Hematoma Hounsfield units for predicting expansion of intracerebral hemorrhage: a potential marker of hemostatic clot contraction

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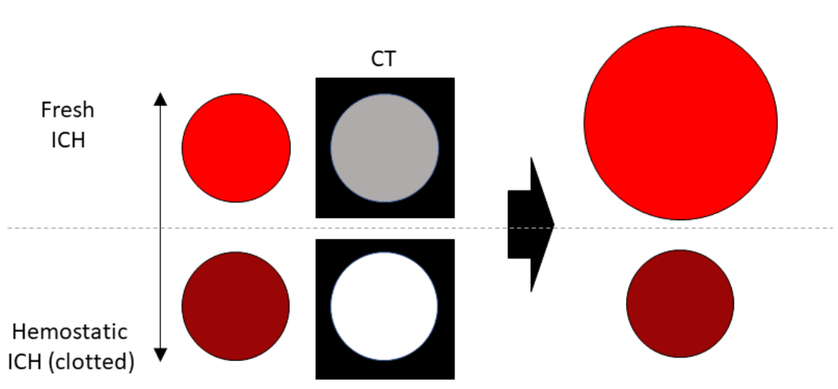
Introduction

Hematoma expansion exacerbates clinical outcomes of patients with intracerebral hemorrhage (ICH). Hematoma density, which is affected by time, hematocrit, clot contraction and thrombosis, may reflect local hemostatic process in the hematoma. Thus, we hypothesized hematoma expansion is more likely to occur in intracerebral hemorrhage with lower hematoma density.



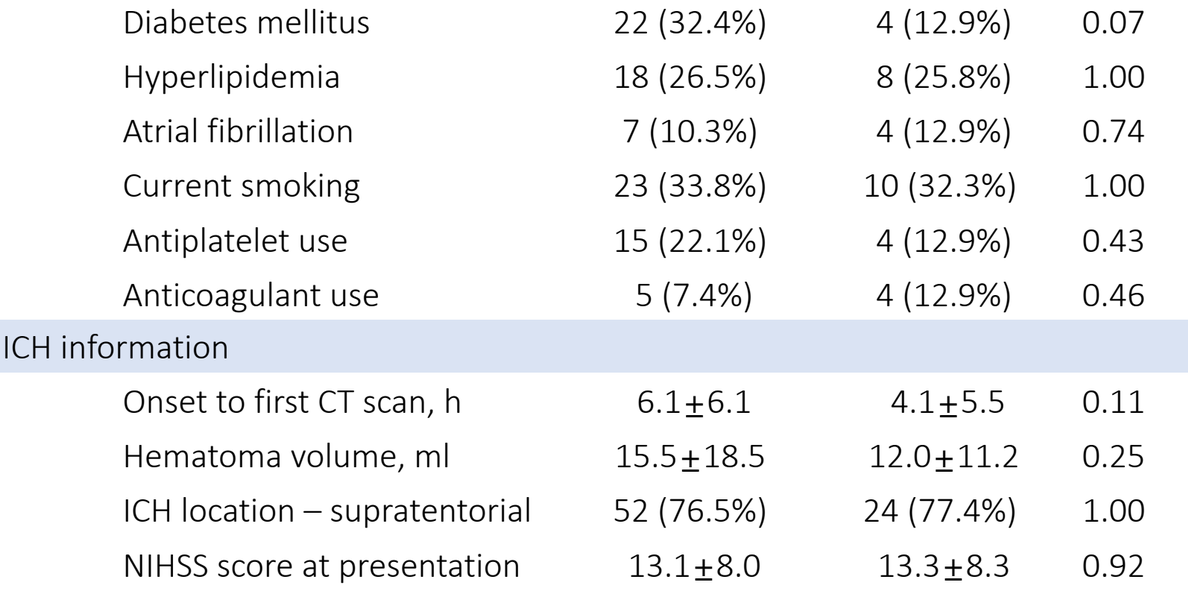
Methods

From a total of 175 spontaneous intracerebral hemorrhage cases of Seoul National University Bundang Hospital between Jan 2015 and Sep 2016, we included 102 patients who had brain CT images within 24 hours after onset. We excluded 3 patients due to no available follow-up images. We segmented hematoma using semiautomated planimetry (Analyze 12.0, Biomedical Imaging Resource, Rochester, NY) with a threshold of 44 to 100 Hounsfield unit (HU) and calculated hematoma density as a mean HU of entire hematoma. Hematoma expansion was defined as increment of hematoma volume over 33% or 6 mL in follow-up images. Multivariable logistic regression was performed for hematoma expansion.

Table 1. Bivariate analysis between baseline characteristics and hematoma expansion

Variables	No HE (n = 68)	HE (n = 31)	*p*-value
Demographics			
Age	62.7±15.1	65.9±13.1	0.28
Male sex	37 (54.4%)	16 (51.6%)	0.97
Vascular risk factors			
Hypertension	59 (86.8%)	26 (83.9%)	0.76
Diabetes mellitus	22 (32.4%)	4 (12.9%)	0.07
Hyperlipidemia	18 (26.5%)	8 (25.8%)	1.00
Atrial fibrillation	7 (10.3%)	4 (12.9%)	0.74
Current smoking	23 (33.8%)	10 (32.3%)	1.00
Antiplatelet use	15 (22.1%)	4 (12.9%)	0.43
Anticoagulant use	5 (7.4%)	4 (12.9%)	0.46
ICH information			
Onset to first CT scan, h	6.1±6.1	4.1±5.5	0.11
Hematoma volume, ml	15.5±18.5	12.0±11.2	0.25
ICH location – supratentorial	52 (76.5%)	24 (77.4%)	1.00
NIHSS score at presentation	13.1±8.0	13.3±8.3	0.92
IVH	25 (36.8%)	7 (22.6%)	0.24
Hematoma density (mean HU)	**58.7±3.0**	**55.8±3.3**	**<0.01**

Figure 2. Receiver Operating Characteristic (ROC) curves for hematoma expansion



Results

Figure 1. Bivariate analysis between hematoma density, hematocrit, time to first CT scan, ICH volume.

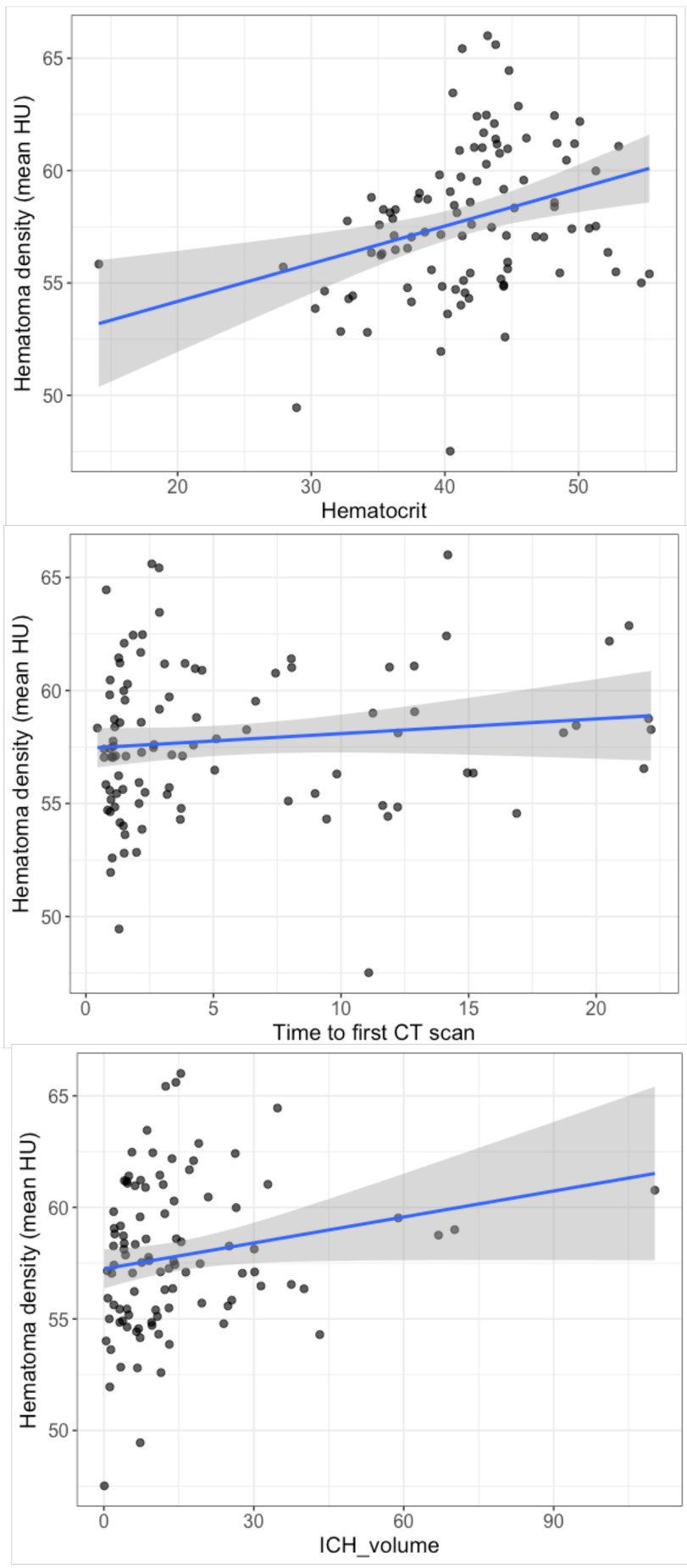


Table 2. Multivariable analysis for hematoma expansion

Covariates	Adjusted odds ratio [95% CI]	*p*-value
Hematoma density, per 1 HU increase	**0.68 [0.54 – 0.87]**	**0.002**
Age, per 1 yr increase	1.00 [0.96 – 1.04]	0.955
Male sex	0.84 [0.22 – 3.20]	0.804
Hematocrit, per 1% increase	1.01 [0.92 – 1.12]	0.818
Platelet count, per 1k increase	0.988 [0.976 – 1.000]	0.050
Serum glucose, per 1mg/dL increase	0.983 [0.967 – 0.998]	0.031
Hematoma volume, per 1ml increase	0.99 [0.96 – 1.03]	0.738
ICH_location - supra vs. infratentorial	2.13 [0.49 – 9.23]	0.314
Onset to first CT scan time, per 1h increase	0.93 [0.83 – 1.04]	0.230

Conclusion

- Intracerebral hemorrhage with lower hematoma density is more prone to experience hematoma expansion.
- Hematoma density (as mean HU) can be a surrogate marker for local hemostatic process in ICH
- These results suggest that therapies facilitating clot contraction or hemostasis might be utilized for patients with lower initial hematoma density.