

Predicting Final Infarct Volume at One Week Post Ischemic Stroke: Recanalization and Baseline Infarct Volume are Important Parameters for Early Infarct Estimation

Mark Krongold^{1,2}, Mohammed Almekhlafi^{1,2}, Andrew Demchuck^{1,3}, Richard Frayne^{1,2}, and Armin Eilaghi^{1,2}

¹Department of Radiology and Clinical Neurosciences, Hotchkiss Brain Institute, University of Calgary, Calgary, Alberta, Canada, ²Seaman Family MR Centre, Foothills Medical Centre, Calgary, Alberta, Canada, ³Calgary Stroke Program, Foothills Medical Centre, Calgary, Alberta, Canada

Target Audience: Establishing infarct volume at one week post stroke would be of interest to researchers interested in stroke treatment and management, as well as to individuals involved in designing clinical trials and acquiring follow up imaging.

Purpose: Stroke infarct volume is an important and dynamic imaging marker.[1] Early and accurate assessment of this marker would allow for improved stroke treatment, maximal recruitment in clinical trials, and efficient stroke management,[2] as it is used to assess tissue fate [3] and make clinical outcome [4] predictions, and to strategize on rehabilitation [5] after stroke. The purpose of this work is to characterize infarct volume evolution over 30-90 days post stroke and to determine the effect of baseline infarct volume and recanalization status on infarct volume evolution.

Methods: Ischemic stroke patients ($n = 964$) recruited for the MONITOR [6] and VISION [7] studies were retrospectively screened and patients who had DWI infarction at baseline, and had at least two follow up FLAIR imaging sessions ($n = 59$) were included. Follow up sessions were performed typically at: 12 h, 24 h, 6-8 day, and ≥ 30 day post stroke. Images were obtained with a 3-T MR (Signa VH/i; GE Healthcare). Single-shot echo-planar imaging was used for DWI images ($b = 0, 1000 \text{ s/mm}^2$; TR = 7000 ms; TE = 96.5 ms; FOV = 320 mm; 5-mm slice thickness; 2-mm gap). The FLAIR imaging parameters were: TR = 9002 ms, TE = 161 ms, TI = 2250 ms, FOV = 320 mm, 5-mm slice thickness. Infarct tissue was traced using MIPAV (<http://mipav.cit.nih.gov/>) software blinded to other time points and confirmed by an experienced stroke neurologist. Infarct expansion index was calculated by normalizing infarct volume at each time point to the baseline DWI infarct volume. Recanalization was assessed at 12 h post stroke. Correlation and statistical comparison analysis were done using the Spearman (ρ), Mann-Whitney, and Kruskal-Wallis rank tests.

Results: Infarct volumes were significantly different at all time points ($p < 0.001$) (Fig 1). Infarct expansion peaked at 6-8 day after stroke and decreased afterward. Follow-up infarct volumes were positively correlated with the baseline infarct volume ($\rho > 0.81$; $p < 0.001$, Fig 2A) where the strongest correlation existing between baseline and 6-8 day post stroke infarct volumes ($\rho = 0.92$; $p < 0.001$). The strongest correlation was found between infarct volumes 6-8 day post stroke and ≥ 30 day points ($\rho = 0.93$; $p < 0.001$). Infarct expansion was higher in larger infarcts (baseline volume $> 10 \text{ mL}$, Fig 2B) than small infarcts (Fig 2C). Infarct expansion was higher in the non-recanalized group than the recanalized group at the 6-8 day ($p = 0.001$) and ≥ 30 day ($p = 0.038$, Fig 2D) time points. Stronger correlation existed between 6-8 day and ≥ 30 day infarct volumes in non-recanalized patients ($\rho = 0.73$; $p = 0.009$) than recanalized patients ($\rho = 0.57$, $p = 0.002$).

Conclusion: Final outcome can be determined as early as 7 days post ictus potentially reducing the need for repeated imaging, decreasing healthcare clinical costs and potentially increasing inclusion rate for clinical trials. Final outcome approximation significantly benefits from consideration of baseline infarct volume and recanalization status of the patient.

References: [1] Tourdias T, et al. *AJNR* 2011; **32**: 352. [2] Gaudinski MR, et al. *Stroke* 2008; **39**: 2765. [3] Eilaghi A, et al. *AJNR* Epub 2013; PMID: 24113471. [4] Wheeler HM, et al. *Stroke* 2013 **44**: 681. [5] Gauthier LV, et al. *Stroke* 2012 **43**: 453. [6] Simon JE, et al. *JCBFM* 2005; **25**: 1236. [7] Coutts SB, *Int J Stroke* 2008; **3**: 3.

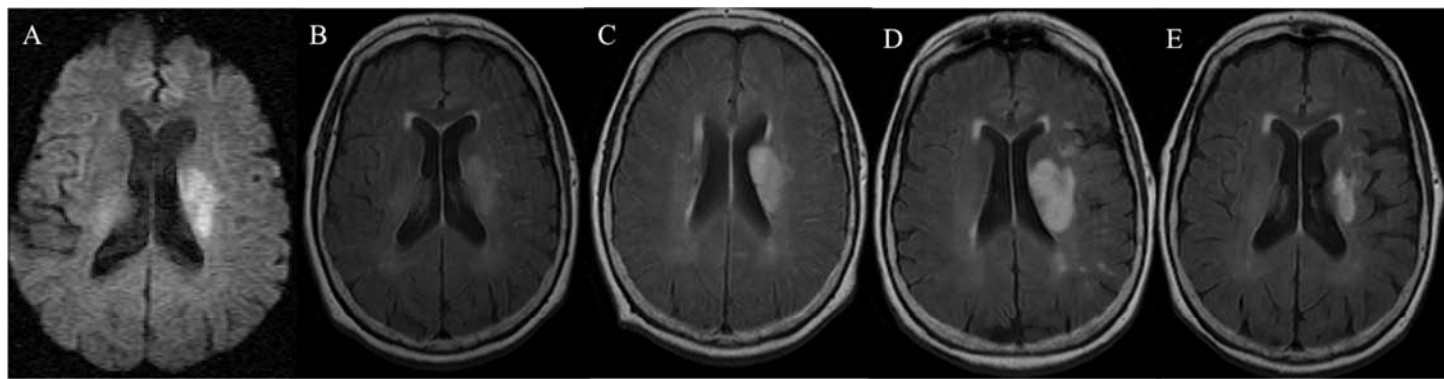


Fig 1. Representative infarct volume changes in an 83-year-old female patient with a left M1 occlusion. DWI of the patient 4 hours after onset (A) and consecutive FLAIR images obtained 13 hours (B), next day (C), 8 days (D) and 45 days (E) post stroke.

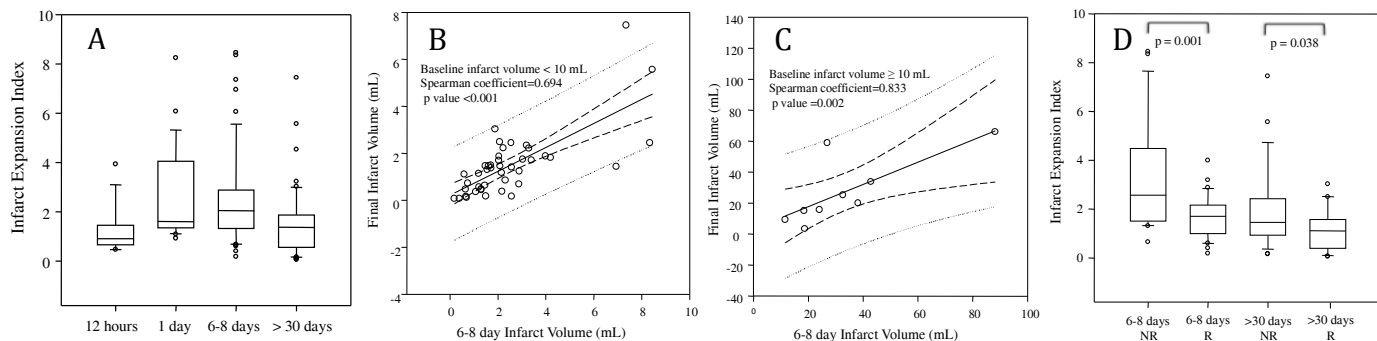


Fig 2. A) Infarct expansion index declines after the sub-acute phase within a week post stroke. Smaller baseline infarcts ($< 10 \text{ mL}$, panel B) showed weaker correlation with the final infarct volume than larger baseline infarcts ($\geq 10 \text{ mL}$, panel C). D) Infarct expansion index is significantly smaller in recanalized (R) than non-recanalized (NR) group for both 6-8 day and final time points.