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Magnetic resonance imaging in patients with chronic partial epilepsy: identification of potential epilepsy candidates

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ABSTRACT

Background: Magnetic Resonance Imaging (MRI) can detect potentially epileptogenic structural abnormality in patients with medically refractory partial epilepsy. *Objective:* To identify the types of MRI abnormality in a cohort of patients with chronic partial epilepsy and to determine the proportion of these patients who might potentially be treated by epilepsy surgery. *Materials and Methods*: 140 patients who had at least 3 years history of partial epilepsy on anti-epileptic drug treatment and had MRI done between 1994 and 1996 were studied. MRI was performed on Siemens Magnetom 1.0 Tesla machine with spin echo and/or gradient echo sequences. T_1 weighted axial and coronal views and T_2 weighted coronal views were obtained. *Results:* Ninety four patients (76.4%) had focal structural abnormalities, of which 71 had temporal abnormality. Mesial temporal sclerosis (MTS) was the commonest structural abnormality (43.6%). Other abnormalities included neuronal migration disorder (5%), cystic lesion (5%), vascular malformation (VM) (4.3%), foreign tissue lesions (3.6%), and MTS and VM (1.4%). Forty six patients (23.6%) did not have focal structural abnormality. *Conclusion:* Approximately three quarter of patients with chronic partial epilepsy had a focal structural abnormality demonstrated on MRI. Of these patients, about 75% had either MTS or other abnormalities in the temporal lobe which might potentially be treated by surgery.

Keywords: Partial Epilepsy, MRI, epilepsy surgery, Singapore

INTRODUCTION

Various studies have shown that magnetic resonance imaging (MRI) can identify potentially epileptogenic structural abnormalities in patients with medically intractable partial epilepsy. The most common structural abnormality is mesial temporal sclerosis (MTS).[1-4] Patients with MTS or other temporal structural lesion had good seizure outcome after resection of the structural abnormality together with the surrounding epileptogenic zone, whereas patients with normal MRI had poorer outcome after surgery.[5-7] In this paper we seek to find out the types of MRI abnormality in a cohort of patients with chronic partial epilepsy and to determine the proportion of these patients who might potentially be treated by epilepsy surgery.

MATERIALS AND METHODS

From the epilepsy data bank of one of the authors (SHL), patients who (a) had at least 3 years history of epilepsy; (b) had definite partial seizures based on history or had definite focal inter-ictal epileptiform discharges on routine EEG; (c) required or were taking anti-epileptic drugs (AEDs) to control seizures at the time of study were retrospectively reviewed. Patients with benign Rolandic epilepsy were excluded. Only those patients who had a MRI study between January 1994 and December 1996 were included. MRI study was done in these patients to look for a focal structural abnormality, the presence of which might explain the cause of the partial seizures and/or focal epileptiform discharges.

MRI was performed using the Siemens Magnetom ,1 Tesla machine. The following imaging techniques were used: (a) T_1 weighted spin echo axial and thin section coronal views with spin echo and/or gradient echo sequences; and (b) T_2 weighted coronal views. Enhanced MRI was done only in cases where a foreign tissue lesion was identified on non-enhanced images. The MRI films were visual inspected. Volumetric study was not performed. The diagnosis of MTS was made by visual analysis of the images using any of the following radiological criteria: (a) atrophy of the head, body and/or tail of hippocampus unilaterally or

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bilaterally; (b) increased signal intensity on T_2 weighted images in the hippocampal region (c) decreased signal intensity of gray mater on T1W images, (d) loss of the normal anatomical organization of the hippocampus.

RESULTS

One hundred and forty patients, 75 females and 65 males, fulfilled the above criteria and were studied. Their racial distribution was as follow: Chinese 126, Indian 8, Malay 5, Others 1. Their median age was 29 years (range 12-62 years). The median age of onset of epilepsy was 13 years (range: 1-49 years) and the median duration of epilepsy was 16 years (range: 3-37 years). One hundred patients (71.4%) had ⩾ one seizure (complex partial seizure ± secondarily generalization) per month and were taking two or more antiepileptic drugs.

Ninety four patients (76.4%) had focal structural abnormalities of which seventy one were in the temporal lobe. The commonest abnormality was MTS (present in 61 patients) which accounted for about two thirds of patients with focal structural abnormality. The number and percentage of patients with various types of structural abnormalities are shown in Table 1. Forty seven of the 61 patients (77%) who had MTS as the only abnormality were taking ⩾2 antiepileptic drugs and had more than one seizure per month.

Forty six patients (23.6%) did not have focal structural abnormality. Thirty of these patients (65.2%) were also taking ⩾2 antiepileptic drugs and had more than one seizure per month.

DISCUSSION

Epilepsy is a common neurological condition. The estimated prevalence rate in Singapore is 3-5 per 1000 population[8-9] In general, patients with focal epilepsy are less likely to go into spontaneous remission than patients with primary generalized epilepsy.[10] These patients are more likely to be managed by neurologists at tertiary referral hospitals. In a report on the AED usage pattern in a tertiary hospital in Singapore, 80% of the patients in that series had focal epilepsy.[11] These patients usually will be tried on newer AEDs, evaluated for epilepsy surgery, or both. Although long-term efficacy and safety of newer AEDs or surgery are the most important factors in deciding subsequent management, cost of these treatments played a major role in physician's and patient's decision process. Tan et al has estimated that it is less costly for suitable surgical candidates to have epilepsy

TABLE 1: Focal MRI Abnormality

Abnormality	Patient No. (%)			
	T	ET	T + ET	Total
MTS	61	0	0	61 (43.6)
VM	4	2	0	6 (4.3)
MTS + VM	1	0	1	2 (1.4)
FTL	2	3	0	5 (3.6)
NMD	1	6	0	7 (5.0)
Cystic Lesion	2	5	0	7 (5.0)
Other Focal Abnormality	0	6	0	6 (4.3)
With Focal Abnormality	71	22	1	94 (76.4)
Without Focal Abnormality	–	–	–	46 (23.6)
			Total	140 (100)

T : Temporal in Location
ET : Extratemporal in Location
T + ET : Temporal & Extratemporal in Location
MTS : Mesial Temporal Sclerosis
NMD : Neuronal Migration Disorder
VM : Vascular Malformation (Arteriovenous Malformation and Cavernous Hemangioma
FTL : Foreign Tissue Lesion

surgery than to prescribe long-term newer AEDs.[12] Thus identification of potential surgical candidates early in the course of evaluation not only can reduce cost of medical treatment and unnecessary exposure to medication side effects but also improve psycho-social outcome after earlier epilepsy surgery.

MRI of brain is a more sensitive investigation than computed tomography of the head in detecting structural abnormalities such as MTS, vascular malformations and neuronal migration disorders which are potentially epileptogenic.[3,13] MRI has demonstrated lesion(s) in a high proportion of patients previously thought to have cryptogenic partial epilepsy.[14] However the detected focal structural abnormality might not be the cause of the patient's epilepsy. Even if the abnormality is epileptogenic, the success of surgery depends not only on complete removal of the lesion but also complete resection of the epileptogenic zone. The latter can only be identified electrophysiologically using extracranial (scalp) with or without intracranial EEG monitoring.[15] Nevertheless, the finding of a potentially epileptogenic abnormality on MRI helps the treating physician to prioritize patients for early extracranial EEG and video monitoring.

In this study, the term "Chronic Epilepsy" was used instead of "Medically Intractable Epilepsy". The former was arbitrarily defined as having epilepsy for at least 3 years and the patient required AED treatment to control seizures. Whether or not the seizures were completely controlled by AEDs was not an important inclusion or exclusion criteria. On the other hand, we found that it was rather difficult to define "Intractability". Although frequency of seizures could be used to determine medical intractability, documentation of the frequency by patients or family members might not be complete or reliable in some cases. Furthermore severity of seizures as well as decreased quality of life as a result of seizures were harder to quantify. Nevertheless, our patients had a median duration of epilepsy of 16 years and more than 70% of these patients had ≥one seizure per month necessitated two or more antiepileptic drugs. These indicate that most of the patients were likely to be medically intractable.

Our study shows that a large proportion of patients (61/140 or 44%) with chronic focal epilepsy had MRI evidence of MTS as the only structural abnormality (Fig 1 & 2). Although the diagnosis of MTS was made by visual inspection, the sensitivity and specificity of MRI in predicting the presence of MTS pathologically has been confirmed by several workers.[2,16-17] Such reliability can be accomplished even with low field system (0.3 Tesla).[16] The gradient

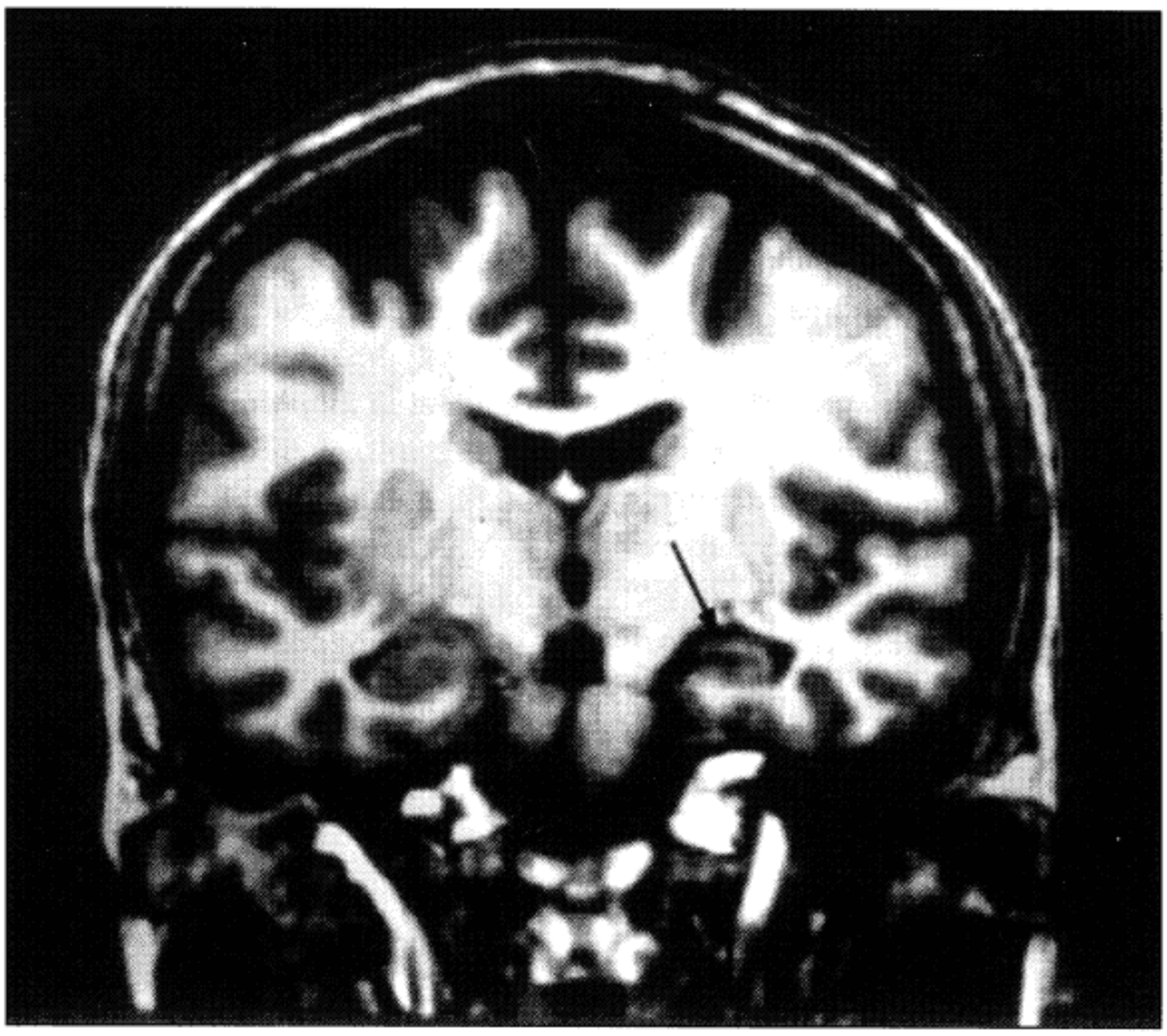

FIG 1: Gradient echo, Tl-weighted coronal MRI showing atrophy of the head of the left hippocampus.

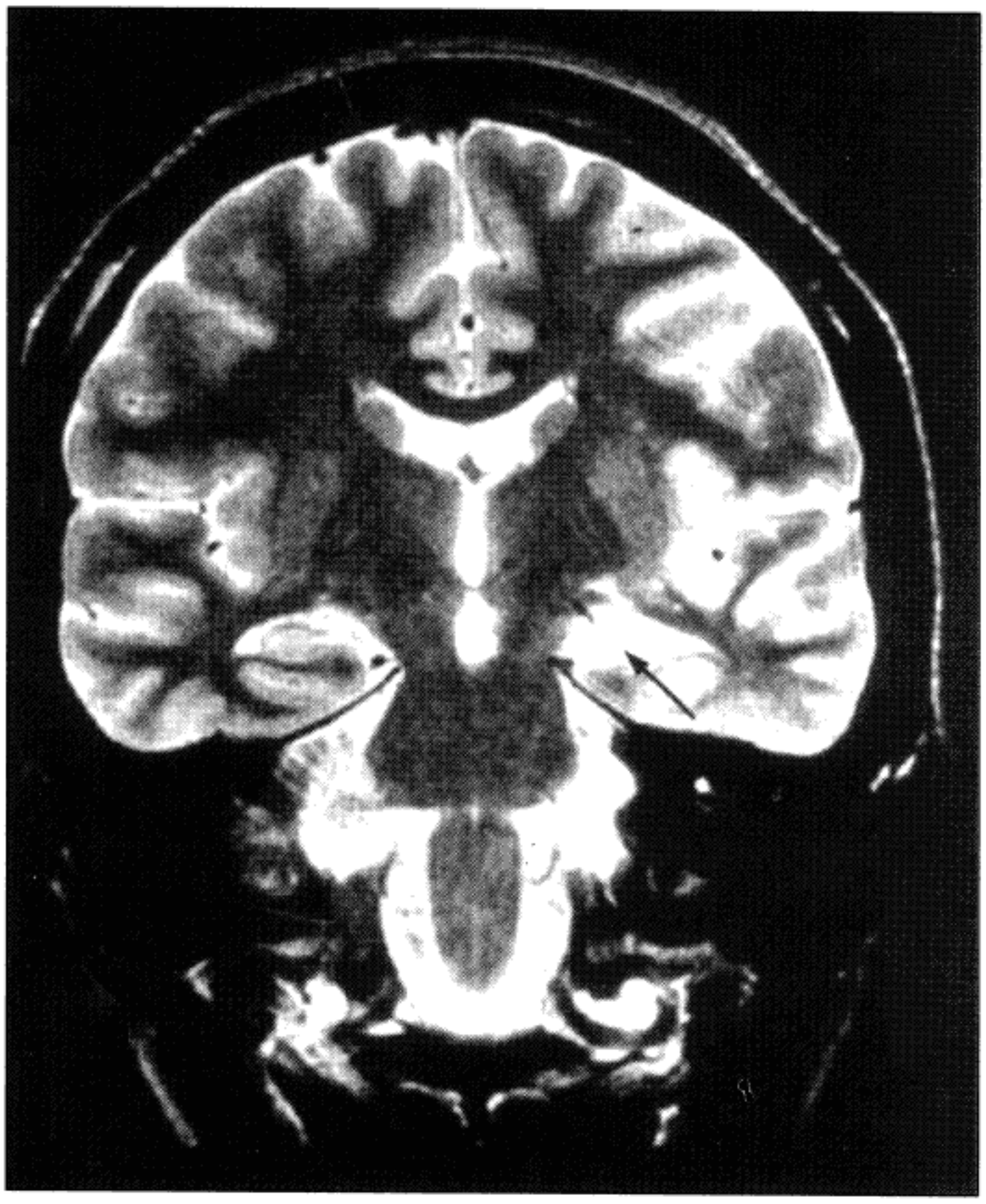

FIG 2: T2-weighted coronal MRI showing increased signal intensity in the region of the left hippocampal body.

echo sequence used in this study gave good gray/white differentiation and could detect loss of normal anatomical organization of the hippocampus without signal abnormality. There are other pulse sequences which are useful in detecting MTS but were not used in our study. One of these sequences is the inversion recovery sequence which has the disadvantage of having long acquisition times.[18] Fast spin echo techniques is probably more sensitive in detecting MTS but may be less sensitive in picking up cortical abnormalities.[19] Volumetric measurement of hippocampal sizes using a three-dimensional spoiled gradient-echo (SPGR) sequences, though considered to be more sensitive than visual analysis [18, 20-21], was not used in this study as it was rather tedious and time-consuming in routine MRI investigation.

The percentage of MTS reported here is was lower than 55-60% reported by Kuzniecky et al [18] but was similar to a smaller series reported from Malaysia where 10 of 23 medically refractory epilepsy patients (43.5%) had MTS. [22] The are a few possible reasons for the lower percentage. Firstly many of the reported series included patients with medically intractable epilepsy while some of our patients might not be medically intractable. Some patients who might have MTS but had smaller degree of hippocampal atrophy could have been be missed without volumetric techniques. Similarly some patients with MTS might be missed without an inversion recovery sequence or fast spin echo techniques. Lastly it is also possible that MTS (or its cause) as an etiology of chronic or intractable epilepsy is less frequent in this part of the world.

Vascular malformations such as arteriovenous malformation (Fig 3) and cavernous hemangioma are known to cause seizures. These were present in 6 patients (4.3%) as the only abnormality (4 temporal and 2 extra-temporal in location) and in another 2 patients who also had MTS (1.4%). Thus 5.7% of our patients had vascular malformation, a percentage that is similar to other reported series.[18]

Due to its ability to distinguish gray from white matter at high resolution, MRI is a sensitive test to diagnose Neuronal Migration Disorder

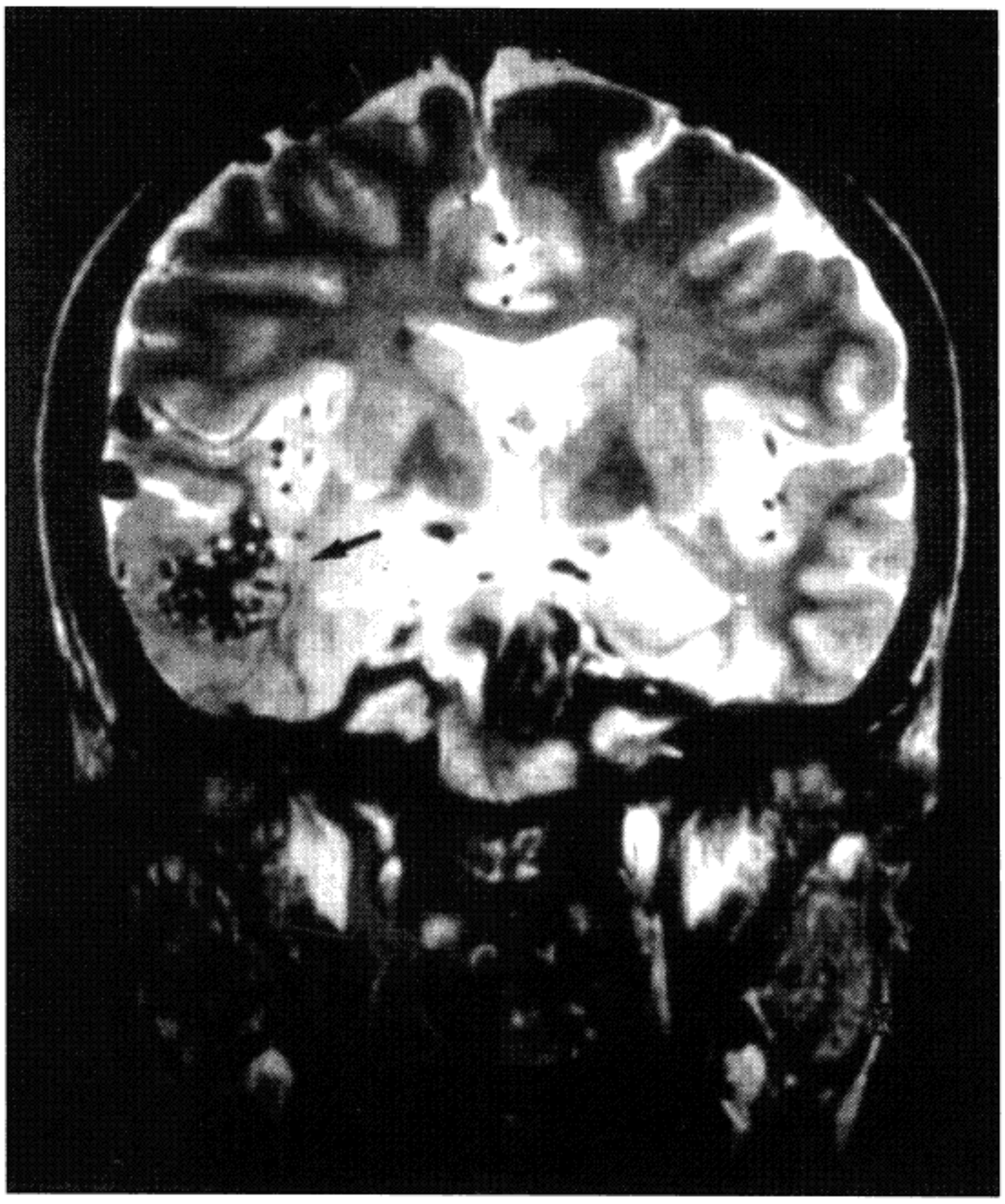

FIG 3: T2-weighted coronal MRI showing an arterio-venous malformation in the right temporal lobe with enlarged draining veins.

(NMD).[14,23-24] This disorder was found in 5% of our cases, in the form of diffuse heteropias, pachygyria, cortical dysplasia and hemimegaencephaly. This percentage appeared to be lower than the 10-11% incidence quoted by Kuzniecky and Jackson.[18] The difference could be partly due to smaller representation of pediatric patients in our study (youngest patient is 12 years of age). Alternatively it could be that the imaging techniques we used did not enable us to detect some of the NMDs. It has been emphasized that many of the NMD can be missed on MRI, and often multiplanar reformatting of MR images is needed to delineate subtle gyral abnormalities.[25]

Five percent of our patients had cystic lesions, the most common being arachnoid cyst. It was uncertain whether the cysts were the cause of epilepsy in these patients or whether these were an incidental finding. It has been suggested that the cyst could cause local irritative effects or associated with developmental dysgenesis of the cortex.

Gadolinium DPTA enhanced MRI was not done routinely for all our MRI studies as it has been shown that such study did not increase the diagnostic yield in patients with intractable epilepsy.[26] Only 3.6% of our patients had a foreign tissues lesion. In contrast, foreign tissue lesions were present pathologically in 10-20%

of epilepsy surgery cases.[18, 27] Whether this is due to a true low incidence of foreign tissue lesion remains speculative.

About a quarter of patients did not have focal MRI structural abnormality even though they had partial seizures based on history and/or presence of definite focal interictal epileptiform discharges on routine EEG. However, two third of these patients were taking ≥2 antiepileptic drugs and had more than one seizure per month. Although some of these patients could have a diffuse insult (e.g. encephalitis) with no focal structural abnormality, other patients might actually have MTS or NMD not detected by the MRI system and imaging techniques used in this study. Perhaps with better MRI systems and/or incorporation of other MRI techniques described recently, we might be able to find an etiology or detect a potentially operable structural abnormality in patients with apparent "cryptogenic" chronic focal epilepsy.

In conclusion, MRI study had help us to detect structural abnormalities which might be responsible for the patients' chronic focal epilepsy. As majority of these abnormalities were temporal in location and the commonest abnormality was MTS, these patients can potentially be treated by surgery should their seizures truly be refractory to anti-epileptic drugs.

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