Surgical Strategies to avoid complications in large anterior clinoidal meningiomas involving the internal carotid artery

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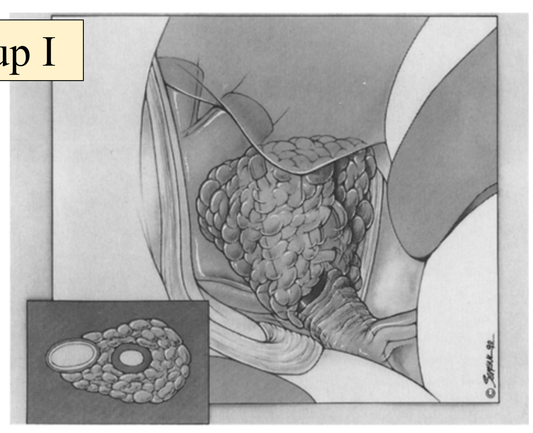
Background:
Anterior clinoidal meningiomas remain a challenging pathology because of their intimate relationship to vital neurovascular structures. Preoperative visual status, duration of symptoms, lesion size, and adherence to internal carotid artery (ICA) and its branches have been shown to be significant determinants of postoperative outcome and there is still a risk of serious complications in the case of a large or huge lesion with major vessels encasement.

Objectives:
The aim of this article is to discuss surgical strategy for large clinoidal meningiomas involving ICA and the perforating branches.

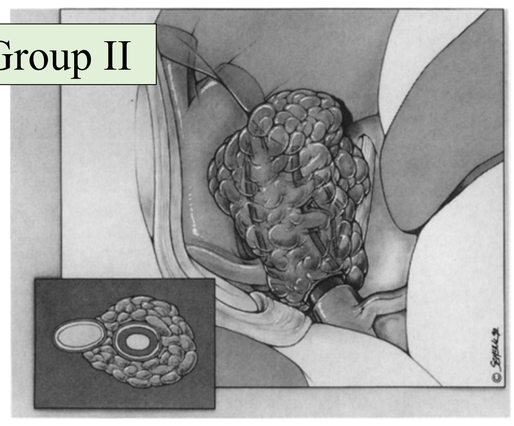
Materials & Methods:
Our experience with large meningiomas involving ICA will be classified using the Al-Mefty classification (*J Neurosurg* 73:840-849,1990), and treatment strategies for each classification will be discussed based on preoperative symptoms, preoperative imaging, and surgical findings.

Group I



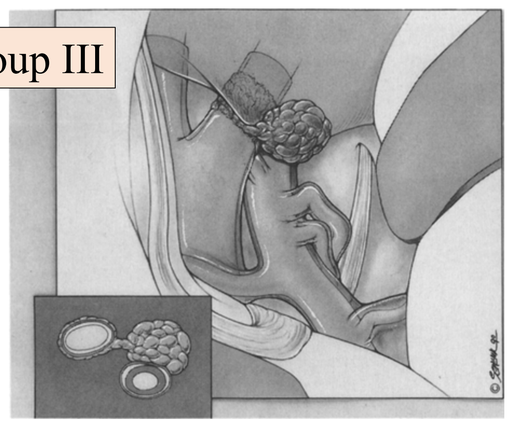
A meningioma originating from the inferior aspect of the anterior clinoid

Group II



Tumors originate from the superior and/or lateral aspect of the anterior clinoid above the segment of the carotid invested in the carotid cistern.

Group III

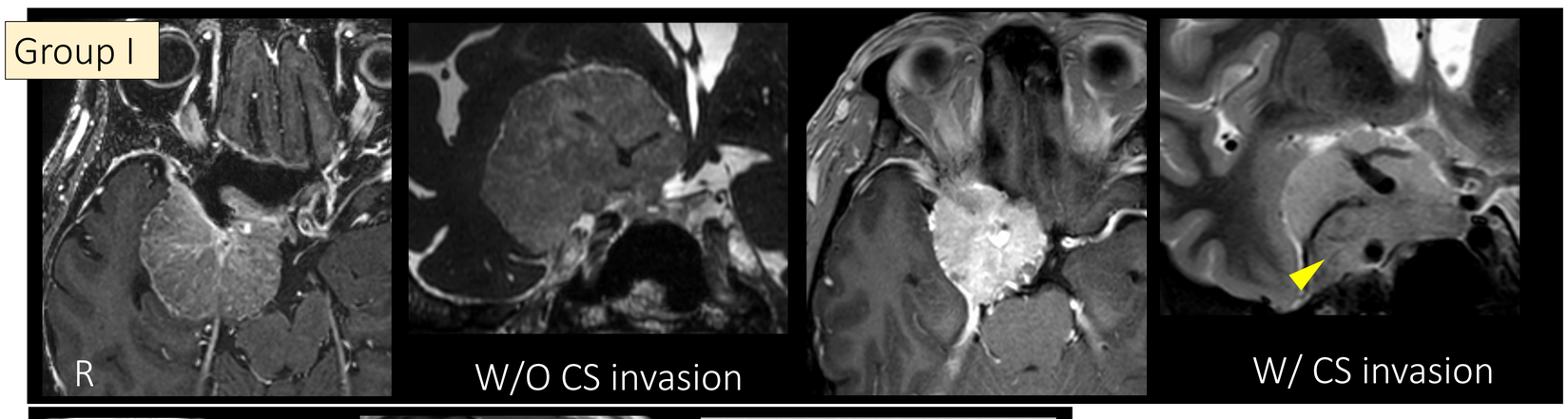


Tumors originate at the optic foramen, extending into the optic canal and the tip of the anterior clinoid process.

Results:
7 cases of large clinoidal meningioma involving ICA were treated between 2020 and 2024 in the Department of Neurosurgery at Hiroshima University Hospital, retrospectively. 4 cases were woman, and median age was 71 years. The diameter of the tumors was 47 mm in median (range 35 – 57mm). With an infraclinoid origin (Al-Mefty Group I) with or without cavernous sinus invasion, some tumors were directly adhered to the adventitia of carotid artery in the absence of an intervening arachnoid membrane. Surgical strategies were required early optic nerve decompression and preservation of important vessels and perforating branches. When we had difficulty in removing the tumor with sparing the perforating branch, determining whether the arachnoid remains around the perforating arteries was critical to the success of the surgery, and sometimes the decision to allow the tumor to remain was necessary. 3D-DSA and high-resolution MRI fusion images were used to identify the ICA perforating branch within the tumor. With large tumor involving the ICA and middle cerebral artery (MCA), it was better to proceed with surgery as a ”pincer” approach from both the central and peripheral sites.

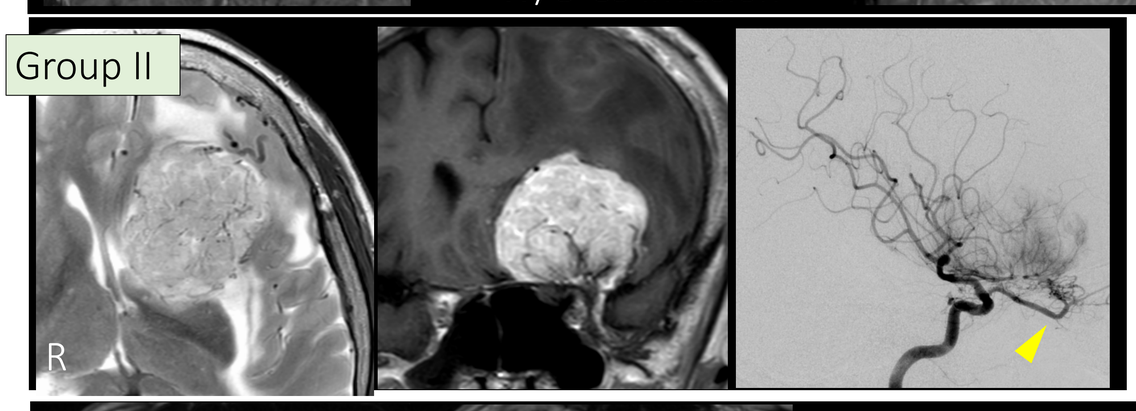
Discussion:

Group I



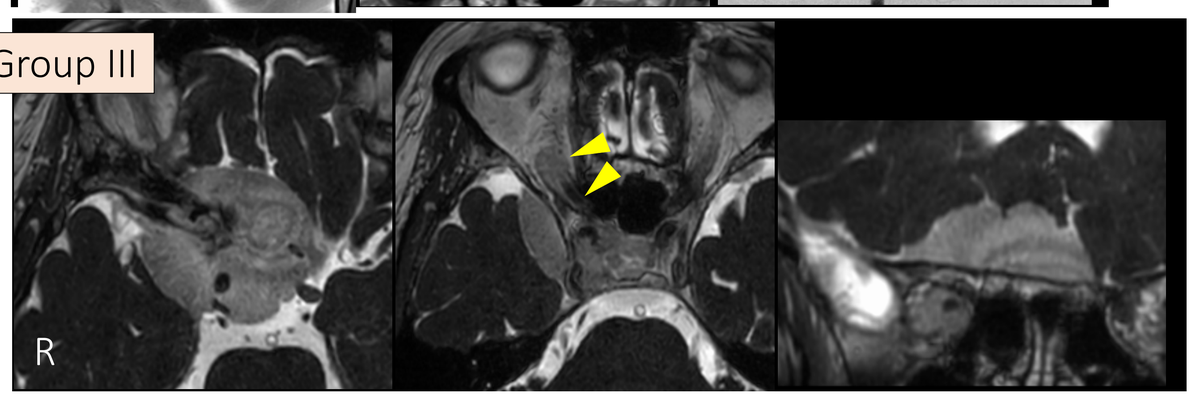
In some cases of Group I, preoperative DSA showed wall irregularities in the ICA running within the tumor, and direct invasion to the carotid artery wall was suspected. It was difficult to remove the tumor in the cavernous sinus and to excavate the perforating branches of ICA, ACA, and MCA from the tumor, so some of tumor adherent to the perforating branches had to be left behind.
(arrows: intra-cavernous sinus tumor)

Group II



Although the two cases in Group II were both large tumors (approximately 5 cm), hemorrhage could be controlled by removing the anterior clinoid process and opening the optic nerve tract from the epidural prior to intradural manipulation, as well as by treating the tumor feeding vessels. The subarachnoid space remained around the ICA and optic nerve, and adhesions were mild.
(arrows: vascular epicenter of the tumor)

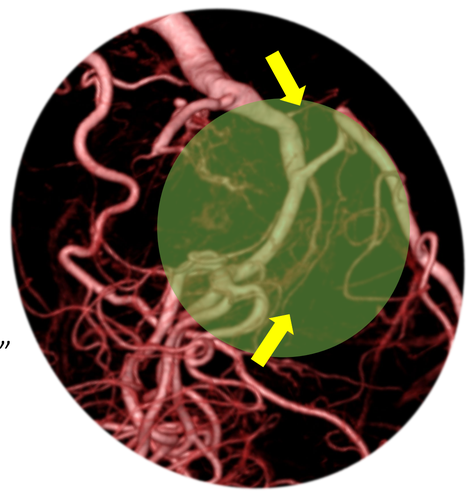
Group III



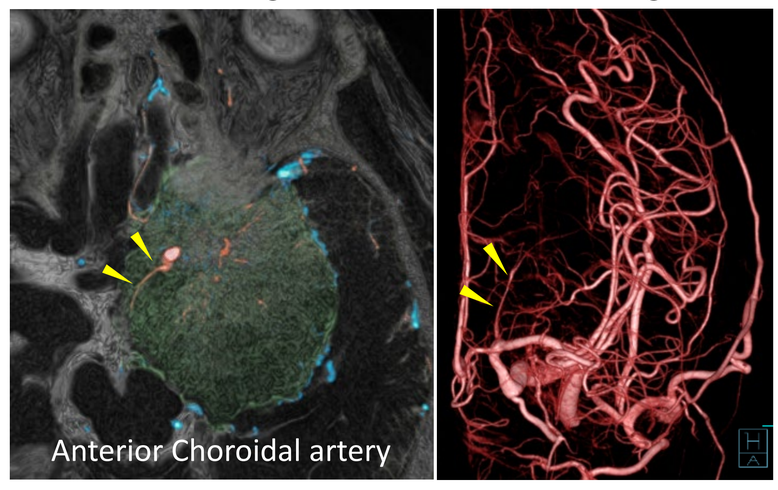
In Group III, the tumors had invaded into the orbit along the optic canal even though the tumors were relatively small, resulting in postoperative deterioration of visual function in one case.
(arrows: tumor invading into optic canal and orbit)

”Pincer” approach

In large tumors involving the ICA and MCA and their perforating branches, we dissected along the vessels with “pincer approach” from both the central and peripheral side.



3D-DSA and high-resolution MRI fusion images



Conclusion:
Treatment of large anterior clinoidal meningiomas that involve the optic nerve, intracranial large vessels, and perforating branches is still challenging. Group III tumors can result in visual deterioration, and perforating branch avulsion from the tumor carries a potential risk of stroke. We assess the risk of resection based on the originating location of the tumor before surgery, and remove the tumor while making full use of conceivable modalities (nerve monitoring, ICG videoangiography, microdoppler,,,) and promising microsurgical techniques.

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