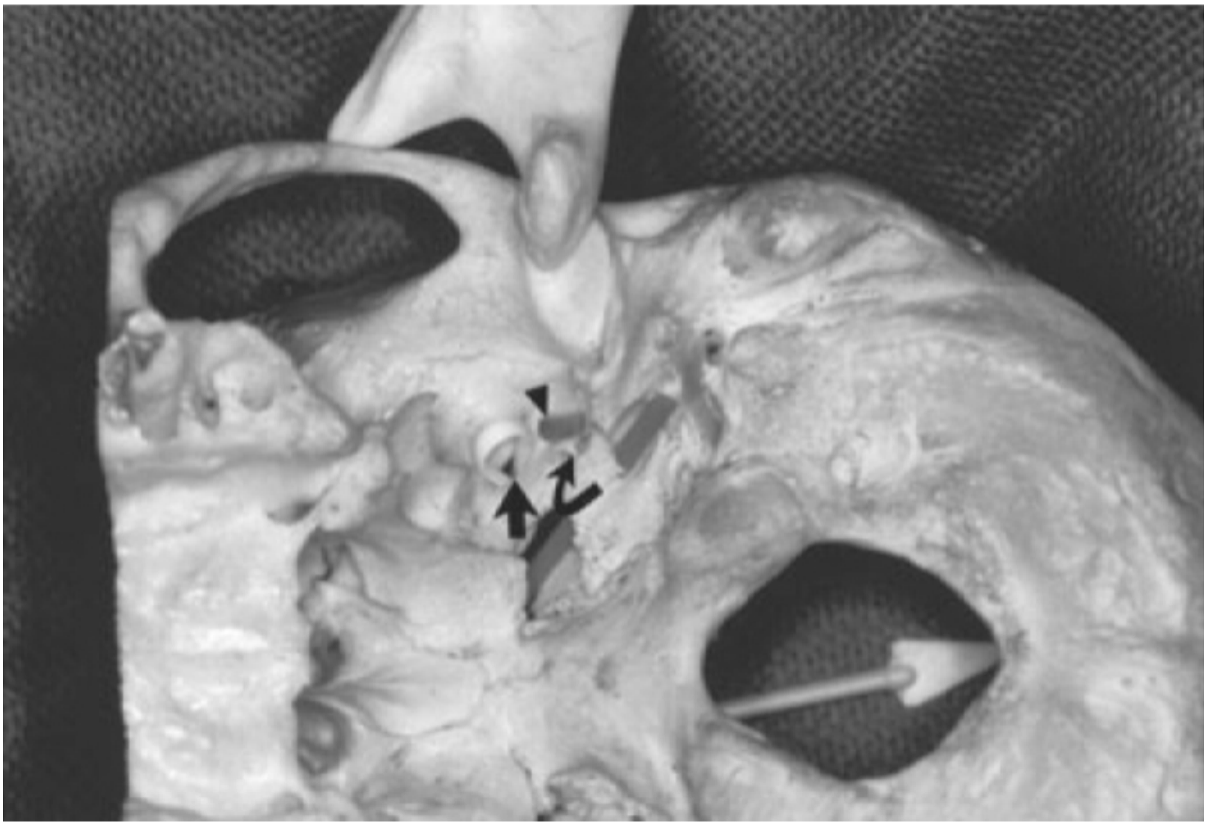


Figure 101-19 Skull demonstrating the anatomic relationships of the internal carotid artery (ICA) and carotid canal. The foramen ovale (*straight arrow;* white vessel loop) and foramen spinosum (*arrowhead;* short dark vessel loop) are in a direct line from the lateral pterygoid plate to the spine of the sphenoid. The ICA (long dark vessel loop) courses through the carotid canal medial to the eustachian tube *(curved arrow)* and the glenoid fossa. The mandible has been disarticulated to reveal the glenoid fossa.

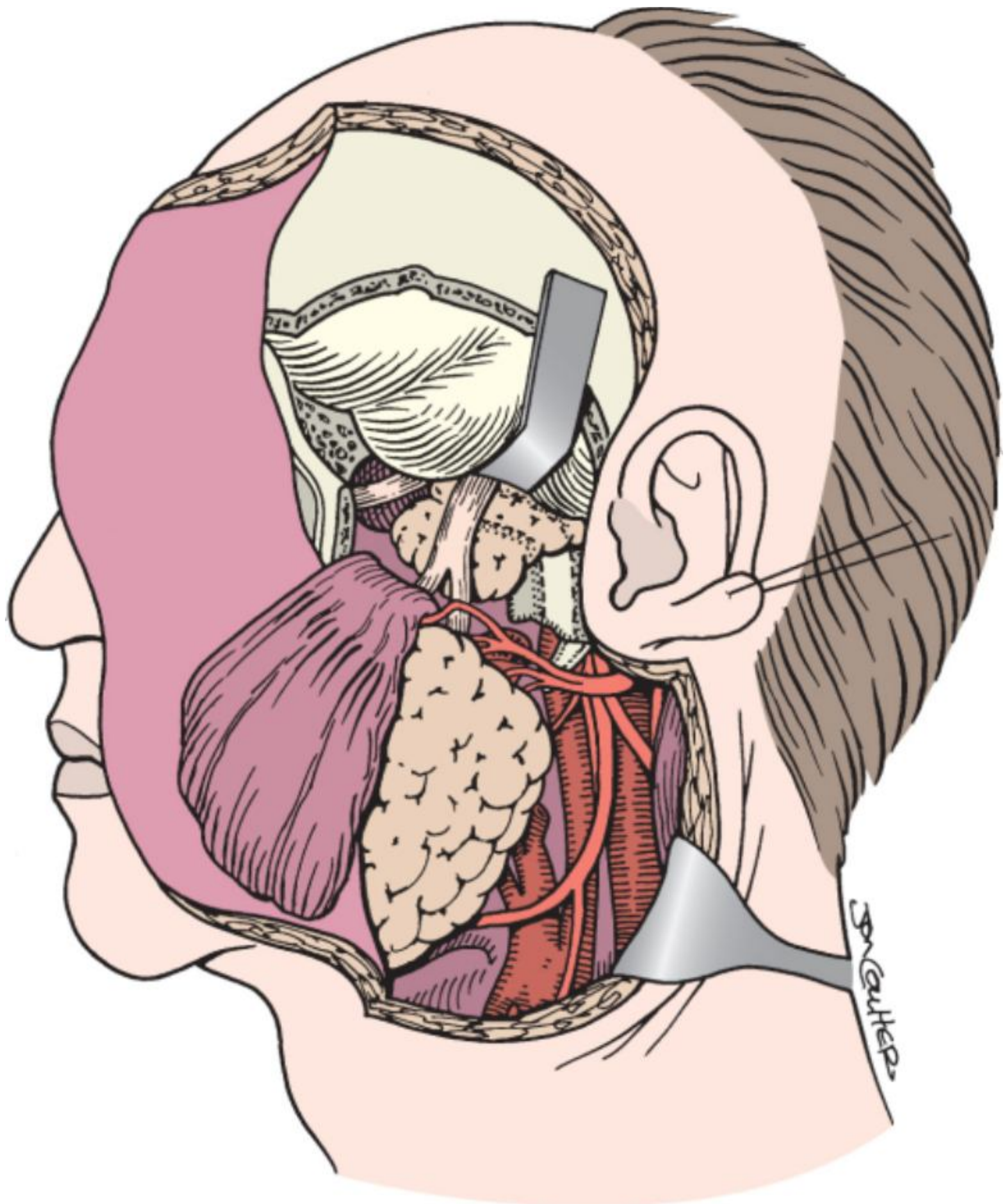


Figure 101-20 Illustration demonstrating a tumor medial to the mandibular division of the trigeminal nerve and in close proximity to the petrous portion of the internal carotid artery (ICA). Additional exposure of the ICA and removal of the tumor often necessitate transection of the mandibular division of the trigeminal nerve.

(Redrawn from Sekhar LN, Janecka IP [eds]: Surgery of Cranial Base Tumors. New York, Raven Press, 1993.)

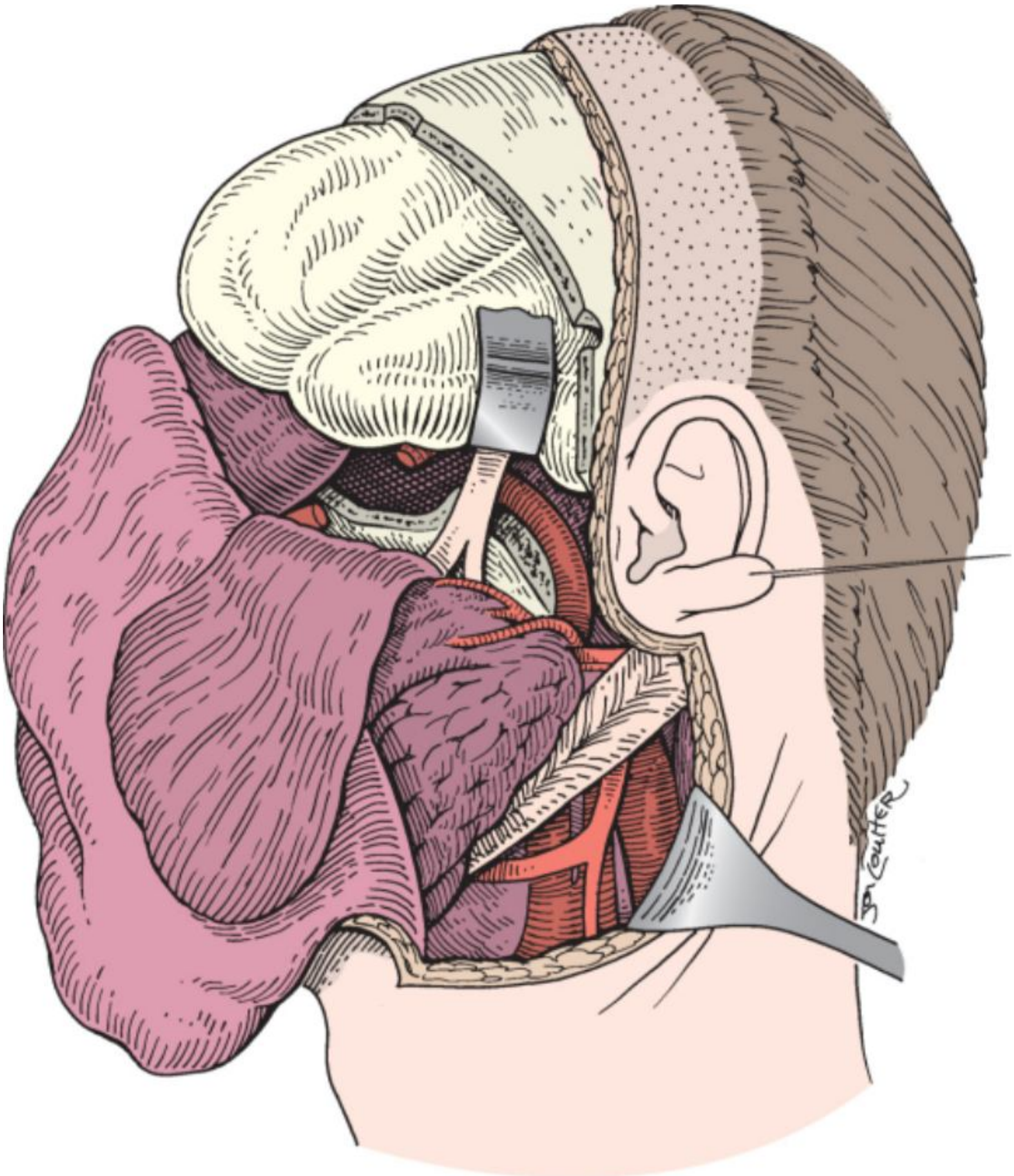


Figure 101-21 Illustration demonstrating an opening into the sphenoid sinus medial to the transected second division of the trigeminal nerve. A segment of the petrous portion of the internal carotid artery has been exposed.

(Redrawn from Sekhar LN, Janecka IP [eds]: Surgery of Cranial Base Tumors. New York, Raven Press, 1993.)

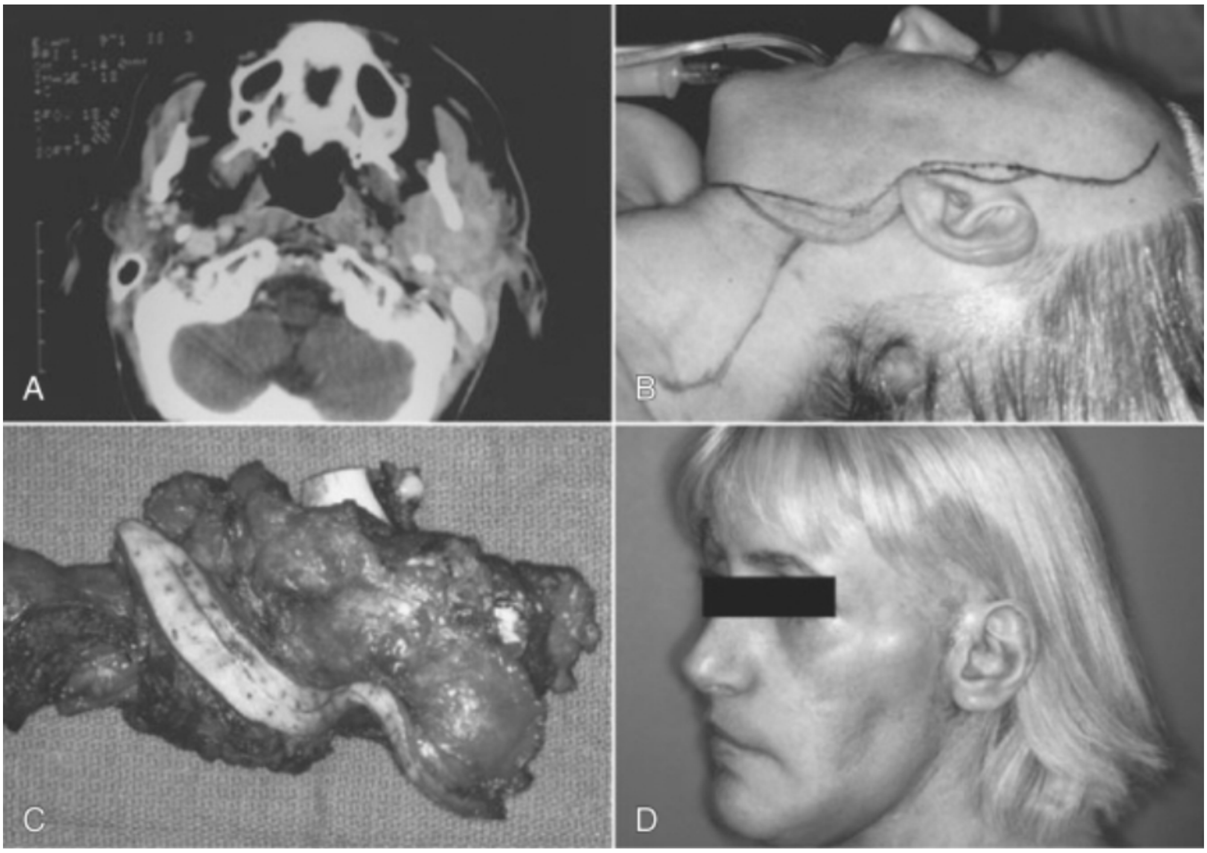


Figure 101-22 **A,** Computed tomography scan demonstrating recurrent adenocarcinoma of the left infratemporal fossa that is encasing the mandible and extending to the lateral aspect of the internal carotid artery (ICA). **B,** A left infratemporal skull base approach was used with excision of the previous scar. **C,** The resected specimen included the ramus and condyle of the mandible, the parotid gland and associated soft tissue, the pterygoid musculature, and the left neck contents. The medial limit of the resection was the extracranial portion of the ICA. **D,** Excellent healing of the surgical site is noted after completion of postoperative neutron beam therapy. Some permanent hair loss has occurred secondary to the radiation therapy.

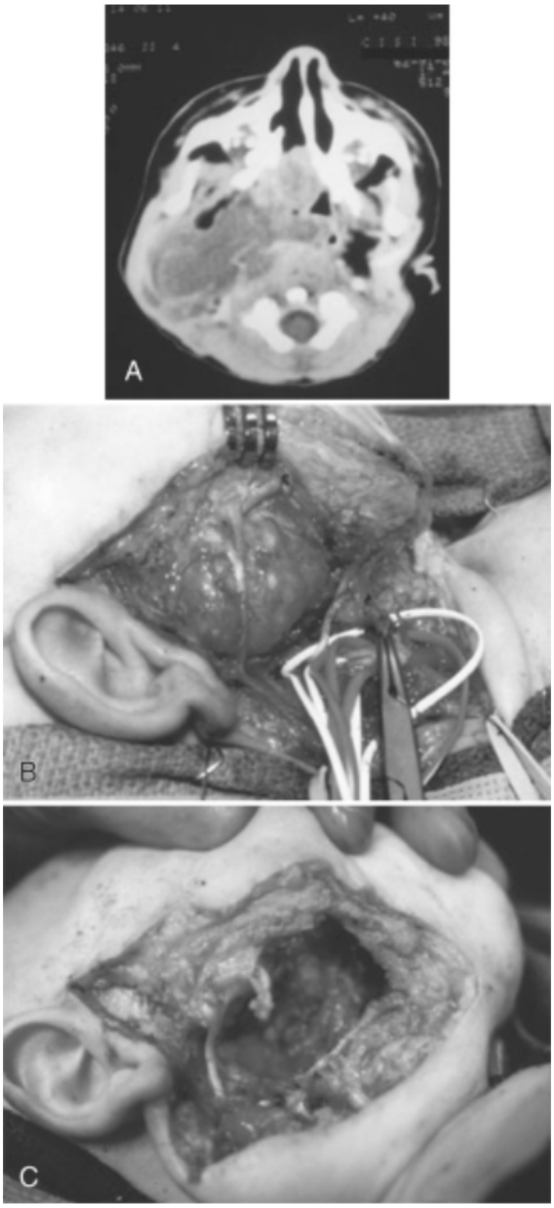


Figure 101-23 **A,** A 4-month-old infant had a large teratoma of the right parapharyngeal space with extension to the skull base and into the cervical region. **B** and **C,** The tumor was successfully removed via a transcervical approach, with preservation of facial nerve function.

After extirpation of the tumor, it is necessary to close any defects that are communicating with the upper aerodigestive tract (Fig. 101-24). If the blood supply to the temporalis muscle is preserved, transposition of the temporalis muscle provides obliteration of the dead space, as well as protection of the ICA (Fig. 101-25). Because of the branching pattern of the blood supply to the temporalis muscle, the anterior one half or lateral portion of the muscle may be transposed with its blood supply intact (Fig. 101-26). The remaining portion of the muscle is used to fill in the anterior portion of the temporal defect. Defects of the orbit may be obliterated by temporalis muscle transposition with skin grafting (Fig. 101-27). In some circumstances, anteriorly or posteriorly based pericranial scalp flaps may be elevated to provide protection of the infratemporal skull base. In the absence of the temporalis muscle, large soft tissue defects are best reconstructed with microvascular free tissue transfers (Fig. 101-28). The orbitozygomatic bone graft is then replaced and held in position with titanium microplates. If resection of the mandibular condyle is necessary for exposure of the petrous ICA, reconstruction of the TMJ is not attempted. Reconstruction has not been shown to improve postoperative function and may actually contribute to scarring and postoperative trismus. Standard closure of soft tissues is performed.

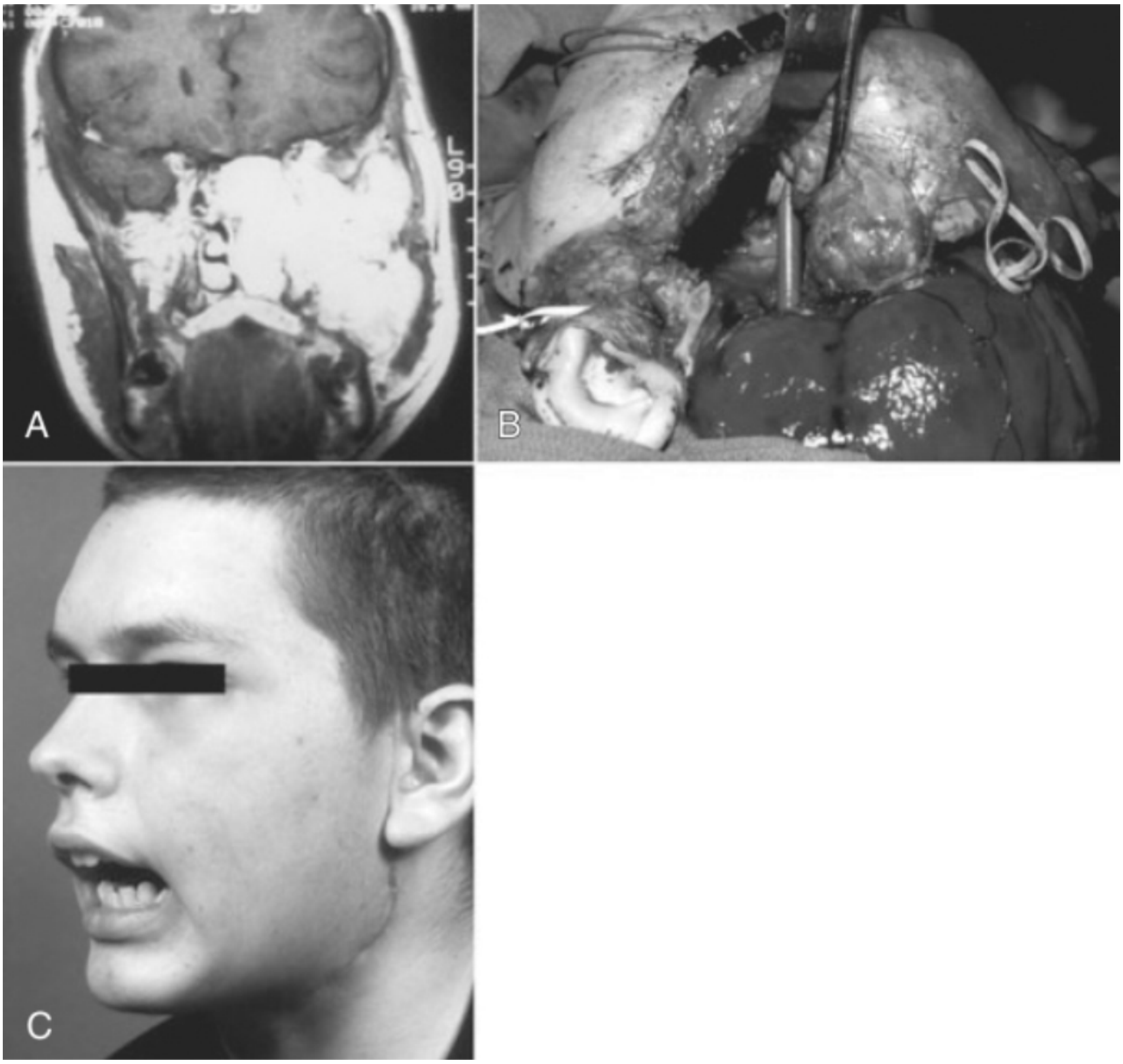


Figure 101-24 **A,** Preoperative magnetic resonance image demonstrating a large angiofibroma extending from the nasopharynx to the left infratemporal skull base. **B,** This tumor was completely excised by subtemporal craniectomy from a left infratemporal skull base approach. A marking pen has been inserted through the nasal cavity to show the extent of the communication with the nasopharynx. **C,** Excellent healing of the surgical site is noted postoperatively with no cosmetic deformity. Moderate trismus with mild deviation of the jaw is present.

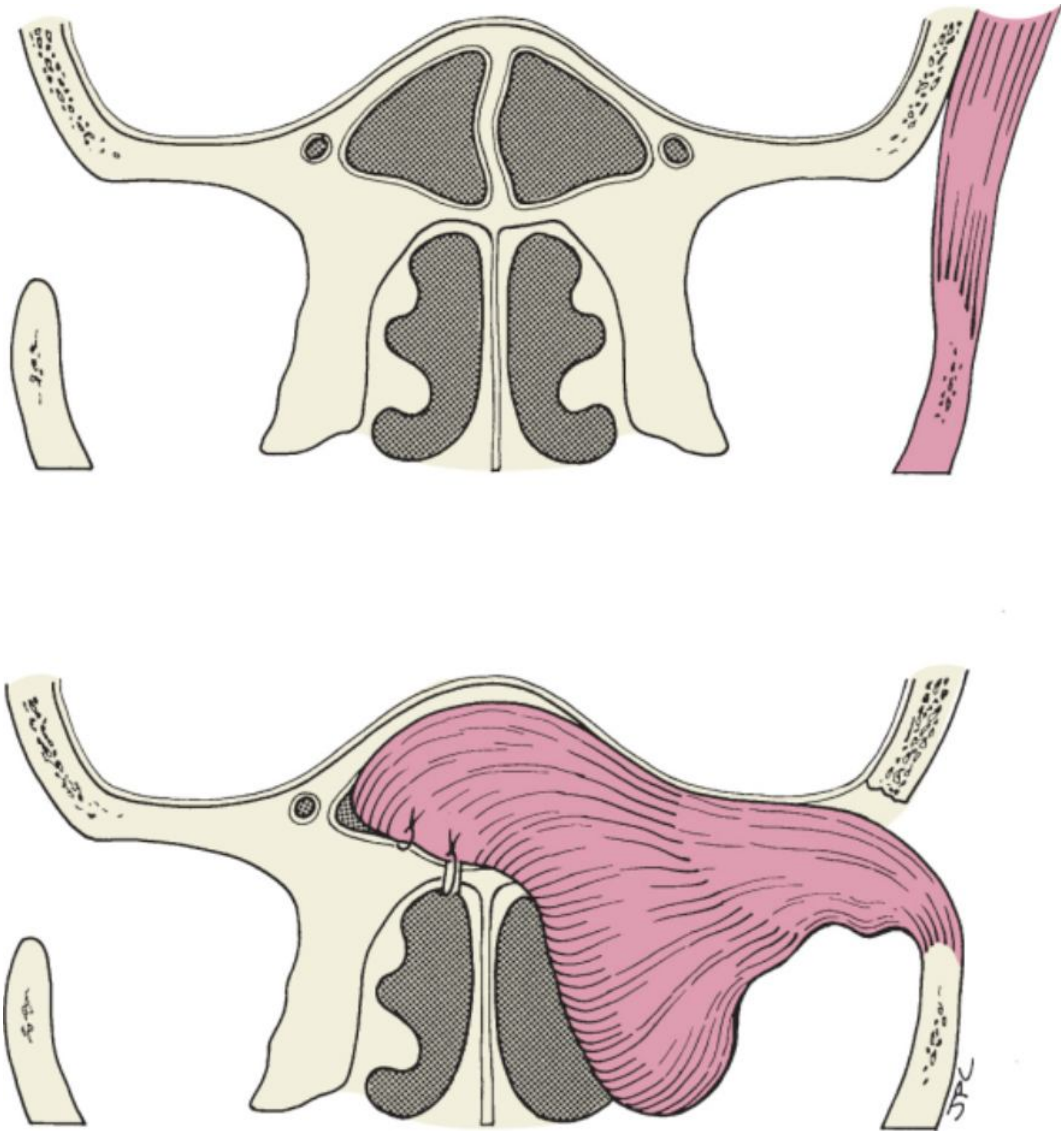


Figure 101-25 The entire temporalis muscle is available for obliteration of a defect in the orbit or infratemporal skull base.
(Redrawn from Sekhar LN, Janecka IP [eds]: Surgery of Cranial Base Tumors. New York, Raven Press, 1993.)

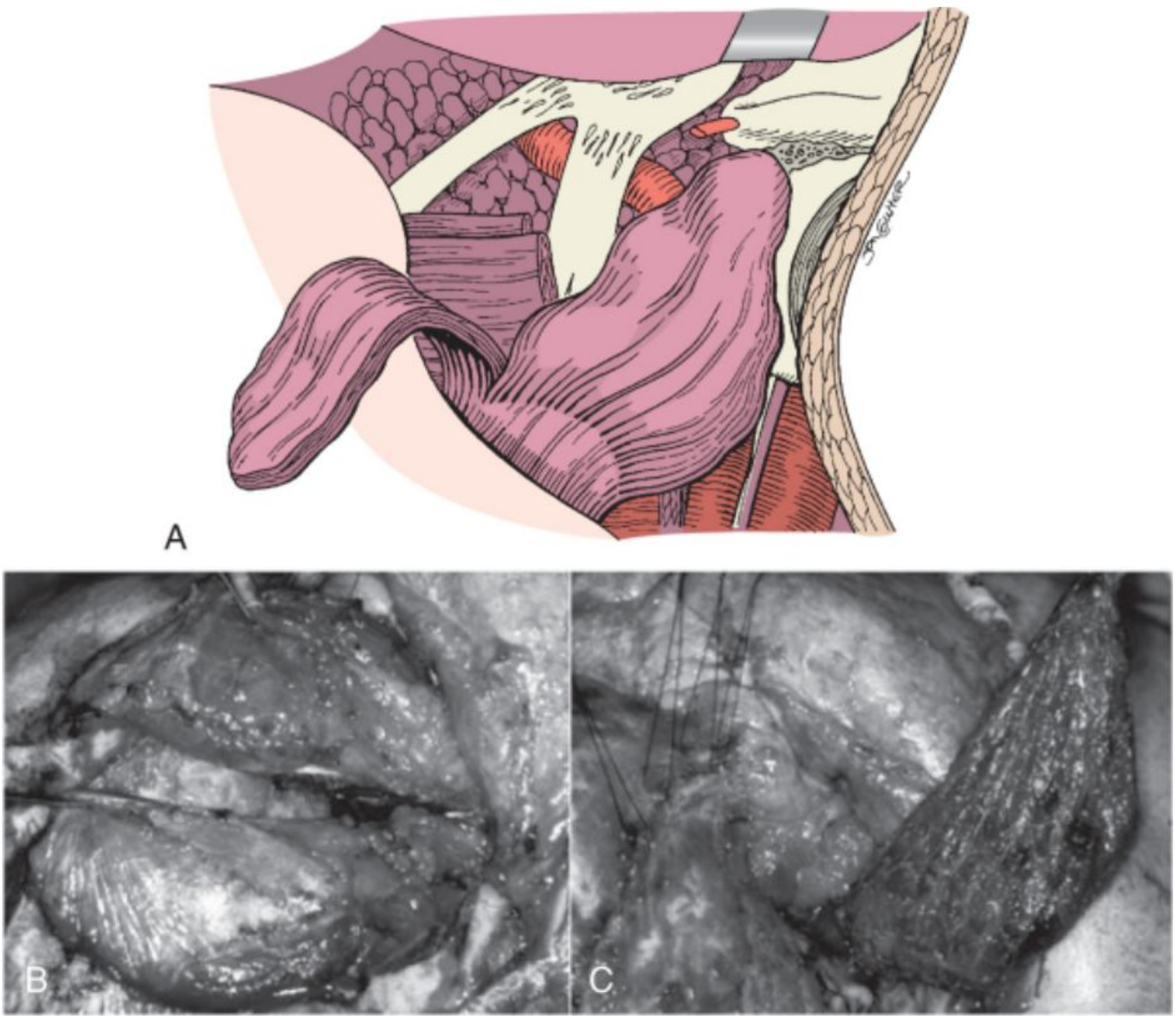


Figure 101-26 **A,** The anterior portion of the muscle may be transposed to fill an infratemporal skull base defect, as illustrated with this left temporalis muscle. **B,** The right temporalis muscle has been split vertically with preservation of its axial blood supply. **C,** The posterior one half of the muscle is sutured to the fascia or bone bordering the superior temporal line and lateral orbital rim to prevent a cosmetic defect.

Figure 101-27 This patient required orbital exenteration and resection of the lateral orbital wall for recurrent squamous cell carcinoma. The defect was reconstructed by temporalis muscle transposition and a skin graft.

Figure 101-28 Large soft tissue defects are best reconstructed by microvascular free tissue transfer, most commonly the rectus abdominis muscle.

Postauricular (Transtemporal) Approach

The postauricular approach is ideal for lesions involving the temporal bone and extending into the ITF.[10,11] A "question mark" or C-shaped incision is started in the temporal area, extended postauricularly into the mastoid region, and curved down to follow one of the midneck horizontal skin creases (Fig. 101-29). If middle ear function is going to be sacrificed as part of the approach or tumor resection and there is a risk of a postoperative CSF leakage, the EAC is closed permanently to prevent CSF otorrhea. The EAC is divided at the bony–cartilaginous junction and then closed with everting stitches. This closure is reinforced with a myoperiosteal U-shaped flap based on the posterior margin of the EAC. Occasionally, closure of the EAC may be necessary in patients with a preexisting tympanotomy tube. Alternatively, the canal may be preserved by placing the incisions in the conchal area (Fig. 101-30). The incision follows the margin of the conchal bowl and tragus so that the scar will be camouflaged. In the conchal area, the skin, cartilage, and perichondrium are incised to communicate with the retroauricular plane of dissection. These incisions allow anastomosis of the EAC to the pinna at the end of the extirpative procedure (Fig. 101-31). An incision within the EAC is not used because it is difficult to suture and obtain a watertight closure and there is a risk of postoperative stenosis. A Penrose drain can be inserted through the defect in the skin flap to provide gentle retraction (Fig. 101-32). The remaining conchal bowl and tragus may be sutured together temporarily to provide better exposure of the operative field.

Figure 101-29 A curvilinear incision is made from the temporal area to the mastoid bone and upper cervical region. The flap is elevated superficial to the deep temporal fascia, deep to the mastoid periosteum, and deep to the platysma muscle. A conchal incision is preferable to incision of the external auditory canal when permanent obliteration of the ear is not indicated.

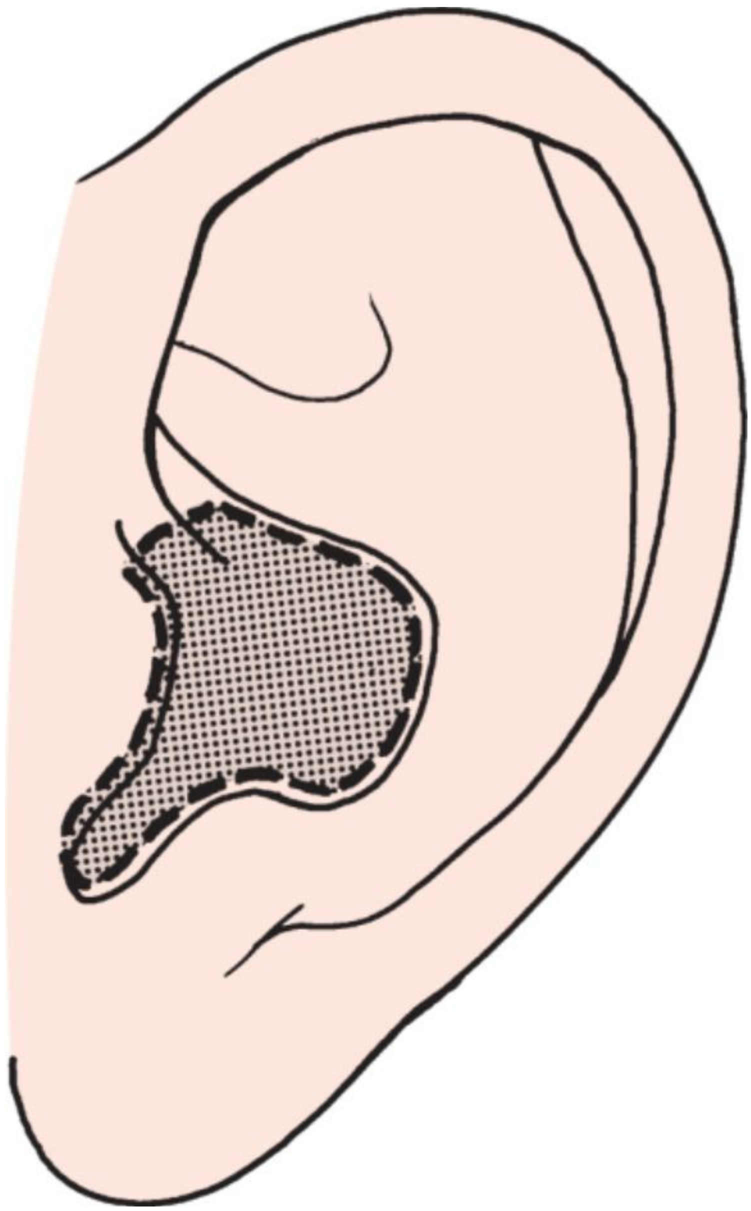


Figure 101-30 The conchal incision is made at the margins of the conchal bowl to facilitate closure and provide an optimal cosmetic result.

Figure 101-31 The auricle is repaired by double-layer closure of the perichondrium and skin. A watertight closure is achieved to prevent cerebrospinal fluid otorrhea.

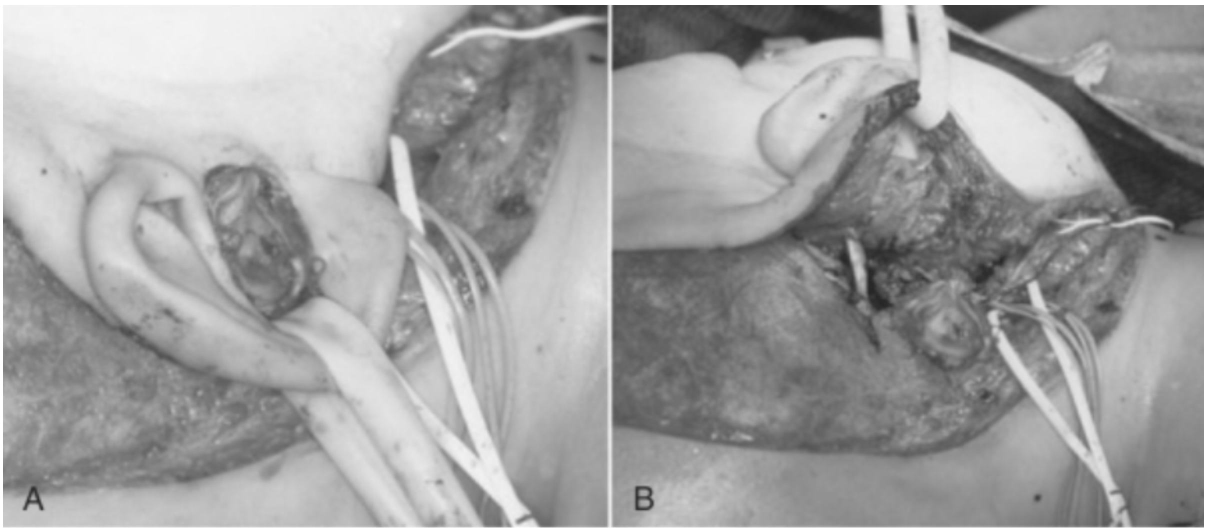


Figure 101-32 The conchal incision communicates with the postauricular incision **(A)**, and a Penrose drain is used to retract the auricle and facial flap anteriorly **(B)**.

The cervicofacial flap is elevated in a subplatysmal plane in the cervical area, lateral to the plane of the superficial aponeurotic system (SMAS) over the parotid area, and along the deep layer of the deep temporal fascia over the cranium. It is then reflected anteriorly (Fig. 101-33).

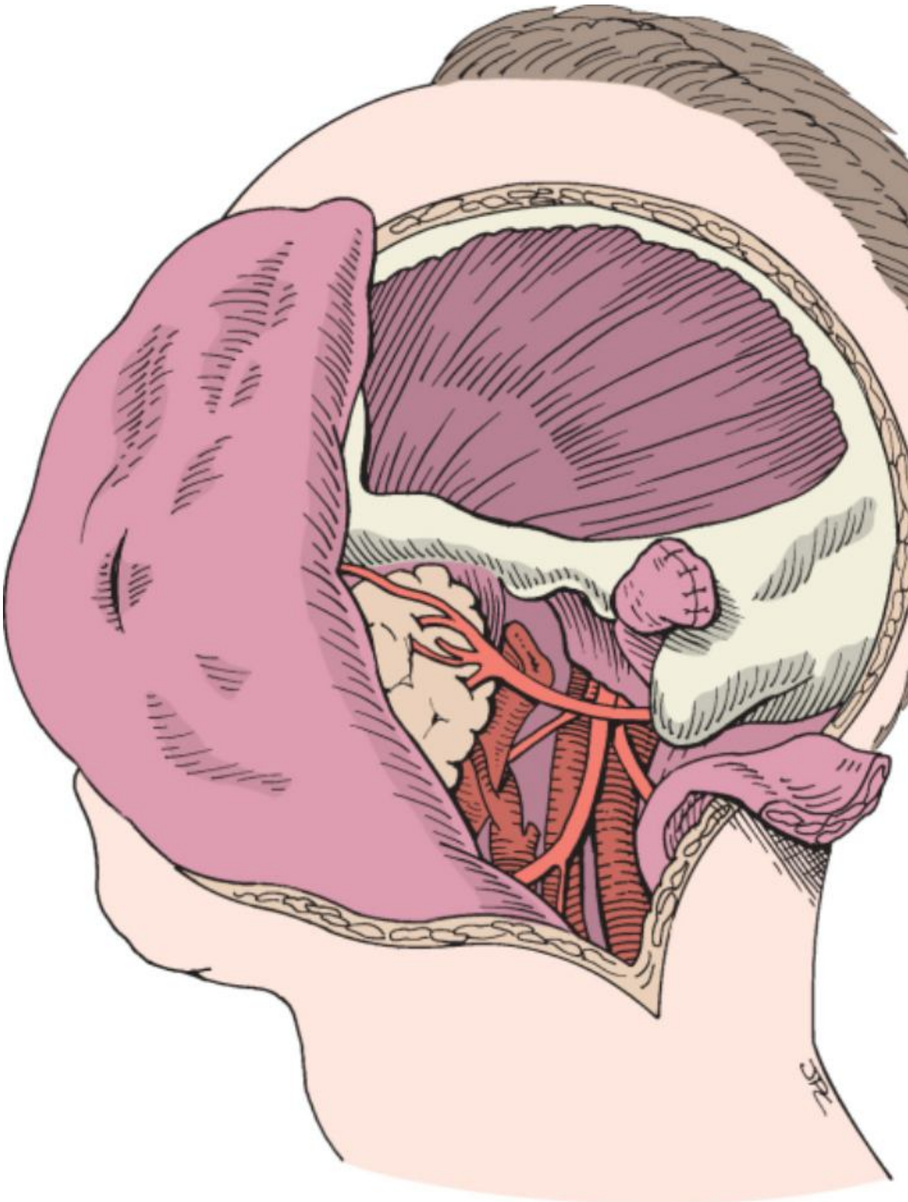


Figure 101-33 The facial flap is reflected anteriorly with exposure of the temporalis muscle, orbitozygomatic bone, masseteric fascia, mandible, parotid gland and facial nerve, and cervical vessels and nerves. The conchal tissues of the auricle are temporarily sewn together to maximize operative exposure.

Dissection continues anterior to the EAC to identify the main trunk of the facial nerve, as done during parotidectomy (see Chapter 62). If the facial nerve does not need to be mobilized, a cuff of soft tissue is left around the facial nerve to minimize direct traction on the nerve when the facial flap is retracted anteriorly. In select cases, an inferior superficial parotidectomy ("tail parotidectomy") may enhance exposure of the retromandibular area. Attention is then directed to the neck to identify and obtain proximal control of the common, internal, and external carotid arteries, as well as the internal jugular vein. Cranial nerves X through XII are identified and preserved. The sternocleidomastoid and digastric muscles are transected at their insertion into the mastoid bone. The stylohyoid and stylopharyngeus muscles are transected and the styloid process is removed. The ninth cranial nerve can usually be identified at this time as it crosses lateral to the ICA.

Mastoidectomy and dissection of the vertical portion of the facial nerve allow superior translocation of the nerve to provide wider access to the ITF (Fig. 101-34). It also permits access to the jugular bulb and lower cranial nerves. Completion of the infratemporal skull base approach, including a temporal craniotomy and orbitozygomatic osteotomy, is performed as described in the previous section. At this time, the anterior, superior, medial, and posterior boundaries of the ITF are well exposed, and all major vessels are “controlled” (Fig. 101-35). Extirpation of the tumor can now proceed, including the involved soft tissue and bone. Reconstruction of the defect is performed as discussed previously.

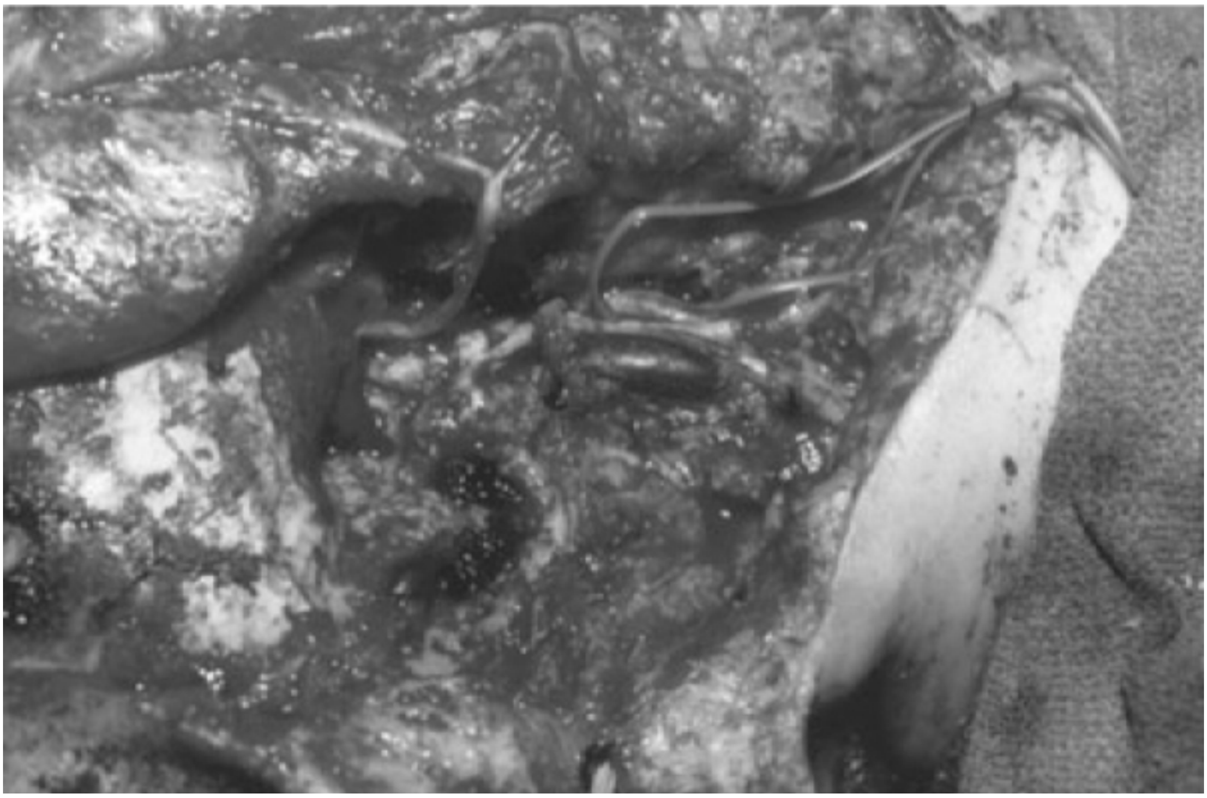


Figure 101-34 The facial nerve has been completely mobilized from the parotid gland to the second genu. Mastoidectomy and resection of the lateral temporal bone have been performed. A vessel loop is placed around the internal carotid artery. The patient is in the right lateral surgical position.

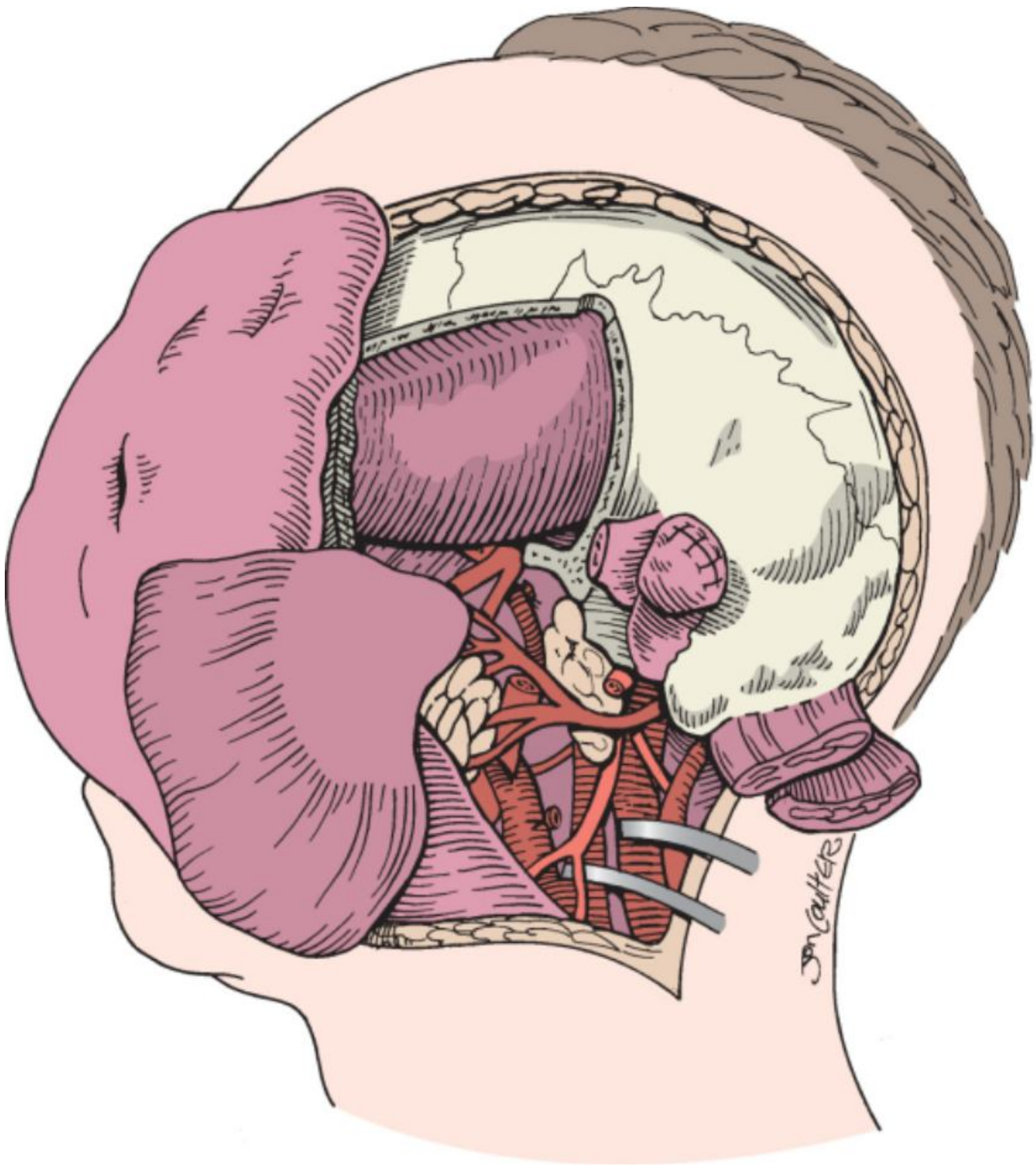


Figure 101-35 The extent of surgical exposure is demonstrated after temporal craniotomy and reflection of the temporalis muscle inferiorly.

Anterior Transfacial Approach (Facial Translocation)

This approach is best used for lesions invading the ITF, the masticator space, or the pterygomaxillary fossa and for tumors of the nasopharynx extending into the ITF[10,11] (Fig. 101-36) (see Chapter 105). A bicoronal incision with an ipsilateral preauricular extension is performed and extended through the subcutaneous tissue (see “Preauricular [Subtemporal] Approach” earlier in this chapter). A Weber-Fergusson incision is completed and extended down to the periosteum. A horizontal incision is carried over the superior edge of the zygomatic bone and extended into the lateral canthus to meet the Weber-Fergusson incision (Fig. 101-37). The frontal branches of the facial nerve are identified and dissected as they cross over the zygomatic arch. They are then entubulated with silicone tubing and transected. These nerve branches will be reanastomosed at the end of the procedure with an entubulation technique (Fig. 101-38). An inferiorly based flap that includes the upper third of the upper lip, the entire cheek, the lower eyelid, the parotid gland, and the facial nerve is reflected inferiorly. The infraorbital nerve is transected and tagged to facilitate reanastomosis at the end of the procedure. The frontotemporalscalp flap is elevated in a subpericranial plane. This flap is reflected anteriorly to expose the superior orbital rims (Fig. 101-39).

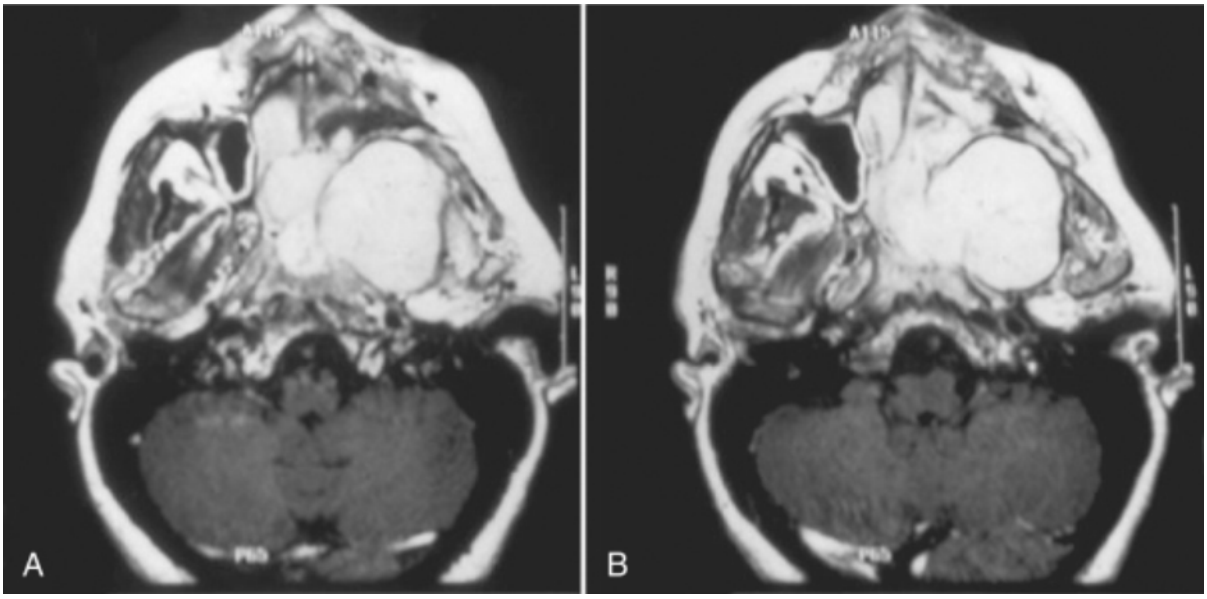


Figure 101-36 **A** and **B,** Computed tomography scans demonstrating a large ameloblastic fibrosarcoma of the left maxilla with extension into the infratemporal fossa. The anterior transfacial approach is ideally suited for excision of such lesions.

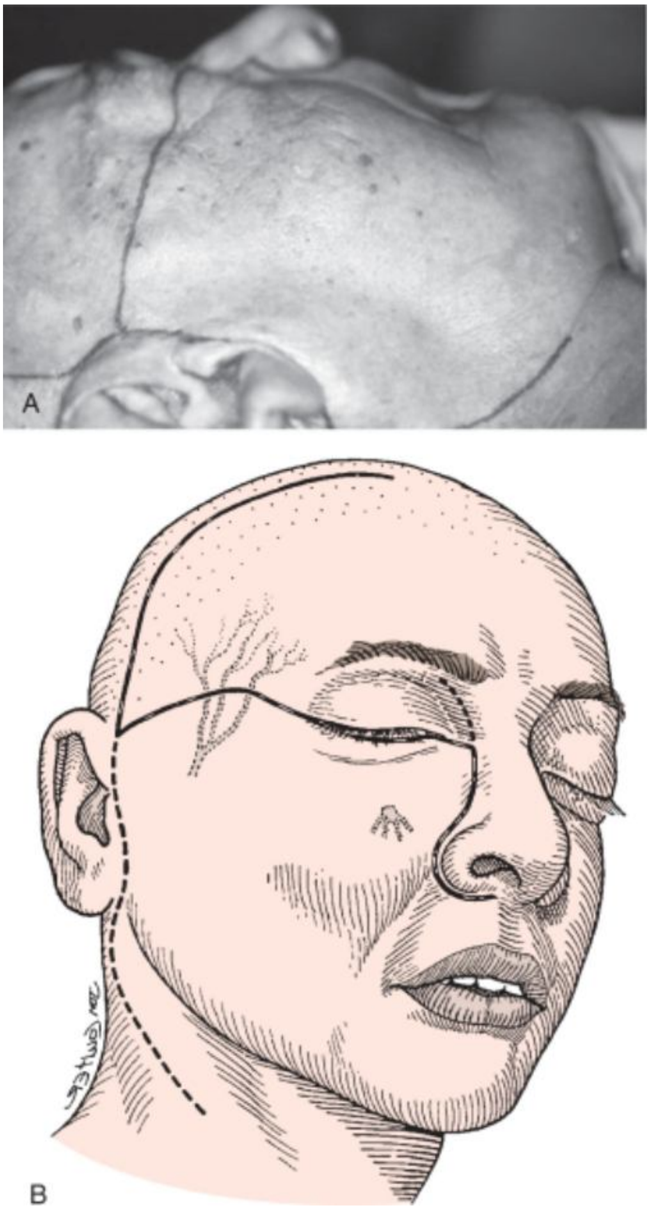


Figure 101-37 **A** and **B,** A hemicoronal incision is combined with an extended Weber-Fergusson incision in the anterior transfacial approach. The incision may be made through the conjunctiva or through the skin several millimeters inferior to the ciliary line.

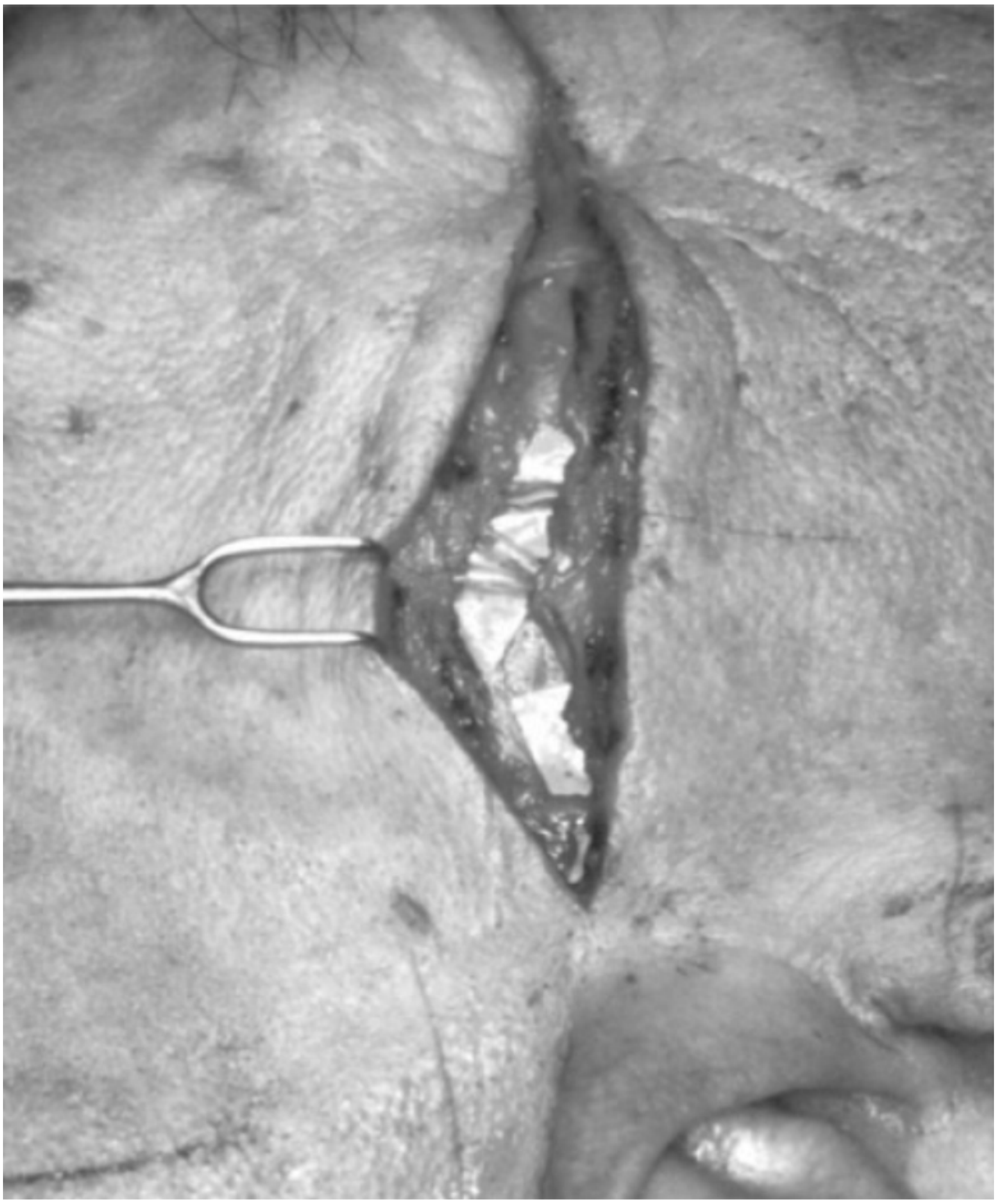


Figure 101-38 Multiple temporal branches of the facial nerve are identified and entubulated with silicone tubes before transection. This facilitates anastomosis of the nerves at the end of the procedure.

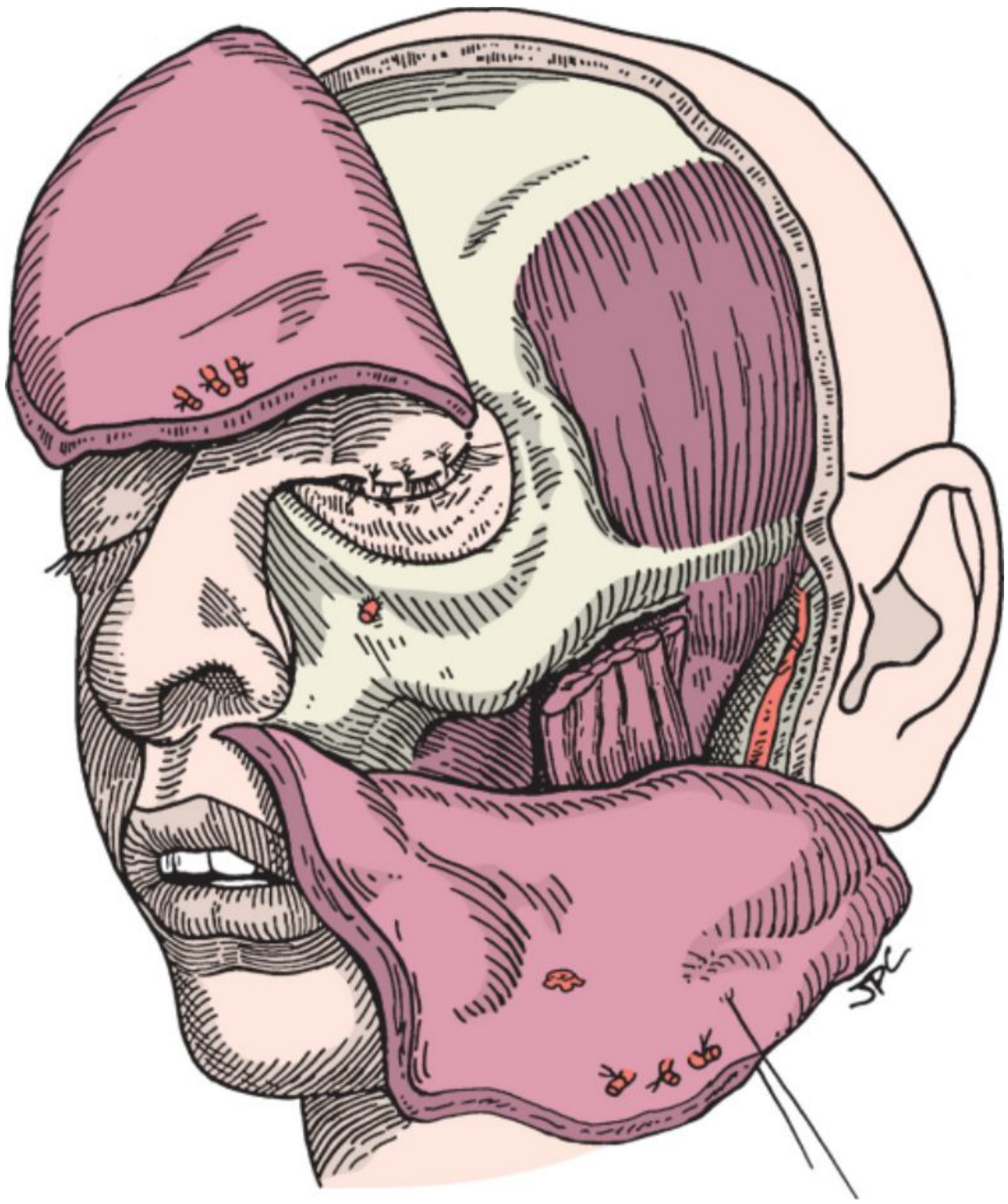
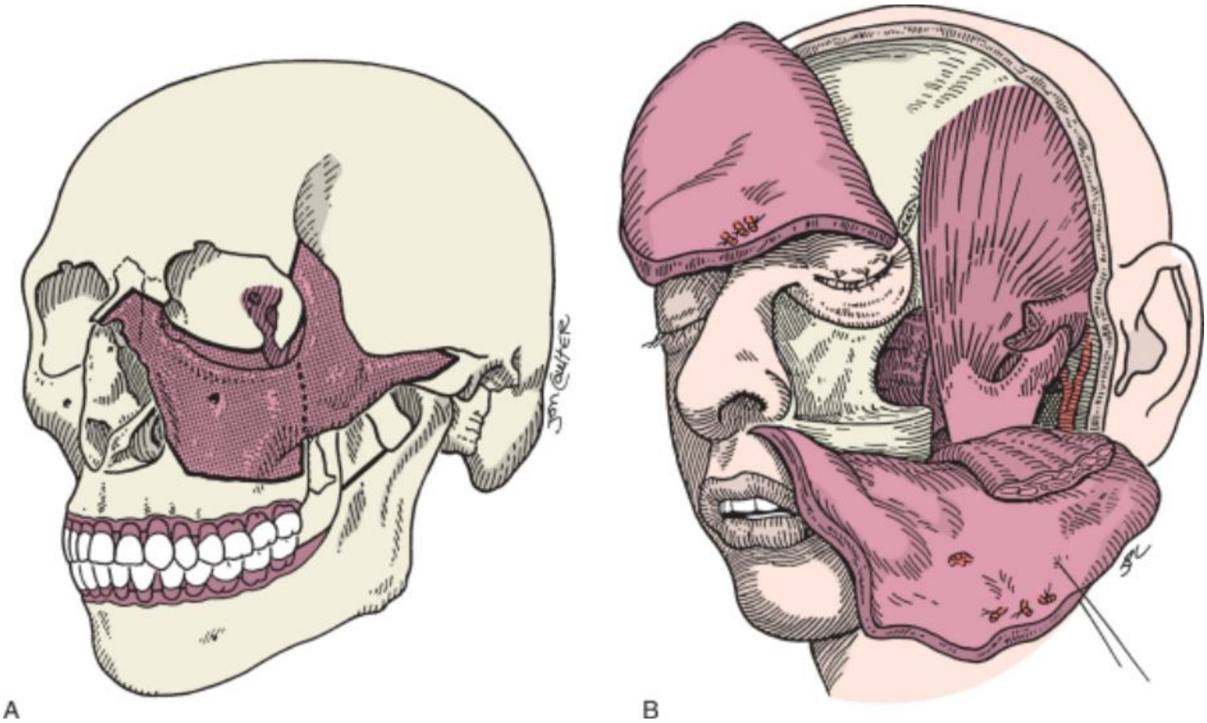


Figure 101-39 The scalp and facial flaps are elevated from the underlying bone and muscle fascia to expose the facial skeleton. The inferior orbital nerve is transected but tagged for later reconstruction.

Orbitozygomatic osteotomies are performed and joined with unilateral maxillary Le Fort II or Le Fort III osteotomies to free the anterior face of the maxilla en bloc with the orbitozygomatic complex. Alternatively, this bone graft can be elevated as a vascularized graft attached to the cheek flap, as described by Catalano and Biller.[8] The temporal and masseter muscles are dissected from the zygomatic bone with electrocautery. Osteotomies are completed, and the bone graft is removed (Fig. 101-40). The temporalis muscle is reflected inferiorly. An osteotomy or removal of the coronoid process increases the caudal arc of rotation of the temporalis muscle. At this time, the anterior, medial, and lateral boundaries of the ITF are well exposed (Fig. 101-41). In select cases, the pterygoid plates can be excised to provide further access to the medial ITF or nasopharynx. A temporal-subtemporal craniotomy provides additional exposure superiorly and allows dissection of intracranial structures (Fig. 101-42). After tumor resection, the temporalis muscle may be transposed to obliterate the surgical defect and provide separation of the cranial cavity from the upper aerodigestive tract (Fig. 101-43).



A B

Figure 101-40 **A,** Segments of the facial skeleton that are removed en bloc with the anterior transfacial approach. **B,** Exposure provided by this approach.

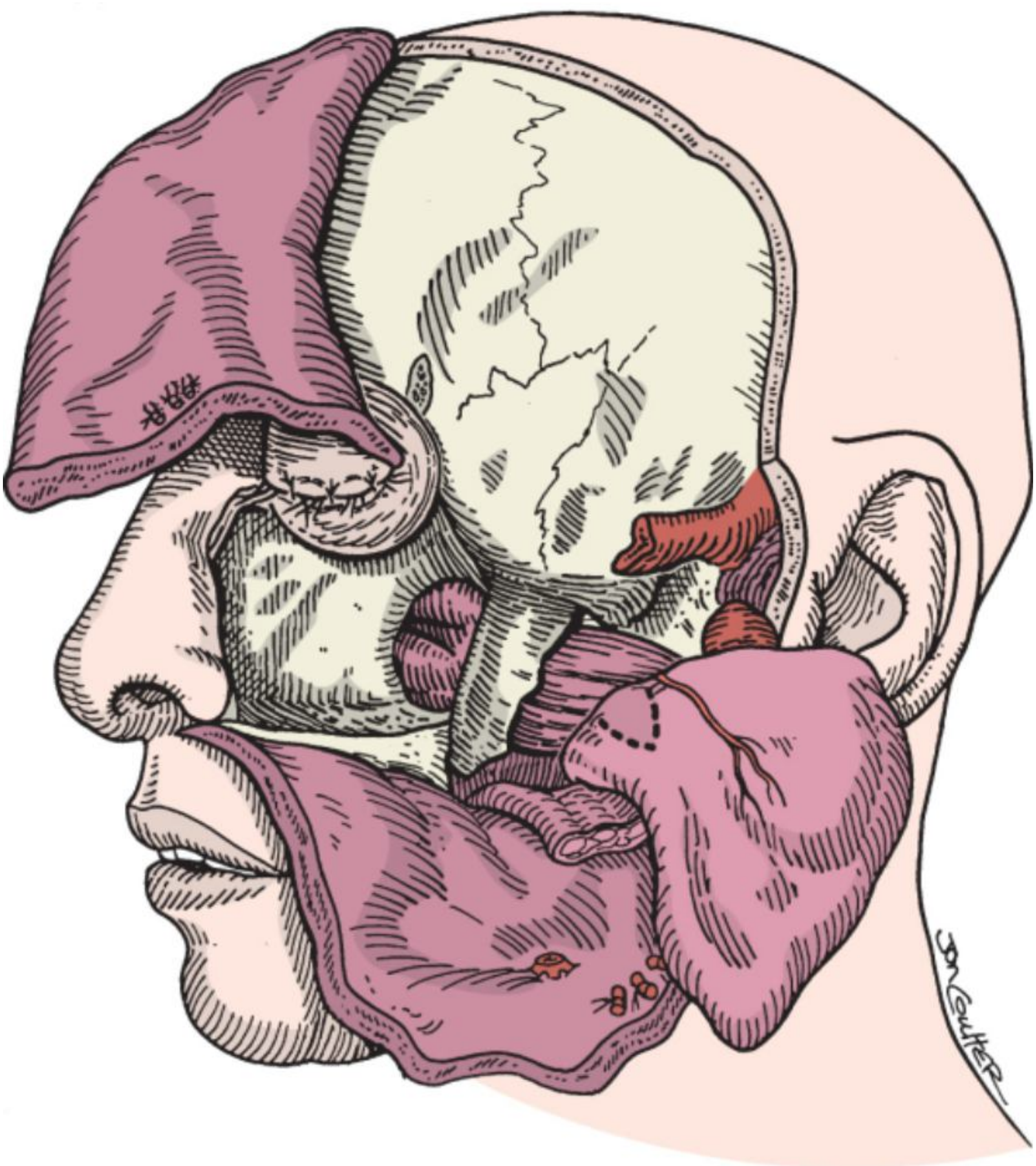


Figure 101-41 After transection of the coronoid process of the mandible and reflection of the temporalis muscle inferiorly, the infratemporal skull base, maxilla, and nasopharynx are well exposed.

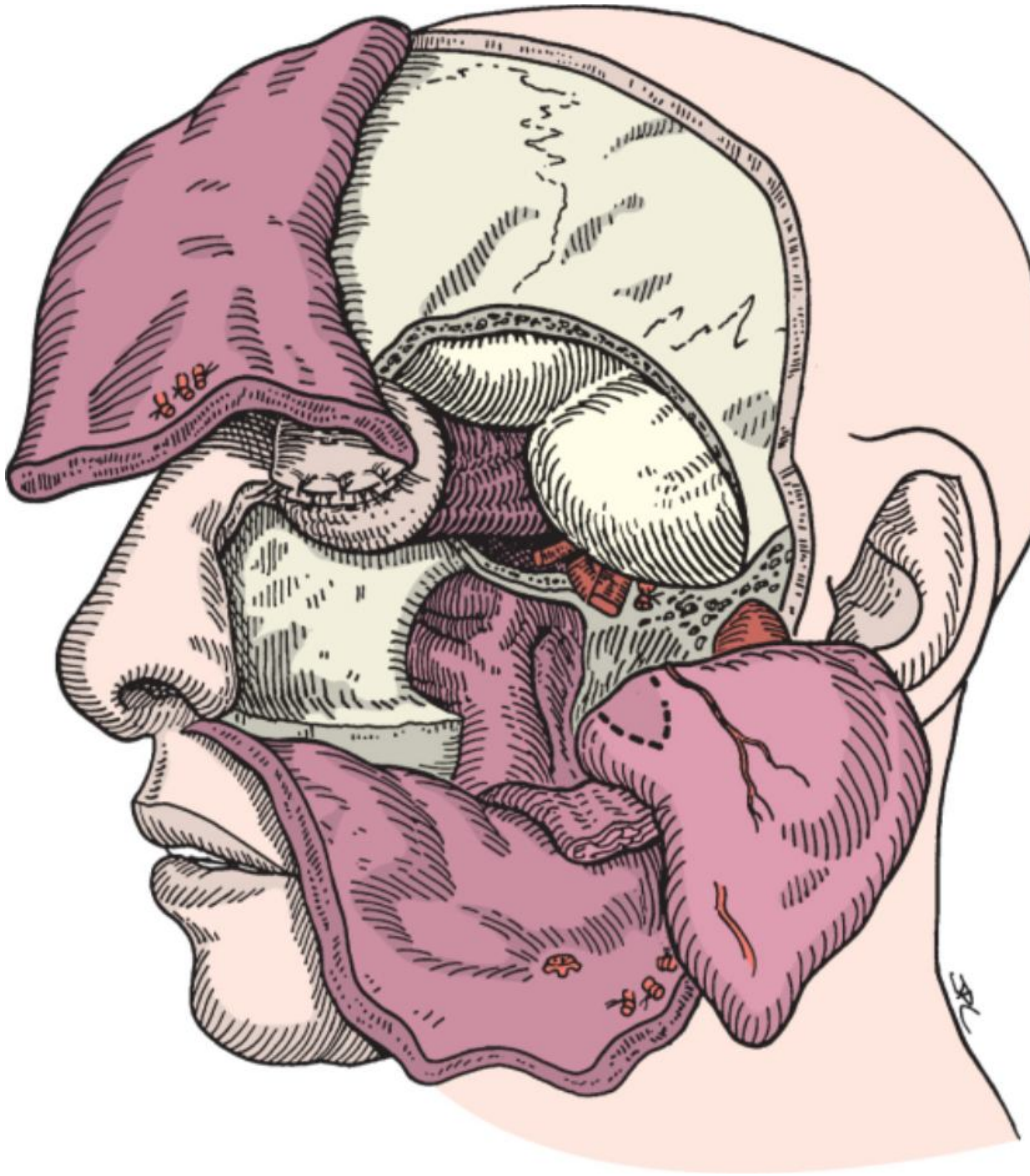


Figure 101-42 A subtemporal craniectomy is performed to provide additional exposure and an adequate resection margin of extracranial tumors. Maximal exposure of the infratemporal and central skull base is achieved.

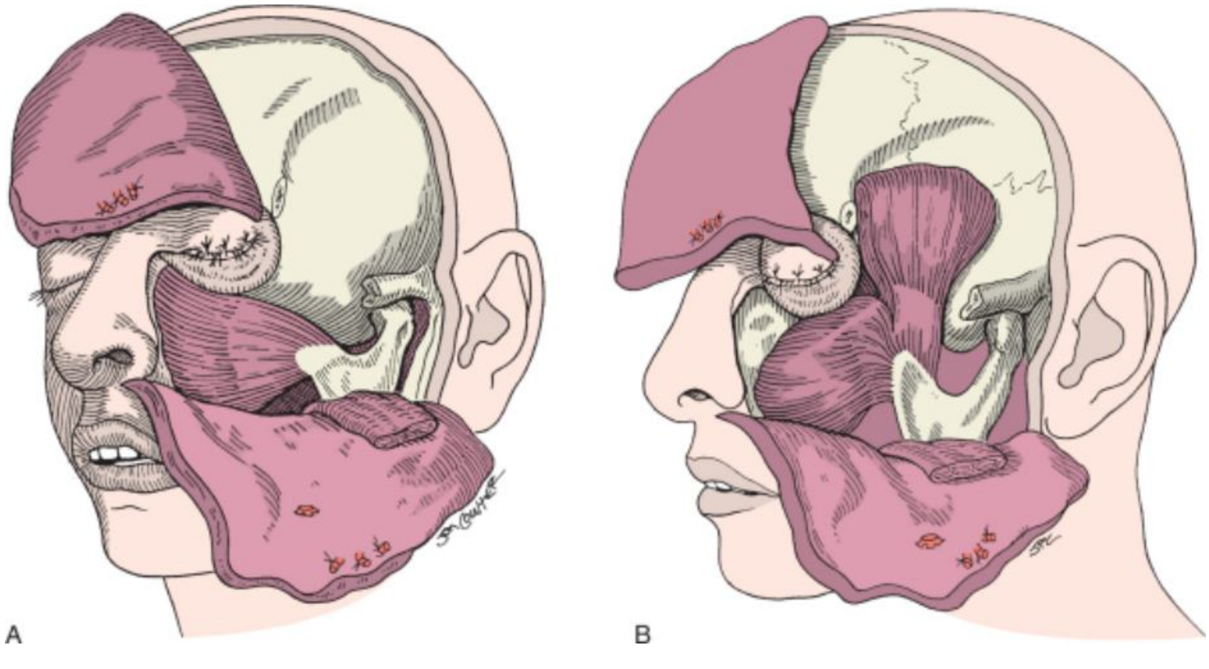


Figure 101-43 The entire temporalis muscle **(A)** or the anterior one half of the muscle **(B)** may be transposed to obliterate the surgical defect and provide separation of the cranial cavity from the upper aerodigestive tract. If the temporalis muscle is not available because of loss of its blood supply, microvascular free flap reconstruction is indicated.

The incisions are closed in a multilayer technique. The conjunctiva is repaired with running 6-0 mild chromic suture. The lacrimal canaliculi are stented with Crawford silicone tubing secured in the nasal cavity. The eye is closed with a temporary tarsorrhaphy for 10 to 14 days to prevent lower lid ectropion.

Transorbital Approach

In select cases, a transorbital approach may be used for optimal exposure of the orbital apex and cavernous sinus. This approach consists of transection of the orbital tissues posterior to the globe with preservation of the attachments of the superficial orbital structures, including the globe, to the scalp flap.

The tissues of the orbital apex and surrounding bone are then removed to provide direct anterior access to the cavernous sinus and cavernous ICA. This approach is reserved for patients with benign tumors of the orbital apex and cavernous sinus who have already lost vision as a result of tumor growth (Fig. 101-44). It may also be used for limited malignant neoplasms with minimal involvement of the orbital tissues. More extensive involvement of the orbital tissues requires orbital exenteration. The advantages of this approach are an improved cosmetic result with preservation of the globe and excellent anterior and lateral exposure of the cavernous sinus and its associated structures.

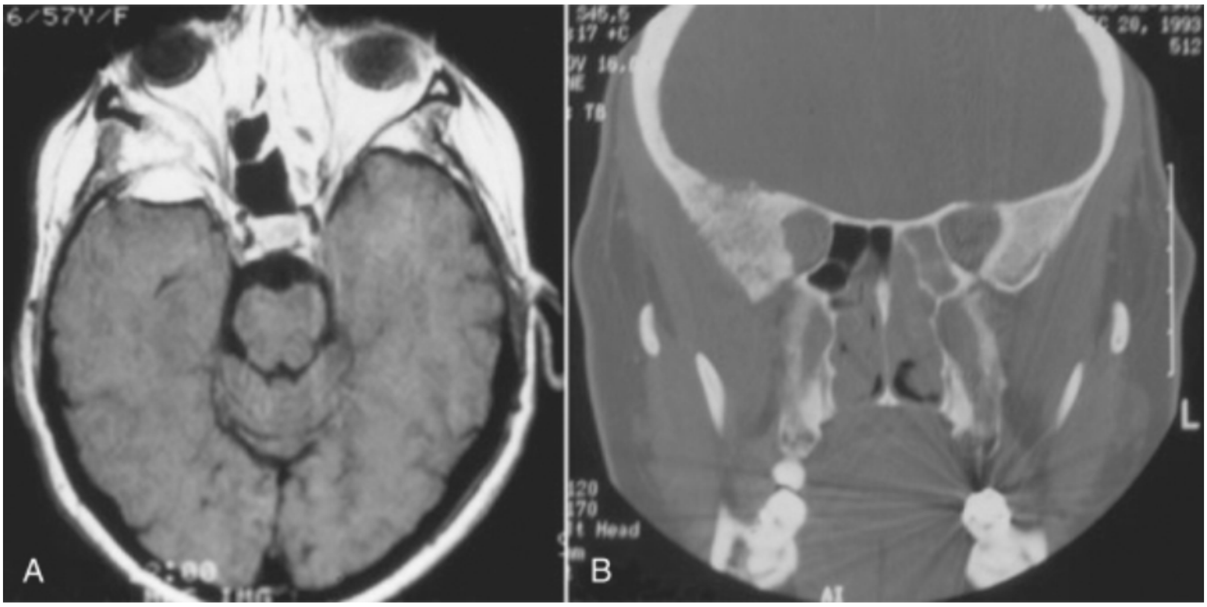


Figure 101-44 Magnetic resonance image **(A)** and computed tomography scan **(B)** demonstrating a meningioma involving the lateral wall of the orbit with extension to the orbital apex and middle cranial fossa. If the patient has permanent visual loss as a result of such a tumor, a transorbital approach may be used.

A preauricular infratemporal skull base approach is used. After elevation of the scalp flap (Fig. 101-45), an orbitozygomatic osteotomy is performed (Fig. 101-46). The periorbita is elevated from the superior, lateral, and inferior walls of the orbit. The periorbita is then incised, and orbital tissues are transected posterior to the globe with bipolar electrocautery and sharp dissection. A cuff of tissue remains at the orbital apex to provide an adequate tumor margin. The remaining periorbital attachments are then elevated medially to allow complete displacement of the globe from theorbital cavity (Fig. 101-47). Using rongeurs, bone is removed from the lateral wall of the orbit to the superior orbital fissure. The contents of the superior orbital fissure and the optic canal are then transected to provide additional exposure of the orbital apex (Fig. 101-48). Further removal of bone and dissection of intracranial structures are performed in conjunction with the neurosurgeon.

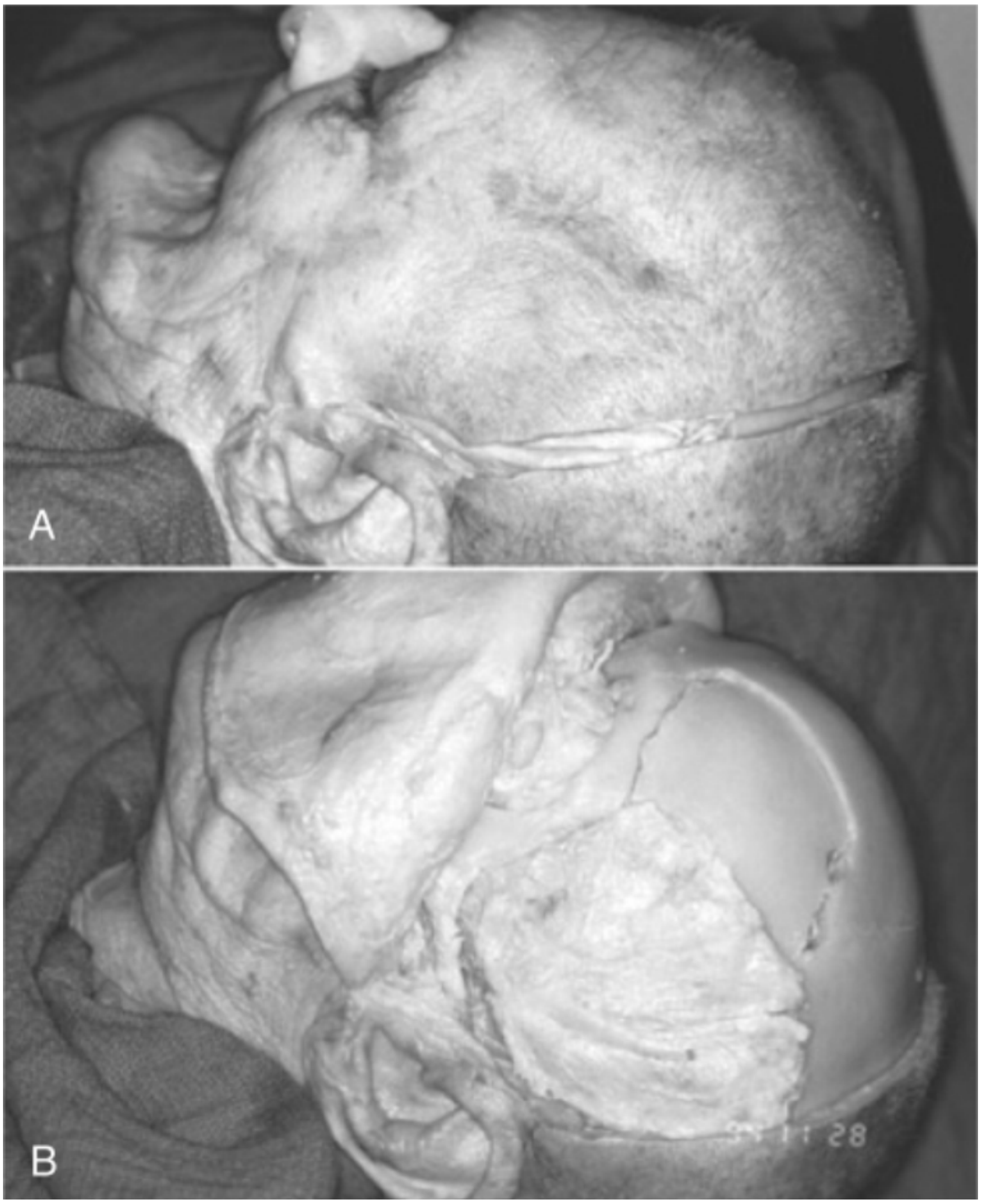


Figure 101-45 A cadaver dissection is used to demonstrate the transorbital approach. **A,** A hemicoronal scalp incision with extension to the preauricular area is made. **B,** The scalp flap is elevated deep to the pericranium and superficial to the deep temporalis fascia. The periorbita is elevated from the superior and lateral orbital walls, and the temporalis muscle is elevated.

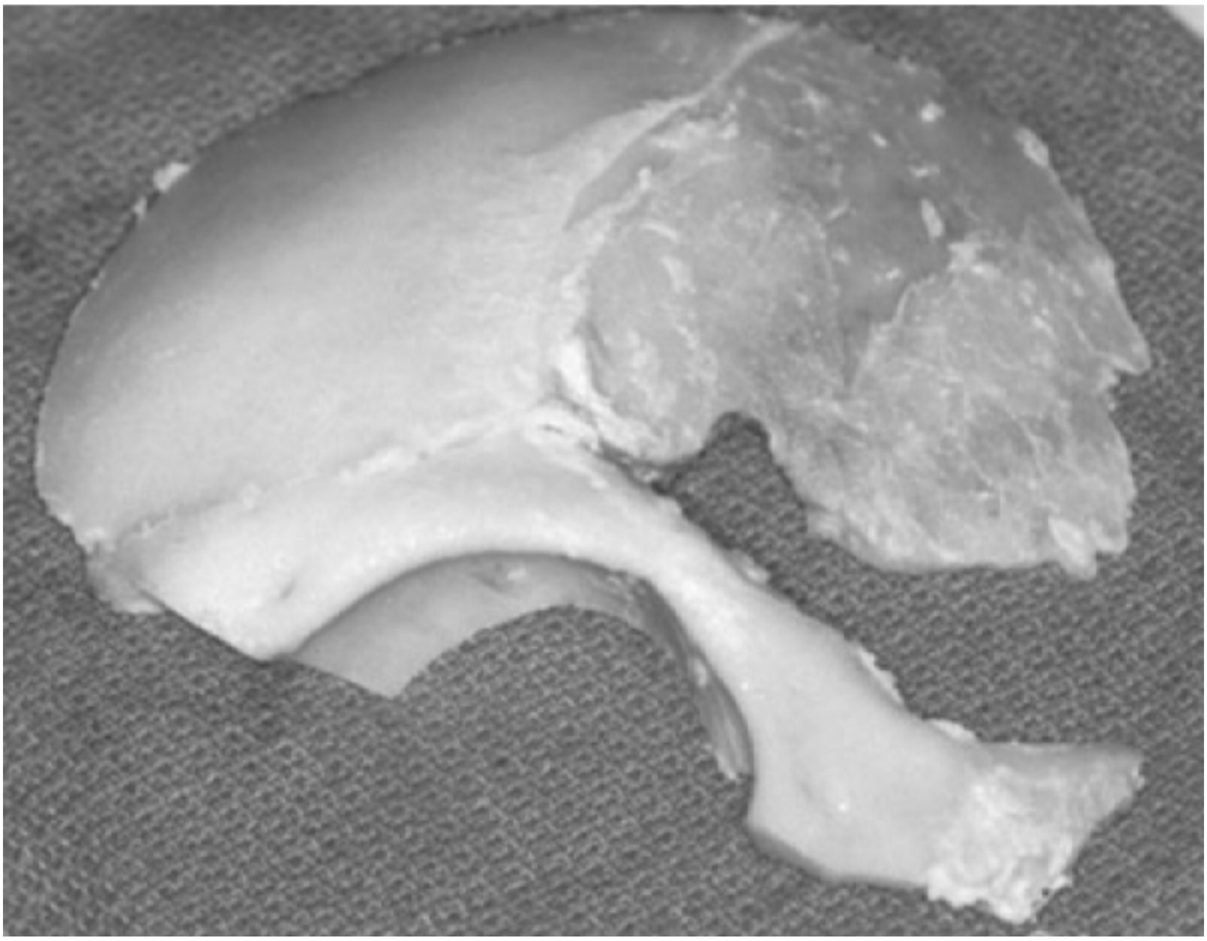


Figure 101-46 A frontotemporal craniotomy and orbitozygomatic osteotomy are performed to provide direct lateral access to the orbital tissues and cavernous sinus region.

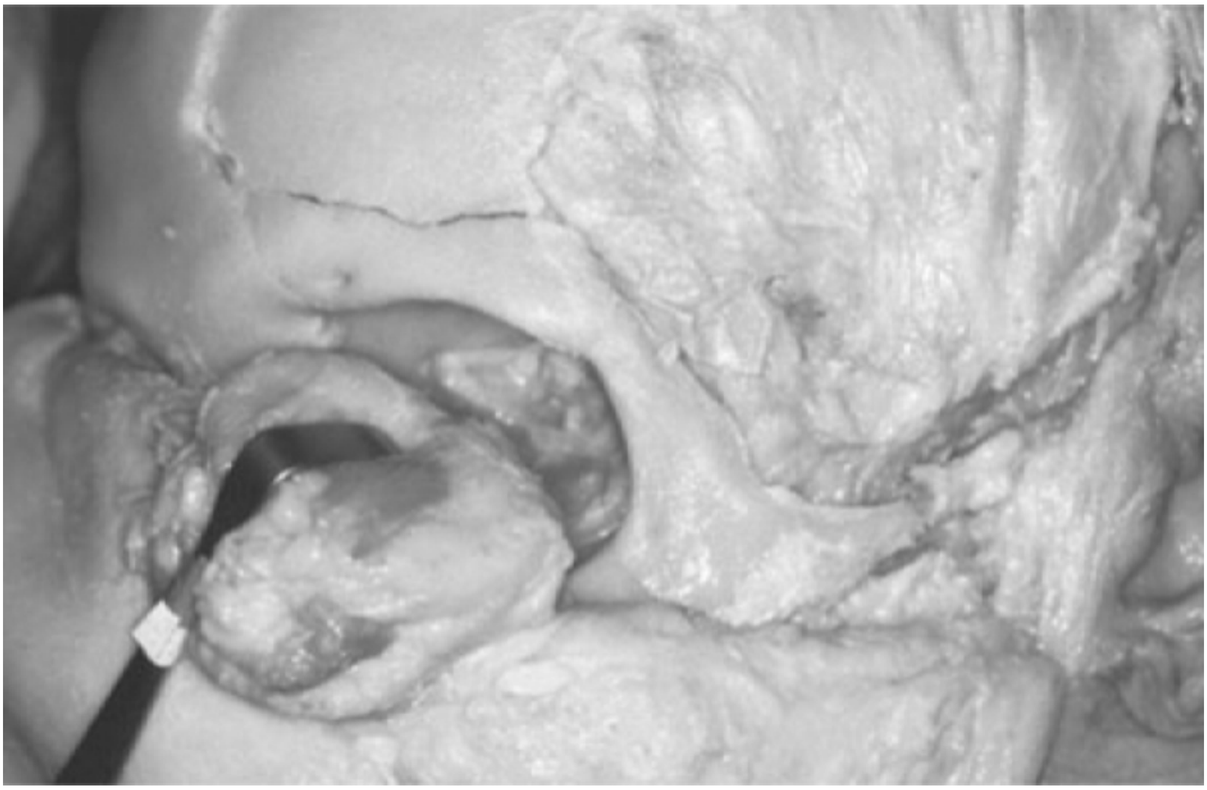


Figure 101-47 The orbital tissues are transected posterior to the globe.

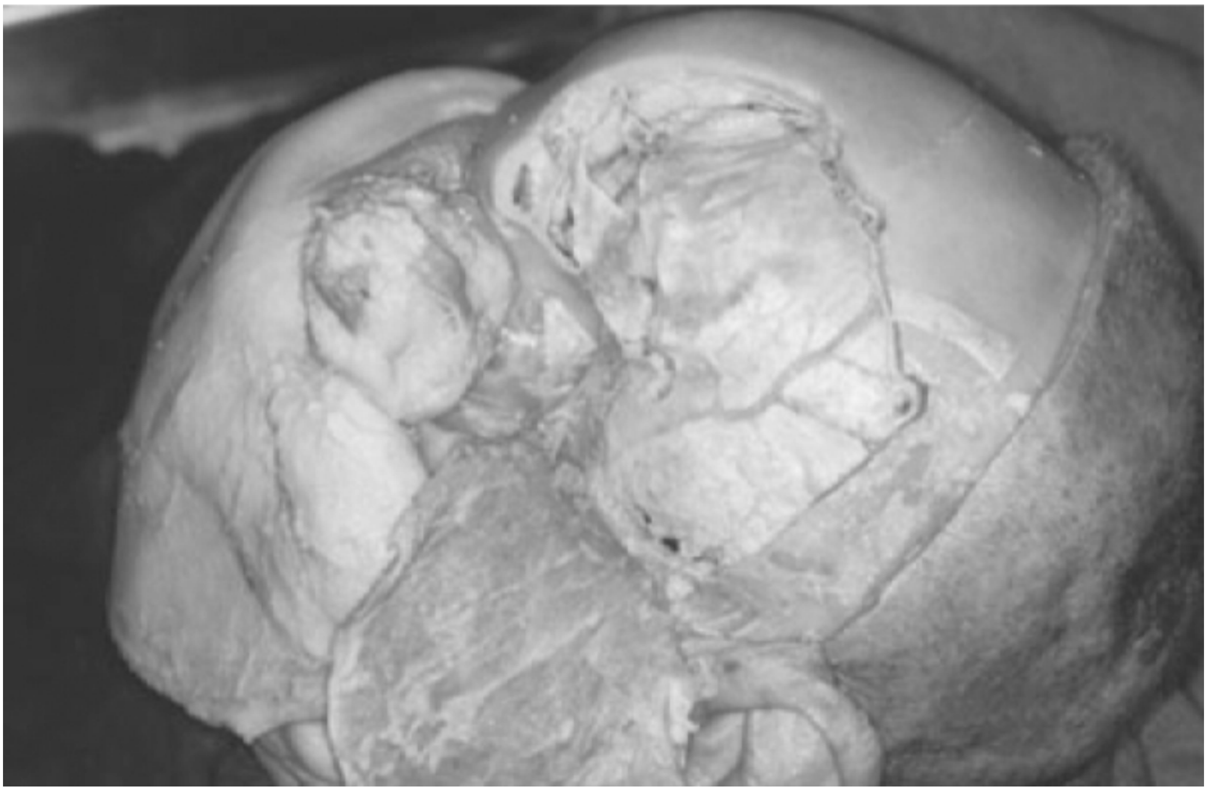


Figure 101-48 Additional bone is removed from the orbit and infratemporal skull base to provide exposure of the contents of the superior orbital fissure and cavernous sinus region.

Because of loss of orbital support, enophthalmos results unless the orbital defect is reconstructed with bone grafts or soft tissue is interposed. A temporalis transposition or free tissue transfer provides excellent soft tissue augmentation and protection of the carotid artery.

Endoscopic Approaches

Select benign tumors originating at the ITF and select benign and malignant tumors of the sinonasal tract extending to the ITF are amenable to resection by endoscopic transnasal or transantral techniques (or both).[14–17]

The patient's head is usually fixed in a three-pin fixation system to facilitate navigation with a line-of-sight optical system. The nose is decongested with 0.05% oxymetazoline. Both sides of the nose are used for the surgical corridor, which is augmented by resection of the posterior septum. Because a bimanual technique is necessary for surgical dissection in this area, a two-surgeon, four-hands technique is recommended. Access to the ITF is gained by removing the medial and posterolateral walls of the antrum. Depending on the need for further exposure, the pterygoid plates, the torus tubarius, and the medial eustachian tube may be removed. To increase lateral exposure, the piriform aperture may also be removed to increase the angle of exposure. The basic steps include removal of the middle turbinate ipsilateral to the lesion; posterior septectomy; creation of a wide middle nasoantral window (may be extended inferiorly by removing the posterior one half of the inferior turbinate); removal of the posterior and lateral walls of the antrum; control of the neurovascular structures of the pterygopalatine fossa by ligation of the sphenopalatine and posterior nasal arteries; and, if necessary, removal of the pterygoid plates, the torus tubarius, and the middle one third of the eustachian tube.

POSTOPERATIVE MANAGEMENT

The patient is transferred to an intensive care unit for continuous cardiovascular and neurologic monitoring. Laboratory tests are ordered to rule out postoperative anemia and electrolyte abnormalities. Patients requiring multiple blood transfusions should be screened for transfusion-induced coagulation disorders. Mild narcotic analgesia is provided, but strong narcotic or sedative medications are avoided to prevent interference with accurate neurologic assessment.

If surgical manipulation, ligation, or grafting of the ICA has been performed, close monitoring of the patient's hemodynamic status is essential. Blood transfusions are considered when the hematocrit is less than 27% or the patient shows heart or brain disfunction. Fluid balance is carefully monitored to prevent hypotension. Strict bed rest is maintained for several days until the patient is hemodynamically stable to prevent hypotension. A CT scan of the head without contrast enhancement is performed on the first or second postoperative day to screen for intracranial complications, such as cerebral contusions, significant edema, hemorrhage, fluid collections, or pneumocephalus. When grafting of the ICA is performed or after surgical injury, an angiogram is obtained in the early postoperative period to assess the patency of the graft and detect pseudoaneurysm formation.

A compressive dressing is maintained for 24 to 72 hours. Once the dressing is removed, the wound is cleaned with normal saline solution and covered with antibiotic ointment three to four times a day. The scalp and other wound drains are kept on suction (80 mm Hg) until the amount of drainage is less than 20 mL/day. If the cranial cavity is entered, suction drainage is not used because of the risk of direct negative pressure on the central nervous system, and the drains are left to gravity drainage.

In most cases, the spinal drain is needed only during surgery and is removed on completion of the procedure. If there is a significant risk of postoperative CSF leak, the spinal drain is kept at the level of the patient's shoulder and 50 mL are removed every 8 to 12 hours. The spinal drain is removed 3 to 5 days after surgery. The lumbar puncture site is closed with an encircling stitch (e.g., 2-0 nylon) placed at the time of surgery.

Inadequate closure of the eye because of weakness or paralysis of the facial nerve may lead to exposure keratoconjunctivitis. Initially, an exposed eye can be protected with artificial tears every 1 to 2 hours, lubrication ointment at bedtime, eye patching, or a moisture chamber. Taping or a temporary tarsorrhaphy is advised if rapid recovery is anticipated. If prolonged paralysis is expected, the authors prefer a gold weight implant. Implantation of a 0.1- to 0.12-g weight (no. 10 or 12) can be performed at the time of the original surgery, or it may be performed days later. Except in select cases, the authors favor the latter because it provides the advantage of being able to insert the exact weight needed by the patient.

In the vast majority of cases, the airway can be secured with a short-term endotracheal tube (high-volume/low-pressure cuff). Nevertheless, for patients in whom significant edema of the upper aerodigestive tract or prolonged intubation is anticipated, the authors recommend a tracheotomy. In patients with an ineffective cough or severe aspiration, tracheotomy also provides better access to the airway for pulmonary toilet.

Patients with high vagal lesions or any combination of deficits of cranial nerves IX, X, or XII will suffer severe swallowing difficulty and aspiration. These patients can be assisted with a thyroplasty type I/arytenoid adduction procedure with or without cricopharyngeal myotomy. Patients who continue to aspirate are managed with a laryngotracheal separation procedure (see Chapter 69).

COMPLICATIONS

Most of the morbidity associated with conventional cranial base surgery for neoplasms involving the ITF is related to deficits of the trigeminal nerve. Sacrifice of the third and sometimes the second division of the trigeminal nerve may be necessary for surgical exposure or adequate tumor margins. Facial anesthesia may predispose the patient to self-inflicted injuries. On rare occasions, neurotrophic ulcers may develop as a result of repeated self-inflicted trauma. Loss of corneal sensation, especially in someone with paresis of the facial nerve, greatly increases the risk of corneal abrasion or exposure keratitis. Loss of motor function of the mandibular nerve causes asymmetry of the jaw opening and decreased force of mastication on that side (Fig. 101-49). Mastication may be further impaired by resection of the TMJ or mandibular ramus. Whenever feasible, the sensory and motor divisions of the trigeminal nerve are repaired after transection for surgical exposure.

Figure 101-49 Mild malocclusion is noted in this patient after an infratemporal skull base approach. A posterior open bite and deviation of the mandible to the right side are noted.

Accidental injury to the facial nerve with subsequent permanent paralysis is uncommon, although possible with the approaches described here. The temporal branches of the facial nerve are at risk for injury with elevation of the scalp flap. Injury is usually a result of dissection in a plane superficial to the superficial layer of the deep temporal fascia. The main trunk of the facial nerve is susceptible to traction injury with retraction of the facial flap anteriorly. For this reason, a pedicle of soft tissue is preserved around the facial nerve when a preauricular approach is used. Temporary paresis of the facial nerve is to be expected with mobilization of the mastoid segment of the facial nerve. Close attention to postoperative eye care must be observed in patients with combined deficits of the trigeminal and facial nerves.

Postoperative trismus is a common occurrence because of postoperative pain and scarring of the pterygoid musculature and TMJ (see Fig. 101-24C). Less trismus is noted six months postoperatively if patients regularly perform stretching exercises by opening the jaw. Devices such as the Therabite appliance are helpful in stretching the scar tissue and forcefully opening the mouth. In severe cases, a dental appliance that is gradually opened with a screw may be fabricated. Surgical resection of the TMJ does not appear to be a major factor in the development of postoperative trismus or difficulties with mastication. Rather, mastication appears to be most affected by loss of function of the mandibular division of the trigeminal nerve. Nevertheless, every attempt is made to preserve the TMJ. If resection of the glenoid fossa is necessary, the capsule of the TMJ is displaced inferiorly. If resection of the TMJ is necessary, no attempt is made to reconstruct the joint.

Infectious complications are rare. Predisposing factors include communication with the nasopharynx, seroma or hematoma, and a CSF leak. In general, all dead spaces should be obliterated to prevent collection of fluid. The use of vascularized tissue flaps is preferred, especially when dissection of the ICA or resection of dura has been carried out.

Necrosis of scalp flaps is an uncommon occurrence because of the excellent blood supply of the scalp. Poorly designed incisions, however, may result in areas of hypovascularity, particularly around the auricle (Fig. 101-50).

Figure 101-50 This patient had previously undergone surgery that used a question mark–shaped left temporal incision. **A,** There is an additional scar anterior to the auricle. These incisions are cosmetically unfavorable, may violate the underlying temporalis muscle, and greatly increase the risk of injury to the temporal branches of the facial nerve. **B,** It was necessary to use segments of the original scars on reoperation to prevent further compromise of the vascularity of the scalp and auricle.

Vascular complications are a great concern with surgery in this area. Surgical dissection of the ICA can result in injury to the wall with either immediate or delayed hemorrhage. The artery is particularly vulnerable to injury at the point where it enters the cranial base. Injuries to the ICA should be repaired primarily. An angiogram is obtained in the early postoperative period to assess adequacy of the repair and to detect early pseudoaneurysm formation. In the event that repair of the artery is not possible, permanent occlusion of the artery by ligation or placement of a detachable latex balloon or vascular coil may be performed. There is a significant risk of immediate and delayed stroke, however, in patients who do not have greater than 35 to 40 mL of blood flow/min/100 g brain tissue by ABOX-CT testing.

Postoperative cerebral ischemia may result from surgical occlusion of the ICA, temporary vasospasm, and thromboembolic phenomena. When the artery is permanently occluded, the occlusion is performed as distal as possible near the origin of the ophthalmic artery. It is believed that there is less potential for thrombus formation with a short column of stagnant blood above the level of occlusion. After reconstruction of the ICA with a vein graft, there is a risk of postoperative occlusion secondary to thrombus formation at the suture line, as well as torsion or kinking of the graft. Pseudoaneurysm formation and delayed blowout of the graft are also risks, especially in the presence of infection. For this reason, reconstruction of the ICA is not usually performed in a contaminated field in which there is communication with the upper aerodigestive tract. In such cases, permanent occlusion of the ICA or rerouting of a vein graft posterior to the surgical field is performed. An extracranial-intracranial bypass graft to the middle cerebral artery may be performed before tumor resection when sacrifice of the ICA is anticipated. Patients who undergo surgical manipulation of the ICA are also susceptible to cerebral ischemia in watershed areas, at the margins of the vascular territories of the cerebral vessels. This is of particular concern when extracranial-intracranial collateral blood vessels, which are not routinely assessed by ABOX-CT, have been sacrificed as part of the surgical approach. Decreased oxygen delivery because of postoperative anemia or hypotension can result in cerebral infarction in these watershed areas.

Watertight dural closure may be difficult to achieve with large infratemporal skull base defects, particularly around nerves and vessels. An epidural fluid collection may result. In most cases, it is contained by the soft tissues and slowly resolves without further intervention. Occasionally, the CSF collection may communicate with the outside through the EAC or along the eustachian tube to the nasopharynx. Most CSF leaks can be managed nonsurgically by placement of a spinal drain to lower CSF pressure and an external pressure dressing. If the CSF leak does not resolve within 1 week, surgical exploration and repair of the dural defect may be necessary. A middle ear effusion is often apparent after infratemporal skull base approaches as a result of dysfunction or interruption of the eustachian tube. Tympanostomy tubes are not placed for at least 6 weeks postoperatively because there is always a risk of CSF communication. The authors have encountered a few patients with profuse unilateral rhinorrhea in the post operative period that was misinterpreted as a CSF leak. These cases were all associated with surgical manipulation of the ICA and were probably due to loss of sympathetic fibers to the nasal mucosa that travel along the ICA. This represents a form of iatrogenic vasomotor rhinitis and may be treated similarly with the use of anticholinergic nasal sprays. Testing of the fluid for β_2-transferrin may be necessary to rule out a CSF leak.

Cosmetic deformities may result from the loss of soft tissue and bone (Fig. 101-51). Transposition of the temporalis muscle results in a depression in the temporal area (Fig. 101-52). It can be lessened by placement of a free fat graft at the time of surgery or at a later date. If the temporalis muscle is not transposed, the anterior margin of the muscle should be resutured anteriorly to prevent a slight depression lateral to the orbital rim. The use of free muscle flaps for reconstruction may necessitate sacrifice of the zygomatic arch. With atrophy of the muscle, a significant depression may occur. Large lateral muscle flaps, such as a latissimus dorsi flap, may also compress the brain if the underlying cranium is not reconstructed.

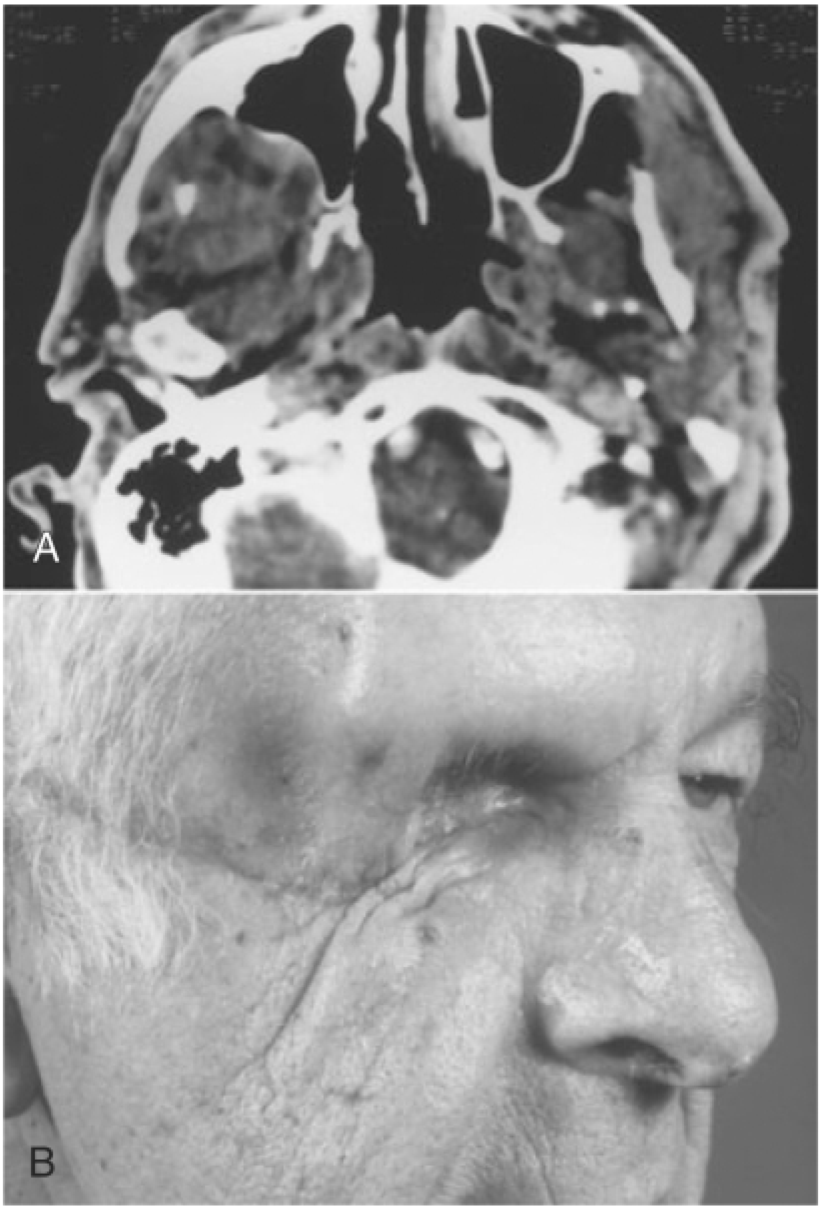


Figure 101-51 **A,** Computed tomography scan demonstrating hemangiopericytoma of the right temporal area with involvement of the temporalis muscle, orbitozygomatic bone, and orbit. **B,** Resection of the temporalis muscle, lateral orbital wall, zygomatic bone, and orbit was necessary to achieve clear tumor resection margins but resulted in a significant cosmetic deformity.

Figure 101-52 This 8-year-old boy underwent a left infratemporal skull base approach for excision of a large angiofibroma that involved the infratemporal skull base. The infratemporal skull base was reconstructed via temporalis muscle transposition, and a significant depression was left in the temporal area. This depression was later reconstructed with a custom-made alloplastic implant.

PEARLS

- Establishment of the origin and extension of tumors involving the ITF is critical to provide optimal surgical management.
- Subtle lower cranial nerve symptoms are often the first sign of ITF/skull base pathology.
- Postoperative stretching and physical therapy will facilitate improved TMJ range of motion and reduce the extent of trismus at 6 months.
- Because of wide variability in histopathology of the ITF, preoperative pathologic confirmation is necessary before proceeding to major ablative surgery.
- Large soft tissue and bone defects are best reconstructed with composite free tissue transfer.
- Partial resuspension of the temporalis muscle to the lateral orbital rim will minimize cosmetic deformity postoperatively.

PITFALLS

- Despite preoperative carotid balloon test occlusion with CT xenon flow testing, some patients will still suffer ischemic brain injury because of loss of collateral vessels and nonphysiologic conditions during testing.
- Dissection superficial to the superficial layer of the deep temporal fascia will put the frontal branch of the facial nerve at risk.
- After resection of the condyle, reconstruction of the TMJ may lead to more scarring and trismus than would occur with no reconstruction.
- Large composite defects of bone and soft tissue are best reconstructed with a free tissue transfer that includes bone to minimize postoperative cosmetic morbidity.
- Unilateral rhinorrhea may be misinterpreted as a CSF leak when in fact it is related to manipulation of the sympathetic supply to the nose during carotid artery dissection.
- Patients with lower cranial nerve deficits will have significant impairment of speech and swallowing function that will necessitate aggressive rehabilitation, if not surgical correction and augmentation.