Acta Neurochir (Wien) (1988) 92: 76–82

Acta Neurochirurgica

Cavernous Sinus Surgery
Approach Through the Lateral Wall

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Summary

The cavernous sinus is divided from the surgical point of view into three parts. The middle part consists of the lateral sinus wall, the cranial nerves III, IV, V, VI and the posterior siphonknee of the internal carotid artery. Lesions of this region, vascular as well as tumorous, can be exposed by approaching the lateral sinus wall. The surgical dissection through the sinus wall is based on some important anatomical details, which are described here. As a consequence a modified transcavernous approach will be introduced and demonstrated by 35 clinical cases.

Keywords: Cavernous sinus; skull base surgery; surgical anatomy; trigeminal nerve.

Introduction

The explosion-like development of technical standards in and around neurosurgery has led to a good solution of some of the almost untreatable problems without too much risk to the patient. One of these problems are the lesions of the cavernous sinus. Improved microtopographical knowledge, supported by excellent neurodiagnostics and modern neuroanaesthesia allows the surgical approach to cavernous sinus lesions with low surgical mortality and morbidity.

From a surgical point of view, the cavernous sinus can be divided into three parts (Fig. 1). The *anterior part* corresponds to the para-infraclinoidal portion and is mainly connected with the problems of surgery of para- and infraclinoid aneurysms[8, 9]. The *middle part* represents the field of the lateral sinus wall consisting of the cranial nerves III, IV, V and the underlying posterior knee of the carotid siphon with the abducent nerve. Previous papers[1, 4–6]dealing with the surergy of the lateral sinus wall underlined the high risk of the approach to this part. Anatomical studies[5, 7, 10, 12] and recent surgical reports [2, 11] showed the possibility of a safe surgical dissection in this region. The present paper will describe the surgically relevant anatomical details of the lateral cavernous sinus wall and demonstrate the surgical technique by refence to 35 surgically treated cases.

Anatomy

The lateral wall of the cavernous sinus consists of two layers. The superficial layer covers the cranial nerves III, IV, and V, which are fixed more to the fibres of the deep layer of the wall. On the other hand the deep layer is connected to the connective tissue of the trabeculae of the cavernous sinus (Fig. 2). This anatomical situatuion allows dissection of the superficial layer of the sinus wall without tearing the underlying cranial nerves and without opening the venous space. So the Gasserian ganglion and the peripheral divisions of the trigeminal nerve can be visualized. The fibres of the nerve can be held away and the deep layer of the sinus wall can be demonstrated (Fig. 3). The flaplike

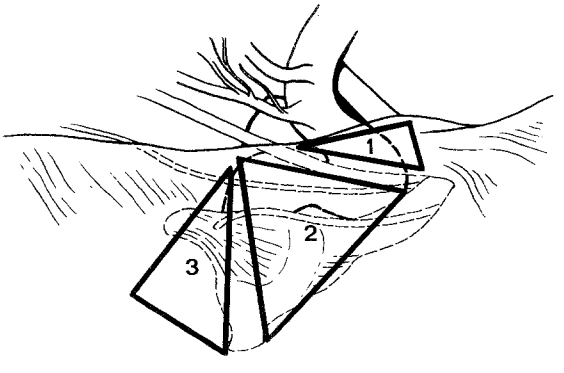


Fig. 1. Schematic presentation of the three surgical parts of the cavernous sinus. *1* anterior part, *2* midportion (lateral sinus wall), *3* posterior part

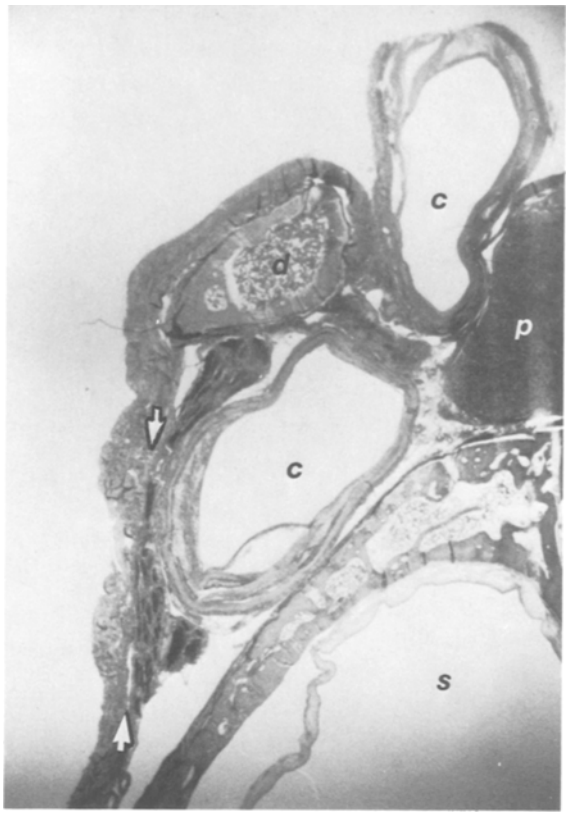


Fig. 2. Histology of a transverse section of the anterior portion of the cavernous sinus demonstrates the two layers of the lateral wall (arrows) of the sinus. *c* internal carotid artery, *d* anterior clinoid process, *p* pituitary gland, *s* sphenoid sinus

dissection of the superficial layer makes possible the closure of the lateral sinus wall at the end of the procedure.

Surgical Technique

The exposure of the lateral wall of the cavernous sinus usually can be carried out by the pterional approach. In different tumour cases, however, where the extension of the process is reaching more to the floor of the middle cranial fossa, a subtemporal approach is necessary. In cases where tumour growth is located more in the direction of the superior orbital fissure, we use an orbito-pterional exposure (Fig. 4). If the lesion is located more in the midportion of the cavernous sinus, extending posteriorly or laterally, we prefer the subtemporal approach. The mobilisation of the zygomatic arch (Fig. 5) allows a good basal overview of the region without too much retraction of the temporal lobe.

After exposure of the lateral-sinus wall the intracisternal portion of the oculomotor nerve has to be defined. The direction of the course of the oculomotor nerve is a guide to the first incision in the lateral wall. The initial cut will be carried out about 3 mm basally to the entrance of the nerve into the dura and parallel to the course of the nerve (Fig. 6). From thence the superficial layer of the lateral wall can easily be sep-

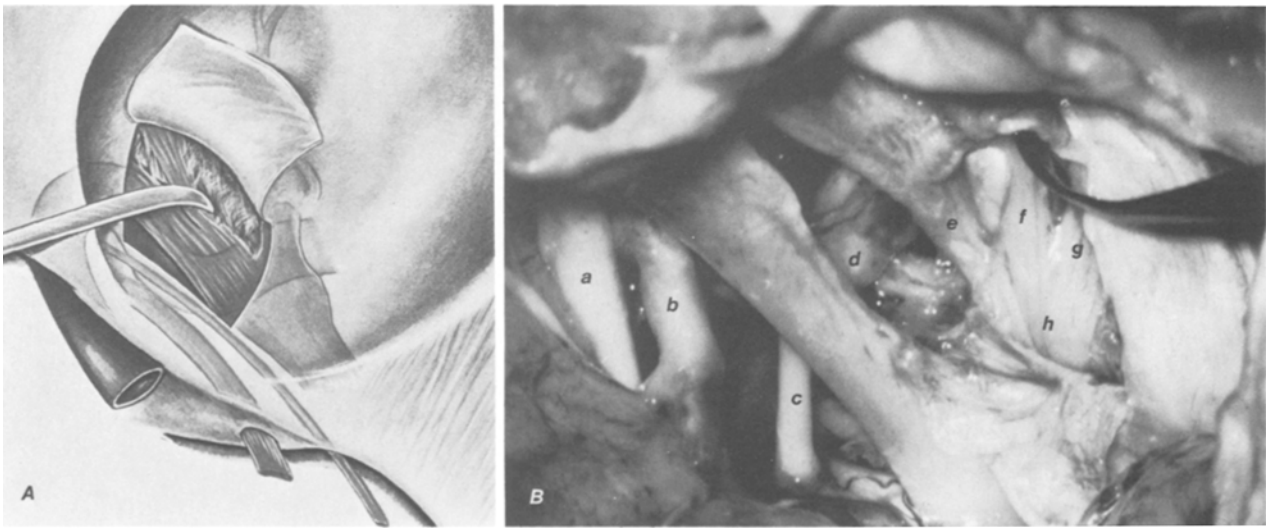


Fig. 3. A) Schematic drawing of the flaplike opening of the superficial layer of the cavernous sinus wall. B) Anatomical dissection of the right cavernous sinus wall. Surgical view. Opening of the superficial layer of the dura. *a* right optic nerve, *b* internal carotid artery, supraclinoidal segment, *c* oculomotor nerve, *d* internal carotid artery, intracavernous segment, *e* ophthalmic nerve, *f* maxillary nerve, *g* mandibular nerve, *h* Gasserian ganglion

arated by blunt dissection from the Gasserian ganglion and the different divisions of the trigeminal nerve. If the lesion is located medially to the nerves, the nerve fibres can safely be held to the side and the tumour can be resected between the different divisions of the

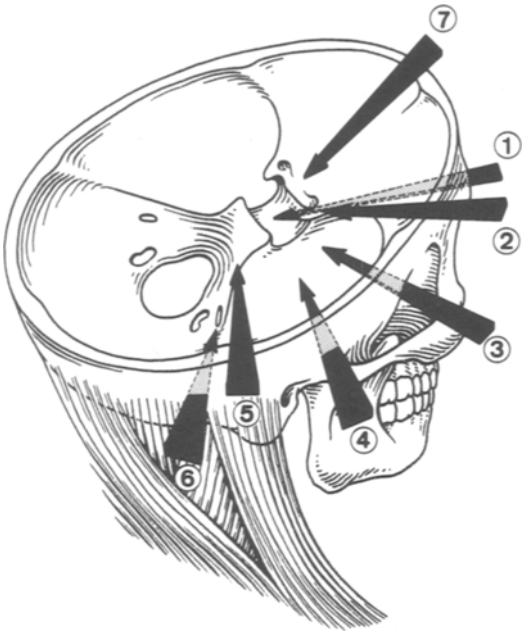


Fig. 4. Scheme of the different approaches to the cavernous sinus region we use. *3* Anterior subtemporal approach. Can be combined with No. *2* and extended to an orbito-pterional approach. *4* Mid-subtemporal exposure, we use for approaching the lateral sinus wall and the posterior aspect of the sinus with dissection of the intrapetrous internal carotid artery. *1* Transnasal approaches, *2* Fronto-latero-basal and pterional approaches, *5* Posterior subtemporal approach, *6* Combined supra-infratentorial exposure extradurally, *7* Frontal interhemispheric approach

trigeminal nerve (Fig. 7A). In cases where the intracavernous portion of the internal carotid artery is involved, at first the intrapetrous portion of the internal carotid artery must be exposed (Fig. 7B). For this exposure, at first the middle menigeal artery has to be coagulated and the greater superficial petrosal nerve transsected in order to prevent traction on the geniculate ganglion. Using a diamond drill with continuous irrigation the carotid canal must be unroofed. The dissection of the petrous segment of the carotid artery belongs to the extradural steps of the procedure.

Venous bleeding from the cavernous sinus can be controlled easily by packing the sinus around the carotid artery with oxycellulose (Surgicel, Tabotamp). The canal of the Eustachian tube and the petrous portion of the carotid artery should be covered with a muscle flap in order to prevent possible CSF leak. If the flaplike dural opening is used, the lateral wall of the cavernous sinus can be closed by sutures. In cases in which a defect of the lateral wall remains, we cover it with oxycellulose and fibrin glue.

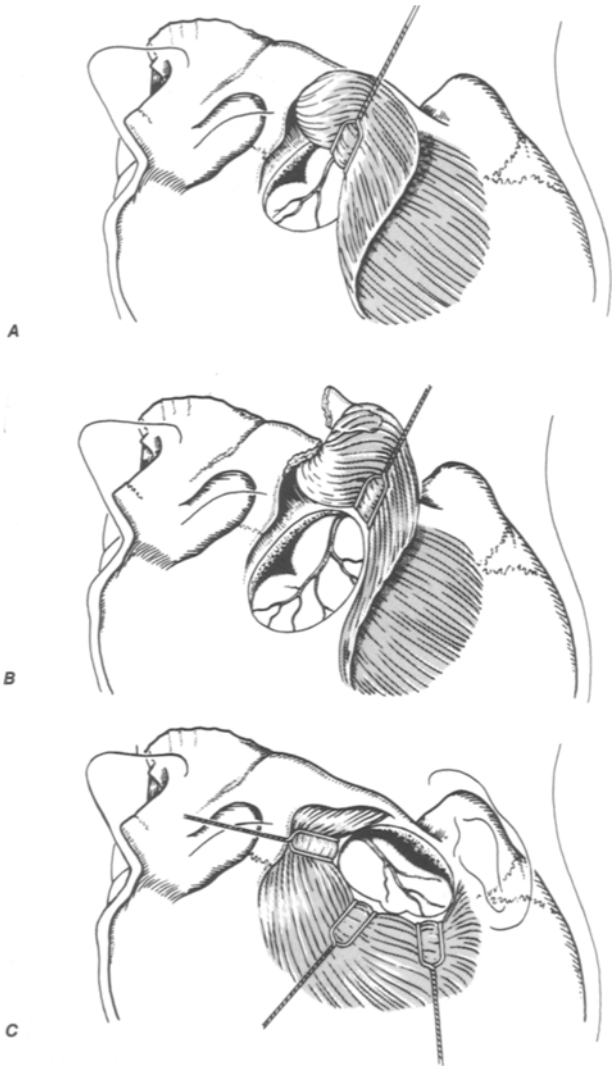
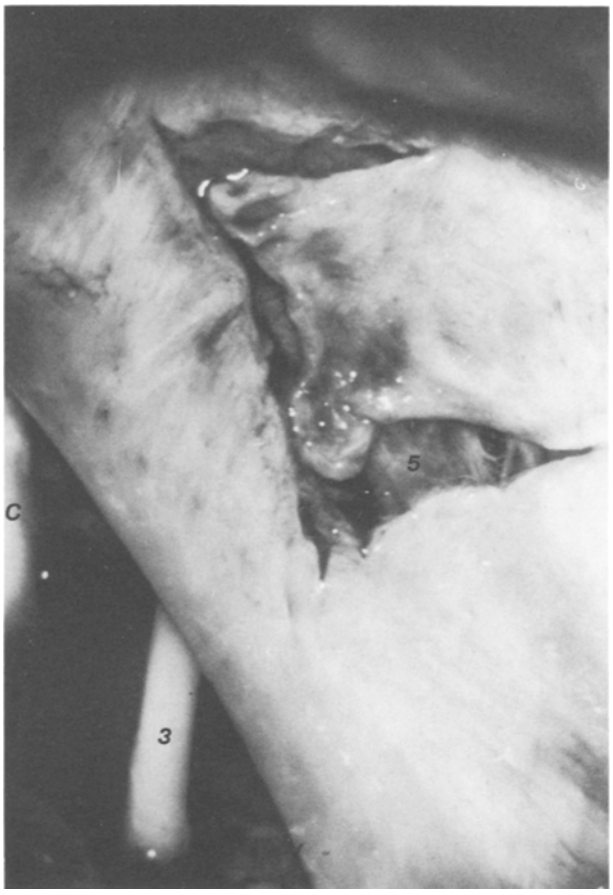


Fig. 5. A) and B) are the approaches we use for the anterior and midpart dissection of the cavernous sinus. Observe in B the diveded zygomatic arch. The approach B can be extended to an orbito-pterional exposure by resection of the lateral wall of the orbit. C) Approach to the middle and posterior part of the cavernous sinus including exposure of the intrapetrous carotid artery segment. In all three variants the blood and nervous supply of the temporal muscle is preserved

Material and Results

Between 1980 and June 1987 we carried out an intraoperative dissection of one or more parts of the



cavernous sinus in 66 cases. The pathology of the lesions operated on is given in Table 1.

Table 2 clearly shows that in the anterior cavernous sinus portion the vascular lesions are predominant and in the midpart of the sinus the tumorous processes are most frequent. Among the 35 cases, where the midpart of the sinus was dissected, there were only 2 vascular lesions.

In all 35 cases with midpart dissection major preoperative cranial nerve symtoms existed. When the anatomical continuity of the involved nerve could be preserved, postoperative improvement in its function was observed in most cases. The most vulnerable nerve seems to be the trochlear nerve and this nerve showed only a poor tendency to recovery. The other nerves, particularly the oculomotor nerve, have a good regenerative capacity.

Fig. 6. Flaplike opening of the lateral wall of the right cavernous sinus. Surgical view. *C* internal carotid artery, supraclinoidal segment. *3* oculomotor nerve, *5* trigemial nerve. The superficial layer of the lateral wall can be lifted without tearing of the underlying trigeminal nerve

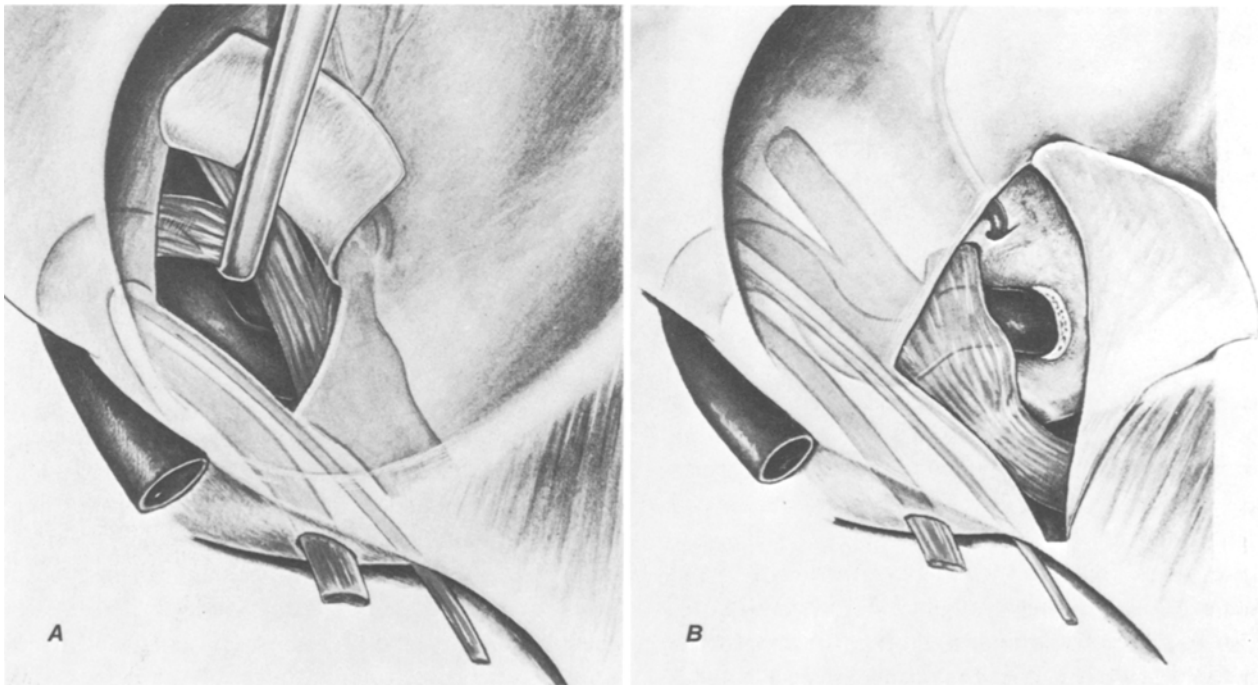


Fig. 7. Schematic presentation of the lateral wall of the sinus. Approach on the right. A) The fibres of the trigeminal nerve can be safely held to the side and further dissection medially from the lateral wall is possible. B) Approach to the posterior part of the cavernous sinus with unroofing of the carotid canal in the petrous bone behind the entrance of the middle meningeal artery

Two patients died in the first postoperative week. An 80 year old woman and a 68 year old man, both with pneumonia. Both had a meningioma of the lateral wall of the cavernous sinus and neither pationt could be mobilized early enough after surgery because of hemiplegia present prior to surgery.

The analysis of the surgical morbidity showed in two cases oculomotor palsy, in two cases trochlear palsy. In one pationt contralateral hemiparesis appeared and in another patient homonymous hemianopsia occured because of a temporal lobe lesion.

In two cases with skull base carcinoma the patency of the internal carotid artery could not be maintained. In both cases there were no postoperative ischaemic symptoms.

Table 1. *Pathology of Cavernous Sinus Lesions Operated on (between 1984–1987)*

			No. of cases
Aneurysm:	— para- and infraclionoid		24
	— intracavernous (giant aneurysms: 11)		2
			26
Tumour:	— Meningioma	— medial sphenoid wing	4
	— petrous bone, clivus	12	
	— orbit	1	
	— Pituitary adenoma	8	
	— Skull base tumours	— Carcinoma	3
		— Chondrosarcoma	3
		— Chondroma	1
		— Neurinoma	2
		— Cholesteatoma	2
		— Dermoid	2
		— Cylindroma	1
		— Plasmocytoma	1
			40

Discussion

The direct surgical approach to the cavernous sinus was first demonstrated by Browder[1] in one case of a carotic-cavernous fistula. Later excellent descriptions by Parkinson[5, 8] and Johnston[4] showed the possibility of direct surgery in the cavernous sinus region. Further development of microtopographical knowledge[7, 10, 12] and surgical techniques allowed more aggressive tactics during surgical treatment of cavernous sinus lesions[2, 3, 8, 9, 11]. Temporary selective occlusion of the intracavernous segment of the internal carotid artery by the application of temporary clips at the point, where the artery enters the cavernous sinus under the mandibular division of the V-th nerve (Fig. 8) and central to the ophthalmic artery, permits a direct repair of vascular lesions as well as resection of tumorous processes. The flaplike opening of the superficial layer of the lateral sinus wall enables one to obtain a good visualization of the structures in the lateral wall and closure of this dural layer at the end of the dissection is possible.

Table 2. *Cavernous Sinus Surgery (1980–1987). Dissected part of the cavernous sinus*

		No. of cases
— anterior part	aneurysm	24
	tumour	6
— midpart (lateral wall)	aneurysm	
	tumour	13
— posterior part	tumour	1
— mid- and posterior part	tumour	20
		66

The results of this series speak in favour of the direct radical repair of intra- and pericavernous lesions. This operative strategy has proven to be a safe procedure, feasible without deep hypothermia, extracorporeal circulation, or cardiac arrest. The technique in many cases permits total removal of intra-cavernous lesions with the preservaton of the internal carotid artery and avoidance of operative traumatization of the nerves. It is likely that this procedure in cases of lesions invading the cavernous sinus will be the treatment of choice in the future.

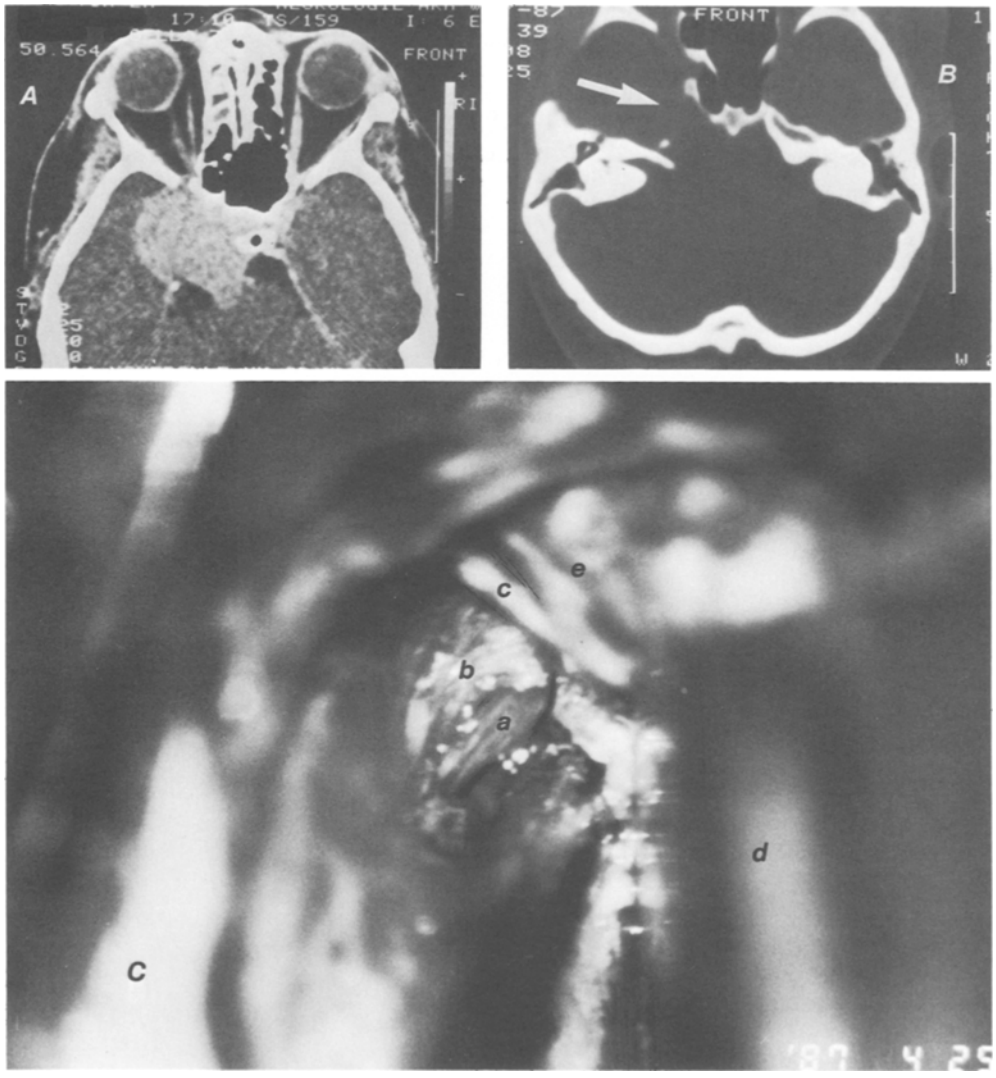


Fig. 8. Chondrosarcoma of the left cavernous sinus region. Subtemporal approach. A) preoperative CT, B) postoperative CT showing the approach and the resected portion of the petrous bone (arrow), C) intraoperative photograph demonstrating the dissection of the intrapetrous carotid artery segment. *a* intrapetrous internal carotid artery, *b* unroofed Eustachian tube, *c* mandibular division of the trigeminal nerve, *d* retractor holding the temporal lobe, *e* lateral wall of the cavernous sinus

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