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Original Article

COMPARATIVE STUDY OF PLAIN CT HEAD VERSUS MRI BRAIN FOR DETECTING ACUTE POSTERIOR FOSSA INFARCT

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ABSTRACT

Background

Posterior fossa infarcts present diagnostic challenges due to their deep location and subtle clinical presentation. Although non-contrast computed tomography (NCCT) is widely utilized due to its accessibility and rapid imaging capabilities, its sensitivity in detecting these infarcts is lower than diffusion-weighted magnetic resonance imaging (DW MRI), which remains the gold standard.

Methods

A prospective analytical study was conducted over the period of 15 months at a tertiary care centre in Nepal. A total of 150 patients with a clinical suspicion of posterior fossa stroke underwent NCCT, followed by DW MRI within 24 hours of symptom onset. The NCCT findings were compared with DW MRI's to assess the sensitivity, specificity, positive predictive value, and negative predictive value in detecting acute infarcts.

Results

Of the 150 patients, 93 (62%) were confirmed to have an acute posterior fossa infarct on DW MRI. The anatomical distribution included infarcts in the midbrain (8.67%), pons (20.00%), cerebellum (28.00%), and medulla (5.33%). NCCT demonstrated a sensitivity of 77.42% and a specificity of 64.91%, with a positive predictive value of 78.26% and a negative predictive value of 63.79%. Clinical features such as headache, high blood pressure, dizziness, loss of consciousness, and hemiparesis were significantly more common in MRI-positive cases.

Conclusion

Although NCCT is an essential initial imaging tool in resource-limited settings, its moderate sensitivity and specificity underscore its limitations in detecting posterior fossa infarcts. DW MRI remains superior, particularly in patients with high-risk clinical features, emphasizing the need for integrated clinical-imaging protocols to optimize stroke diagnosis and management.

Keywords: Computed Tomography Scanners, Stroke, Sensitivity, Magnetic Resonance Imaging

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INTRODUCTION

Stroke potentiates a major risk of morbidity and mortality, with ischemic strokes accounting for 80% of cases[1]. Posterior fossa infarcts are particularly challenging to diagnose due to their deep location and often subtle clinical presentation. Early detection is crucial, as delays can lead to severe neurological deficits[2]. Imaging plays a key role, with non-contrast computed tomography (NCCT) and magnetic resonance imaging (MRI) being the primary modalities[3].NCCT is widely used due to its accessibility and speed, but its sensitivity in detecting posterior fossa infarcts is lower compared to MRI[4]. MRI, particularly diffusion-weighted imaging (DWI), is more sensitive (88–100%) and specific (95–100%) for detecting acute infarcts[5,6].

MRI availability in Nepal is limited due to high costs and inadequate infrastructure, making NCCT the primary imaging tool despite its lower sensitivity in detecting posterior fossa infarcts. This raises concerns about misdiagnosis and delayed treatment, especially in rural areas where advanced imaging is often inaccessible.

This study evaluates NCCT's accuracy in Nepal, using MRI as the gold standard. The findings will help improve stroke diagnosis and optimize imaging protocols in resource-limited settings, ensuring better patient outcomes.

METHODS

This analytical study was conducted over a period of 15 months (December 2023–March 2025) at a tertiary care centre in the eastern part of Nepal after obtaining Institutional Review Committee (IRC) clearance (Ref No: 911/2023). Posterior fossa strokes are frequently missed or underdiagnosed on plain CT head scans, yet they carry significantly higher morbidity and mortality than strokes in other regions. Accurate diagnosis is therefore imperative.

The objectives of the study were:

- To examine the accuracy, sensitivity, specificity, positive predictive value and negative predictive value of non-contrast CT (NCCT) head in detecting suspected posterior fossa ischemic infarcts, considering diffusion-weighted (DW) MRI as the gold standard.
- To determine the various sites of infarction within the posterior fossa.
- Correlation of the clinical symptoms with DW MRI confirmed stroke.

All patients referred for NCCT head with clinical symptoms suggestive of a posterior fossa stroke and subsequently undergoing MRI brain for diagnostic confirmation were included in the study. Patients with hemorrhagic stroke, ischemic stroke in regions other than the posterior fossa, or contraindications for MRI (e.g., presence of metallic implants) were excluded.

According to a study by Mehndiratta et al., the overall prevalence of posterior fossa stroke was 11.37%[7].

The sample size was determined using the Cochrane formula:

$$N = (Z^2 \times P \times Q) / E^2$$

Where:

P = prevalence of posterior fossa stroke (11.37%),

Q = 1 – P (88.63%),

E = margin of error (5%), and

Z = 1.96 (for 95% confidence interval).

The calculated sample size was 146; to enhance study accuracy, 150 patients were recruited using a purposive sampling technique.

All symptomatic patients underwent a plain CT head examination using a Siemens 128-slice CT scanner with multiplanar imaging. This was immediately followed by an MRI brain examination on a 3 Tesla Siemens scanner employing conventional T1, T2, and FLAIR sequences, with an additional DW sequence. In select cases, contrast-enhanced studies were performed to confirm diagnoses other than infarction. Both CT head and MRI brain examinations were conducted within 36 hours of the onset of symptoms.

The sensitivity and diagnostic accuracy of NCCT head in detecting posterior fossa acute infarcts were determined by comparing its findings with those of DW MRI, which served as the gold standard.

Data were recorded in Microsoft Excel and analyzed using IBM SPSS Statistics for Windows, version 29 (IBM Corp., Armonk, NY, USA). Categorical variables were analyzed using the chi-square test, while continuous or numerical variables were evaluated using the t-test.

RESULTS

A total of 150 patients with suspected posterior fossa stroke were included in the study over a period of 15 months. The mean age was 64.21 ± 8.72 years, with 89 (59.33%) males and 61 (40.67%) females. The most frequently reported symptoms were dizziness/vertigo in 92 (61.33%) cases, high blood pressure in 79 (52.67%) cases, and headache in 60 (40.00%) cases. Other presenting features included loss of consciousness in 35 (23.33%) cases, hemiplegia/hemi-paresis in 55 (36.67%) cases, and paraplegia/para-paresis in 41 (27.33%) cases. Detailed explanations of these demographic and clinical findings are tabulated in **Table 1:**

Table 1: Demographics and Clinical Presentation (N = 150)

Parameter	Value
Age (years)	64.21 ± 8.72
Gender	
• Male	89 (59.33%)
• Female	61 (40.67%)
Symptoms	
• Headache	60 (40.00%)
• High Blood Pressure	79 (52.67%)
• Dizziness/Vertigo	92 (61.33%)
• Loss of Consciousness	35 (23.33%)
• Hemiplegia/Hemi-paresis	55 (36.67%)
• Paraplegia/Para-paresis	41 (27.33%)

On MRI, 93 (62.00%) patients were confirmed to have an acute posterior fossa infarct. The infarct locations were distributed as follows: midbrain in 13 (8.67%), pons in 30 (20.00%), cerebellum in 42 (28.00%), and medulla in 8 (5.33%) patients. Additionally, 27 (18.00%) patients exhibited findings other than infarct (infarct mimics), including demyelination in 11 (7.33%), glioma in 3 (2.00%), metastasis in 9 (6.00%), and tuberculoma in 4 (2.67%). Detailed explanations regarding MRI findings are presented in **Table 2:**

Table 2: MRI Findings: Infarct Location and Other Mimics

MRI Findings	N (%)
Posterior Fossa Infarct	
• Midbrain	13 (8.67%)
• Pons	30 (20.00%)
• Cerebellum	42 (28.00%)
• Medulla	8 (5.33%)
Total Infarct	93 (62.00%)
Infarct Mimics	
• Demyelination	11 (7.33%)
• Glioma	3 (2.00%)
• Metastasis	9 (6.00%)
• Tuberculoma	4 (2.67%)
Total Mimics	27 (18.00%)

Comparison of plain CT head with MRI findings is summarized in **Table 3:** Among the 93 MRI-positive patients, CT detected infarct in 72 cases, while it falsely reported infarct in 20 cases among the 57 MRI-negative patients. Conversely, CT failed to detect infarct in 21 MRI-positive cases and correctly identified the absence of infarct in 37 MRI-negative cases. Based on these data, the sensitivity of CT was 77.42%, specificity was 64.91%, the positive predictive value (PPV) was 78.26%, and the negative predictive value (NPV) was 63.79%.

Table 3: Correlation of CT Head with MRI Brain for Posterior Fossa Infarct

	MRI Infarct Present (n=93)	MRI Infarct Absent (n=57)	Total (n=150)
CT Infarct Present	72	20	92
CT Infarct Absent	21	37	58
Total	93	57	150

- **Sensitivity:** 77.42%
- **Specificity:** 64.91%
- **Positive Predictive Value (PPV):** 78.26%
- **Negative Predictive Value (NPV):** 63.79%
- **Accuracy of the study:** 72.66%

Furthermore, clinical parameters were compared between patients with MRI-confirmed infarcts (MRI-positive, n = 93) and those without infarct on MRI (MRI-negative, n = 57). The MRI-positive group had a mean age of 63.20 ± 8.50 years compared to 66.10 ± 7.90 years in the MRI-negative group (p = 0.045). Male gender was more common in the MRI-positive group (60, 64.52%) compared to the MRI-negative group (29, 50.88%; p = 0.037). The frequency of key symptoms also differed significantly: headache was present in 48 (51.61%) MRI-positive patients versus 12 (21.05%) MRI-negative patients (p = 0.002); high blood pressure was noted in 80 (86.02%) versus 60 (52.63%) (p < 0.001); dizziness/vertigo in 65 (69.89%) versus 27 (47.37%) (p = 0.015); loss of consciousness in 30 (32.26%) versus 5 (8.77%) (p = 0.001); hemiparesis in 50 (53.76%) versus 5 (8.77%) (p < 0.001); and paraparesis in 35 (37.63%) versus 6 (10.53%) (p = 0.001). Detailed comparisons are provided in **Table 4:**

Table 4: Comparison of Clinical Parameters between MRI-Positive and MRI-Negative Groups

Parameter	MRI-Positive (n=93)	MRI-Negative (n=57)	p-value
Age (years)	63.20 ± 8.50	66.10 ± 7.90	0.045
Gender (Male)	60 (64.52%)	29 (50.88%)	0.037
Headache	48 (51.61%)	12 (21.05%)	0.002
High Blood Pressure	80 (86.02%)	60 (52.63%)	<0.001
Dizziness/Vertigo	65 (69.89%)	27 (47.37%)	0.015
Loss of Consciousness	30 (32.26%)	5 (8.77%)	0.001
Hemiparesis	50 (53.76%)	5 (8.77%)	<0.001
Paraparesis	35 (37.63%)	6 (10.53%)	0.001

These statistical analyses indicate that certain clinical features—such as headache, high blood pressure, and dizziness/vertigo, loss of consciousness, hemiparesis, and paraparesis—are significantly associated with MRI-confirmed posterior fossa infarcts. Detailed explanations of these findings, along with their respective p-values, are provided in Table 4.

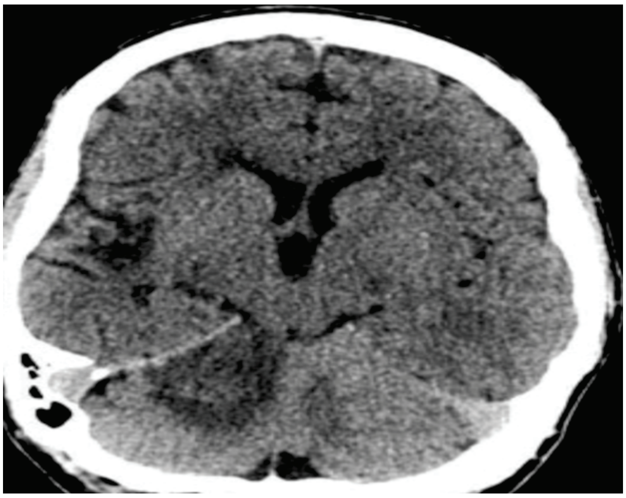

Figure: Illustrates an acute infarct in the right cerebellar hemisphere as identified on NCCT head.

DISCUSSION

Acute posterior fossa infarcts present a significant diagnostic challenge because of the intricate anatomy of the region and the often subtle clinical manifestations that accompany ischemic events[2]. In our study, which evaluated 150 patients with suspected posterior fossa stroke, 93 cases (62%) were confirmed to have an infarct on diffusion-weighted magnetic resonance imaging (DW MRI), the gold standard for identifying acute ischemic lesions. The results highlight several important aspects, including the demographic characteristics of the patient population, the anatomical distribution of infarcts, the diagnostic accuracy of non-contrast computed tomography (NCCT), and the relationship between clinical symptoms and imaging findings.

The demographic profile of our patients showed a mean age of 64.21 ± 8.72 years, with a higher proportion of males (59.33%) compared to females (40.67%). These findings are in accordance with previous epidemiological studies indicating that cerebrovascular accidents are more prevalent among older adults, particularly in men[8, 9]. Notably, when comparing patients with MRI-confirmed infarcts to those with negative MRI findings, we observed that the MRI-positive group had a statistically lower mean age (63.20 ± 8.50 years) compared to the MRI-negative group (66.10 ± 7.90 years; $p = 0.045$). This difference suggests that subtle ischemic changes may be more readily detected in slightly younger patients, while older individuals might present with additional comorbidities that complicate the imaging findings. Moreover, the increased frequency of symptoms such as headache, high blood pressure, and dizziness in the MRI-positive group underscores the importance of integrating clinical assessment with demographic data to enhance diagnostic precision.

The anatomical distribution of the infarcts in our study was varied, with 8.67% of lesions located in the midbrain, 20.00% in the pons, 28.00% in the cerebellum, and 5.33% in the medulla. The high prevalence of cerebellar infarcts is consistent with earlier research that has documented the vulnerability of the cerebellum due to its unique vascular supply and the small calibre of its arterial branches[10, 11]. However, the challenges posed by beam-hardening artefacts from the surrounding bony structures significantly reduce the sensitivity of NCCT in detecting small or subtle infarcts in these areas[4]. DW MRI, on the other hand, offers markedly improved sensitivity—reported in literature as ranging from 88% to 100%—and specificity, sometimes as high as 95–100%, in detecting acute ischemic changes[5,6]. This discrepancy in imaging performance is especially evident in the brainstem and cerebellar regions, where precise identification of infarcts is critical for guiding timely clinical management[4].

The diagnostic performance of NCCT in our study was further elucidated by calculating a sensitivity of 77.42% and a specificity of 64.91%. The positive predictive value (PPV) was 78.26%, while the negative predictive value (NPV) was 63.79%. These figures indicate that nearly one in four true infarcts may be missed by CT imaging, and there is also a significant rate of false-positive results. Such moderate sensitivity and specificity underscore the limitations of NCCT, particularly in the context of posterior fossa infarcts where anatomical complexities and imaging artefacts are prevalent[4]. According to a study by Lev et al., the sensitivity of NCCT for stroke is around 57%, which can increase to 71% with variable window width and centre level settings[12]. Sensitivity is as low as 12% with NCCT alone for cerebellar lesions, which increases to around 38% and 52% with automated core penumbra mapping and automated core penumbra matching along with unprocessed maps, respectively. The sensitivity increases as the size of the infarct increases to almost 91% in certain conditions[13].The relatively low NPV is particularly concerning in an acute stroke setting, as a negative CT scan cannot reliably exclude the presence of an infarct, potentially leading to delayed treatment in a time-sensitive situation.

The relationship between clinical symptomatology and imaging findings was a notable aspect of our investigation. Patients with MRI-confirmed infarcts exhibited a higher frequency of key clinical symptoms compared to those with negative MRI findings. Specifically, the prevalence of headache was 51.61% in the MRI-positive group versus 21.05% in the MRI-negative group ($p = 0.002$), high blood pressure was noted in 86.02% versus 52.63% ($p < 0.001$), dizziness or vertigo was present in 69.89% versus 47.37% ($p = 0.015$), loss of consciousness in 32.26% versus 8.77% ($p = 0.001$), hemiparesis in 53.76% versus 8.77% ($p < 0.001$), and paraparesis in 37.63% versus 10.53% ($p =$

0.001). These statistically significant differences suggest that the presence of such high-risk clinical features should alert clinicians to the possibility of a posterior fossa infarct, even when initial NCCT findings appear unremarkable[14, 15]. In resource-limited settings, where immediate access to advanced imaging modalities like DW MRI is constrained, these clinical indicators become even more critical in guiding the decision to pursue further diagnostic evaluation.

In numerous low- and middle-income countries, NCCT remains the preferred imaging modality for the initial evaluation of suspected strokes due to its widespread availability and quick turnaround time, despite its known limitations[16]. The ease of accessibility and lower cost of CT scanning often outweigh its diagnostic drawbacks in emergency settings. Nevertheless, our findings clearly indicate that sole reliance on NCCT can lead to diagnostic oversights, particularly in the context of posterior fossa strokes where small infarcts may be easily missed. This gap underscores the need for a more integrated diagnostic approach, combining clinical risk stratification with imaging findings. In practice, patients presenting with a constellation of high-risk symptoms—such as abrupt neurological deficits or brainstem signs—should be considered for follow-up evaluation with DW MRI, even if their initial NCCT is negative.

The development of enhanced CT techniques, such as CT perfusion imaging, has been suggested as a means to improve the sensitivity of CT in detecting subtle ischemic changes. However, these advanced protocols require additional technological resources and specialized expertise, which may not be available in all healthcare settings[17, 18]. An alternative approach in resource-limited environments is the utilization of telemedicine, wherein NCCT images can be transmitted to expert neuroradiologists for remote consultation. This method can help bridge the gap in expertise and ensure that patients receive timely and accurate diagnoses[19]. In our setting, such an integrated model of care could potentially mitigate the inherent limitations of NCCT and lead to improved outcomes for patients with suspected posterior fossa infarcts.

CONCLUSION

In summary, our study demonstrates that while NCCT is a valuable initial tool for evaluating suspected posterior fossa infarcts, its moderate sensitivity and specificity highlight significant limitations. DW MRI remains superior, particularly in patients with high-risk clinical features. Integrating clinical assessment with imaging can improve diagnostic accuracy and optimize stroke protocols in resource-limited settings.

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