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The Asymmetric Mamillary Body: Association with Medial Temporal Lobe Disease Demonstrated with MR

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PURPOSE: To determine whether mamillary body atrophy is caused by deafferentation of the mamillary body in patients with mesial temporal sclerosis. **METHODS:** We studied 36 patients with thin-section MR to assess mamillary body symmetry. These patients included 10 control subjects without seizures and 26 patients with a history of seizures. Thin-section T1 scans were available for all cases. The patients with epilepsy underwent axial and coronal T2 scans as well. **RESULTS:** In five of eight cases with prior medial temporal lobe resection for intractable epilepsy, there was evidence of unilateral mamillary body atrophy ipsilateral to the resection. Similar findings were evident in three of six patients with MR findings of mesial temporal sclerosis without surgery. Two patients with medial temporal stroke or tumor also had ipsilateral mamillary body atrophy. **CONCLUSION:** These findings provide support for the proposed mechanism of mamillary body atrophy caused by prior medial temporal lobe injury.

Index terms: Brain, asymmetry/disymmetry; Brain, atrophy; Sclerosis, mesial temporal; Seizures

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Mamillary body atrophy has been reported in autopsy cases in association with epilepsy (1). A report by Lindboe et al suggested that this atrophy is caused by deafferentation of the mamillary body in patients with mesial temporal sclerosis (2). We evaluated mamillary body symmetry in patients with medial temporal lobe abnormalities to test this proposed pathogenesis. We also studied 10 patients without seizures to determine the normal appearance of the mamillary bodies using a thin-section technique.

Materials and Methods

Mamillary body size and symmetry were observed in 10 patients without epilepsy and without focal brain abnormalities by MR. These patients all underwent multiplanar 1-mm reconstruction of an MP-RAGE (magnetization-prepared rapid-acquisition gradient-echo) sequence obtained through the anterior temporal lobe region, in addition to their routine MR examination. This included an axial T1 (600/15/1 [repetition time/echo time/excitations]), axial proton-density and T2 (3000/30,90/1), and sagittal T1 (600/15/1) scan through the entire brain.

In 26 patients with a history of seizures, we obtained either a 3-mm T1 scan (500/15/2) (17 cases) or three-dimensional MP-RAGE sequence (18/7/1; 15° flip angle; inversion time, 500) with 1-mm reconstructed sections through the mamillary bodies (9 cases) (Fig 1). All 26 also had axial and coronal proton-density T2 scans (3000/30,90/1), as well as axial T1 (600/15/1). The 26 patients with seizures included 8 patients with prior temporal lobe resection for intractable epilepsy, 5 with seizures and imaging evidence of infarct or tumor, and 13 consecutive patients who were studied as part of their evaluation for epilepsy.

The eight patients with temporal lobe surgery included five men and three women with an average age of 34 years. All patients had a seizure history of more than 10 years and scans were obtained 6 months to a year after surgery. The five with tumor or infarct included three men and two women with an average age of 35 years. The 13 with intractable epilepsy included eight women and five men with an average age of 34 years. These patients all had a modified temporal lobe resection. In this surgery the first 4 cm (6 cm on the right) of temporal neocortex is removed, sparing the superior and often the middle tem-

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Fig 1. T1-weighted sagittal image from an MP-RAGE sequence (18/7/1) demonstrates the preferred angled axial plane of reconstruction for seeing the mamillary bodies.

Fig 2. One-millimeter axial section (18/7/1) demonstrates the prior right temporal resection (*arrows*). The right mamillary body (*small arrow*) is smaller than the left.

poral gyri. The amygdala is removed, and up to 4 cm of hippocampus is resected (Table 1).

Results

In all 10 healthy patients the mamillary bodies were symmetric on visual inspection.

Of the eight patients with prior temporal lobe surgery for intractable epilepsy, five had asymmetric mamillary bodies. The smaller mamillary body was ipsilateral to the resection in all cases. In several cases the asymmetry was quite striking (Fig 2).

Of the five patients with seizures and MR evidence of previous infarct or tumor, two had asymmetric mamillary bodies. In both cases the ipsilateral medial temporal lobe structures were absent or atrophic (Fig 3). In the other three cases with symmetric mamillary bodies, the parenchymal lesion was extratemporal.

Of the 13 patients evaluated for intractable epilepsy (Table 2), 5 (38%) had asymmetric

TABLE 1: Eight patients with prior temporal lobe surgery

Patient	Location	Basis for Location	Type of Surgery	Postoperative Status	Pathology	Mamillary Bodies
1	Temporal	Clinical; response to surgery	L-modified temporal lobectomy	Seizure-free	HC; neuronal loss and gliosis	Symmetric
2	Temporal	Clinical; response to surgery	R-modified temporal lobectomy 10/24/91	Seizure-free	HC; neuronal loss and gliosis	Asymmetric
3	Temporal	Clinical; response to surgery	R-modified temporal lobectomy 11/15/91	Seizure-free	HC; neuronal loss and gliosis	Asymmetric
4	Temporal	Clinical; depths; response to surgery	L-modified temporal lobectomy 12/5/91	>90% reduction	No HC submitted; no change in neocortex	Symmetric
5	Temporal	Clinical; response to surgery	L-modified temporal lobectomy 3/26/92	Seizure-free	HC; neuronal loss and gliosis; neocortex normal	Symmetric
6	Temporal	Clinical; response to surgery	L-modified temporal lobectomy 9/12/91	Seizure-free	HC; neuronal loss and gliosis; neocortex normal	Asymmetric
7	Temporal	Clinical; response to surgery	L-modified temporal lobectomy 10/3/91	Seizure-free	HC; neuronal loss and gliosis; neocortex normal	Asymmetric
8	Temporal	Depths; response to surgery (clinically atypical)	R-modified temporal lobectomy 4/23/92	Seizure-free	HC; neuronal loss and gliosis; neocortex normal	Asymmetric

Note.—Depths indicates depth electrodes and HC, hippocampus.

Fig 3. Coronal scan (500/15/1) demonstrates enhancement of a large right middle fossa meningioma (*A*). Postoperative (18/7/1) 1-mm axial scan (*B*) reveals a smaller right mamillary body than left (*arrow*).

TABLE 2: Thirteen patients with intractable epilepsy

Patient	Location	Basis for Location	Type of Surgery	Postoperative Status	Pathology	Mamillary Bodies	Hippocampus
1	Temporal	Clinical; depths	L modified temporal lobectomy 4/22/93	No change	Mild nonspecific gliosis	Asymmetric	Symmetric
2	R-parietal	Electroencephalogram	None	. . .	. . .	Asymmetric	Symmetric
3	Frontal	Clinical; depths	L orbital frontal resection 6/5/93 and 6/16/93	No change	Normal L inferior frontal; neuronal loss and gliosis from R frontal lesion	Asymmetric	Asymmetric
4	Temporal	Clinical; response to surgery	L modified temporal lobectomy	Seizure-free	Neuronal loss and gliosis in HC; no change in neocortex	Symmetric	Asymmetric
5	Extratemporal	Clinical scalp monitoring	None	. . .	. . .	Symmetric	Asymmetric
6	Unknown	Clinical scalp monitoring	None	. . .	. . .	Symmetric	Asymmetric
7	Nonepileptic		None			Symmetric	Symmetric
8	Frontal	Clinical; depths; response to surgery	L orbital frontal response 4/14/93	>90% decrease	No abnormalities	Symmetric	Symmetric
9	Nonepileptic		None			Symmetric	Symmetric
10	Multifocal	Clinical; response to surgery	Callosotomy 7/23/92	>90% decrease		Symmetric	Symmetric
11	Temporal	Clinical; depths	None			Symmetric	Symmetric
12	Temporal	Clinical; depths; response to surgery	R modified temporal lobectomy 1/13/92	Seizure-free	Hippocampus; neuronal loss and astrocytosis; changes in neocortex caused by electrodes only	Asymmetric	Asymmetric
13	Temporal	Clinical; depths; response to surgery	L modified temporal lobectomy 9/16/93	Seizure-free	Amygdala and HC = neuronal loss and astrocytosis	Asymmetric	Asymmetric

Note.—Depths indicates depth electrode.

A B C

Fig 4. The coronal T2-weighted image (2500/90/1) (*A*) shows a smaller and hyperintense left hippocampus (*arrow*) compared with the right. The axial (*B*) and coronal (*C*) reformatted 1-mm sections (18/7/1) demonstrate a smaller left mamillary body (*small arrow*) than right. The coronal scan also demonstrates the small left hippocampus (*open arrow*).

mamillary bodies. Three of the 5 also had ipsilateral mesial temporal sclerosis by MR criteria as well as depth electrode location (Fig 4). The diagnosis of mesial temporal sclerosis was based on the presence on coronal scans of both a relatively small and hyperintense hippocampal formation (3). Although we did not do a volumetric analysis of the hippocampal volumes, visual inspection alone has a comparable sensitivity (4).

Two of the 13 patients with seizures had asymmetric mamillary bodies with a normal hippocampal formation. In one of these patients (Fig 5) depth electrodes located the seizures in the temporal lobe ipsilateral to the small mamillary body. The patient subsequently underwent a temporal lobe resection but the seizure frequency was not diminished after surgery. The other patient underwent only surface electroencephalography, which located the seizures in the ipsilateral parietal occipital region. This patient responded to medication and invasive location was not performed. The remaining 8 cases had symmetric mamillary bodies.

Discussion

Previous reports have documented a symmetric reduction in mamillary body size (using volumetric techniques) in patients with Wernicke encephalopathy and Korsakoff syndrome. The authors of these papers described the problem of volume averaging this small structure with surrounding cerebrospinal fluid (5, 6). In these previous studies, in which a 3-mm T1-weighted technique only was used, there were no cases among their 34 collective healthy control subjects with mamillary body

Fig 5. Coronal T2-weighted image (2500/90/1) (*A*) demonstrates symmetric hippocampal formations. An axial T1-weighted image (600/16/1) (*B*) shows a marked asymmetry of the mamillary bodies. The right appears normal (*arrow*) but the left is virtually absent. Depth electrodes located the seizures in the left medial temporal lobe. This patient's seizure did not change after left temporal lobe surgery.

asymmetry. This would support our observation of mamillary body symmetry among our control patients without seizures. All of the control patients had 1-mm sections through the region of the mamillary bodies. We used an independent console to evaluate the MP-RAGE volume in multiple planes in these cases to optimize visibility of the mamillary bodies. Artifactual asymmetry is a potential pitfall in cases with asymmetric positioning of the head or dolichoectasia of the basilar or posterior cerebral arteries. A confident assessment of mamillary symmetry usually requires an interactive selection of the optimum plane for reconstruction of the MP-RAGE scan.

In five of eight patients with previous temporal lobe resection, the mamillary body was visibly smaller on the side of the resection. We did not have comparable preoperative thin-section scans of these patients, and therefore we could not determine whether there was asymmetry before surgery.

There were two among the patients with seizures who had encephalomalacia of the medial temporal lobe. In one patient this was caused by a previous infarct, and in another this was secondary to the mass effect of a middle fossa meningioma. In both, the mamillary body was smaller on the involved side. These findings suggest that mamillary body asymmetry is not unique to patients with mesial temporal sclerosis. The patient with the meningioma resection had only postoperative seizures, which responded to medication; therefore a longstanding seizure disorder could not be invoked as a potential mechanism. In contrast, one of the patients had a temporal lobe tumor (ganglioglioma) that did not involve the hippocampal formation. In that individual the mamillary bodies were symmetric.

In three of the four cases with MR and clinical findings of mesial temporal sclerosis, the ipsilateral mamillary body was small. There were no cases in which the small mamillary body was contralateral to the abnormal temporal lobe.

The proposed explanation for these findings is suggested by the discrete anatomic relationships of these limbic structures. Although the hippocampus proper has been implicated as the seizure focus in some patients with partial seizures (7), experimental evidence suggests that the subiculum alone provides the primary input to the mamillary body (8, 9). Thus, it is reasonable to consider that the hippocampus alone might be abnormal without significant involvement of the subiculum in some patients with mesial temporal sclerosis. In one study of non-Korsakoff amnestic patients, a reduction in hippocampal volume was identified without diminished mamillary body size in some cases, and the authors proposed a similar explanation (4). There is some evidence that the subiculum is not involved in cases of mesial temporal sclerosis, however. In a study of 45 temporal lobes resected for epilepsy, there was no evidence of cell loss in subiculum (10). This observation may explain the infrequent association of mamillary body atrophy in cases of mesial temporal sclerosis.

It was surprising that two cases with mamillary body atrophy had a normal appearance of the hippocampal formations on magnetic resonance. It would seem unlikely that by coincidence a patient might have a small mamillary body and seizures, particularly because mamillary body asymmetry was not seen or described as a normal variant. However, we could not exclude that possibility based on the relatively small sample of patients examined. Another explanation suggests a primary role for the mamillary body in epilepsy (11). Although there is some animal work that supports this contention, more evidence is necessary to confirm this hypothesis in humans. In our one patient with asymmetric mamillary bodies and normal hippocampal formations, surgery did not reduce the frequency of seizures.

This experience provides additional support for the previously proposed pathogenesis of mamillary body atrophy. However, our cases with asymmetric mamillary bodies and normal appearing hippocampal formations suggest the possibility of another mechanism for this atrophy in some patients with seizures.

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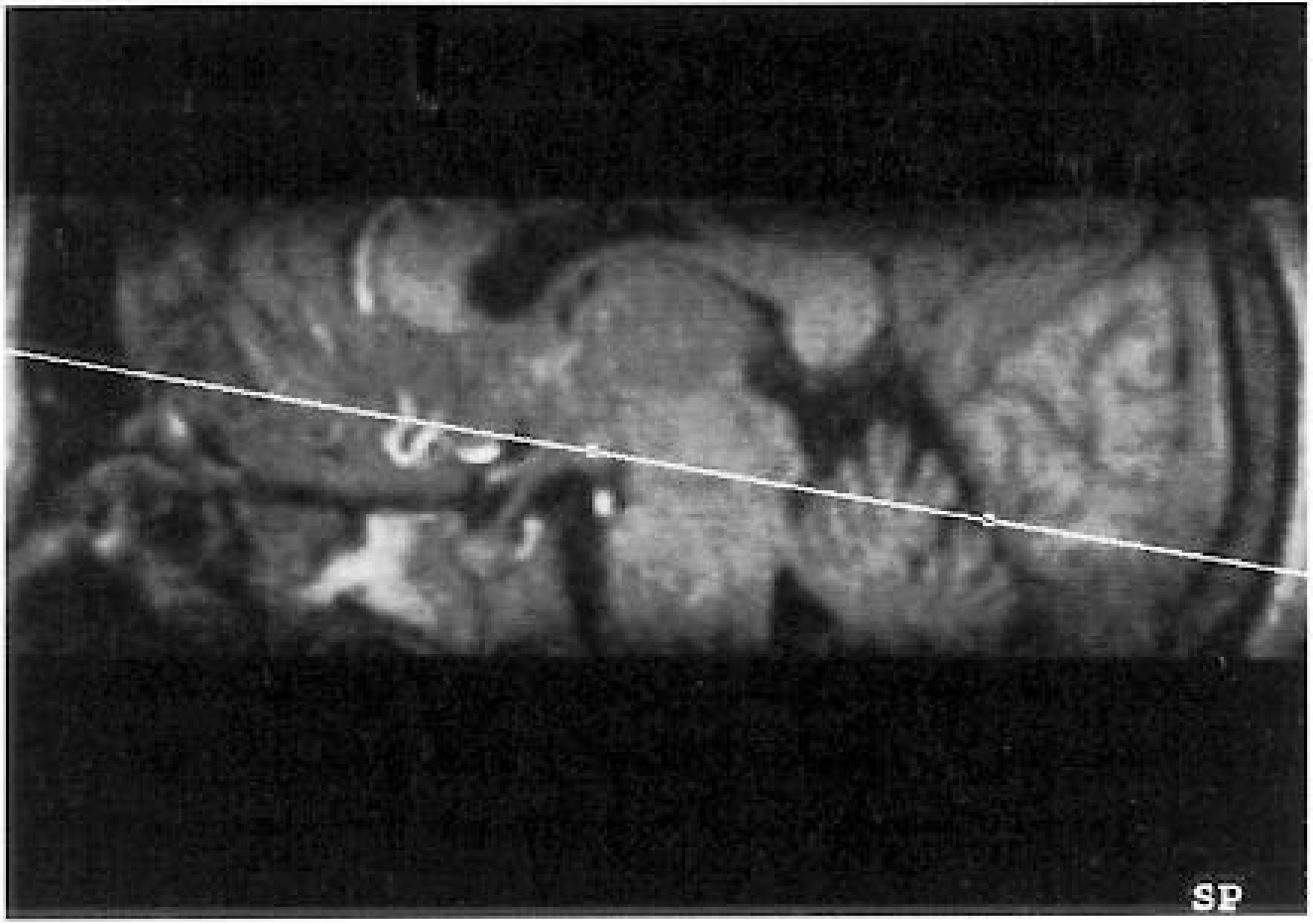
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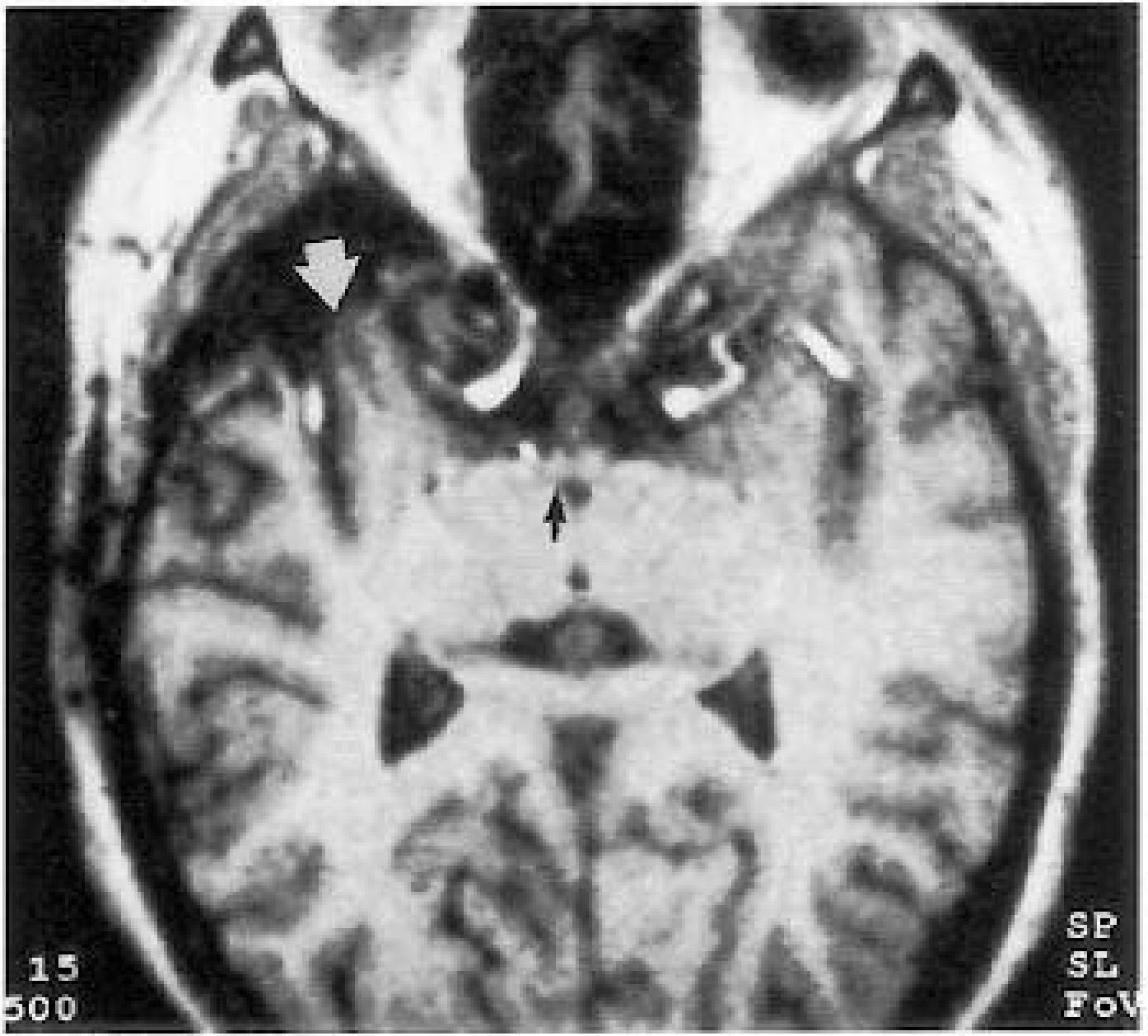
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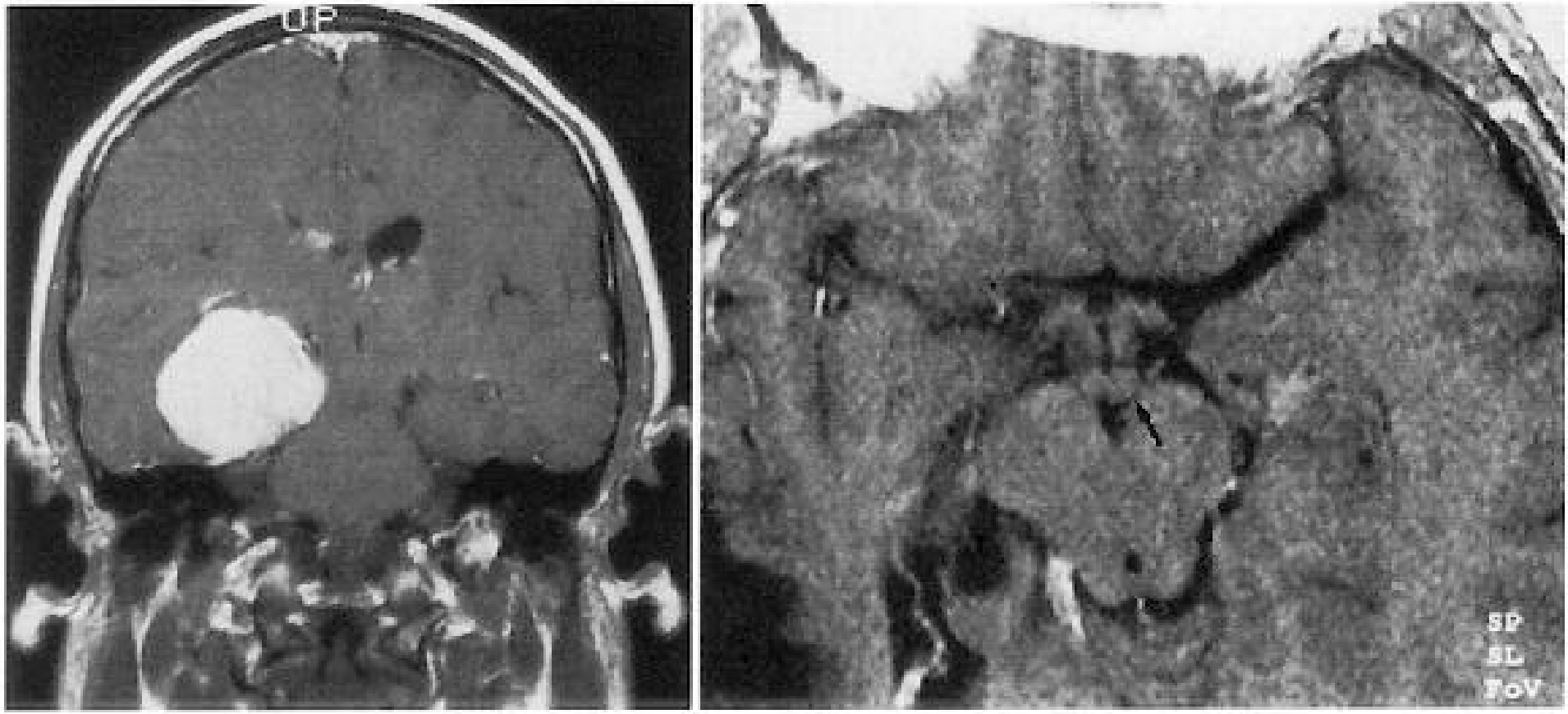

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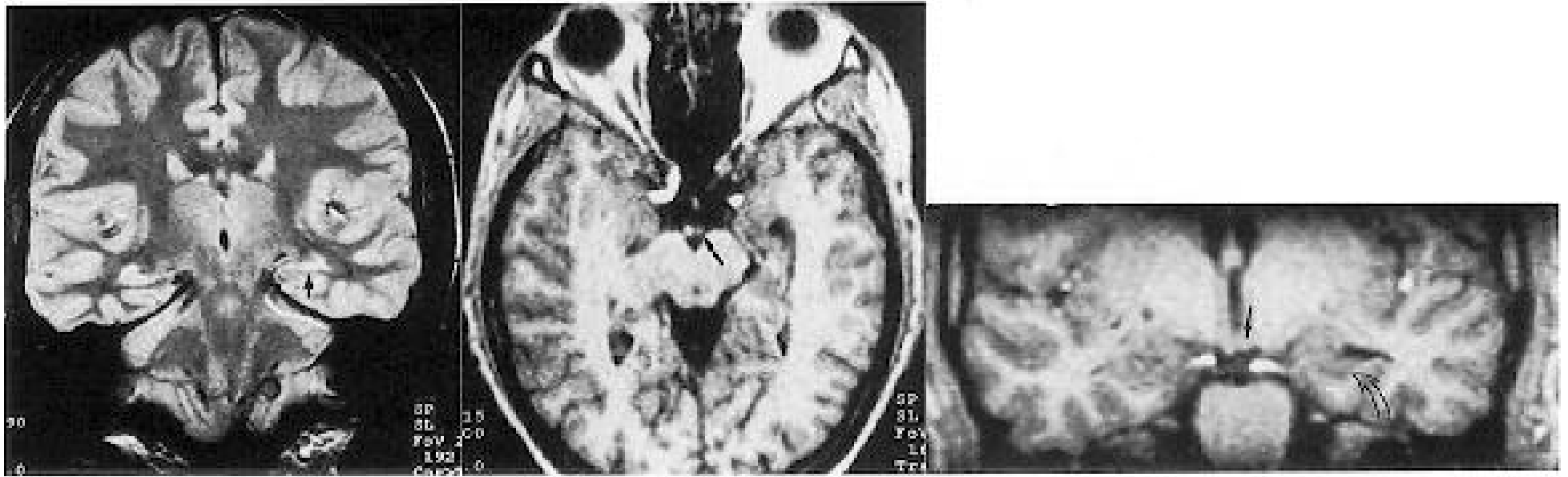

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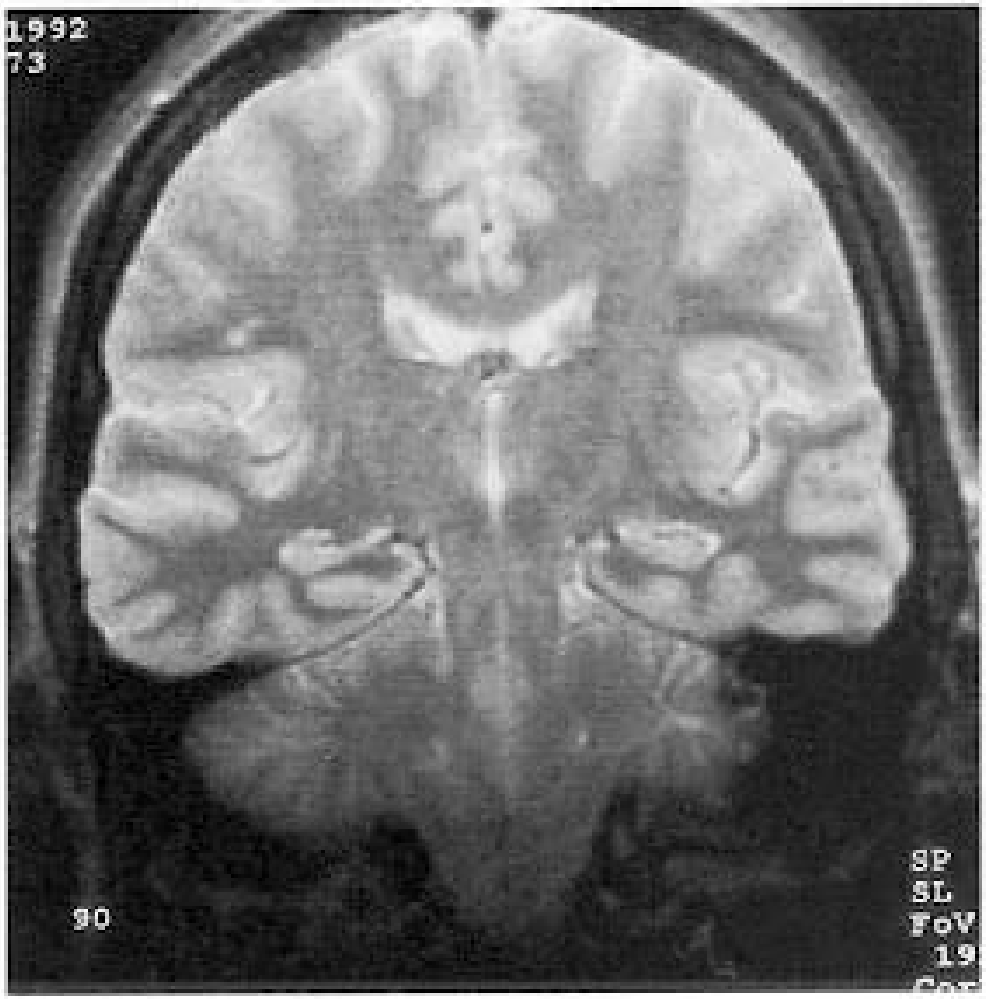

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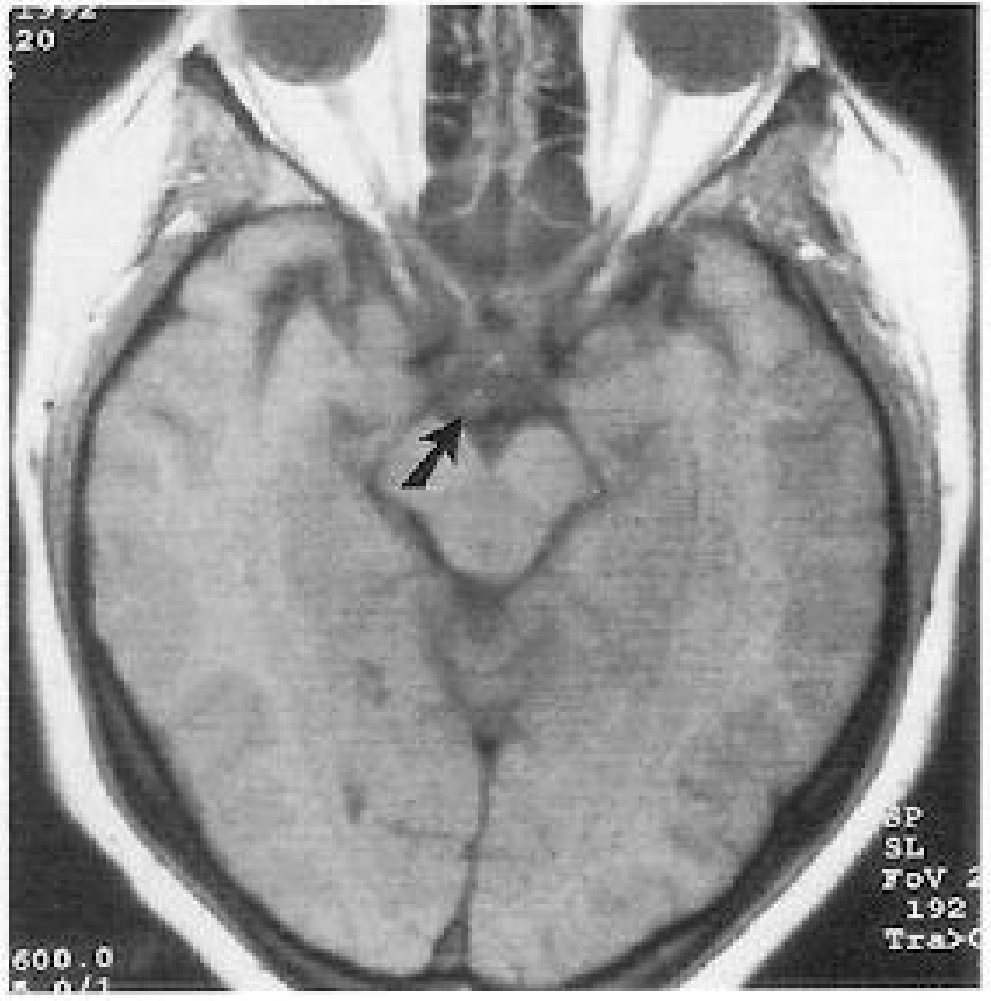

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