



Transfacial approaches to the clivus

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The clivus is centrally located in the skull base surrounded by critical neurovascular structures making surgical access difficult. Several approaches to this region have been described. Herein we discuss the transfacial approaches to the clivus with emphasis on endoscopic approaches.

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The clivus is composed of the posterior inferior portion of the sphenoid bone and basilar portion of the occipital bone. This anatomical region separates the nasopharynx from the posterior cranial fossa. It can be divided into upper, middle, and lower thirds. The intracranial portion abuts the pons at its upper third, whereas the extracranial surface faces the upper nasopharynx. The petroclival fissure separates the upper and middle thirds from the petrous portion of the temporal bone bilaterally. Between 2 dural layers at the upper clivus, sits the basilar venous plexus. This plexus connects with the inferior petrosal sinuses laterally, the cavernous sinuses superiorly, and the marginal sinus and epidural venous plexus inferiorly.

Indications

Clival lesions are of varied pathology and clinical behaviors. Their location and proximity to critical structures make operative management challenging. While preoperative imaging is paramount, in most cases their radiographic appearances are not pathognomonic necessitating tissue diagnosis. While gross total resection is the goal when feasible, both patient and tumor factors should be considered.

At our institution, both magnetic resonance imaging and fine-cut computed tomography scans are taken and used

intraoperatively for image guidance (Medtronic Fusion, Minneapolis, MN). Magnetic resonance imaging is utilized to confirm the relationship of the tumor to critical structures. Fine-cut computed tomography elucidates the bony anatomy and can be coupled with angiography to highlight the relationship to vascular structures. Preoperative evaluation should also elicit any previous nasal or cranial surgeries and document a thorough ophthalmologic (including visual field testing) and cranial nerve examination.

Techniques

Open approaches

Anterior transfacial approaches to the clivus were originally described in the 1960s to address intracranial pathology, mainly vertebrobasilar aneurysms.¹ Transfacial approaches broadly include the transseptal or transsphenoidal, transmaxillary, transoral-transpalatal, transmandibular, facial translocation, and endoscopic endonasal approaches.

While transfacial approaches offer a more direct approach, the risks of cerebrospinal fluid (CSF) leak and concern for contamination of the intracranial compartment have limited most of these approaches to extradural lesions.² While these approaches have the benefit of traversing the mostly aerated spaces of the nasal cavity, nasopharynx, oral cavity, and oropharynx, these approaches are limited by the indirect access to critical neurovascular structures such as the internal carotid artery.

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Transmaxillary approaches

The lateral rhinotomy approach can provide unilateral access to the maxillary or ethmoid regions, anterior sphenoid, nasopharynx, and pterygopalatine fossa.³ Lesions that involve this region and extend to the clivus are suitable for this approach; however, extensive lesions or those with inferior extension likely require more access. The midfacial degloving approach is utilized for most clival lesions as it affords midline access with excellent visualization.⁴ This approach is combined with a medial maxillectomy and resection of the ascending process of the palatine bone to provide visualization of the nasopharynx and sphenoid face. Alternatively, a Lefort I osteotomy can be utilized to provide a more inferior exposure.

The patient is intubated via the transoral approach. Preoperative antibiotics should be administered based on surgeon preference. After infiltration of local anesthetic with vasoconstrictors, the initial incision is made in the upper buccal sulcus sparing a minimum of 3 mm of mucosa above the gingiva. Dissection is taken down to the anterior maxilla and the periosteum is incised. A freer is then used to elevate superiorly to expose the piriform apertures bilaterally. Endonasal incisions are then made and the skin of the nose is elevated from the underlying cartilages using a cotton-tipped applicator and sharp scissors.

Once exposure of bilateral maxillary sinuses is obtained, oscillating saw is used to remove the anterior maxilla over to the infraorbital foramen. Depending on the extent of exposure needed, the cuts can be connected to the orbital rims bilaterally. Septectomy and external ethmoidectomies are then performed to expose the sphenoid face and nasopharynx. The mucosa is then incised in the midline and elevated laterally off of the clivus. Alternatively, an inferiorly based mucosal flap can be made. Dissection of the tumor can then proceed using microsurgical instruments as needed. Closure is performed by reapproximating the dura and mucosa. The bone can be replaced with midfacial plating sets. Predrilling is helpful if performed prior to initial bony cuts and can speed up reconstruction. The intraoral incision is then closed and both internal and external splints can be used to support the nasal reconstruction.

Transoral approaches

For lesions of the clivus that extend to the upper cervical vertebrae, a transoral or transpalatal approach can be utilized. If necessary, this can be combined with a mandibulotomy and parapharyngeal space dissection. A benefit of this approach is that it affords safe dissection of the parapharyngeal space carotid and vascular control for tumors, which originate centrally but extend lateral to the internal carotid artery. Alternatively, lateral approaches may be utilized.

For exposure of the entire central skull base, the midfacial split approach has been described.⁵ In this approach, the entire midfacial skeleton is displaced, including bilateral maxillas, the orbital floors, and the palate. Reconstruction of

the central skull base is most often accomplished with a pericranial or temporalis flap.

Endoscopic approach

With advancements in endoscopic visualization, microsurgical dissection techniques, and pedicled reconstructive options, there has been a trend toward endoscopic management of clival lesions. While the majority of the initial dissection is done with standard endoscopic sinus surgical instruments, expanded endonasal approaches to the clivus do require special instrumentation. We find a Mayfield head clamp to be particularly helpful in providing complete immobilization, a requirement for fine work near critical structures. A 0° endoscope is normally all that is needed for exposure; however, angled scopes can be helpful for visualization around structures. Multiple high-definition monitors allow for ergonomic head positioning for both operating and assisting surgeons in the 4-hand technique. Some surgeons find irrigating sheaths helpful, although these are not required. Multiple sizes of Kerrison rongeurs are useful for removing bony partitions of the skull base and providing a wide exposure. A high-speed drill with extended 4 mm round course diamond burr is utilized for drilling of the sphenoid septations and skull base.

For the soft tissue dissection, the kassam/snyderman take-apart bipolar forceps (Karl Storz, Germany) are particularly useful for hemostasis. Owing to the 20-cm working length, deep anatomical regions can be easily addressed. In addition, microdissection instruments with extended reach are required to perform the tumor resection and mobilization. A full set of suction devices that allow for the suction intensity to be regulated, such as Fukushima suction, are paramount and can be used to perform a significant portion of the dissection. If a nasal septal flap is considered for closure, and extended length needle-tip bovie with the tip bent 70° is utilized for harvesting.

Patient positioning and preparation

The patient is positioned supine with the head in a neutral position. In these expanded approaches, a Mayfield head holder is utilized for complete immobilization during detailed drilling and dissection near critical structures. Neuromonitoring may be used in select cases. Oxymetazoline-soaked pledgets are placed bilaterally to decongest the nasal cavity. All patients are given a third- or fourth-generation cephalosporin (clindamycin if allergic) for antibiotic prophylaxis. The bed (which has been flipped so that the patient's head is at the foot of the bed (allowing placement of pedals underneath) and the bed is then rotated 180°.

Initial exposure

The initial exposure has been extensively detailed previously⁶ and serves to facilitate bimanual dissection,

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