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# Microsurgical Management of Giant Pituitary Tumors

***Abstract***—Pituitary tumors with large suprasellar extensions are a difficult surgical challenge. A series of 11 patients with giant pituitary adenomas is reported. Seven men and four women (mean age 54.1 years) were diagnosed following a mean duration of symptoms of 60 months. Common presenting symptoms included visual disturbances, headache, personality changes, and panhypopituitarism. A single patient presented with rapid onset of coma and oculomotor nerve palsy. Eight patients underwent a transsphenoidal approach, and three patients underwent a craniotomy as the initial surgical procedure. A total of 16 surgical procedures were performed, resulting in complete or near complete resection in seven patients, and partial removal in four. Six patients had a good outcome and one patient in poor condition prior to surgery was unchanged postoperatively. One patient was worse following surgery, and there were two operative deaths. These tumors have a consistency and a propensity to adhere to neurovascular structures, making complete surgical resection difficult. Management should be individualized and should be based upon the radiographic and clinical features of the tumor. We feel that most lesions are best approached initially transsphenoidally, unless there is significant lateral extension. In many patients, aggressive surgery is not indicated and limited subtotal transsphenoidal resection followed by irradiation is recommended. Surgical decision making and strategy is discussed in relation to our recent experience with giant pituitary adenomas. (*Skull Base Surgery, 6(1):17–26, 1996*)

Microsurgical resection of pituitary adenomas has become a routine neurosurgical procedure with a low complication rate at many medical centers. Although treatment of the majority of these tumors is straightforward, infrequently they become invasive or grow to a very large size, making surgical extirpation extremely difficult.[1–4] Giant pituitary adenomas are a rare, formidable surgical challenge which have long been recognized as having a high surgical complication rate. Jefferson first reported a postoperative mortality rate of 35% in patients with tumors with very large suprasellar extension.[5] Similar high mortality rates have been reported by others.[2,6,7] Improved microsurgical instrumentation and technique have significantly reduced the morbidity and mortality of surgery for giant pituitary adenomas during the last two decades.[8–10]

In this report we present our experience with giant pituitary tumors and suggest a strategy for dealing with this unusual and challenging problem. We have individualized our management of pituitary adenomas, including giant lesions, basing the surgical approach on the radiographic features of the tumor and the clinical setting. Giant pituitary tumors have been removed satisfactorily with a transsphenoidal approach. The propensity of giant adenomas to adhere to adjacent structures and enter the subarachnoid space necessitates a careful preoperative strategy. Magnetic resonance imaging (MRI) has allowed precise preoperative visualization of the size, shape, and

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location of intracranial neoplasms and thus enhances surgical planning.[11,12]

## SUMMARY OF CASES

### Clinical Materials and Methods

Eleven patients with histologically verified pituitary adenomas who met our criteria for giant tumors underwent surgical treatment at UCLA-affiliated hospitals between September 1985 and September 1992. This group represents approximately 2% of patients admitted to our service with pituitary adenomas during this same period. Tumors were considered giant if the suprasellar extension reached to within 5 mm of the Foramen of Monro or if extension was greater than 45 mm in any direction (Fig. 1). The study population consisted of seven men and four women with ages ranging between 35 and 82 years (mean age 54.1). A summary of the cases is shown in Table 1. Ten patients (91%) presented with severe uni- or bilateral visual acuity or field abnormalities. Associated symptoms included headache (45%) and personality changes (27%). The personality changes recognized by family members were described as blunted affect, diminished memory, and apathetic behavior. A single patient had the rapid onset of obtundation after a 4-day history of cerebrospinal fluid (CSF) rhinorrhea (case 11). In this patient there was no prior stated history of endocrinologic dysfunction, personality change, or visual disturbance. The duration of symptoms preceding diagnosis ranged from 4 days to 15 years with a mean of 60 months (5 years). No patients had physical stigmata of hormonal hypersecretion, although one patient (case 5) was known preoperatively to have a markedly elevated prolactin level (40,000 ng/mL).

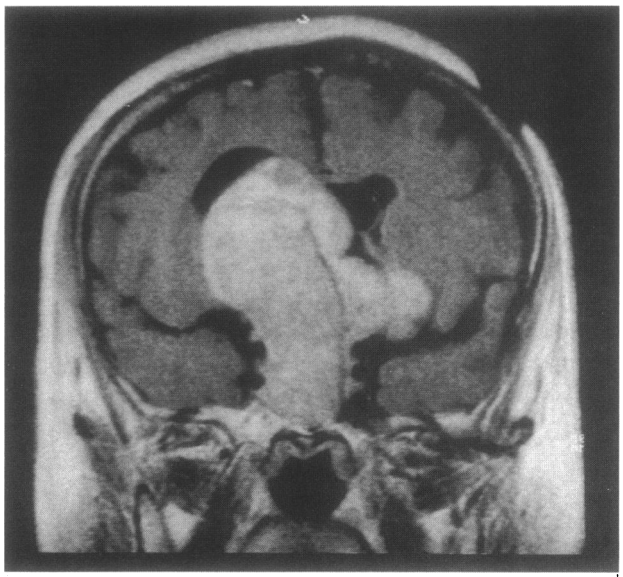


**Figure 1.** T1-weighted MRI of a giant pituitary adenoma extending above the level of the Foramen of Monro (case 4). The tumor mainly has a midline location and has not invaded the cavernous sinus.

### Radiographic Features

Ten tumors were diagnosed preoperatively with MRI. One patient (case 11) was admitted emergently with only a CT scan and underwent surgery before an MRI could be obtained. Sagittal and coronal reconstructed CT scans were obtained for this patient. On T1-weighted MRI, the tumors were isointense compared to brain tissue, with moderate enhancement upon contrast administration in all but one patient. In this patient there was intense homogeneous enhancement more typical of a meningioma (case 9). The tumor was predominantly midline in location in all but two patients (cases 5 & 8) whose tumors had a significant lateral extension into the middle cranial fossa (Hardy type D).[13] The sella appeared to be eroded radiographically in 10 cases, with frank sphenoid sinus invasion in only one patient (case 1). In this latter patient, the MRI demonstrated a sellar mass which filled the sphenoid sinus and extended into the nasopharynx. One patient (case 4) had moderate hydrocephalus preoperatively, and another (case 11) had pneumocephalus.

### Histological Features

Adenoma tissue obtained at the time of surgery was studied by light microscopy and immunohistochemistry. For light microscopy, paraffin embedded sections of the tumors were stained with hematoxylin and eosin, and PAS-Orange G stains. These sections showed features of a typical adenoma; fronds and papilli of uniform tumor cells were present, with occasional epithelioid cells lining pools of eosinophilic material. The fibrovascular stroma was extremely abundant in many cases, resulting in the grossly fibrotic consistency of these tumors at surgery (Fig. 2). This is quite different from the delicate, thin fibrovascular stroma typical of small pituitary adenomas. There were no malignant features such as mitoses or pleocytosis on examination of any of the specimens. The avidin-biotin-peroxidase complex technique was used for immunohistochemical evaluation using antisera for prolactin, adrenocorticotropic hormone (ACTH), growth hormone, luteinizing hormone (LH), follicle stimulating hormone (FSH), and thyroid stimulating hormone (TSH). Tumors that did not stain for any of the anterior pituitary gland-specific hormones were designated null cell adenomas. Two tumors were found to be strongly positive for prolactin on immunohistochemistry staining, although only one of these patients had marked elevation of prolactin preoperatively. The other patient (case 1) had a modest prolactin elevation (98 ng/mL) and preoperatively was felt not to have a prolactinoma. One tumor was strongly positive for FSH and LH, while another was immunoreac-

Table 1. Clinical Summary of 11 Patients with Giant Pituitary Adenomas*

| Case No. | Age (yrs) Sex | Duration of Symptoms | Symptoms | Adenoma Type** | Surgery | Stages | Operative Complications | Outcome |
|---|---|---|---|---|---|---|---|---|
| 1 | 36, M | 2 yrs | Visual field disturbance, headache, nasal destruction | PRL | TNTS FT craniotomy | 2 | Transient CN 3 palsy | Good |
| 2 | 57, M | 15 yrs | Diminished visual acuity, headache | FSH, LH | TNTS | 1 | Internal capsule infarct | Poor |
| 3 | 57, M | 4 mos | Visual field disturbance | Null cell | TNTS | 1 | CSF leakage | Good |
| 4 | 63, F | 11 yrs | Diminished visual acuity, headache | Null cell | TNTS | 1 | Hemispheric swelling | Dead |
| 5 | 33, M | 10 mos | Visual field disturbance, headache | PRL | FT craniotomy | 1 | Hemispheric infarction, pulmonary embolus | Dead |
| 6 | 42, M | 4 mos | Visual field disturbance | Null cell | TNTS | 2 | Delayed CSF leak | Good |
| 7 | 57, F | 6 mos | Visual field disturbance, diminished visual acuity, headache, depressed mentation | Null cell | TNTS | 1 | None | Good |
| 8 | 55, F | 4 yrs | Severely debilitated, ataxia, headache, diminished visual acuity | ACTH | Subfrontal craniotomy | 1 | None | Stable |
| 9 | 82, F | 6 mos | Diminished visual acuity, depressed mentation | Null cell | FT craniotomy VP shunt | 1 | None | Good |
| 10 | 74, M | 1 yr | Visual field disturbance, headache | TSH, LH | TNTS | 1 | None | Good |
| 11 | 39, M | 4 days | CSF rhinorrhea, coma, CN III palsy | FSH, trace LH | TNTS, FT craniotomy, VP shunt | 2 | None | Good |

*Abbreviations: ACTH = adenocorticotropic hormone secreting; CN = cranial nerve; CSF = cerebrospinal fluid; FSH = follicle stimulating hormone secreting; FT = fronto-temporal; LH = luteinizing TNTS = transnasal transsphenoidal approach; TSH = thyroid stimulating hormone secreting; VP = ventriculoperitoneal.
**based upon immunohistochemical examination.

tive for FSH and had trace staining for LH. Immunoreactivity to TSH was seen in one tumor, and diffuse immunohistochemical staining for ACTH was seen in a patient who had no clinical evidence of Cushing's disease (case 8). The remaining tumors did not show evidence of hormonal production on histochemical evaluation.

## Operative Procedures

The transsphenoidal approach was used when the tumor was predominately midline without anterior extension under the frontal lobe or lateral extension into the temporal fossa. Eight tumors were exposed initially via a transnasal transsphenoidal (TNTS) route. A standard rhinoseptal exposure was performed, and has been well described elsewhere.[14] Intermittent Valsalva maneuvers to a pressure of 35 mm Hg were performed during tumor resection to promote delivery of tissue into the sphenoid sinus. In several cases, a lumbar catheter was used to increase subarachnoid pressure by injecting sterile saline. Attempts were made not to enter the subarachnoid space for as long as possible in all cases. Invariably, however, this step could not be avoided. Once CSF was encountered, increasing subarachnoid pressure (via lumbar catheter or Valsalva) could not be instituted. In these circumstances, tumor tissue was removed in a piecemeal fashion. In all cases the sella was reconstructed with fascia lata placed against the tumor capsule or exposed arachnoid. This was augmented with autologous fat and secured with cartilage or bone removed from the nasal septum. Frontal or fronto-temporal craniotomies were performed as the initial procedure in three patients who had anterior (case 9) or lateral tumor extension (cases 5 and 8). A total of 16 operative procedures were performed on a total of eleven patients. Two patients underwent planned staged resections—a TNTS approach followed within 2 weeks by a fronto-temporal craniotomy. Two patients required a VP shunt following tumor resection, and one patient required a repeat TNTS procedure 5 months following the initial surgery for repair of a CSF fistula (case 6).

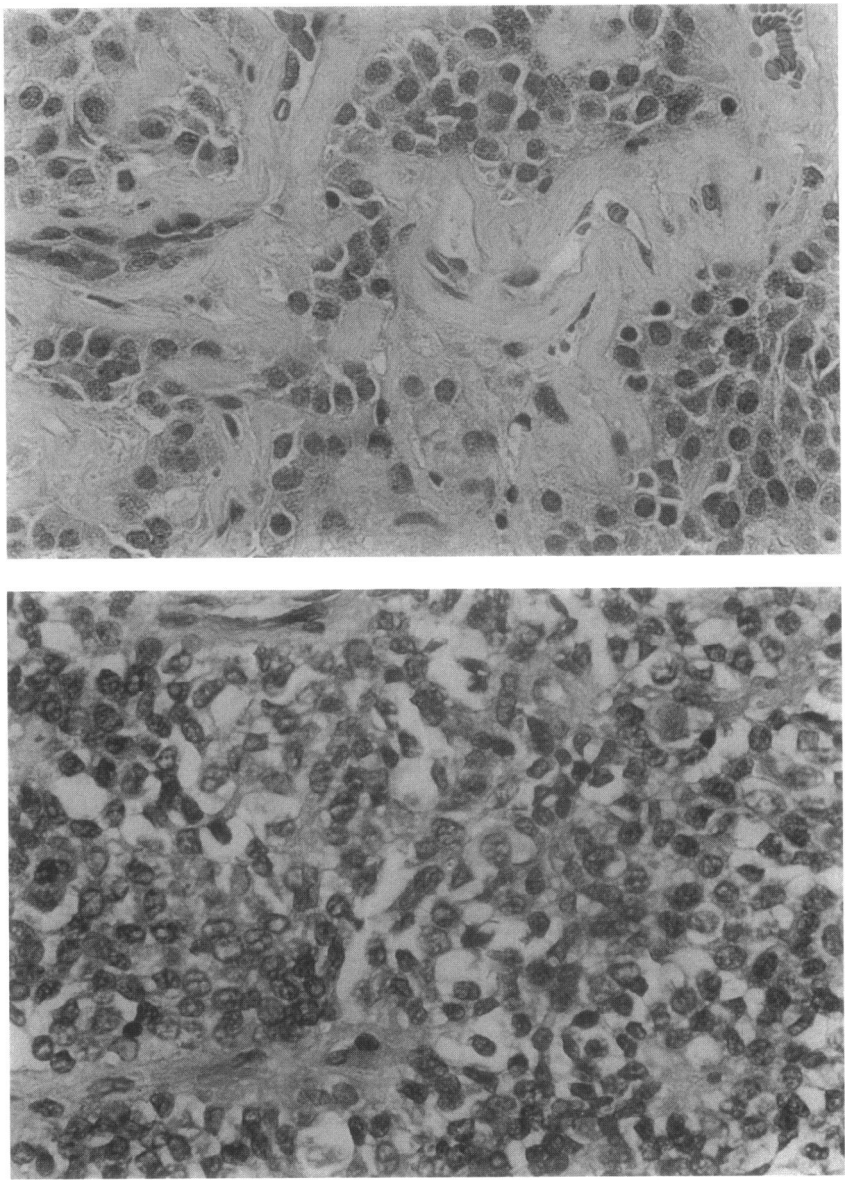


**Figure 2.** A: Histologic specimen from a giant pituitary adenoma demonstrates nests of cells separated by a thick fibrovascular stroma. B: This is in contrast to the appearance of a typical pituitary adenoma with monotonous sheets of adenomatous cells and only a delicate connective tissue stroma.

## Surgical Outcome

A near total (>90%) or total resection was achieved in seven patients (64%), and in the other four patients only a partial resection was possible because of the inability to separate the tumor from adjacent structures. Patients with partial resection were treated with radiation. The average follow-up has been 42 months. Outcome was defined as good if the patient had independent function at the 3-month follow-up and poor if there was significant debilitation or neurologic deficit. Seven patients (64%) had good outcomes, one patient who was severely debilitated preoperatively had an unchanged neurologic examination postoperatively, and one patient whose tumor was only partially removed was left with significant neurologic deficits (poor outcome) due to an infarct involving the internal capsule. There were two operative deaths. The first death was a 33-year-old man (case 5) whose tumor had considerable lateral extension into the left Sylvian fissure. Surgery was complicated by hemispheric brain swelling and a massive postoperative pulmonary embolus. The second patient (case 4) awoke from surgery and exhibited symmetrical motor function, but 8 hours postoperatively she experienced a generalized seizure, rapid onset of hemiparesis, and died within two days due to uncontrollable cerebral edema. It was assumed that she had sustained a large hemispheric infarct. Two patients had CSF rhinorrhea following transsphenoidal procedures—requiring repair in one (case 6) and lumbar drainage in the other (case 3). Other complications included a single transient oculomotor nerve palsy and a small capsular infarction (case 2). There has been no recurrence of resected tumors or demonstrable growth of residual tumor in this group of patients.

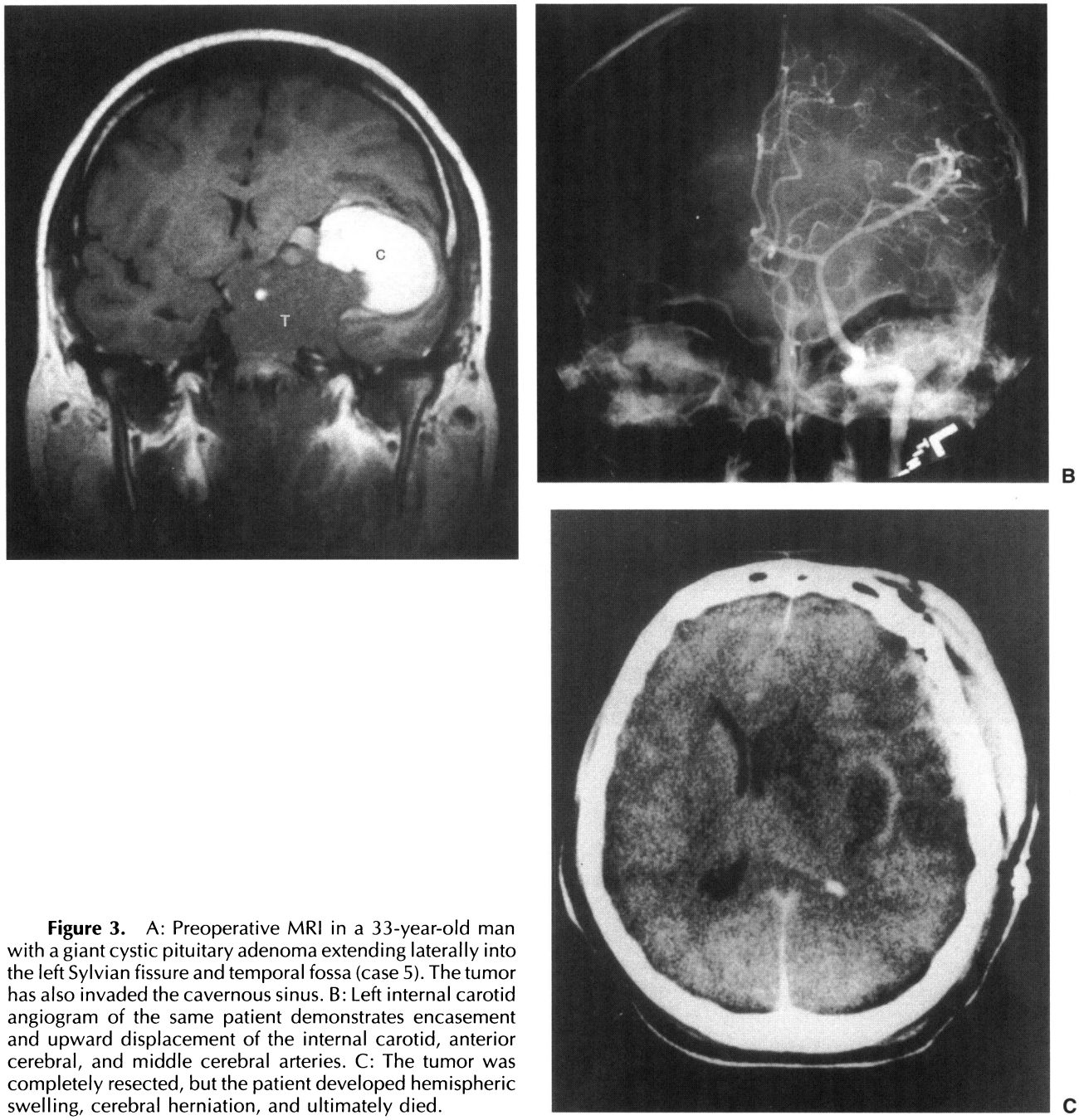



**Figure 3.** A: Preoperative MRI in a 33-year-old man with a giant cystic pituitary adenoma extending laterally into the left Sylvian fissure and temporal fossa (case 5). The tumor has also invaded the cavernous sinus. B: Left internal carotid angiogram of the same patient demonstrates encasement and upward displacement of the internal carotid, anterior cerebral, and middle cerebral arteries. C: The tumor was completely resected, but the patient developed hemispheric swelling, cerebral herniation, and ultimately died.

## Illustrative Cases

*Case 5*

This 33-year-old man presented with headache, markedly diminished visual acuity in the left eye, and a serum prolactin level of 40,000 ng/mL. MRI demonstrated a very large tumor within the sella turcica, extending into the left Sylvian fissure and middle cranial fossa (Fig. 3). Cerebral angiogram showed encasement and displacement of the left internal carotid artery and its major branches. Because of the size of the tumor and its lateral extension into the middle fossa, a craniotomy was performed. The surgery was protracted, but a complete resection was achieved. Postoperatively, the patient had a third nerve palsy on the left and moved all four extremities. While in the recovery room he sustained a pulmonary embolus requiring placement of an inferior vena cava umbrella. Over the subsequent 24 hours the patient's neurologic status progressively worsened, and he developed bilateral dilated nonreactive pupils and minimal brainstem function. CT revealed marked left hemispheric swelling consistent with either a cerebrovascular accident or vasogenic edema. The patient never recovered and ultimately died.

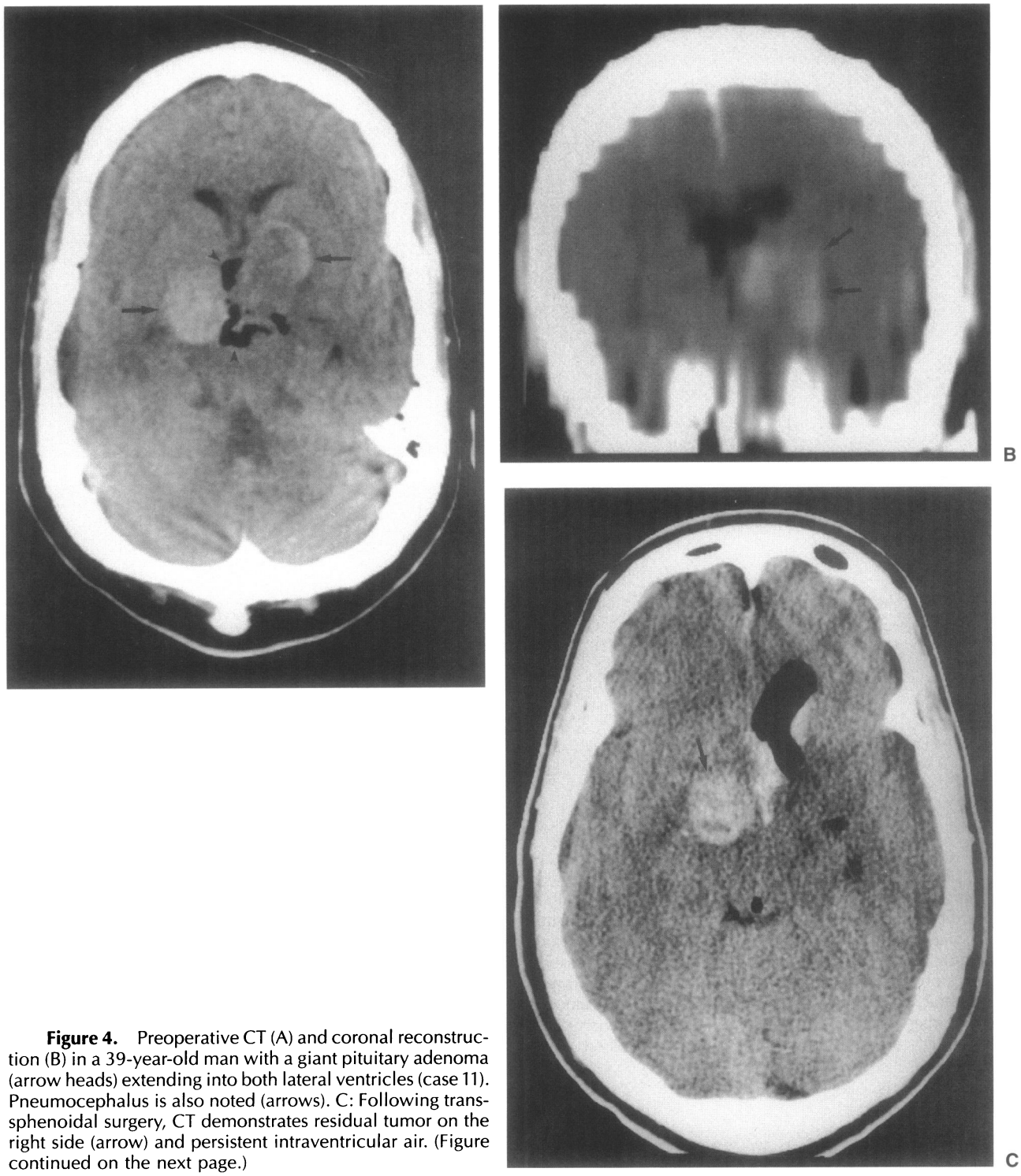
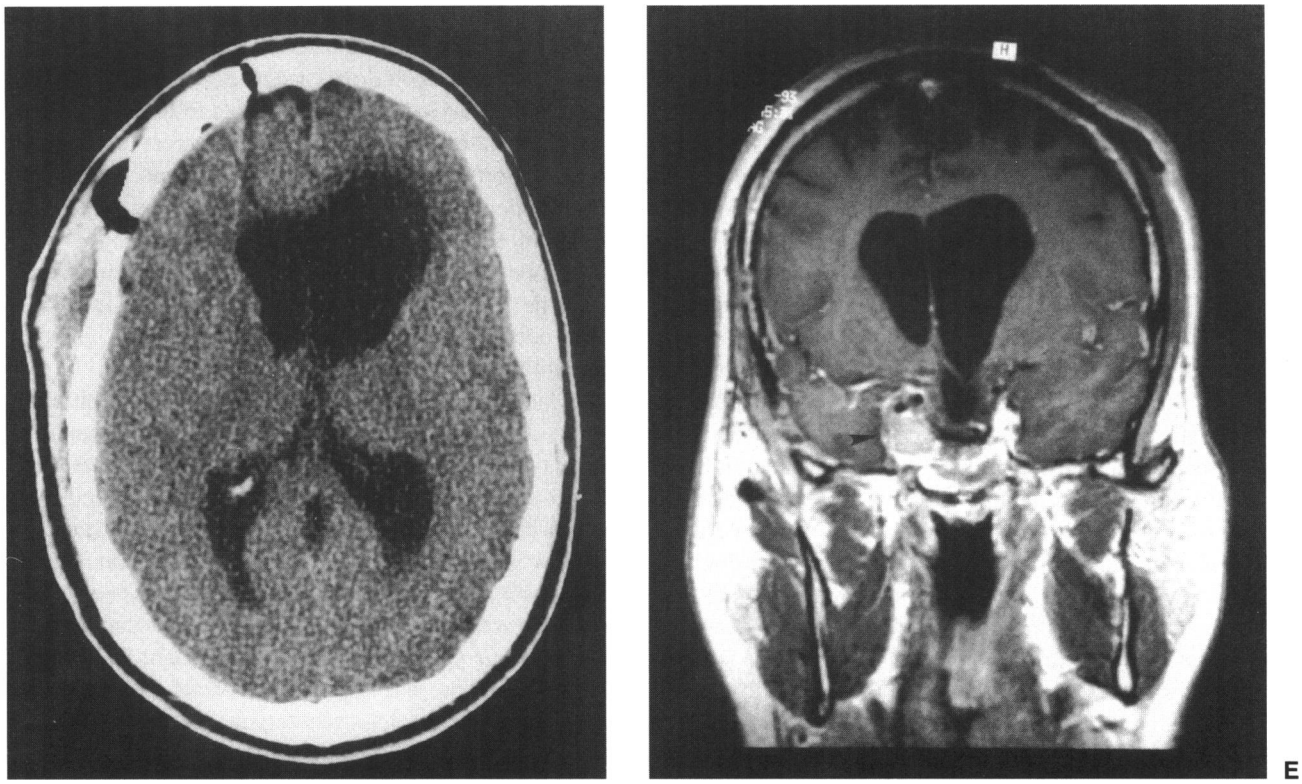


**Figure 4.** Preoperative CT (A) and coronal reconstruction (B) in a 39-year-old man with a giant pituitary adenoma (arrow heads) extending into both lateral ventricles (case 11). Pneumocephalus is also noted (arrows). C: Following transsphenoidal surgery, CT demonstrates residual tumor on the right side (arrow) and persistent intraventricular air. (Figure continued on the next page.)

*Case 11*

This 39-year-old man was transferred to the UCLA Medical Center after a 4-day history of CSF rhinorrhea, a right third nerve palsy, and progressive loss of consciousness. CT revealed a large mass involving the sella turcica extending superiorly to the level of the lateral ventricles and associated with pneumocephalus (Fig. 4). Emergent transsphenoidal surgery was performed because of acute obtundation, with the hope that immediate decompression via a less morbid procedure would result in neurologic improvement. Removal of approximately 70% of the tumor was achieved, with improvement in the patient's level of consciousness. Follow-up CT scans showed residual tumor extending towards the right lateral ventricle and persistent air within the ventricles, despite closure and repair of the sella turcica using autologous fat, fascia



D E

**Figure 4. (Continued)** D: After a subsequent craniotomy the residual tumor has been removed and the CSF fistula into the third ventricle has been repaired. A ventriculo-peritoneal shunt was subsequently placed. E: Postoperative MRI shows a near complete tumor resection. There is a remnant of tumor (arrow head) compressing, though not invading, the right cavernous sinus.

lata, and fibrin glue. The patient was subsequently taken back to the operating room 10 days later, at which time a craniotomy was performed for resection of the remaining tumor and reconstruction of the sella using autologous fascia lata. CT following the second surgery confirmed near complete tumor resection and absence of intracranial air. The patient has subsequently done well.

## DISCUSSION

### Giant Pituitary Adenomas

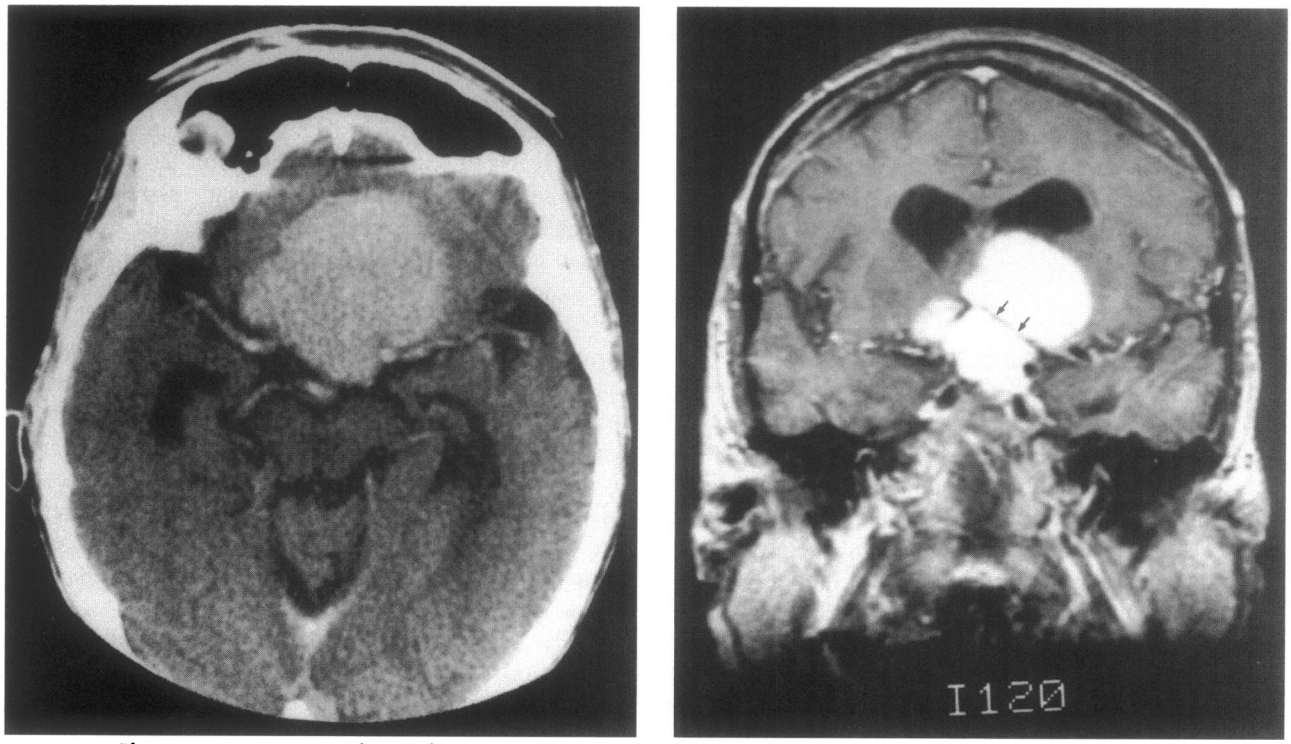
Giant pituitary adenomas have long been recognized as a clinical challenge. In Jefferson's review of 12 personal cases undergoing craniotomy, he ascribed the high operative mortality (35%) to the "malignancy" of these lesions.[5] More recently, improved operative results have been achieved. Wirth reported a mortality rate of 18% in patients with "larger tumours."[7] In 1979, Symon described 16 cases of giant pituitary tumors, and found an immediate operative mortality of 18.7%.[10] Two other patients died within 6 months of surgery. The inclusion criteria in his study were similar to ours except that tumors with intracranial extension in more than two directions regardless of their size were also included. Diagnosis and tumor size were determined using lateral pneumoencephalography and angiography, as well as CT in a few patients. All of Symon's patients underwent craniotomy for radical excision of the intradural part of the tumor and decompression of the optic apparatus and hypothalamus. A complete resection was achieved in 11 patients (69%), and all received postoperative irradiation. The high mortality rate is in contrast to the 101 patients reported by Symon who had adenomas whose suprasellar extension did not meet the giant criteria.[15] In this latter group there was a mortality rate of only 1% following transsphenoidal surgery or craniotomy. Mohr et al reported on 77 surgically treated giant pituitary adenomas (suprasellar extensions of Hardy type C in 66 cases and of Hardy type D in 11 cases).[8] Their complications consisted of one CSF-leak, one empty-sella syndrome, and four fatal postoperative hematomas. This represented a 5% mortality rate. In another series of 515 giant pituitary adenomas operated over the period 1953 to 1983, Pia et al reported a decrease in the mortality rate from 30% in the early patients to a low 6% in the final 5 years.[9]

Our series differs from previous studies in several respects. First, most of the tumors in this review were approached initially through a transsphenoidal route. We feel comfortable performing transsphenoidal procedures in most cases of giant pituitary tumors, as previously mentioned. Our series also differs from others in that inclusion was based strictly on tumor size without consid-

eration of the direction of tumor spread. This is important because in our experience tumor size best correlates with subarachnoid spread of pituitary tumors, consistency of the lesions, and their propensity to adhere to surrounding structures. Finally, tumor diagnosis and measurements were made using MRI in all cases except one in which only CT was available. This allowed a more accurate assessment of the growth characteristics of the tumor and its relationship to adjacent structures.[11,12]

In the present review, we report an operative mortality of 18% and a good or stable outcome in approximately 71% of cases which compares variably with previous studies.[2,8–10,16] There are several possible explanations for the high morbidity that we experienced. First, as these tumors enlarge, the subarachnoid space is often violated, usually above the diaphragma sella into the chiasmatic cistern (Fig. 5). This allows tumor attachment to critical vascular and neural structures, in a similar fashion to craniopharyngiomas. Traction on the tumor can thus cause ischemia within the hypothalamus, brainstem, and cerebral hemisphere by compromise of arterial feeders. This is especially true in the elderly patient who is more likely to have associated small vessel cerebrovascular disease. This is the most likely explanation for the ischemic events and poor outcome in at least two of our patients (cases 2 & 5). A second possibility is that subtotal resection can lead to infarction and swelling of residual tumor causing compression of adjacent vital structures or acute obstructive hydrocephalus. We agree with Symon that even a subtotal tumor debulking can be associated with significant morbidity (cases 2 & 4). Hydrocephalus was documented in two of our patients following surgery, and has been reported by others who suggest that this can be an important cause of postoperative morbidity with these particular tumors.[4] Hydrocephalus was evident radiographically in one patient preoperatively (case 4). Finally, one can hypothesize that vasoactive substances might be released at the time of surgery causing vasogenic edema and increasing the possibility of cerebral herniation.

The goal of surgery in patients with giant pituitary tumors is twofold. First, surgery should be undertaken to make a pathologic diagnosis. Since the majority of these tumors are endocrinologically silent, the second goal should be to decompress the neural tissue. Because of the slow growth and chronic neural compression, significant visual improvement should not be an expected outcome. In fact, improvement in vision was not documented in any of our patients, and only one patient in Symon's series had vision that returned to normal following surgery. Partial or panhypopituitarism is commonly seen preoperatively with giant pituitary adenomas. Improvement of hypopituitarism can occur following pituitary surgery, but this is unusual with large tumors and in patients with panhypopituitarism and thus should not be a surgical indication.




A B

**Figure 5.** Contrast enhanced CT (A) and coronal T1-weighted MRI (B) of an 82-year-old woman with deteriorating vision (case 9). The tumor has homogenous enhancement and minimal sellar enlargement compared with the suprasellar extension, more typical of the appearance of a meningioma. The left anterior cerebral artery (A-1 segment) can be seen to be elevated and to course through the tumor (arrows).

## Hormonal Activity

Preoperatively, the majority of the tumors in our series were felt to be endocrinologically inactive. Not surprisingly, nonsecreting adenomas often present as significantly larger lesions than their hormonally active counterparts. Only after they reach a size large enough to produce visual symptoms or nonspecific complaints such as headache or personality change do they come to clinical attention. In many cases, the gradual visual disturbance will go unnoticed. Interestingly, it has recently been shown that the majority of those tumors previously felt to be nonsecretory might in fact be glycoprotein secreting.[17,18] Glycoprotein (FSH, LH, and TSH) secreting tumors can produce the active hormone alone or in combination with the alpha subunit which is common to all of the proteins. The alpha or beta subunits can also be produced alone. Our documented FSH, LH, and TSH secreting adenomas suggest that this may indeed be the case. Prolactin, growth hormone, and ACTH producing tumors can also be clinically silent, but this is less common.

Although the role of surgery and dopaminergic agents in the treatment of prolactinomas remains controversial, it is generally agreed that bromocriptine is a suitable primary treatment modality in most cases.[19] However, the medical management of certain tumors with very high serum prolactin levels may be enhanced by surgical resection.[20] In the rare situation of a giant prolactinoma, we do not feel that medical therapy should preclude surgery. Certainly, postoperative bromocriptine would likely be required since hormonal cure after surgery alone is inversely related to tumor size. One of our deaths was in a patient with a known prolactinoma who presented with a rapid acceleration of chronic visual loss. Although the surgical procedure was unremarkable, this poor outcome would suggest that a less aggressive approach should be considered in this group of patients. The role of preoperative bromocriptine with very large adenomas is unclear. This has been advocated by some for patients with large prolactinomas to reduce tumor size and perhaps soften the tumor to promote resection, but we fell that this would likely make little difference with giant lesions.

## Tumor Growth Characteristics

It is generally recognized that the invasive characteristics of a pituitary tumor are related to their hormonal secretory status.[21] Specifically, hormonally active tumors, especially prolactinomas, tend to invade dura and adjacent structures more readily than nonsecretory tumors. In our experience prolactin and growth hormone secreting tumors tend to have a high frequency of cavernous sinus invasion which we have not seen with hormonally inactive tumors. Because most giant pituitary adenomas are nonsecretory, they are typically noninvasive and only compress surrounding neural and vascular structures. Only two patients in this series had cavernous sinus involvement demonstrated on preoperative radiography. One of these had a markedly elevated serum prolactin level and invaded the sinus (case 5). The other had no evident hormonal hypersecretion and appeared noninvasive (case 11). Another patient with marked sphenoid sinus invasion also had a tumor that was immunohistochemistry-positive for prolactin. Thus, all of the hormonally silent adenomas behaved in a noninvasive manner.

The cranial nerve palsy seen in one of our patients (case 11) was felt to be due to stretch of the oculomotor nerve within the subarachnoid space rather than by involvement of the cavernous sinus, since the paresis has almost completely resolved 6 months following surgery even though a small tumor remnant remains compressing the cavernous sinus. As previously mentioned, when the tumor enlarges the subarachnoid space may be violated because of the upward pressure of the tumor, most frequently into the chiasmatic cistern, the cistern of laminal terminalis, and third ventricle. It is not always possible to be certain that the subarachnoid space is violated with pituitary adenomas, although this is usually the case with these large tumors. Consequently, an intraoperative CSF communication will frequently be unavoidable. It is essential that a watertight closure and repair of the sellar floor is achieved in these situations.

Pituitary micro- and macroadenomas are characterized by their soft consistency and lack of vascularity, features that make them readily resectable transsphenoidally. However, as they become large they may develop a vascular supply as evidenced by the MRI contrast enhancement of large pituitary tumors not seen with smaller lesions. Concomitant with this increase in vascularity is a tendency for the giant tumor to become fibrotic (Fig. 2A), multiloculated, and firm. This can make surgery difficult, necessitating sharp dissection to open tumor septations, combined with gentle traction on the tumor to pull it into the sella. In some cases it may be impossible to dissect the tumor from the surrounding tissue when the arachnoid has been violated.

## Surgery for Giant Pituitary Tumors

The initial surgical approach to any pituitary tumor should be based upon the radiographic features of the tumor, the surgical indication, and the surgeon's experience. We prefer, when possible, to approach these lesions transnasally, because large portions of the adenomas may be soft and readily deliver into the sphenoid sinus. The transsphenoidal approach is particularly suitable when the tumor has grown in a postero-superior direction, even when there is compression of the brainstem or ventricular system. Unfortunately, giant pituitary adenomas, perhaps because of their greater age, often have a hard collagenous consistency, rendering a complete transnasal

resection difficult. In this situation a craniotomy as a second stage surgery or, alternatively, irradiation will be required. When there is a lateral extension of the tumor or if it has grown anteriorly under the frontal lobe, an initial craniotomy is usually indicated.

In conclusion, our experience with giant pituitary adenomas would suggest that surgery is associated with unique problems not encountered with the more routine macroadenomas. Elderly or debilitated patients who have lesions with extensive suprasellar extension would perhaps be best treated with limited transsphenoidal excision for diagnostic purposes, followed by irradiation. Complete surgical resection will be the goal in most other cases. When complete surgical resection is desired, one should consider combined approaches and staged procedures because lengthy surgeries are poorly tolerated. Staged transsphenoidal procedures have been advocated by others who suggest that, after subtotal resection of tumor, the CSF pressure will, over weeks to months, encourage suprasellar tumor descent into the sella. We, however, have not been impressed by any tendency for these very large tumors to descend into the sella after subtotal transsphenoidal resection and have not included this strategy in our surgical algorithm.

## REFERENCES


1. Ciric I, Mikhael M, Stafford T, [AUS]: Transsphenoidal microsurgery of pituitary macroadenomas with long-term follow-up results. J Neurosurg 59:395–401, 1983
2. Jefferson A: Chromophobe pituitary adenomata the size of the suprasellar portion in relation to the safety of operation. J Neurol, Neurosurg, Psychia 32:633, 1969 (Abstract)
3. Nakane T, Kuwayama A, Watanabe M, [AUS]: Transsphenoidal approach to pituitary adenomas with suprasellar extension. Surg Neurol 16:225–229, 1981
4. Wilson CB: Neurosurgical management of large and invasive pituitary tumors. In Tindall FT, Collins WF (eds): Clinical Management of Pituitary Disorders. New York: Raven Press, 1979, pp 335–342
5. Jefferson, G: Extrasellar extensions of pituitary adenomas. President's address. Proceedings of the Royal Society of Medicine 33: 433–458, 1940
6. Bakay L: The results of 300 pituitary adenoma operations (Professor Herbert Olivecrona's Series). J Neurosurg 7:240–255, 1950
7. Wirth P, Schwartz HG, Schwestechenan PR: Pituitary adenomas: factors in treatment. Clin Neurol 21:8–25, 1974
8. Mohr G, [AUS]: Surgical management of giant pituitary adeomas. Can J Neurol Sci 17(1):62–66, 1990
9. Pia HW, Grote E, Hildebrand G: Giant pituitary adenomas. Neurosurg Rev 8(3–4):207–220, 1985
10. Symon L, Jakubowski J, Kendall B: Surgical treatment of giant pituitary adenomas. J Neurol Neurosurg Psychia 42:973–982, 1979
11. Snow RB, Johnson CE, Morgello S, [AUS]: Is magnetic resonance imaging useful in guiding the operative approach to large pituitary tumors? Neurosurgery 26:801–803, 1990
12. Snow RB, Lavyne MH, Lee BCP, [AUS]: Craniotomy versus transsphenoidal excision of large pituitary tumors: the usefulness of magnetic resonance imaging in guiding the operative approach. Neurosurgery 19:59–64, 1986
13. Hardy J, Vezina JL: Transsphenoidal neurosurgery of intracranial neoplasm. In RA Green Jr (ed): Advances in Neurology. New York: Raven Press. 1976, pp 261–274
14. Tindall GT, Collins WF Jr, Kichner JA: Unilateral septal technique for transsphenoidal microsurgical approach to the sella turcica. J Neurosurg 49:138–149, 1978 Technical note.
15. Symon L, Jakubowski J: Transcranial management of pituitary tumors with suprasellar extension. J Neurol Neurosurg Psychia 42:123–133, 1979
16. Decker RE, Chalif DJ: Progressive coma after the transsphenoidal decompression of a pituitary adenoma with marked suprasellar extension: Report of two cases. Neurosurgery 28:154–158, 1991
17. Daneshdoost L, Gennarelli TA, Bashey HM, [AUS]: Recognition of gonadotroph adenomas in women. N Engl J Med 324:589–594, 1991
18. Snyder PJ: Gonadotroph cell adenomas of the pituitary. Endocr Rev 6:552–563, 1985
19. Candrina R, Galli G, Bollati A, [AUS]: Results of combined and medical therapy in patients with prolactin-secreting pituitary mascroadenomas. Neurosurgery 21:894–897, 1987
20. Fahlbusch R, Buchfelder M, Schrell U: Short-term preoperative treatment of macroprolactinomas by dopamine agonists. J Neurosurg 67:807–815, 1987
21. Scheithauer BW, Kovacs KT, Laws ER, [AUS]: Pathology of invasive pituitary tumors with special reference to functional classifications. J Neurosurg 65:733–744, 1986


## REVIEWER'S COMMENTS

Although significant advances have been made in the fields of microsurgical neuroanatomy, surgical technique and neoplasic biology, large pituitary tumors remain a complicated problem for neurosurgeons. As the authors of this paper assert, patients with giant pituitary tumors are prone to a high -sometimes unacceptable- operative morbidity and mortality rate. After a long experience, we have rationalized our approach to this kind of cases as follows: patients under the age of 55 years old are operated through a combined approach we described in 1984 (1), we simultaneously perform a pterional-orbito-zygomatic craniotomy and a transnasal transsphenoidal approach in such a way that one neurosurgeon dissects the tumors' pseudocapsule from adjacent neural structures under direct microsurgical vision, while the other decompresses the tumoral mass from the transsphenoidal approach; after gross total resection, these patients receive radiotherapy with megadosis voltage; in our hands this approach has rendered very good results, with operative mortality under 2%. As has been clearly emphasized by the authors of this excellent paper, older patients with higher chance of postoperative morbidity should undergo a descompresive transsphenoidal approach, also followed by radiotherapy.

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