sphere. Absence of the normal cerebrospinal fluid shadow between the dura and brain is highly suggestive of tumor invasion of dura. The absence of this shadow combined with an alteration in the normal configuration of the brain at that site, especially when accompanied by a halo of radioluency indicating edema at the periphery, is an almost certain sign of brain invasion (Fig. 5.21). Enlargement of a cranial nerve branch or increased enhancement on MRI suggests perineural spread of tumor (Fig. 5.22). Unfortunately, the absence of this sign does not necessarily indicate that the nerve is tumor free. The maxillary sinus has the infraorbital nerve traversing through its roof, providing easy access to tumor, especially in view of the fact that dehiscences in the neural canal are not uncommon at this site. When tumor gains the infratemporal fossa the mandibular branch of the trigeminal nerve may become invaded. Erosion of the bone of the foramen rotundum or ovale is a late sign of perineural involvement and almost always portends intracranial spread. If the gasserian ganglion is enlarged and lights up with gadolinium contrast (Fig. 5.23) then a middle fossa/infratemporal fossa approach will be needed (see chapter 9).

In tumors involving the sphenoidal sinus, erosion of the lateral wall gives direct access to the cavernous sinus. Small degrees of cavernous sinus dural invasion can be resected and repaired through the transfacial approach, but more extensive invasion involving the proximity of the internal carotid artery will need a middle fossa/infratemporal fossa approach. The coronal projection of the CT scan will suggest bony wall erosion, and the MRI may show the degree of involvement of the cavernous sinus and internal carotid.

Despite the use of the most modern diagnostic techniques, often the establishment of the extent of tumor can be determined only at the time of resection. If resectability can
be established only at the time of surgery, the patient must be so apprised. As the surgery proceeds, great care is taken to perform mainly a debulking procedure without compromising any major function or producing any major cosmetic defect. If the lesion is deemed unresectable, as much gross tumor is removed as possible, and postoperative irradiation is done once healing has taken place.

**Treatment**

**Nasal Vestibule Lesions**

Lesions of the vestibular region of the nose (Fig. 5.24) are sneaky and treacherous. Whereas even squamous cell cancers of the nasal dorsum are not regarded with much apprehension, because local resection and the application of a skin graft are usually sufficient to eradicate the disease and reconstruct the defect, the vestibular area of the nose is distinctly different. Extension of a seemingly innocuous tumor on the nasal sill or columella into the premaxilla and for a considerable distance along the nasal floor is a common finding. Resection of a generous margin of tissue in the region of the nasal tip, nasal floor, premaxilla, and upper lip is important. If the alveolar bone is to be spared (Fig. 5.25), the patient must be warned about the likelihood of losing the vitality of the upper central teeth.

A skin incision is made outlining the tumor by at least 2 cm (Fig. 5.26). This invariably results in the loss of the nasal columella, one or both alae, and the superior central part of the upper lip. Intranasally a much wider resection of up to 4 cm from the visible edge of the tumor is done along the septum, nasal floor, and even the anterior maxilla. A lateral rhinotomy (Fig. 5.27) may be required for improved exposure. The premaxilla is excised (Fig. 5.28) using a power saw or a cutting needle. Bleeding from the incisive artery is controlled with bone wax or cautery. The upper lip is approximated or

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**Fig. 5.22** Coronal view computed tomographic scan showing gadolinium enhancement of the second division of the trigeminal nerve by perineural spread of squamous cell carcinoma. (From Donald PJ, Gluckman JL, Rice DH, eds. The Sinuses. New York: Raven; 1995:453)

**Fig. 5.23** Coronal view magnetic resonance imaging showing enhancement of the gasserian ganglion secondary to perineural spread of the malignant schwannoma. (From Donald PJ. Surgery of the Skull Base. Philadelphia: Lippincott-Raven; 1998:291)

**Fig. 5.24** Squamous cell carcinoma of the nasal vestibule.
reconstructed by the Karapandzic, Abbe flap, or Gillies technique and the raw area covered with a split-thickness skin graft. The postoperative cosmetic appearance is usually quite acceptable (Fig. 5.29), and further reconstruction should be delayed for at least a year because of the danger of local recurrence. At that time, a nasolabial flap with a previously implanted cartilage graft for structural support of the nasal ala is used for reconstruction (Fig. 5.30). The conchal cartilage of the ear provides an excellent source for a composite graft (Fig. 5.31). It beautifully mimics the nasal alar curve, and the cosmetic impact on the donor site is minimal.

If the defect is larger, and especially if it involves all or part of the nasal lobule, reconstruction of the tip as a unit is best done utilizing a midline forehead flap (Fig. 5.32). Tip support is essential for good aesthetic restoration, and grafts of cartilage or bone are necessary to shore up the framework. When reconstructing the nose, it is also vital to remember to provide an internal as well as an external lining. The internal lining can be contributed by the skin of a composite graft or
it can be contributed by the nose itself. Millard has developed an ingenious method of reconstructing the support of the nasal tip. If a sufficient portion of the nasal septum remains, an L-shaped chondromucosal flap is constructed that when advanced will provide tip support. The flap is pedicled superiorly on the mucoperichondrium, the cartilage cut subperichondrially under this pedicle, and the strut swung forward on this hinge (Fig. 5.33). Septal mucosa is advanced to cover all raw cartilage, and all otherwise exposed areas are lined with split-thickness skin. At the next stage, deficient nasal lining is replaced by utilizing the skin of the dorsum, which is cut, elevated to the rim, and turned under. A midline forehead flap pedicled on either the supratrochlear or supraorbital arteries or both is turned to cover the raw area and to refashion the nasal alae, columella, and lobule.

In the delayed case, the skin of the nasal dorsum is used to provide the inner lining as just described (Fig. 5.34). The midline forehead flap is used for the external coverage and formation of the nasal tip (Figs. 5.32 and Fig. 5.33). It may be created as a regular cutaneous or as an island flap. If the latter is used, a subcutaneous tunnel may be made in the residual nasal skin through which the flap may be introduced. Alternatively, the skin bridge can be split, the flap rotated into place, and continuity restored over the pedicle (Fig. 5.32). The advantage of the island flap is the elimination of a second stage. The disadvantages are bulkiness in the glabella–nasion region and the risk of pedicle compression by subsequent edema of the skin bridge. The midline flap is rotated into the defect and the columella and tip areas reconstructed. The forehead defect is approximated in the midline. If there is much tension in the closure, large stay sutures can be placed well to the outside of the suture line. These remain for 2 to 3 weeks.

Anterior Facial Lesions

A few facial lesions acquire such a size or extent that they are beyond curative resection (Fig. 5.35). However, some that may initially appear to be hopeless can be rescued with a heroic procedure (Fig. 5.36). So many cutaneous carcinomas of either basal or squamous cell type are readily curable by limited resection, and reconstruction is simply achieved with application of a skin graft or the rotation of a small flap into the defect. Occasionally, a pernicious lesion that persistently recurs despite repeated limited local excisions frustrates such efforts. At this point “whittling away” of the tumor
Fig. 5.30  Staged nasal alar reconstruction using a nasal labial flap and conchal composite graft.

Fig. 5.31  (A) Lesion. (B) Composite cartilage graft used to reconstruct the nasal ala.
Fig. 5.32 Midline forehead flap used to reconstruct the nasal dorsum. (A) Flap outlined. (B) Island flap pediculed on the supraorbital and supratrochlear arteries, elevated and ready to transpose into defect. (C) Flap turned and sutured into position. (D) Six weeks postoperatively.
Fig. 5.33  (A) L-shaped composite strut of septal cartilage and mucoperichondrium of both sides of nasal septum. (B) Flap is pedicled on the mucoperiosteum of the nasal dorsum and adjacent septum. Cartilage is fractured to the dorsal extent of the septum, and the flap is swung anteriorly. (From Millard R. Anesthetic reconstructive rhinoplasty. Clin Plast Surg 1981;8:169)

Fig. 5.34  (A) Midline forehead flap used to reconstruct the nasal dorsum. Turn-down flap on nasal tip is outlined and ready to dissect to nasal rim, where it is pedicled and used to provide the inner nasal lining. Midline forehead flap is outlined and may be delayed. Inner ling is provided by a turn-down flap of skin of the nasal dorsum. Midline forehead flap is rotated under the subcutaneous tunnel after a portion of the flap has been deepithelialized. (B) Flap rotated into place.
must cease and a definitive resection with wide margins be done. The tumor specimen in such a case will reveal deep infiltration into the skeletal elements of the nose and even into the adjacent maxillary sinuses.

The patient in Fig. 5.36 exemplifies such a case. Following numerous attempts at local excision the tumor had deeply infiltrated the soft tissues of the anterior part of the face and the cartilaginous portion of the nasal dorsum and had breached the anterior walls of the maxillary sinuses. The cutaneous resection margin is outlined in Fig. 5.37. A wide skin margin must be taken to avoid cutting across tumor that may have infiltrated laterally into the dermis, previous scar

Fig. 5.34  (continued) (C) Alternatively the flap is rotated extracutaneously, with the pedicle then divided and returned to the forehead at a later stage. When a longer pedicle is required, an “up-down” design may be utilized.

Fig. 5.35  Elderly man with extensive multifocal squamous cell carcinoma of the face.

Fig. 5.36  Midline nasal squamous cell cancer that had been repeatedly treated by small conservative excisions and radiation therapy. Tumor extended throughout the skin of the entire nose as well as its framework. In addition, spread to the cheek skin and underlying tissue was also palpable.
tissue, or muscle planes, a phenomenon that is very often seen in these cases. Spread along embryological cleavage lines is another common trend in these aggressive cancers. Through-and-through excision is done into both nasal cavities and maxillary antra (Fig. 5.38). Also included is a portion of premaxilla, because of tumor infiltration into the nasal sill and vestibule.

Coverage of such a defect presents a significant reconstructive challenge. An extensive rebuilding effort using flaps should be resisted, since the burying of a local recurrence under a large flap may result in the tumor becoming unresectable by the time it is detected (Fig. 5.39). In the patient shown in Fig. 5.36, coverage was achieved by local advancement of the facial soft tissue utilizing two large Kuhnt-Szymanowski flaps (Fig. 5.40), which permitted closure of the defect and clear visualization of the resection margins on follow-up. The unsightly area of the amputated nose can be covered by a prosthesis until a 12- to 18-month follow-up ensures the absence of local recurrence. At that time, the patient may even decide to retain the prosthesis rather than undergo the rigors of a nasal reconstruction.

Another site that produces substantial difficulties in management is the nasal–jugal area. This region of skin between the caruncle of the eye and the dorsum of the nose just lateral to the nasion occasionally harbors malignancies, usually of the basal cell variety (Fig. 5.41), that acquire a particularly pernicious character. They have a tendency to extend deeply and laterally from the cutaneous surface into the underlying ethmoid and even the maxillary sinuses, thereby jeopardizing the eye. The morpheaform type of basal cell tumor is common in this area, and local recurrences following conservative local resections are the rule (Fig. 5.42). Many surgeons are lulled into a sense of complacency usually engendered by their favorable experience with this lesion in other sites. However, with such tumors in this dangerous site, even rather aggressive excisions may prove unsuccessful.
Mohs fresh tissue technique (see chapter 7) has one of its most pertinent applications in these cases. It is not uncommon for the recurrent and larger lesions to require an orbital exenteration and even a craniofacial procedure.

Several cutaneous malignancies acquire through some unknown mechanism the ability to spread along the perineural spaces. Malignant melanoma, basal cell, and squamous cell carcinoma all may acquire this propensity. These patients usually have a skin cancer that has been present for some time, often removed on several occasions. The first sign of perineural spread is numbness. The tumor spreads from the peripheral branches of the nerve to the main trunk. In the midfacial region this is to the infraorbital nerve, and with time the tumor spreads, often with histologically normal-appearing skip areas back through the foramen rotundum to the gasserian ganglion.

Effective treatment entails resection of the primary tumor with wide margins with a connecting area of subcutaneous tissue to the infraorbital foramen. The presence of tumor at this site means removal of the infraorbital nerve to the ptery-
gomaxillary space. An area of anterior maxillary sinus wall in the vicinity of the foramen needs excision. The bone along the course of the nerve in the sinus roof, which of course, is the orbital floor, is also removed. The periorbita is sampled along the course of the nerve to determine involvement. If the nerve is positive in the pterygomaxillary space then the nerve is dissected to the foramen rotundum, the bone around the foramen is drilled away, and the nerve trunk is severed at the level of the dura. If the frozen section of the nerve is negative for tumor at this site then the operation is complete. If the nerve is still positive then a middle fossa/infratemporal fossa approach must be done to dissect the ganglion from the Meckel cave and complete the excision. Chapter 9 covers this topic in greater depth.

**Craniofacial Resection**

The standard maxillectomy and external ethmoidectomy procedures are not covered in this chapter because they are well described in several surgical atlases and texts. Although the maxillary portion of these operations can usually be accomplished en bloc, the ethmoidal part is more of a piece-meal affair. A significantly wide margin of healthy tissue is often difficult to attain, and the bony nature of the specimen makes frozen sections unobtainable. Considerable judgment is required to establish a good cancer ablative procedure at this site. The goal in resection of any head and neck cancer is to strive for an en bloc removal with histological negative margins. It is not always possible to achieve such a resection in one single block. This is especially pertinent in many skull base resections when the sheer bulk of the tumor obscures the view of the margins and an unnecessarily large removal of normal tissue must be done to achieve complete tumor extirpation. This obviously occurs in any traditional en bloc removal when positive margins are obtained and a repeat excision is done at those margins to remove the entire tumor. The violation of the en bloc rule is commonplace in parotid salivary gland resection for cancer as when preservation of the facial nerve is attempted. In skull base surgery initially a debulking procedure removes the tumor that obscures the view of the margins. Second the main specimen containing most of the tumor is excised with most of the periphery of the specimen histologically negative. This is the first layer of the resection. The second layer is removed and the margins checked with frozen sections. Subsequent resection layers are excised until all margins are negative. This is similar to the Mohs technique so successfully used in dermatology, and the technique has evolved. It is not a piecemeal resection.

![Fig. 5.43](image1)

Basal cell carcinoma of the inner canthus managed by an aggressive skin excision, exenteration of the ethmoid sinus, and resection of part of the bony wall of the nose. Despite this resection, most tumor margins were positive. Curative excision required orbital exenteration and a craniofacial procedure.

![Fig. 5.44](image2)

(A) A 21-year-old woman with a well-differentiated fibrosarcoma of the anterior ethmoid sinuses invading the soft tissue adjacent to the glover and medial canthal skin. The tumor invaded the periorbita and a small amount of periorbital fat. The medial one third of the lids was removed as well as the lacrimal system. A window of periorbita and adjacent fat was removed down to the medial rectus muscle. Tumor-free margins were obtained. The medial canthus was reconstructed and the nasal-orbital skin resection replaced with a midline forehead flap. Lacrimal drainage was accomplished by the insertion of a Jones tube. (B) Patient 15 years postoperative and tumor free. She has mild restriction at the terminal parts of lateral and medial gaze but has no diplopia on straight-ahead gaze. Despite multiple attempts at reconstruction of a lacrimal drainage system she still has occasional epiphora. (From Donald J. Surgery of the Skull Base. Philadelphia: Lippincott-Raven; 1998:168)
but an orderly approach layer by layer to achieve total tumor extirpation with negative margins. "Gross tumor removal" is not the goal of this exercise. Craniofacial resection facilitates the establishment of superior and lateral tissue margins and has significantly broadened the perspective in ethmoidal and maxilloethmoidal cancer surgery. Surgical resection has traditionally been the method of choice in the management of paranasal sinus cancer. Irradiation therapy is usually reserved for adjunctive therapy or palliation in patients with hopeless unresectable disease or in those who are too debilitated by intercurrent disease to operate upon. For tumors of the maxilla located below the Ohngren line, maxillectomy is the standard approach and is often curative. Simple maxillectomy is much less successful with tumors above this line because of their proximity to the orbit and pterygomaxillary space. A much more radical procedure is required, often involving orbital resection.

The performance of orbital resection has undergone considerable debate over the years. Even the notion that the prognosis is so bad when paranasal sinus tumors have become so advanced that the removal of the eye is not worth it, has been posited. Prior to the advent of skull base surgery, resection of advanced sinus tumors that invaded the orbit was poor. Currently, 5-year tumor-free survival rates for anterior skull base malignancy range from 50 to 65%. With this, an evolution of thought has occurred regarding ocular resection. In the past many surgeons believed that invasion of the periorbita and even the orbital bone was an indication for orbital exenteration. The seminal work of Perry et al. showed that the eye could be preserved in many cases of advanced maxilloethmoidal malignancy. We made our first attempt at this in 1986 in a case of fibrosarcoma of the ethmoid sinuses that invaded the periorbita and periorbital fat of the eye. The involved tissues with negative margins were removed down to the medial rectus muscle. The patient remains tumor-free to this day (Fig. 5.44A,B). Over the years we have developed a treatment algorithm depicted in Table 5.1. Unfortunately, many advanced sinus tumors that have grown large enough to require skull base resection have more often invaded the orbital apex than the area of the globe (Fig. 5.45A,B).

Although small ethmoidal tumors can be adequately excised transfacially, usually these tumors, because of their occult nature, are not detected until they are quite large. Adequate excision in these instances must include the floor of the anterior cranial fossa, the medial and superior orbital walls, and often the orbital contents.

To enhance the survival rate, follow-up radiotherapy is employed. The histopathologic establishment of integrity of the surgical margins in these cases is exceptionally difficult because of the modified en bloc nature of portions of the resection and the presence of cure at the margins. The addition of radiotherapy greatly enhances the opportunity for complete tumor ablation.

Craniofacial resection is used for cancers whose geographic center may be either maxillary or ethmoidal in origin. If the lesion originated in the ethmoid sinus, occasionally a portion of the maxilla can be spared. A primarily maxillary tumor may not have as much cranial spread, thus reducing the amount of anterior fossa floor needing resection. Occasionally maxillary encroachment by an ethmoid tumor is minimal, permitting salvage of the dental arch of the affected side. However, in many instances, a maxilloethmoidectomy and orbital exenteration are required. When there is cutaneous involvement, a wide margin of skin must be excised, compounding the reconstructive problem.

If oncologically possible, because of its vital role in the aesthetics of the face, an attempt should be made to preserve...
some aspect of the malar eminence. This can be done when there is only a small amount of bone invasion on the sinus side of the malar eminence. The bone is hollowed out with the cutting bur. A frozen section of marrow curetting at this site can establish a negative margin.

The greatest advance in the management of paranasal sinus malignancy has been the advent of skull base surgery. Following Ketcham’s initial report in 1964, small series of patients were reported on a sporadic basis. It was not until the 1980s that organized skull base teams became established, and reports of cases in significant numbers were published. A clear survival advantage over subtotal removal and follow-up irradiation stimulated widespread interest in cranial base resection techniques.

Skull base surgery should be a well-coordinated cooperative venture between the head and neck surgeon and the neurological surgeon. These combined intracranial/extracranial resections exploit the knowledge of these two disciplines, enabling a safe and usually complete resection of malignancies that were once considered inoperable and incurable. The team approach is essential. One of the principal reasons sinus tumors that invaded the intracranial cavity were thought to be inoperable was that they crossed the arbitrary anatomical barriers established by specialty tradition. Now that skull base surgery is more commonplace there arises the concern that individuals in a single specialty will attempt these operations without the assistance of their partner in the sister-discipline.
It is the coordination of the expertise of both surgical specialties that is essential to produce the best results.

Pathophysiology

Although each individual cell type of malignancy has its own idiosyncratic behavior, these tumors as a whole have some growth and spread characteristics in common. Most malignant tumors of the paranasal sinuses are of epithelial origin (Table 5.1). Squamous cell cancer, adenocarcinoma, acinic cell, and adenoid cystic carcinomas are most common. Esthesioneuroblastoma, although of olfactory epithelial origin, characteristically invades the adjacent ethmoid sinuses. Mucosal melanoma, probably the deadliest of all sinonasal tumors, is fortunately very uncommon. Sarcomas may take origin in the bone of the sinuses or in the bony and cartilaginous septum. Fibrosarcoma, chondrosarcoma, and osteogenic sarcoma are the most usual tumors of this type, although uncommon as a whole. Intracranial tumors and those of the supporting skeleton of the skull base may even present as neoplasms in the nose or sinuses. Chordomas and chondrosarcomas of the sphenoid or ethmoid bone, meningioma (although not usually malignant), and craniopharyngioma make up most of the tumors at this site. Plasmacytomas, lymphomas, and metastatic tumors from primary sites below the clavicles are occasionally seen.

Method of Spread

Sinus malignancies make their way into the intracranial compartment by way of direct bone erosion, penetration of cranial base foramina, perivascular and perineural spread, and, exceedingly rarely, by metastasis. Although referred to on occasion in literature of other medical specialties, brain metastasis from head and neck cancer, other than that of the thyroid, is very rare. This is more so the situation in the paranasal sinus malignancy.

Direct erosion of bone can occur anywhere along the interface of the sinus cavities and the supporting bone of the cranial floor. The fovea ethmoidalis is the thinnest bone of the anterior skull base and is a common site of erosion from carcinomas of the ethmoid sinuses. Malignancies primary to the maxillary sinuses may invade the orbit and the globe itself. They then extend superiorly through the orbital roof into the anterior cranial fossa. A common site of orbital invasion is in the posterior aspect near the apex. From there the tumor may erode the posterior or posterolateral wall into the middle cranial fossa (Fig. 5.46). Frontal sinus tumors, although rare, erode the posterior wall to enter this anterior fossa and invade the dura over the anterior pole of the frontal lobe and the inferior reaches of the superior sagittal sinus (Fig. 5.47). The sphenoidal sinus is usually involved with tumor by virtue of extension rather than per颇prenum. Tumors in this site may invade superiorly through the planum sphenoidale to the anterior fossa dura (Fig. 5.48), laterally to that of the cavernous sinus in the middle cranial fossa (Fig. 5.49) or posteriorly, through the clivus, into the posterior cranial fossa (Fig. 5.50A,B).

The foramina of the skull base that provide access for vascular and neural structures also provide a portal of entry for direct tumor extension. Notable among these are the small neurovascular foramina that emit the fila olfactoria. There
are ~43 foramina per side in the cribiform plate that emit these first-order neurons whose cell bodies are contained and that synapse in the olfactory bulbs. Each olfactory filament is sheathed in dura. Therefore tumors that erode through the cribiform plate, by definition, invade dura. In the case of esthesioneuroblastoma, because the tumor begins in the supporting cells (Fig. 5.51) of the olfactory epithelium, virtually all of them have invaded dura. The rare exception to this may be the unusual case in which the tumor arises in the infrequently and occurring islands of olfactory epithelium in the supreme meatus of the nose. In our series of esthesioneuroblastomas we have seen only one such case (Fig. 5.8).

There are three foramina in the posterior orbit, which allow direct tumor spread: the superior orbital fissure, the optic foramen, and the foramen rotundum (Fig. 5.52). All three lead into the middle cranial fossa. The superior fissure leads into the cavernous sinus, the optic foramen, and the foramen rotundum into the middle cranial fossa. The optic canal exits at the superior border of the cavernous sinus, but the optic nerve is outside the dura of the sinus as it exits the foramen and enters the middle fossa. At a variable point in the canal the periesteum becomes continuous with the middle fossa dura, and the nerve is subdural as it enters the intracranial space, then meets its fellow nerve of the opposite side to become the optic chiasm.

The foramen rotundum admits the maxillary division of the trigeminal nerve that enters the gasserian ganglion in the Meckel cave, which in turn is situated in the trigeminal impression on the middle fossa floor (Fig. 5.53). A direct extension of the cavernous sinus often encloses this nerve trunk. The cavernous sinus dura marks the medial boundary of the Meckel cave. Sinus tumors can extend along the intra-
Tumors involving the sphenoidal sinus can spread through the pterygoid (vidian) canal to the middle fossa floor and the internal carotid artery. The positions of the optic canal, foramen rotundum, and vidian canal occupy a triangular point of access to the anteroinferior part of the middle fossa near the cavernous sinus (Fig. 5.54).

Vascular spread of tumors can also proceed through skull base foramina. Regarding tumors the most notable foramen is the foramen lacerum. Although not intimately related to the sinuses, it is closest to the sphenoidal sinus. Tumors originating in the sinus or having spread from the ethmoid block, turbinates, or nasal septum can spread along the nasopharyngeal vault, penetrate the mucosa, and erode through the cartilage plug that fills the inferior aspect of the foramen, thus gaining access to the cavernous sinus (Fig. 5.55).

Rarely will a sinus tumor be so extensive as to creep across the undersurface of the sphenoid bone and penetrate the jugular foramen.

Perineural spread, already alluded to, is a common mechanism of intracranial spread of tumors originating in the sinuses. The method of spread was once thought to be via the perineural lymphatics; however, these structures do not exist to any extent. The mode of spread appears to be via cranial aspect of the middle fossa deep in the infratemporal fossa. From there they can spread through the foramen ovale and from there to the Meckel cave.

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the perineural spaces of the nerve trunks or branches (Fig. 5.56). Rarely is there penetration into actual nerve substance (Fig. 5.57), and for some curious reason, the tumor, once intracranial, appears to stay confined mostly to the nerve and only occasionally invades the overlying dura. Another interesting phenomenon is that in the extracranial course, neurotropic tumors tend to have skip areas. This is especially characteristic of adenoid cystic carcinoma, where one focus of perineural tumor may be separated by as much as 2 cm from another tumor deposit. This is rarely seen once the nerve becomes intracranial. The tumor seems packed together, and skip areas hardly ever occur. The mechanism by which perineural invasion takes place is as yet obscure. Some tumors that have extensive perineural spread such as neuroblastomas have high concentrations of polysialated neuro-nal cell adhesion molecules (NCAMs). This class of proteins is ubiquitous throughout embryogenesis, but rapidly disappears shortly after birth. Some NCAMs, however, persist, and they are found mainly in the brain. These compounds are seen in relatively high concentrations in multiple myeloma and some lymphomas. In our series they were particularly prominent in primary carcinomas of the salivary gland, especially those with distant metastasis. In our first series of patients, no clear difference was seen in concentrations of polysialated NCAMs in tumors with perineural spread compared with those without. Because of some potential flaws in this study, especially the freshness of the tissue under study and the quality of the markers used, the study continues.

There are certain other characteristics that head and neck cancers express once intracranial invasion has taken place. The dura forms a rather solid barrier to the spread of these malignancies. Perhaps the dense collagenous structure of this tissue impedes the movement of the cancerous tissue within it. The tumor tends to become rather densely concentrated and has often a pushing rather than an infiltrative margin of advance (Fig. 5.58). The underlying brain is rarely invaded. In our series of cases of dural invasion only 20 patients have spread to the brain. Even when the tumor does spread to underlying brain, meningeal carcinomatosis is rarely seen. Our 5-year tumor free survival rate for these 20 patients is 27.6%.

◆ Preparation  Preparing the patient for surgery requires the coordinated efforts of the head and neck surgeon, neurosurgeon, and maxillofacial prosthodontist. The planning and timing of each surgeon’s step in the procedure is anticipated and agreed upon ahead of time. Each participant should plan to be present for most of his or her partner’s contribution to the procedure because the most difficult aspect of the operation is to establish clear surgical margins. Both surgical participants contribute to and jointly decide on the determination of these margins, which are especially crucial in the region of the fovea ethmoidalis and planum sphenoidale. The patient needs to understand the gravity of the procedure and that it is “brain surgery,” with its possible aftereffects as well as the attendant problem of the usually inevitable facial deformity.