Doi: https://doi.org/10.3329/bjnm.v28i2.89152

The Utility of 18F-Fluorodeoxyglucose PET (FDG PET) in Epilepsy

Azmal Kabir Sarker[1], Afroza Naznin[2], Zeenat Jabin[3]

[1]PMO, [2]. SMO, [3]Director & CMO, Institute of Nuclear Medicine and Allied Sciences (INMAS), Suhrawardy

Correspondence Address: Dr. Azmal Kabir Sarker, Principal Medical Officer, INMAS, Suhrawardy, Shaheed Suhrawardy Medical College & Hospital Campus, Dhaka. Email: azmalbaec@gmail.com

INTRODUCTION

The utility of 18F-Fluorodeoxyglucose (FDG) positron emission tomography (PET) is for pre-surgical localization of epileptogenic foci in patients with drug-resistant epilepsy (DRE), rather than primary diagnosis (1-3). Since FDG reflects local consumption of glucose, the major energy substrate of the brain, the metabolic variation at the synaptic level is proportionally represented by FDG uptake in both stimulated and dysfunctional states (4). In an interictal PET, the epileptogenic foci are represented by regional hypometabolism, meaning reduced glucose phosphorylation, a pattern that indicates diminished neuronal activity, synaptic density, and glial dysfunction (5). FDG PET is particularly useful for localization of epileptogenic zones when MRI is negative or in cases when MRI and EEG are discordant (6). The pooled prevalence of DRE among epilepsy patients is 30% (7), with the cumulative incidence being 25% in children (8). These DRE patients require neurosurgical interventions like resective surgery or corpus callosotomy depending on the type of brain involvement (9-12), where FDG PET not only can aid the surgical planning but also can predict a favorable outcome (13).

The acquisition protocol of brain FDG PET is well described in the international guidelines (2, 3). For the clinical interpretation of FDG PET images, the traditional standard has been the visual reading, which has been aided by quantitative approaches like asymmetry index and statistical parametric mapping (14). Recently, use of vendor-provided databases has become a common practice. This database is composed of scans from confirmed normal individuals that are used to derive regional quantification of deviation from normal tracer uptake, comparing the patient's brain PET to a database of brain images of the same radiotracer and displaying it in three-dimensional Stereotactic Surface Projection (3D-SSP) using the Automated Anatomical Labeling (AAL) atlas in order to confirm the findings from traditional visual assessment from axial, coronal, and sagittal slices.

THE TRENDS OF BRAIN FDG PET

Institute of Nuclear Medicine & Allied Sciences (INMAS), Suhrawardy, is strategically located adjacent to the National Institute of Neurosciences and Hospital (NINS), the largest neuroscience center in Bangladesh. This proximity has facilitated a collaborative pathway for FDG brain PET-CT studies, particularly in patients referred from NINS with drug-resistant epilepsy undergoing pre-surgical evaluation. To the best of our knowledge, this is the first report of this imaging modality being performed in Bangladesh. A few key cases of brain FDG PET are briefly highlighted here, which had a substantial impact in the process of clinical decision-making.

The first case of a 12-year-old girl with refractory epilepsy since birth showed bilateral periventricular leukodystrophy on MRI and multifocal epileptiform activity on EEG. FDG brain PET revealed diffuse cortical hypometabolism with widespread hypermetabolic activity, indicating a generalized epileptic network without any specific focus (Figure 1). These findings supported the decision for functional surgery (corpus callosotomy).

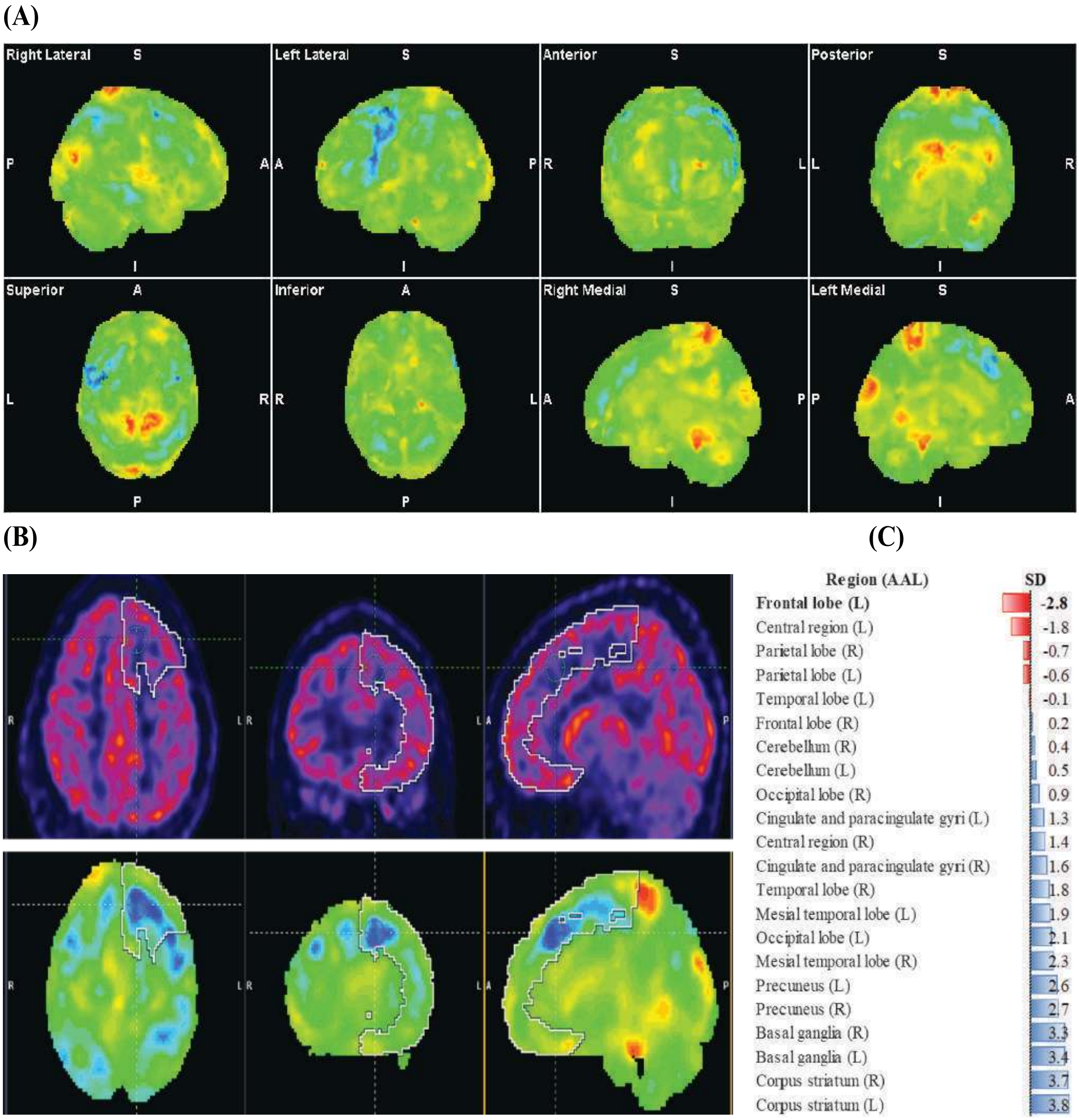

Figure 1: Representative images showing 3D-SSP metabolic map (A), statistics in three axes with the area showing lowest FDG uptake in left frontal lobe (SD – 2.8) (B) and a waterfall plot of summarized AAL statistics (C)

Second case of a 17-year-old male with long-standing epileptic encephalopathy showed bilateral temporal gliosis and encephalomalacia on MRI, with EEG indicating focal epilepsy and global dysfunction. FDG brain PET demonstrated marked hypometabolism in the right mesial temporal lobe and bilateral frontal lobes, suggesting a predominant right temporal focus with multifocal extra-temporal network involvement (Figure 2). These findings supported candidacy for functional surgery (corpus callosotomy).

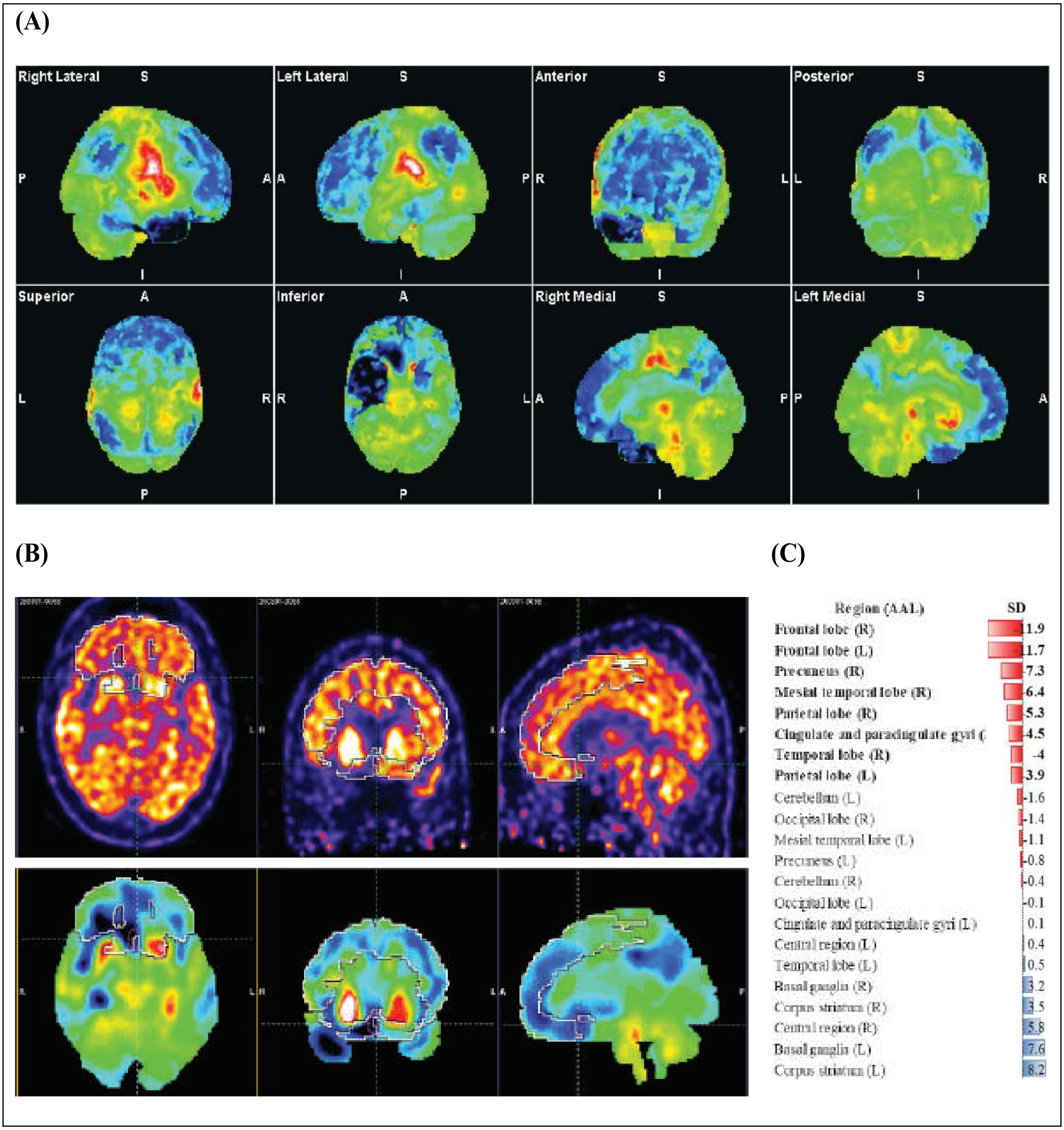

Figure 2: Representative images showing 3D-SSP metabolic map (A), statistics in three axes with the area showing lowest FDG uptake Bilateral frontal lobes (SD – 11.9 on right and – 11.7 on left) (B) and a waterfall plot of summarized AAL statistics (C)

Third patient was a 12-year-old male with refractory epilepsy for five years. MRI of the brain was unremarkable, while EEG demonstrated focal epilepsy of left frontal onset. FDG brain PET revealed marked hypometabolism in the left frontal lobe, suggestive of focal cortical dysplasia or a microstructural abnormality corresponding to the epileptic focus (Figure 3). Findings supported consideration for resective surgery.

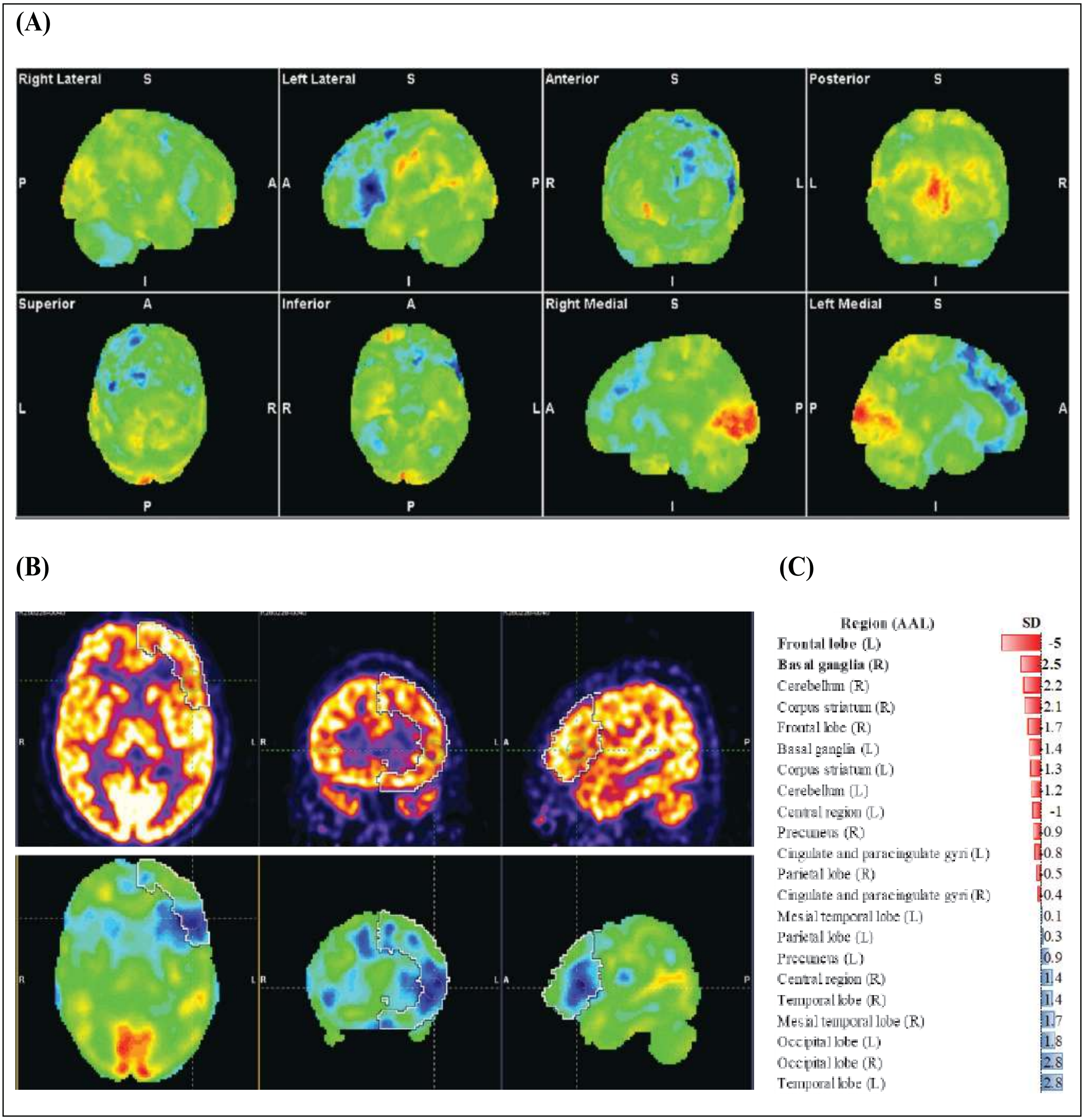

Figure 3: Representative images showing 3D-SSP metabolic map (A), statistics in three axes with the area showing lowest FDG uptake left frontal lobe (SD – 5) and right basal ganglia (SD – 2.5) (B) and a waterfall plot of summarized AAL statistics (C)

Fourth patient was a 15-year-old male with generalized tonic–clonic seizures for seven years. MRI of the brain was normal, while EEG indicated focal cerebral dysfunction in the right temporal and occipital regions. FDG brain PET demonstrated predominant hypometabolism in the left temporo-parieto-central cortex without a well-defined epileptogenic focus (Figure 4). Findings suggested non-localizing disease, and further evaluation was recommended prior to surgical intervention.

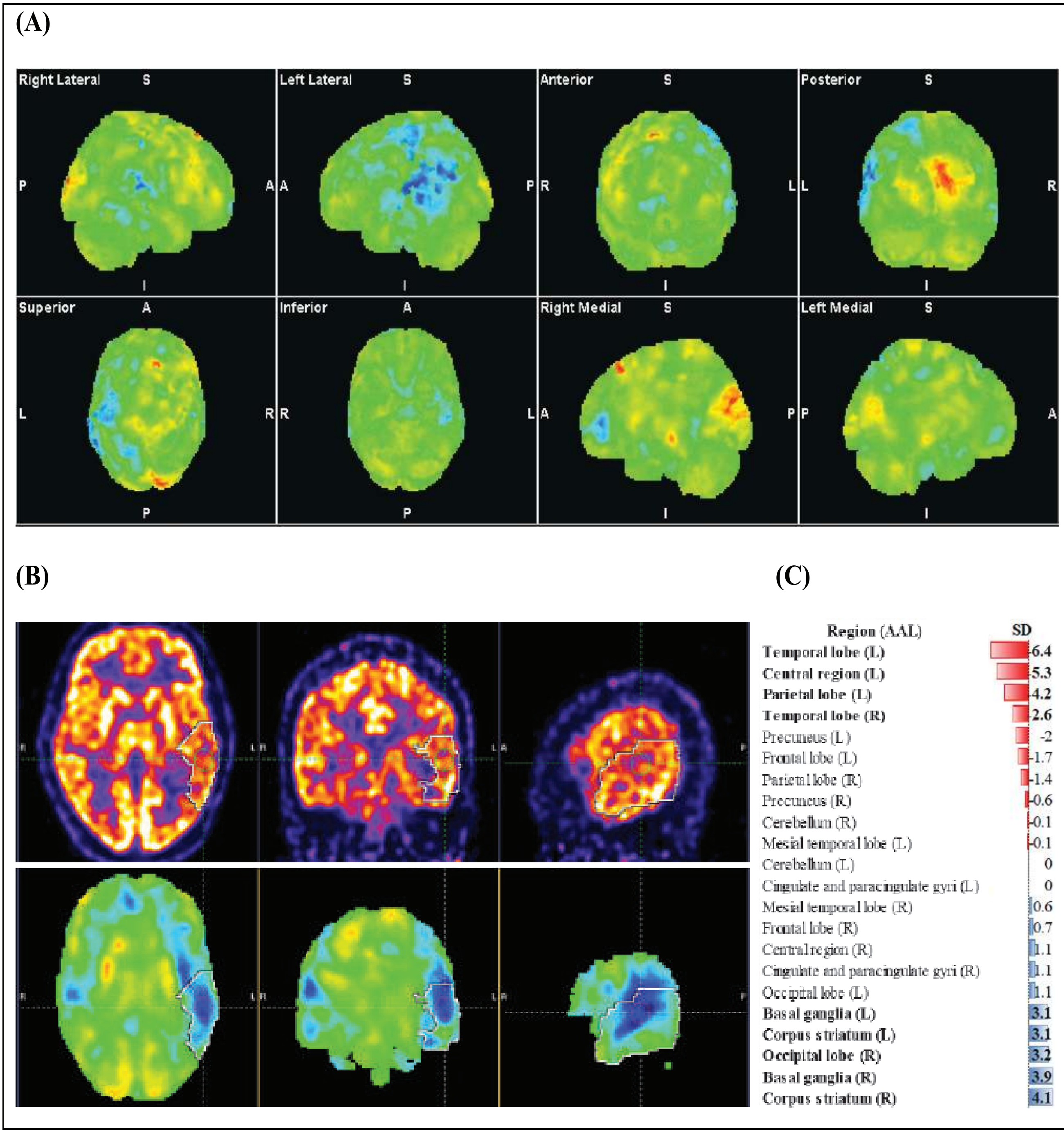

Figure 4: Representative images showing 3D-SSP metabolic map (A), statistics in three axes with the area showing lowest FDG uptake left temporal lobe (SD – 6.4), left central gyrus (SD – 5.3), left parietal lobe (SD – 4.2) and right temporal lobe (SD – 2.6) (B) and a waterfall plot of summarized AAL statistics (C)

The last case highlights a 13-year-old male with seizures since the neonatal period. MRI of the brain was normal, while EEG showed bilateral fronto-temporo-centro-parietal epileptiform discharges. FDG brain PET revealed significant hypometabolism in the left parietal lobe with additional involvement of bilateral precunei, indicating a non-localizing epileptic network (Figure 5). These findings were not suggestive of a surgically resectable focus.

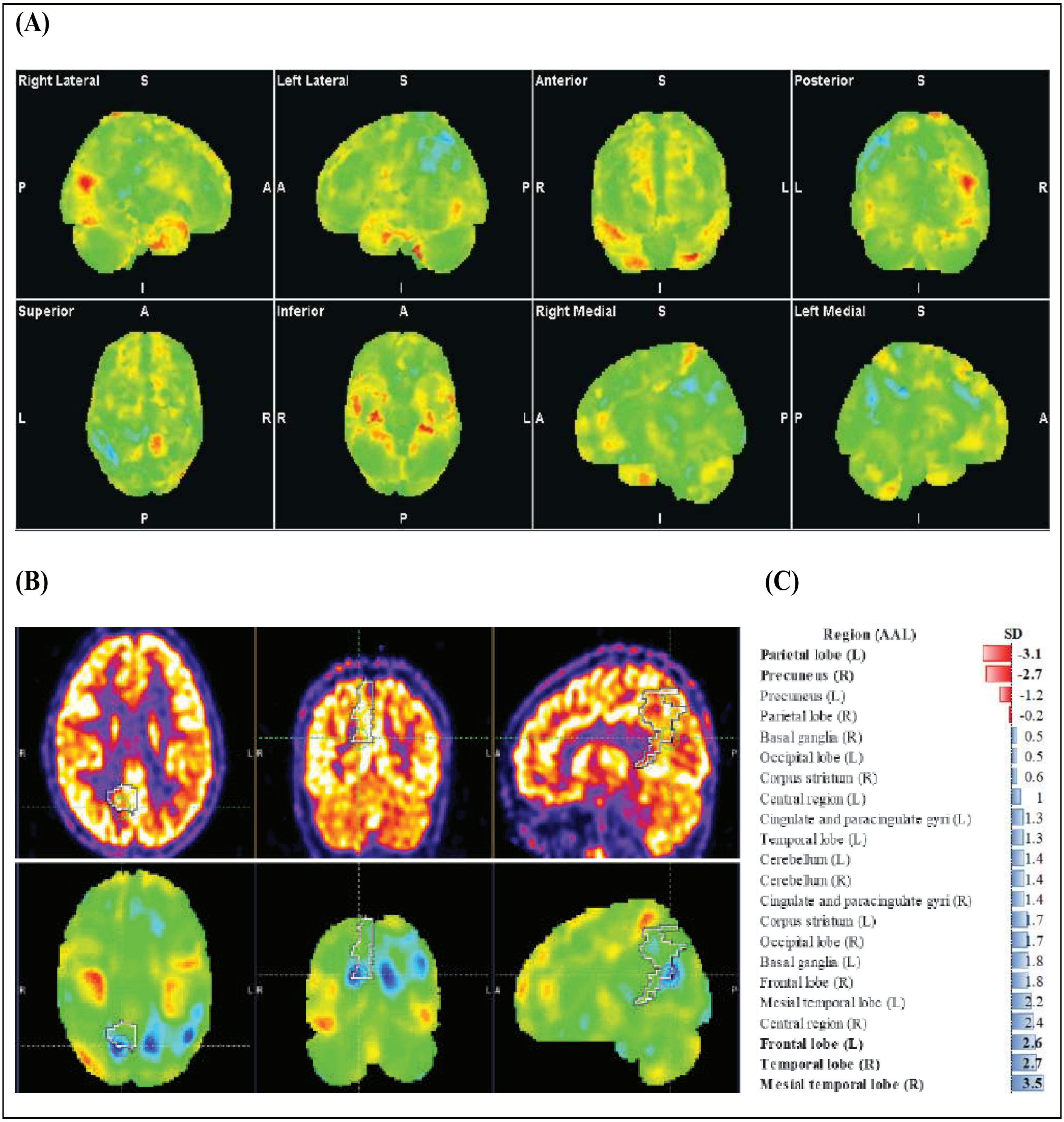

Figure 5: Representative images showing 3D-SSP metabolic map (A), statistics in three axes with the area showing lowest FDG uptake left parietal lobe (SD – 3.1) and right precuneus (SD – 2.7) (B), and a waterfall plot of summarized AAL statistics (C)

These case illustrations underscore the pivotal role of FDG brain PET-CT in the evaluation of drug resistant epilepsy. By revealing metabolic abnormalities that complement MRI and EEG findings, FDG PET-CT provides critical insights into epileptic networks, helps distinguish focal from widespread dysfunction, and guides the choice between resective and functional surgical approaches. Its integration into the pre surgical workup thus enhances clinical decision making and strengthens the multidisciplinary management of complex epilepsy patients.

LIMITATION

Despite the increasing demand for F-18 FDG brain PET scan in DRE evaluation, resource constraint poses a significant barrier to wider application and highlights the need for expanded capacity to meet clinical requirements. Moreover, the absence of long term surgical outcome data limits the ability to assess predictive accuracy.

CONCLUSION

Although FDG PET with its robust role dominates the clinical practice, the precise localization of neurochemical process will be possible with incorporation of specific 11C and 18F based tracers for neurotransmitter and neuromodulator systems which is expected to elevate the current standards of management in patients with DRE.

REFERENCE

1. Drzezga A, Arnold S, Minoshima S, Noachtar S, Szecsi J, Winkler P, Römer W, Tatsch K, Weber W, Bartenstein P. 18F-FDG PET studies in patients with extratemporal and temporal epilepsy: evaluation of an observer-independent analysis. Journal of Nuclear Medicine. 1999 May 1;40(5):737-46.
2. Guedj E, Varrone A, Boellaard R, Lammertsma AA, Albert NL, Barthel H, Berckel BV, Brendel M, Cecchin D, Ekmekcioglu O, Garibotto V. EANM procedure guidelines for brain PET imaging using [18F] FDG, version 3 [translational research].
3. Arbizu J, Morbelli S, Minoshima S, Barthel H, Kuo P, Van Weehaeghe D, Horner N, Colletti PM, Guedj E. SNMMI procedure standard/EANM practice guideline for brain [18F] FDG PET imaging, version 2.0. Journal of Nuclear Medicine. 2025 Jun 1;66(Supplement 2):S45-60.
4. Sokoloff L. Localization of functional activity in the central nervous system by measurement of glucose utilization with radioactive deoxyglucose. Journal of Cerebral Blood Flow & Metabolism. 1981 Mar;1(1):7-36.
5. Lotan E, Friedman KP, Davidson T, Shepherd TM. Brain 18F-FDG-PET: utility in the diagnosis of dementia and epilepsy. The Israel Medical Association Journal: IMAJ. 2020 Mar;22(3):178-84.
6. Perissinotti A, Farré-Melero A, López-González FJ, del Carmen Mallón-Araujo M, Cortés J, Setoain X, Fritsch A, Quintero K, Esteban A, Morbelli S, Bauckneht M. Added Value of Quantitative [18F] FDG-PET Analysis in MRI-negative Epilepsy: A simulation-based study using realistic ground-truths. NeuroImage. 2026 Jan 20:121740.
7. Kalilani L, Sun X, Pelgrims B, Noack-Rink M, Villanueva V. The epidemiology of drug-resistant epilepsy: a systematic review and meta-analysis. Epilepsia. 2018 Dec;59(12):2179-93.
8. Sultana B, Panzini MA, Veilleux Carpentier A, Comtois J, Rioux B, Gore G, Bauer PR, Kwon CS, Jette N, Josephson CB, Keezer MR. Incidence and prevalence of drug-resistant epilepsy: a systematic review and meta-analysis. Neurology. 2021 Apr 27;96(17):805-17.
9. Dong H, Shi J, Wei P, Shan Y, Zhao G. Comparative efficacy of surgical strategies for drug-resistant epilepsy: A systematic review and meta-analysis. World Neurosurgery. 2025 Mar 1;195:123729.
10. Pichardo-Rojas D, Pech-Cervantes CH, Macias-Lopez JU, Camarena-Rubio KJ, Del Río-Quiñones MA, Ballesteros-Herrera D, Paredes-Aragon E, Hernández-Vanegas LE, Pichardo-Rojas PS, Mejía-Pérez SI. Long-term outcomes of corpus callosotomy in adult patients with drug-resistant epilepsy: Results from a single neurosurgical center in Mexico. Epilepsia Open. 2025 Aug;10(4):1176-86.
11. Proteasa K, Proteasa S, Lado F. Corpus Callosotomy for Drug Resistant Epilepsy. Long Term Outcome in Adult Population.(S44. 005). Neurology. 2023 Apr 25;100(17_supplement_2):4522.
12. Khan AH, Islam KT, Barman KK, Barua KK, Abraham M. Outcome of surgical treatment in medically refractory epilepsy. Bangladesh Medical Research Council Bulletin. 2015;41(3):121-4.
13. Courtney MR, Antonic-Baker A, Chen Z, Sinclair B, Nicolo JP, Neal A, Marotta C, Bunyamin J, Law M, Kwan P, O'Brien TJ. Association of localizing 18F-FDG-PET hypometabolism and outcome following epilepsy surgery: systematic review and meta-analysis. Neurology. 2024 May 14;102(9):e209304.
14. Kumar A, Chugani HT. The role of radionuclide imaging in epilepsy, part 1: sporadic temporal and extratemporal lobe epilepsy. Journal of Nuclear Medicine. 2013 Oct 1;54(10):1775-81.