Level I to III craniofacial approaches based on Barrow classification for treatment of skull base meningiomas: surgical technique, microsurgical anatomy, and case illustrations

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Object. Although craniofacial approaches to the midline skull base have been defined and surgical results have been published, clear descriptions of these complex approaches in a step-wise manner are lacking. The objective of this study is to demonstrate the surgical technique of craniofacial approaches based on Barrow classification (Levels I–III) and to study the microsurgical anatomy pertinent to these complex craniofacial approaches.

Methods. Ten adult cadaveric heads perfused with colored silicone and 24 dry human skulls were used to study the microsurgical anatomy and to demonstrate craniofacial approaches in a step-wise manner. In addition to cadaveric studies, case illustrations of anterior skull base meningiomas were presented to demonstrate the clinical application of the first 3 (Levels I–III) approaches.

Results. Cadaveric head dissection was performed in 10 heads using craniofacial approaches. Ethmoid and sphenoid sinuses, cribriform plate, orbit, planum sphenoidale, clivus, sellar, and parasellar regions were shown at Levels I, II, and III. In 24 human dry skulls (48 sides), a supraorbital notch (85.4%) was observed more frequently than the supraorbital foramen (14.6%). The mean distance between the supraorbital foramen notch to the midline was 21.9 mm on the right side and 21.8 mm on the left. By accepting the middle point of the nasofrontal suture as a landmark, the mean distances to the anterior ethmoidal foramen from the middle point of this suture were 32 mm on the right side and 34 mm on the left. The mean distance between the anterior and posterior ethmoidal foramina was 12.3 mm on both sides; the mean distance between the posterior ethmoidal foramen and distal opening of the optic canal was 7.1 mm on the right side and 7.3 mm on the left.

Conclusions. Barrow classification is a simple and stepwise system to better understand the surgical anatomy and refine the techniques in performing these complex craniofacial approaches. On the other hand, thorough anatomical knowledge of the midline skull base and variations of the neurovascular structures is crucial to perform successful craniofacial approaches. (DOI: 10.3171/2011.3.FOCUS1110)

Key Words • anterior cranial fossa • craniofacial approach • meningioma • microsurgical anatomy • surgical technique

Midline craniofacial approaches provide various routes for reaching lesions from the ACF down to the upper cervical spinal cord. For lesions situated in the midline, they are advantageous over the lateral approaches (that is, orbitozygomatic-periorbital cranioiogy and transpetrosal approaches), which have some disadvantages such as critical structures surrounding the lesions, long working distances, and limited operative maneuverability. Midline craniofacial approaches provide direct access to the lesions and involve fewer neurovascular structures on the surgical avenue than the lateral approaches.13,14,16,21

Abbreviation used in this paper: ACF = anterior cranial fossa.

Since its early description by Smith in 1954 and Ketchan in 1963, the basic transbasal approach and its modifications have been coined under various and often confusing names, including the extended cranial approach, subcranial approach, and telecanthal approach.7,8,10,19,25,26 The Barrow group created a new classification system that simplified the description of these complex approaches to find a common terminology and better understand the surgical anatomy.10,12

Numerous reports exist regarding the indications, techniques, and variations of craniofacial approaches in the neurosurgical literature. The purpose of this study is to describe the technical aspects of craniofacial approaches in cadaveric dissections in a stepwise manner.
Recent advances in general endoscopic techniques have led to advances in endoscopic skull base surgery as well. Nowadays, many of the lesions that required complex skull base surgical approaches may be amenable to endoscopic techniques. However, there are still particularly complex and difficult cases that require craniofacial approaches. This report consolidates the approaches for the first 3 of the 5 different levels in stepwise cadaveric dissections. It also describes the relationships of important anatomical landmarks, foramina, and sutures in 24 dry skulls. Surgical case examples consisting of meningiomas of the ACF in which 3 of these approaches (Levels I–III) were used are presented, along with the relevant microsurgical anatomy, to demonstrate the applications and indications of each craniofacial approach.

Methods

Ten cadaveric heads were injected with colored silicone (red for arteries, blue for veins) to demonstrate craniofacial approaches based on the Barrow classification. Step-by-step dissections were performed to demonstrate the differences of each approach. In addition, important anatomical landmarks and techniques were demonstrated on cadaveric heads. Clinical case illustrations are presented to show applications for the first 3 craniofacial approaches.

The supraorbital foramen or notch is the first bony landmark seen during surgery when performing Level I, II, and III craniofacial approaches. This passage can be either in the form of a foramen or a notch. The type of passage in each dry skull was evaluated, and the distance from the supraorbital foramen or notch to midline was measured. The nasofrontal suture was considered a useful and simple anatomical landmark during Level I, II, and III craniofacial approaches. The distances between the anterior and posterior ethmoidal foramina and the optic canal were also measured.

Surgical Techniques

Level I Craniofacial Approach and Illustrative Cases

Removal of the inferior frontal bone and the orbital roofs provides a direct flat view to the ACF floor. The key to this modification is elevation of bilateral supraorbital bars and an osteotomy made in the nasofrontal suture without detachment of the medial canthal ligaments.

A bicoronal (tragus to tragus) scalp incision was used for this approach (Fig. 1 left). The incision must be posterior enough to allow the dissection of an adequate length of the periosteal (pericranial) layer, which is used to reconstruct the ACF. Part of this layer can also be used for duraplasty. More flap can be obtained by further undermining of the galea posteriorly (arrows). CS = coronal suture; SS = sagittal suture.

Fig. 1. Photographs. Left: The tragus-to-tragus bicoronal scalp incision. Right: The cadaveric dissection showing the pedicled, vascularized periosteal (pericranial) layer, which is used to reconstruct the ACF.

expose the so-called keyhole region on both sides. These also can be used for bur hole placement. For Level III approaches, subfascial or interfascial temporalis muscle dissection is performed to expose the pterion, the zygomatic bone, and the frontozygomatic suture. A detailed description of subfascial dissection to expose the zygoma, which is commonly used in the orbitozygomatic approach, is given in previous publications. Blunt dissection is used to free the periorbita from the superior, medial, and lateral aspects of the orbital rims. The supraorbital nerves can be freed from the supraorbital notch with blunt dissection. In the case of the supraorbital foramen, a small chisel or drill can be used to free the nerve (Fig. 2). Advancing the scalp reflection to provide adequate exposure to the level of the nasofrontal suture might be difficult in some cases. A useful technique described by Fujitsu et al. involves a midline incision of the procerus muscle, which relaxes the scalp and leads to an easier exposure of the nasion. The initial 2 holes are made at each keyhole region bilaterally, and the other bur holes can be made near or wherever necessary depending on the particular patient’s anatomy at the midline. After bifrontal craniotomy is performed (Fig. 3), the dura is reflected from the ACF (Fig. 4). Size and lateral extension of the bifron-
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Fig. 3. A bifrontal craniotomy has been performed. Both orbital rims (supraorbital bars) are shown on the cadaver. FD = frontal dura; O = orbit; SOB = supraorbital bar; SON = supraorbital notch; SSS = superior sagittal sinus.

Fig. 4. The orbitofrontal dura has been reflected from both orbital walls. FD = frontal dura; OR = orbital roof.

Cranial craniotomies are tailored according to size of the lesion and other variables such as the extent of the edema. The frontozygomatic suture is the lateral landmark for an osteotomy made in the supraorbital bar (Fig. 5A). The orbital roofs are cut in an arch that extends posteriorly to incorporate as much of the roof into the bar as possible (Fig. 5B), then anteromedially just lateral to the cribriform plate to the level of the foramen cecum in front of the crista galli (Fig. 5C). The inferomedial landmark is the nasofrontal suture (Fig. 5D). This facilitates exposure of the ACF and cribriform plate (Fig. 5E–H). The exposure is a wide subfrontal one that leaves the nasal bones in place and gives access to the ACF and cribriform plate but not access into the nasopharynx (Fig. 5E–H).

Case 1. This 61-year-old woman presented with a 2-year history of personality change and depression. On workup, she was found to have a very large homogeneously contrast-enhancing mass in the anterior cranial fossa (Fig. 6A–C). Although the origin of this meningioma could not be exactly determined preoperatively, at surgery it was found to be arising from the olfactory groove. She underwent a Level I craniofacial approach with lumbar drain placement (Fig. 6D and E). She made an excellent recovery and went back to her premorbid baseline. Postoperative MR imaging at 2 years did not show any recurrent or residual meningioma (Fig. 6F and G). Of note, she did not have any smelling function before surgery, which remained unchanged.

Case 2. This 57-year-old woman presented with headache and long-standing decreased visual acuity, which progressed to bilateral blindness very recently. Magnetic resonance imaging showed a very large tuberculum sellae meningioma (Fig. 7A–C). She underwent a Level I craniofacial approach with lacerum drainage placement (Fig. 6D and E). She made an excellent recovery and went back to her premorbid baseline. Postoperative MR imaging at 2 years did not show any recurrent or residual meningioma (Fig. 6F and G). Of note, she did not have any smelling function before surgery, which remained unchanged.

Case 3. This 54-year-old woman presented with personality changes and decreased executive functions. Routine neurosurgical examination revealed grossly intact neurological functions except for loss of smelling bilaterally. Magnetic resonance imaging showed a very large anterior fossa meningioma with extensive vasogenic edema (Fig. 8A and B). The patient underwent a Level I craniofacial approach with lumbar drain placement. Gross-total resection of the meningioma was achieved. Postoperatively, the origin of the meningioma could not be determined exactly but was narrowed down to either the olfactory groove or planum sphenoidale. The patient made an excellent recovery with no recurrent meningioma at 2-year follow-up and almost complete resolution of T2 signal changes (Fig. 8C–E).

Level II Craniofacial Approach and Illustrative Case

This approach provides an additional inferior exposure to the Level I approach by removing the nasal bone, which allows access to the nasopharynx and clivus. It is used to expose lesions in the ACF, nasopharynx, clivus, and the orbit.

The orbital bar osteotomies typically include the nasal bone, medial orbital wall, and orbital roof. The lateral orbital wall is not included to a significant extent. The inferior orbital fissure is not incorporated in the osteotomy of the orbital bar (Fig. 9A). With this osteotomy, detachment of the medial canthal ligaments either unilaterally or bilaterally is required (Fig. 9B). The medial canthal ligament lies in front of the lacrimal sac, and the angular vein (the uppermost end of the facial vein) lies in front of the medial canthal ligament (Fig. 9C and D). The nasolacrimal duct continues downward from the lacrimal sac and opens into the inferior nasal meatus.

The flap is reflected anteriorly, exposing the nasal bones and nasal process of the maxilla (Fig. 9A and B). The supraorbital nerves are freed from the supraorbital notch or the foramen with a small chisel or drill. The me-
The canthal ligaments are taken down, and the upper cartilages are detached from the nasal bones. The nasolacrimal duct is exposed and preserved. A fragment of bone can be retained on the medial canthal ligament for easy, subsequent transnasal wiring. A bifrontal craniotomy and dural dissection are then performed. The cuts across the lateral orbital walls and roofs are the same for the Level I and II craniofacial approaches (Figs. 5 and 9). Medially, the osteotomies extend inferiorly to the nasal aperture. The nasal cuts are made across the nasal process of maxilla, anterior and medial to the nasolacrimal ducts, and then posteriorly along the medial orbital wall to the foramen of the anterior ethmoidal artery (Fig. 9A–D). The frontoethmoid suture is the main anatomical landmark in the medial orbital wall. The anterior and posterior ethmoidal foramen and the optic foramen are usually in the superior localization at this suture and trace in a parallel manner. The anterior ethmoidal foramen can easily be found by following the frontoethmoid suture during this osteotomy. The cut is approximately 1 cm in front of the optic canal. To free the supraorbital nasal bar, a last cut across the frontal crest anterior to the crista galli is made. The supraorbital bar and the nasal orbital complex are osteotomized and removed (Fig. 9F and G).

**Case 4.** This 40-year-old man presented with loss of smelling, nasal fullness, and mild personality changes over the course of a year. Magnetic resonance imaging revealed a contrast-enhancing mass lesion located in the AFC with extension into the nasal cavity and destructing the cribriform plate (Fig. 10A). He underwent a Level II craniofacial approach with lumbar drain placement (Fig. 10B). The meningioma was totally excised (Fig. 10C), and his postoperative course was uneventful. However, this patient was lost to follow-up.
Level III Craniofacial Approach and Illustrative Case

The indications for a Level III craniofacial approach are to expose large ACF, nasopharyngeal, and clival lesions. The method of dissection is identical to that used in the Level II craniofacial approach. The osteotomy includes the lateral orbital walls from the level of the inferior orbital fissure as part of the supraorbital fragment (Fig. 11). To expose the inferior orbital fissure, zygoma, and suprolateral orbital rim, the temporalis fascia is elevated in the subfascial plane between the muscle and deep fascia (Fig. 12). Approximately 2.5 cm of the orbital roof should be included in this cut so as to minimize the possibility of a postoperative pulsatile enophthalmos (Fig. 13A and B). Most of the superior orbital roof can be included in the fragment to facilitate the lateral retraction of the globe. Osteotomies are performed to remove the frontonasoorbital unit, leaving the cribiform plate exposed. Under direct vision, an osteotomy is performed posterior to the cribiform plate through the planum sphenoidale. The final cut is made through the ethmoid bone and nasal mucosa. Care should be taken to preserve a generous cuff of nasal mucosa attached inferiorly to the cribiform plate. This final maneuver completes the separation of the cribiform plate from all bony connections and leaves it attached to the base of the frontal dura with the olfactory nerve rootlets left intact. The frontal lobes, with the dura intact, can be elevated generously to access the involved area (Fig. 13C and D).

Case 5. This 22-year-old man presented with a large mass lesion located in the frontal region that had invaded the nasopharynx, paranasal sinuses, sella turcica, sphenoid sinus, and nasal cavity. This mass lesion extended into the bilateral orbital fissures more on the right than left (Fig. 14A and B). The patient underwent a Level III craniofacial approach because of periorbital involvement and involvement of the superior orbital fissures. The preoperative differential diagnosis was meningioma. The lateral walls of the orbits were also cut, and the tumor was totally removed (Fig. 14C). The histopathological diagnosis was juvenile ossifying fibroma. This case was included to demonstrate the utility of this approach (Level III) when the mass is very extensive and compresses both orbits from the medial to lateral direction.

Results

The anatomical structures in the frontoorbital region and their relationship should be well known for Level I, II, and III craniofacial approaches. The supraorbital notch or foramen is the first structure that is recognized during the surgery for all 3 approaches. The supraorbital artery and the nerve pass between the periorbita and the superior levator palpebrae muscle and leave from the supraorbital foramen or notch. The supraorbital nerve innervates the sensation of the upper eyelid, conjunctiva, and skin of the forehead up to the lambdoid suture. The freeing of this nerve during surgery is easier if it traverses through a notch rather than the foramen. Our study demonstrates that the opening of the notch might be either narrow or wide. The dimension of the opening of the supraorbital notch is important in that the risk of damaging the nerve during surgery can be minimized if the opening is wide. In our study, the notch occurred in 85.4% of specimens and the foramen occurred in 14.6% of specimens. The
opening of the notch was wide in 68.7% of cases and narrow in 16.7% of cases. Distances for important anatomical structures in the frontoorbital region are given in Table 1.

### Discussion

Lesions of the ACF, especially those with extension into the orbits, clivus, paranasal sinuses, and nasopharynx are surgically challenging. The complex and critical anatomy of the neurovascular structures in this region can cause significant problems for the surgeon and the patient. The ultimate goal in surgical management is maximum resection of the tumor with minimal morbidity. Craniofacial surgical techniques have been described to accomplish these goals. Beals et al. listed the important features in the selection of the craniofacial approach as 1) the location and size of the lesion, 2) the tumor type and its biological behavior, 3) the patient's age, and 4) the surgeon's preference and experience. Based on these considerations, they developed the Barrow classification scheme, which simplifies the description of the craniofacial approaches and provides a common terminology. This classification system, which is based on selecting the most appropriate angle of approach to the anatomical location of the tumor, can help the surgeon to plan appropriate surgical strategies for lesions of this region. This system is simple and useful for planning surgical treatment.

The first 3 of these 5 different levels of craniofacial approaches (Levels I–III) access the midline skull base from a superior trajectory (Fig. 15), whereas Levels IV and V provide access to the midline skull base via Le Fort I or II osteotomies. Levels IV and V are used primarily for oncological resection of extensive neoplastic processes of the paranasal sinuses and nasopharynx. For the first 3 levels of craniofacial approaches, the face is degloved from above using a bicoronal incision, and facial disassembly is built around a supraorbital bar. The subfrontal access achieved by removing the supraorbital bar (Level I) is extended vertically downward by removing the nasal complex and medial orbital walls on the supraorbital bar (Level II), exposing the entire midline skull base down to the craniocervical junction. Greater horizontal exposure is achieved by removing the lateral orbital walls with the supraorbital-nasal bar (Level III) and retracting the globes laterally.

In the literature relevant to craniofacial approaches, the supraorbital notch was seen in 69.9% of cases but the supraorbital foramen was only seen in 28.9% of cases. In our study, the notch was seen in 85.4% of cases and the foramen in 14.6%. The opening of the notch was wide in 68.7% of cases and narrow in 16.7% of cases. The distance between the midline and supraorbital foramen or notch was 21.9 mm on the right side and 21.8 mm on the left. The medial orbital wall is rectangular in shape and makes the lateral wall at the ethmoid sinuses. The medial orbital wall is very thin and has anterior and posterior ethmoidal foramina. In this region, the distances between the anatomical structures and nasofrontal suture is important. Proximity of the optic nerve to the posterior ethmoidal foramen is an important point that should be kept in mind. In the literature, the mean distances between the posterior ethmoidal foramen and the optic foramen have been reported to be 5.34 ± 2.81 mm on the right side and 4.9 ± 3.35 mm on the left. In the present study, the mean distances between the posterior ethmoidal foramen and the optic foramen were 7.1 mm on the right side and 7.3 mm on the left. Furthermore, an additional foramen was found in 35.4% of cases between the anterior and the posterior ethmoidal foramina in cadaveric specimens.
Fig. 8. Case 3. **A and B:** Preoperative T1-weighted postcontrast axial (A) and T2-weighted axial (B) MR images showing a very large meningioma of the ACF associated with extensive vasogenic edema. The meningioma extends toward the tuberculum/diaphragma sellae. **C–E:** Images obtained 2 years postoperatively. Postcontrast axial T1-weighted MR image (C). There are almost no residual T2 signal changes on T2-weighted FLAIR sagittal (D) and T2-weighted axial (E) MR images.

Fig. 9. Demonstration of osteotomy cuts for the Level II craniofacial approach. **A:** Overview of the Level II craniofacial approach. **B:** After a bifrontal craniotomy is performed, the location of the nasal bone osteotomies are demonstrated by dashed lines in a higher magnification. Arrows indicate the supraorbital notch. SON = supraorbital nerve. **C:** Demonstration of the medial canthal ligament (MCL) in a separate cadaveric dissection. This ligament lies in front of the lacrimal sac. The angular vein (AV) lies in front of the medial canthal ligament. The arrow points to the nasolacrimal duct (NLD). **D:** Further dissection of the anterior ethmoidal artery (AEA). The anterior ethmoidal artery is in the lamina papyracea of the medial orbital wall at the anterior ethmoidal foramen. **E:** Color demonstration of the bifrontal craniotomy and nasoorbital osteotomies on a dry skull. **F:** Demonstration of the bifrontal bone flap and supraorbital bar with nasal bone osteotomies. **G:** Final extradural exposure after the Level II approach. AA = angular artery; N = nasal bone; NC = nasal cavity; NFS = nasofrontal suture.
The anterior ethmoidal artery usually courses between the second and third lamellae and is responsible for supplying the anterior ethmoidal cells, the frontal sinus, the anterior third of the nasal septum, and the lateral wall of the adjacent nasal cavity. Embolization might be of significant advantage to prevent a large amount of operative blood loss during the surgical procedures for large tumors of the ACF, especially for highly vascular neoplastic lesions. Embolization for anterior and posterior ethmoidal arteries is usually performed through the ophthalmic artery. During the interventional procedure, the rate of visual compromise is up to 10%. The brain retraction during the application of Level I, II, and III craniofacial approaches might be diminished by a broad removal of the bone in the cranial base and proper and early exposure of arterial feeders. When endovascular embolization is not feasible, the early control of blood supply to the tumor minimizes blood loss and leads to decreased surgical risk. In a large series of cranial base tumors, 12% of patients were not eligible for embolization because a suitable vessel was not available. It was reported that 9% of patients had experienced permanent major complications, and 12.6% of patients presented minor neurological complications. In general, we prefer no preoperative embolization of the meningiomas involving the ACF to avoid additional risk of the embolization procedures.

Three important locations exist for proximal microsurgical access to these vessels. One location is in the

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**Fig. 10.** Case 4.  
A: Preoperative T1-weighted postcontrast coronal MR images showing a large anterior skull base meningioma extending into the nasal cavity.  
B: Intraoperative photograph showing the final view after removal of the tumor.  
C: Postoperative T1-weighted postcontrast coronal MR image demonstrating gross total-tumor resection at the 6-month follow-up.

**Fig. 11.** Color demonstration of the bifrontal craniotomy along with osteotomies for the Level III approach is shown on a dry skull.

**Fig. 12.** Cadaveric dissection showing the exposure of the zygoma (Z) and superolateral orbital rim. The temporalis fascia (TF) has been elevated in the subfascial plane between the muscle and deep fascia.
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lamina papyracea of the medial orbital wall at the anterior ethmoidal foramen,¹ which is located 32 mm on the right side and 34 mm from the middle point of the nasofrontal suture in our study (Fig. 9D). Another site is at the lateral ethmoid wall as the anterior ethmoidal artery traverses the anterior ethmoidal foramen and travels in the anterior ethmoidal canal (Fig. 16 left). The anterior ethmoidal canal is between the second and third lamellae of the ethmoid sinus, and in 60 of 70 cases it was attached to the base of the cranium.²⁸,²⁹ These findings are consistent with our dissections, showing that the anterior ethmoidal artery usually travels in a bony canal through the ethmoid sinus, requiring careful bone removal at the level of the floor of the anterior cranial fossa to identify and control the anterior ethmoidal artery at the lateral ethmoid wall. A third location for proximal control is extradurally at the cribriform plate (Fig. 16 right).

Level I craniofacial approaches are used to access tumors of the anterior skull base and those that extend into the superior orbital region. It improves the exposure of a traditional bifrontal craniotomy by removing the ledge of bone inferiorly that typically houses the frontal sinuses to create a flat or tangential view along the anterior cranial fossa. Feiz-Erfan et al.¹⁰ recommended a Level I craniofacial approach for tumors located primarily extradurally or for large midline meningiomas. In agreement with their findings, a Level I approach is the most commonly used approach by our group in the resection of large olfactory

**Fig. 13.** A: Final overview of the bifrontal bone flap and nasoorbital bar in a Level III approach. B: Approximately 2.5 cm of the orbital roof should be included for supraorbital osteotomies. C: The final extradural exposure of the anterior cranial fossa, both globes (G), and ethmoidal sinus via a Level III approach in a cadaveric specimen. D: A Level III approach facilitates the lateral retraction of the globe. SON = supraorbital nerve; SpS = sphenoid sinus.

**Fig. 14.** Case 5. Preoperative T1-weighted postcontrast coronal (A) and axial (B) MR images showing a giant mass lesion located in the ACF, invading the nasopharynx, paranasal sinuses, sella turcica, sphenoid sinus, and nasal cavity. Postoperative T1-weighted postcontrast sagittal MR image (C) demonstrating gross-total tumor resection.
groove or planum sphenoidale meningiomas reaching approximately 5 cm in size and associated with extensive vasogenic edema (Figs. 6 and 8). Although some authors would use unilateral approaches in these meningiomas, we believe a Level I approach significantly minimizes brain retraction, gives direct tangential view to the lesion, and carries minimal to no risk for cosmetic problems in our hands (data not shown). The disadvantage of this approach over pterional or cranioorbital approaches is that the surgeon remains blind to the optic nerves and internal carotid arteries in the early stage of microsurgical dissection.

Level II and III craniofacial approaches provide additional inferior exposure. Removal of the nasal complex provides wider access to the nasopharynx, the ethmoid and sphenoid sinuses, and the clivus (Fig. 17). A Level III craniofacial approach was developed to access large anterior cranial fossa lesions, nasopharyngeal lesions, and clival lesions with anterior extension. This approach is similar to the Level II approach but is augmented by including the lateral orbital wall on the frontonasal fragment. The addition of a lateral orbital wall osteotomy facilitates retraction of the globes, an otherwise potentially hazardous maneuver that can be associated with diminished vision. This approach potentially decreases retraction pressure on the globes, and in addition it allows exposure of lesions with lateral extension into the superior and inferior orbital fissures and medial aspect of the infratemporal fossa. Level II and Level III craniofacial approaches offer slightly more exposure of the clivus than the Level I approach. However, at present, we rarely use these 2 approaches because of the...
extensive work and associated cosmetic problems in the postoperative period. When performing a Level II or III approach on a tumor that does not involve the cribriform plate, the integrity of the cribriform plate and olfactory nerves can be preserved. A circumferential cribriform plate osteotomy permits greater exposure because it is easy to see beyond the cribriform plate onto the planum sphenoidale. This technique also reduces the risk of CSF leak and preserves olfaction. Chandler et al. found this maneuver to hinder their approach and not result in clinically significant preservation of olfaction.

Anterior approaches to midline skull base lesions have important advantages. First, these techniques capitalize on a midline plane, which is relatively avascular and critical neurovascular structures do not represent obstacles. Second, the direction of the surgery is straight at the bulk of the lesion with a short working distance. Facial incisions are seldom needed, and facial degloving and disassembly are far less complicated than expected. Craniofacial approaches provide the neurosurgeon the greatest chance of preserving neurological function and completely resecting the lesion. The absence of intraoperative shifts in skull base surgery provides the opportunity to use neuronavigation reliably and accurately and enhance the surgeon’s ability to localize and verify the anatomical structures.

The use of the endoscope in addition to the surgical microscope has been reported to afford a wide panoramic view in the depths of the surgical field. Pure endoscopic approaches have emerged as a feasible alternative to the craniofacial resection. They are reported to have comparable results in terms of the extent of resection and superior results in terms of the complication and recurrence rates, hospital stay, and the added benefit of desirable cosmetic outcomes in selected cases. However, in most of the cases with a malignant skull base pathology, open resection is still the best option to achieve oncological resection, which is the primary prognostic indicator. Moreover, in some selected cases the endoscope can also be used as an adjunct to craniofacial approaches to reduce bone removal and to provide an inferior trajectory.

Conclusions

Craniofacial resections are best performed by a multidisciplinary team comprising a neurosurgeon, a craniofacial surgeon, and an otolaryngologist. Craniofacial approaches to the midline skull base provide access for the safe removal of complex lesions. A better understanding of the interaction of surgical anatomy with the nature and extent of the lesion, along with refinements of each approach, are of great importance in improving outcomes and avoiding complications.

Disclosure

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

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