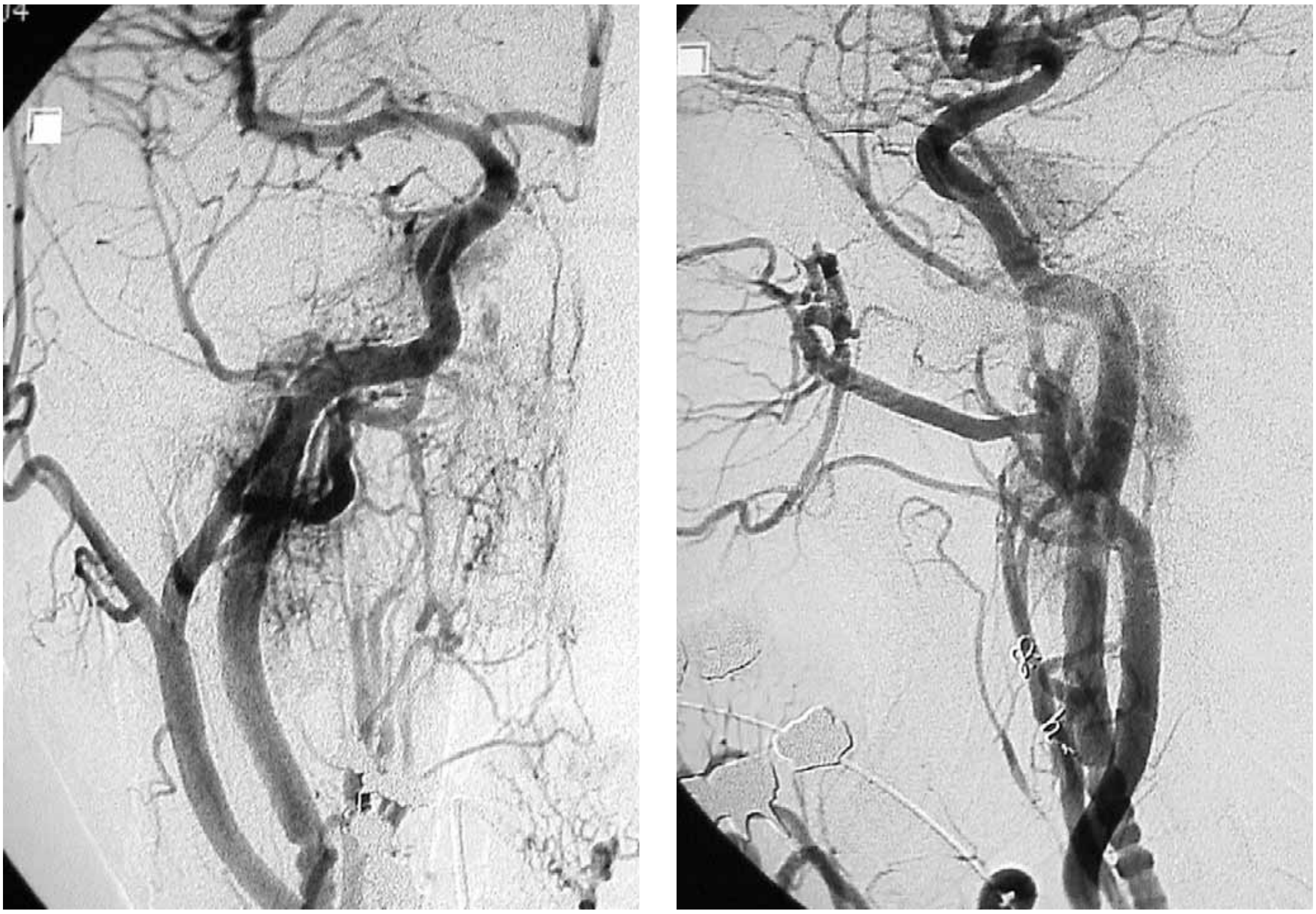


Fig. 15.**22 a,b** Class C4 glomus jugulare tumor. Stenting of the internal carotid artery. Same case as shown in Fig. 15.**18 a–f**. Common carotid injection, in anteroposterior (**a**) and lateral (**b**) views after embolization showing marked reduction of the tumoral blush.

## Surgical Management Modalities of the Internal Carotid Artery

Modalities of surgical management of the ICA include:

- Skeletonization
- Displacement
- Subperiosteal/subadventitial dissection
- Dissection and resection after permanent balloon occlusion
- Subadventitial dissection after reinforcement with stent

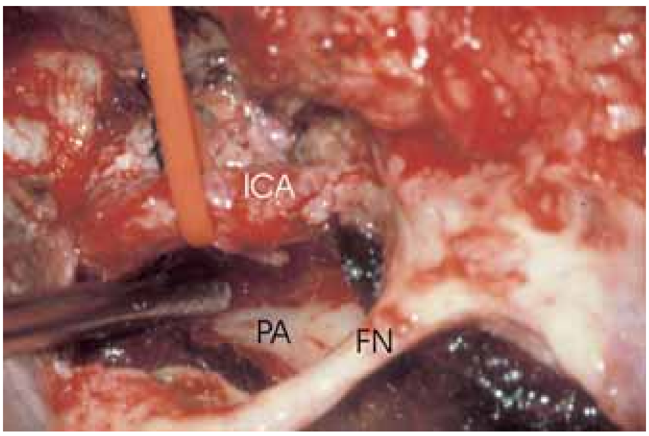



Fig. 15.**23** A case of right clival chordoma. The vertical internal carotid artery (**ICA**) is gently displaced to allow proper control of the petrous apex (**PA**) lying medial to the artery.

### Skeletonization

This is done in tumors reaching but not adhering to the artery. The most common lesions are represented by petrous bone cholesteatomas and type C1 glomus tumors. The artery can be exposed in certain approaches to provide proximal control, e. g. the infratemporal fossa approach or the modified transcochlear approach type A.

In the middle fossa transpetrous approach the artery is one of the anatomical boundaries that are skeletonized to avoid injuring while drilling the petrous apex. Skeletonization carries little risk in experienced hands.

An exhaustive knowledge anatomy is mandatory; a large diamond burr parallel to the course of the artery is used to remove the last shell of bone covering the artery.

### Displacement

Displacement is used to gain access, e. g., during an infratemporal fossa type B approach to the petrous apex (Fig. 15.**23**). Displacement should be done gently and complete liberation of the artery is needed first.

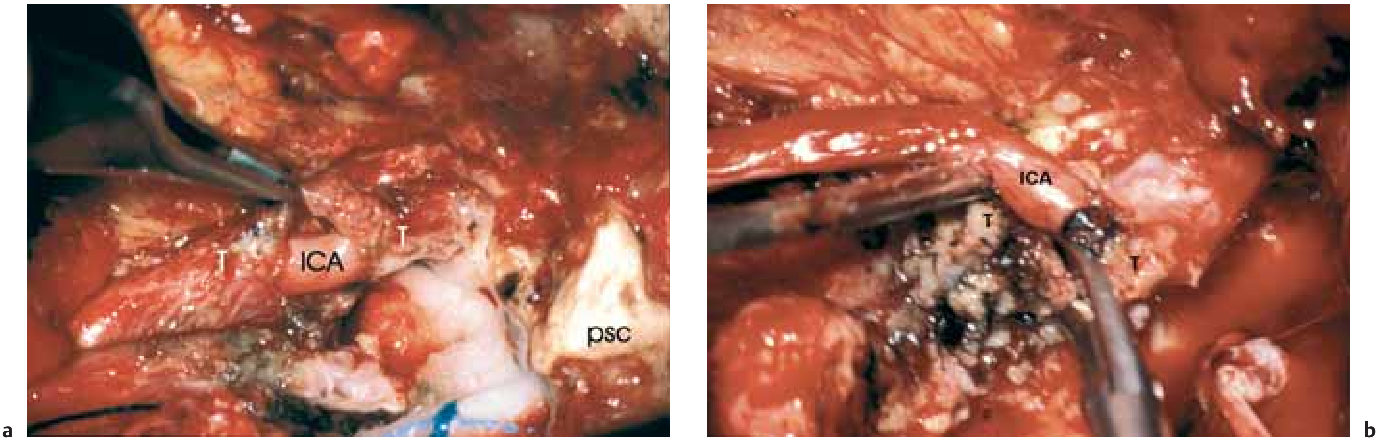



Fig. 15.**24** **a** A case of left glomus jugulare tumor (**T**). Subperiosteal dissection of the tumor is performed. **b** A case of left en-plaque meningioma. Dissection of subadventitial tumor (**T**) is carried out.

## Subperiosteal/Subadventitial Dissection

Subperiosteal/subadventitial dissection is accomplished for tumors that involve the ICA to a greater extent, such as C2 glomus tumors and meningiomas (Fig. 15.**24 a, b**). In general, dissection of the tumor from the artery is relatively easier and safer in the vertical intrapetrous segment, which is thicker and more accessible than the horizontal intrapetrous segment.

A plane of cleavage between the tumor and the artery should be found first. In most cases, the tumor is attached to the periosteum surrounding the artery. Dissection is better started at an area immediately free of tumor. Aggressive tumors may, however, extend even to the adventitia of the artery and subadventitial dissection may be needed. This should be done very carefully in order to avoid any tear to the arterial wall, which can become weakened (Fig. 15.**25**), with the risk of subsequent blowout.

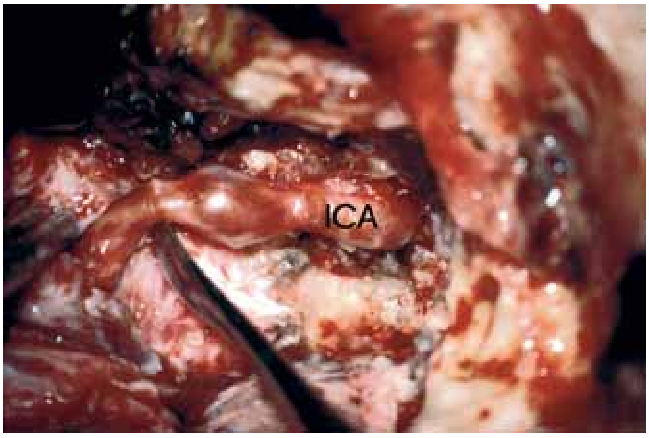



Fig. 15.**25** A case of left glomus jugulare tumor in our early experience. Subadventitial dissection has been performed because the artery had been so weakened after the tumor removal. Although the patient had no relevant complications postoperatively, such excessive manipulation is better avoided and permanent balloon occlusion or stenting are preferably tried preoperatively.

## Dissection and Resection after Permanent Balloon Occlusion of the Internal Carotid Artery

In patients in whom the tumor is adjacent to the carotid artery, the preoperative examination to determine whether the carotid artery has to be resected is a crucial and difficult task that can lead to false-negative and false-positive results.

Carotid artery invasion is difficult to assess even at operation: often the tumor obscures a portion of the carotid artery or completely surrounds it; malignant tumors, by their infiltrative nature, do not allow for their separation from the ICA; manipulating vascular tumors can increase the difficulty, as bleeding impairs visualization.

When the carotid artery has been controlled by balloon occlusion these problems are lessened but not eliminated.

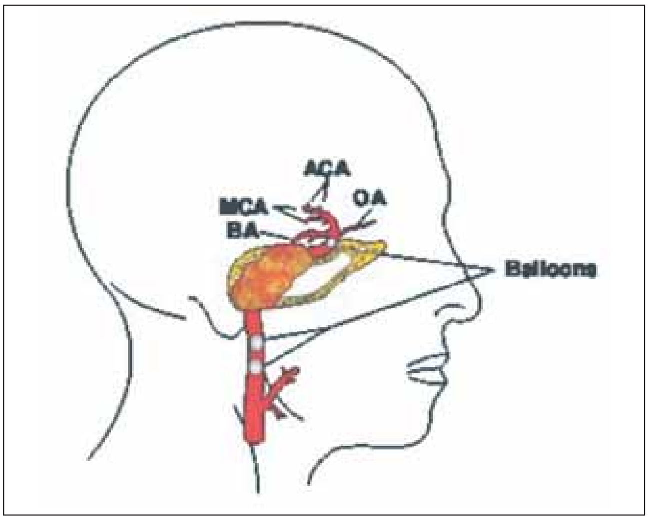
Dissection of the occluded ICA is started the cervical level; after isolation, the artery is ligated immediately after the proximal balloon; then dissection and separation from the tumor proceeds from the vertical petrosal segment until the junction between horizontal petrosal and lacerum segments; finally, thanks to the presence of a balloon in the cavernous segment, the petrous portion of the artery is resected, possibly with a portion of tumor adherent to it, and sent for pathological examination (Fig. 15.**26**). Indeed only after serial sections of the suspected arterial segment are made can a determination be made whether there has been vascular invasion.

Despite the lack of carotid wall infiltration, removal of these tumors and of the adventitia can significantly weaken the carotid wall and lead to blowout; therefore, PBO of the ICA should be strongly considered in skull base tumors with massive radiological involvement of the ICA.

## Subadventitial Dissection after Reinforcement with Stenting

From a surgical point of view, preoperative stent insertion allows the skull base surgeon to perform subadventitial dissection (Fig. 15.**27**) of the ICA with a significant reduction of the surgical risk.


a



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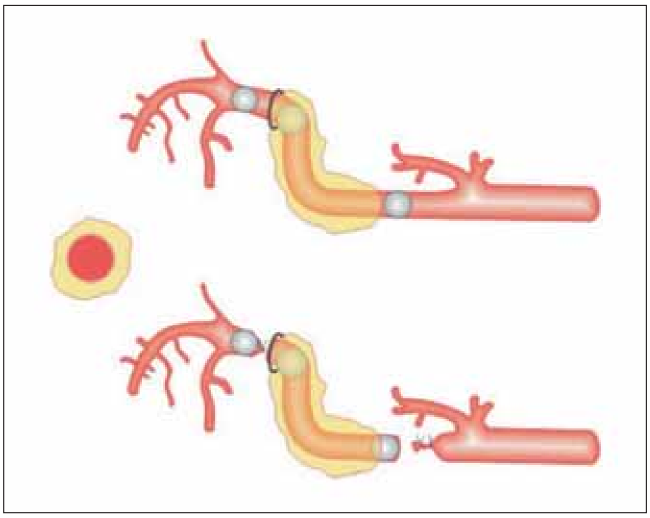
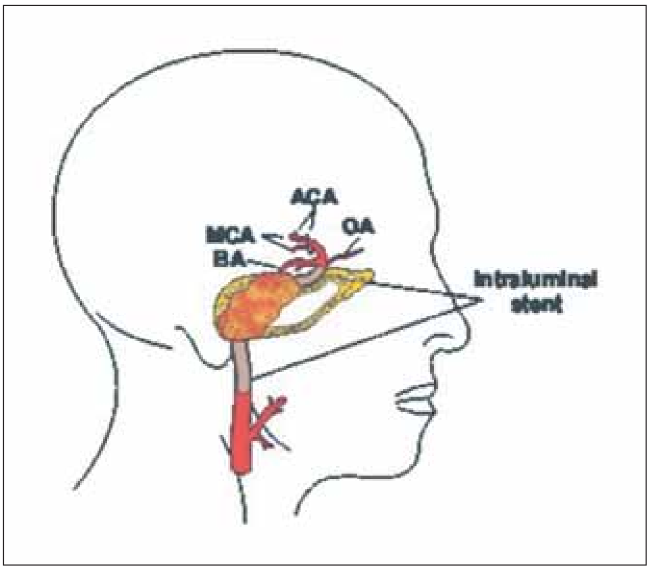

c

Fig. 15.**26** **a** Intraoperative view of the balloon used to permanently occlude the internal carotid artery. **b, c** Schematic drawings showing the permanent balloon occlusion of the internal carotid artery. **MCA** middle cerebral artery. **BA** basilar artery. **ACA** anterior cerebral artery. **OA** ophthalmic artery.



a

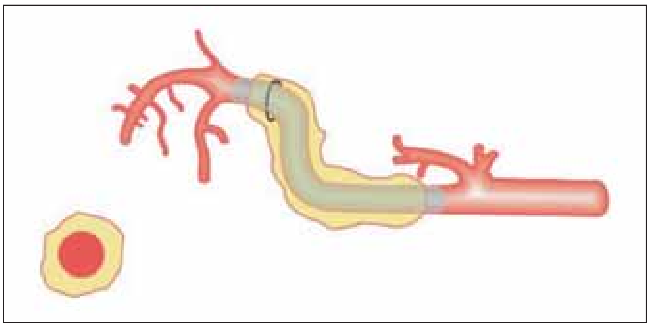

b

Fig. 15.**27** **a, b** Schematic drawings showing the stent reinforcement of the internal carotid artery. **MCA** middle cerebral artery. **BA** basilar artery. **ACA** anterior cerebral artery. **OA** ophthalmic artery.

In the presence of an intraluminal stent, in fact, the surgeon is usually able to establish a cleavage plane reaching the external surface of the stent, so removing all the involved portion of the arterial wall.

At the same time, the presence of the metallic net of the stent represents protection against accidental rupture; this is particularly true when working at the level of the carotid genu and the horizontal segment of the petrous ICA. In this area the surgical room and the mobility of the artery are reduced and direct control of the medial wall is particularly demanding, increasing the difficulty and the risk of surgery.

The thickness of the struts of the stent, which determines its rigidity and its resistance to crushing, can offer different surgical sensations: although surgical dissection in the presence of thicker stents has seemed more comfortable, it has been possible without surgical problems even in the presence of softer stents.

Dissection usually starts at the cervical level, away from the tumor, where it easier to find the correct cleavage plane and proceed distally; the anteromedial wall of the artery is considered the most difficult to manipulate because direct visualization requires bony decompression and anterior displacement of the intrapetrous segment of the ICA. The unsolved surgical problem remains the medial wall of the ICA at the level of the anterior foramen lacerum, until now unreachable with the available surgical approaches.

## Clinical Application of Carotid Artery Stenting

**Case 15.1—Third Stage of Case 8.4 (p. 169)**
[Figures 15.**1–1** to 15.**1–7**]

Remnants of the glomus tumor involve massively the internal carotid artery (Fig. 15.**1–1**). Angiography revealed inadequacy of the collateral circulation. A stent was placed in the artery preoperatively (Fig. 15.**1–2**). Intraoperatively, the tumor could be separated from the artery with relative ease without endangering the thinned arterial wall (Figs. 15.**1–3**–15.**1–7**).

Fig. 15.**1–1** Angiogram of the case shows the tumor blush and the massive involvement of the internal carotid artery.

Fig. 15.**1–2** Angiogram, lateral view, showing the stent inside the internal carotid artery. ▷