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Transsphenoidal Hypophysectomy:
Postsurgical CT Findings

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Transsphenoidal surgery produces changes in the paranasal sinuses and sella that should be familiar to radiologists in view of the frequency of this type of surgery. Some of these changes, such as soft-tissue-density debris in the sinuses, are transient. Fat and other packing material identifiable in the sinuses and sella after surgery is permanent. The procedure is associated with a variety of complications that are readily detectable by computed tomography (CT). These include bleeding, compression of parasellar structures by packing material, cerebrospinal fluid leaks, and pneumocephalus. After a transsphenoidal procedure, with or without follow-up radiation therapy, residual enhancing intrasellar and parasellar lesions may still be identified.

Transsphenoidal surgery is considered safe and effective and is the procedure of choice for removal of intrasellar lesions. In view of the frequency with which it is currently performed, the radiologist evaluating the computed tomographic (CT) scans of patients who have had transsphenoidal surgery should be aware of those changes normally produced by the procedure as well as those caused by complications. This report is based on a review of the posttransphenoidal CT studies in 50 patients and was initiated to attempt to define how a transsphenoidal hypophysectomy alters the appearance of the sella and parasellar region.

Transsphenoidal surgery is indicated with intrasellar tumors. It is also indicated when a sellar tumor is associated with cerebrospinal fluid (CSF) rhinorrhea, pituitary apoplexy, or primary extension into the sphenoid sinus [1] and when removal of the pituitary gland is performed for palliation of pain due to metastases [2, 3]. It is an effective, rapid, decompressive procedure in situations where vision is severely compromised and transcranial manipulation of visual structures might endanger remaining vision [4, 5]. Even lesions with prominent suprasellar extension may be approached transsphenoidally as decompression of the mass, rather than complete removal of the tumor, is the primary goal of surgery [1, 3, 5, 6].

The transsphenoidal approach is contraindicated when the sellar lesion involves the brain [7, 8], cavernous sinus, or middle fossa [1, 7, 9]. Dumbbell-shaped tumors constricted at the diaphragm are best approached transcranially [1, 4]. Relative contraindications to the transsphenoidal approach include an incompletely pneumatized sphenoid sinus [1, 7], nasal or sinus infection [4], and a previous craniotomy for a sellar lesion [9].

After the appropriate intrasellar procedure has been completed, pieces of muscle or fat, usually taken from the patient's thigh or abdomen, or Gelfoam or Surgicel are used to pack the sella and sphenoid sinus. Pieces of resected bone or Silastic material are frequently used to reconstruct the floor of the sella and the face of the sphenoid sinus [1, 3, 7, 10, 11].

Materials and Methods

We reviewed CT scans obtained between August 1976 and August 1983 and found 50

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cases in which one or more examination was performed after transsphenoidal hypophysectomy. The postoperative studies were performed within hours to 5 years after surgery. In 29 patients, 33 studies were performed within 1 week after transsphenoidal hypophysectomy. In most of these cases, the development of symptoms prompted the CT examination. In the rest, the studies were indicated as baseline examinations for evaluation of future therapy.

Of the 94 available postoperative scans, 57 were obtained with and without contrast enhancement (a bolus of 28.2–42.3 g I) and seven were obtained only after enhancement. In the other 30 cases, contrast material was not used.

Results

At surgery, a spectrum of pathology was encountered (table 1). Six of the patients had operative findings suggesting previous pituitary apoplexy. In only one of these patients, however, were symptoms and CT findings compatible with apoplexy. In other reports, evidence of pituitary apoplexy has been found in asymptomatic patients [12].

TABLE 1: **Indications for Transsphenoidal Hypophysectomy**

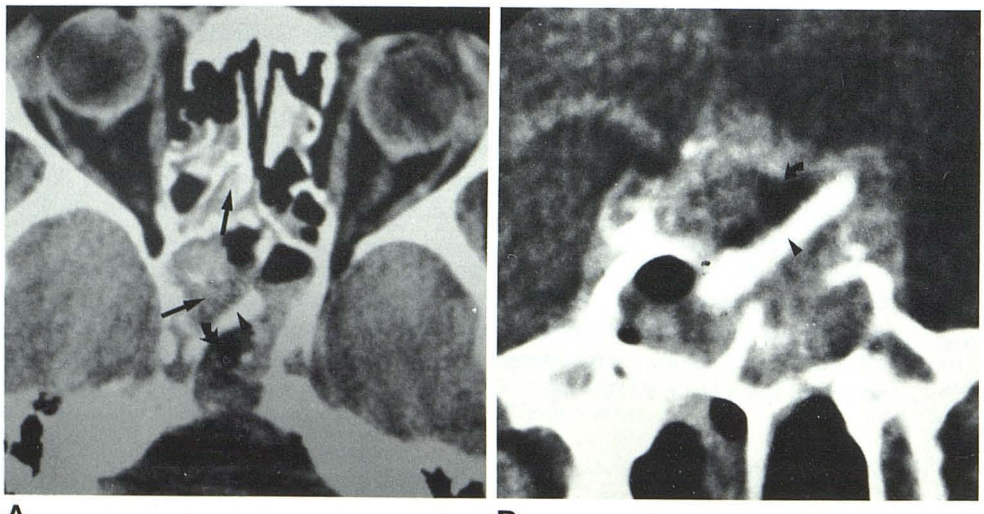
Pathology	No. of Cases
Functioning tumor:	
Prolactin	5
Growth hormone	8
ACTH	4
Subtotal	17
Nonfunctioning tumor:	
Adenomas	20
Pituitary carcinoma	1
Metastatic	3
Craniopharyngioma	1
Subtotal	25
Other:	
Normal (hypophysectomy for relief of pain from metastases)	2
Necrotic pituitary gland	4
Unknown	2
Subtotal	8
Total	50

All of the CT examinations in the immediate postoperative period demonstrated changes in the sinuses related to the procedure itself (fig. 1). In the maxillary and ethmoid sinuses, soft-tissue density representing mucosal thickening, blood, and postoperative debris was found. The density in the sphenoid sinus ranged from fat to bone and depended on the type of packing material used during the procedure. The frontal sinuses were not involved. On follow-up studies, the density in the maxillary and ethmoid sinuses disappeared spontaneously within the first 2 months after surgery, but the abnormal density in the sphenoid sinus, especially the high density related to bone chips or Silastic material, persisted unchanged for years.

In 23 cases low density in the range of fat was identified within the sella on CT examinations within 1 year after surgery. In five cases, fat was present in the sella on studies 1 year or more after surgery. In eight cases in which intrasellar fat could be identified on postoperative scans, the fat density eventually became smaller or disappeared.

On the postoperative CT examinations of 23 patients, residual enhancing lesions were identified on studies 4 days to 5 years 8 months after surgery (fig. 2). Seven of these patients had functioning adenomas (table 2), and in each case elevated hormone levels were demonstrated postoperatively correlating with persistent tumor, as suggested by the presence of contrast enhancement. Most of the patients whose studies did not demonstrate residual tumor were not followed and their endocrine status was not known.

Twelve patients with pituitary adenomas had CT examinations after completion of postoperative radiation therapy. On the scans of four of these patients, obtained 1–4 years after surgery, no intrasellar pathology was identified. In one case, the patient had a persistently elevated prolactin level despite lack of visualization of a lesion. No endocrine follow-up was available for the other three patients. Eight patients who had received postoperative radiation therapy had residual enhancing lesions on studies 100 days to 3.5 years after surgery, but in none of these cases was there evidence of growth of



A B

Fig. 1.—Contrast-enhanced transverse axial (**A**) and coronal (**B**) scans 5 days after transsphenoidal hypophysectomy. Soft-tissue-density material in ethmoid and sphenoid sinuses (*straight arrows*). Linear density (*arrowheads*) representing piece of Silastic material used to reconstruct sellar floor has been dislodged, probably by aggressive packing of sphenoid sinus, and it is now within sella. Fat (*curved arrows*) used as packing material is also present within sella.

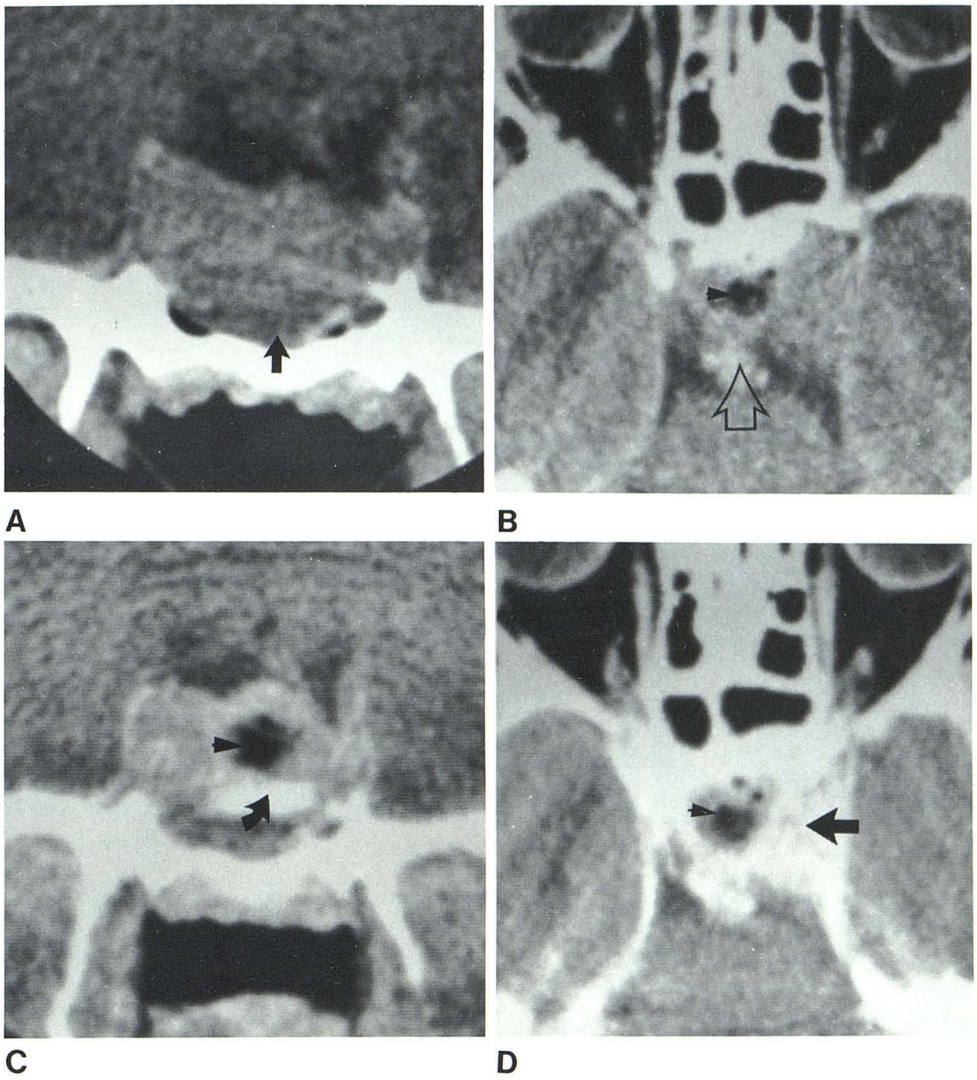


Fig. 2.—26-year-old man with prolactin-secreting pituitary adenoma. **A**, Contrast-enhanced coronal scan before surgery. Large intrasellar tumor has eroded sellar floor and fills sphenoid sinus (*arrow*). **B–D**, After surgery. **B**, Unenhanced transverse axial section. Enhanced coronal (**C**) and transverse axial (**D**) scans. Persistence of large, enhancing lesion (*straight solid arrow*). Fat (*arrowheads*) and a Silastic bar (*curved arrow*). Small focus of bleeding (*open arrow*) at posterosuperior aspect of tumor.

TABLE 2: **Changes Seen on CT after Transsphenoidal Hypophysectomy**

Change	No. of Patients (n = 50)
In sinus	35*
Fat within sella	23
Residual enhancement:	
Nonfunctioning tumor	11
Prolactin-secreting tumor	5†
Growth-hormone-secreting tumor	2†
Carcinoma	3
Unknown functional status	2
Total	23
Other:	
Excess suprasellar fat	1
Bone in suprasellar cistern	2
Frontal lobe hematoma	1
Blood in suprasellar cistern	1
Intraventricular hemorrhage	2
Silent sellar hemorrhage	6
Pneumocephalus	4

* 35/35 Studied within 2 months of surgery.
† All with elevated hormone levels.

the pituitary lesion on serial studies (fig. 3). Of the patients with residual enhancing lesions, five had nonfunctioning adenomas. Two patients with prolactin-secreting lesions and one with a growth-hormone-secreting tumor had persistent elevations of hormone levels after radiation therapy.

Numerous complications of the surgical procedure were encountered in our series, and several of these produced demonstrable abnormalities on postoperative CT scans. In six cases, the development of visual signs and symptoms (new field abnormalities, diplopia, cranial nerve palsies) prompted the postoperative CT examinations. In one case, an excessive amount of fat was discovered in the suprasellar cistern. In two cases, bone density was present in the suprasellar cistern. One of these patients required a second surgical procedure, at which time bone chips were found to have migrated upward impaling the inferior aspect of the chiasm (fig. 4). In the other case, as well as in the case of excess fat in the suprasellar cistern, the symptoms resolved with removal of nasal packing. One patient developed a new cranial nerve palsy postoperatively, but no cause was discernible on the CT examination.

Of the other two patients developing new visual symptoms

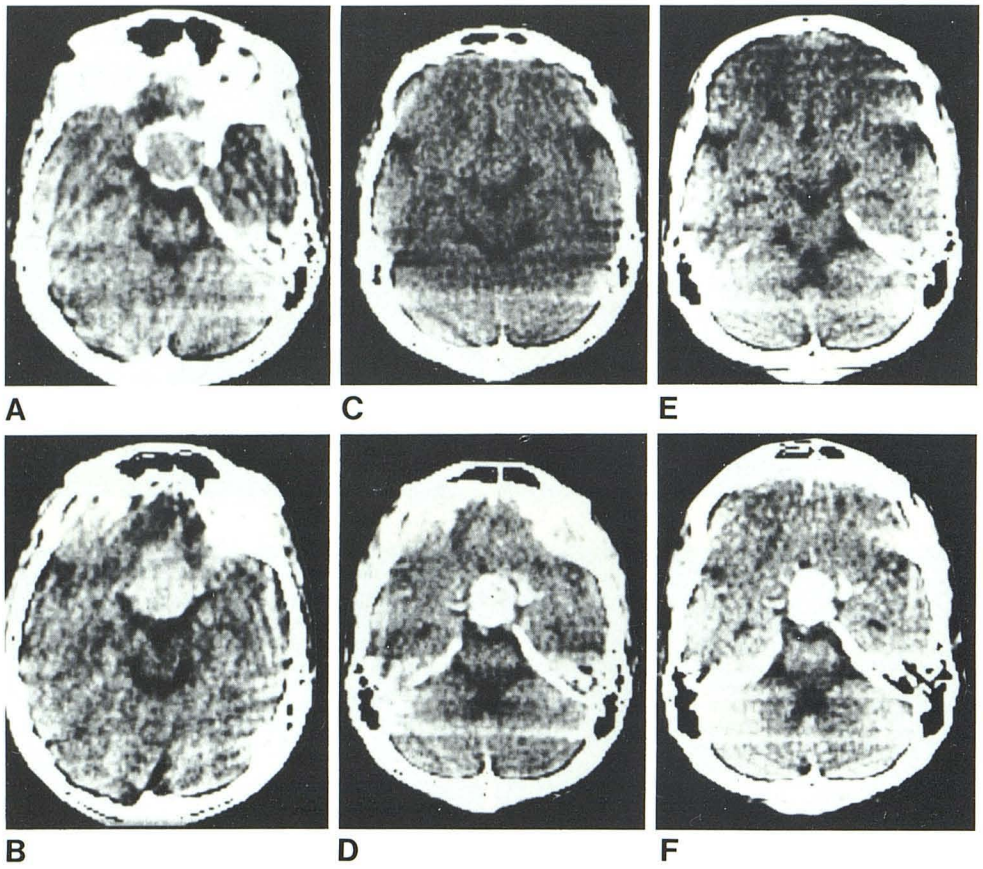


Fig. 3.—**A** and **B**, First CT scans in 37-year-old man were obtained only after contrast enhancement. Markedly expanded sella containing dense lesion with suprasellar extension. At surgery, mass proved to be nonfunctioning adenoma. Pre- (**C**) and post- (**D**) enhancement scans 1 year after transsphenoidal hypophysectomy and subsequent radiation therapy. Persistent though smaller enhancing lesion with suprasellar extension. Pre- (**E**) and post- (**F**) enhancement scans almost 2 years after surgery. No change in size or degree of enhancement of residual lesion. Patient remained asymptomatic.

after surgery, one had a right frontal lobe intracerebral hematoma (fig. 5), and the CT study of the other demonstrated blood outlining the suprasellar cistern (fig. 6). Subsequent surgery in the latter case verified the finding.

Two patients developed meningeal signs, and CT demonstrated intraventricular bleeding. In one case, the lesion proved to be a vascular pituitary carcinoma. In the other, the bleeding was from intraventricular extravasation of a hematoma in the upper half of bilobed pituitary adenoma that underwent apoplectic change when the lower half was removed.

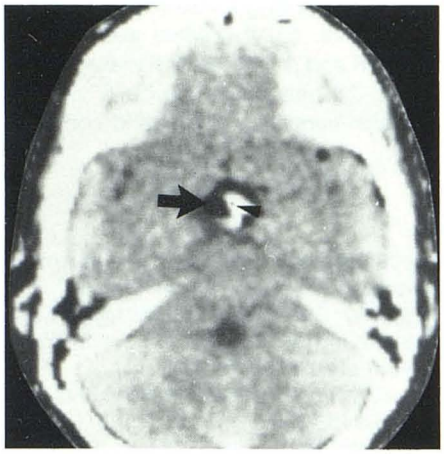
In six other cases, small foci of blood density could be identified in the sella or suprasellar cistern on CT studies performed within the first week after surgery. One of these patients had headaches postoperatively and was known to have had bleeding into the tumor capsule during surgery. Another developed unexplained tinnitus. In four cases, the pituitary tumors were large and subtotally removed. CT studies were performed to evaluate residual tumor before radiation therapy. In all of these cases, the blood density appeared to be confined to the superior aspect of the residual tumor (fig. 2). Only bleeding clearly involving structures outside the sella or residual tumor, that is, intracerebral hematomas, subarachnoid bleeding, and intraventricular bleeding, was associated with symptoms.

CSF leaks were encountered surgically in nine cases. On CT examination 1–23 days after surgery, pneumocephalus was present in four cases; of these, a necrotic pituitary gland was found in one and two patients had microadenomas. In the other case, a normal gland had been removed for relief of bone pain from metastases. In the case in which a necrotic tumor was found, the patient subsequently developed communicating hydrocephalus, which required shunting (fig. 7). In those cases without pneumocephalus, no CT abnormalities suggesting a CSF leak were demonstrated, and for the most part, these leaks were noted and repaired at the time of surgery.

Discussion

The abnormalities demonstrated on CT after a transsphenoidal hypophysectomy may be the expected consequences of the way in which the procedure is performed or caused by the development of complications.

On those scans obtained in the immediate postoperative period, all demonstrated changes in the maxillary, ethmoid, and sphenoid sinuses related to the surgery itself. The ethmoid sinuses are primarily affected due to resection of their bony septa and are filled with soft-tissue density representing blood, swollen mucosa, and debris. The maxillary sinuses may be similarly involved or may contain air-fluid levels. Fractures in the medial walls of the maxillary sinuses may also be seen. The soft-tissue densities observed in the maxillary and ethmoid sinuses usually disappear spontaneously within 2 months, although persistent mucosal thickening is occasionally encountered. Chronic sinusitis may develop after a transsphenoidal procedure due to persistent blockade of the ostia of the sinuses by fractures, and occasionally a mucocele may form [13]. The sinusitis may be associated with a clear nasal discharge resembling a CSF leak. In such cases, an isotope



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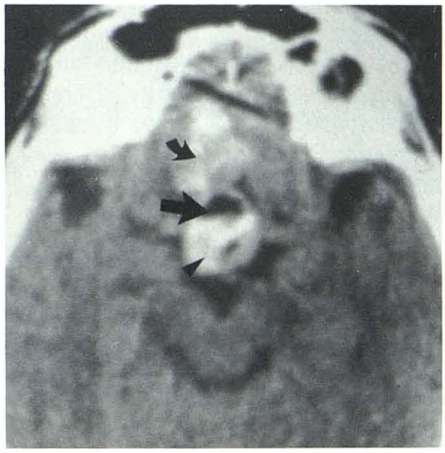

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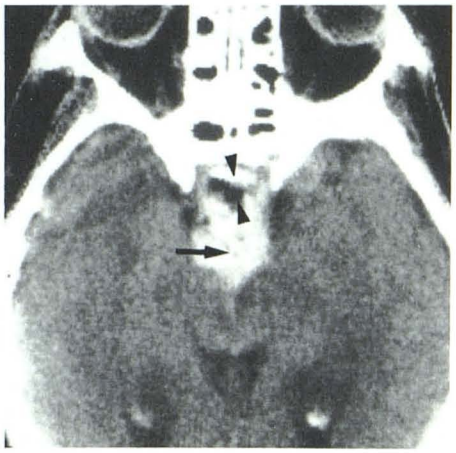

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Fig. 4.—Decreased peripheral vision developed bilaterally within hours after hypophysectomy. Emergency CT study shows fat density in suprasellar cistern (*arrow*) and sliver of bone (*arrowhead*) that, during repeat surgical procedure, was found to be packing material that had migrated superiad, impaling optic chiasm, thus explaining symptoms.

Fig. 5.—63-year-old man had nonfunctioning pituitary adenoma removed transsphenoidally 1 day before. On day of CT study, he suddenly developed an unreactive right pupil and new right field deficit. Unenhanced scan shows fat (*straight arrow*) in lesion anteriorly. Blood density is confined to capsule, (*arrowhead*), but there is also extravasated blood presenting as right frontal intracerebral hematoma (*curved arrow*).

Fig. 6.—57-year-old man with nonfunctioning, vascular adenoma removed 1 day before CT study. After surgery, he was somnolent. CT scan shows blood in suprasellar cistern (*arrow*) and bone plug and fat anteriorly (*arrowheads*). Subsequent surgery proved presence of hematoma in suprasellar cistern.

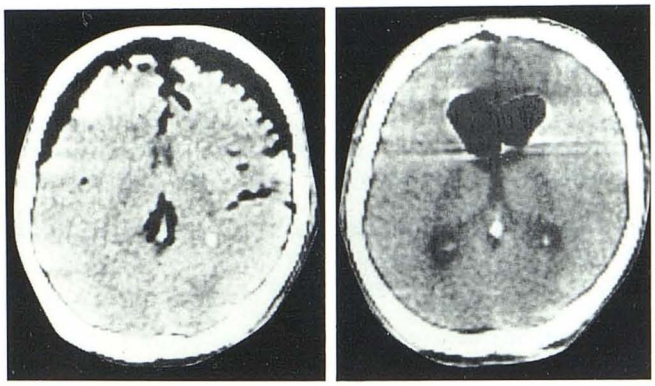

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Fig. 7.—48-year-old patient seen with acute painless visual loss. Preoperative evaluations included tomograms showing expansion of sella, CT scans showing only lucency in sella, and negative angiogram. At surgery, only necrotic material was found in sella. **A**, Postoperative day 1 after CSF leak developed. Air is in subarachnoid space. A second surgical procedure was performed 10 days later to repair leak. **B**, Postoperative day 22 (12 days after second surgery). Ventricular enlargement and intraventricular air. Progressive memory deficit developed subsequently, as did ventricular enlargement, which responded to shunting.

or metrizamide cisternogram might be of value to determine the etiology of the nasal discharge.

On CT studies after a transsphenoidal hypophysectomy, the sellar contents may be of increased or decreased density depending on the types and quantities of material used to pack the sella at the end of the surgical procedure. If fat is used, only lucency may be identified within the sella. This appearance may be confused with an empty sella unless the density of the sellar contents is measured. Also, in such cases, if contrast material is administered, the fat remains lucent and the contrast-enhancing cavernous sinuses stand out strikingly against the fat and may be confused with a residual, enhancing tumor capsule. Thin-section studies using fine-resolution technique may be helpful to define the origin of the enhancing area.

Postoperative CT evaluations of the amount of residual tumor may be deceptive. The detection of small residual lesions is limited by the resolution of the scanning technique. In these cases, endocrine studies for the detection of persistently elevated hormone levels are more sensitive in detecting remaining tumor than either CT [14] or surgical estimations of gross tumor removal [15]. On studies in the immediate postoperative period (0–6 weeks after surgery), the amount of apparent residual lesion may be deceptively large, as packing may elevate the remaining superior aspect of the lesion. As the packing is resorbed, the lesion may become smaller on subsequent studies [14].

After the administration of contrast material, enhancing lesions may be identified within the sella for several years after surgery, even after postoperative radiation therapy. In this series, patients with hormone-secreting adenomas who had residual enhancing lesions after radiation therapy also had persistent elevations of hormone levels, although in one case, persistent prolactinemia was present even though no lesion was demonstrated on CT. In patients with nonfunctioning tumors, the presence of enhancement may be the only indication of persistent tumor, but in this small series, none of these patients has developed symptoms related to growth of a tumor, and surgical confirmation of residual tumor was not available. The apparent lack of growth may not be from stabilization of the lesions, but rather may reflect the slow rate of growth of pituitary adenomas, and longer follow-up is needed [14, 16].

In the immediate postoperative period, a frequent complication is the development of visual symptoms (i.e., blurred vision, diplopia, or hemianopia), which are usually due to compression of the optic chiasm or the cranial nerves in the

cavernous sinuses by a hematoma or excessive packing of the sella or sphenoid sinus. Excess packing is usually manifested on CT as fat or nonenhancing soft-tissue density in the suprasellar cistern. Occasionally, the bone or Silastic material used to reconstruct the sellar floor may become dislodged and impinge on surrounding structures. Excess packing may compress the carotid artery, producing a hemiparesis [1, 6]. A rare cause of visual symptoms is impingement on the optic nerve by fractures of the optic canal produced by the surgical manipulations [13]. Underpacking of the sella may result in an empty sella [6].

Hemorrhages found on the postoperative CT studies in our series ranged from small, asymptomatic hematomas, probably located in the residual tumor capsule, to an intracerebral hematoma. The number of hemorrhages in this group of patients was high (10 of 50) compared with other series in which the incidence varied between 0.5% and 2.4% [1, 7, 10, 13]. In the latter series, most of the patients were studied before the advent of CT or in the early CT era when a small hematoma might not have been detectable. Four of the patients with hematomas in our series were asymptomatic at the time the bleeding was detected.

Although not encountered in our small series, other complications related to vascular damage and potentially detectable by CT have been reported and include development of a false aneurysm [1, 6, 7], vascular occlusion [5–7, 13], and arterial laceration [1, 5].

During a transsphenoidal hypophysectomy, a common complication is the development of a CSF leak [1, 2, 7, 13, 17, 18], which occurs when the arachnoid membrane is punctured, as it occasionally must be to remove a tumor completely. Usually, the leak can be alleviated at the time of the surgery by meticulous packing of the sella and sphenoid sinus. Reexploration is necessary only rarely. However, meningitis may be encountered in these cases, and patients with CSF leaks should be carefully observed for the development of this complication [1, 7, 10, 17]. In our series, CSF leaks associated with pneumocephalus were primarily associated with the removal of small lesions. This may be from the presence of a residual tumor capsule in the case of larger lesions, which helps to prevent the development of a leak. Another phenomenon observed in our series for which there is no adequate explanation was the development of communicating hydrocephalus in a case complicated by a CSF leak and persistent pneumocephalus. Normal-pressure hydrocephalus has complicated transsphenoidal hypophysectomies in other series [1]. It could be caused by unappreciated subarachnoid hemorrhage related to the surgical procedure. In our case, however, hemorrhage was never observed despite multiple CT examinations.

Nasal complications occur occasionally after a transsphenoidal hypophysectomy. The development of adhesions of the mucosa of the lateral nasal wall to the septum, which may impair nasal ventilation [17], and nasal septal perforations may be encountered [13].

In conclusion, the transsphenoidal approach has become the procedure of choice for removing intrasellar lesions. It is considered safe and effective, but it creates abnormalities related to the surgery itself and it may be associated with a variety of complications. CT has proven to be a valuable means of detection of both surgical changes and complications.

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