Cavernous Sinus Invasion

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The diagnosis of cavernous sinus invasion by pituitary adenomas is of paramount importance, particularly for secreting pituitary adenomas: it is accepted that surgery alone is usually unable to cure the disease in these cases. Clinically, cavernous sinus invasion is most of the time silent. The radiological diagnosis of subtle cavernous sinus invasion remains difficult and can remain uncertain even with the highest quality MRI and the highest experience of the neuroradiologist. For these reasons, frequency of cavernous sinus invasion is differently appreciated in the literature.

Nevertheless, huge invasion of cavernous sinus is usually obvious: a tissue of an identical MR signal and an identical enhancement as those of the intrasellar component of the tumor completely encircles the intracavernous internal carotid artery. The lateral wall of the cavernous sinus is bulging. The normal enhancement of the venous extrasellar spaces is missing. Cavernous sinus invasion by pituitary adenomas is mostly unilateral, the laterally displaced normal pituitary gland "protecting" the contralateral cavernous sinus (Fig. 11.1). The lumen of the intracavernous internal carotid artery is usually unchanged, different to what is observed in cavernous sinus meningioma. When cavernous sinus invasion is massive, the pituitary adenoma can pass into the subarachnoid spaces of the temporal lobe. It was initially believed that this severe extension was through a rupture of the thick lateral dural wall of the cavernous sinus. In fact, the tumoral growth follows and enlarges the dural pocket accompanying the oculomotor nerve (Fig. 11.2).

In some cases, a simple displacement and a compression of the cavernous sinus structures by a lateral extension of the pituitary adenoma can mimic a true invasion; but here there is no perforation of the dural medial wall of the cavernous sinus. Asymmetrical tentorial enhancement has also been described with invasion, as in severe compression of the cavernous sinus by sellar tumor, and is then not specific. It may represent venous congestion in the tentorium caused by obstructed flow in the medial venous compartment of the cavernous sinus.

Historical classifications based on anatomical landmarks, such as those of Knosp or Cottier, are of no absolute value (Fig. 11.3). For Knosp, cavernous sinus invasion is "very likely" if the tumor extends laterally and passes a line drawn between the cross-sectional centers of the supra- and intracavernous segments of the internal carotid artery. Cottier suggests that a percentage of encasement of the internal carotid artery by tumoral tissue of more than 67 % makes invasion certain. Another criterion, the nonvisualization of the carotid sulcus venous compartment, as described by Bonneville with dynamic CT, is scarcely reproducible with MRI. Nevertheless, an intracavernous internal carotid artery remote from the sphenoid carotid sulcus is highly suggestive of cavernous sinus invasion (Fig. 11.4).

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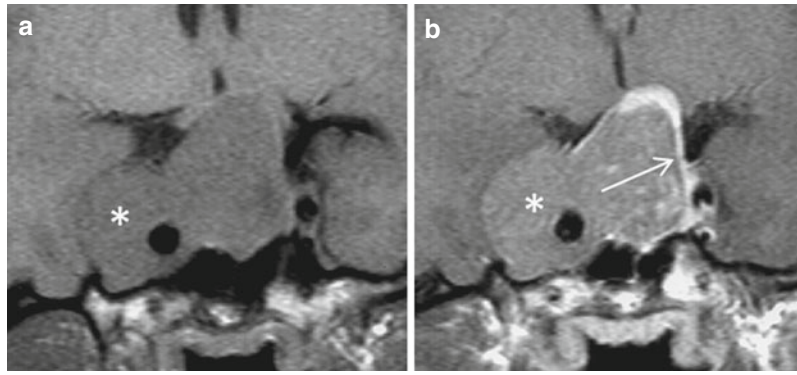

Fig. 11.1 Pituitary macroadenoma invading right cavernous sinus (*asterisk*). (**a**, **b**) Coronal T1 and CE T1 WIs. The internal carotid artery is totally encased by the tumor. The normal pituitary tissue (*arrow*) is displaced laterally and superiorly

Limited tumoral extensions within the cavernous sinus need to be detected, given that their presence can radically change the medical strategy. Their diagnosis needs high-quality, high-resolution MRI and special sequences, ideally with demonstration of the thin internal dural membrane separating the sellar content from the cavernous sinus. Such a demonstration is more frequently obtained with 3.0 T than with 1.5 T MR scanners. Early cavernous sinus extensions are located initially posteriorly, i.e., where the internal dural wall is the thinnest: high-resolution axial T2WIs are the most informative to detect these extensions and must be added to the usual sequences (Fig. 11.5). If not completely torn, the internal medial wall appears as an incomplete thin, T2-hypointense line floating as a curtain between cavernous sinus and pituitary fossa (Fig. 11.6). The second most frequent site of invasion is located in the concavity of the internal carotid artery siphon, with a tongue-like appearance best demonstrated on axial views. A shoulder-like tumoral expansion above the internal carotid artery seen on coronal view is also suggestive of cavernous sinus invasion (Fig. 11.7). Finally it is noticeable that, in pituitary adenomas treated medically, shrinkage of the intracavernous part of the tumor, if any, occurs in the same way as for the intrasellar component.

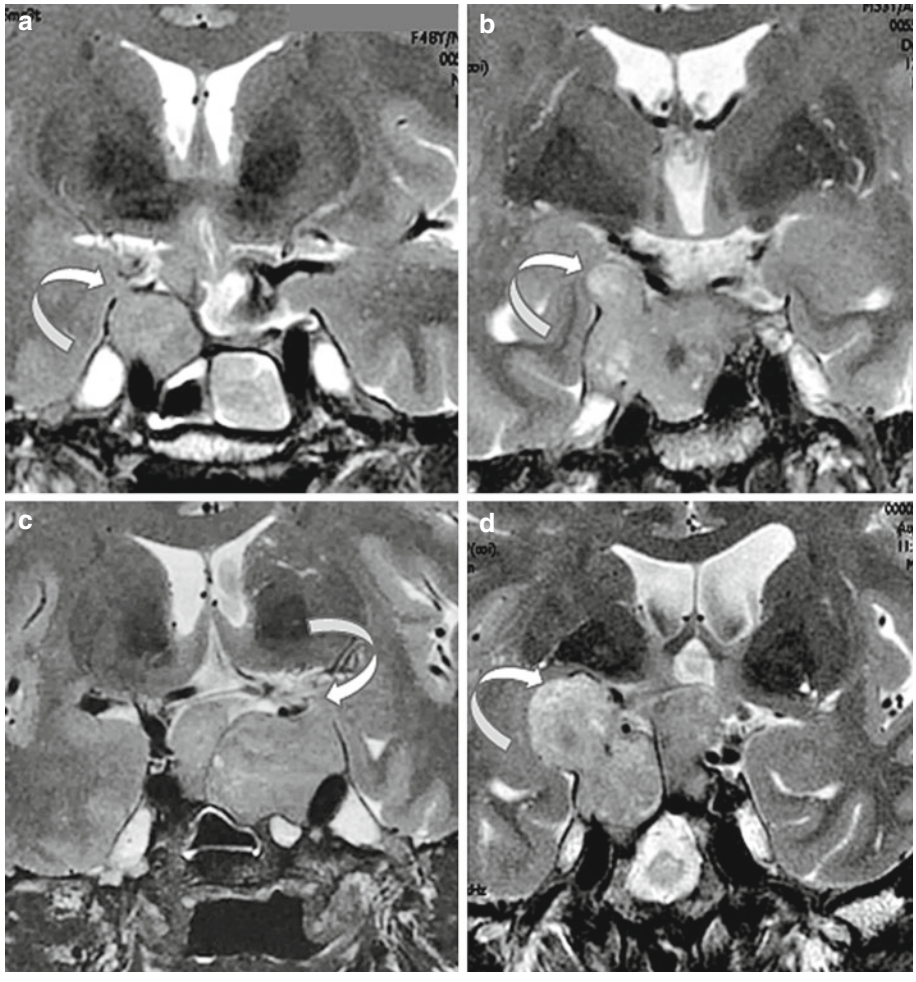

Fig. 11.2 Cavernous sinus invasion extended into the subarachnoid space of the temporal lobe in four patients with recurrence of pituitary adenoma. (**a**–**d**) Coronal T2WIs. Limited (**a**–**c**) and huge (**d**) tumoral extension, presumably through the dural pocket of the oculomotor nerve (*arrows*)

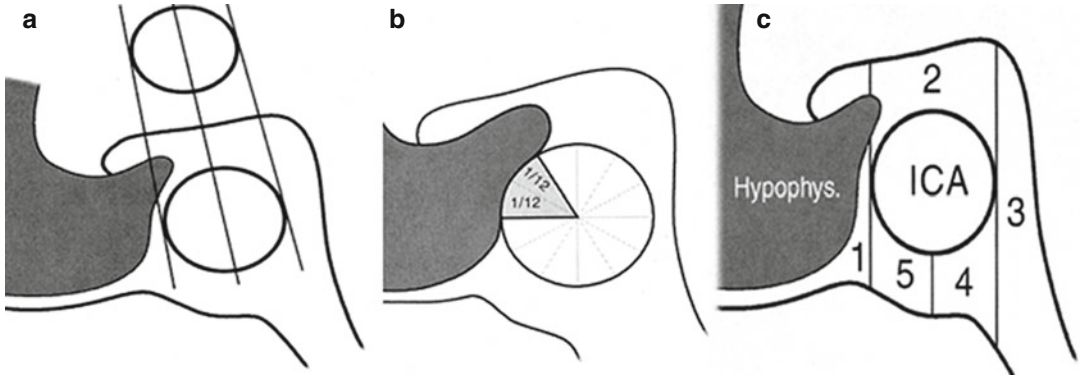

Fig. 11.3 (**a**) Knosp landmark. Cavernous sinus invasion is said to be very likely if the tumor passes the line joining the centers of intracavernous and supracavernous internal carotid artery sections. (**b**) Cottier landmark. Encasement of the internal carotid artery of more than 67 % is said to indicate cavernous sinus invasion, as is obliteration of the carotid sulcus venous compartment (5 in **c**)

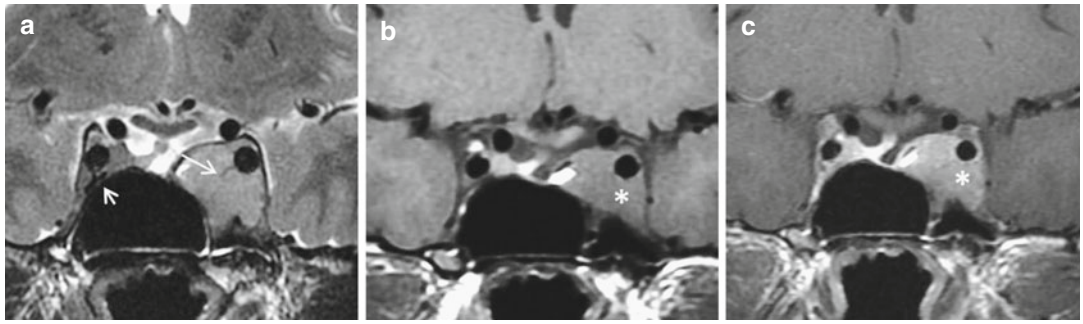

Fig. 11.4 Recurrent pituitary adenoma invading left cavernous sinus. (**a**–**c**) Coronal T2, T1, and CE T1 WIs. Normally, as seen in the right cavernous sinus, the intracavernous internal carotid artery is separated from the sphenoid carotid sulcus by a vein (*small arrow*) or is in close contact with the carotid sulcus. On the left, there is no visible vein of the carotid sulcus and the left internal carotid artery is distant from the sphenoid bone: invasion of the cavernous sinus is clear (*asterisk*). Note that the torn medial wall of cavernous sinus (*arrow*) is partially demonstrated only on T2WI (**a**)

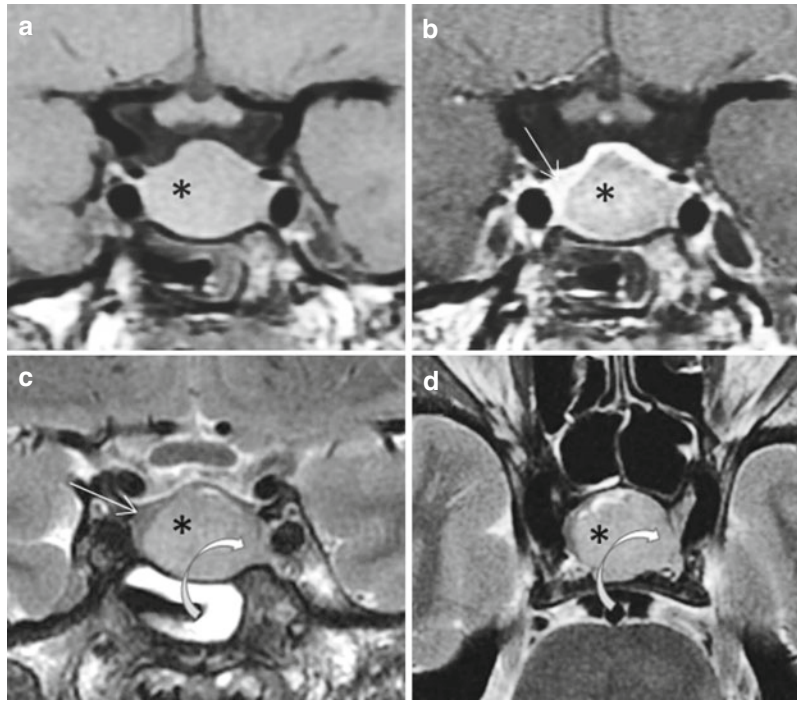

Fig. 11.5 T2-hyperintense GH-secreting pituitary adenoma with cavernous sinus invasion (*asterisk*). (**a**–**c**) Coronal T1, CE T1, and T2 WIs, and (**d**) axial T2WI. Compressed anterior pituitary gland (*straight arrow*). Limited left cavernous sinus invasion. Demonstration of the incomplete medial wall of the cavernous sinus (*curved arrow*) is only visible on T2WI

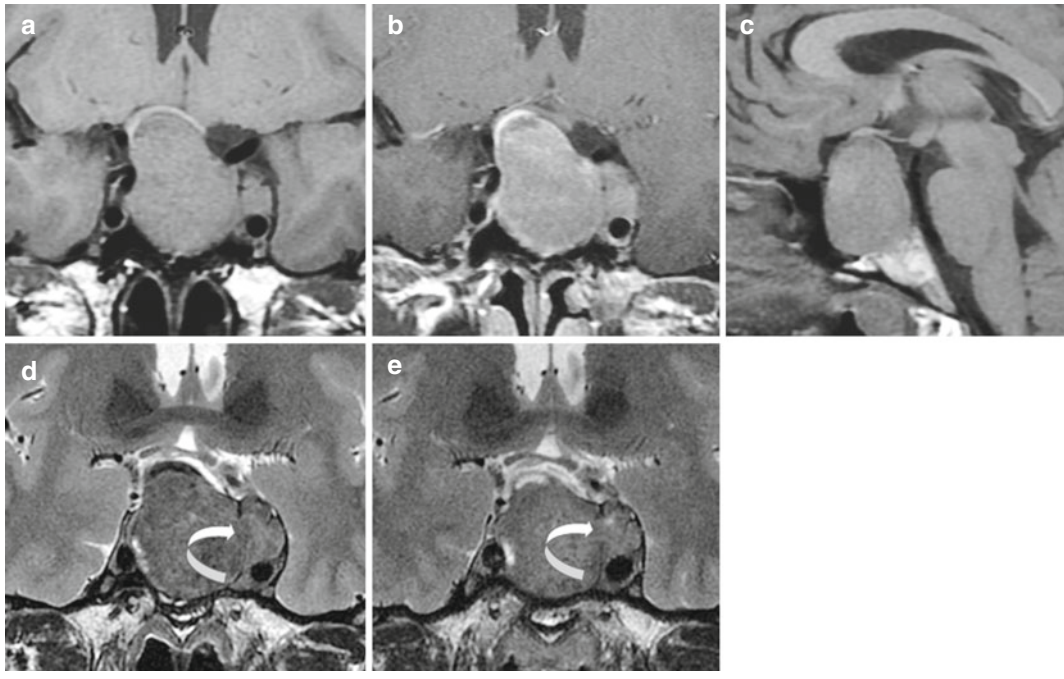

Fig. 11.6 Nonfunctioning macroadenoma invading left cavernous sinus. (**a**, **b**, **d**) Coronal T1, CE T1, and T2 WIs. (**c**) Sagittal T1WI. (**e**) Coronal T2WI after tumoral debulking. The torn medial wall of the cavernous sinus (*arrow* in **d**) is pushed laterally and less displaced after debulking in (**e**)

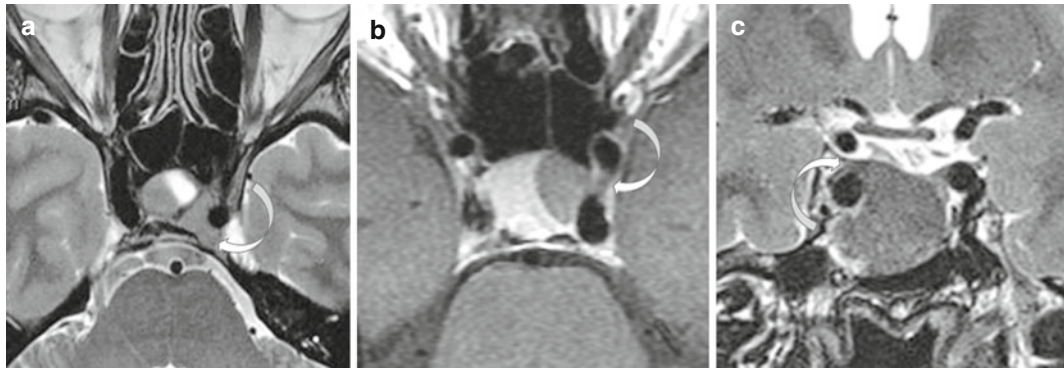

Fig. 11.7 Limited tumoral extensions to cavernous sinus (*arrows*). (**a**) Posterior extension on axial T2WI. (**b**) Between two segments of intracavernous internal carotid artery on axial CE T1WI. (**c**) Above the internal carotid artery on coronal T2WI

Further Reading

Cao L, Chen H, Hong J et al (2013) Magnetic resonance imaging appearance of the medial wall of the cavernous sinus. J Neuroradiol 40:245–251

Knosp E, Steiner E, Kitz K et al (1993) Pituitary adenomas with invasion of the cavernous sinus space: a magnetic resonance imaging classification compared with surgical findings. Neurosurgery 33(4):610–616

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