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Diagnostic Accuracy of Preoperative CT Scanning of Pituitary Somatotroph Adenomas

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Between 1980 and 1986, 58 patients (23 women and 35 men) had coronal CT scans of the sella turcica for suspected growth hormone-secreting adenoma and underwent transsphenoidal exploration. The CT examinations were performed with a fourth-generation EMI scanner (CT 7070), and reports of the preoperative CT were compared with the findings at transsphenoidal exploration. The same neurosurgeon performed all the operations. In three patients arthritic changes in the neck caused difficulties in positioning, which made it impossible to obtain adequate coronal CT scans. These nondiagnostic examinations are excluded from the statistical calculations. In all 55 patients with scans that were able to be evaluated, distinct adenomas were found at surgery. Among these were 39 macroadenomas (diameter larger than 10 mm) and 16 microadenomas. Three macroadenomas and two microadenomas caused combined hypersecretion of growth hormone and prolactin. All macroadenomas were localized correctly on the preoperative CT scans (sensitivity 100%), but in two cases there was a discrepancy in size of more than 5 mm compared with the operative findings.

Preoperative CT scans correctly localized 13 of 16 microadenomas, for a sensitivity rate of 81.2%. Two patients with negative scans and one patient in whom the adenoma was found in a location other than that reported on the preoperative CT scan were considered to have negative scans for the purpose of statistical calculations. If both correct localization and size estimation within 2 mm of that found at surgery are considered, the accuracy rate was 90.9% for the entire group of patients, 94.9% for those with macroadenomas, and 81.2% for microadenomas.

In recent years, high-resolution CT of the sella turcica has almost completely replaced all other imaging methods in the investigation of abnormalities of the pituitary gland. However, there is rather scant information about the diagnostic accuracy of this procedure with fourth-generation equipment in regard to the identification of growth hormone (GH)-secreting adenomas [1-4]. Over a period of six years, between 1980 and 1986, 58 patients who had coronal CT scans of the sella turcica for suspected GH-secreting adenoma underwent transsphenoidal exploration. We reviewed the findings in this group of patients to document the reliability of CT for identifying the lesion preoperatively.

Subjects and Methods

The patients included in this study were referred for CT of the sella turcica because of clinical and biochemical evidence of acromegaly. All patients were evaluated by an endocrinologist prior to referral for CT scan examination. The CT examinations were performed with a fourth-generation scanner (EMI CT 7070). The patients were placed on the scanner couch in the prone position with the neck hyperextended. The scanner gantry was angled 90° to the canthomeatal line to obtain direct coronal views. Scans were closely monitored by a radiologist, and it was possible to make changes in scanning technique partway through the examination. In some instances it was necessary to increase the scan angle to avoid artifacts from the teeth; however, the maximum gantry angle obtainable with our machine is 30° from the vertical plane. In three patients arthritic changes in the neck caused difficulties in

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positioning, which made it impossible to obtain adequate coronal CT examinations; these nondiagnostic examinations are excluded from statistical calculations.

Technical factors, methods of administration of contrast medium, and criteria for distinguishing between hypodense lesions and artifacts were as we have previously described [5]. Fifteen of the 55 patients were scanned before August 1982 and were given a contrast agent (60% iohalamate [Conray 60] 2.2 ml/kg body weight up to a maximum of 150 ml, or about 42 g I maximum) as a single bolus. Subsequent patients received 76% diatrizoate (Renografin 76 or MD 76%) given as a rapid initial bolus of 30 ml, followed by further aliquots of 15–20 ml for every three slices [5], for a total dose of about 20 g I. There were no significant differences in the results obtained with these two methods. Small changes in gland height or in the contour of the sellar floor alone were not considered to be diagnostic at the time of reporting for purposes of clinical management of the patients.

Data concerning interpretation of CT scans were gathered through a review of the reports that had been made by the examining neuroradiologist before the transsphenoidal surgical interventions. The neuroradiologists had access to clinical information such as history, physical findings, and results of biochemical tests, and they were able to see the patients while obtaining and interpreting the scans. Two patients had more than one CT scan before surgery. In these cases the study closest to the date of surgery was the one included in the series.

In the three patients with nondiagnostic CT scans, the decision to proceed to surgery was based on clinical and biochemical findings and positive hypocycloidal tomograms. One patient with a negative but technically adequate sella CT examination had had a previous unsuccessful transsphenoidal exploration in another center. For this reason abdominal sonograms and abdominal and chest CT examinations were obtained in a search for possible growth hormone-releasing hormone (GRH)-secreting lesions [6, 7]; these investigations were negative. As this patient had had inadequate response to medical therapy with dopamine agonists, it was decided to proceed with repeat surgery. All transsphenoidal explorations were performed by the same neurosurgeon. The size and location of the adenoma reported by the neurosurgeon and confirmed by pathology reports were taken as the standard against which the CT findings were compared.

Results

In all 55 patients distinct adenomas were found at surgery. CT scans of 37 of the 39 patients with macroadenomas showed obvious changes in gland height, superior contour,

stalk position, and appearance of the bone of the sella turcica. Two patients had only 6-mm and 10-mm hypodense lesions, respectively, on CT scan. At surgery, however, they were found to have adenomas of 12-mm and 15-mm diameter, respectively, in the locations suspected on the scans.

Thirty-three macroadenomas were isodense with brain and showed enhancement to a density slightly higher than that of brain but less than the carotid arteries after infusion of contrast material (Fig. 1). Four were initially hypodense and enhanced poorly, remaining hypodense relative to brain after administration of contrast material. One of the four large hypodense tumors was found to contain areas of necrosis or hemorrhage at surgery, while one of the isodense lesions contained such areas. One isodense macroadenoma contained areas of calcification (Fig. 1). Nine patients with large macroadenomas had evidence of invasion of the sphenoid sinus or cavernous sinus both on CT scan and at surgery (Fig. 2).

Among the 16 cases with confirmed microadenomas, gland height was 3 mm in one case, 4 mm in one, 5 mm in four, 6 mm in two, 7 mm in one, 8 mm in four, 9 mm in one, 10 mm in one, and 11 mm in one. A convex superior contour was seen in three cases, whereas three showed local bulging, six had a flat superior border, and four had a concave contour. Of the three patients whose microadenomas were not detected correctly on CT scan, two had a concave and one had a flat superior contour. The pituitary stalk was displaced to the left in one patient with a hypodense lesion (confirmed correct) and was midline in all the others. Changes in the bone of the floor of the sella turcica—localized thinning or depression—were seen in 10 cases and correlated with the position of the adenoma in seven. The two patients without hypodense lesions had bone changes, but there was correlation with the position of the adenoma found at surgery in only one of them. Thus, CT changes other than hypodense lesions were not helpful in diagnosing pituitary microadenomas in these acromegalic patients. In the statistics presented below, positive CT findings refer only to hypodense lesions. Figure 3 shows the scan of the patient with the smallest microadenoma of our series.

Table 1 compares the surgical and CT findings in the 55 patients with interpretable scans in this series. Thirty-nine of the patients had macroadenomas (>10 mm in diameter) at

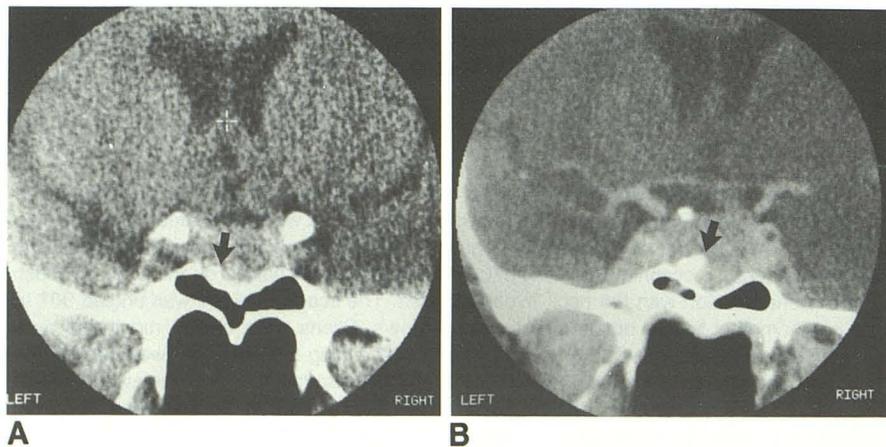


Fig. 1.—Example of isodense macroadenoma showing several calcifications (arrows) and slight enhancement after administration of contrast agent.

A, Slice through anterior clinoid processes showing small calcification near floor of sella.

B, Slice through posterior clinoid processes; note different calcification close to sellar floor and displaced distorted pituitary stalk.

Fig. 2.—Example of macroadenoma eroding floor of sella and invading sphenoid sinus.

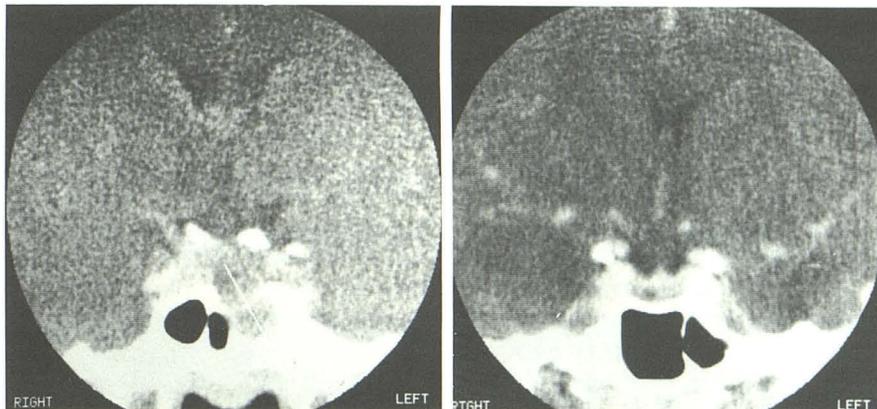


Fig. 3.—Coronal CT scan showing 4-mm hypodense microadenoma situated laterally on right side of pituitary gland. Note concave superior border, midline pituitary stalk, and absence of changes in floor of sella turcica.

TABLE 1: Somatotroph Adenomas

| Tumor Type | CT | | Surgery | |
|---------------|----------------------|---------------------|----------------------|---|
| | + | - | + | - |
| Microadenomas | 13 2 ^a | 1 ^b 2 | 13 1 2 | |
| Total | 15 | 3 | 16 | |
| Macroadenomas | 37 | | 37 2 ^a | |
| Total | 37 | | 39 | |

^a Lesion size is wrong.

^b Lesion suspected on CT at wrong location.

surgery, and all had been correctly localized on CT scan. However, in two cases the size had been underestimated by 5 mm or more. Of 16 microadenomas suspected on the basis of the CT scan, 15 (93.8%) were confirmed at surgery, but two were the macroadenomas with wrong size estimates mentioned above. Of 16 microadenomas found at surgery, 13 (81.2%) had been correctly identified by CT scan. Two patients had normal CT scans and one patient with a reported hypodense lesion on CT was found to have the adenoma in a different location than that suspected by CT. Among the tumors correctly localized on preoperative CT scan were three residual or recurrent macroadenomas in patients who had had previous transsphenoidal operations. Thus, in the present series coronal CT scans permitted correct preoperative localization of adenomas in 52 of 55 patients, for a sensitivity, or true positive, rate of 94.5%. For the group of microadenomas, sensitivity was 81.2% (13 of 16 patients). Since there were no patients with negative surgical explorations, specificity cannot be calculated. The overall accuracy rate including correct size determination was 90.9% for the entire group of patients, 94.9% for the subgroup of macroadenomas, and 81.2% for microadenomas.

The size distribution of the 16 microadenomas found by the neurosurgeon is shown in Figure 4. The average diameter of the microadenomas in this series was 7.31 mm, as compared with 5.97 mm for our group of 62 microprolactinomas [8] and 4.08 mm for 24 microadenomas in our series of

SOMATOTROPH MICROADENOMAS

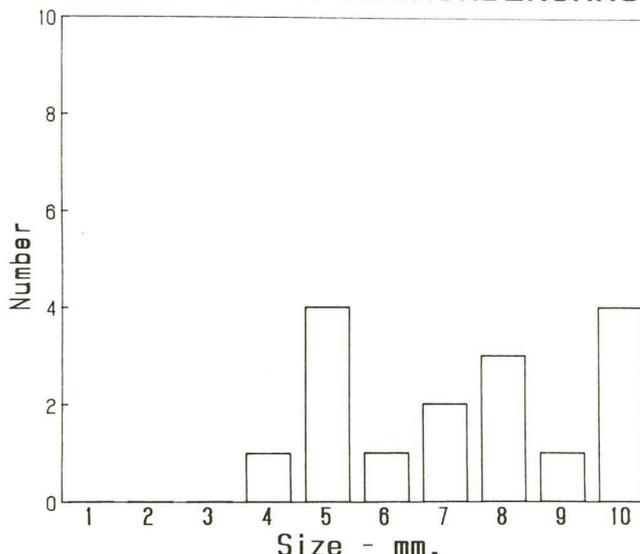


Fig. 4.—Size distribution of 16 microadenomas as determined at transsphenoidal surgery.

ACTH-secreting tumors [5] seen during the same period of time. Comparison of these groups by ANOVA and Duncan's multiple range test [9] shows the size difference to be significant at $p < .01$ for somatotroph adenomas and prolactinomas vs ACTH adenomas and at $p < .05$ for somatotroph adenomas vs prolactinomas. The location of the adenomas was classified as central, paracentral, or lateral. Of the 16 microadenomas, two were central, two were paracentral, and the rest were lateral. In all three patients with negative CT scans the adenomas were located laterally.

Discussion

In our experience, CT is very helpful in the preoperative localization of pituitary somatotroph or mixed GH/PRL-secreting adenomas and microadenomas of these secretory types, which usually appear as focal hypodense lesions on CT, as do microprolactinomas [8]. Comparison of our results with other published data is limited by the small number of

cases reported to date. Gardeur et al. [1] included four GH adenomas and two "mixed-cell" adenomas in their series of microadenomas, with the exact sizes of lesions not specified. They reported "diffuse heterogeneous" enhancement in one GH adenoma, no abnormal enhancement in another GH adenoma, and relative hypodensity in one mixed adenoma. Two GH-secreting and one mixed adenoma were reported as empty sella, with no mention about whether a distinct adenoma was visualized on CT or proved at surgery. The report of Sakoda et al. [2] included 14 patients with surgically proved GH-secreting adenomas (including one mixed adenoma) in a retrospective analysis of axial CT scans. Two of the lesions were microadenomas; sensitivity and specificity rates are not documented. The series of surgically proved microadenomas reported by Hemminghytt et al. [3] included four GH-secreting adenomas, of which three were hypodense on CT and one was "slightly hypodense." In the retrospective study of surgically proved adenomas by Davis et al. [4], there were 19 GH-secreting adenomas (among which four were associated with prolactin hypersecretion as well); 11 were macroadenomas, of which four were isodense, five were hypodense, and two showed mixed density on CT. Among the eight patients with microadenomas, focal lesions (hypodense) were encountered in only four cases.

It is unlikely that systematic exclusion of patients with negative CT scans from surgical therapy has occurred in our series, since no patients with persistently elevated circulating GH and clinical evidence of acromegaly have had negative CT scans and been advised against surgery on that basis during this period of time. Patients who did not have neuro-ophthalmologic complications and who were found to be responsive to dopaminergic agonists on dynamic endocrine testing were offered the options of transsphenoidal surgery or medical therapy. Those who chose medical therapy did so out of personal preference or apprehension about surgery rather than by medical advice based on CT scan criteria.

Four (25%) of our 16 patients with microadenomas had a concave superior gland contour indicative of partially empty sella on CT scan. This proportion is similar to that reported for the general population [10–12], and coexistence of somatotroph adenomas with partially empty sella has been reported previously [13, 14]. Partially empty sella was present in the two patients with false-normal CT scans, but the significance of this association is doubtful in view of the small number of cases.

The fact that no CT criteria other than a focal lesion were helpful in detecting a microadenoma is in concordance with the report by Davis et al. [4]. This finding is not at all surprising in view of the variability in normal gland heights reported in other CT studies [1, 15–19] and in normal cadaver pituitaries [15, 20], and of the variability found with age among asymptomatic women [21]. Although the superior gland surface is usually flat or concave, convex bulging is not rare in asymptomatic patients [19, 22, 23], especially young women [18]. Lack of correlation between the position of microadenomas and areas of cortical thinning or depressions of the sellar floor has also been reported [24–26].

The inability to obtain proper patient positioning for CT scanning due to lack of sufficient mobility of the cervical spine was a problem we did not encounter in our patients with prolactinomas or ACTH adenomas, and was probably attributable to the acromegaly itself. This series of patients also

had a smaller proportion of microadenomas than did either of our other groups, and the microadenomas were larger [5, 8]. This finding probably reflects the delayed clinical suspicion of the diagnosis due to the gradual development of physical manifestations in acromegaly.

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