Eighty-seven patients with sellar and parasellar pathology were evaluated by magnetic resonance imaging to categorize lesions with hyperintensity on T1-weighted images. Postoperative fat packing after transsphenoidal hypophysectomy, intratumoral subacute or chronic hemorrhage in pituitary adenomas, and hemorrhagic or fat-containing craniopharyngiomas accounted for 33 of 35 abnormalities with short T1 values. Forty-three percent of nonsurgically treated pituitary adenomas had subacute intratumoral hemorrhage present. Using T2-weighted images to distinguish fat from subacute hemorrhage and attempting to identify the normal anterior pituitary gland on T1-weighted images may help to differentiate these three entities. T1-weighted images alone were not sufficient to distinguish between all sellar and parasellar masses.

KEY WORDS:
Magnetic resonance imaging, pituitary gland, hemorrhage, adenoma, sellar

Considerable effort is being devoted to streamlining magnetic resonance imaging (MRI) sequences in an attempt to shorten examination times yet maintain optimal diagnostic accuracy. For the examination of the sellar and parasellar regions, several investigators have suggested that T1-weighted images are sufficient for detection of pathology (1–4). Furthermore, since most intracranial lesions are hyperintense on T2-weighted sequences, the T1 signal characteristics are most important for diagnostic specificity. We retrospectively reviewed our experience over a 15-month period to categorize sellar and parasellar lesions by their T1 characteristics. We hoped to determine how often pituitary adenomas, craniopharyngiomas, and other sellar lesions are bright on T1-weighted images.

SUBJECTS AND METHODS
Since February 1986, 87 patients studied on a 1.5 Tesla G.E. Signa superconducting MRI unit had positive scans for sellar and/or parasellar pathology. Scanning sequences included sagittal and coronal T1-weighted images employing TR 500–700 msec, TE 20–30 msec, 3–5 mm slice thickness with a 0- to 1.5-mm gap depending on tumor size, 256 x 256 matrix, four excitations, and 16- to 20-cm fields of view. Additionally, T2-weighted and proton density coronal images were performed (except in some cases of nonhemorrhagic pituitary microadenomas) with scanning parameters of TR 2000 msec, TE 50 and 100 msec, 3–5 mm slice thickness with a 0- to 1.5-mm gap, 128 x 256 matrix, one excitation, and 16- to 20-cm fields of view. Axial scans were performed only if deemed necessary to better localize the tumor. MRI images were reviewed by at least two neuroradiologists (D.Y. and A.J.K.). Intensity characteristics were compared with the normal anterior pituitary gland intensity which, in the adult, approaches that of gray matter.

Correlation with the patients’ hospital charts, office notes, pituitary hormonal levels, pathologic specimens, and surgical records was made so as to deter-
examinations of the sella. At our institution, it is routine to pack the sella with fat and fascia during transsphenoidal hypophysectomy and in nine of these cases the high signal intensity was believed to be due to fat, because of the reduction in signal intensity on the second echo of the long TR sequence compared with the first echo (Figure 1). In two cases that had concurrent computed tomography (CT) scans, fat density was demonstrated in the region corresponding to hyperintensity on the T1-weighted scan. In the 10th case the hyperintensity was due to a large hematoma within the operative bed, confirmed at re-operation. In this case, as opposed to the cases of fat packing, signal intensity remained bright on T2-weighted images.

The remaining 19 cases of pituitary adenomas with areas of short T1 values had not been surgically treated before the MRI scan. Six patients subsequently went to operation where hemorrhagic tumor was found in five cases. All five of these cases also demonstrated hyperintensity on T2-weighted scans. A cystic ACTH-secreting adenoma with high liquid cholesterol content in the tumor cyst was discovered in the sixth case. It was of low intensity on the T2-weighted scan. The cause of hyperintensity on T1-weighted images in the remaining 13 cases was thought to represent subacute or chronic hemorrhage due to its bright intensity characteristics on T2-weighted images, more so than neighboring fat (Figures 2 and 3). The remaining cases of pituitary adenomas were hypointense or isointense on T1-weighted images and were seen as discrete bulges or masses within the anterior pituitary gland.

### RESULTS

**Pituitary Adenomas**

Of the 87 patients with sellar and parasellar lesions, 68 had pituitary adenomas (Table 1). Of these 68 patients, 41 were white, 24 were black, 3 were oriental; there were 51 women and 17 men. The ages of these patients ranged from 10 to 85 years old with a mean average of 38. There were 39 prolactinomas, 23 nonsecreting adenomas, 2 ACTH-secreting adenomas, 2 growth hormone-secreting adenomas, and 2 tumors secreting multiple hormones.

On MRI images, 37 pituitary adenomas were macroadenomas with an average linear height of 2.1 cm. Thirty-one were microadenomas with a 5.4-mm average vertical dimension, as measured on coronal or sagittal T1-weighted images.

T1-weighted hyperintensity to normal anterior pituitary tissue within the sella was seen in 28 cases (Table 2). Ten of these cases were in postoperative examinations of the sella. At our institution, it is routine to pack the sella with fat and fascia during transsphenoidal hypophysectomy and in nine of these cases the high signal intensity was believed to be due to fat, because of the reduction in signal intensity on the second echo of the long TR sequence compared with the first echo (Figure 1). In two cases that had concurrent computed tomography (CT) scans, fat density was demonstrated in the region corresponding to hyperintensity on the T1-weighted scan. In the 10th case the hyperintensity was due to a large hematoma within the operative bed, confirmed at re-operation. In this case, as opposed to the cases of fat packing, signal intensity remained bright on T2-weighted images.

The remaining 19 cases of pituitary adenomas with areas of short T1 values had not been surgically treated before the MRI scan. Six patients subsequently went to operation where hemorrhagic tumor was found in five cases. All five of these cases also demonstrated hyperintensity on T2-weighted scans. A cystic ACTH-secreting adenoma with high liquid cholesterol content in the tumor cyst was discovered in the sixth case. It was of low intensity on the T2-weighted scan. The cause of hyperintensity on T1-weighted images in the remaining 13 cases was thought to represent subacute or chronic hemorrhage due to its bright intensity characteristics on T2-weighted images, more so than neighboring fat (Figures 2 and 3). The remaining cases of pituitary adenomas were hypointense or isointense on T1-weighted images and were seen as discrete bulges or masses within the anterior pituitary gland.

### Cranioopharyngiomas

Nine craniopharyngiomas were diagnosed during the 15-month examination period. The average age was 9.4 years (range 1–23 years) and there were four

### Table 1. Frequency of Hyperintensity in Sellar and Parasellar Lesions on T1-Weighted Images

<table>
<thead>
<tr>
<th>Lesion</th>
<th>Percent with hyperintense foci (no./total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pituitary adenomas</td>
<td>45% (19/42)</td>
</tr>
<tr>
<td>Craniopharyngiomas</td>
<td>44% (4/9)</td>
</tr>
<tr>
<td>Rathke's cleft cysts</td>
<td>33% (1/3)</td>
</tr>
<tr>
<td>Hypothalamic hamartomas</td>
<td>0% (0/2)</td>
</tr>
<tr>
<td>Hypothalamic glioma</td>
<td>0% (0/2)</td>
</tr>
<tr>
<td>Optic chiasm glioma</td>
<td>0% (0/2)</td>
</tr>
<tr>
<td>Spontaneous pituitary hemorrhage</td>
<td>100% (1/1)</td>
</tr>
<tr>
<td>Postoperative sellas</td>
<td>35% (9/26)</td>
</tr>
<tr>
<td>Total</td>
<td>39% (34/87)</td>
</tr>
</tbody>
</table>

### Table 2. Causes of T1-Weighted Hyperintensity in 87 Intrasellar and Parasellar Lesions

<table>
<thead>
<tr>
<th>Lesion</th>
<th>No.</th>
<th>Hemorrhage</th>
<th>Cholesterol</th>
<th>Fat and fluid</th>
<th>Fat graft</th>
<th>No. hyperintense</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pituitary adenoma</td>
<td>42</td>
<td>18</td>
<td>1</td>
<td></td>
<td>9</td>
<td>19</td>
</tr>
<tr>
<td>Postoperative sellas</td>
<td>26</td>
<td>1</td>
<td>2</td>
<td></td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>Craniopharyngioma</td>
<td>9</td>
<td>2</td>
<td>2</td>
<td></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Rathke's cysts</td>
<td>3</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Spontaneous hemorrhage</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Chiasm glioma</td>
<td>2</td>
<td>0</td>
<td></td>
<td></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Hypothalamic glioma</td>
<td>2</td>
<td>0</td>
<td></td>
<td></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Hypothalamic hamartomas</td>
<td>2</td>
<td>0</td>
<td></td>
<td></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>87</td>
<td>23</td>
<td>1</td>
<td>2</td>
<td>9</td>
<td>35</td>
</tr>
</tbody>
</table>

*Five pathologically proven, 13 by MRI criteria.*
MAY 1990

FIGURE 1. Hyperintense area on sagittal T1-weighted sequence (A) extends from sphenoid sinus below (curved arrow) to the suprasellar cistern compatible with extensive fat packing after transsphenoidal hypophysectomy. Coronal T2-weighted (B) image demonstrates signal characteristic of “lesion” that parallels subcutaneous fat signal (arrow). This is the typical pattern of postoperative fat packing of the sella.

FIGURE 2. Surgically confirmed case of chronic hemorrhage in a pituitary adenoma. The lesion within the sella is bright on T1-weighted coronal (A) and T2-weighted (B) images (straight arrows) and on the latter scan is hyperintense to subcutaneous fat (curved arrow).

males and five females; seven patients were white and two were black.

Four of the nine craniopharyngiomas were hyperintense to anterior pituitary tissue on T1-weighted images and in all but two of the nine cases the anterior
pituitary gland was clearly distinguished and separated from the tumor. At surgery, two of the short T1 cases had hemorrhagic products and two were filled with oily fluid (Figures 4 and 5). All nine craniopharyngiomas were hyperintense on T2-weighted scans.

Rathke’s Cleft Cysts

Three Rathke’s cysts were discovered by MRI and surgically removed. One case had short T1 values and surgery confirmed a hemorrhagic cyst (Figure 6). All three lesions were hyperintense on T2-weighted images.

Miscellaneous

One spontaneous pituitary hemorrhage (without neoplasm) showed high signal intensity on T1-weighted images. Two hypothalamic hamartomas and four optic chiasm or hypothalamic gliomas were isointense or hypointense on T1-weighted images.

DISCUSSION

Although CT is very helpful in evaluating the sella turcica and parasellar regions, it has been shown to be limited in its ability to detect pituitary microadenomas (5–9). The superb resolution and sensitivity of MRI, coupled with its lack of ionizing radiation and improved accuracy in lesion detection, have enabled this modality to rival contrast-enhanced CT as the study of choice for evaluating lesions of the pituitary gland (1–3, 10, 11). T1-weighted images provide the best anatomic detail of sellar structures and are usually used as the first imaging sequence.
FIGURE 5. Layering of subacute clot anteriorly on acute hemorrhage posteriorly is seen in this craniopharyngioma on T1-weighted sagittal (A) and T2-weighted sagittal images (B). The patient was 16 months old and presented with visual impairment and abnormal optic discs on fundoscopic examination. Old and new hemorrhage was found.

It is well recognized that hyperintensity on T1-weighted images can be due to fat, subacute or chronic hemorrhage, elevated protein concentration, or slow blood flow on unenhanced images though the application of these findings to the sellar region has not been previously described. Fat has short T1 and long T2 values and can be seen to become less intense on the second echo of a proton-density/T2-weighted sequence. Gomori and others (12-14) have described intensity characteristics of evolving hematomas. They explain that in the subacute and chronic stage the T1 shortening effects of methemoglobin lead to a bright T1 image. High cholesterol content and/or the presence of concentrated protein may also account for hyperintensity on T1-weighted sequences.

FIGURE 6. A 1 cm hemorrhagic Rathke's cyst is hyperintense on T1-weighted (A) and T2-weighted (B) images. No evidence of craniopharyngioma was noted at pathology.
calcification, seen better on CT scans, may assist the neuroradiologist in this differential diagnosis. While hemorrhage in the early subacute phase with intracellular methemoglobin may be hypointense on T2-weighted scans; this was never seen in any of our hemorrhagic lesions in the sella. The potential for misdiagnosing early subacute hemorrhage as fat could be eliminated by observing the chemical shift artifact or by performing scans employing a fat-suppression technique.

In short, a wide variety of lesions in the sella and parasellar region may have short T1 values and, therefore, T2-weighted images will continue to be useful in separating the fat-containing ones from the late subacute/chronic hemorrhagic ones. By MRI criteria, pituitary adenomas bleed more frequently (43%) than previously reported in the CT literature and are the most common intrinsic hemorrhagic sellar masses (23). Craniopharyngiomas may contain hemorrhage or fat intensity and are the most common extrasellar lesions to be hyperintense on T1-weighted images. Of fat-containing lesions, postoperative packing is most common in the sella, whereas craniopharyngiomas, teratomas, and cholesterol-containing cysts are seen most frequently outside the sella.

REFERENCES

MAY 1990

BRIGHT LESIONS ON SELLAR/PARASELLAR T1-WEIGHTED SCANS


