SAS Journal of Medicine
Abbreviated Key Title: SAS J Med
ISSN 2454-5112
Journal homepage: https://saspublishers.com

OPEN ACCESS

Nuclear Medicine

Contribution of 99mTc-HMPAO Brain Perfusion SPECT in Epilepsy: A Case Report

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DOI: https://doi.org/10.36347/sasjm.2025.v11i10.021 | **Received:** 06.09.2025 | **Accepted:** 23.10.2025 | **Published:** 29.10.2025

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Abstract **Case Report**

Epilepsy is a chronic neurological disorder, and up to 30% of patients remain pharmacoresistant despite adequate treatment. Precise localization of the epileptogenic focus is essential for surgical management, particularly when CT or MRI findings are inconclusive. We report the case of a 21-year-old patient with post-traumatic pharmacoresistant epilepsy. Brain perfusion SPECT with 99mTc-HMPAO, performed in both ictal and interictal phases, revealed focal hyperperfusion and hypoperfusion patterns that guided localization of the epileptogenic zone. This case illustrates the key role of functional imaging in the pre-surgical evaluation of refractory epilepsy.

Keywords: Epilepsy, Pharmacoresistant, SPECT, 99mTc-HMPAO, Epileptogenic focus, Perfusion.

INTRODUCTION

Epilepsy is a neurological disorder that reflects an abnormality in brain function. It manifests through paroxysmal episodes known as epileptic seizures. In its broader sense, epilepsy is defined as the chronic recurrence of spontaneous epileptic seizures in the same individual [1].

The concept of drug-resistant epilepsy was updated in 2010 by the International League Against Epilepsy. According to this definition, epilepsy is considered pharmacoresistant when seizures persist despite adequate trials of at least two appropriate antiepileptic drugs, correctly chosen for the patient's syndrome and administered at effective dosages [2].

In many patients with epilepsy, conventional structural imaging such as CT or MRI does not reveal abnormalities. For this reason, significant progress has been made over the past decades in functional imaging techniques, including positron emission tomography (PET) and ictal/interictal subtraction single-photon emission computed tomography (SPECT) [3].

Perfusion brain scintigraphy with 99mTc-HMPAO has emerged as a valuable tool in the evaluation of pharmacoresistant epilepsy. When performed in both ictal and interictal states, it highlights cerebral perfusion changes: ictal hyperperfusion reflecting transient neuronal hyperactivity during seizures, and interictal hypoperfusion. This technique provides critical information for localizing the epileptogenic focus, particularly in cases where EEG or structural imaging is inconclusive or discordant.

The aim of this study is to assess the contribution of 99mTc-HMPAO brain perfusion scintigraphy in localizing the epileptogenic zone in patients with drug-resistant epilepsy, in order to optimize the selection of surgical candidates.

CLINICAL OBSERVATION

We report the case of a 21-year-old male patient, followed since 2012 for post-traumatic drug-resistant epilepsy. His medical history included a previous head injury, which was later complicated by the onset of recurrent epileptic seizures, poorly controlled despite well-conducted antiepileptic polytherapy. Electroencephalography (EEG) demonstrated paroxysmal discharges in the bilateral parieto-temporal regions, more pronounced on the left side, suggesting a focal origin but with imprecise localization. Cerebral computed tomography (CT) revealed an occipital hypodensity, without other significant structural abnormalities.

Given the persistence of seizures and the consideration of potential surgical management, brain perfusion scintigraphy with 99mTc-HMPAO was performed during both interictal and ictal phases, using a

SPECT/CT gamma camera, following intravenous administration of the radiotracer 99mTc-HMPAO.

RESULTS

The SPECT findings revealed that during the interictal phase, there was a clear and localized hypoperfusion involving the mesial frontal associative cortex, as well as the right parietal and temporal regions. This reduction in perfusion also extended to the hippocampi and the occipital associative cortex (Figure 1). Since the study was performed outside of seizure activity, it is recommended to compare these results with a second ictal SPECT, ideally conducted under video-EEG monitoring, in order to better delineate the seizure onset zone.

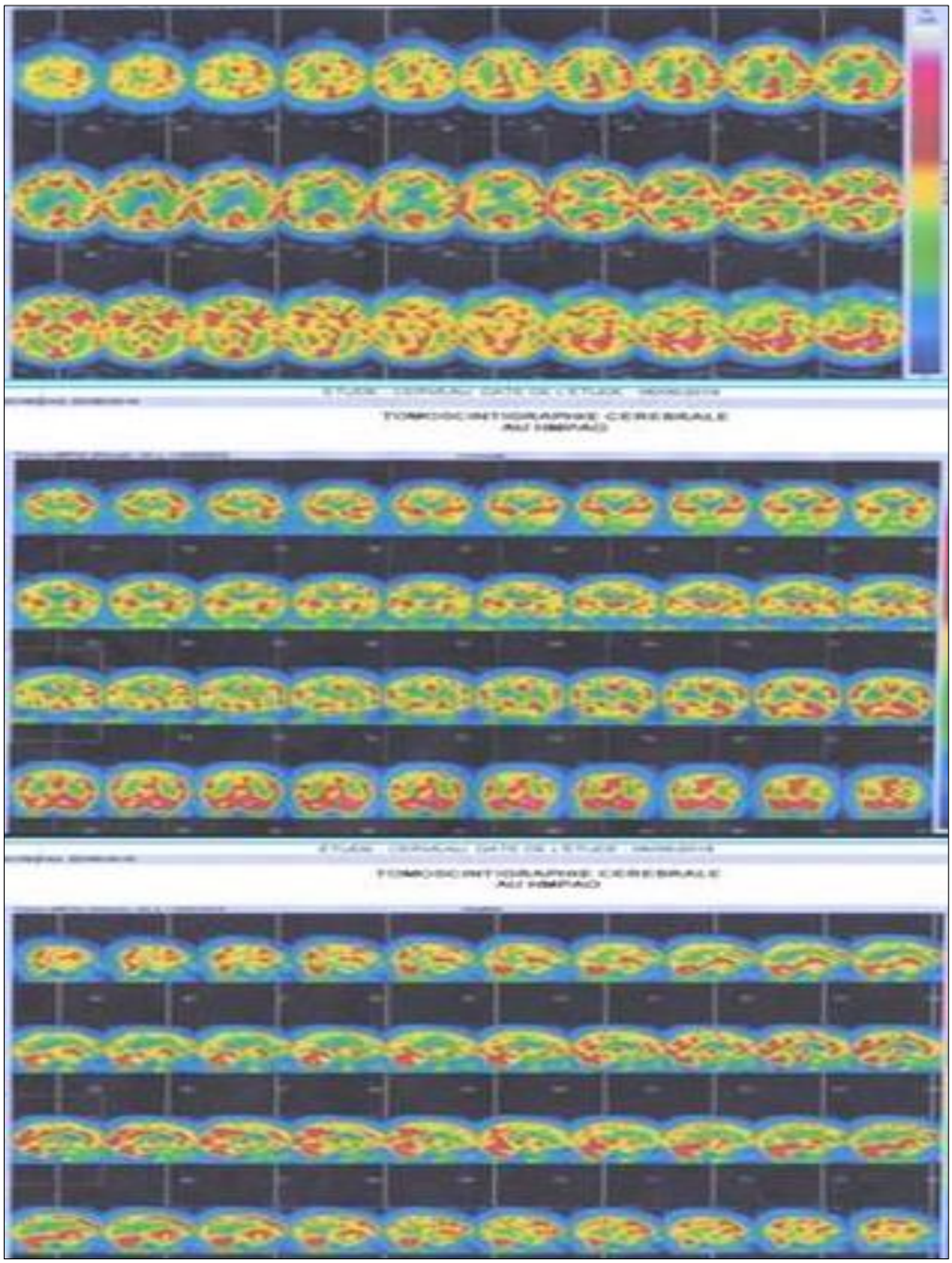

Figure 1: Interictal cerebral SPECT/CT (sections: axial, transverse and sagittal)

On the other hand, during the perictal phase, scintigraphic examination revealed a focus of intense hyperfixation located at the parietal level, bilateral but clearly more marked on the right side. In contrast, the rest of the cortex presented a regular and symmetrical perfusion (Figure 2).

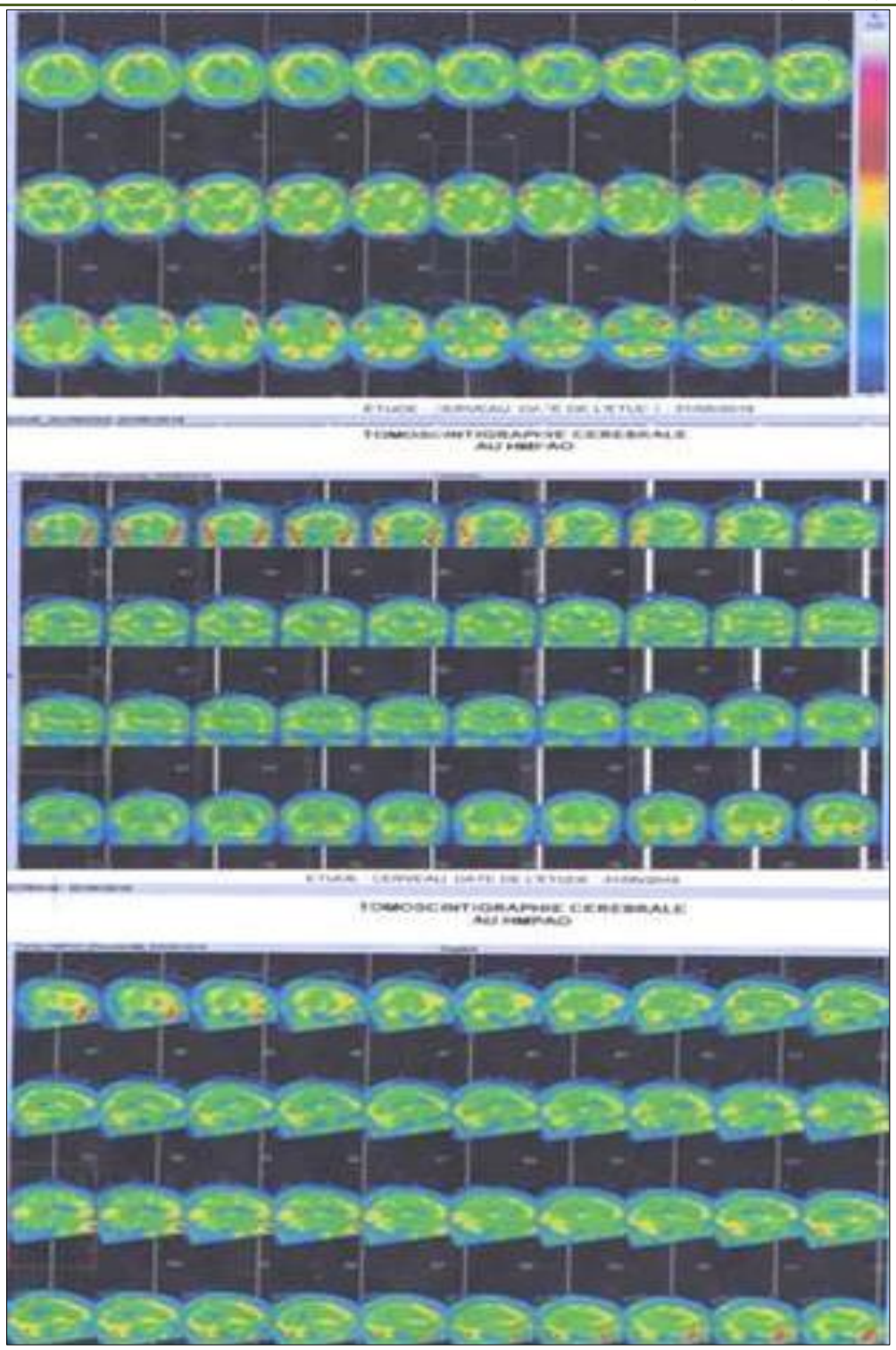

Figure 2: Perictal cerebral SPECT/CT (sections: axial, transverse and sagittal)

DISCUSSION

Epilepsy, also referred to as an epileptic disorder, is a chronic brain condition characterized by recurrent seizures caused by excessive electrical discharges from groups of neurons. These events occur spontaneously, are not triggered by reversible conditions, and take place more than 24 hours apart. Antiepileptic drugs (AEDs) are effective in controlling seizures for many patients; however, approximately 20–30% continue to experience seizures despite appropriate therapy [4]. Surgical intervention has therefore become an important and accepted treatment strategy in carefully selected patients with refractory focal epilepsy. Precise resection of the epileptogenic zone is critical to achieving optimal seizure control, making accurate localization essential both for identifying the seizure onset zone and minimizing postoperative side effects. In this context,

SPECT has a significant role in presurgical evaluation, as it can detect epileptogenic foci in morphologically inconspicuous areas and, unlike EEG-based methods, is not solely dependent on electrical brain activity [5].

Perfusion SPECT is performed to "capture" cerebral blood flow (CBF) changes during a seizure (ictal SPECT) and compare them with interictal perfusion (interictal SPECT). Interictal SPECT has limited sensitivity (around 43%) and variable accuracy (23–80%). Consequently, it is mainly used as a baseline for comparison with ictal perfusion imaging. Ictal SPECT alone, however, can reach an accuracy of up to 90%, and in some reports, close to 100% [6, 7].

Initially, iodine-123–labeled amines were employed for this purpose. However, these tracers peak in brain activity only about 20 minutes after injection and undergo redistribution over time, leading to a cortical uptake that does not strictly reflect the initial CBF (8). For this reason, 99mTc-hexamethylpropyleneamine oxime (99mTc-HMPAO) and 99mTc-ethyl cysteinate dimer (99mTc-ECD) have become the most commonly used tracers for evaluating initial CBF. These agents offer several advantages: they demonstrate rapid cerebral uptake, reaching peak concentration within 2 minutes of injection, without redistribution. Thus, the tracer distribution faithfully reflects CBF at the time of injection and remains stable for at least two hours, independent of subsequent perfusion changes. This allows the tracer to be administered outside the nuclear medicine department—for example, during a seizure in an epilepsy monitoring unit—while image acquisition can be delayed until after clinical recovery. The favorable half-life of technetium (6 h) and the high stability of these tracers, especially ECD, make this approach practical and cost-effective in routine clinical practice [9].

Images are visually interpreted using the complete set of slices. In normal adult brains, tracer distribution is bilaterally symmetrical, with relatively higher uptake in the temporal, parietal, and occipital (primary visual) cortices, as well as the basal ganglia, thalami, and cingulate gyrus (Figure 3). Lower activity is typically observed in white matter and interhemispheric fissures [10]. An additional phenomenon, known as the "postictal switch," may lead to false localization or lateralization of the seizure focus if there is a significant delay between seizure onset and tracer administration [11].

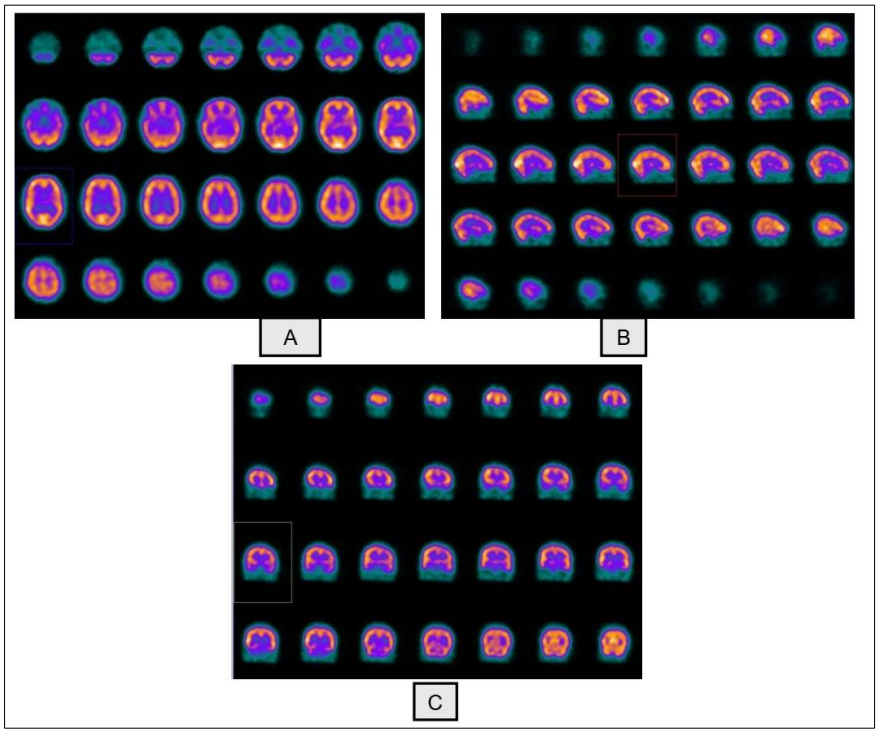

Figure 3: Normal brain perfusion SPECT (sections: axial, transverse and sagittal)

PET imaging is always interpreted in conjunction with the structural and functional information provided by MRI, which remains an essential investigation in the presurgical workup of epilepsy. Recently, hybrid scanners capable of performing both PET and MRI in a single session within the same system have been developed. These devices hold significant potential for application across multiple fields, including oncology, cardiology, and, of course, neurology. Preliminary results have been highly encouraging, and ongoing studies aim to further assess the role of this novel modality in both clinical practice and research [9-12).

PET and SPECT can also provide insights into the possible pathophysiological mechanisms underlying epileptic spasms, particularly regarding the probable origin and propagation of the electrical events involved. For instance, some patients may present with focal cortical hypometabolism associated with increased glucose metabolism in the lenticular nuclei and brainstem, suggesting complex cortico–subcortical interactions [13].

CONCLUSION

La scintigraphie cérébrale de perfusion ne constitue pas un outil diagnostique de l'épilepsie, mais elle joue un rôle essentiel dans la localisation du foyer épileptogène, en particulier dans l'épilepsie temporale, en vue d'une éventuelle chirurgie. L'approche optimale repose sur une double acquisition, en phase intercritique et en phase critique, cette dernière nécessitant une injection précoce du traceur dès le début de la crise afin de maximiser la valeur localisatrice de l'examen. Elle contribue au développement et à la mise en œuvre de diverses interventions thérapeutiques, notamment la chirurgie résécative des épilepsies réfractaires.

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