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Computed Tomography and Magnetic Resonance Imaging Findings in Eclampsia-Associated Posterior Reversible Encephalopathy Syndrome: A Retrospective Observational Study

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ABSTRACT

Background: Posterior reversible encephalopathy syndrome (PRES) is a clinico-radiological disorder commonly associated with hypertensive disorders of pregnancy, particularly eclampsia. Early neuroimaging is essential for prompt diagnosis, assessment of disease extent, and identification of imaging features associated with severe neurological injury. This study evaluated the spectrum of computed tomography (CT) and magnetic resonance imaging (MRI) findings in patients with eclampsia-associated PRES.

Materials and Methods: This retrospective observational study included 30 women aged 18–28 years with clinically diagnosed pre-eclampsia or eclampsia presenting with acute neurological manifestations who underwent neuroimaging. Non-contrast CT of the brain was performed in 24 patients, while MRI including T1-weighted, T2-weighted, FLAIR, diffusion-weighted imaging (DWI), apparent diffusion coefficient (ADC), and susceptibility-weighted imaging/gradient echo (SWI/GRE) sequences was performed in six patients. Imaging findings were evaluated for lesion distribution, laterality, edema pattern, diffusion restriction, and hemorrhagic complications. Data were analyzed descriptively using frequencies and percentages.

Results: CT demonstrated bilateral subcortical vasogenic edema predominantly involving the parietal (91.7%) and occipital (79.2%) lobes, with atypical frontal (37.5%) and temporal (45.8%) extension in several patients. Subarachnoid hemorrhage was identified in 12.5% of CT examinations. MRI revealed parieto-occipital involvement in all patients, with additional abnormalities involving the frontal lobes, temporal lobes, basal ganglia, corpus callosum, and cerebellum. Diffusion restriction suggestive of cytotoxic edema was observed in three patients, while hemorrhagic components were detected in four patients on SWI/GRE sequences.

Conclusion: Eclampsia-associated PRES most commonly manifests as bilateral parieto-occipital vasogenic edema, although atypical multilobar involvement is frequent. CT remains an effective initial imaging modality in emergency settings, whereas MRI provides superior tissue characterization and improved detection of diffusion restriction and hemorrhagic

lesions, facilitating comprehensive evaluation of disease extent and imaging severity.

Keywords: Posterior reversible encephalopathy syndrome; eclampsia; computed tomography; magnetic resonance imaging; vasogenic edema; diffusion-weighted imaging

INTRODUCTION

Posterior Reversible Encephalopathy Syndrome (PRES) is a clinic-radiological entity characterized by acute neurological manifestations including headache, altered sensorium, visual disturbances, and seizures, commonly occurring in the setting of acute blood pressure fluctuations, endothelial dysfunction, and systemic inflammatory states. Among the various etiologies, eclampsia remains one of the most important and potentially reversible causes of PRES, particularly in the developing world, where hypertensive disorders of pregnancy continue to contribute significantly to maternal morbidity. [1]

The underlying pathophysiology of PRES is multifactorial and incompletely understood. Proposed mechanisms include failure of cerebral autoregulation due to sudden hypertension leading to hyperperfusion and vasogenic edema, as well as endothelial injury with disruption of the blood–brain barrier. In eclampsia, circulating antiangiogenic factors, endothelial dysfunction, and cerebral vasospasm further predispose to the development of cerebral edema. These mechanisms explain the predilection for involvement of the posterior circulation territories, although increasing evidence suggests that PRES frequently extends beyond the classic parieto-occipital regions, particularly in obstetric patients. [2,3,4]

Neuroimaging plays a pivotal role in the diagnosis, characterization, and prognostication of PRES. Computed tomography (CT) is often the first-line imaging modality in emergency settings due to its widespread availability and rapid acquisition; however, CT may be normal or demonstrate only subtle hypodensities, especially in early or mild cases. Magnetic resonance imaging (MRI) is substantially more sensitive and allows detailed assessment of lesion distribution, extent, and nature of cerebral edema. Typical MRI findings include symmetrical hyperintensities on T2-weighted and FLAIR sequences predominantly involving the parieto-occipital white matter. Nevertheless, a wide spectrum of atypical imaging features has been increasingly recognized, including involvement of the frontal lobes, temporal lobes, basal ganglia, brainstem, and cerebellum. [5,6,7,8]

Advanced MRI sequences further refine the diagnostic and prognostic evaluation of PRES. Diffusion-weighted imaging (DWI) and apparent diffusion coefficient (ADC) mapping are particularly important in differentiating reversible vasogenic edema from irreversible cytotoxic injury. While most PRES lesions demonstrate facilitated diffusion with elevated ADC values, areas of restricted diffusion may be present, indicating infarction and correlating with poorer clinical outcomes. T1-weighted imaging assists in identifying hemorrhage, cortical laminar necrosis, or chronic sequelae on follow-up imaging. [9]

Despite growing literature on PRES, systematic studies comparing CT and MRI findings in eclamptic patients, with detailed MRI sequence-based analysis, remain limited, especially in the Indian population. There is a need to better define the imaging spectrum, atypical patterns, and severity markers of PRES in eclampsia to facilitate early diagnosis, guide management, and predict reversibility. [10]

The present study aims to compare CT and MRI findings in patients with eclampsia-associated PRES, analyze the spectrum of MRI signal characteristics across T1-weighted, T2-weighted, FLAIR, DWI, and ADC sequences, and identify atypical imaging patterns and markers of disease severity.

MATERIALS AND METHODS

Study Design and Setting

This retrospective observational study was conducted in the Department of Radiodiagnosis, Government Medical College, Akola, Maharashtra, India, over a period from 2023 to 2025. The study evaluated the neuroimaging findings of patients diagnosed with pre-eclampsia or eclampsia who developed acute neurological symptoms suggestive of posterior reversible encephalopathy syndrome (PRES). The study was conducted in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.

Ethical Approval

The study protocol was approved by the Institutional Ethics Committee of Government Medical College, Akola, Maharashtra (IEC Approval No. 237/2026). Owing to the retrospective nature of the study, the requirement for written informed consent was waived by the Ethics Committee. Patient confidentiality was maintained by anonymizing all clinical and imaging data before analysis, and the study adhered to the ethical principles of the Declaration of Helsinki.

Study Population

A total of 30 women aged 18–28 years with clinically diagnosed pre-eclampsia or eclampsia who presented during the antenatal, intrapartum, or postpartum period and underwent neuroimaging for acute neurological manifestations were included in the study. Neurological symptoms included seizures, headache, visual disturbances, altered sensorium, or focal neurological deficits suggestive of PRES.

Patients with a history of chronic neurological disorders, intracranial neoplasms, traumatic brain injury, central nervous system infections, known cerebrovascular disease unrelated to hypertensive disorders of pregnancy, incomplete clinical records, or poor-quality imaging studies were excluded from the analysis.

Neuroimaging Protocol

All patients underwent neuroimaging as part of their routine clinical evaluation. Non-contrast computed tomography (CT) of the brain was performed in 24 patients using a 128-slice GE CT scanner with axial 5-mm sections. Magnetic resonance imaging (MRI) of the brain was performed in six patients on a 1.5-T Philips Ingenia MRI system when clinically indicated for further characterization of neurological abnormalities or when CT findings were inconclusive. The MRI protocol included axial T1-weighted, T2-weighted, fluid-attenuated inversion recovery (FLAIR), diffusion-weighted imaging (DWI), apparent diffusion coefficient (ADC) mapping, and susceptibility-weighted imaging/gradient echo (SWI/GRE) sequences.

Image Analysis

All CT and MRI examinations were independently reviewed by two experienced radiologists who were blinded to each other's imaging interpretation. Any discrepancies were resolved by consensus. Imaging findings were evaluated for lesion location, lobar distribution, laterality, signal characteristics, presence of vasogenic or cytotoxic edema, diffusion restriction, hemorrhagic complications, and atypical involvement of deep gray nuclei, corpus callosum, cerebellum, or brainstem.

Diagnostic Criteria

The diagnosis of PRES was established based on the combination of clinical presentation and characteristic neuroimaging findings, including predominantly subcortical vasogenic edema involving the posterior cerebral regions in patients with hypertensive disorders of pregnancy. Areas demonstrating diffusion restriction on DWI with corresponding low ADC values were considered suggestive of cytotoxic edema. Hemorrhagic complications were identified

on CT or susceptibility-sensitive MRI sequences (SWI/GRE).

Outcome Measures

The primary outcome was to describe the spectrum and distribution of CT and MRI findings in patients with eclampsia-associated PRES. Secondary outcomes included characterization of atypical imaging patterns, diffusion restriction, hemorrhagic complications, lesion laterality, and imaging features associated with extensive disease involvement.

Statistical Analysis

Data were entered into Microsoft Excel (Microsoft Corporation, Redmond, WA, USA) and analyzed using SPSS software version 20 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation (SD), whereas categorical variables were summarized as frequencies and percentages. As the study was descriptive in nature and intended to characterize imaging findings, no inferential statistical analyses were performed.

RESULTS

Study Population and Imaging Modality

A total of 30 female patients with clinically diagnosed eclampsia presenting during the antenatal, intrapartum, or postpartum period were included in the study. The age of the patients ranged from 18 to 28 years, with a mean age of approximately 22 years. The demographic profile and distribution of imaging modalities are summarized in Table 1.

Of the total cohort, 24 patients (80%) underwent non-contrast computed tomography (CT) of the brain, while 6 patients (20%) underwent magnetic resonance imaging (MRI) of the brain as part of their neurological evaluation.

CT Findings (n = 24)

All patients who underwent CT imaging demonstrated ill-defined hypodense areas predominantly involving the subcortical white matter, consistent with changes of vasogenic edema.

The parietal lobes were the most frequently involved region, followed by the occipital lobes, with many patients showing bilateral and symmetrical involvement. In several cases, the hypodensities extended beyond the classical posterior regions to involve the frontal and temporal lobes, reflecting an atypical distribution. The lobar distribution of CT abnormalities is detailed in Table 2. The laterality and pattern of CT involvement are presented in Table 3. CT-detected complications including subarachnoid hemorrhage are summarized in Table 4.

The majority of CT lesions showed preserved gray–white matter differentiation, and no significant mass effect was observed. Subarachnoid hemorrhage was identified on CT in a small subset of patients, appearing as hyperdensity within cortical sulci, predominantly in the frontal or occipital regions.

Based on CT distribution patterns, patients were categorized into typical posterior-predominant PRES and atypical PRES, with a significant proportion demonstrating involvement beyond the parieto-occipital regions.

MRI Findings (n = 6)

MRI demonstrated hyperintense lesions on T2-weighted and FLAIR images with additional abnormalities identified on diffusion-weighted and susceptibility-sensitive sequences. All MRI-positive cases showed hyperintense signal on T2-weighted and FLAIR sequences involving the subcortical white matter, with corresponding hypointensity on T1-weighted images. The MRI signal characteristics across sequences are detailed in Table 5, and the anatomical distribution of MRI findings is summarized in Table 6. Imaging-based severity markers across all patients are presented in Table 7. Representative CT and MRI images are illustrated in Figures 1 through 4.

The parieto-occipital regions were involved in all MRI cases, with additional involvement of the frontal lobes, temporal

lobes, basal ganglia, external capsule, cerebellum, and corpus callosum in selected patients, indicating atypical patterns of PRES.

Diffusion-weighted imaging (DWI) and apparent diffusion coefficient (ADC) maps revealed two distinct patterns:

- Vasogenic edema without diffusion restriction in a subset of patients
- Areas of restricted diffusion with corresponding low ADC values in others, suggestive of superimposed cytotoxic edema and acute infarction

Susceptibility-weighted imaging (SWI/GRE) demonstrated hemorrhagic components, including sulcal subarachnoid hemorrhage and cortical–subcortical microhemorrhages, which were not appreciable on CT in several cases.

Table 1. Demographic Profile and Imaging Modality Distribution

Parameter	Value
Total patients	30
Age range (years)	18–28
Mean age (years)	22.1 ± 2.4
CT brain performed	24 (80%)
MRI brain performed	6 (20%)

Table 2. Lobar Distribution of Abnormalities on CT (n = 24)

Brain region involved	Number of patients	Percentage
Parietal lobe	22	91.7%
Occipital lobe	19	79.2%
Temporal lobe	11	45.8%
Frontal lobe	9	37.5%

Table 3. Laterality and Pattern of CT Involvement

Imaging feature	Number of patients	Percentage
Bilateral involvement	19	79.2%
Unilateral involvement	5	20.8%
Typical posterior PRES pattern	15	62.5%
Atypical PRES pattern	9	37.5%

Table 4. CT-Detected Complications (n = 24)

Complication	Number of patients
Subarachnoid hemorrhage	3

Complication	Number of patients
Mass effect	0
Loss of gray–white differentiation	0

Table 5. MRI Signal Characteristics and Sequence-Based Findings (n = 6)

MRI sequence	Imaging finding	Number of patients
T2 / FLAIR	Hyperintensity	6 (100%)
T1-weighted	Hypointensity	6 (100%)
DWI / ADC	Vasogenic edema (no restriction)	3 (50%)
DWI / ADC	Cytotoxic edema (restriction)	3 (50%)
SWI / GRE	Hemorrhage / blooming	4 (66.7%)

Table 6. Anatomical Distribution of MRI Findings

Brain region	Number of patients
Parietal lobes	6
Occipital lobes	6
Frontal lobes	3
Temporal lobes	2
Basal ganglia / external capsule	2
Corpus callosum (splenium)	1
Cerebellum	1

Table 7. Imaging-Based Severity Markers

Severity indicator	Number of patients
Restricted diffusion (acute infarction)	3
Hemorrhagic component	4
Multilobar involvement	7

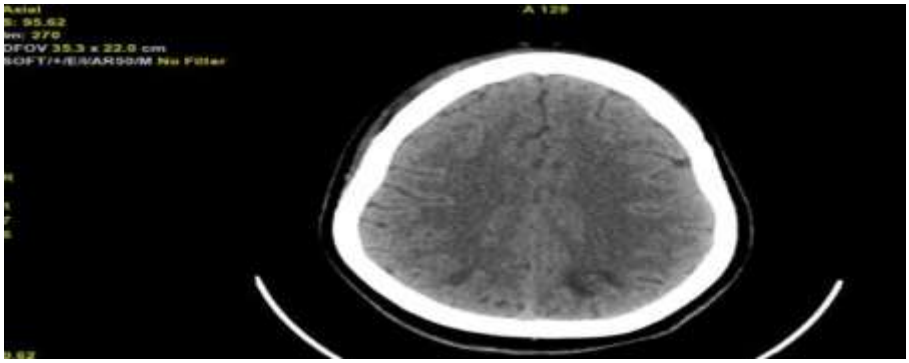

Fig 1: Non-contrast axial CT image of the brain shows ill-defined subcortical hypodensity in the bilateral high parietal lobes, suggestive of posterior reversible encephalopathy syndrome in the appropriate clinical setting.

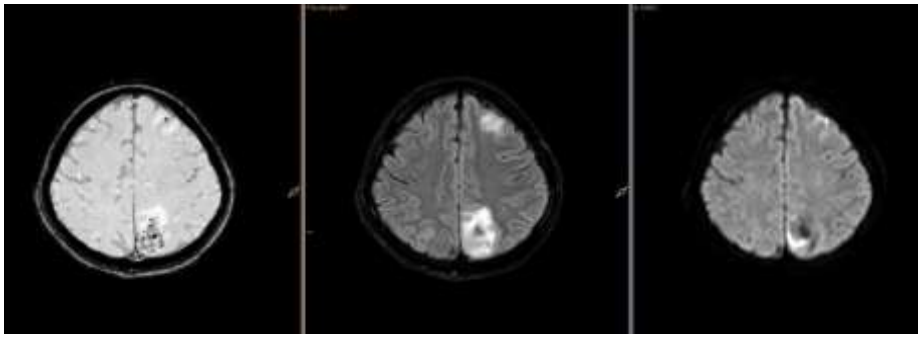

Fig 2: Axial MRI images (SWI, FLAIR and DWI) show a focal haemorrhagic lesion in the left parasagittal parietal cortex with surrounding cortical–subcortical edema, in keeping with haemorrhagic changes in posterior reversible encephalopathy syndrome.

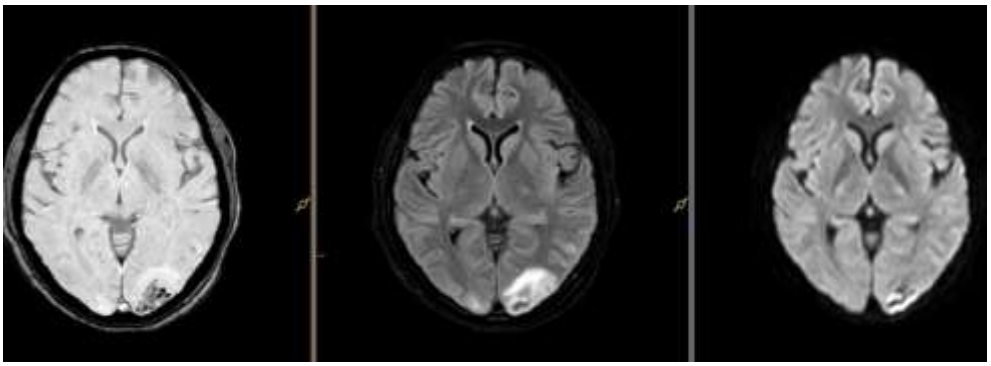

Fig 3: Axial MRI images (SWI, FLAIR and DWI) demonstrate a focal hemorrhagic lesion in the left occipital lobe with surrounding cortical–subcortical edema, consistent with haemorrhagic involvement in posterior reversible encephalopathy syndrome.

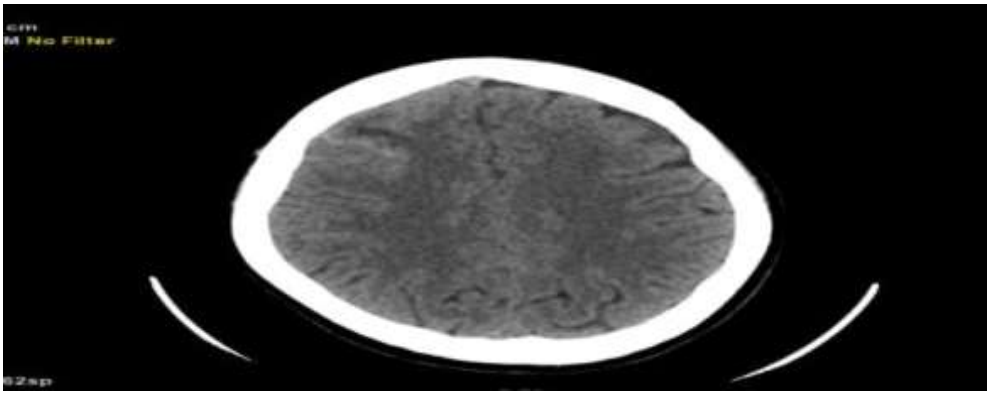

Fig 4: Axial non-contrast CT scan of the brain shows hyperdense sulcal spaces along the right frontal convexity, suggestive of acute subarachnoid hemorrhage.

DISCUSSION

Posterior reversible encephalopathy syndrome (PRES) is increasingly recognized as a neuroimaging manifestation of acute hypertension, particularly in eclampsia and preeclampsia. The current study - comprising 30 young women aged 18-28 years - demonstrated a consistent imaging spectrum typical of hypertensive encephalopathy, ranging from classical posterior vasogenic edema to atypical and complicated presentations.

Imaging Spectrum and Distribution

The study confirmed a high prevalence of parieto-occipital involvement (91.7% and 79.2% on CT respectively), in line with the pathognomonic posterior predilection of PRES described in major series by Bartynski et al [2]. and others. This pattern corresponds to the unique regional susceptibility of posterior circulation territories—particularly the parieto-occipital lobes—attributed to limited sympathetic innervation, making them vulnerable to hypertension-induced autoregulatory failure and vasogenic edema.

However, atypical involvement was seen in approximately one-third of patients, with frontal (37.5%) and temporal (45.8%) extension, and occasional deep gray nuclei, corpus callosum, and cerebellar changes on MRI. These findings mirror the evolving literature describing "overlapping" and "central" PRES patterns, indicating that PRES should not be excluded solely based on atypical topography. Studies by McKinney et al. and Liman et al. [6,11] have reported a 30–40% incidence of such atypical extensions, similar to the present cohort.

In the present series, CT was the principal modality for emergency assessment, demonstrating early detection of hypodense regions denoting vasogenic edema in 80% of patients. However, MRI offered markedly superior lesion characterization, differentiating vasogenic from cytotoxic edema and detecting small hemorrhagic foci. Half of the MRI cases showed diffusion restriction with low ADC values, suggestive of cytotoxic edema and early infarction—findings documented by previous radiologic–pathologic correlation studies (Mukherjee et al.) [12]. Hemorrhagic foci were detected in two-thirds of MRI patients on SWI/GRE, emphasizing MRI's sensitivity for subtle microbleeds and sulcal hemorrhage, which were under-recognized on CT.

Three patients demonstrated restricted diffusion, and four had hemorrhagic components—markers of complicated PRES. The coexistence of vasogenic and cytotoxic edema in these cases implies progression beyond reversible endothelial dysfunction toward irreversible ischemic injury. PRES with hemorrhage has been reported in 10–25% of cases, more frequent in eclampsia, likely due to endothelial fragility and disordered autoregulation during hypertensive surges (Hefzy et al.) [13]. Subarachnoid hemorrhage was documented in three CT scans (12.5%), consistent with published obstetric PRES data showing sulcal hemorrhage in up to 15–20% of eclamptic presentations [14]. Importantly, none of the patients exhibited mass effect or gray–white blurring on CT, indicating primarily vasogenic rather than infarct-like cytotoxic edema at presentation.

In eclampsia, acute endothelial dysfunction, intravascular volume shifts, and loss of autoregulatory capacity lead to hyperperfusion and subsequent leakage of plasma into interstitial spaces, producing vasogenic edema. The imaging findings in this cohort across CT and MRI modalities correspond to this pathophysiological mechanism. The posteriorly predominant involvement and occasional deep structure changes conform to the recognized pattern in hypertensive encephalopathy due to pregnancy-related vascular instability.

The frequencies of posterior (92%), bilateral (79%), and hemorrhagic (13%) involvement in this series closely mirror global PRES literature findings. The comparable PRES–infarction overlap and microhemorrhagic rates substantiate the view that PRES in eclampsia represents a continuum of vascular endothelial injury, not a single entity. MRI detection of cytotoxic edema and

hemorrhagic foci likely indicates higher disease severity and potential for incomplete reversibility cohorts [14].

In contrast to series involving non-obstetric patients, our study population showed younger mean age, higher posterior predominance, and fewer chronic vascular changes, reaffirming eclampsia as a unique, high-intensity but typically reversible cause of PRES when managed promptly.

CONCLUSION

Posterior reversible encephalopathy syndrome (PRES) associated with eclampsia demonstrates a characteristic neuroimaging pattern of bilateral parieto-occipital vasogenic edema, although atypical involvement of the frontal and temporal lobes, deep gray nuclei, corpus callosum, and cerebellum may also occur. In this study, computed tomography (CT) served as a valuable first-line imaging modality for the rapid identification of cerebral edema and hemorrhagic complications in emergency settings, whereas magnetic resonance imaging (MRI) provided more comprehensive characterization of lesion distribution, diffusion abnormalities, and hemorrhagic foci through advanced imaging sequences. Recognition of atypical imaging features and diffusion restriction is important for accurate diagnosis and assessment of disease severity in patients with eclampsia-associated PRES. Early neuroimaging, combined with prompt multidisciplinary management, may facilitate timely diagnosis and appropriate clinical decision-making. Although the present findings are consistent with the established imaging spectrum of PRES, the retrospective single-center design and limited number of patients undergoing MRI warrant cautious interpretation. Larger prospective multicenter studies with standardized neuroimaging protocols and longitudinal clinical follow-up are needed to validate these observations, determine the prognostic significance of advanced MRI findings, and further optimize imaging-based evaluation of PRES in hypertensive disorders of pregnancy.

Declaration by Authors

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Conflict of Interest: The authors declare no conflict of interest.

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