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Original Research Article

Study of CT Imaging Profile and Clinical Outcome in Patients of Acute Non-Traumatic Intracerebral Haemorrhage

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Abstract

Background: Acute non-traumatic intracerebral hemorrhage (ICH) is a critical neurological emergency associated with high morbidity and mortality. Early diagnosis using computed tomography (CT) can offer essential insights into hematoma characteristics that influence clinical outcomes.

Objective: To assess CT imaging features and correlate them with clinical outcomes in patients with acute non-traumatic ICH.

Materials and Methods: This prospective cohort study included 100 adult patients with acute non-traumatic ICH admitted within 24 hours of symptom onset. CT head scans were analyzed for hematoma location, volume, intraventricular/subarachnoid extension, midline shift, and herniation. Clinical presentation was assessed using Glasgow Coma Scale (GCS) at admission, and outcomes were measured using the Modified Rankin Scale (mRS) at 30 days. Statistical analysis was done using SPSS version 22.0.

Results: The most common hematoma site was the basal ganglia (54%), followed by the thalamus (24%). Intraventricular extension was present in 43% of cases, midline shift ≥5 mm in 42%, and herniation in 11%. A statistically significant correlation was observed between higher hematoma volume and poor outcomes (mean volume in deceased patients: 42.82±24.27 cc; $p<0.01$). GCS at admission negatively correlated with mRS scores at discharge ($p<0.001$). Mortality at 30 days was 30%. Poor clinical outcomes were significantly associated with intraventricular extension, midline shift, herniation, and lower GCS scores at admission.

Conclusion: CT imaging provides critical prognostic information in acute non-traumatic ICH. Hematoma volume, location, and associated features like midline shift and intraventricular extension significantly influence short-term outcomes. Early and comprehensive CT evaluation is essential for timely therapeutic decisions and predicting prognosis.

Keywords: Intracerebral hemorrhage, CT scan, Glasgow Coma Scale, Modified Rankin Scale, Hematoma volume, Prognosis.

Introduction

Intracerebral hemorrhage (ICH) is a life-threatening neurological emergency that accounts for 10–15% of all strokes globally and is associated with high morbidity and mortality [1,2]. Non-traumatic ICH typically arises from spontaneous rupture of cerebral vessels, often secondary to chronic hypertension or cerebral amyloid angiopathy (CAA) [3]. In Asian populations, including India, the incidence of ICH appears to be higher, comprising up to one-third of all stroke cases [4].

Despite significant advances in medical care, mortality within the first month after ICH remains as high as 40%, and functional independence is achieved in fewer than 20% of survivor [5]. Rapid identification and management are essential for improving outcomes, making neuroimaging a cornerstone in the initial evaluation. Among available modalities, non-contrast computed tomography (CT) remains the gold standard for detecting ICH in the acute phase due to its wide availability, speed, and sensitivity [6]

CT imaging provides critical information such as the location and volume of the hematoma, presence of intraventricular extension, midline shift, and brain herniation—all of which have significant prognostic implication [7]. Several studies have

demonstrated a direct correlation between hematoma volume and clinical outcome, with volumes exceeding 30 cc being associated with increased mortality [8]. Similarly, intraventricular hemorrhage (IVH) and midline shift have been independently linked with poor outcomes [9]. While global studies have proposed scoring systems like the ICH Score and FUNC Score incorporating such CT features to estimate prognosis, there remains a paucity of comprehensive data in Indian populations, where different demographic and clinical patterns may exist [10] This study aims to evaluate the CT imaging profile of acute non-traumatic ICH and its correlation with clinical outcome at 30 days using standardized neurological scales such as the Glasgow Coma Scale (GCS) and Modified Rankin Scale (mRS).

Materials and Methods

This prospective cohort study was conducted in the Department of Radiodiagnosis at Shri Guru Ram Rai Institute of Medical and Health Sciences, Dehradun, over a period of two years. A total of 100 adult patients presenting with acute non-traumatic intracerebral hemorrhage (ICH) were enrolled after obtaining written informed consent. Inclusion criteria consisted of adult patients (age >18 years) with CT-confirmed non-traumatic ICH, presenting within 24 hours of the onset of neurological symptoms. Patients with traumatic hemorrhage, aneurysmal subarachnoid hemorrhage, prior stroke with residual deficits, or those receiving anticoagulant or thrombolytic therapy were excluded.

All patients underwent non-contrast CT brain scans using a 128-slice multidetector CT scanner (Ingenuity CT, Philips Healthcare, and The Netherlands). The CT images were assessed for hematoma location, volume (using an NCCT-based hematoma computation tool), intraventricular or subarachnoid extension, presence of midline shift, and herniation. Hematoma volume was calculated by ABC/2 method and verified with the software tool. Clinical presentation was assessed at admission using the Glasgow Coma Scale (GCS), and patient outcomes were measured at 30 days using the Modified Rankin Scale (mRS).

GCS evaluated the patient's consciousness level based on eye, verbal, and motor responses, while mRS categorized disability on a scale from 0 (no symptoms) to 6 (death). Patients were managed either conservatively or surgically based on neurological status, hematoma size, and clinical judgment. No imaging or treatment was performed for research purposes alone.

Statistical analysis

All data were tabulated in Microsoft Excel and analyzed using SPSS version 22.0 (SPSS Inc., Chicago, IL). Continuous variables were expressed as means with standard deviation and compared using Student's t-test or ANOVA. Categorical data were analyzed using chi-square tests. Correlation coefficients were computed to assess the association between CT findings and clinical scores. A p-value of less than 0.05 was considered statistically significant.

Results

A total of 100 patients with acute non-traumatic intracerebral hemorrhage were included in the study. The mean age of the patients was 57.8±14.3 years. There was a slight male predominance, with 63% males and 37% females. The age distribution was relatively uniform across age groups, with the majority of patients falling between 41 and 70 years. CT imaging showed that the most common site of hemorrhage was the basal ganglia (54%), followed by the thalamus (24%), lobar regions (10%), cerebellum (7%), and brainstem (5%). Intraventricular extension was present in 43% of patients and midline shift ≥5 mm in 42%. Brain herniation was noted in 11% of cases (table 1).

Table 1: Distribution of Hemorrhage Site and CT Features (n = 100)

CT Parameter	Frequency (%)
Location of Bleed	
Basal Ganglia	54%
Thalamus	24%
Lobar	10%
Cerebellum	7%
Brainstem	5%
Intraventricular Extension	43%
Midline Shift ≥5 mm	42%
Brain Herniation	11%
Mean Volume (cc)	23.73 ± 22.87

At admission, 40% of patients had a Glasgow Coma Scale (GCS) score ≤8, 36% had a GCS score between 9–12, and 24% had a GCS of 13–15. At discharge (or death), the proportion of patients with GCS ≥13 improved to 73%, while 30% of patients had died during the hospital stay ($p<0.01$).

Table 2: Glasgow Coma Scale (GCS) at Admission and Discharge

GCS Score Range	At Admission (%)	At Discharge (%)
13–15 (Mild)	24%	73%
9–12 (Moderate)	36%	16%
≤8 (Severe)	40%	11%

Clinical outcomes assessed by the Modified Rankin Scale (mRS) at 30 days revealed that 30% of patients had died, and 15% each had severe or moderate disability. Better outcomes (mRS 0–2) were seen in 26% of patients. Patients with intraventricular extension, midline shift ≥5 mm, or herniation had significantly higher rates of mortality and disability ($p<0.01$). A strong positive correlation was observed between hematoma volume and mRS score ($r = 0.624$, $p<0.001$). Similarly, higher midline shift correlated with worse outcomes ($r = 0.434$, $p<0.001$).

Hematoma volume also showed significant negative correlation with GCS at admission ($r = -0.697$, $p<0.001$) (table 3).

Table 3: Correlation of CT parameters with MRS and GCS score at admission and discharge

	GCS score at admission		GCS score at discharge		MRS score at discharge	
	r value	p value	r value	p value	r value	p value
Volume of bleeding	-0.697	<0.001	-0.516	<0.001	0.624	<0.001
Midline shift	-0.612	<0.001	-0.423	0.02	0.434	<0.001

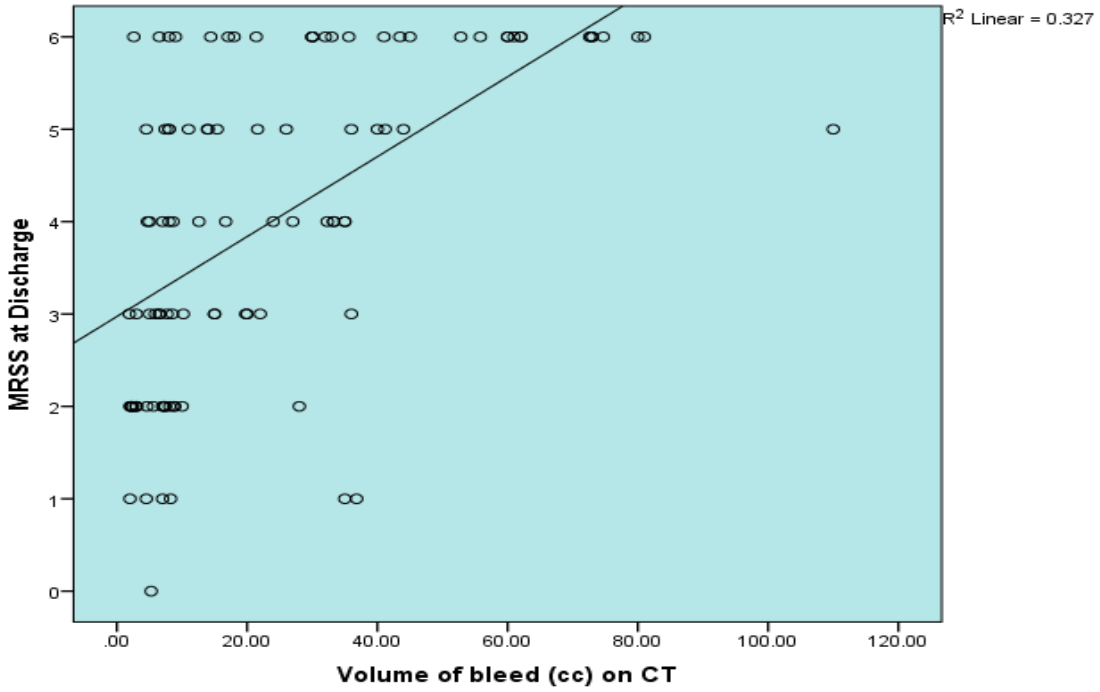

Figure 1: Correlation of volume of bleed with MRS score at discharge

Discussion

This prospective study investigated the CT imaging profile of acute non-traumatic intracerebral hemorrhage (ICH) and its relationship with short-term clinical outcomes in an Indian tertiary care setting. The findings reaffirm the global understanding that ICH is a life-threatening neurological emergency with high early mortality, especially in patients presenting with larger hematoma volumes, intraventricular extension, midline shift, and herniation [1,5,8]. In our cohort, males represented 63% of cases, which aligns with the gender trends reported in other Indian studies, including those by Suthar et al. and Das et al., suggesting a higher prevalence of modifiable risk factors such as hypertension and smoking among men [11,12]. The age distribution revealed that most patients were between 41 and 70 years, a vulnerable age group for spontaneous ICH due to age-related vascular fragility and comorbidities.

The basal ganglia were the most common site of hemorrhage (54%), consistent with the established association between chronic hypertension and deep perforator artery rupture [4,11]. Thalamic bleeds accounted for 24% of cases and were most commonly associated with intraventricular

extension (79.2%). This anatomical proximity to the ventricular system supports previous findings by Hallevi et al., where IVE was a strong predictor of mortality and poor outcome [9]. In our study, IVE was observed in 43% of patients, and over half of these cases resulted in death ($p<0.01$). The increased mortality associated with IVE is attributed to secondary hydrocephalus, raised intracranial pressure, and difficulty in clot resolution [14].

Hematoma volume was another critical predictor of outcome. Our results showed that patients with higher volumes had significantly worse outcomes.

The mean volume in patients who died was 42.8 cc, significantly higher than that in survivors. This supports the thresholds suggested by Broderick et al. and Rost et al., where volumes >30–60 cc were associated with very poor prognoses [8,18]. Our correlation analysis confirmed a strong positive correlation between bleed volume and mRS score ($r = 0.624$, $p<0.001$), reaffirming that volume remains one of the most important radiological predictors of short-term mortality.

Midline shift ≥5 mm was found in 42% of patients, and more than half of these cases ended in mortality. The mechanical distortion of midline structures contributes to brainstem compression, herniation, and ischemia. Fogelholm et al. emphasized that midline shift >6 mm is associated with significantly higher mortality [15], findings that are echoed in our results, with midline shift showing a positive correlation with poor mRS outcome ($r = 0.434$, $p<0.001$). Similarly, brain herniation, present in 11% of our patients, was almost universally fatal (81.8% mortality), confirming that this radiologic sign often marks a critical turning point in patient prognosis [16].

The Glasgow Coma Scale (GCS) at admission emerged as a reliable clinical predictor of outcome. Patients with a GCS <8 had markedly higher mortality. This inverse relationship between GCS and mRS has been demonstrated in previous works, including by Hemphill et al. in the development of the ICH Score [10,17]. Our study supports this, as lower GCS scores at admission were significantly associated with higher mRS scores at discharge ($p<0.001$), and thus worse outcomes.

Interestingly, while age and gender did not significantly influence outcomes in our study ($p>0.05$), some international studies report a marginally worse prognosis in older patients [3,20].

This discrepancy may reflect different population health profiles or management approaches and warrants further investigation in larger, multicenter Indian cohorts. Another important observation was the poor outcome in patients with cerebellar and brainstem hemorrhages, despite their smaller hematoma volumes. Due to limited space in the posterior fossa, even small bleeds can compress vital structures, leading to early deterioration. This anatomical vulnerability has also been emphasized in literature, including by Juvela et al. and Anderson et al. [14,19]. Compared to previous Indian studies which often focused on individual parameters like location or volume alone [11,12], our study comprehensively analyzed multiple CT variables together with clinical scores, offering a more integrated and predictive approach to outcome estimation.

These results reinforce the need for a standardized CT-based assessment protocol at admission for patients with acute ICH. This would help clinicians rapidly identify high-risk patients who may benefit from early neurosurgical intervention or intensive monitoring. Furthermore, future studies incorporating long-term follow-up and functional rehabilitation outcomes would strengthen our understanding of the recovery trajectory in ICH survivors.

Conclusion

This study reaffirms the pivotal role of CT imaging in the early assessment of acute non-traumatic intracerebral hemorrhage. Hematoma volume, midline shift, intraventricular extension, and herniation are all strongly associated with short-term clinical outcomes. Lower GCS scores at presentation also correlate with worse prognosis. Among these, hematoma volume and IVE were the most significant predictors of mortality and severe disability.

Routine use of CT imaging not only confirms the diagnosis but provides critical prognostic indicators that can inform treatment decisions, including early neurosurgical referral. Comprehensive CT evaluation within 24 hours of symptom onset should therefore be considered standard in managing acute ICH.

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