Evolution of spontaneous intracerebral hemorrhage: Effect of hematoma regression on clinical outcomes

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Introduction

Spontaneous intercerebral hemorrhage (sICH) often results in residual hypodense (RH) regions on follow-up neuroimaging studies. The evolution of sICH into RH regions and the association of these regions with clinical outcomes have not been studied. We hypothesized that the volume of RH following sICH is associated with baseline ICH volume and long term neurologic outcomes.

Methods

This post hoc exploratory analysis used computed tomography (CT) scans collected from three trials evaluating acute therapies for sICH: CLEAR IVH, ICES, and MISTIE II (Table 1). sICH and RH volumes were determined using semi-automated volumetric analysis of CT images at ICH onset (diagnostic scan), following IVC placement (stability scan), at 30 days, and at 180 days post sICH (Figure 1). Paitents were excluded if craniotomy had been performed or if the day 30 CT showed residual hyperdense blood . RH volumes were compared with early sICH volumes and prospectively collected 30 and 180 day modified Rankin scores (mRS) and NIH Stroke Scale (NIHSS).

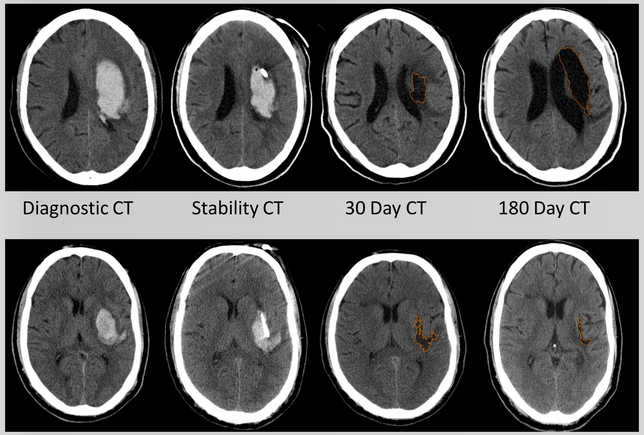

Figure 1. Representative CT scans showing the resolution of ICH into residual hypodense regions over time. Top: RH region increase between 30 and 180 days. Bottom: RH region decrease between 30 and 180 days.

Results

Characterization of Residual Hypodensities on Follow-up CT

Of the 96 patients that had CT at 30 and/or 180 days, median diagnostic and stability sICH volumes were 30.2 (iqr 23.6) and 35.7 (23.8)cc respectively. sICH regression resulted in RH volumes of 7.7(9.9) at 30 days and 8.7(11.6)cc at 180 days (Table 2). Diagnostic sICH volume was highly correlated with RH volume at 30 and 180 days (p<0.001) (Figure 2) and most RH were located central to the admission ICH site (Figure 3).

Table 1. Patient Demographics and Admission Characteristics (N=96)

Age (years), ± SEM	59.5 ± 1.1
Male, N (%)	60 (62.5)
Race, N (%)	
Caucasian	47 (48.9)
African-American	33 (34.4)
Asian or Pacific Islander	6 (6.3)
Hispanic	8 (8.3)
Other	2 (2.1)
Admission GCS Score, Median [IQR]	11 [6]
Intraventricular Hemorrhage (%)	42 (43.8)
ICH Score, Median [IQR]	2 [1]
ICH Location	
Lobar	22 (22.9)
Putamen	55 (57.3)
Globus pallidus	6 (6.3)
Caudate	1 (1.0)
Thalamus	12 (12.5)

Table 2. Radiology and Outcomes (N=96)

Admission ICH Volume (cc), Median [IQR]	30.1 [23.6]
Stability ICH Volume (cc), Median [IQR]	35.7 (23.8)
Time from Admission to Stability CT (hr), Median [IQR]	13.4 [11.8]
Day 30 RH Volume (cc), Median [IQR] [N=68]	7.7 [9.9]
Day 180 RH Volume (cc), Median [IQR] [N=66]	8.7 [11.7]
Day 30 mRS, Median [IQR]	4 [1]
Day 30 NIHSS, Median [IQR]	13 [12]
Day 180 mRS, Median [IQR]	3 [1]
Day 180 NIHSS, Median [IQR]	6 [8]

SEM-Standard Error of the Mean; GCS-Glasgow Coma Scale; IQR-Interquartile Range

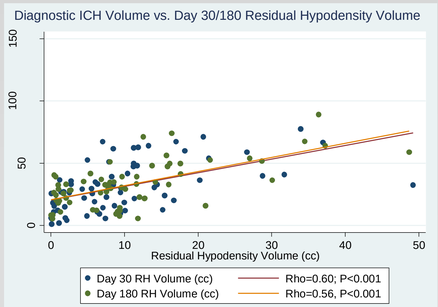

Figure 2. Admission ICH volume vs. 30 and 180 day RH volumes. Admission ICH volume is highly correlated with follow-up RH volume (p<0.001).

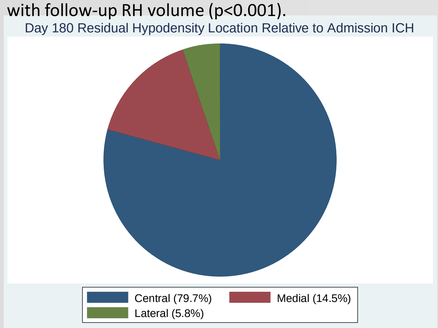

Figure 3. Location of RH relative to the admission ICH. RH location was classified as central, medial or lateral to the admission ICH.

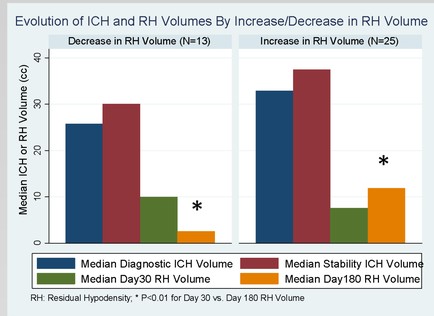

Figure 4. Evolution of ICH and RH volumes. Increases in RH volume between 30 and 180 days is associated with larger diagnostic and stability ICH volumes.

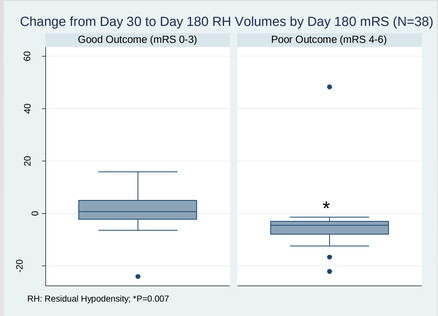

Figure 5. Change in RH volumes between 30 and 180 days. An increase in RH volume was associated with a poor outcome (mRS 4-6).

Hematoma Regression and Functional Outcome

Larger median RH volumes at 30 and 180 days were significantly associated with poor outcome (mRS 4-6) at both time points (p=0.04; p=0.007, respectively) (Table 3). Median RH volume decreased by 0.70 [7.35] cc in patients with good outcome at 180 days (mRS 0-3) and increased by 4.45 [4.87] cc in patients with poor outcome (p=0.007) (Figures 4 and 5).

Table 3. ICH or RH Volume and Outcomes

ICH or RH Volume (cc)	Day 30 Outcome (N=68)		P-value
Median [iqr]	Good (mRS 0-3)	Poor (mRS 4-6)	
Admission	22.90 [20.34]	29.70 [28.89]	0.11
Stability (72 hr)	22.44 [25.23]	33.92 [26.07]	0.01
Day 30	3.01 [9.38]	7.91 [9.06]	0.046
ICH or RH Volume (cc)	**Day 180 Outcome (N=66)**		**P-value**
Median [iqr]	Good (mRS 0-3)	Poor (mRS 4-6)	
Admission	29.11 [23.27]	34.63 [14.7]	0.22
Stability (72 hr)	31.59 [20.16]	41.02 [14.98]	0.03
Day 180	7.36 [8.98]	11.83 [8.48]	0.007

Conclusions

- **Residual hypodense regions at 1 and 6 months post sICH have significantly smaller volumes than admission hematomas and may be associated with long term neurologic outcomes.**
- **An increase in RH volume over time may signal a poor recovery.**
- **Etiology of changes in RH volume after sICH represents a topic of further research.**

Disclosures

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