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The far lateral approaches to the craniovertebral junction

N.W.M. Thomas, MD, FRCS(Glas), FRCS(Eng) Surgical Neurology

From the Head of Skull Base Surgery, Department of Neurosurgery, King's College Hospital, London, UK

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Access to pathologies at the craniovertebral junction can be achieved with a number of approaches; all should avoid manipulation of the neural structures. In much the same way as an orbito-zygomatic approach is used to augment fronto-temporal access and reduce brain retraction and a trans-labyrinthine approach is chosen rather than a retrosigmoid approach to a vestibular schwannoma, so bone at the foramen magnum, including condyle, can be removed to improve access to structures ventral to the brainstem and the spinal cord. Large tumors may create a corridor of access allowing a more posterior approach to be employed. Smaller tumors and pathologies that do not distort the brain may, however, require more bone removal along with mobilization of the vascular structures, particularly the vertebral artery and occasionally the jugular tubercle. The far lateral approach with partial condylectomy and vertebral artery mobilization is described as the preferred access.

Pathologies at the craniovertebral junction present technically demanding surgical challenges. Tumors and vascular anomalies are often ventral to the brainstem and spinal cord and the planned surgical approach should avoid neural retraction. The direct posterior approach may not adequately expose the surgical target without neural manipulation and the attendant risk of neurologic injury but has been described for anterior foramen magnum meningioma resection.[1] The transfacial and transoral approaches have largely been reserved for extradural pathology and although intradural lesions have been addressed by this route there remains the significant risk of cerebrospinal fluid leak and subsequent meningitis[2]; the anterior approach has, however, received renewed interest with the introduction and development of the extended transnasal endoscopic approach and better dural closure techniques although lateral access is still limited by the carotid arteries.[3,4] The retropharyngeal approach may provide a limited exposure unless combined with mandibular mobilization.

The far lateral approach provides a corridor of access to tumors originating from the anterior and lateral foramen magnum, intrinsic brainstem tumors, posterior inferior cerebellar artery (PICA), and vertebral artery aneurysms and other vascular anomalies with the avoidance of retraction of neural elements, therefore overcoming the limitations of the other approaches. In its simplest form, the operation is a retrosigmoid craniectomy placed more laterally and inferiorly than that for exposure of the cerebellopontine angle. This then forms the basis of a variety of other far lateral approach techniques, varying most particularly as to whether there is vertebral artery mobilization or condylar resection to a greater or lesser degree; the far lateral approach therefore encompasses a number of modifications, which can be tailored according to the pathology being treated.

The basic approach (standard or retrocondylar or supracondylar) involves a retrosigmoid craniectomy extending to the foramen magnum with a C1 hemilaminectomy. To gain greater exposure and a more ventral angle of approach, the vertebral artery is mobilized and the condyle is either partially (transcondylar or extreme lateral transcondylar or dorsolateral suboccipital transcondylar) or completely resected (extended transcondylar or complete transcondylar transjugular or complete far lateral suboccipital transtubecular or extreme lateral inferior transcondylar-transtubercular exposure), the latter procedures also involve removal of the jugular process and tubercle.[5-10]

Address reprint requests and correspondence: N.W.M. Thomas, MD, FRCS(Glas), FRCS(Eng) Surgical Neurology, Head of Skull Base Surgery, Department of Neurosurgery, King's College Hospital, London, UK.

E-mail address: nick.thomas1@nhs.net

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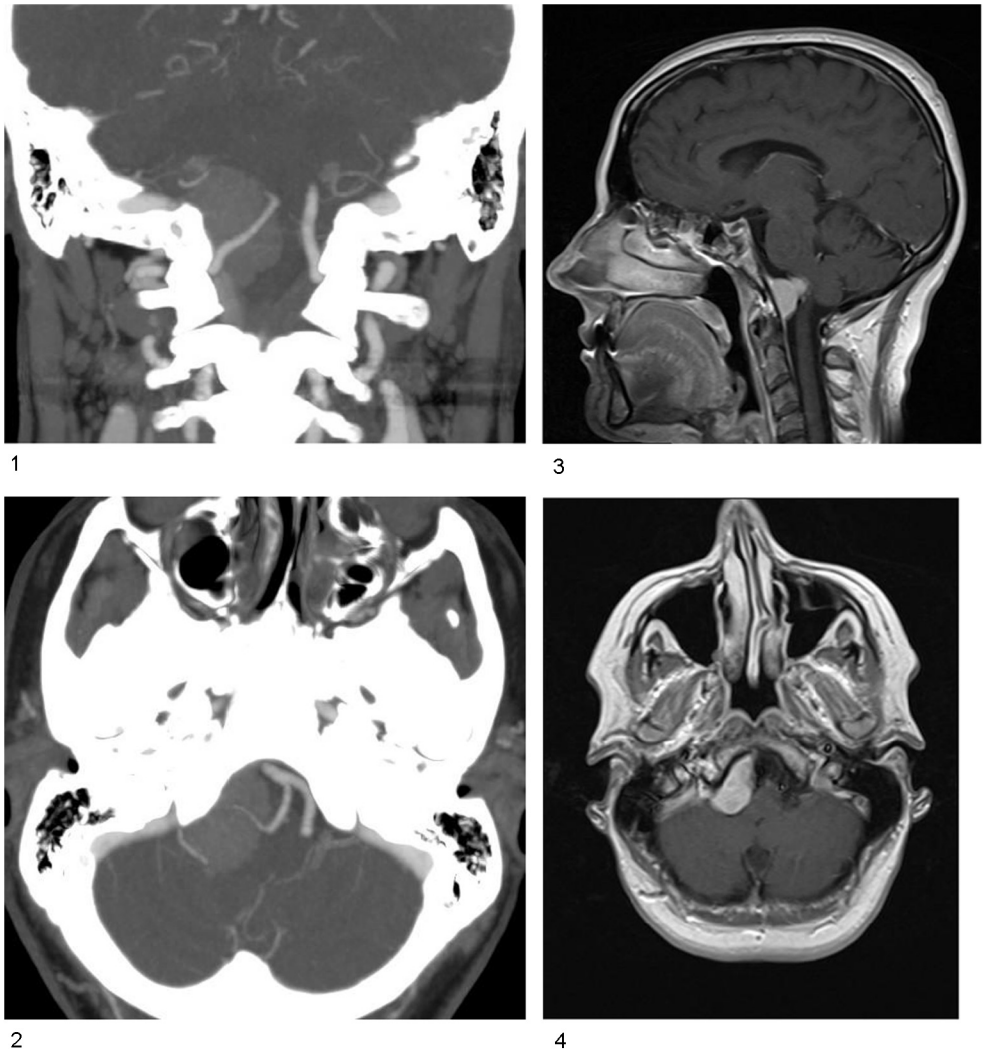

Figures 1-4 (1) CT angiogram demonstrating relationship of meningioma to the intracranial vertebral artery and vertebrobasilar junction. (2) CT angiogram demonstrating relationship of meningioma to the intracranial vertebral artery and vertebrobasilar junction. (3) MRI of right foramen magnum meningioma. (4) MRI of right foramen magnum meningioma.

Preoperative assessment and investigations

Full documentation of the function of the relevant cranial nerves is required preoperatively. Lower cranial nerve dysfunction may not be readily apparent and assessment of vocal cord function with laryngoscopy should be considered. A combination of magnetic resonance imaging and computed tomography imaging is useful to delineate the anatomy (Figures 1-4); if occipitocervical fixation is being considered, fine-cut computed tomography of the atlas and axis is required to identify relevant points of fixation and the position of the vertebral artery and its branches. Digital subtraction angiography, magnetic resonance angiography, and computed tomography angiography identifies vascular anatomy, the dominance of the vertebral arteries and their branches, and is important both as part of the exposure and for vascular pathology. The V3 segment of the vertebral artery extends from the C2 transverse process to the dura, and the V4 segment from the dura to the junction with the basilar artery. Along the V3 segment there are muscular branches, the C2 radicular artery, the posterior meningeal artery, and the posterior spinal artery. The PICA has an extradural origin from the V3 segment in 20% cases. The posterior spinal artery has a variable origin from the distal V3 segment just before entering the dura, the V4 segment or from the PICA.[10]

Surgical technique

Lumbar drainage

Although lumbar drainage is not used routinely in our practice, it can be considered for certain lesions particularly where it is anticipated that dural closure might be difficult and there is a high risk of postoperative cerebrospinal fluid (CSF) leak. With careful drainage of CSF, the risk of significant tonsillar herniation is small.