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## Poster Session 1

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## Prehospital Time Saving: Brain Saver

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### Purpose:

Patients suspected acute stroke are critical in time delay of endovascular or intravenous thrombolytic therapy. Prehospital notification from emergency medical services (EMS) may shorten the door to recanalization time. The 'Brain Saver', web-based prehospital notification system could reduce the time interval from symptom onset to recanalization.

### Methods:

Beginning in March 2016, stroke team consisted of stroke specialized doctors, nurses and radiologists of multi departments received direct alarms via smart phone application from paramedics of EMS about transport information of patients with suspected stroke. We compared baseline characteristics and prehospital/ in-hospital delay time in stroke patients treated with intravenous thrombolysis or endovascular treatment for 12 months with and without EMS use Brain Saver Protocol.

### Results:

167 patients (69 patients with protocol and 98 patients without protocol) were enrolled in this program. The patients who used Brain Saver had shorter median onset-to-arrival times (63 minutes versus 142 minutes,  $P < .001$ ) and in in-hospital delay time (35 minutes versus 52 minutes,  $P < .001$ ). Prehospital notification by Brain Saver was associated with shorter median door-to-imaging time (5 minutes versus 12 minutes,  $P < .001$ ), door-to-needle time (20 minutes versus 31 minutes,  $P < .05$ ), door to puncture time (55 minutes versus 137 minutes,  $P < .001$ )

### Conclusions:

We found that prehospital notification was associated with faster door-to-imaging time, door-to-needle time and door-to-puncture time in patients presenting within 6 hours of symptom onset. Close collaboration between stroke team in hospitals and the EMS system gives stroke suspected patients an in-time emergency care system.

## Single Centre Comparison of Thrombolysis Outcomes Between Stroke Neurologist and Non-neurologist Stroke Physician

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### **Purpose:**

The aim of this study is to compare the outcomes of thrombolysis under standard clinical settings between subjects treated by a stroke neurologist vs those treated by a non neurologist stroke physician.

### **Methods:**

Single center, observational cohort study of subjects thrombolysed in a calendar year, stratified according to the physician type authorizing thrombolysis. Endpoints measured include proportion of subjects with symptomatic intracranial hemorrhage, door to needle time, change in NIHSS and discharge destination.

### **Results:**

Two hundred and ten subjects underwent thrombolysis. There was no difference in terms door to needle time, proportion of individuals with hemorrhagic transformation, mortality or discharge destination between the 2 groups. Glyceryl trinitrate was use for blood pressure control during thrombolysis deployment.

### **Conclusions:**

Due to the single center, observational nature of this study, the equivalent outcomes between those thrombolysed by a stroke neurologist vs those thrombolysed by a non neurologist stroke physician must be interpreted with caution pending further studies. Nevertheless, in the current setting, no signal for harm has been detected. This study is unique as it is the first to our knowledge comparing outcomes between a neurologist and non-neurologist following thrombolysis. Rates of symptomatic intracranial haemorrhage was low in our population and this may be attributable to patient selection for thrombolysis and blood pressure control with glyceryl trinitrate.

## Hospital Disparity in the Recanalization Therapy for the Patients with Acute Ischemic Stroke: Korean Nationwide Study

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### Purpose:

Healthcare disparities are widespread throughout the world and strokes are no exception. Thrombolytic therapy is the standard treatment for acute ischemic stroke, but there may be disparities across hospitals.

### Methods:

This retrospective observational study was performed by analyzing the data of the patients admitted to 258 acute stroke care hospitals covering entire country from the Acute Stroke Quality Assessment Program from 2008 to 2014. Primary outcome was the recanalization therapy rate (RTR) in each hospital. RTR was the proportion of intravenous tPA (IVT) and/or endovascular thrombectomy (EVT) in potentially thrombectomy-eligible population, whose onset-to-arrival time less than 6 hours and initial NIHSS $\geq$ 4 or GCS $\leq$ 14. RTR was adjusted with age, sex, onset-to-arrival time and initial stroke severity. Adjusted RTR was compared according to several hospital characteristics.

### Results:

During the study period, 2,790 potentially thrombectomy-eligible patients were admitted to 174 hospitals in Korea for acute stroke care. Overall RTR was 47.2%, which was composed of IVT alone 39.3%, EVT alone 2.8% and combination 5.2%. Hospital characteristics including the number of beds, average stroke admission per month, averaged IVT or EVT per month, the presence of stroke unit and the number of stroke neurologists were significantly associated with increased RTR with dose-responsive manners. Higher number of beds and average stroke admission per month were associated with higher adjusted RTR. (Spearman correlation coefficient = 0.42 and 0.43,  $p < .0001$ , separately)

### Conclusions:

Adequacy of thrombolytic therapy in acute ischemic stroke patients in Korea was associated with hospital characteristics, such as the number of beds, average stroke admission per month, averaged IVT or EVT per month, the presence of stroke unit and the number of stroke neurologists.

## Short-term Outcome of the Ischemic Stroke Patients with Systemic Malignancy

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### Purpose:

Knowledge on the short-term mortality in acute stroke patients with systemic malignancy may be helpful for the decision of reperfusion therapy. In this study, we determined the factors that are associated with 6-month survival in patients with acute ischemic stroke who had co-existing systemic malignancy.

### Methods:

Consecutive stroke patients with systemic malignancy were retrospectively analyzed. We classified the patients into three groups: non-active cancer group, the active non-metastatic cancer group, and the metastatic cancer group. We compared baseline characteristics and 6-month survival.

### Results:

Of 468 ischemic stroke patients with systemic malignancy during 8-year period, 223 patients had non-active cancer, 105 patients had active non-metastatic cancer, and 140 patients had metastasis. During 6-month of the follow-up, 122 patients (26.1%) were dead (Non-active cancer group [7.2%, 16/223], active non-metastatic cancer group [11.4%, 12/105], metastatic cancer group [67.1%, 94/140]). The metastatic cancer group showed worse outcome than the other two groups ( $P < 0.001$ ). On multivariate analysis, the presence of metastasis (hazard ratio 4.527; 95% confidence interval, 2.175–9.422) was independently associated with 6-month poor outcome. However, active non-metastatic cancer group showed similar short-term outcome with the nonactive cancer group (hazard ratio 0.711; 95% confidence interval 0.828–1.795).

### Conclusions:

Metastatic cancer was associated with poor short-term outcome. Our data suggested more active reperfusion therapy who do not have metastatic lesion.



## Prognosis of Isolated ACA Territory Infarction without Reperfusion Therapy

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### Purpose:

Mechanical thrombectomy is effective treatment for middle cerebral artery occlusion. Considering low probability for occlusion of isolated anterior cerebral artery because of its anatomical location, the effect of mechanical thrombectomy for isolated anterior cerebral artery occlusion has not been revealed. We investigated the prognosis of isolated ACA territory infarction without reperfusion therapy for helping to make a decision whether or not to treat patients who has the isolated ACA occlusion if the patients arrived at hospital in therapeutic time window.

### Methods:

From 2012 to 2017, total 57 patients who had isolated ACA occlusion was admitted in our hospital. We obtained information about modified Rankin score (mRS), any remained symptom related to frontal lobe function after infarction, and influence to their lives, and 1 year through review of medical records in outpatient department or face to face interview in outpatient clinic by neurologist or clinical research associates. When the patients missed the visit, we obtained the information from the patient or their families through telephone interview. Occlusion site was also studied and divided as two categories: proximal (A1-A2), distal (distal part from A3).

### Results:

Mean age of enrolled patients was  $64.83 \pm 13.76$ . Initial NIHSS score was 2 [1-5]. mRS at 3 months showed that 0 was 19 (34.5%), 1 was 19 (34.5%), 2 was 5 (7.3%), 3 was 5 (7.3%), 4 was 3 (5.5%) and 5 was 4 (7.3%). mRS at 1 year showed that 0 was 25 (45.5%), 1 was 13 (23.6%) and 2 (3.6%) was 3, 3 was 7 (12.7%), 4 was 3 (5.5%) and 5 was 4 (7.3%). The patients who had mRS 0-2 was 43 (78.2%) at 3 months, and 41 (74.5%) at 1 year. In mRS 0-2 at 1 year, 11 patients (26.8%) had frontal lobe related dysfunction without motor weakness. 6 (54.5%) had behavior change, 3 (27.2%) had mood disorder, and 2 (18.2%) had cognitive decline. 4 had previous job with not returning to their job and 3 had lived in chronic care facilities. 9 of 11 patients (81.8%) had proximal occlusion of ACA.

### Conclusions:

Most of patients who had isolated ACA territory infarction had favorable outcomes without reperfusion therapy. However, this finding suggests that reperfusion of isolated ACA occlusion in therapeutic time window may be considered if the occlusion site is proximal lesion. Future study about reperfusion therapy for isolated ACA occlusion may be needed.

## Relationship Between Collateral Status and Clinical Outcome of Endovascular Therapy in Acute Ischemic Stroke

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### Purpose:

The collateral circulation is an important determinant of clinical outcome in the reperfusion therapy of anterior circulation major artery occlusion, in which embolic occlusion (Embolic-O) is a major etiology. Also, Intracranial atherosclerosis-related occlusion (ICAS-O) is frequently encountered at the time of endovascular therapy, especially in Asian countries. However, the influence of baseline collateral flow remains uncertain about clinical outcome following reperfusion therapies in ICAS-O. We aim to investigate relationship between collateral status and outcome of endovascular therapy for acute ICAS-O and Embolic-O, respectively.

### Methods:

We enrolled 405 patients (January 2011 to May 2016) from three comprehensive stroke centers in Korea who received endovascular therapy for acute ischemic stroke (AIS) caused by anterior circulation large arterial occlusions. Underlying ICAS-O was identified in 73 patients and Embolic-O was identified in 332 patients. CTA collateral pattern were evaluated and categorized into two groups by ASITN (American Society of Interventional and Therapeutic Neuroradiology) score: absent/poor collaterals (CTA collateral score 0-1) versus moderate/good collateral score (CTA collateral score 2-4). Anterior circulation ischemic stroke was defined as an intracranial carotid artery, middle cerebral artery could be confirmed by angiography. The etiology of target large vessel occlusion (Embolic-O or ICAS-O) was determined by core laboratory imaging analyses based on angiographic diagnosis. Outcome was determined by the modified Rankin Scale (mRS) at 3 months and was grouped as either good (mRS 0-2) or poor (mRS 3-6).

### Results:

No significant difference in outcome was found between the ICAS-O group and Embolic-O group. Age was significantly lower in ICAS-O group and onset to puncture time was significantly longer in ICAS-O group. In multivariate analysis, young age and low NIHSS score were associated with good outcome in ICAS-O group. Young age, low NIHSS score and good collateral were associated with good outcome in Embolic-O group.

### Conclusions:

Collateral status was associated with a good outcome in Embolic-O group of acute ischemic stroke. However, the association has not been confirmed in ICAS-O group.

## Premorbid Malnutrition As Assessed by Nutritional Risk Index Predicts Poor Short-term Functional Outcome in Patients with Acute Ischemic Stroke

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### Purpose:

Malnutrition is defined as long-standing negative imbalance in intake and requirement of both energy and protein. It is associated with an increased prevalence of complications, impaired immunologic function, aggravated neurological outcome, increased risk of hospital admission, and a high mortality rate among acute stroke patients. The Nutritional Risk Index (NRI), which was developed by the Veterans Affairs Total Parenteral Nutrition Cooperative Study Group, was known as objective measurement of nutrition in hospitalized patient populations. Previous studies about the impact of premorbid undernutrition on stroke outcome have used the SGA tool or a flexible informal assessment due to practical difficulties in adopting a standard methodology. Therefore, we investigated the prognostic role of premorbid undernutrition using objective assessment method, NRI, at admission of patients with ischemic stroke for short-term outcomes of acute ischemic stroke.

### Methods:

A consecutive 1,973 patients who were admitted within 7 days after ischemic stroke onset between March 2010 and September 2016 were included for analysis. The patients were categorized into four groups on the basis of NRI [No risk (NRI >100), Mild risk (NRI 97.5-100), Moderate risk (NRI 83.5-97.5), and Severe risk (NRI <83.5)]. We evaluated the short-term outcomes using a modified Rankin Scale (mRS) at three-months after stroke onset. We divided patients into two groups with favorable outcome (mRS score ≤1) and unfavorable outcome (mRS score ≥2). We compared the clinical characteristics and NRI between two groups.

### Results:

Among the included patients, 720 (45.4%) patients had unfavorable outcome. The unfavorable outcome group was older and more likely to have atrial fibrillation, lower body mass index, and higher initial NIHSS. The lower NRI patients (Moderate risk and Severe risk) were more frequent in unfavorable outcome group (73.3% vs 26.7%, and 62.2% vs 37.8%,  $P < 0.001$ ). After adjustment for covariates, lower NRI groups were independently associated with a higher risk of unfavorable outcome [Odds ratio (95% confidence interval); 1.666(1.347-2.062),  $P$  for trend  $< 0.001$ ].

### Conclusions:

This study demonstrated that the lower NRIs predicted unfavorable outcome at 3 months following ischemic stroke. This suggests that premorbid undernutrition could be a modifiable risk factor for prognosis following stroke.



## Red Cell Distribution Width Predicts Infection in Patients with Acute Ischemic Stroke

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### Purpose:

The red cell distribution width (RDW) is a rapid, inexpensive laboratory test. Elevated RDW values are associated with poor outcomes in adult critical illness, especially in cardiovascular disease and infection. We examined the association between RDW and stroke-associated infection

### Methods:

A consecutive 1,973 patients who were admitted within 7 days after ischemic stroke onset between March 2010 and September 2016 were included for analysis. The patients were categorized into two groups on the basis of initial RDW values ( $\geq 15.0\%$ ). We evaluated the stroke-associated infection within 7 days after admission in patients with acute ischemic stroke. We compared the clinical characteristics and initial RDW values between stroke-associated infection and control groups.

### Results:

The patients were divided into two groups according to infection identified as infection group (n=200, 10.1%) with mean age  $68 \pm 12.4$  years; 61.1% males and control group (n=1773, 89.9%) with mean age  $68 \pm 12.2$  years; 61.3% males. As expected, the patients with infection were older and more likely to have atrial fibrillation, history of diabetes mellitus, and higher RDW values ( $13.90 \pm 1.76$  vs  $13.32 \pm 1.57$ ,  $p < 0.001$ ). The RDW values were higher in the infection group as compared to control group with odds ratio 1.11; confidence interval 1.016 to 1.215;  $p = 0.021$ , even after adjustment for traditional cardiovascular risk factors.

### Conclusions:

This study demonstrated that initial higher RDW values predicted infection following acute ischemic stroke. This study has shown that RDW values provides additive prognostic data for ischemic stroke patients.

## Late Neurological Deterioration in Hospitalized Patients with Acute Ischemic Stroke or TIA

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### Purpose:

To investigate incidence, prognostic implications, and contributing factors of late neurological deterioration (ND) after early stabilization of neurologic symptoms in patients hospitalized for acute stroke,

### Methods:

From a multicenter, prospective stroke registry database (CRCS-K), patients admitted within 24 hours after acute ischemic stroke or TIA between May, 2008 and September 2015 were identified. ND was diagnosed in hospitalized patients by an increase of NIHSS score  $\geq 2$  (total) or  $\geq 1$  (motor or consciousness) from the baseline score or any new neurological symptoms within the 21 days after stroke onset, and defined as late ND when it occurred after 72 hour of stroke onset. Multiple logistic regression analysis was used to look for contributing factor for Late ND.

### Results:

Of the 18,866 patients included, 3,129 (16.6%) experienced ND, and 581 (18.6%) of which were late ND. As for the causes of late ND, stroke progression was the most common (55.2%), followed by recurrence (20.1%), systemic causes (8.6%), and hemorrhagic transformation (7.7%). All outcome measures including functional disability or mortality at 3 months and 1 year after stroke, and length of hospital stay were worse in patients with late ND than in those with ND that occurred within 72 hours or in those without. Older age (odds ratio [OR], 1.02; 95% confidence interval [CI], 1.01-1.03), diabetes mellitus (OR, 1.47; 95% CI, 1.21-1.79), atrial fibrillation (OR, 1.25; 95% CI, 1.01-1.53), higher NIHSS score at baseline (OR, 1.04; 95% CI, 1.03-1.05), no thrombolytic therapy (OR, 0.69; 95% CI, 0.54-0.88), higher serum glucose (OR, 1.002; 95% CI, 1.001-1.003), and steno-occlusion of relevant artery (OR, 1.88; 95% CI, 1.54-2.29) were independent predictors for late ND.

### Conclusions:

Although uncommon, late ND in patients receiving in-hospital acute stroke care was associated with poor prognosis. The predictors found in this study may be used to identify patients with high risk for LND.

## Blood Pressure Variability and Hemorrhagic Transformation After Intravenous Thrombolysis in Acute Ischemic Stroke

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### Purpose:

The effectiveness of intravenous tissue plasminogen activator (t-PA) is well established in hyperacute ischemic stroke. Despite its efficacy, spontaneous intracranial hemorrhage after t-PA is a severe complication associated with poor prognosis. We evaluated the role of blood pressure (BP) and BP variability, measured before and after injection of t-PA within 24 hours.

### Methods:

Herein, 116 patients were enrolled in this study. BP (systolic blood pressure, diastolic blood pressure, and pulse pressure) were recorded before t-PA and every hour after t-PA for 24 hours. The BP profiles were characterized by initial, mean, maximum (max), minimum (min), max-min, and standard deviation (sd). The intracranial hemorrhage was assessed via computed tomography, 24-36 hours after injection of t-PA. The hemorrhagic transformation was classified using clinical and radiological criteria as follows: hemorrhagic transformation (HT), parenchymal hemorrhage (PH), and symptomatic hemorrhage (SH).

### Results:

The intracranial hemorrhage occurred as follows: HT 25.52% (n=25), PH 10.81% (n=12), SH 3.60% (n=4). The PPsd during the 24-hour period post-injection (24h PPsd) was significantly higher in patients with HT (14.57±0.76 vs. 11.84±0.39, 95% confidence interval [CI] 1.07-4.40, p<0.001) and PH (16.74±4.17 vs. 11.93±3.48, 95% CI 2.65-6.97, p<0.001). The odds ratio per 5 mmHg of 24h-PPsd was 2.41 (95% CI 1.23-4.72) in HT and 4.76 (95% CI 1.60-12.17) in PH.

### Conclusions:

The variability in pulse pressure during the first 24 hours may be associated with hemorrhagic transformation after thrombolytic therapy with t-PA in hyperacute infarction.

## Subclinical Hyperthyroidism Could Predict Poor Outcome in Acute Ischemic Stroke Treated with Reperfusion Therapy

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### Purpose:

The evidence of effect for subclinical thyroid dysfunction on prognosis of acute ischemic stroke patients receiving reperfusion therapy is still lacking. We aimed to investigate association between STD and outcomes in acute ischemic stroke treated with reperfusion therapy.

### Methods:

A total 156 consecutively recruited acute ischemic stroke patients receiving reperfusion therapy (intravenous thrombolysis, intraarterial thrombectomy and combined intravenous thrombolysis and intraarterial thrombectomy) were included in this prospective observational study. We divided subclinical thyroid dysfunction into 3 groups: subclinical hyperthyroidism ( $0.1 < \text{thyroid-stimulating hormone} \leq 0.44 \mu\text{U/mL}$ ), subclinical hypothyroidism ( $2.5 \leq \text{thyroid-stimulating hormone} < 20 \mu\text{U/mL}$ ), and euthyroid state ( $0.44 < \text{thyroid-stimulating hormone} < 2.5 \mu\text{U/mL}$ ). Patients with overt thyroid dysfunction were excluded. Primary outcome was functional disability at 3month (modified Rankin Scale) and secondary outcome was successful reperfusion (Thrombolysis in Cerebral infarction). Multivariable analysis was performed to evaluate the association subclinical thyroid dysfunction and primary and secondary outcomes.

### Results:

Patients with subclinical hyperthyroidism had increased risk of unfavorable and poor functional outcome at 3month after stroke compared with euthyroid state (odds ratio 4.84, 95% confidence interval 1.44-16.29 for mRS 2 to 6; OR 2.38, 95% CI 1.02-5.57 for mRS 3 to 6). Also, patients with subclinical hyperthyroidism had decreased risk of successful reperfusion after reperfusion therapy (OR 0.17, 95% CI 0.06-0.51).

### Conclusions:

Subclinical hyperthyroidism was independently associated with poor prognosis at 3month and unsuccessful reperfusion in acute ischemic stroke patients receiving reperfusion therapy.

## Endovascular Thrombectomy beyond 6 Hours from Stroke Onset: An Analysis Based on DAWN Eligibility Criteria

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### Purpose:

Recent clinical trials of endovascular treatment in acute ischemic stroke showed promising role of endovascular reperfusion up to 24 hours from stroke onset. The aim of this study was to show the clinical and angiographic outcome in patients treated beyond 6 hours from stroke onset based on the DAWN eligibility criteria.

### Methods:

Between January 2011 and April 2018, we selected patients who met the following criteria from our prospectively maintained endovascular registry: (1) acute ischemic stroke attributable to anterior proximal vessel occlusion; (2) groin puncture time more than 6 hours from stroke onset; and (3) evaluable DWI for automated lesion volume analysis. For comparison, DAWN eligibility criteria were used, which include imaging and clinical parameters for inclusion.

### Results:

A total of 201 patients were included for analysis. Among them, 109 patients were assigned to DAWN eligible group, and 92 patients were assigned to DAWN ineligible group. The reasons for DAWN ineligibility include lesion volume threshold exclusion (n=39; 42.4%), low baseline NIHSS score (n=27; 29.3%), high pre-morbid mRS score (n=23; 25.0%), and time for treatment more than 24 hours for endovascular thrombectomy (n=3; 3.3%). At baseline, median NIHSS score was statistically different between DAWN eligible and ineligible groups [17 (IQR 13-21) vs. 14 (IQR 8-18); p<0.001]. Successful angiographic reperfusion was achieved in 97 patients (89.0%) and 77 patients (83.7%) in each group (p=0.273). Favorable clinical outcome at 3-month was achieved in 60 patients (55.0%) and 47 patients (51.1%) in each group (p=0.575). Among the DAWN ineligibility criteria, low NIHSS score at baseline was the only predictor for favorable clinical outcome in comparison with DAWN eligible group (OR 3.59, 95% CI 1.27-10.18; p=0.016).

### Conclusions:

Endovascular thrombectomy beyond 6 hours based on DAWN eligibility seems feasible. Also, patients with low NIHSS score at baseline can be benefitable from endovascular thrombectomy if other DAWN eligibility criteria were met.

## Ten-year Single Center Experience of Intra-hospital Triage for Endovascular Treatment: The Hardest Hurdle During Late off-duty Hours

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### Purpose:

Intra-hospital time delays can affect the outcome of endovascular treatment (EVT). To overcome these hurdles, multidisciplinary quality improvement program could be helpful in that it can shorten intra-hospital time-related factors with subsequent better clinical outcome. We aimed to describe our ten-year experience of endovascular triage via the multidisciplinary quality improvement program with emphasis on time-related factors.

### Methods:

Based on our prospectively maintained EVT registry (n=602), three consecutive periods were defined based on the implementation of quality improvement (QI) program and the changes in the primary modality of first angiographic imaging: (1) period 1 (May 2006 to December 2009; n=138); period 2 (January 2010 to August 2012; n=159); and (3) period 3 (September 2012 to April 2016; n=305). Also, on-duty was defined as regular working hour from AM 8:00 to PM 06:00, and off-duty was defined as night shift from PM 06:00 to AM 08:00 the following day. Further, off-duty was classified into two groups by early off-duty as PM 6:00 to midnight and late off-duty as midnight to AM 08:00 the nest day. Also, normal working hours in holidays were considered same as early off-duty.

### Results:

Overall, successful reperfusion (mTICI 2b-3, post-procedure) and favorable outcome (mRS 0-2 or equal to prestroke mRS at 3-month) was achieved in 452 patients (75.1%) and 311 patients (51.7%), respectively, A trend for increase in successful reperfusion and favorable outcome over periods was observed (46.4% in period 1 vs. 85.6% in period 3,  $p<0.001$ ; 37.0% in period 1 vs. 57.7% in period 3,  $p<0.001$ ). Also, significant trends for shorter door-to-picture and door-to-puncture times over periods were observed ( $p<0.001$ , respectively). Inside each period, late off-duty hours were the hardest time period for improvement. In period 3, the door-to-puncture time was  $101.6\pm 4.2$  minutes in late off-duty hours compared to  $81.7\pm 3.4$  minutes ( $p<0.001$ ) in on-duty hours.

### Conclusions:

Upward trend in successful reperfusion and better outcome were observed along with improvement in intra-hospital workflow to decrease door-to-puncture time, which emphasizes the importance of incessant QI program of EVT workflow. However, late off-duty hours were the hardest time point for improvement despite the QI program.



## Circadian Variation of Efficacy Ofivrtpa

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### Purpose:

A few studies reported that time of stroke, especially ischemic stroke, was influenced by circadian rhythm as well as acute myocardial infarction or pulmonary thromboembolism. Among several physiologic factors to influence the occurrence of ischemic stroke, the serum concentration of plasminogen activator inhibitor-1 (PAI-1) was shown to have clear circadian variation, which could influence platelet aggregation, blood viscosity, and endogenous/exogenous fibrinolytic activity. The aim of our study is to investigate whether the effect of intravenous recombinant tissue plasminogen activator (rtPA) could be influenced by circadian time in patients with acute ischemic stroke and the stroke subtypes according to etiologic mechanism.

### Methods:

3,773 patients treated with IV rtPA was identified from the Clinical Research Center for Stroke (CRCS) 5th division registry database—a prospective, multicenter, nationwide web-based, acute stroke registry database, and 1,923 patients were finally enrolled for the analysis. The patients were stratified according to stroke onset time by every 4 hours (23-3h, 3-7h, 7-11h, 11-15h, 15-19h, and 19-23h). National Institute of Health stroke scales at emergency room (iNIHSS), NIHSS at 24 hours after IV rtPA administration (day#1NIHSS), NIHSS at discharge (disNIHSS), and a change of follow-up NIHSS from iNIHSS (cNIHSS, day#1NIHSS – iNIHSS) were analyzed. Three stroke subgroups according to TOAST classification (large artery atherosclerosis, LAA; small vessel occlusion, SVO; cardio-embolism, CE) were separately reviewed. 3mon modified Rankin Scale (mRS) was used to compare a long term outcome between groups.

### Results:

The whole group analysis showed that the 23-3h group had the highest cNIHSS1 and followed by 3-7h group although statistically insignificant. LAA, CE group showed the same pattern as the whole groups, and cNIHSS1 of the 3-7h group was higher than that of 23-3h in patients with SVO group. No statistical significance was found. The prevalence of patients with favorable outcome defined by 3month mRS 0 or 1 was not different according to LNT. However, in LAA group, 23-3h group showed a tendency of higher prevalence than other groups.

### Conclusions:

This analysis did not show a definite circadian difference of the efficacy of IV rtPA, measured by the changes of NIHSS and 3mon mRS in acute ischemic stroke patients. A further study with different measures for the efficacy is needed to investigate circadian variation of efficacy of IV rtPA.

## Successful Carotid Stenting Before Aortic Dissection Surgery for a Patient with Stroke Resulting from Aortic Dissection

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### Purpose:

Stanford type A aortic dissection (AAD) is severe emergency that is based on surgical treatment. It is associated with acute ischemic stroke (AIS) in 5-10% of AAD patients. In this case, there is no guideline for emergent surgery or delayed surgery. We experienced a case of three AIS patients with occlusion of the right common carotid artery (CCA) with AAD. One patient underwent emergent AAD surgery after stent insertion of right CCA. Two patients underwent immediate surgery without emergent stent insertion of right CCA.

### Methods:

We report the difference in prognosis at these three patients.

### Results:

We performed brain perfusion computed tomography angiography (CTA) in three patients who visited emergency room with left hemiparesis. All three patients had right CCA occlusion, AAD with aortic arch and perfusion mismatch. The first patient underwent immediate AAD surgery without treatment for AIS. In the second patient, emergent stent insertion was considered for right CCA occlusion, but emergent surgery was performed for AAD due to low blood pressure and cardiac tamponade. The third patient underwent an AAD surgery after emergent stent insertion in right CCA. Patient who underwent right CCA stent insertion showed local cerebral infarction after surgery and two patients who did not undergo stent insertion showed extensive cerebral infarction after surgery.

### Conclusions:

Patient who underwent stent insertion for right CCA before AAD surgery had better prognosis than patients who underwent surgery without stent insertion. In patients with suspected AIS, performed perfusion CTA with aortic arch is helpful in making early decision about AIS treatment by identifying the penumbra and early diagnosis of asymptomatic AAD.

## Cost-effectiveness Analysis of Acute Ischemic Stroke Treatment According to the Charlson Comorbidity Index

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### Purpose:

Comorbidities are prevalent among stroke patients. The current study assesses the variations in cost and stroke prognosis by concurrent comorbidities in patients with acute ischemic stroke.

### Methods:

The Charlson comorbidity index was used to measure the composite comorbidity level as 0 (none), 1 (mild), 2 (moderate), and  $\geq 3$  (severe). Good outcome was defined as modified Rankin Scale  $\leq 2$  at 3 months. Mortality and stroke recurrence within 1 year were also analyzed. The incremental cost-effectiveness ratio (ICER) was calculated in a cost-effectiveness analysis for a given comorbidity group in comparison with the no-comorbidity group.

### Results:

Patients with severe comorbidities were less likely to have good outcome [hazard ratio (HR) = 0.32, 95% confidence interval (CI): 0.22–0.45] and were more likely to die due to a stroke (HR = 4.86, 95% CI: 3.17–7.44) at 3 months in comparison with those without comorbidities. Patients with a severe comorbidity showed higher death rate due to a stroke (HR = 10.36, 95% CI: 5.09–21.07) and stroke recurrence (HR = 3.38, 95% CI: 1.47–7.77) in comparison with patients without comorbidities. The costs for the severe comorbidity group increased by 4,376 USD in 3 months and 7,074 USD in 1 year due to stroke occurrence, whereas for the mild comorbidity group the marginal increases were 985 and 1,265 USD in comparison with the no-comorbidity group. ICER was largest for the severe comorbidity group with a short-term good prognosis, whereas ICER was smallest in the same group due to the relatively small increase in cost and the large increase in a poor stroke prognosis compared to the no-comorbidity group.

### Conclusions:

Patients with severe comorbidities showed poor prognosis and large total health expenditure. Comorbidities should be considered in prioritizing treatment for acute ischemic stroke patients.

## Serum Insulin-like Growth Factor 1 is Not Associated with Initial Stroke Severity and Functional Outcome in Acute Ischemic Stroke

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### Purpose:

Insulin-like growth factor 1 (IGF-1) is known to have a potent neuroprotective effect. Some previous studies have shown that higher levels of IGF-1 in acute phase of ischemic stroke are associated with better outcome. This study aimed to evaluate the relationship between IGF-1 and initial stroke severity and 3-month functional outcome of acute ischemic stroke (AIS).

### Methods:

Serum IGF-1 levels were collected from 405 patients (age 68.2±12.7 years, female 42%) with AIS who were admitted to Hallym University Sacred Heart Hospital between February 2014 and June 2017. The serum IGF-1 levels were measured with a standardized method within 24 hours of admission. Initial stroke severity was divided into 3 grades according to the National Institute of Health Stroke Scale (NIHSS) score: mild (NIHSS 0-8), moderate (NIHSS 9-15), and severe stroke (NIHSS 16-42). Functional outcome was assessed with the modified Rankin Scale (mRS) at 3 months after AIS onset and were divided into 2 groups of good (mRS 0-2) and poor outcomes (mRS 3-6). We performed proportional ordinal regression and multivariable logistic regression analysis to assess the impact of serum IGF-1 on initial stroke severity and 3-month mRS.

### Results:

Of 405 patients included in this study, 271(66.3%) patients have mild stroke and 237(57.9%) patients have good outcome. In univariate analysis between serum IGF-1 and initial stroke severity, higher IGF-1 levels were not associated with less severe stroke at the time of presentation. Univariate analysis between serum IGF-1 levels and 3-month mRS, higher serum IGF-1 were associated with better functional outcome at 3 months, with the lowest tertile of IGF-1 levels having 1.98-fold higher risk of worse outcome (95% CI, 1.22-3.21, p=0.006) compared to those in highest tertile. However, multivariable analyses did not show significant association of high serum IGF-1 with either milder stroke at presentation (p=0.533) or better outcome at 3-month after AIS onset (p=0.685).

### Conclusions:

In our study, the results showed that high serum IGF-1 did not correlate with either initial stroke severity or functional outcome at 3 months after AIS. Further studies are needed to clarify the neuroprotective effect of IGF-1.

## Immunomodulatory and Anti-inflammatory Effects of Poly (ADP-Ribose) Polymerase-1 Inhibitor After Ischemic Stroke Patients and Animal Models

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### Purpose:

Immunomodulatory function with increasing regulatory T cells (Tregs) have been suggested to improve outcome after ischemic stroke. The aim of this study is to demonstrate up-regulation of regulatory T cells and anti-inflammatory mRNAs after treatment of poly (ADP-ribose) polymerase-1 (PARP-1) inhibitor in ischemic stroke patients and animal models.

### Methods:

Peripheral blood samples were collected from 12 ischemic stroke patients (within 72 hours of stroke onset) and 5 control subjects. Fluorescence-activate cell sorting (FACS) analyses and quantitative reverse transcription polymerase chain reaction (qRT-PCR) were performed with peripheral blood mononuclear cells (PBMCs) before and after PARP-1 inhibitor (3-AB, JPI-289 1  $\mu$ m, JPI-289 10  $\mu$ m) treatment for 24 hours. In addition, we also performed qRT-PCR in penumbra of ischemic stroke model after with or without bolus injection of PARP-1 inhibitor (1 hour) with recanalization.

### Results:

Treg proportion was significantly higher in healthy control ( $3.5 \pm 1.8$  %) than ischemic stroke patients ( $1.6 \pm 0.6$  %) ( $p < 0.001$ ). After PARP-1 inhibitor treatment, the proportion of Treg was increased ( $2.1 \pm 0.7$  %). RT-PCR showed increased expression of Treg associated transcription factors such as FoxP3 and CTLA-4 mRNA after PARP-1 inhibitor treatment. PARP-1 inhibitor treatment also decreased pro-inflammatory cytokines such as IFN- $\gamma$ , TNF- $\alpha$ , and IL-17 and increased anti-inflammatory cytokines such as IL-4, IL-10, and TGF- $\beta$ 1. Those up-regulation of Treg associated transcription factors were also shown in penumbra of ischemic stroke animal model after PARP-1 inhibitor treatment. In addition, M2-type microglia associated molecules such as TGF- $\beta$ 1, Arginase 1, CD 206 and CX3CR1 were increased after PARP-1 inhibitor treatment.

### Conclusions:

Treg proportion was decreased in patient with acute ischemic stroke and it was up-regulated after treatment of PARP-1 inhibitors. PARP-1 inhibitor showed possible anti-inflammatory effect by regulating cytokines and microglia. PARP-1 inhibitor may ameliorate outcome of ischemic stroke by immune modulation.

## Effects of a Combination of Acetazolamide and Head-down Tilt in a Rat Stroke Model

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### Purpose:

In the large hemispheric infarction, collateral is important for brain tissue survivals. Collateral augmentation treatments including acetazolamide (ACZ) and head down tilt (HDT) can enhance cerebral collateral perfusion in acute ischemic stroke. Recent trials comparing head position strategy was failed to show the effectiveness in ischemic stroke patients. However, animal study showed that HDT was most effective collateral therapeutics. To better outcome, combination of multimodal treatment may bring synergistic effects. We investigated whether collateral augmentation treatments with ACZ, HDT, or combination are effective in rats with the transient middle cerebral artery occlusion (MCAO) models.

### Methods:

All animals were induced transient MCA occlusion for 1h 30min and reperfusion for 24h. Acetazolamide 100 mg/kg solution in 0.9% saline was administered in a single intravenous bolus of 0.5 ml over 3 min, 30 min after onset of MCAO. HDT was administered using a 15° tilted platform for 60 min, 30 min after onset of MCAO. To measure infarct volume and neurological score, 36 male Wistar rats (8 to 12 weeks, weight  $296.3 \pm 8.8$  g) were divided into four groups : control (n=9), ACZ treated group (n=9), HDT group (n=9) and combination group (n=9). To measure brain water content and neurological score (Ongoing study), 17 male Wistar rats were divided into four groups : control (n=7), ACZ group (n=6), HDT group (n=2) and combination group (n=2).

### Results:

The collateral augmentation groups had smaller infarct volume (control,  $30.39 \pm 8.18$  vs. collateral augmentation groups  $16.89 \pm 11.45$ ,  $p=0.005$ ). Neurological scores were better in collateral augmentation groups than control group (control,  $9.77 \pm 2.20$  vs. collateral augmentation groups,  $12.27 \pm 3.10$ ,  $p=0.011$ ). Among groups, the ACZ group was significantly associated with small infarct volume (ACZ group,  $11.79 \pm 5.40$  vs. control group,  $30.39 \pm 8.18$ ,  $p<0.001$ ) and the combination group was significantly associated with better neurological scores (combination group,  $13.30 \pm 2.71$  vs. control group,  $9.77 \pm 2.20$ ,  $p=0.043$ ). Longa score and brain water content were similar between groups.

### Conclusions:

We found that collateral augmentation was associated with smaller infarction volume and better neurological outcome compared to untreated animal after transient MCA occlusion. Among the treatment methods, ACZ showed the smallest infarction volume and combination group showed the best neurological recovery.



## Increased Thrombogenicity in Chronic Renal Failure in a Rat Model Induced by 5/6 Ablation/Infarction

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### Purpose:

Abnormalities in hemostasis and coagulation have been suggested in chronic renal failure (CRF). In this study, we compared processes of thrombus formation between rats with CRF and those with normal kidney function.

### Methods:

CRF was induced by 5/6 ablation/infarction of the kidneys in Sprague-Dawley rats, and surviving rats after 4 weeks were used. Ferric chloride (FeCl<sub>3</sub>)-induced thrombosis in the carotid artery was induced to assess thrombus formation. Whole blood clot formation was evaluated using rotational thromboelastometry (ROTEM). Platelet aggregation was assessed with impedance platelet aggregometry.

### Results:

FeCl<sub>3</sub>-induced thrombus formation was initiated faster in the CRF group than in the control group (13.2±1.1 sec vs. 17.8±1.0 sec, p=0.027). On histological examination, the maximal diameters of thrombi were larger in the CRF group than in the control group (394.2±201.1 μm vs. 114.0±145.1 μm, p=0.039). In extrinsic pathway ROTEM, the CRF group showed faster clot initiation (clotting time, 59.0±7.3 sec vs. 72.8±5.0 sec, p=0.032) and increased clot growth kinetics (α angle, 84.8±0.2° vs. 82.0±0.6°, p=0.008), compared to the control group. Maximal platelet aggregation rate was higher in the CRF group than in the control group (58.2±0.2% vs. 44.6±1.2%, p=0.006).

### Conclusions:

Our study demonstrated that thrombogenicity is increased in rats with CRF. An activated extrinsic coagulation pathway may play an important role in increasing thrombogenicity in CRF.

## Annual Analysis of Clinical Outcome in Acute Ischemic Stroke Patients

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Dong-eog Kim<sup>9</sup>, Joon-tae Kim<sup>10</sup>, Jay Chol Choi<sup>11</sup>, Mi-sun Oh<sup>12</sup>, Wook-joo Kim<sup>13</sup>,  
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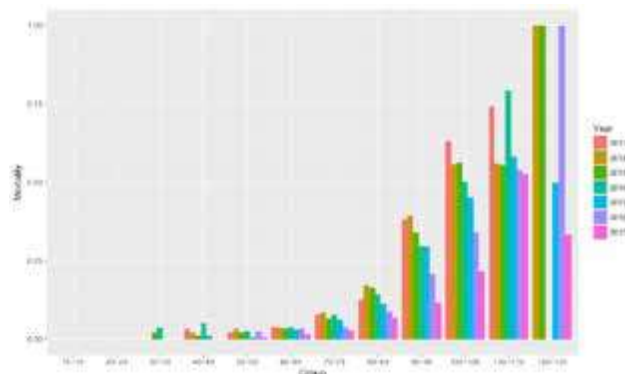
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### Purpose:

Treatment of acute ischemic stroke has been updating, continuously. To check the treatment results, clinical outcome of each patient at various periods was analyzed, but patients have not been compared each year.

### Methods:

We enrolled patients who were admitted within 24 hours after acute ischemic stroke or TIA between January 2011 and May 2017 from a multicenter stroke registry database in Korea (CRCS-K). Patients were classified using combined method of prediction model in VISTA and SPAN-100 index, which were defined as combination of age and NIHSS. Score of combination of age and NIHSS were categorized by 10 points. We analyzed how each group change from year to year in mortality and good outcome defined mRS of 0~1.



**Results:**

Of the 28,230 patients enrolled, follow-up loss of 1,627 was excluded, finally, 26,603 patients included. The mortality decreased as the years go by (p value 0.004, 95% CI -0.98 - -0.48). Even if analyzed by each group, the mortality tended to decrease. This was best reflected in the groups of '70~79' (p value 0.010, 95% CI -0.98 - -0.35), '80~89' (p value 0.029, 95% CI -0.97 - -0.13), '90~99' (p value 0.001, 95% CI -0.99 - -0.67), and '100~109' (p value < 0.001, 95% CI -0.99 - -0.73) but it was found to be less in the group '110~119' (p value 0.282, 95% CI -0.90 - 0.43), and '120~129' (p value 0.490, 95% CI -0.91 - 0.64). The sensitivity analysis of group with thrombolysis and patients who were admitted within 6 hours after acute ischemic stroke showed no significant difference. There was no improvement in good outcome.

**Conclusions:**

The mortality has improved, but further studies are needed for acute ischemic stroke treatment that may show good outcomes.

## The Incidence of Fractures After Acute Ischemic Stroke in Korea

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### Purpose:

Many stroke survivors have disabilities and complications which could increase the risk of falls and serious fractures. However, it is largely unknown on the incidence of fractures after stroke in Asian population.

### Methods:

The patients with acute ischemic stroke within 7 days of symptom onset were enrolled in a Korean multicenter stroke registry. This cohort were retrospectively linked to a claimed data source of the National Health Insurance Corporation between January 2011 and November 2013 (N=11,522), and were investigated for the event rates of fractures (spine, hip and others) for 4 years. The cumulative incidences were measured by Kaplan-Meier estimation. Cox proportional hazards regression was performed for the predictors of poststroke fractures.

### Results:

A total of 1,616 fracture events were identified: 712 spine fractures, 397 hip fractures and 714 other fractures. The cumulative incidences of all fractures were 1.69% at 3 months, 4.69% at 1 year and 9.97% at 4 years. Those of spine/hip fractures were 0.70%/0.43% at 3 months, 1.99%/1.08% at 1 year and 6.71%/3.64% at 4 years respectively. Age per 10 years (hazard ratio [HR] 1.33, 95% confidence interval [CI] 1.26-1.40), female (HR 1.69, 95% CI 1.49-1.91), previous fracture (HR 1.76, 95% CI 1.58-1.97), osteoporosis (HR 1.41, 95% CI 1.25-1.60) and serum creatinine (HR 2.28, 95% CI 1.36-3.81) were independently associated with all fractures after adjusting potential determinants.

### Conclusions:

The event rate of fractures for 4 years after acute ischemic stroke was about 10% in Korea. Older age, female, prestroke fracture, osteoporosis and increased serum creatinine raised the risk of poststroke fractures.

## **Incidence and Risk factors of Post-stroke dementia: Linked data between the Clinical Research Center for Stroke and the Health Insurance Review & Assessment Service Analysis**

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### **Purpose:**

Post-stroke dementia is an important factor of poor functional outcome following stroke. However, few longitudinal studies on the incidence and risk factors of dementia after stroke have been performed. We aimed to investigate the incidence and clinical factors related to dementia after ischemic stroke.

### **Methods:**

A total of 47,779 patients with acute ischemic stroke (within 7 days from stroke onset) were enrolled, who were registered in the Clinical Research Center for Stroke (CRCS) registry from 2006 to 2014 and successfully linked the Health Insurance Review and Assessment Service (HIRA) big database. All included patients did not have dementia before index stroke. The incidence of post-stroke dementia was identified using International Classification of Diseases, Tenth Revision, dementia diagnosis codes (F00, F01, F02, F03, and G30) with prescription of an anti-dementia medications after index stroke based on linked big data.

### **Results:**

Of the 47,779 patients, 10,357 patients (21.7%) had post-stroke dementia. The cumulative incidence of dementia after stroke was 10.4% after 1 year, 15.6 % after 3 years, 19.5% after 5 years, 22.9% after 7 years, and 27.1% after 10 years. The crude incidence rate of post-stroke dementia was 40.03 cases per 1000 person-years in this stroke registry based linkage big data. Post-stroke dementia groups were older, more frequently female, and were more likely to have severe stroke, history of stroke, lower education level, dependency before stroke.

### **Conclusions:**

Our study demonstrated that the risk of incident dementia is high among patients with ischemic stroke, particularly in association history of stroke, and stroke severity. These patients with high risk of dementia after stroke should be controlled risk factors for stroke prevention.

## Stroke Risk Prediction Model in Middle-aged Korean Population: From the Korean Genome and Epidemiology Study (KoGES)

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### Purpose:

Stroke is a third leading cause of death after cancer and heart diseases in Korea. Several risk models for predicting the risk of incident stroke have been developed based on the diverse cohorts of various ethnics. Not only clinical but also biochemical variables can be used to construct the risk prediction model. This study aimed to examine whether the model performance is improved an ability for predicting stroke risks when the biochemical variables are added to the model with the traditional clinical variables in the Korean middle-aged population.

### Methods:

The Korea Genome and Epidemiology Study (Ansan-Ansung) is an ongoing prospective community-based cohort that started in 2001 and has a biannual follow-up. Of the 10,030 participants, we analyzed 7,932 subjects without stroke at baseline study. Stroke was defined as subjects who had any one of the following; 1) diagnosis of cerebral vascular diseases, 2) taking medication for stroke  $\geq 3$  months. We evaluated whether the discrimination, calibration, and reclassification were improved by addition of biochemical variables to a traditional clinical model using the area under the receiver operating characteristic curve (AUC), Hosmer and Lemeshow's  $\chi^2$ -test, and category-free net reclassification improvement (NRI) and integrated discrimination improvement (IDI), respectively.

### Results:

During the average follow-up of 9.8 years, 233 were newly diagnosed with stroke. The clinical model to predict the risk of incident stroke included 6 variables which were associated with incidence of stroke; age, sex, current smoking status, physical activity, and diabetes and hypertension status. And we also developed a biochemical model that added the C-reactive protein (CRP) and the serum calcium level to the clinical model. There was no significant difference of discrimination between the clinical and the biochemical model (AUC, 0.726 in the clinical model and 0.730 in the biochemical model). Predicted and observed risks were matched well over all deciles in the clinical and the biochemical model ( $P=0.6491$  and  $0.7401$ , respectively). Reclassification analysis showed that there were no significant improvement after the addition of biochemical variables to clinical model (NRI, 0.034; 95% CI, -0.096 to 0.164 and IDI, 0.002; -0.002 to 0.005).

### Conclusions:

We constructed 10-year stroke risk prediction models in Korean middle-aged population. Both of the clinical and biochemical models demonstrated the moderate discrimination and good calibration. In addition, NRI/IDI indicate no improvement of reclassification in the biochemical model compared to the clinical model.



## High Dietary Glycemic Load is Associated with Poor Functional Outcome in Patients with Acute Cerebral Infarction

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### Purpose:

Elevated postprandial blood glucose is a critical risk factor for stroke. The dietary glycemic load (GL) and glycemic index (GI) are frequently used as markers of the postprandial blood glucose response to estimate the overall glycemic effect of diets. We hypothesized that high dietary GL, GI, or total carbohydrate intake is associated with a poor functional outcome in patients with acute ischemic stroke.

### Methods:

We prospectively included 263 first-ever ischemic stroke patients who completed a semiquantitative food-frequency questionnaire. The dietary GL, GI, and total carbohydrate intake were investigated by examining the average frequency of intake during the previous year based on reference amounts for various food items. Poor functional outcome was defined as a score on the modified Rankin Scale (mRS) of  $\geq 3$  at 3 months after stroke.

### Results:

The patients were aged  $65.4 \pm 11.7$  years (mean  $\pm$  standard deviation), and 58.2% of them were male. A multivariate analysis adjusted for age, sex, marital status, prestroke mRS score, diabetes mellitus, hyperlipidemia, body mass index, triglycerides, low-density lipoprotein, hemoglobin A1c, stroke classification, and National Institutes of Health Stroke Scale score, early neurological deterioration, and high-grade white-matter hyperintensities revealed that the dietary GL and total carbohydrate intake were associated with a poor functional outcome, with odds ratios for the top quartile relative to the bottom quartile of 28.93 (95% confidence interval=2.82-296.04) and 36.84 (95% confidence interval=2.99-453.42), respectively (p for trend=0.002 and 0.002, respectively). In contrast, high dietary GI was not associated with a poor functional outcome (p for trend=0.481).

### Conclusions:

Increased dietary GL and carbohydrate intake were associated with a poor short-term functional outcome after an acute ischemic stroke.

## The First Use of Tenecteplase in Central Retinal Artery Occlusion

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### Purpose:

Central retinal occlusion (CRAO) is the ocular analogue of ischemic stroke and is caused by occlusion by a platelet-fibrin thrombus or embolus the retinal artery resulting in profound visual loss. Several studies have shown potential benefit of tissue plasminogen activator (tPA) in restoring vision if administered early. Tenecteplase is a novel fibrinolytic that has been shown to have benefit in ischemic cerebral stroke. We present a case report of a patient with CRAO and subsequent use of tenecteplase.

### Methods:

A 30 year old woman underwent coiling of a left para-ophthalmic aneurysm. A filling defect was noted of the left ophthalmic artery. No reperfusion was noted following catheter withdrawal. The initial visual acuity (VA) was hand movement only. Tenecteplase 0.25 mg/Kg was given as a single bolus dose following consent for off-label use was gained from the patient. Initial VA was at day 1 was 6/21 and 6/12 at 1 month with corresponding improvement of visual perimetry (figure 4).

### Results:

CRAO accounts for 1 in 10 000 episodes of visual loss and is rare. Although it can be argued that loss of vision of one eye can be compensated by the unaffected eye, the loss of depth perception leads to increased. Randomized controlled trials comparing IV alteplase and intra-arterial thrombolytic in CRAO have not demonstrated a benefit, although earlier deployment have shown a signal for benefit. Tenecteplase with its ease of use given as a single IV bolus, more thrombin specificity that translates into potentially more effective reperfusion and less risk of bleeding is an attractive alternative to alteplase. Evidence of ocular reperfusion was achieved when tenecteplase was deployed early.

### Conclusions:

To our knowledge this is the first time tenecteplase has been use in CRAO for successful ocular ischemia reperfusion with no side effects and complete restoration of vision.

## Clinical Outcomes of the DAWN-like Patients Measured Initial Infarction Volume Using ABC/2 Formula

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### Purpose:

The DAWN study showed the clinical benefit of endovascular thrombectomy (EVT) that is performed more than 6 hours after the onset of ischemic stroke. The DAWN study used mismatch criteria between the severity of the clinical deficit and the infarct volume for patients selection. In DAWN study, the RAPID software was used to measure the initial infarction volume, and only specific stentriever used for EVT. However, the RAPID software is not often available, and device for EVT depends on operator's preference in the many clinical practices. We wanted to know the clinical results of selecting the eligible patients for the DAWN study using infarction volume measured in a way in a readily available way in real clinical use.

### Methods:

We analyzed single-center registry data retrospectively for last five years. We used the ABC/2 formula for intracerebral hemorrhage volume to measure initial infarction volume. EVT was performed with the several devices, depending on the operator's preference.

### Results:

Forty-six patients have included analysis. Median age was 72. Median NIHSS was 15. Median Initial infarction volume which measured by ABC/2 formula was 9cc. Successful recanalization(mTICI 2b-3) was achieved in 36 patients (83%). Initial ABC/2 Twenty-two patients(48%) had a good functional outcome(modified mRS 0-2). The mortality rate was 11%.

### Conclusions:

In this analysis, clinical outcome was very similar to it in the DAWN study. It would be a beneficial idea to measure the infarction volume with the ABC/2 formula to select patients that meet the DAWN study criteria.

## Identification of Intracranial Atherosclerosis-related Acute Large Vessel Occlusion in Endovascular Treatment: Comparison Between Occlusion Type and Common Operational Definition

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### Purpose:

Identification of intracranial atherosclerosis-related acute large vessel occlusion (ICAS-O) is one of important issues in setting up the optimal endovascular strategy and in the research field. We compared two typical methods that were commonly used to identify the ICAS-O.

### Methods:

We retrospectively reviewed patients underwent endovascular treatment for their acute intracranial large vessel occlusion. We assessed the presence of the ICAS-O by two different methods: 1) occlusion type and 2) common operational definition. With the common operational definition, patients with fixed focal stenosis and/or reocclusion tendency after significant recanalization were considered as the ICAS-O. As for the occlusion type, truncal-type occlusion (TTO) was considered as the ICAS-O.

### Results:

A total of 379 patients were reviewed. Among them, 75 (19.8%) had TTO. Based on the common operational definition for the ICAS-O, 64 patients (18.3%; in 349 patients) were assigned to have an ICAS-O. The common operational definition was not applicable in 30 patients, because their occlusions were never once recanalized during procedure. Identification consistency between the occlusion type and the common operational definition was 92.3%. In patients with TTO, 20.6% did not fit the common operational definition for the ICAS-O. All they had an AOL (arterial occlusive lesion) 3 recanalization by conventional endovascular modalities (eg. stent retriever) and never showed any reocclusion tendency. For patients with branching-site occlusion, 4.9% showed the final recanalization with AOL 2 or reocclusion tendency after significant recanalization, who were considered as the ICAS-O under the common operational definition.

### Conclusions:

Identification of an ICAS-O based on the occlusion type was well corresponded to that from the common operational definition.

## Direct Stenting Versus Rescue Stenting for the Acute Large Vessels Occlusion Associated with Intracranial Atherosclerosis

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### Purpose:

Endovascular reperfusion therapy(ERT) is difficult to perform in patients with acute large vessel occlusion (ALVO) associated with intracranial atherosclerosis (ICAS), as it often requires additional rescue stenting with or without angioplasty. However, direct stenting in the ALVO associated with ICAS may be rather fast, safe, and effective. This study compares the effectiveness and safety of direct stenting versus rescue stenting after ERT in patients with ALVO associated with ICAS.

### Methods:

After retrospectively reviewed a registry of consecutive patients with acute ischemic stroke who underwent direct stenting or rescue stenting after ERT, between January 2012 and November 2017. 24 patients with direct stenting versus 30 patients with rescue stenting after ERT were compared. We performed the direct stenting as determined by the operator when the ALVO with a tapered shape. Rescue stenting had performed the discretion of the neurointerventionist when failed to successful recanalization after a repeat ERT attempt. Assessment of good clinical outcome was defined as a modified Rankin scale(mRS)  $\leq 2$  at 90 days.

### Results:

Twenty-four direct stenting patients and 30 rescue stenting patients were included. Patients who performed the rescue stenting had more frequently presented infarct volume extent on follow-up imaging5 [(16.7%) vs. 1 (4.2%)] and longer procedure duration [86.0 (62.0–131.0) vs. 77.5 (61.0–112.0)] than patients who performed the direct stenting. Clinical outcome was significantly better [19 (63.3%) vs. 22 (91.7%);  $P = 0.036$ ] in direct stenting group than rescue stenting group. In a multivariate model, low initial NIHSS score (odds ratio, 0.79; 95% confidence interval, 0.65–0.93;  $P = 0.0074$ ) and direct stenting (odds ratio, 5.11; 95% confidence interval, 0.99–41.82;  $P = 0.074$ ) were independent predictors of good clinical outcome.

### Conclusions:

In this retrospective designed study shows that the direct stenting is relatively effective and safe than rescue stenting after ERT when the ALVO highly associated with ICAS.

## Long-term Results of Endovascular Treatment for Ugly Aneurysms Using Sandwich Technique

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### Purpose:

To report long-term results of endovascular treatment for ugly aneurysms with Sandwich technique.

### Methods:

Between Dec 2009 and Nov 2016 endovascular treatment with sandwich technique (stent/coils/stent) was performed in 12 patients (M:F=5:7, mean age: 56.5 years) with aneurysm surgically difficult or difficult with conventional endovascular treatment. Lesion characteristics were as follows: unruptured aneurysm in eleven and ruptured in one, 7 saccular dissecting aneurysms: six in supraclinoid ICA, one in P1 segment and four fusiform dissecting aneurysm in intracranial vertebral artery and one P-com aneurysm (rupture during stent-assisted coiling).

### Results:

Technical success was achieved in all patients (total occlusion in seven and subtotal occlusion in five). There was no procedure-related morbidity or mortality. Serial angiographic follow-up was available in seven patients (mean: 22.4 months, range: 2-48 months). Two patients with subtotal occlusion showed near-total occlusion on 3 month follow-up angiogram and there was no recanalization or regrowth of aneurysm in remaining six patients.

### Conclusions:

Endovascular treatment with sandwich technique was technically feasible and safe for treatment of ugly aneurysm which was surgically difficult or difficult with conventional endovascular treatment. It could be another treatment option for aneurysm difficult to deploy flow diverter stent such as Pipeline embolization device.



## Unilateral Olivary Degeneration Secondary to Brainstem Cavernous Angioma

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### Purpose:

Hypertrophic olivary degeneration (HOD) is usually caused by a disruption of the dentato-rubro-olivary pathway, also known as the triangle of Guillain-Mollaret. HOD is a unique form of degeneration because it results in enlargement of the affected structure rather than atrophy.

### Methods:

We present a case of unilateral atrophic olivary degeneration secondary to brainstem cavernous angioma.

### Results:

Case: A 55-year-old man was admitted to gastrointestinal department due to a acute gastric ulcer. He also complained of constant symptoms of dysarthria and clumsiness of the right hand over the past 12 years. He had a history of hypertension and smoking. Neurologic examination showed moderate dysarthria and mild clumsiness of fine finger movements in the right hand. There was no palatal myoclonus on the 8 days follow up period. The first brain MRI was performed 4 years after the onset of symptoms, and MRI showed a 2.5 x 2cm, multinodular mass lesion on the right side of the midbrain and pons tegmentum. T2 weighted images showed popcorn-like central area of mixed signal intensity with peripheral rim of decreased signal intensity. A Follow-up MRI obtained 8 years later showed no significant interval changes of cavernous angioma of the brainstem except a tiny T2 weighted low signal lesion in the right inferior olivary nucleus. He was treated with choline alfoscerate and proton pump inhibitors.

### Conclusions:

We report a case of unilateral olivary degeneration secondary to cavernous angioma of the brainstem. We suggest that HOD might be changed to atrophy of the olivary in chronic stage.

## **A Case of MCA Infarction Due to Thrombus Migration from the Unruptured Aneurysm at the Bifurcation of MCA Detected by Susceptibility Weighted Image (SWI)**

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### **Purpose:**

Thrombus migration to the distal artery from a proximal unruptured aneurysm is rare. In this case we present MCA infarction due to distal migration from the proximal thrombosed unruptured aneurysm detected by SWI.

### **Methods:**

A 70 year-old woman was brought to ER for aphasia with right hemiplegia. Initial non contrast CT scan showed patch low density lesions in the left corona radiata and the left parietotemporal lobes suggestive of acute infarction.

### **Results:**

In MRI diffusion, multifragmented small acute infarctions were shown in the left MCA territory including left corona radiata, frontoparietotemporal and insular lobes with focal hemorrhagic transformation in the left parietal lobe. In MRA, left proximal MCA inferior trunk was occluded. In FLAIR, about 1cm sized oval heterogeneous high signal intensities in the left MCA cistern suggestive of thrombosed aneurysm. In SWI, blooming artifact was shown in the proximal segment of the left MCA inferior trunk and the above mentioned oval area in the left MCA cistern. 4 days after initial MRI, CT angiography was performed showing patchy hypodense infarction in the left MCA territory suggestive of hemorrhagic transformation, and recanalization of left MCA inferior trunk was occurred but still remaining focally severe stenosis at proximal M2 segment and about 1cm sized oval hyperdense lesion without enhancement at left MCA bifurcation suggestive of thrombosed aneurysm. For further evaluation, we performed conventional angiography showing flow delay in the territory of the left MCA inferior division due to intraluminal thrombus of the proximal segment. In cardiology work up, Holter monitoring showed regular sinus rhythm without atrial fibrillation or flutter.

### **Conclusions:**

Advanced MRI sequence such as susceptibility weighted image would be a useful tool to find a hidden thrombosed aneurysm difficult to detect in a conventional CT angiography.

## Imaging Features and Outcomes in Cervicocerebral Artery Dissection

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### Purpose:

Although cervicocerebral artery dissection is a common cause of ischemic stroke in young adults, the effectiveness of imaging findings in predicting outcomes is not well established. We aimed to identify the baseline characteristics and imaging outcomes as well as prognostic factors which influence imaging outcomes for cervicocerebral artery dissection.

### Methods:

We included 190 consecutive patients who presented with ischemic symptoms associated with cervicocerebral artery dissection on baseline vascular images. Imaging findings on the baseline were obtained within 7 days after symptom onset, and follow-up vascular images were performed at 3 months, 6 months, or 1 year. We compared the imaging features and the degrees of recovery (complete or partial recovery) between the baseline and follow-up vascular images.

### Results:

A total of 133 patients who underwent vascular imaging at baseline and either 6 months or 1 year were compared for these analyses. The mean age of the patients was 47 (SD 12), and the number of females was 42 (31.6%). The median interval between baseline symptom onset and the first vascular imaging was within 24 hours (IQR 0, 1). The proportion of patients with hypertension, diabetes mellitus and dyslipidemia was 38.3%, 6.0%, and 19.5% respectively. Most dissection sites were in the posterior circulation (70.7%). Regarding the lesion sites, a dissection was more common in the intracranial arteries (78.2%) than the extracranial (21.8%). The most common site of dissection was the vertebral artery (51.1%) with V4 being the most common (38.3%). Follow-up images showed partial or complete improvement of the dissected vessels in 53%(95% CI, 42%-63%) at 6 months and 91%(95% CI, 83%-95%) at 1 year. The lesions with stenotic/occlusion revealed better imaging recovery compared with lesions with an aneurysm (67.6% vs. 21.3% at 6 months,  $p<0.002$ ; 85.7% vs. 27.7% after 1 year,  $p<0.002$ ). After adjustment for the age, gender, and eGFR, a multivariate analysis proved that dyslipidemia (OR 8; 95% CI, 2.6-24.4;  $p<0.001$ ) and a lesion site on the vertebral artery (OR 2.6; 95% CI, 1.1-6.1;  $p=0.026$ ) were independent predictors of poor imaging outcome.

### Conclusions:

In patients who were diagnosed with cervicocerebral artery dissection based on baseline vascular images, the rate of complete or partial improvement was over 50% in the 6-month follow-up images. Dyslipidemia and vertebral artery dissection were poor prognostic factors for the recovery of the vascular lesion after cervicocerebral artery dissection.

## Automated Classification of Stroke Subtypes Using 3 Dimensional Convolutional Neural Networks and Support Vector Machine Algorithms

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### Purpose:

There have been suggestions about different ischemic lesion patterns in different stroke mechanisms. Recent advances in artificial intelligence techniques have led to the application of deep learning or machine learning algorithm to the analysis of neuroimaging. The present study sought to classify stroke subtypes based on the ischemic lesion patterns on magnetic resonance imaging using feature extraction of convolutional neural networks (CNN) and classifier of support vector machine (SVM) algorithm.

### Methods:

We tried an automated classification using 3 dimensional CNN-SVM model to classify the diffusion-weighted magnetic resonance imaging scans from patients with presumed large artery atherosclerosis (LAA), cardioembolism (CE), and small vessel occlusion (SVO) subtypes. The dataset consisted of 1,200 diffusion-weighted magnetic resonance imaging cases. Images were normalized to the MNI 152 template. Without any information about the clinical variables and vascular imaging, we trained, validated and tested our 3 dimensional convolutional networks algorithm.

### Results:

We used 720 cases for training and 120 cases for validation. Shown on a test set of 360 cases, our 3 dimensional CNN-SVM model correctly classified 83.5% (range, 77% to 91%) of the test set into their respective groups. The feature map showed medium sized scattered lesion for LAA subtype, large lesion with cortical involvement for CE subtype, and small subcortical or brainstem lesion for SVO subtype.

### Conclusions:

The results show the feasibility of stroke subtype classification based on ischemic lesion patterns analysis and indicate a role for 3 dimensional CNN-SVM model in acute ischemic stroke imaging.

## Brain MR Findings of Extensive Neuronal Damage from Hyperosmolar Hyperglycemic State

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### Purpose:

The hyperosmolar hyperglycemic state(HHS) is the most serious acute hyperglycemic emergency defined as plasma glucose level>600mg/dL, plasma osmolality>320mOsm/kg, and absence of ketoacidosis. Previous reports on brain MR findings in HHS showed signal change limited to basal ganglia or corpus callosum. We report a case of extensive cerebral hemisphere damage after HHS in spite of normalized serum glucose level.

### Methods:

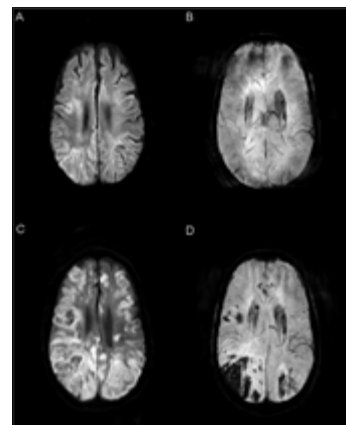
82-year-old female came to emergency room with sudden onset decreased mentality started 1 day ago. She suffered from DM, HTN using insulin 30 unit, oral hypoglycemic agent. Her mental status was semicoma. Her pupil was isocoric, prompt to light reflex, and showed roving eye movement. Doll's eye sign and corneal reflex was intact. In motor and sensory exam she showed even response to pain. DTR was normoactive, and Babinski's sign was positive in both sides. Initial serum glucose level was 708 mg/dL, and serum osmol level was 317 mOsm/kg. ABGA(pH-pCO<sub>2</sub>-pO<sub>2</sub>-HCO<sub>3</sub>) was 7.457-30.5-87.5-21.3. Initial brain MR imaging(Fig. A, B) showed both cerebral hemispheres and thalamus with high signal intensity in diffusion weighted image. MRA imaging showed intracranial multifocal stenosis. SWI showed small microbleed in right parietal cortex.

### Results:

With an impression of hyperosmolar hyperglycemic state induced by recent pneumonia, she was treated with antibiotics and insulin injection, but her neurological status was not recovered. F/U brain MRI(Fig.C, D) after 7 days showed both cerebral hemispheres with diffuse swelling and increased signal intensity in diffusion weighted image. SWI showed bilateral BG, thalamus and cortices diffuse hemorrhagic transformation.

### Conclusions:

Hyperglycemia induces glycosuria(osmotic diuresis), and then dehydration. Dehydration results in hyperosmolarity and severe hyperglycemia, consequently, severe inflammatory state and increased oxidative stress. Widespread cytotoxic and hemorrhagic neuronal injury from both DWI and SWI, suggesting pathophysiological mechanism of sustained coma after hyperglycemic encephalopathy.



## Visualization and Quantification of Human Connectome in Stroke Syndrome

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### Purpose:

Cerebral network attributes and connectome is expected to be an intuitive marker for individual threshold for cognitive and functional decline after stroke. We aimed to investigate whether the neural network attributes and the visual representation of connectome reflect the risk of cognitive and functional decline after stroke.

### Methods:

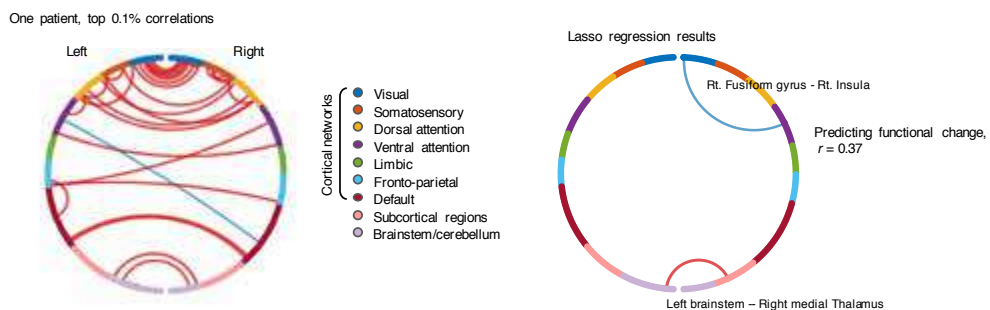
Patients with ischemic stroke who were hospitalized within 1 week of onset between May 2017 and April 2018 and had acute ischemic lesions on diffusion-weighted imaging were enrolled. At 3 months after stroke, cognitive and functional status was assessed using Montreal Cognitive Assessment and modified Rankin scale. Cerebral network attributes were analyzed using volumetric MRI, diffusion tensor imaging, and resting-state functional MRI. Connectome was visualized using a circular representation method to characterize each patient's network structure.

### Results:

Currently, 17 patients were analyzed. Mean age was 64.4 years, and median NIHSS was 3 (IQR 1-5). Mean interval between index-stroke and connectome MR acquisition was 117.5 days (SD 28). As for the lesion locations, 11 subjects had pure subcortical lesions, 2 had mixed cortical and subcortical, and 4 had infratentorial lesions. A representative patient's connectome pattern is shown in the figure. We are still recruiting patients, and the results of the network attributes and the connectome aspect according to stroke syndromes will be presented.

### Conclusions:

Visualization and quantification of cerebral network architectures may be an intuitive method to understand the pathophysiological mechanism of cognitive and functional decline after stroke.



## A Case of Sporadic Creutzfeldt-Jakob Disease Presenting As Acute Cerebral Infarction

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### Purpose:

Creutzfeldt-Jakob disease (CJD) is a rare transmissible neurodegenerative disorder caused by prion protein (PrP) that causes rapidly progressive dementia. Among four forms of CJD, sporadic CJD is most common form (85%). The hallmark symptoms of CJD are a rapid progressive dementia, myoclonus and pyramidal or extrapyramidal signs. In the early stages, the diagnosis is difficult due to various uncharacteristic disease presentations.

### Methods:

We present a rare case of CJD which mimicking acute cerebral infarction.

### Results:

A 82 year old woman admitted with sudden onset right hand weakness which started 2 weeks ago. Prior to her hospitalization, she had been taking antihypertensive agent. Diffusion weighted MRI showed high signal intensity on right parietal lobe, corpus callosum of splenium and bilateral occipital lobe. We suspected multiple cerebral infarction, she underwent stroke work up including echocardiography and 24 hour ECG monitoring. No cardiogenic source was found to explain embolic infarction. By the end of the first week of hospitalization, she complained for insomnia and depressive mood. Follow up DWI showed more extensive lesion on bilateral parietal and occipital cortices. At that time, CJD was highly suspected, there was no typical clinical presentation protein 14-3-3. One month after admission, intermittent jerky movement appeared on her left hand and abulia was observed. Follow up EEG revealed frequent sharp wave on right hemisphere. The result of CSF study was positive for protein 14-3-3. We could not perform the brain biopsy, only the diagnostic criteria of possible CJD were satisfied.

### Conclusions:

The incubation period was over 30 years and early signs are often non-characteristic. The typical EEG findings are found in late stage of the disease. Therefore CJD is often misdiagnosed or underdiagnosed. Clinicians should repeat neuroimaging and EEG in patient with suspected CJD even if the initial symptoms and imaging are not characteristic.



## A Case of Diffuse Dural Enhancement in Dural Arteriovenous Fistula

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### Purpose:

Diffuse dural enhancement may represent intracranial hypotension, dural carcinomatosis or chronic hypertrophic pachymeningitis from a variety of causes, including idiopathic, syphilis, sarcoidosis, antineutrophil cytoplasmic antibody associated vasculitis and immunoglobulin G4 related disease. Dural enhancement has also rarely been reported with venous sinus thrombosis, temporal arteritis and cavernous sinus dural arteriovenous fistula. We present a case of diffuse dural enhancement in dural arteriovenous fistula.

### Methods:

Case Report

### Results:

A 52-year-old woman was admitted due to right facial pain for a month. Brain MRI showed dural thickening and enhancement around the right cavernous sinus and tentorium. Time of flight MR angiographic source image demonstrated multiple high-intensity structures adjacent to the right superior petrosal sinus, supporting the presence of dural arteriovenous fistula. After oral administration of carbamazepine, her symptom was improved. Follow up MRI after a month revealed marked decrease of dural thickening and enhancement.

### Conclusions:

We experienced a case of diffuse dural enhancement in dural arteriovenous fistula. Dural arteriovenous fistula should be included in the differential diagnosis in patients with dural thickening and enhancement.

## A Case of Ischemic Stroke Occurring After Overdose of Quetiapine for a Suicidal Attempt

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### Purpose:

Quetiapine, an atypical antipsychotic agent, is widely used for behavior control in those with elderly patients. Quetiapine may be particularly advantageous in regards of less extrapyramidal symptoms and lack of anticholinergic activity enhancing the use of quetiapine in elderly patients with various neurological diseases. Though quetiapine is a relatively safe drug for elderly patients, we experienced a patient who had ischemic stroke after oral overdose of quetiapine as a suicidal attempt.

### Methods:

A 77 years-old female patient visited emergency department by altered mental status. Previously she was diagnosed to have hypertension and major depressive disorder and was under regular medication. At the time of when the patient was found, a suicidal note with an empty bottle of Quetiapine was found. After arriving to the emergency department, gastric lavage was performed. The blood pressure was 90/60mmHg, heart rate was 122/sec and the respiratory rate was 20/min. The patient was assessed as toxic encephalopathy with suicidal attempt and was admitted to the Medical Intensive Care Unit. After 3 days of treatment, mental status improved from semi-coma to drowsy status. Right side weakness of arm and leg was first found. Magnetic resonance image was performed, and a high signal intensity lesion was observed from the left medial medulla and left middle cerebral artery territory. No significant stenosis was found in the corresponding arteries. There was no abnormality from the transthoracic echocardiography. 24h-Holter monitoring did not show any abnormality. D-dimer was elevated to 8.61mg/dl. Antiphospholipid antibody screening was normal and no cancer was found from the chest x-ray and abdominal CT scan. No deep vein thrombosis was observed. D-dimer decreased to 3.14mg/dl at follow-up.

### Results:

Previously, several reports describing cerebral infarction after suicidal attempts by monoxide poisoning, ingestion of ethylene glycol ingestion, methanol, or herbicides, medication overdose, and hanging were reported. Though antipsychotics are frequently overdosed with a suicidal purpose, not much reports exist.

### Conclusions:

Several health regulatory agencies reported an increased risk of cerebrovascular events for antipsychotics based on the results of clinical trials. However still the exact mechanism of quetiapine increasing the risk of ischemic stroke is unclear. In several studies orthostatic hypotension, QTc prolongation, increasing platelet aggregation and coagulation by hyperprolactinemia or antiphospholipid antibodies was suggested as the mechanism. Here, we report a case of ischemic stroke occurring after overdosage of quetiapine as a suicidal attempt.

## Free Fatty Acid Level and Epicardial Fat Thickness are Predictors of Atrial Fibrillation in Acute Ischemic Stroke

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### Purpose:

Increased epicardial fat is known to be associated with the presence and chronicity of atrial fibrillation (AF). Free fatty acids (FFAs) are major components of epicardial fat; however, their potential association with AF in ischemic stroke has not been investigated. We aimed to assess the performance of echocardiographic epicardial fat thickness (EFT) and plasma FFA level in identifying patients with ischemic stroke and AF.

### Methods:

We enrolled a total of 214 consecutive patients (mean age,  $66.8 \pm 12.3$  years; 39.7% women) diagnosed with acute ischemic stroke between March 2011 and June 2014. The patients were divided into two groups: ischemic stroke with AF (n = 35, 16.4%) and ischemic stroke without AF (n = 179, 83.6%).

### Results:

The ischemic stroke with AF group showed significantly higher serum FFA level ( $1379.7 \pm 717.5$  vs.  $757.8 \pm 520.5$  uEq/L,  $p < 0.0001$ ) and EFT ( $6.5 \pm 1.2$  vs.  $5.3 \pm 1.2$  mm,  $p < 0.001$ ) than the group without AF. Multivariable logistic regression analysis demonstrated that age (odds ratio [OR], 1.112), serum FFA level (OR, 1.002), and EFT (OR, 1.740) were independently associated with the ischemic stroke group with AF. EFT and FFA significantly improved the goodness-of-fit and discriminability of the simple regression model including age as a covariate (log likelihood difference, 21.35;  $p < 0.001$ ; c-index difference, 17.9%;  $p < 0.001$ ).

### Conclusions:

High EFT and serum FFA level were associated with ischemic stroke in patients with AF. Echocardiographic EFT and serum FFA level can play a significant role in identifying ischemic stroke with AF.

## Susceptibility Weighted Imaging Findings among the Patients with Acute Cerebral Infarction with Polycythemia Vera

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### Purpose:

Susceptibility weighted image (SWI) is a velocity compensated high resolution three dimensional gradient echo sequences that uses magnetic susceptibility differences to generate a unique contrast. Exaggerated erythrocytosis in polycythemia vera (PV) can induce both thrombotic and hemorrhagic vascular events due to increased viscosity within vessels. We illustrated SWI findings among acute cerebral infarction patients with PV.

### Methods:

Between 2013 and 2016, acute cerebral infarction patients combined with PV who admitted to Chung-Ang University Hospital or Seoul National University Hospital were included in the study. We reviewed their clinical, imaging and laboratory findings. The findings of SWI were analyzed by two neurologists and compared with the patients with PV but without acute cerebral infarction.

### Results:

Total of five acute cerebral infarction patients were combined with PV (mean age =  $67 \pm 10$  years, all male patients). The infarction patterns from diffusion weighted image included three infarctions within single vascular territory and two multi-territorial infarctions. The signal intensity of venous structures from SWI showed wide exacerbation throughout cerebral hemispheres in three patients and localized exacerbation in two patients. Follow up SWI several days after initial imaging revealed decreased signal intensity of cerebral venous structure in four stroke patients. Among five PV patients without cerebral infarction, only one patient shows slight exacerbation of venous signal from SWI.

### Conclusions:

This study shows exaggerated venous signal intensity among cerebral infarction patients with PV, suggesting pathophysiological link between increased red blood cell mass and increased blood viscosity within cerebral vasculature.

## Nonbacterial Thrombotic Endocarditis: A Rare Cause of Multifocal Embolic Stroke in a Patient with Disseminated Malignancy

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### Background:

The diagnosis of nonbacterial thrombotic endocarditis (NBTE) is often challenging, as its clinical picture differs from that of typical infective endocarditis, its small, multiple vegetation is hard to detect, and often it is the first manifestation of cancer.

### Case:

A 64-year-old man presented to our neurology department with dysarthria, slurred speech and cognitive decline of subacute onset. He was otherwise healthy except peripheral artery disease in his left leg diagnosed 5 months before admission. Diffusion-weighted image (DWI) of brain MRI revealed subacute infarction in bilateral cerebral cortices, right frontal white matter, bilateral corona radiata and left cerebellum. Brain computed tomography angiography (CTA) did not show significant stenosis except total occlusion of right middle cerebral artery M2 superior division. Atrial fibrillation or any arrhythmia was not recorded in routine electrocardiogram (EKG) and 24-hour holter monitoring. Transthoracic echocardiography was grossly normal with preserved ejection fraction and intact valvular function apart from pericardial effusion. The result of basic laboratory studies and screening for coagulopathy and autoimmune disease was unremarkable. To find out unidentified embolic source, transesophageal echocardiography (TEE) was performed.

### Results:

There was no thrombus or patent foramen ovale (PFO), but echogenic mass on the mitral leaflet suggesting infective endocarditis was detected. Antibiotics of ceftriaxone and gentamycin were started. However, he did not have any risk factors of infective endocarditis such as valve disease or prosthetic valve, fever had never been checked, microorganism was not grown in repeated blood cultures, and had no response to antibiotics. Therefore noninfective endocarditis was indicated and considering that there was little evidence of Lupus or Sjogren disease, Libman-Sacks endocarditis was ruled out. Meanwhile, lung cancer (T3N3M1) was diagnosed from lung mass and multiple enlarged neck lymph nodes. Additionally, although cytology from pericardial effusion showed malignant cells, cardiac MRI showed no evidence of cardiac metastasis. Marantic endocarditis derived from metastatic adenocarcinoma of lung was highly suspected. Eventually after treating the patient with afatinib, irreversible EGFR inhibitor, and anticoagulation of low-molecular-weighted heparin, vegetation was no longer visible in follow-up TEE.

### Conclusions:

So far, NBTE is considered to be underdiagnosed despite of the fact that the risk of systemic embolism is especially high. Therefore, in patient with undetermined embolic stroke and suspicious of non-infective endocarditis, diagnostic evaluation to investigate the presence of malignancy should be under way.

## Study Protocol to Assess the Efficacy and Safety of HT047 in Patients with Acute Ischemic Stroke: A Randomized Controlled Phase II Trial

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### Purpose:

Numerous pharmacological agents have been introduced and evaluated in acute ischemic stroke, but there is no definite answer yet. HT047 is a combination of *Scutellaria baicalensis* and *Pueraria lobata* extract which has been frequently used in traditional oriental medicine. The current study aims to evaluate the efficacy and safety of HT047 in patients with acute ischemic stroke.

### Methods:

This clinical study is designed to initiate treatment with high or low dose HT047 or placebo in acute ischemic stroke patients and evaluate neurological function recovery in these subjects as measured by the extent of motor function recovery at week 12 of treatment. Subjects must have had a recent (<14 days) onset of acute ischemic stroke as confirmed by brain imaging. The patients who have motor function impairment with FMA motor score  $\leq 55$  as well as neurological function impairment with National Institutes of Health Stroke Scale (NIHSS) score  $\geq 4$  and  $\leq 15$  are eligible for study participation. At baseline, subjects will be randomized to HT047 high dose group (2250 mg/day), HT047 low dose group (1500 mg/day), or placebo group in a 1:1:1 ratio in a double blind fashion and be treated with the investigational product for 12 weeks starting from the next morning of baseline with a three times a day dosing schedule, 3 tablets per dose. The projected sample size is 141 patients (considering 20% drop-out rate) with at least 3 months of follow-up, and all subjects will visit the hospital at Weeks 1, 4, 8, and 12 during study treatment.

### Results:

Primary endpoint is change at Week 12 of treatment with HT047 from baseline Fugl-Meyer Assessment (FMA) motor function score. Secondary endpoint includes 1) change at weeks 4 and 8 from baseline FMA motor function score, 2) change at weeks 4, 8, and 12 from baseline FMA motor function score, 3) change at weeks 4 and 12 from baseline NIHSS score, modified Rankin Scale (mRS) score, and modified Barthel Index, and 4) proportion of subjects with NIHSS score 0-2 and mRS score 0-2 at week 12. Safety endpoint includes predefined adverse events and abnormalities in vital signs, physical examination, and laboratory tests.

### Conclusions:

This study is a first-in-human trial of HT047, and the results may also help identify the neuroprotective effect of HT047.

## Effects of Extracorporeal Shockwave Therapy in Chronic Stroke Patients with Knee Osteoarthritis: A Pilot Study

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### Purpose:

Extracorporeal shockwave therapy (ESWT) has been widely used for pain relief and treatment of musculoskeletal disorders. The aim of this study was to evaluate the effects of extracorporeal shockwave therapy (ESWT) on pain, function, and ultrasonographic features in chronic stroke patients with knee osteoarthritis (OA).

### Methods:

Thirty-three knee joints in 18 chronic stroke patients with unilateral or bilateral knee OA ( $\geq$ Kellgren-Lawrence grade I) were enrolled. The patients were randomly allocated to an experimental group receiving ESWT (n=9) and a control group receiving sham ESWT (n=9). For ESWT, the patients received 1000 pulses weekly for 3 weeks, totaling to an energy dose of 0.05 mJ/mm<sup>2</sup>. The assessments were performed before the treatment, immediately after the first treatment, and 1 week after the last treatment using the following: Visual analog scale (VAS) for pain; patient perception of the clinical severity of OA; the Korean modified Barthel index (K-MBI; ambulation and chair/bed transfer); the functional independence measure scale (FIM; bed/chair/wheelchair transfer, toilet transfer, walking, and stairs); and ultrasonographic features (articular cartilage thickness, doppler activity, and joint effusion height).

### Results:

The experimental group showed a significant improvement in the VAS score (4.50 $\pm$ 1.87 to 2.71 $\pm$ 1.38) and patient perception of the clinical severity of OA (1.87 $\pm$ 0.83 to 2.75 $\pm$ 0.46). The bed/chair/wheelchair transfer components of the FIM score also improved significantly (4.12 $\pm$ 1.55 to 4.62 $\pm$ 1.30). In terms of the ultrasonographic features, increased doppler activity was observed in the medial knee in the experimental group immediately following ESWT (Figure 1).

### Conclusions:

The present study suggested that ESWT may reduce pain and improve function in chronic stroke patients with knee OA and may increase site-specific doppler activity following ESWT, even though the increase is not sustained and seems to be on the decrease as time passes. For these reasons, we thought that ESWT could be one of the treatment methods appropriate for human knee OA. Although the results of this pilot study are very encouraging, further studies focusing on the treatment regimen and morphologic or hemodynamic cartilaginous changes with a larger sample size will be necessary.

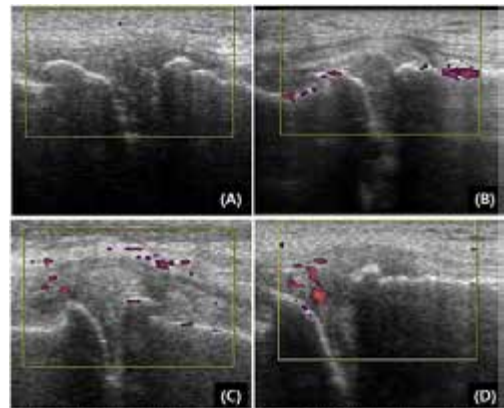


Fig. 1. Doppler activity on ultrasonography in the medial joint in the experimental group (A) before and (B) immediately after the first ESWT session. Increased doppler activity was observed in the medial joint and most commonly on the distal femoral and proximal tibial surfaces. Doppler activity was also increased on (C) the medial ligament and (D) medial meniscus.



## Age and Aphasia Type in Acute Stroke Patients

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### Purpose:

Aphasia is a common sequela after stroke. Although aphasia type is primarily attributed to the location of stroke, the relationship between age and aphasia type remains unclear. The aim of this study was to investigate the association of age, aphasia type and etiology of stroke in patients with early stage of stroke.

### Methods:

1177 patients with stroke were referred to SLPs for the assessment of aphasia in neurology, Asan Medical Center from 2005 to 2015. The patients with previous stroke history (308/1177, 26.2%), underlying other diseases such as parkinsonism or dementia (31/869, 3.6%), and those of left-handed or ambidextrous (57/838, 6.8%), those with subacute (more than 7 day from their onset) stroke (312/781, 39.9%), and those with right hemispheric lesions (23/469, 4.9%) were excluded. The type and severity of aphasia was evaluated by the Korean version-Western Aphasia Battery (K-WAB). Stroke severity (NIHSS), etiology (SSS-TOAST) and demographic data were recorded.

### Results:

A total of 446 patients were included. There was no gender difference in stroke or aphasia severity (NIHSS or AQ in K-WAB score) but the mean age of female patients (68.8±11.9) was significantly older ( $p < .01$ ) than males (62.3±11.8). There were no significant correlations between age and aphasia severity. However, the patients with Broca's aphasia (BA) were significantly younger ( $p < .05$ ) and more severe ( $p < .05$ ) than those with Wernicke's aphasia (WA) even though there was no sex difference between the two groups. The BA group more frequently ( $p < .05$ ) had large artery atherosclerosis (LAA) whereas WA group more frequently had cardioaortic embolism (CE), which may explain why the patients with WA were older than those with BA.

### Conclusions:

These results indicate that the age and stroke etiology may influence the types of aphasia in patients with acute stroke.

## Comparison of Clopidogrel and Ticlopidine/Ginkgo Biloba in Patients with Clopidogrel Resistance and Carotid Stenting

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### Purpose:

Patients undergoing carotid artery stenting (CAS) who show low responsiveness to clopidogrel may have a higher risk of peri-procedural embolic events. This study aimed to compare the effectiveness and safety of clopidogrel and ticlopidine plus Ginkgo biloba in clopidogrel-resistant patients undergoing CAS.

### Methods:

In this multi-center, randomized, controlled trial, we used platelet reactivity test to select patients undergoing CAS who showed clopidogrel resistance, and compared treatments using clopidogrel and ticlopidine plus ginkgo. The primary outcome was the incidence of new ischemic lesion in the ipsilateral hemisphere of CAS. Detection of microembolic signal on transcranial Doppler was the secondary outcome. The clinical outcomes were also monitored.

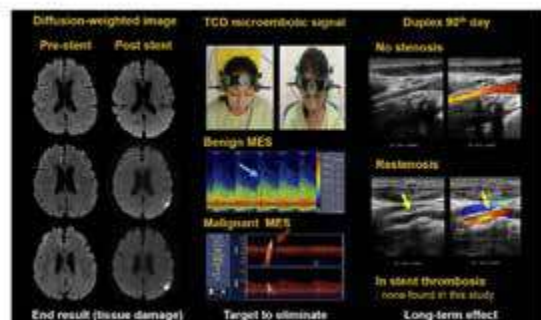
### Results:

This trial was discontinued after preplanned interim analysis owing to impractical re-estimated sample size. The primary endpoint occurred in 12 patients (54.5%) in the clopidogrel group and 13 patients (65.0%) in the ticlopidine–ginkgo group ( $P = 0.610$ ). No significant differences in the presence of microembolic signal (15.0% vs. 11.8%,  $P = 0.580$ ), clinical outcomes (ischemic stroke or transient ischemic attack, 0.0% vs. 5.5%; acute myocardial infarction 0.0% Vs. 0.0%; all-cause death, 4.5% vs. 0.0%), or incidence of adverse events were found in the two groups. In terms of resistance to clopidogrel, treatment with ticlopidine–ginkgo significantly increased the P2Y12 Reaction Units (difference, 0.0 [−0.3–3.0] vs. 21.0 [6.0–35.0],  $P < 0.001$ ).

### Conclusions:

In patients who showed clopidogrel resistance, ticlopidine–ginkgo treatment was safe and increased P2Y12 Reaction Units; however, compared to clopidogrel, it failed to improve surrogate and clinical endpoints in patients undergoing CAS. This multimodal biomarker-based clinical trial is feasible in neurointerventional research. Clinical Trial Registration: URL: <http://www.clinicaltrials.gov>. Unique identifier: NCT02133989.

Figure 1. Measurement of laboratory outcomes



Abbreviations: TCD, transcranial doppler; MES, microembolic signal

## Different Effect of Cilostazol and Aspirin on Cerebral Hemorrhage Depending on Presence of Microbleeds Versus Prior Intracerebral Hemorrhage

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### Purpose:

Although both cerebral microbleeds (CMBs) and intracerebral hemorrhage (ICH) are at risks for future hemorrhagic and ischemic vascular events, it is uncertain if event outcomes might differ according to type of antiplatelet agent. This study aimed to evaluate the safety and efficacy of cilostazol versus aspirin between ischemic stroke patients with CMBs and those with prior ICH.

### Methods:

We conducted a post hoc analysis of the the Prevention of Cardiovascular Events in ISchemic Stroke Patients with High Risk of Cerebral Hemorrhage (PICASSO) trial. Patients with recent non-cardioembolic ischemic stroke or transient ischemic attack enrolled in the PICASSO trial were divided into two subgroups according to their underlying lesions prone to cerebral hemorrhage: CMBs and prior ICH, and cilostazol and aspirin were compared in these population. The primary safety outcome was the first occurrence of cerebral hemorrhage (ICH and subarachnoid hemorrhage) confirmed by neuroimaging. The primary efficacy outcome was a composite of major vascular events, including stroke, myocardial infarction, and vascular death.

### Results:

Of the 1,512 patients analyzed in this study, 903 (59.7%) had multiple CMBs and 609 (40.3%) had prior ICH. Patients with multiple CMBs were more likely to be older ( $66.2 \pm 10.9$  vs.  $65.0 \pm 10.6$ ) and a smoker (21.4% vs. 17.1%), have higher heart rate ( $81.7 \pm 14.7$  vs.  $79.7 \pm 13.8$ ), mini-mental status examination score (26 vs. 25), and proportion of severe white matter hyperintensities (27.8% vs. 22.0%), have lower baseline National Institutes of Health Stroke Scale score (1 vs. 2), and be on statin therapy (78.7% vs. 71.1%) compared with the patients with prior ICH. Cerebral hemorrhage occurred in 1 (0.12%) and 13 (1.49%) of patients with multiple CMBs administered cilostazol and aspirin, respectively (hazard ratio [HR], 0.08; 95% CI, 0.01-0.60), and 8 (1.26%) and 5 (0.79%) of patients with prior ICH treated with cilostazol and aspirin, respectively (HR 1.60; 95% CI 0.52-4.90), with  $p=0.010$  for treatment x subgroup interaction effect. There were no interaction effects of treatment allocation by the subgroups of CMBs and ICH on primary efficacy outcome and secondary outcomes.

### Conclusions:

Ischemic stroke patients with multiple CMBs might have benefit on the prevention of cerebral hemorrhage from treatment with cilostazol compared to aspirin.

# Multifocal Cerebral Infarction After Inhaling Vapor of Nebulizer

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## Purpose:

Atrovent (ipratropium bromide) is a medication which widens the medium and large airways in the lungs. It is used to treat the chronic obstructive pulmonary disease and asthma. We describe a patient who had a multifocal cerebral infarction after inhaling of atrovent vapor.

## Methods:

A 77-year-old woman with history of fibromyalgia, hyperlipidemia and osteoporosis was come to our emergency room for symptoms of mental confusion, amnesia and disorientation to time, place, and date. Her husband was hospitalized with pneumonia, and while she was caring for her husband, suddenly, she began to repeatedly ask questions that “where am I?”, “why am I here?” So, some caregiver brought her to our emergency room. Neurological examination showed only psychiatric symptoms. Emergency laboratory and EKG were normal. Brain DWI showed focal signal change in the left frontal periventricular white matter area. She was admitted and evaluated based on TGA and cerebral infarction. Her symptoms of amnesia partially resolved approximately some hours. After the admission, she was asked about the situation in detail. Those symptoms were evoked after inhaling vapor of nebulizer (Atrovent) that used to treat husband disease.

## Results:

There were interval overt and newly developed multifocal high signal lesions on follow-up DWI, which appeared to be a multifocal cardiac embolic infarction in both cerebral hemispheres. But, 24-hour Holter ECG monitoring and transthoracic echocardiography showed normal range. There was no atrial or ventricular fibrillation, flutter and arrhythmia. EEG showed occasional independent brief delta slow waves in bilateral temporal lobe, which suggest focal bi-temporal cerebral dysfunction. On follow-up her memory symptom gradually improved and there were no newly developed abnormal neurological symptoms.

## Conclusions:

Atrovent (ipratropium bromide) is used by inhaler or nebulizer and onset of action is typically within 15-30 minutes. Atrovent is a muscarinic antagonist. So, there were some side effects such as dry mouth, cough, airway inflammation, sedation, skin flushing, acute angle-closure glaucoma, palpitation and tachycardia. Therefore, although careful, the inhaled atrovent drug seems to increase the risk of cardiac arrhythmia, which provoked cardiac origin multifocal embolic infarction. A causal relationship between drug use and disease occurrence was difficult to establish. However, we think that inhaled atrovent may be related to multifocal embolic infarction, because there were clear temporal relationship between inhaled drug and neurological abnormal symptoms.

## rs5030625, rs1801026 and rs16260 Polymorphisms of Cadherin Gene are Associated with Leukoaraiosis

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### Purpose:

Blood-brain barrier (BBB) disruption plays a key role in Leukoaraiosis (LA). Cadherin is a component of adherent junctions (AJ), which play a crucial role in homeostasis in BBB development. We hypothesized that alterations in cadherin genes might be a potential cause of BBB abnormalities that result in LA.

### Methods:

A total of 339 LA individuals were enrolled, who underwent brain magnetic resonance imaging with obtainable vascular risk factors. Genotyping of cadherin single-nucleotide polymorphisms (SNPs) (rs5030625, rs1801026, and rs16260) was performed by real-time polymerase chain reaction with LightSNiP reagents (coupled primer and probe) and FastStart DNAMaster HybProbe (Roche Diagnostic, GmbH, Mannheim, Germany) on a LightCycler 2.0 instrument.

### Results:

Two SNPs, rs1801026 and rs16260, were significantly different between the control and LA groups. The combinatorial effects of the three SNPs were also significant. The haplotypes G-T-C and GA-T-A increased the development of LA-PVWM (OR = 1.76 and OR= 40.7, respectively). The haplotypes G-T-A and GA-T-A increased the development of LA-DWM (OR = 2.56 and OR= 10.48, respectively), but G-C-C decreased the development of LA-DWM (OR=17.57).

### Conclusions:

This study provides evidence for genetic polymorphisms of the AJ component cadherin gene and the association of its haplotypes with LA.

## Strategic Methods Based on Atherosclerotic Burden and Stroke Recurrence for Secondary Prevention of Ischemic Stroke in Patients with Non-valvular Atrial Fibrillation

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### Purpose:

To decide which NOAC would be preferred in patients with non-valvular atrial fibrillation and a high atherosclerotic burden and to establish the strategic methods based on atherosclerotic burden and stroke recurrence for determining which subpopulation in patients with non-valvular atrial fibrillation should be treated more aggressively with anti-coagulation plus anti-platelet to prevent stroke recurrence.

### Methods:

Retrospective observational cohort study of patients with acute ischemic stroke or transient ischemic attack and non-valvular atrial fibrillation in Seoul St. Mary's Hospital from March 2014 to May 2018.

### Results:

Risk stratification of ischemic stroke or transient ischemic attack patients with non-valvular atrial fibrillation based on atherosclerosis burden and stroke recurrence Primary efficacy outcome: Recurrence of ischemic stroke in each stratified subpopulation under anti-coagulation and/or anti-platelet therapy Primary safety outcome: Occurrence of intracranial hemorrhage in each stratified subpopulation under anti-coagulation and/or anti-platelet therapy.

### Conclusions:

We suggest strategic methods to determine which subpopulations in ischemic stroke or transient ischemic attack patients with non-valvular atrial fibrillation should be treated with anti-coagulation plus anti-platelet based on atherosclerotic burden and stroke recurrence.

## Early Sleep Apnea in Acute Ischemic Stroke

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### Purpose:

Sleep apnea (SA) is emerging as a risk factor of stroke, and stroke itself can also influence the sleep. However, investigation of SA in acute ischemic stroke is scanty. We evaluated the prevalence of SA in early stage of stroke and analyzed the factors associated with SA.

### Methods:

We prospectively performed overnight polysomnography (PSG) in consecutive acute ischemic stroke patients who were admitted to the stroke unit within 72 hours from onset. PSG was performed on the first night, and severe stroke patients who could not stand the PSG were excluded. The apnea-hypopnea index (AHI) was calculated using the total number of apneas and hypopneas per hour sleep, and categorized into mild (AHI 5-14/hour), moderate (15-29), and severe ( $\geq 30$ ). Ordinal logistic regression was performed to predict the factor associated with severity of SA (no, mild, moderate and severe).

### Results:

From August 2015 to March 2016, a total of 141 patients were enrolled: mean age  $63.5 \pm 13.3$  years, 69.5% male, median (IQR) NIHSS 3 (1-6). Among them, 124 (87.9%) patients had SA (AHI  $\geq 5$ /hour) of any degree: 41.1% mild, 21.8% moderate, and 37.1% severe. Higher NIH stroke scale was associated with SA severity ( $p = 0.010$ ). According to the stroke subtype by TOAST classification, cardioembolism was associated with more severe SA ( $p = 0.043$ ).

### Conclusions:

SA is frequently found in acute phase of ischemic stroke. Higher degree of SA is associated with severe stroke and cardioembolic etiology.



## Subtype and Outcome of Acute Ischemic Stroke with Chronic Kidney Disease

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### Purpose:

Chronic kidney disease (CKD) is recognized as an independent risk factor for cardiovascular disease and stroke. Our goal was to investigate the association between estimated glomerular filtration rate (GFR) and stroke outcome and to assess whether CKD affect ischemic stroke subtype and stroke outcome.

### Methods:

We examined the association between baseline estimated GFR and CKD and 1-year outcomes in 2654 consecutive patients with acute ischemic stroke. GFR was estimated by the Modification of Diet in Renal Disease (MDRD). An estimated GFR rate 60 mL/min/1.73 m<sup>2</sup> defined CKD.

### Results:

Among the 2654 patients, 332(13%) had CKD with eGFR <60 mL/min/1.73 m<sup>2</sup>. Compared with a group without CKD, mean age (74.6 vs. 67.0years, p<0.01), the prevalence of atrial fibrillation (AF) (29% vs. 18%, p<0.01) and a history of coronary heart disease (14% vs. 8%, p<0.01) were significantly higher in that with CKD. A comparison of mRS at discharge and 1-year outcomes revealed a significantly poor outcome (at discharge mRS 6; 6% vs. 2%, p<0.05, at 1-year outcomes mRS 6; 23.7% vs 9.9%, p<0.05) in the group with, than without CKD. The adjusted ORs for death after 1 year were 3.2(2.3 to 4.4) with CKD compare without. CKD is an independent predictor of mortality and poor outcome in patients with acute stroke.

### Conclusions:

Patients with CKD may have a poor prognosis due to high proportion of cardioembolic cerebral infarction..But, patients with CKD of cardioembolic cerebral infarction has a bad prognosis.

## Risk of Post-stroke Pneumonia with Acid-suppressive Medication and Mucoprotective Agents

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### Purpose:

Stroke patients are at an increased risk for pneumonia. In stroke patients, proton pump inhibitors (PPI) and H<sub>2</sub> receptor antagonists (H<sub>2</sub>RA) are commonly prescribed for control of gastroesophageal symptoms and prevention of gastrointestinal bleeding. PPI and H<sub>2</sub>RA have acid-suppressive property and reduce acidity in gastric juice. Gastric juice has bactericidal activity, which is acid-dependent. Based on the anti-acid property of PPI and H<sub>2</sub>RA, epidemiologic data suggested that use of the anti-acid medications may increase risk for pneumonia. We investigate use of the anti-acid medications on risk for pneumonia during long-term follow-up period after acute ischemic stroke. We also evaluate the risk for pneumonia with use of mucoprotective agents (rebamipide, teprenone, irsogladine, ecabet sodium, polaprezinc, sofalcone, sucralfate, and misoprostol) which are used as protective agents for gastric mucosa with no or less anti-acid property.

### Methods:

We performed a retrospective cohort study using the nationwide population-based sample cohort by the National Health Insurance Service in South Korea (NHIS-NSC). Included patients were who admitted with acute ischemic stroke (ICD-10 code of 'I63') between 2002 and 2013. Primary outcome is the time to development of pneumonia determined based on ICD-10 code of 'J10-J18'. All patients were followed until development of pneumonia, death or Dec 2013, the end date of NHIS-NSC. After discharge of index stroke, use of PPI, H<sub>2</sub>RA, and mucoprotective agents were determined based on the prescription record in NHIS-NSC. We treated the use of medications during the follow-up period as time-dependent variable. Multivariate time-dependent Cox proportional hazard regression was done. Adjustments were performed for sex, age, hypertension, diabetes mellitus, prior history of myocardial infarction, atrial fibrillation, use of thrombolysis, household income, and duration of hospital stay for index stroke.

### Results:

This study included 8319 patients with acute ischemic stroke and no prior history of pneumonia. During the mean follow-up period of  $3.94 \pm 3.01$  years (mean  $\pm$  standard deviation), 2035 patients had pneumonia. In the multivariate time-dependent Cox regression, both PPI (adjusted HR [95%CI], 1.57 [1.26–1.95]) and H<sub>2</sub>RA (1.42 [1.27–1.59]) was associated with increased risk for pneumonia. Use of mucoprotective agents did not increase the development of pneumonia (0.88 [0.78–1.00]).

### Conclusions:

We demonstrated that use of acid-suppressive medication may increase risk for pneumonia in patients with ischemic stroke. Mucoprotective agents without acid-suppression did not increase the risk for pneumonia. Clinician should caution the potential risk for pneumonia following use of gastric acid-suppressive medication.

## Comparative Occurrence of Ischemic Stroke with Rhythm versus Rate Control Strategy in a National Prospective Cohort of Atrial Fibrillation

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### Purpose:

Comparative occurrence of ischemic stroke for rhythm versus rate control in patients with non-valvular atrial fibrillation (NVAF) has been still inconclusive. The aim of this study was to compare differences of ischemic stroke occurrence between the rhythm and rate control strategies in AF patients.

### Methods:

The CODE-AF registry prospectively enrolled 6,280 consecutive patients who were treated for NVAF at 10 tertiary referral centers in South Korea. Of these, 2,513 (40.0%) NVAF patients were clinically followed up for 1-year and divided into rate control 1,233 (49.0%) and rhythm control 1280 (51.0%) group. After propensity score matching, 1,800 of these patients was compared and analyzed between rate control and rhythm control group.

### Results:

Among enrolled patients (age, 67±10 years; male, 61.8%), those treated with the rhythm control group were younger, and had less proportions of underlying disease compared to those treated with the rate control strategy. However, after propensity score matching, those treated with the rhythm control group were similar in the baseline characteristics including age and CHA2DS2-VASC score compared to those treated with the rate control strategy. The rate of oral anticoagulation, all bleeding, and hospitalization were also similarly between two groups. The incidence rate of ischemic stroke in the rhythm control group was significantly lower than rate control group (0.7 vs. 6.9 per 1000 person-years, p=0.011).

### Conclusions:

In this national prospective AF cohort, the rhythm control strategy demonstrated beneficial effect to lower the risk of ischemic stroke during 1-year follow-up compared to rate control strategy.

## Development of Predictive Scale for Cardioembolic Stroke Using Immunohistologic Study of Clot Obtained by Mechanical Thrombectomy

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### Purpose:

The main purpose of this study was to analyze and compare the histopathological findings of the clots obtained from acute ischemic stroke patients by mechanical thrombectomy between the angiographic occlusion type and the conventional TOAST (Trial of Org 10172 in Acute Stroke Treatment) classification system. Another purpose was to check the possibility of these pathological findings through ancillary diagnostic tests that can be used on undetermined ischemic stroke patients.

### Methods:

From January 2013 to December 2015, the patients who underwent mechanical thrombectomy to treat acute ischemic stroke at Inje University Haeundae Paik Hospital were enrolled for this study. Among these patients, only cases with the occlusion of the intracranial internal carotid artery (ICA) and the proximal part (M1) of the middle cerebra artery (MCA) were included in this study. Histopathologic findings of clots in all patients included in this study were compared and analyzed using two classification systems. We developed a predictive scale for the cardioembolism among the undetermined stroke patients using the results from this study, including the histopathologic findings of clots. Validation of this BOCS2 scale (total 4 points) was performed using the cardioembolic criteria of the TOAST classification as the gold standard.

### Results:

A total of 90 patients with terminal ICA occlusion and proximal MCA occlusion have been recruited for 3 years. Fifty-seven patients had enough removed clots by mechanical thrombectomy for histopathologic examination, and 52 cases of these patients were able to be performed with all immunohistochemical tests. There was no significant difference in red blood cell, fibrin, and platelet fractions between the patients of the 3 groups classified by the TOAST and 2 groups according to angiographic occlusion. However, when the platelet distribution pattern was identified by CD61 immunostaining, the type was mostly peripheral pattern in the large artery atherosclerotic group or truncal-type occlusion group, whereas the cardioembolic group or branching-site occlusion group had mostly clustering pattern ( $p=0.02$  in TOAST classification;  $p=0.007$  in angiographic occlusion classification). Patients with BOCS2 scale score above 2 points (3 or 4) had a sensitivity of 93.5%, a specificity of 100%, a positive predictive value of 100% and a negative predictive value of 83.3% for cardioembolic stroke.

### Conclusions:

The BOCS2 scale developed using these results may be helpful as an adjunctive diagnostic tool for identifying cases caused by the cardiogenic embolism in undetermined ischemic stroke patients.

## Relationship Between White Matter Change and Homocysteine Concentration in Healthy Adults

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### Purpose:

The purpose of this study was to analyze the correlation between white matter change and homocysteine concentration through brain computed tomography in healthy subjects without stroke or dementia history.

### Methods:

We studied 722 out of 900 patients who had a health screening from 2016 to 2017. Based on the medical records, retrospective studies were conducted and analyzed using SPSS. After the subjects were divided into the group with and without white matter change, the population characteristics of study were analyzed.

### Results:

The mean age, homocysteine concentration and prevalence of hypertension and diabetes were higher and duration of education was shorter in the group with white matter change. When odd ratio was compared based on the lowest group (Q1), age, hypertension and hyperhomocysteinemia were independent risk factor for white matter change.

### Conclusions:

It is clinically significant that we have identified modifiable risk factors such as hypertension and hyperhomocysteinemia in order to prevent complications of white matter change. However, there has been no report of risk for the cause of hyperhomocysteinemia and relationship between white matter change and homocysteine concentration in Koreans. So, large scale prospective studies are needed based on this study.

ICSU 2018 & 1<sup>st</sup> AKJSC

## Poster Session 2

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## Compare the Intracranial Pressure Trend After the Decompressive Craniectomy Between Massive Intracerebral Hemorrhagic and Major Ischemic Stroke Patients

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### Purpose:

Massive intracerebral hemorrhage (ICH) and major infarction (MI) are devastating cerebral vascular diseases. Decompression craniectomy (DC) is a common treatment approach for these diseases and acceptable clinical results have been reported. Author experienced the postoperative ICP trend is somewhat different between the ICH and MI patients. In this study, we compare the ICP trend following DC and evaluate the clinical significance.

### Methods:

143 patients who underwent DC following massive ICH (81 cases) or MI (62 cases) were analyzed retrospectively. In all patients, ventricular puncture was done before the DC and ICP trends were monitored during and after the surgery. Outcome comparisons included the ictus to operation time (OP-time), postoperative ICP trend, favorable outcomes and mortality.

### Results:

Initial GCS ( $p=0.364$ ) and initial ventricular ICP ( $p=0.783$ ) were similar among the ICH and MI patients. The postoperative ICP of ICH patients were drop rapidly and maintained within physiological range if greater than 80% of the hematoma was removed. While in MI patients, the postoperative ICP were not drop rapidly and maintained above the physiologic range (MI =18.8 vs. ICH=13.6 mmHg,  $p=0.000$ ).

### Conclusions:

Authors propose that DC is no need for the massive ICH patient if a significant portion of their hematoma is removed. But DC might be essential to improve the MI patients' outcome and timely treatment decision.



## The Impact of P/D-mismatching in Patients Treated with Solitair Stent Retriever

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### Purpose:

Intraarterial thrombolytic therapy (IA-Tx) with retrieval stent is accepted as an additional treatment for patients, that did not recanalize after intravenous tissue plasminogen activator therapy (IV-tPA) or those not indicated for IV-tPA. The authors analyzed the clinical outcomes of IA-Tx with Solitaire device, according to P/D-mismatching or P/D-matching.

### Methods:

Eighty-one treated with IA-Tx and with the Solitaire device, that were diagnosed with anterior circulation larger vessel occlusion were included in this study. CT-angiography was done as an initial diagnostic image and acute stroke MR imaging followed after the IV-tPA and before the IA-Tx. 66 patients were in the P/D-mismatch group and 15 patients were P/D-matched group. 42 patients were in the tPA group and 39 patients were in the non-tPA group. Recanalization rate, clinically significant hemorrhagic (sICH) and clinical outcomes were recorded according to the P/D mismatching and IV-tPA.

### Results:

The recanalization rate was 91.9% in the mismatched group and 46.7% in the matched group ( $p=0.008$ ). The sICH rate was 16.7% in the mismatched group and 46.7% in the matched group ( $p=0.019$ ). A favorable outcome was 69.7% in the mismatched group, but it was 0% in P/D-matched group ( $p=0.000$ ). And recanalization rate and sICH were 81.0% and 19.9% in IV-tPA treated group, while they were 69.2% and 25.6% in non-tPA group ( $p=0.167$  and  $p=0.328$ ), respectively.

### Conclusions:

For patients treated with IA-Tx with retrieval stent, IV-tPA did not influence the recanalization rate or sICH. But P/D-mismatching correlated well with recanalization rate, sICH and clinical outcomes.

## Blood Pressure and Pulse Rate Changed Before and After Decompression Surgery; Reverse Cushing Phenomenon

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### Purpose:

Cushing reflex has been reported as the occurrence of hypertension, bradycardia and apnea following intracranial hypertension. Various pathophysiological studies, refined Cushing's findings by showing an initial tachycardia associated with hypertension before the onset of bradycardia. Therefore theoretically, it is expected that decreased ICP due to decompressive craniectomy can restore systemic blood pressure and pulse rate. And bradycardia patient outcomes may be worse than tachycardia patients.

### Methods:

60 patients who had taken decompressive craniectomy were included in this study. All of these patients were under general anesthesia, so the respiration rate and body temperature were maintained in a steady state. Systemic mean arterial blood pressure and pulse rate were compared before and after the craniectomy with 5 minute intervals. Data analyze 30 minutes before and after the decompressive craniectomy were collected.

### Results:

Intravenous tissue plasminogen activator administration (IV-tPA) is standard treatment for the acute ischemic stroke patient. Authors tried to evaluate the early recanalization rate of I.V. tPA administration in larger artery intracranial occlusion disease patients.

### Conclusions:

Early recanalization rate after IV-tPA in LAICOD patients is very low. Author would like to propose that dynamic brain CT in well-equipped stroke center as initial image study and in a selected patient such as LAICOD patients, IA-Tx might be applied as primary therapy.

## Estimation of Clinical Benefit and Care Burden of Stroke Corresponding to Window Extension of Endovascular Thrombectomy

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### Purpose:

The recent success of the DAWN and DEFUSE 3 trials has extended the therapeutic time window for endovascular treatment (EVT). Accordingly, increased care burden and clinical benefit for patients with acute stroke in emergency room are expected. It is necessary to evaluate and respond to these changes to provide the best care to the appropriate patients.

### Methods:

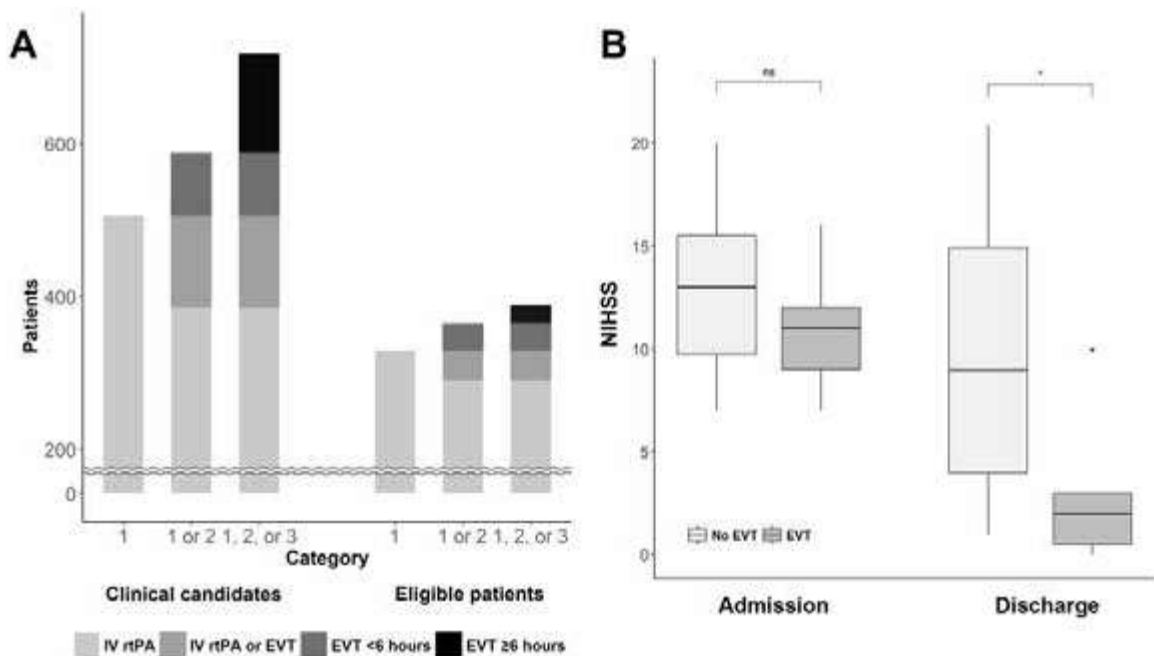
The data of patients with acute stroke or transient ischemic attack between October 2010 and September 2016 were reviewed, and clinical candidates and eligible patients were selected according to the criteria for early stroke intervention, such as intravenous thrombolysis or EVT. Clinical candidates were defined as potential patients for early stroke intervention after history taking and neurological examinations. Eligible patients were those suitable for early stroke intervention after a thorough evaluation, including laboratory and neuroimaging tests. In addition, the data of patients who received EVT after 6 hours from the disease onset were reviewed.

### Results:

There were 506 (19.8%), 588 (23.0%), and 718 (28.0%) clinical candidates and 329 (12.8%), 365 (14.3%), and 389 (15.2%) eligible patients for early stroke intervention out of 2,561 patients with stroke according to 2009, 2015, and 2018 updated stroke guidelines, respectively. Compared to previous 2015 stroke guidelines, the number of clinical candidates for early stroke intervention increased with 130 (22.1%) patients; however, the number of patients suitable for EVT increased with only 24 (6.6%) patients. Among 24 patients qualified for EVT beyond 6 hours, 7 went through “off-label” EVT and showed significantly lower discharge NIHSS scores.

### Conclusions:

The burden of acute stroke care is anticipated to increase. Although the revised stroke guidelines for early stroke intervention did not significantly increase the number of patients, it would certainly improve the outcome of eligible patients.



**(A)** Clinical candidates and eligible patients selected by criteria of the category 1, 2, and 3: 506 (19.8%) of 2,561 patients were suitable for category 1 clinical candidates and 588 (23.0%) patients were clinical candidates who meet the criteria of category 1 or 2. The number of clinical candidates satisfying at least one of the criteria of category 1, 2, or 3 was 703 (27.5%). A total of 329 (12.8%), 365 (14.3%), and 385 (15.0%) patients were eligible by criteria of category 1, category 1 or 2, and category 1, 2, or 3, respectively.

**(B)** Neurologic status at admission and discharge according to "off-label" EVT beyond 6 hours of LKN time. Initial deficits were similar in both groups; however, neurological symptoms at discharge were significantly improved in those who received "off-label" EVT. The horizontal line inside the box represents the median, the box shows the interquartile range, and the vertical lines present the interquartile range extended to 1.5 times.

\* $p < 0.05$

EVT, endovascular treatment; IV rtPA, intravenous recombinant tissue plasminogen activator; LKN, last known normal; NIHSS, the National Institutes of Health Stroke Scale

## Aspirin Versus Aspirin Plus Clopidogrel Following Endovascular Treatment of Acute Ischemic Stroke

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### Purpose:

An antiplatelet drug strategy following endovascular treatment (EVT) in acute ischemic stroke has been depended on the physician's decision and their clinical effectiveness is poorly investigated.

### Methods:

From the prospective, multicenter stroke registry of comprehensive research center for stroke – Korea (CRCS-K), patients treated with EVT due to symptomatic occlusion of middle cerebral artery and internal carotid artery were retrospectively identified between January 2012 and January 2016. Those experienced major bleeding within 24 h were excluded. Based on first antiplatelet drug, they were divided into aspirin mono user (ASA) and aspirin and clopidogrel dual user (DUAL). The imbalances of baseline characteristics between groups were stabilized using the inversed probability of treatment weighting (IPTW) method. Primary outcome defined as a 3-month good outcome (modified Rankin Scale  $\leq 2$ ) were compared by groups with consideration of predetermined confounders.

### Results:

The comparisons of baseline characteristics of ASA (n = 375) and DUAL (n = 242) showed the significant imbalances in preceding intravenous thrombolysis, diabetes mellitus, dyslipidemia, atrial fibrillation and stroke subtypes. They were stabilized by applying the IPTW (Table). The DUAL did not show a significant association with primary outcome compared to the ASA (adjusted odds ratio, 1.17, 95% confidence interval, 0.84 – 1.64) with adjustments by age, sex, baseline NIHSS score, stroke subtypes, intravenous thrombolysis and successful recanalization.

### Conclusions:

The antiplatelet regimen would not make a significant effect after endovascular treatment.

Table. Comparison of baseline characteristics between DUAL and ASA

Variables	Before IPTW			After IPTW		
	ASA (n = 375)	DUAL (n = 242)	SMD	ASA (n = 375)	DUAL (n = 242)	SMD
Male	202 (53.9%)	153 (63.2%)	0.02	218.6 (57.6%)	132.5 (55.3%)	0.05
Age, y, mean $\pm$ SD	68.5 $\pm$ 13.4	67.6 $\pm$ 12.1	0.07	68.3 $\pm$ 13.4	68.2 $\pm$ 12.2	0.01
Baseline NIHSS, mean $\pm$ SD	13.8 $\pm$ 6.6	13.6 $\pm$ 6.7	0.69	13.9 $\pm$ 6.6	14.0 $\pm$ 6.6	0.02
Recanalization method			0.16			0.02
Combined	250 (66.7%)	143 (59.1%)		237.5 (62.6%)	152.5 (63.6%)	
Hypertension	214 (57.1%)	173 (71.5%)	0.30	240.1 (63.3%)	149.1 (62.2%)	0.02
Diabetes mellitus	76 (20.3%)	61 (25.2%)	0.12	80.6 (21.2%)	49.1 (20.5%)	0.02
Dyslipidemia	76 (20.3%)	64 (26.4%)	0.15	88.9 (23.4%)	57.3 (23.9%)	0.01
Atrial fibrillation	192 (51.2%)	48 (19.8%)	0.69	145.6 (38.4%)	93.0 (38.8%)	0.01
Stroke subtypes			0.76			
Large artery disease	60 (16.1%)	115 (47.5%)		114.2 (30.1%)	71.3 (29.7%)	
Cardioembolism	207 (55.6%)	66 (27.3%)		164.5 (43.4%)	104.2 (43.5%)	
Other determined	6 (1.6%)	6 (2.5%)		6.6 (1.7%)	4.2 (1.7%)	
2 or more	22 (5.9%)	11 (4.5%)		21.4 (5.7%)	14.3 (6.0%)	
Negative	46 (12.4%)	20 (8.3%)		39.9 (10.5%)	25.6 (10.7%)	
Incomplete	31 (8.3%)	24 (9.9%)		32.7 (8.6%)	20.0 (8.4%)	
Successful recanalization	259 (69.6%)	167 (69.0%)	0.05	270.1 (71.2%)	172.1 (71.8%)	0.01

The SMD of covariates before and after PS analysis with stabilized IPTW were compared using the Generalized estimating equation.

IPTW was abbreviated for inversed propensity treatment weighting, SMD for standardized mean difference, NIHSS for National Institute of Health for Stroke Scale and SD for standard deviation.

## **Blood Glucose Level on ER Arrival is Associated with Hemorrhagic Conversion, According to Intravenous Thrombolysis, in Patients with Successful Recanalization by Mechanical Thrombectomy**

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### **Purpose:**

Elevated blood glucose level (BGL) is known to be related to hemorrhagic conversion (HC) after reperfusion therapy. There is some difference in relationship of HC and BGL between intravenous thrombolysis and endovascular treatment (EVT). However, the effect of BGL on HC, according to intravenous thrombolysis remains uncertain, especially in patients with successful recanalization after EVT.

### **Methods:**

A consecutive 211 patients with occlusion of major cerebral artery and successful recanalization from three centers were included for the analysis between 2013 and 2017. The information on the clinical findings was reviewed retrospectively. We compared the association of blood BGL and HC, between group of mechanical thrombectomy only and combined therapy.

### **Results:**

Among the included patients, 23 patients (10.9%) developed major HC over the first 24 hours after successful recanalization. Univariate analysis showed that fasting BGL was associated with HC and BGL on ER arrival had the tendency to increased HC among total patients enrolled. The history of diabetes mellitus was not related to HC. Among the patients with intravenous thrombolysis and EVT, the HC had the tendency to the high fasting glucose level, although initial BGL was not related. However, among the patients with EVT only, the incidence of HC was higher in the patients with high BGL on ER arrival with marginal significance.

### **Conclusions:**

Our results suggested that the effect of serum glucose level on HC was different according to the intravenous thrombolysis treatment, in the patients with recanalization after EVT. In the patients with intravenous thrombolysis, the control of BGL during the intravenous actylase infusion might be more important for the prevention of HC.



## Characteristics of the Degree of Early Neurological Deterioration in Acute Ischemic Stroke

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### Purpose:

Early neurological deterioration (END) in acute ischemic stroke occurs within a few hours or a few days after the onset of symptoms and is caused by various pathophysiological mechanisms. The purpose of this study is to investigate the cause of cerebral infarction, and the association of risk factors for END.

### Methods:

This is a retrospective study of patients with acute cerebral infarction who were admitted to our hospital from January 2010 to December 2015. Subjects were included in the study when acute cerebral infarction was identified in diffusion-weighted magnetic resonance imaging patients. The definition of END means that the National Institutes of Health Stroke Scale score is increased more than 1 point in the intensive care unit within 72 hours of symptom onset. In this study, we analyzed according to each score group.

### Results:

According to the location of the lesion, the lesions in the lenticulostriate artery and middle cerebral artery regions were more likely to cause END. Patients with greater score changes had more cardioembolic infarction with arrhythmia. Patients with worsening symptoms also had a longer hospital stay and had a higher rate of receiving Intensive Care Unit (ICU) treatment. Many patients had cardiac dysrhythmia and the proportion of patients with vascular stenosis was also high.

### Conclusions:

END was different according to the location of lesion and more frequently occurred in patients with cardioembolic infarction. These symptoms may lead to ICU treatment and death, so it is important to identify the triggering factors and to cope early.

## Image to Door Time Gradually Decreased in Acute Ischemic Stroke Transferred for Revascularization in Busan Regional Stroke Center

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### Purpose:

An implementation of regional networking for urgent stroke care is a most critical purpose to build up a regional comprehensive stroke center. A delay of transfer patients with acute stroke needed emergent revascularization is a huge hurdle for efficacy of revascularization. Particularly, after 2015 showing successful 5 trials for mechanical thrombectomy, it has been focused a rapid transfer system for acute stroke patients into a regional comprehensive stroke. This study showed changes of transportation time calculated by image to door time (from checking brain images at first contact hospital into arriving our emergency center) before and after 2015.

### Methods:

This study was performed in retrospective manner from 2013 into 2017. We collected 806 AIS patients having IV t-PA and/or mechanical thrombectomy during observation period.

### Results:

Of those patients, we selected 205 patients with revascularization under ‘drip and ship’ or ‘ship and drip’ paradigm. Among 205 patients, 73 patients treated under Drip and Ship and 132 under Ship and Drip manner. It has a trend that ‘Ship and Drip’ manner was increased during observation period in our Busan metropolitan area. In 2013, 35 patients (from 18 hospitals, mean distance 25.5 km) transferred to our regional stroke center and their mean I to D time was  $123 \pm 60$  min. Their time parameter was gradually decreased after 2015. At 2017, I to D time was significantly shortened into  $96.0 \pm 46.0$  min ( $p < 0.05$ ) without significant changes of its transfer distance. However, the onset to arrival time and severity of neurologic deficits in transferred AIS patients were no any differences before and after 2015 in our stroke region.

### Conclusions:

Our results implicated that many hospitals in our stroke region might have recognized an importance of rapid transportation for AIS after 2015. Also, we need to set up more sophisticated networking system for urgent stroke care in Busan metropolitan area.

## Optimal Blood Pressure After Acute Ischemic Stroke in Patients Treated with Thrombolysis

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### Purpose:

The optimal blood pressure (BP) 24–72 h after acute ischemic stroke (AIS) has not yet been defined in patients treated with thrombolysis. We investigated the relationship between mean BP at 24–72 h post-AIS and clinical outcomes in patients treated with thrombolysis, especially those with recanalization.

### Methods:

This prospective cohort study evaluated data from consecutive patients with AIS admitted to a comprehensive stroke center between January 2007 and December 2016. The primary outcome was measured using the modified Rankin Scale (mRS) 3 months after AIS and was based on mean systolic BP (SBP) at 24–72 h post-AIS. Favorable outcome was defined as mRS scores of 0–2 (functional independence). Secondary outcomes included the occurrence of symptomatic intracranial hemorrhage (sICH) and early clinical outcomes.

### Results:

A total of 1540 patients treated with thrombolysis were enrolled in the study. There was a significant linear association between mean BP 24–72 hours and the mRS scores 3 months after AIS. Favorable outcomes occurred more frequently in patients with BP  $\leq$  130/80 mmHg, and the risk of sICH and early neurological deterioration was lower in this optimal BP group. Multivariable analysis showed a significant association between mean BP  $\leq$  130/80 mmHg at 24–72 h and favorable outcomes 3 months after AIS. Prespecified subgroup analyses showed that BP  $\leq$  130/80 mmHg during the 24–72 h period post-AIS has a more significant impact on clinical outcome in patients with recanalization than in those without recanalization.

### Conclusions:

These data indicate that BP  $\leq$  130/80 mmHg at 24–72 h post-AIS is independently associated with favorable outcomes in patients treated with thrombolysis, particularly in those with recanalization.

## Associations of Various Blood Pressure Parameters with Functional Outcomes After Endovascular Thrombectomy in Acute Ischemic Stroke

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### Purpose:

High blood pressure (BP) at presentation is associated with poor outcomes in acute ischemic stroke (AIS), but serial BP measurements may better delineate the clinical implications of BP. We aimed to investigate the association between various BP parameters and functional outcomes in AIS patients treated with endovascular thrombectomy (EVT).

### Methods:

This study consisted of an analysis of a prospective registry from a comprehensive stroke center between January 2011 and September 2016. Patients treated with EVT due to large vessel occlusion in the anterior circulation were enrolled. BP was measured hourly during the first 24h after admission. Associations of various BP parameters, including BP variability, with functional outcomes at 3m, including good outcomes (modified Rankin Scale [mRS] score 0-2), were analyzed.

### Results:

Of the 378 enrolled patients (mean age; 70±11yrs, male; 54.2%), 313 (82.8%) achieved successful reperfusion after EVT, and 149 (39.4%) had good outcomes at 3m. Higher mean SBP (each 10 mmHg increase; OR 0.82 [0.69-0.97]) and higher systolic successive variation (SV) (each 10% increase; OR 0.37 [0.18-0.76]) were associated with a reduced likelihood of achieving good outcomes. In addition, reperfusion status after EVT could moderate the influence of higher systolic SV on good outcomes (Pint=0.05). Briefly, among patients with successful reperfusion, those with a higher systolic SV were less likely to achieve good outcomes at 3m (OR 0.27 [0.12-0.61]), whereas no association was observed between higher systolic SV and good outcomes among patients without successful reperfusion (OR 0.94 [0.34-2.63]).

### Conclusions:

The results showed that a higher mean SBP and systolic SV during the first 24h of EVT reduced the likelihood of good outcomes at 3m. The effects of these parameters on outcomes are more substantial among patients with successful reperfusion after EVT, suggesting that different BP control strategies according to reperfusion status might be needed.

## Time to Antithrombotic Therapy in Ischemic Stroke and Transient Ischemic Attack (TIA)

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### Purpose:

There has been emphasis on timely administration of thrombolysis and clot retrieval but not antithrombotic therapy for ischaemic stroke. The frequency of antithrombotic administration within 48 hours among patients with transient ischemic attack (TIA) was 73% in Australia, while among patients with ischaemic stroke this ranged from 21% in New Zealand to 95% in North America. We plan to assess factors associated with time to antithrombotic therapy.

### Methods:

Retrospective study of admissions to the stroke unit at Monash Medical Centre over 12 months in 2015. We collected data on demographic variables, admission diagnoses, time to triage, imaging, and time to administration of antithrombotic. We plot the cumulative event of patients receiving antithrombotic therapy against the time to administration.

### Results:

There were 514 patients (age 72.9±14.7) who had an ischaemic event, TIA (n=75) or ischaemic stroke (n=439). Of those with ischaemic stroke, 70.8% of the patients were started on antithrombotic therapy by 24 hours and 92.0% by 48 hours. The use of thrombolytic therapy and nil by mouth status were associated with delay in commencing antithrombotic (p<0.001). Of those with TIA, 54.7% received antithrombotic therapy within 12 hours, 86.7% within 24 hours and 98.7% at 48 hours. There was no weekend effect (p=0.9) or after hour effect (p=0.6) on the time to antithrombotic.

### Conclusions:

The proportion of patients with ischaemic stroke or TIA receiving antithrombotic therapy within 48 hours was higher than previously reported in Australia and New Zealand. Our data are comparable to the high standard set by North American hospitals.

## Lack of Association Between Low Cumulative Dose of Voluven and Acute Kidney Injury in Patients with Acute Ischemic Stroke

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### Purpose:

Voluven, a synthetic colloid, is associated with severe renal injury in patients with sepsis. However, a small dose of voluven (6%, 130/0.4) has sometimes been used as a volume expander in patients with acute ischemic stroke. Therefore, we investigated whether a small dose of voluven was linked with renal deterioration in patients with acute ischemic stroke.

### Methods:

A consecutive 420 patients with acute ischemic stroke within 7 days from onset were included between January 2012 and April 2016. We collected admission serum creatinine (SCr), estimated glomerular filtration rate (eGFR), and renal function was assessed using KDIGO definition of acute kidney injury on hospital day 7. Proportion of patients with good functional outcome (mRS 0-2) at 90 days were compared between voluven group and controls.

### Results:

Among the included patients (mean age, 68.5; male, 54.3 %), 71 patients (16.9 %) were treated with voluven (median cumulative dose,  $1.5 \pm 0.2$  L). Initial SCr was lower ( $0.78 \pm 0.45$  vs.  $1.19 \pm 1.24$ ,  $P = 0.022$ ) and eGFR was higher ( $87.3 \pm 24.1$  vs.  $73.4 \pm 29.4$ ,  $P < 0.001$ ) in voluven group compared with controls. The rate of AKI was not different between voluven group and control (1.41% vs. 1.43 %,  $p = 0.477$ ). Moreover, use of voluven decreased SCr ( $0.06 \pm 0.19$ ,  $P = 0.009$ ; paired t test) and increased eGFR ( $9.57 \pm 19.81$ ,  $P < 0.001$ ; paired t test) similar to control group (SCr,  $-0.12 \pm 0.64$ ,  $P < 0.001$ ; eGFR,  $6.94 \pm 19.07$ ,  $P < 0.001$ ). Voluven treatment did not lead to better functional outcome after 3 months of acute ischemic stroke (57.7% vs. 62.8%,  $P = 0.425$ ).

### Conclusions:

Voluven did not negatively affect renal outcome in patients with acute ischemic stroke if voluven was used with a small dose.

## Effect of Imaging and Telemedicine on Operation of Mobile Stroke Unit for Stroke Codes

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### Purpose:

It is important to optimize parameters for using mobile stroke unit (MSU) to deliver recombinant tissue plasminogen activator (TPA) at the patient's location and expedite endovascular clot retrieval (ECR). Several models of mobile stroke unit (MSU) are currently in existence. The Berlin model operates MSU with a 16 minutes radius from base. However, other models have not defined a clear distance from the treating hospital. Unexplored questions in the use of MSU include, maximal distance from base, limit with regards to the use CT imaging, CT Angiography, CT Perfusion and Telemedicine. We developed a computational model as an app (<https://gntem3.shinyapps.io/ambmc/>), taking into account traveling time, to explore this issue.

### Methods:

There are 2 Melbourne hospitals (Royal Melbourne Hospital/RMH, Monash Medical Centre/MMC) designated to provide ECR. In these spatial simulations, the MSU is based at RMH and delivers TPA at the patient's location and returns to base for ECR. We extract geocode of suburbs in Melbourne using ggmap, an interface to Google Map API. Next, we obtain travel time from these locations to each hospital. The app contains widgets for varying the processing time at the patient location (default=20 minutes), performing CT angiography (default=10 minutes), performing telemedicine consultation (default=15 minutes). The data were compared against those for usual ambulance metrics (default traveling time =15 minutes, processing time at patient's location =10 minutes, door to TPA=30 minutes, door to groin=60 minutes). Varying the widgets allow the viewer to explore the trade-off between the variable of interest and time to therapy at a suburb level.

### Results:

In spite of the large area, MSU is superior for delivering TPA to all Melbourne suburbs (76 minutes from RMH) as long as the combined processing and imaging time is < 60 minutes. However, it was superior for providing ECR to only 39.3% of suburbs if the return base is RMH and 63.9% if the return base is both RMH and MMC. Addition of CT perfusion or telemedicine consult, affect ability of a single hospital to provide ECR service but not TPA if CT perfusion or telemedicine can be limited to 35 minutes. If the door to groin is 70 minutes for usual ambulance metrics, then MSU is superior to this in 93.4% of suburbs.

### Conclusions:

Effect of imaging and telemedicine on operation of Mobile Stroke Unit for Stroke Codes



## Stroke Mimics and Chameleons When Activating Stroke Code

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### Purpose:

When encountering a suspected stroke patient in the emergency room, stroke code activation should occur. However, it is challenging to distinguish patients with acute stroke (AS) in a short time in an emergency. We aimed to determine the frequency and characteristics of stroke mimics (false positive cases, AS-M) and stroke chameleons (false negative cases, AS-C), and identify the key clinical features.

### Methods:

All consecutive patients admitted in the emergency room with stroke code between April 2016 and December 2017 were included for the analysis. Patients with a sudden onset of neurological deficit in a time window less than 8 hours were accepted in the stroke code pathway. After a neurological evaluation and brain MRI imaging, stroke mimics (AS-M) were determined by an expert neurologist. To distinguish stroke chameleons (AS-C), we retrospectively reviewed all patients with acute ischemic stroke from the prospectively constructed acute stroke registry (Korean Stroke Registry of Seoul National University Hospital). Stroke chameleons were defined as failure to suspect stroke or incorrect exclusion of stroke at the emergency department.

### Results:

The mean age of included patients was 65.7, and 57.1 % were male. Among the all included patients, 443 patients were correctly diagnosed as AS, 205 patients were non-stroke patients (AS-M), and 37 patients were missed stroke code activation (AS-C) at the initial screening. The positive predictive value of stroke code activation was 68.4%, and the sensitivity was 92.3%. In the AS-M patients, the most frequent discharge diagnosis was epilepsy (19.5%), brain tumor (10.2%), drug-related encephalopathy (9.8%), and metabolic encephalopathy (8.3%). In the AS-C patients, the initial diagnosis was mistaken for non-stroke for the following reasons: only dizziness symptoms (32.4%), visual symptoms (13.5%), and headache (8.1%).

### Conclusions:

While over-diagnosis of stroke can result in an economic burden on patients, the failure to diagnosis stroke may preclude time-sensitive treatments. This study demonstrated that the frequency and characteristics of stroke mimics and chameleons. These findings may be used to raise awareness in emergent setting to recognize and treat such patients appropriately.

## Epicardial Adipose Tissue Thickness and a Short-term Functional Outcome in the Acute Ischemic Stroke

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### Purpose:

Epicardial adipose tissue (EAT) is one of the markers of visceral adiposity, associated with inflammation and correlated with major adverse cardiovascular event. Also, EAT is easy to measure on the bedside. We assessed whether EAT could be a prognostic factor in the acute ischemic stroke patients.

### Methods:

Consecutive data were collected retrospectively at the Seoul National University Hospital (SNUH). A total of 98 patients with ischemic stroke who admitted at the SNUH between May 2016 and June 2016 and performed Echocardiography during the admission were enrolled. We measured an epicardial adipose tissue thickness on the free wall of the right ventricle in end-diastole. And we defined poor functional outcome as modified Rankin Scale (mRS) 3-6.

### Results:

Among the total patients, 63.3% were male, with a mean age of 69.2 years. Seventy three (74.5%) patients showed good functional outcome (mRS 0, 1, 2) and twenty five (25.5%) were poor functional outcome (mRS 3-6) after 3 months of stroke. The patients with poor outcome tended to be low body weight (65.36 vs 60.42;  $p=0.028$ ). Higher epicardial adipose tissue (EAT) thickness had a tendency to be associated with a poor functional outcome after 3 months, but not statistically significant (6.68 vs 8.40;  $p=0.07$ ).

### Conclusions:

Higher epicardial adipose tissue (EAT) thickness is a possible prognostication factor of the acute ischemic stroke. EAT thickness can be a useful tool for the prognostication of the acute ischemic stroke.

## Implementation of Multimodal CT for Acute Stroke Treatment in a Telestroke Network

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<sup>1</sup> Acute Stroke Services, Neurology, John Hunter Hospital, University of Newcastle, Newcastle, NSW, Australia

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<sup>3</sup> Neurology, Melbourne Brain Centre - Royal Melbourne Hospital, University of Melbourne, Melbourne, VIC, Australia

### Purpose:

Multimodal brain CT to identify reperfusion therapy responders is now “best-evidence practice” in acute ischemic stroke. CT Perfusion (CTP) in particular, is especially useful for excluding stroke mimics as well as a tool to select optimal candidates for thrombolysis and clot retrieval. Nevertheless, CTP is generally available only in tertiary stroke centers. John Hunter Hospital (New South Wales, Australia) is the Comprehensive Stroke Centre for a population of 920,370 inhabitants, spread across 131,785 km<sup>2</sup> (similar area to England). A telestroke network with five spoke hubs has been developed, with an average distance between the spoke centre and the hub of 284 km, all centres have CTP capability 24/7. We describe our experience using CTP in rural hospitals, including rate of thrombolysis and outcome.

### Methods:

Consecutive patients assessed with via telemedicine from April 2013 to January 2018. The stroke call criteria was initially defined as FAST+ within the 4.5 hours window. In mid-2017 the NIHSS scale was started to be used as triage tool ( $\geq 4$  points). In November 2017, the time window of the stroke call was expanded to 24 hours. Clinical data was retrospectively collected from April 2013 to June 2016, and prospectively thereafter. The primary outcome was independence 3 months post-stroke (modified Rankin scale 0-2).

### Results:

In the 2013-2018 period, 200 patients were assessed, 132 of them with CTP. Forty of the CTP patients were thrombolysed (30.3%). The mean age was 69 years (range 56) and 67.5% were male. The median baseline NIHSS was 10 (IQR 7-19). Of the treated patients, 31 (77.5%) had a large vessel occlusion; 52.6% were independent at three months and 15.8% were dead. The median door to treatment time was 86 minutes (IQR 71-103) and the median “Call to Stroke Neurologist to Treatment” time was 67 minutes (IQR 52-85). Outcomes were very similar to the SITS-MOST registry. With similar baseline populations, mRS 0-2 at 3 months after stroke was 55% in SITS-MOST compared to 52.6% in our population. 16% of the SITS-MOST patients were bedridden/dead after stroke, compared to our 18.4%. Our rate of symptomatic intracranial haemorrhage was 2.5% compared to 7.3% in SITS-MOST.

### Conclusions:

Implementation of CTP in the rural hospitals for alteplase delivery is feasible and leads to higher treatment rates with low rate of complications. Similar outcomes are achieved for the thrombolysed group, despite exclusion of stroke mimics and already reperfused patients in our study by use of CTP.

## Concomitant Psychiatric Symptoms with Patients Visiting Neurologic Outpatient Department

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### Purpose:

In patients visiting neurologic outpatient department, depression and anxiety are frequently accompanied and these psychiatric problems might reduce the quality of life. Therefore, physicians should pay attention to the proper treatment for these conditions. The aim of this study was to evaluate the different psychiatric characteristics according to the disease subtype in the outpatient setting.

### Methods:

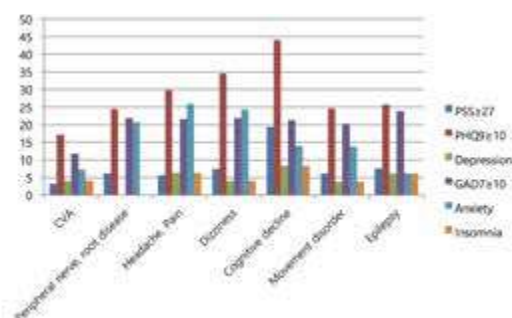
We analyzed a total of 762 patients who went outpatient with neurologic symptoms. Concomitant depression was defined as patients who were previously diagnosed or those who were taking medications. Anxiety was captured through medical records or was defined as patients who were taking anxiolytics. In addition, we assessed each patients' stress, depression, and anxiety using different measures such as perceived stress scale (PSS), patient health question-9 (PHQ-9), generalized anxiety disorder-7 (GAD-7).

### Results:

Compared to patients with epilepsy, subjects with cerebral infarction or cognitive decline were older. Severe stress (PSS $\geq$ 27) was the most frequent in patients with cognitive decline (19.4%), followed by epilepsy (7.6%) and dizziness (7.4%). Although anxiety seems to be captured accordingly, there are some discrepancy between known depression (4.7%) and captured moderate to severe depression (26.9%). Moderate to severe depression (PHQ-9 $\geq$ 10) was the most frequent in patients with cognitive decline (44.1%), followed by dizziness (34.5%) and headache/pain (29.8%). Moderate to severe anxiety (GAD-7 $\geq$ 10) was the most frequent in patients with epilepsy (23.8%), followed by dizziness (21.8%) and peripheral nervous disease (21.8%).

### Conclusions:

Interestingly, the intensity of accompanying neuropsychiatric symptoms varies according to the type of neurological disease. In elderly patients with cognitive decline, those may not actually receive appropriate treatment for depression or anxiety. However, because psychiatric problems including depression or anxiety have a profound effect on the quality of life of the patient, the physician should pay more attention to detect these hidden psychiatric symptoms.



## Inter-arm Blood Pressure Difference is Associated with Poor Functional Outcome and Recurrent Stroke in Non-cardioembolic Stroke Patients

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### Purpose:

Inter-arm blood pressure difference is associated with occurrence of stroke, peripheral artery disease and mortality. Stroke is one of leading cause of disability in worldwide and this disability may cause serious burden to patients themselves and their care-giver. Recurrent strokes also increase patient mortality and exacerbate the disability. We hypothesized that increased inter-arm blood pressure difference would be related to long-term poor functional outcome and recurrent stroke.

### Methods:

A total of 1226 consecutive non-cardioembolic ischemic stroke patients, in whom bilateral brachial blood pressures were checked from the ankle-brachial index automatically measuring device, were included for our study. Poor functional outcome was defined as modified Rankin scale  $\geq 3$ .

### Results:

The inter-arm systolic, diastolic blood pressure difference  $\geq 10$  mmHg were noted in 13.2% (162/1226), 5.5% (68/1226), respectively. During median 24 months (interquartile range 16–34 months), 303 (24.7%) patients had poor functional outcome. In multivariate analysis, inter-arm blood pressure difference  $\geq 10$  mmHg were significantly related with poor functional outcome (hazard ratio: 1.48, 95% confidence interval: 1.11–1.99,  $p=0.008$  for systolic blood pressure; hazard ratio: 3.14, 95% confidence interval: 2.20–4.48,  $p=0.001$  for diastolic blood pressure, respectively). The 127 (10.3%) patients were experienced recurrent stroke during median 23 months follow up. Patients who had both inter-arm systolic and diastolic blood pressure difference  $\geq 10$  mmHg were also associated with recurrent stroke (hazard ratio: 4.26, 95% confidence interval: 2.53–7.19,  $p=0.004$ ) in multivariate analysis.

### Conclusions:

The inter-arm blood pressure difference  $\geq 10$  mmHg could be a useful indicator of risk of long-term functional outcome and recurrent stroke in non-cardioembolic stroke patients.

## Inter-arm Blood Pressure Difference is Associated with Early Neurological Deterioration in Non-cardioembolic Stroke Patients

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### Purpose:

Inter-arm systolic and diastolic blood pressure differences (IASBD and IADBD) are found in various populations. END is generally defined as neurological worsening of acute ischemic stroke and is associated with poor prognosis. We hypothesized inter-arm systolic and diastolic blood pressure differences would be associated with early neurological deterioration (END).

### Methods:

In total, 1,008 consecutive non-cardioembolic cerebral infarction patients who were admitted within 24 hours of onset and had an automatic measurement of blood pressure from bilateral arms were included. END was assessed within 72 hours of stroke onset according to predefined criteria. An absolute blood pressure differences in both arms were defined as IASBD and IADBD.

### Results:

END occurred in 15.3% (155/1008) of patients. A multivariate analysis after adjustment for sex, age, and variables which had p value <0.1 in a univariate analysis (smoking, coronary artery disease, left ventricular hypertrophy, prior statin medication, stroke severity, cerebral atherosclerosis, high-grade white matter hyperintensities, thrombolytic therapy, white blood cell count, and brachial ankle pulse wave velocity) revealed that IASBD  $\geq 10$  mmHg was significantly associated with END [odds ratio (OR): 1.75, 95% confidence interval (CI): 1.02–3.01, p=0.041]. An IADBD  $\geq 10$  mmHg was significantly related to END (OR: 3.11, 95% CI: 1.61–5.99, p=0.001).

### Conclusions:

Our study demonstrated that IASBD  $\geq 10$  mmHg and IADBD  $\geq 10$  mmHg were independently associated with END. If IABD  $\geq 10$  mmHg were noted in acute non-cardioembolic stroke, it is necessary to consider the possibility of the occurrence of the END.

## Inter-arm Blood Pressure Difference is Diversely Associated with Presence and Burden of Cerebral Small Vessel Diseases in Non-cardioembolic Stroke Patients

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### Purpose:

Inter-arm blood pressure difference (IABD) is independently related with occurrence of cardiovascular disease and mortality. Cerebral small vessel diseases (SVD) are important risk factors for stroke, cognitive dysfunction, and mortality. We aimed to investigate that whether IABD was related with the cerebral SVD in non-cardioembolic stroke patients.

### Methods:

In our study, 1205 consecutive non-cardioembolic ischemic stroke patients who confirmed by brain MRI and performed simultaneous bilateral brachial blood pressures examination from Vascular Profiler-1000 device were included. We investigated cerebral SVD as high-grade white matter hyperintensities (HWHs), presence of cerebral microbleeds (CMBs), high-grade perivascular spaces (HPVSs), and asymptomatic lacunar infarctions (ALIs) on brain MRI.

### Results:

In multivariate logistic regression, inter-arm systolic blood pressure difference (IASBD)  $\geq 15$  mmHg was associated with the presence of HWHs (odds ratio (OR):3.37, 95% confidence interval (CI):1.58-7.11,  $p=0.002$ ), HPVSs (OR:2.23, 95% CI:1.04-4.75,  $p=0.024$ ) and ALIs (OR:2.12, 95% CI:1.02-4.41,  $p=0.006$ ), but not with presence of CMBs. Inter-arm diastolic blood pressure difference (IADBD)  $\geq 10$  mmHg was also related with presence of HWHs and ALIs, but not with presence of CMBs and HPVSs. In multivariate linear regression adjusted for age, sex and  $p < 0.1$  in univariate analysis, IASBD, IADBD  $\geq 10$  mmHg was significantly correlated with increased total burden of SVD ( $\beta=0.080$ ,  $p=0.006$  and  $\beta=0.065$ ,  $p=0.023$ , respectively).

### Conclusions:

The IABD  $\geq 10$  mmHg in patients with non-cardioembolic stroke could be a useful indicator of cerebral SVD, poor functional outcome and mortality.



## Direct Visit to Comprehensive Stroke Center Reduces Time Delay in Thrombolytic Therapies for Acute Ischemic Stroke

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### Purpose:

The benefit of thrombolytic therapies for acute ischemic stroke is time-dependent. However, since many hospitals are not capable of thrombolytic therapies, patients are often transferred to comprehensive stroke center, resulting in a time delay for treatment. We evaluated the differences of time intervals in thrombolytic therapies between directly admitted and referral patients.

### Methods:

Between July 2014 and February 2018, we identified stroke patients who received intravenous rtPA within 4.5 hours and/or endovascular thrombectomy within 6 hours after symptom onset. We divided stroke patients into two groups; those who visit our center directly and those who were referral from outside hospitals. All of the baseline characteristics and the time variables were compared between two groups. We also evaluated factors associated with favorable outcome at 3 months.

### Results:

A total of 382 (mean age, 69.0±11.4; male, 52.5%) patients who received thrombolytic therapies within therapeutic time window were included in this study. While 108 (28.2%) patients were referred from other hospitals, 275 (71.8%) patients visited our hospital directly. Patients with direct visit were faster in thrombolytic therapies by onset-to-needle (126 versus 163 minutes,  $p < 0.001$ ) time and onset-to-puncture time (194 versus 226 minutes,  $p < 0.001$ ) compared with referral group. Lower age (OR, 0.94; 95% CI, 0.91-0.97;  $p < 0.001$ ), lower NIHSS score (OR, 0.86; 95% CI, 0.82-0.90;  $p < 0.001$ ), and direct visit to our center (OR, 1.78; 95% CI, 1.03-3.11;  $p = 0.041$ ) were independently associated with favorable outcome at 3 months on multivariate analysis.

### Conclusions:

Direct visit to comprehensive stroke center bypassing local hospitals reduced time delay to thrombolytic therapies and improved favorable outcome of patients with acute ischemic stroke.

## Cerebral Angiography through Radial Artery; Merit and Demerit

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<sup>1</sup>Neurosurgery, St. Paul's Hospital, The Catholic University of Korea, College of Medicine., Seoul, Korea

### Purpose:

Trans-radial angiography is convenient for patient, wound are very small and move as soon as finished the study. Authors tried to evaluate the merits and demerits of radial angiography.

### Methods:

Two patients, who studied cerebral angiography through the radial artery, were retested cerebral angiography through the femoral artery. One patient was coil treatment at 2008, and follow up the cerebral angiography through radial artery. The other patient tested cerebral angiography through the radial artery 2 years ago and diagnosis as ICA cavernous stenosis.

### Results:

Two patients, who studied cerebral angiography through the radial artery, were retested cerebral angiography through the femoral artery. One patient was coil treatment at 2008, and follow up the cerebral angiography through radial artery. The other patient tested cerebral angiography through the radial artery 2 years ago and diagnosis as ICA cavernous stenosis.

### Conclusions:

Radial angiography is convenient for diagnostic angiography. Thin diagnostic catheter less invasive for approach, no need to long bed rest, easy to move after study. But radial angiography is limited for interventional treatment, hard to fine selection angiography. Above all, injected contrast media amount and time, it make laminar flow and make image confusion. Authors thought that cerebral angiography through radial artery is applied in some limited cases.

## Mechanical Thrombectomy in Large Stroke (DWI-ASPECT<6) within Three Hours of Onset Time: Is it Worthwhile? – Single Center Case Series

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### Purpose:

Whether to withhold mechanical thrombectomy when the diffusion-weighted imaging (DWI) lesion exceeds a given volume is undetermined. Our aim was to identify favorable factors in large ischemic stroke [DWI Alberta Stroke Program Early Computed Tomography Score (DWI-ASPECTS)  $\leq 5$ ] that may benefit from the mechanical thrombectomy (MT) within 3 hours of onset time.

### Methods:

From May 2010 to November 2016, 82 acute ischemic stroke patients with DWI-ASPECTS  $\leq 5$  (43 patients) were identified. 29 patients came with large stroke (DWI-ASPECTS  $\leq 5$ ) within 3 hours of onset time.[Figure 1] Recanalization was defined as a TICI grade 2B-3 and significant hemorrhagic transformation as parenchymal hematoma type 2. Pretreatment variables were compared between patients with a good outcome (modified Rankin Scale 0-2).

### Results:

Overall, 18 patients (62%) underwent MT. 13 patients were recanalized (72%) and 5 patients were partially or failed to recanalize (28%). [Figure 2] The recanalized group showed favorable outcome in 3 month mRS (38.5% vs. 0%). Less severe brain swellings were observed in the recanalized group (23.1% vs 60%).[Figure 3]

### Conclusions:

In patients with DWI-ASPECTS  $\leq 5$ , one-third of patient experienced good neurological outcome when recanalized within 3 hours of onset and less severe brain swelling Further studies are warranted as the numbers are small and it is only single center study.

## Comparison of Contact Aspiration Thrombectomy Using Penumbra Catheter and SOFIA Catheter for Acute Ischemic Stroke

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### Purpose:

Advancement in endovascular thrombectomy devices resulted in improvement of angiographic and clinical outcomes in patients with acute ischemic stroke. Recent aspiration thrombectomy devices have tended to be more flexible distal tip and larger bore for easy target access and effective reperfusion. Here, we review our experiences with contact aspiration thrombectomy using the Penumbra reperfusion catheter and SOFIA catheter.

### Methods:

The subjects comprised 189 patients, who underwent contact aspiration thrombectomy (90 with Penumbra reperfusion catheter, and 99 with SOFIA catheter). The patients' data were retrospectively analyzed to evaluate the overall clinical and angiographic outcome and compared the two thrombectomy devices.

### Results:

The baseline characteristics were similar between groups except intravenous alteplase use and arterial occlusion location. Intravenous alteplase was more frequently administered in Penumbra group (43.3% vs. 29.3%,  $p=0.045$ ), incidence of ICA occlusion was higher in SOFIA group (18.9% vs. 38.4%,  $p=0.013$ ). The final reperfusion rate (thrombolysis in cerebral infarction [TICI] 2b-3) was 87.8% of Penumbra group and 87.9% of SOFIA group ( $p=0.983$ ). However, first pass effect was more frequently achieved in the SOFIA group (12.0% vs. 38.4%,  $p=0.006$ ) and endovascular procedure time was significantly shorter (55.5 minutes vs. 36 minutes,  $p<0.001$ ). However, the clinical outcomes did not differ significantly in the rate of mortality (11.1% vs. 6.1%,  $p=0.213$ ), hemorrhagic complications, and mRS 0-2 at 3 months (63.3% vs. 58.6%;  $p=0.504$ ).

### Conclusions:

Contact aspiration thrombectomy using SOFIA may be safe and comparable to thrombectomy using Penumbra reperfusion catheter. And, SOFIA catheter could be advantageous for rapid reperfusion, without any significant difference in the clinical outcome.

**Table 1.** Baseline characteristics and outcomes.

Variables	<i>Penumbra</i> (n=90)	<i>SOFIA</i> (n=99)	<i>p</i>
Age, median (IQR)	70 (60.75-76.0)	71 (63-78)	0.276
Female	29 (32.2%)	42 (42.4%)	0.148
NIHSS, median (IQR)	16 (9.75-21.0)	16 (11-21)	0.540
Intravenous alteplase	39 (43.3%)	29 (29.3%)	0.045
Hypertension	45 (50.0%)	50 (50.5%)	0.945
Diabetes	28 (31.1%)	23 (23.2%)	0.223
Dyslipidemia	34 (37.8%)	51 (51.5%)	0.058
Atrial Fibrillation	42 (46.7%)	59 (59.6%)	0.075
Coronary diseases	11 (12.2%)	18 (18.2%)	0.256
Occlusion location			0.013
ICA	17 (18.9%)	38 (38.4%)	
ICA with tandem lesion	13 (14.4%)	12 (12.1%)	
MCA M1	41 (45.6%)	31 (31.3%)	
MCA M2	11 (12.2%)	4 (4.0%)	
Basilar artery	8 (8.9%)	13 (13.1%)	
Multiple	0	1 (1.0%)	
Time intervals, median (IQR), min			
Onset to door	155.5 (48.25-404.25)	184 (66.5-415)	0.374
Door to groin puncture	72.5 (57-88.25)	74 (62-88.25)	0.469
Groin puncture to reperfusion	55.5 (34.75-92.25)	36 (20-73)	<0.001
Onset to reperfusion	280 (195.5-508.5)	311 (168.5-563)	0.874
Mechanical thrombectomy strategy			0.964
Aspiration only	63 (70.0%)	69 (69.7%)	
Switching to Stent retriever	27 (30.0%)	30 (30.3%)	
First pass effect	18 (20.0%)	38 (38.4%)	0.006
TICI 2b-3 of final reperfusion	79 (87.8%)	87 (87.9%)	0.983
Hemorrhagic complication			0.621
Parenchymal Hematoma	6 (6.7%)	4 (4.0%)	
Subarachnoid hemorrhage	0 (0.0%)	1 (1.0%)	
Mixed	1 (1.1%)	2 (2.0%)	
Symptomatic ICH	3 (3.3%)	3 (3.0%)	>0.999*
mRS 0-2 at 3 months	57 (63.3%)	58 (58.6%)	0.504
Mortality	10 (11.1%)	6 (6.1%)	0.213

\* Fisher's exact T test

## DWI-ASPECT Score in Basilar Artery Occlusion. 6 Points or Less is Always Bad Outcome?

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### Purpose:

The prognosis of patients with acute basilar arterial occlusion (BAO) after endovascular reperfusion therapy (ERT) in diffusion-weighted imaging (DWI) -Alberta Stroke Program Early Computed Tomography Score (ASPECTS)  $\leq 6$  remains unclear. Our aim was to assess the characteristics and prognosis of ERT in DWI-ASPECTS  $\leq 6$  patients with acute BAO.

### Methods:

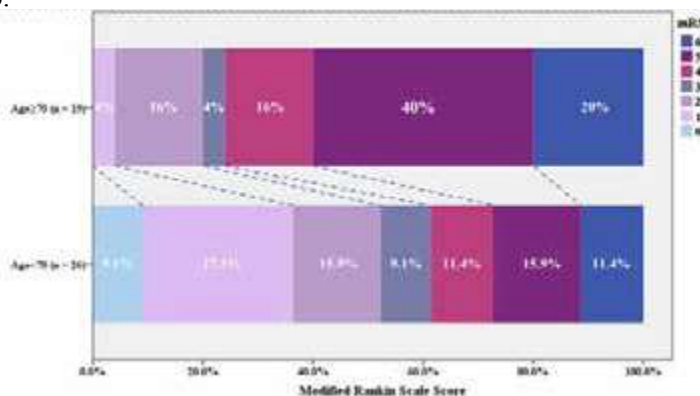
We analyzed data collected from January 1, 2012 to January 31, 2018 in a prospective neuro-interventional registry of consecutive patients treated with ERT. Clinical and imaging data in patients that underwent ERT for acute BAO with DWI-ASPECTS  $\leq 6$  was collected for this study. A good clinical outcome (GCO) was defined as a modified Rankin Scale score  $\leq 2$  at 90 days.

### Results:

Forty five acute BAO patients with a DWI-ASPECTS  $\leq 6$  were included. Among them, 11 (24.4%) patients had GCO at 90 days. Patients with GCO had less severe neurologic symptom at presentation (National Institutes of Health Stroke Scale (NIHSS) 19.0 (12.0–25.0) versus 8.0 (6.0–11.5);  $P=0.003$ ) and relatively young ages (72.5 (57.0–80.0) versus 63.0 (55.5–69.0),  $P=0.096$ ) compared to poor clinical outcome (PCO). The symptomatic intracranial hemorrhage rate was significantly higher in PCO group (13 (38.2%) versus 0 (0.0%);  $P=0.045$ ). Especially, in patients over 70 years, favorable outcome was low (18 (52.9%) versus 1 (9.1%);  $P=0.027$ ) even successful recanalization. In a multivariate model, low initial NIHSS (odds ratio, 1.21; 95% confidence interval, 1.07–1.44;  $P=0.0093$ ) and age over 70 years (odds ratio, 15.27; 95% confidence interval 1.85–379.79;  $P=0.0321$ ) were independent predictors of PCO.

### Conclusions:

Even with DWI-ASPECTS  $\leq 6$ , GCO can be achieved after ERT. Relatively mild initial symptom and younger age can predict better outcome in acute BAO patients with a DWI-ASPECTS  $\leq 6$ .



## Isolated Middle Cerebral Artery Dissection with Atherosclerosis: Case Report

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### Purpose:

Isolated middle cerebral artery (MCA) dissection (MCAD) with atherosclerosis is a rare entity, and its clinical progression is not well known. We recently came across a case of isolated MCAD with atherosclerosis.

### Methods:

Case description: A 62-year-old man presented to the emergency department with right-sided weakness and mild aphasia. Diffusion-weighted imaging (DWI) showed a multifocal infarction in the left MCA region, and perfusion Magnetic Resonance Imaging (MRI) detected a moderate time delay in the left MCA region. High-resolution MRI and transfemoral cerebral angiography (TFCA) revealed that the atherosclerotic plaque was accompanied by the dissecting intimal flap.

### Results:

Despite 40 days of antiplatelet therapy, the ischemic stroke recurred and the dissection did not heal at all. After stenting, the MCA and intracranial circulation revealed a widened lumen and improved flow across the dissection, and no embolic sequelae in the distal intracranial circulation.

### Conclusions:

In our case, we could confirm that the atherosclerotic plaque was accompanied by the dissecting intimal flap on HR-MRI and TFCA. These patients might fail to respond to medical treatment. In a case of dissection with atherosclerosis, we recommend early stage intracranial stenting rather than medical treatment, to prevent recurrent cerebral infarction.



## Histological Characteristics of Retrieved Thrombi in Patients with Acute Intracranial Atherosclerosis Related Occlusion

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### Purpose:

Intracranial atherosclerosis (ICAS)-related occlusion is a condition that is often encountered during endovascular revascularization treatment (ERT). In many cases, recanalization may not be fully achieved with ICAS-related occlusion. The histological characteristics of thrombi can affect successful recanalization, however, pathological studies have not focused on ICAS-related thrombi retrieved from ERT. We aimed to investigate the histological characteristics of retrieved thrombi in patients with acute ICAS-related occlusion.

### Methods:

From Jan 2016 to Dec 2017, 47 patients with acute ICAS-related occlusion were included in this retrospective study. ICAS-related occlusion was assessed angiographically based on the consensus of the American society of neuroradiology. We reviewed baseline demographics, ERT parameters, and treatment outcome from prospective large vessel occlusion registry. Retrieved thrombi from patients were analyzed using semi-automated color-based segmentation method. Thrombus patterns were dichotomized into circumferential or scattered distribution of fibrin. The relative fractions of red blood cells (RBCs), fibrin and platelets congregate, and white blood cells were calculated.

### Results:

Histological analysis of retrieved thrombi was available in 20 patients (42.6%). In 27 patients without retrieved thrombi, most patients did not undergo stent retriever or aspiration thrombectomy: 15 patients (31.9%) treated with intra-arterial injection or angioplasty, 5 patients (10.6%) failed to approach. Seven patients (14.9%) were treated with stent retriever, however, thrombi were disintegrated during retrieval. Eighteen patients (38.3%) were posterior circulation stroke. In thrombus pattern analysis, 16 patients (80%) revealed circumferential pattern representing a white head-red tail, only 4 patients showed scattered fibrin pattern. Reocclusion occurred in 6 patients (30.0%) during first 48 hours and the thrombus pattern did not differ according to the presence of reocclusion. The fraction of RBC tended to increase in the case of reocclusion, however, statistical significance was not achieved (48.1% in patients with reocclusion vs. 36.7% in patients without reocclusion,  $p=0.180$ ).

### Conclusions:

This study shows that histological characteristics can affect treatment outcome in ICAS-related occlusion. Further molecular analysis can give more information on treatment strategies in acute ICAS patients.

## Platelet Activation May Be More Important in Artery-to-artery Embolism than in Local Branch Occlusion Among Ischemic Stroke Due to Large Artery Atherosclerosis

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### Purpose:

Ischemic stroke can occur even under the use of antiplatelet agent. Various mechanisms are involved in ischemic stroke due to large artery atherosclerosis under the use of aspirin.

### Methods:

We have consecutively enrolled patients with ischemic stroke classified as large artery atherosclerosis and under the use of aspirin. Ischemic stroke was classified according to the location of atherosclerosis (intracranial versus extracranial), ischemic lesion pattern and mechanism of stroke (artery-to-artery embolism, in situ thrombosis, local branch occlusion and hemodynamic). Aspirin resistance unit (ARU) was measured at the day of admission ARU>550 was regarded as resistant to aspirin. ARU and proportion of patients with aspirin resistance was compared among different groups.

### Results:

During the study period, 198 patients with large artery atherosclerosis experienced ischemic stroke under aspirin. Among them, 117 (59.4%) and 80 (40.6%) patients were associated with intra and extracranial stenosis, respectively. By mechanism, 150 (76.1%) patients were classified as artery-to-artery embolism, 29 (14.7%) as local branch occlusion, 5 (2.5%) as hemodynamic and 13 (6.6%) as in situ thrombosis. ARU was higher in those with extracranial than intracranial atherosclerosis (492.9 vs 461.8; respectively,  $p=0.007$ ). Aspirin resistance was more frequently observed from extracranial atherosclerosis (28.8% VS. 10.3%;  $P=0.001$ ). By mechanism ARU was low in those with local branch occlusion than other mechanisms ( $p=0.037$ ). Aspirin resistance was less frequent in those with local branch occlusion (20.2% vs 3.4%;  $p=0.029$ ) Similarly, ARU was most low in those with subcortical infarction pattern ( $p=0.001$ ).

### Conclusions:

ARU in Ischemic stroke due to large artery atherosclerosis differs according to the mechanism of stroke. Ischemic stroke occurring under aspirin due to extracranial atherosclerosis and artery-to-artery embolism is associated with aspirin resistance, whereas the role of platelet inhibition is limited in ischemic stroke due to local branch occlusion in intracranial atherosclerosis.

## Association of Intracranial Calcification with Cognitive Impairment in Hemodialysis Patients

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### Purpose:

Cognitive impairment is becoming a major social problem. In hemodialysis patients, cognitive impairment is more prevalent. Vascular and uremic factors could be involved with the mechanism of cognitive impairment in hemodialysis patients. We investigated whether vascular factors using intracranial artery calcification and uremic factors including FGF23 might associated with cognitive impairment in hemodialysis patients.

### Methods:

We investigated 69 stable hemodialysis patients. Korean version Montreal Cognitive Assessment was tested. Intracranial arterial calcification was measured using a validated scoring system. Blood FGF23, osteoprotegerin, soluble alpha-klotho was analyzed using with commercial ELISA Kits.

### Results:

Cognitive impairment was observed in 22 patients (31.9%). Among these, 3 patients have significant cognitive impairment. ICA calcification score was higher in patients with cognitive impairment compared with these without cognitive impairment (177.3 vs 87.6, p-value 0.022). ICA calcium score is associated with cognitive dysfunction after adjusting by FGF23 and 25OH Vitamin D but is not significant after adjusting by age, FGF23, and 25OH vitamin D. The low level of FGF 23 is associated with cognitive dysfunction.

### Conclusions:

We suggested that ICA calcium score and low FGF 23 could be related with cognitive dysfunction in hemodialysis. Longitudinal studies are needed to investigate whether ICA calcification and FGF23 affect the cognitive function in hemodialysis.

## Assessment of Region-of-interest for Time-of-flight Magnetic Resonance Angiography to Differentiate Intracranial Arterial Dissection from True Atherosclerotic Stenosis

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### Purpose:

Three-dimensional time-of-flight magnetic resonance angiography (3D TOF MRA) is commonly used to visualize an intracranial arterial stenosis. However, it is difficult to identify the etiology of a stenosis. Our aim was to determine the effectiveness of 3D TOF MRA for differentiating an intracranial arterial dissection from other causes of true artery narrowing, such as atherosclerosis.

### Methods:

A total of 356 patients with a confirmed intracranial artery stenosis by high resolution-magnetic resonance imaging (HR-MRI) were assessed from 2015 to 2017; 51 patients with severe focal stenosis due to dissection and atherosclerosis were enrolled. We compared the dissection group with the atherosclerotic narrowing group by measuring the region-of-interest (ROI) values 3 mm proximal and 3 mm distal from sites of severe focal stenosis.

### Results:

Significant differences were observed between the median ROI score of the dissection (n = 18) and atherosclerosis (n = 33) groups [35.6 (20.9–78.4) vs. 165.5 (99.8–328.5); P < 0.001]. A receiver operating characteristic curve was prepared to distinguish between dissection and atherosclerosis using the ROI values, and the area under the curve (AUC) was calculated. The AUC was 0.919 (sensitivity 81.8%, specificity 83.3%). Youden's index for maximum diagnostic accuracy was determined. The optimal cut-off values of the ROI that distinguished between dissection and atherosclerosis were obtained using a Youden's index of 86.5.

### Conclusions:

The ROI value of 3D TOF MRA was a predictive factor that distinguished between a dissection and atherosclerosis. If the difference in the ROI on 3D TOF MRA before and after stenosis is small (<86.5), additional examinations, such as transfemoral cerebral angiography or HR-MRI are necessary, as there would be a possibility of a dissection.

## Outcomes After Ischemic Cerebrovascular Disease Caused by Intracranial Atherosclerosis Versus Dissection: a High-resolution MRI Study of 512 Patients

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<sup>2</sup> Radiology, Severance Hospital, Seoul, Korea

### Purpose:

To compare the outcomes between patients with non-traumatic intracranial arterial dissection (ICAD) and intracranial atherosclerotic stenosis (ICAS) using high-resolution MRI (HR-MRI).

### Methods:

We conducted a prospective study using HR-MRI in patients with acute symptomatic cerebrovascular disease due to intracranial occlusive disease and no dissection on luminal images. Patients were followed-up for  $27.9 \pm 19.3$  months. We compared the functional outcome, recurrence, and changes in vascular status between patients with ICAD (dissection and no plaque on HR-MRI) and ICAS (atherosclerosis plaque on HR-MRI).

### Results:

We included 312 patients (mean age,  $59.0 \pm 14.2$  years; men, 58.3%), of whom 113 had ICAD and 199 had ICAS. The functional outcome (as measured by modified Rankin score) on the 90th day after symptom onset was not different between the groups, after adjusted for other factors ( $P = 0.095$ ). However, recurrent ischemic cerebrovascular disease on the relevant vascular territory was lower in the ICAD group (7 patients, 6.2%) than in the ICAS group (37 patients, 18.6%). ICAD was a significant independent determinant of disease recurrence (hazard ratio, 0.43; 95% CI, 0.19–0.98). Improvement in vascular stenosis on follow-up vascular studies was more frequently observed in ICAD (50.7%) than in ICAS (11.6%). ICAD was an independent determinant of vascular improvement (odds ratio, 7.94; 95% CI, 3.32–19.01).

### Conclusions:

Considering the high prevalence of ICAD in the patients with presumed ICAS and the differential outcomes between ICAD and ICAS, HR-MRI may be a useful diagnostic tool in this population.

## Transcranial Doppler Sonographic Criteria for Progression or Regression of Middle Cerebral Artery Stenosis

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### Purpose:

Intracranial arterial stenosis may progress or regress, of which the diagnosis is important to predict the risk of stroke or to evaluate the response of treatment. Transcranial Doppler (TCD) seems to be useful for this purpose. However, optimal diagnostic criteria have not been validated yet. Our study was designed to compare TCD changes with magnetic resonance angiography (MRA) to validate optimal TCD criteria for progression or regression of middle cerebral artery (MCA).

### Methods:

We prospectively enrolled patients with MCA stenosis diagnosed with TCD (mean flow velocity (MFV)  $\geq 80$  cm/s and associated abnormalities), and MRA ( $\geq 50\%$  narrowing). Progression or regression was defined by change of MRA grading (normal, mild, moderate, severe or occlusion). Criteria of absolute difference and percent change of MFV were validated.

### Results:

Total of 61 MCAs from 47 patients were included (mean age 66.6 years, male 80%). According to MRA criteria, progression and regression was detected in 7 (11.4%) and in 14 (23%), while 40 (65.6%) were static. For the progression group, best optimal sensitivity and specificity of TCD were 85.7% and 92.5% at MFV 20 cm/s increment cutoff value among various criteria (area under curve (AUC) 0.859,  $P=0.003$ ). For the regression group, best optimal sensitivity and specificity were 71.4% and 92.5% at 20 cm/s decrement cutoff value (AUC 0.837,  $P=0.09$ ).

### Conclusions:

TCD accurately diagnose progression or regression in patients with MCA stenosis. These validated criteria would be useful for clinical practice and research.

## Development of Graphical User Interface for Quantification of Intracranial Vessel Tortuosity in Time-of-flight MR Angiography

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### Purpose:

Knowledge of intracranial vessel tortuosity may be important for predicting a risk of ischemic stroke. The 3D nature of the intracranial vessels would make it challenging to measure the vessel's segmental lengths unless a software dedicated to such a purpose is available. The goal of this study is to develop a customized graphical user interface that facilitates user's measurement of intracranial vessel tortuosity in an easy and interactive manner.

### Methods:

A custom graphical user interface (GUI) was implemented on a MATLAB environment. A layout is shown in Figure 1. Intracranial vessels were segmented from time-of-flight (TOF) MR angiography data. The centerlines of intracranial vessels were obtained after applying the skeletonization to the binary format of the vessels. The GUI allowed the user to locate and click the two landmarks that correspond to the start and end points of a vessel segment of interest. The user's mouse-click of the 'Compute vessel length' button resulted in automatic calculation of the branch length as well as Euclidean distance between the start and end points (shown in Figure 1). The automatic tracking from the start point to the end point was based on the directional cosine measure. Figure 1 shows an example of the visualization of a selected vessel segment (indicated by the yellow arrow). The vessel tortuosity was calculated as the ratio of the branch length to the Euclidean distance of the two end points. The total number of vessel segments was 64 in this study.

### Results:

Using the proposed user interface software, we have obtained vessel tortuosity data from 108 patients with intracranial dissection and 118 normal volunteers. The processing time of obtaining vessel tortuosity from all the vessel segments took 16-20 minutes per subject.

### Conclusions:

A novel custom graphical user interface software was developed to allow the user to semi-automatically extract vessel tortuosity information from all vessel segments of interest in intracranial arteries of normal volunteers. In current implementation, there are many manual user interactions involved, and the manual procedure of locating anatomical landmarks (i.e., vessel branch points) is a main bottleneck. An automatic identification of the landmarks (or automatic labeling of the vessels) will be crucial in saving time and effort, and its development remains as future work.

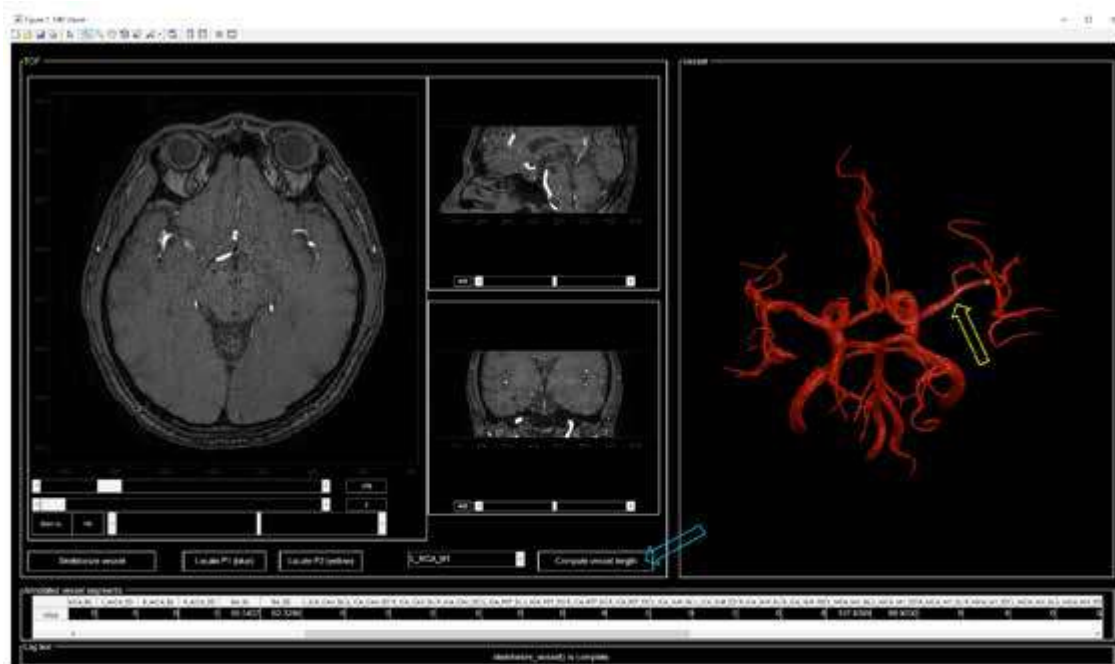


Figure 1. A layout of the proposed user interface for the vessel tortuosity measurement. Mouse-clicking the "Compute vessel length" button (see the blue arrow) results in 1) automatic calculation of the branch length and Euclidean distance of the two end points, and 2) display of a vessel segment of interest in the user interface (see the yellow arrow).



## Correlation of Vessel Wall MR Features of Intracranial Vertebral Artery Dissection to Intravascular Ultrasound Findings

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<sup>2</sup>Neurology, Gwangmyeong Sungae Hospital, Gwangmyeong-si, Korea

### Purpose:

To correlate several features of vessel wall MR imaging of intracranial vertebral artery dissection (VAD) to intravascular ultrasound (IVUS) findings.

### Methods:

Vessel wall MR study (3D variable refocusing flip-angle volume isotropic turbo-spin-echo acquisition, VISTA T1 and PD using 3.0T) was performed in 243 patients with fusiform and/or stenodilatation on CT angiography between May 2015 and January 2017. Among these patients, stent deployment for dissection was performed in 26 patients and poststent vessel wall MR images were also obtained in 16 of 26 patients. IVUS study was performed in 6 patients. Pre-stent vessel wall MR features were categorized into several parts and correlated to IVUS findings.

### Results:

Pre-stent vessel wall MR features of VAD were categorized into as follows, 1) Curvilinear high signal intensity (SI): 26/26 patients, 2) Different size and shape of vessel with heterogeneous SI on T1 and PD: 25/26, 3) Double lumen with heterogeneous SI: 11/26, 4) Relatively homogeneous intermediated SI in vascular volume: 9/26, 5) Vascular dilatation: 24/26. IVUS findings correlated each features of vessel wall MR study as follows, 1) Curvilinear high SI: circumferential intramural hematoma, 2) Different size and shape of vessel with heterogeneous SI on T1 and PD: eccentric and uneven intramural hematoma, thrombus and small false lumen, 3) Double lumen with heterogeneous SI: Intramural hematoma, thrombus and large false lumen, 4) Relatively homogeneous intermediated SI in vascular volume: probable flow dynamic abnormality, 5) Vascular dilatation: increased vascular diameter.

### Conclusions:

Vessel wall MR imaging of VAD might demonstrate several features representing combinations of intramural hematoma, thrombus, false lumen and flow dynamics seen on. Further study might be necessary.

## A Case of Late Delayed Radio- and Chemo-Therapy Induced Brain Injury Presenting with Ischemic Stroke

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<sup>3</sup>Radiology, Asan Medical Center, University of Ulsan College of Medicine, Seoul, Korea

### Purpose:

As radiation to brain and chemotherapy have been used to treat the pediatric patients with hematologic malignancies, there have been produced various neurological complications.<sup>1</sup> One of the most critical complications is the delayed neurotoxicity ameliorating of irreversible and progressive neurological sequelae in some patients.<sup>2</sup>

### Methods:

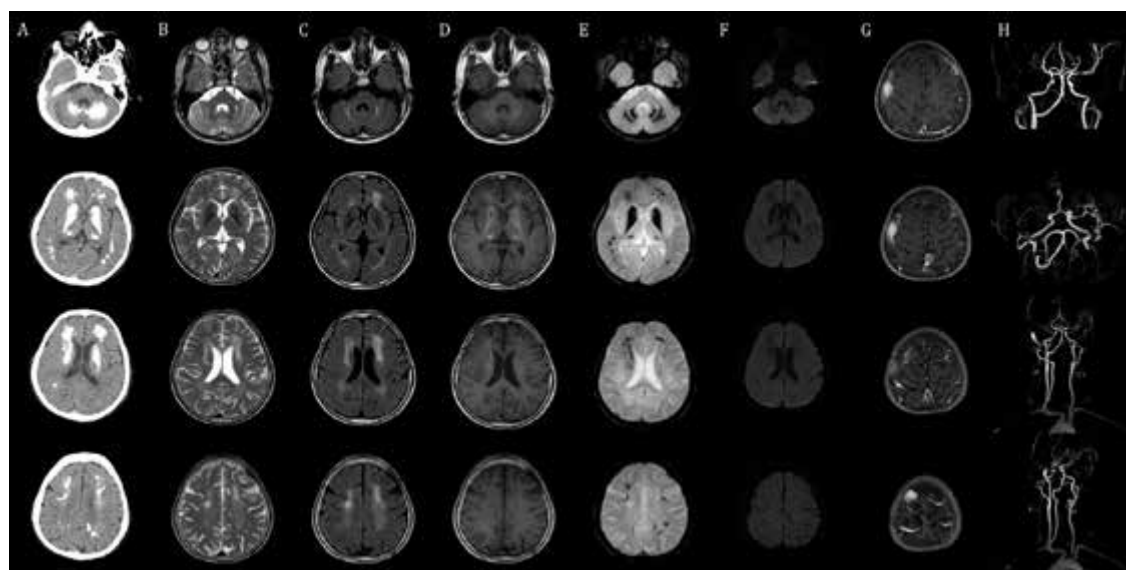
We report a patient diagnosed with late delayed radiotherapy and chemotherapy induced brain injury presenting with ischemic stroke.

### Results:

A 30-year-old short-statured man was admitted because of weakness of the right hemi-body for 2 months. Initially, the patient intermittently felt the right side weakness primarily during exercise. Recently the right side weakness was continuing and did not improved. The patient had leukemia treated by receiving radio- and chemo-therapy in 2 years of age. He cured and has never been complained of neurological impairment previously. He had no vascular risk factors including, hypertension, diabetes mellitus, dyslipidemia, history of smoking and alcohol drinking. He had no recognized family history of neurological illness. The clinical features of the patient are as follows: (1) low scores of mini-mental status examination; (2) reduction in semantic and phonemic verbal fluency; (3) right hemi-body paresis, including face, upper and lower extremity; (4) hyperactive tendon reflexes on bilateral biceps brachii, triceps brachii, patellar, and Achilles tendon; (5) positive pathological reflexes, including bilateral Hoffmann sign, Babinski sign, and ankle clonus. We present a video of a 30-year old male patient presented with weakness on the right hemi-body (see Video 1). We also present a video of him improving state of weakness on right hemi-body after supportive care and rehabilitation during 4 weeks (see Video 2). Imaging findings of the patient are described in Figure 1. We also investigated the hormone level for evaluating pituitary and thyroid function. The levels of IGF-1 and IGFBP-3 were lower than the normal range (69.0ng/mL, and 1442ng/mL, respectively). Based on the clinical and radiologic findings, the patient was diagnosed with late delayed radiotherapy and chemotherapy induced brain injury.

### Conclusions:

We report a patient diagnosed with late delayed radio- and chemo-therapy induced brain injury, which is critically supported by the typical findings of neuroimaging. In conclusion, we propose that radiotherapy and chemotherapy induced brain injury should be considered in the differential diagnosis for a patient with ischemic stroke who previously had radio- and chemo-therapy.



## Cerebral Venous Thrombosis Involving Sphenoidal Sinus with Hemorrhagic Transformation

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<sup>1</sup>Neurology, Inha University Hospital, Incheon, Korea

### Purpose:

Diverse anatomy variation of cortical veins makes thrombus only involving these cortical vessels difficult to diagnose both clinically and radiologically. Because of the rare incidence of isolated cortical venous thrombus, the clinical manifestation and the outcome of cortical venous thrombosis remained unknown.

### Methods:

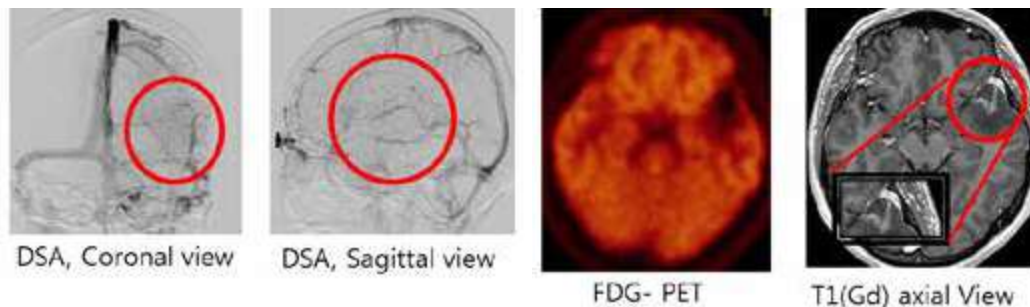
We report the case of a 41-year-old woman, who presented to the Neurology department with ongoing and intractable headaches, and nausea. Brain MR scans showed ill, non-enhancing lesion with low signal intensities (SI) on Gradient echo images, in left anterior temporal pole. Further digital subtraction images showed that the diagnosis of a thrombosed left sphenoidal sinus and venous congestion of left anterior temporal area.

### Results:

The laboratory findings indicated the severe iron-deficiency anemia. After the 2 months of oral anticoagulation, the headache improved and follow-up MR images revealed that lesion with partial resolution of the thrombus.

### Conclusions:

The venous infarction related to thrombosed cortical sphenoidal sinus is a rare clinical finding. If diagnosed early and treated properly, outcomes seem favorable. If the patients with unexplained edema in the anterior temporal area, venous thrombosis of sphenoidal sinus might be ruled out.



## Brain Mapping of Motor and Functional Recovery After Supratentorial Stroke

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<sup>1</sup>Physical Medicine and Rehabilitation, Veterans Health Service Medical Center, Seoul, Korea

### Purpose:

The present study aimed to identify the brain regions involved in upper and lower limb motor and functional recovery after stroke.

### Methods:

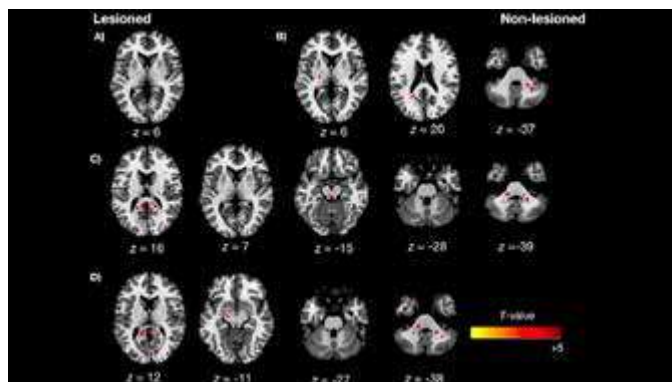
Twenty-five patients (mean age, 73.4 years; average duration from stroke onset, 50.1 months) were examined. Fractional anisotropy (FA) mapping using diffusion tensor imaging, and clinical measures, including the Fugl-Meyer motor assessment of upper and lower limbs, the Modified Barthel Index, and Functional Ambulation Category were used for examinations. Linear regression analyses were conducted with the FA map as a dependent variable, each clinical measure as an independent variable, and patient age as a covariate.

### Results:

FA in the internal capsule of the posterior limb of the lesioned hemisphere was significantly associated with Fugl-Meyer motor assessment scores for the upper limbs, whereas that in the internal capsule of the posterior limb of the lesioned hemisphere, posterior corpus callosum of the lesioned hemisphere, and middle cerebellar peduncle of the contralateral hemisphere was associated with Fugl-Meyer motor assessment scores for the lower limb. FA in brain regions with bilateral connection fibers was commonly associated with the score on the Korean version of the Modified Barthel Index and participants' functional ambulation. Furthermore, the FA in the corticospinal tract in the contralesional hemisphere was also associated with the score on the Korean version of the Modified Barthel Index (corrected  $p < .05$ ).

### Conclusions:

Motor and functional recovery of upper and lower limbs involves different brain regions. This finding is of particular relevance for treatment and recovery in stroke.



## The Value of Wavelet Coherence Analysis of Near-infrared Spectroscopy Signals for Evaluating Cerebral Perfusion in Patients with Hemodynamic Stroke

Tae Jung Kim<sup>1</sup>, Jaemyoung Kim<sup>2</sup>, Soo-hyun Park<sup>1</sup>, Hae-bong Jeong<sup>1</sup>,  
Hyeon-min Bae<sup>2</sup>, Sang-bae Ko<sup>1</sup>

<sup>1</sup>Neurology, Seoul National University Hospital, Seoul, Korea

<sup>2</sup>Electrical Engineering, Korea Advanced Institute of Science and Technology (KAIST), Daejeon, Korea

### Purpose:

The functional near infrared spectroscopy (fNIRS) could evaluate brain function based on measuring changes in oxygenated and deoxygenated hemoglobin concentrations. The wavelet phase coherence (WPCO) can reveal the relationship of two signals between oscillations such as oxygen saturation or brain connectivity within certain frequency ranges. Therefore, the aim of this study is to assess the prefrontal functional connectivity in various frequency intervals using WPCO analyses of cerebral oxyhemoglobin (OxyHb) in patients with hemodynamic strokes.

### Methods:

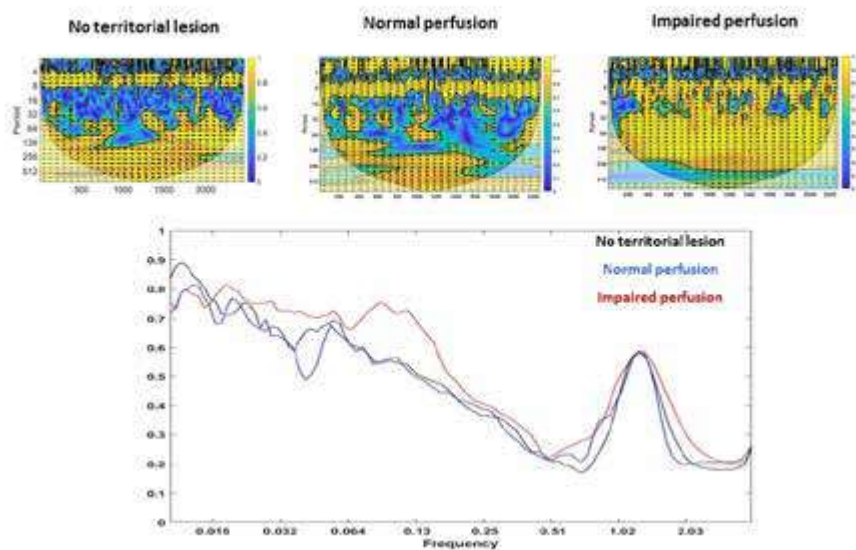
A 35 consecutive patients with anterior circulation ischemic strokes were included for analysis. Moreover, we included control patients without the lesions of anterior circulation territory (n = 34) for comparison. The cerebral OxyHb data were collected using multichannel fNIRS (NIRSIT, OBELAB Inc. Korea). The coherences between eight segments of prefrontal OxyHb oscillations in five frequency intervals (I, 0.6–2Hz; II, 0.145–0.6Hz; III, 0.052–0.145Hz, IV, 0.021–0.052Hz, and V, 0.005–0.0095 Hz) were analyzed using wavelet coherence analysis. The patients were categorized into three groups with control groups, patients with perfusion defect and patients without perfusion defect. We compared the result of coherence analysis of OxyHb between three groups.

### Results:

Among the included 35 patients (age, 63.8; and male, 62.9%), 21 patients (60.0%) had perfusion defect in anterior circulation stroke. In patients with perfusion defect, phase coherence was significantly higher compared to patients without perfusion defect and control group, especially in myogenic activity frequency interval III (0.052–0.145Hz) under the myogenic mechanism of cerebral autoregulation ( $0.70 \pm 0.17$  vs.  $0.57 \pm 0.20$  vs.  $0.58 \pm 0.15$ ,  $P = 0.021$ ) In addition, severe stroke patients were more likely to have higher phase coherence in interval III ( $P = 0.078$ ).

### Conclusions:

Our results demonstrated that the higher phase coherence of OxyHb in myogenic signal, which was originated locally from intrinsic myogenic activity of smooth muscle cells in brain (interval III) was related to impaired cerebral perfusion and severity in patients with stroke. This suggests that monitoring cerebral oxygenation using fNIRS could be a useful noninvasive measuring tool for evaluating impaired cerebral autoregulation in stroke patients.

**Figure 1 Wavelet Phase coherence analysis of OxyHb**



## Right Anterior Subcortical Strokes are Prone to Be Unrecognized! : Demonstration of Six Cases

A-hyun Cho<sup>1</sup>, Eun Ye Lim<sup>1</sup>, Ha-neul Jeong<sup>1</sup>, Yoon-sang Oh<sup>1</sup>

<sup>1</sup>Neurology, Yeouido St. Mary's Hospital, Catholic University, College of Medicine, Seoul, Korea

### Purpose:

Silent strokes irrelevant to the index symptom are not infrequently observed in our clinical practice or routine check-up. Silent cerebral infarcts or hemorrhages are unrecognized when their sizes and locations are not enough for inducing neurological deficit or patients lack stroke knowledge. However, the presence of silent stroke can be a predictor of the occurrence of further stroke event. Herein, we present six cases which demonstrate that unrecognized but sizable stroke-lesion in the right anterior subcortical lesion.

### Methods:

We retrospectively collected cases which demonstrate incidentally found old stroke lesion but without definite stroke like symptom by patients' reports and reviewing medical records. The radiological findings on MRI (T2-weighted or fluid attenuated inversion recovery, and gradient-echo or susceptibility weighted image) and MR angiography or CT angiography were reviewed. The location and diameter of stroke lesion were analyzed. Clinical factors including age, sex, index symptom (reason) for imaging, the presence of hypertension, diabetes, hyperlipidemia, smoking, alcohol, atrial fibrillation, and stroke etiology were obtained. Index symptoms which are the main reason why the patients had underwent MRI exam were presented. The stroke etiologic subtype for incidental stroke lesion were documented. The clinical course were followed up as lately as possible.

### Results:

70-year-old female, 67-year-old male and 50-year-old male with acute unilateral corona radiata and/or internal capsular infarct showed incidentally found old stroke lesion (unrecognized by patients) on right corona radiata and basal ganglia (maximal diameter 18, 18.9, 21.5 mm). Two cases were cryptogenic stroke, the other was large vessel disease. Stroke recurred in two cases after 5 and 7 years later. An 81-year-old female with hypertension and diabetes visited clinic because of syncope. Her MRI revealed large sized old intracerebral hemorrhage-like lesion on right anterior corona radiata and basal ganglia (30.15mm). She denied any stroke-like symptom before. 52-year-old female and 89-year-old male who performed MRI because of nonspecific dizziness showed old right basal ganglia and anterior corona radiata lesion (12, 20mm) of small vessel disease and cryptogenic etiology.

### Conclusions:

All of our cases showed incidentally found sizable stroke lesion in right anterior subcortical area, non-eloquent area for inducing definite stroke deficit. These subjects are important candidates for secondary stroke prevention. Therefore, imaging screening for silent stroke might be required in certain population.



## Correlation of Cerebrovascular Reserve Assessed by Acetazolamide-stress SPECT with Collaterals on Arterial Spin-labeling MRI in Patients with Carotid Occlusive Disease

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<sup>1</sup>Radiology, Seoul Veterans Hospital, Seoul, Korea

### Purpose:

We evaluated the correlation between cerebrovascular reserve (CVR) on acetazolamide (ACZ)-stress single photon emission computed tomography (SPECT) brain scans and collaterals on arterial spin-labeling (ASL) magnetic resonance imaging (MRI) in internal carotid artery (ICA) stenosis.

### Methods:

86 patients with ICA stenosis (>70%) were enrolled in this study. Including pulsed ASL, MRI was acquired on a 3 tesla system. On ASL, late-arriving flow appears as serpiginous high ASL signal within cortical vessels, which has been termed arterial transit artifact (ATA). Images were interpreted for the presence of ATA. 82/86 ICA stenosis patients underwent SPECT imagings with Tc-99m-ECD in the resting and after ACZ challenge. We observed the presence of intracranial collaterals, which are manifested by ATA, on ASL brain perfusion scan. CVR based on rest-SPECT and ACZ-stress SPECT was calculated. With ACZ-stress SPECT, the 82 patients were grouped as either showing or not showing evidence of decreased CVR. We assessed the relationship between reduced CVR and intracranial collaterals shown as ATA on ASL brain perfusion.

### Results:

In 61/86 (70%) of the ICA stenosis patients, ASL showed ATA in ipsilateral to the stenosis. With acetazolamide stress SPECT, the 27/82 (32%) patients showed evidence of decreased CVR. In 45/55 (81%) of the normal CVR group and 16/27 (59%) of the reduced CVR from the SPECT results, pulsed ASL showed ATA in ipsilateral to the stenosis. Significant positive relationship was observed between normal CVR group and ATA showing group in ICA stenosis patients on ASL brain perfusion ( $p=0.035$ , chi-square test).

### Conclusions:

The ATA with ASL imaging as a noninvasive and no contrast demanding technique, can depict slow flow in excellent collateral vessels and has clinical utility in detecting CVR in patients with ICA stenosis.

**Figure 1. 72-year-old male, severe stenosis of the right proximal cervical ICA.**

- A) 95% stenosis of the right proximal cervical ICA is seen on the curved linear CT carotid angiography (arrow).
- B) Multiple serpiginous high intensity (red) structures are seen in the right frontotemporal area on pulsed ASL (arrows).
- C) Basal resting SPECT image shows normal CBF in the right frontotemporal area.
- D) ACZ stress SPECT image shows no vascular reserve change in the right frontotemporal area.

Figure 1. 72-year-old male, severe stenosis of the right proximal cervical ICA.

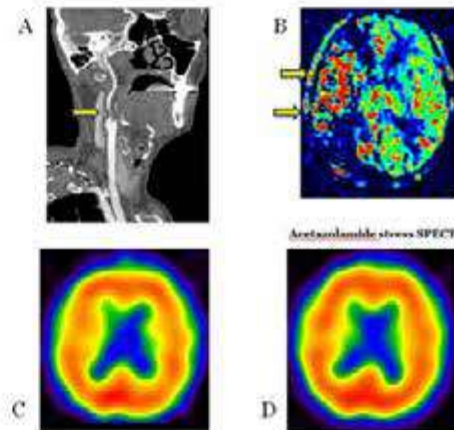
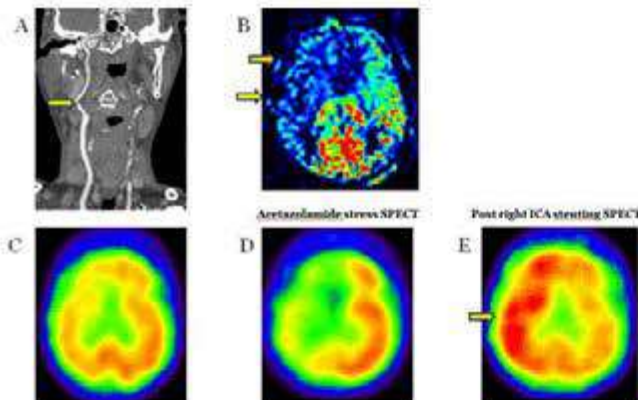


Figure 2. 79-year-old male, severe stenosis of the right proximal cervical ICA.



**Figure 2. 79-year-old male, severe stenosis of the right proximal cervical ICA.**

- A) Severe stenosis of the right proximal cervical ICA is seen on the curved linear CT carotid angiography (arrow).
- B) Decreased signal changes without ATA are seen in the right frontotemporal area on pulsed ASL (arrows).
- C) Basal resting SPECT image shows mildly decreased CBF in the right frontotemporal area.
- D) ACZ stress SPECT image shows reduced vascular reserve change in the right frontotemporal area.
- E) Post right ICA stenting SPECT shows hyperperfusion in the right frontotemporal area (arrow).

## Distal Versus Proximal Middle Cerebral Artery Occlusion: Different Mechanisms and Prognoses

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Hyun Young Kim<sup>2</sup>, Seong Ho Koh<sup>2</sup>, Dae-il Chang<sup>1</sup>

<sup>1</sup>Neurology, Kyung Hee University, Seoul, Korea

<sup>2</sup>Neurology, Hanyang University, Seoul, Korea

### Purpose:

Clinical and radiological characteristics of middle cerebral artery (MCA) infarction may differ according to the location of MCA occlusion (MCAO). Here, we investigated the difference between proximal and distal symptomatic MCAO in patients with ischemic stroke.

### Methods:

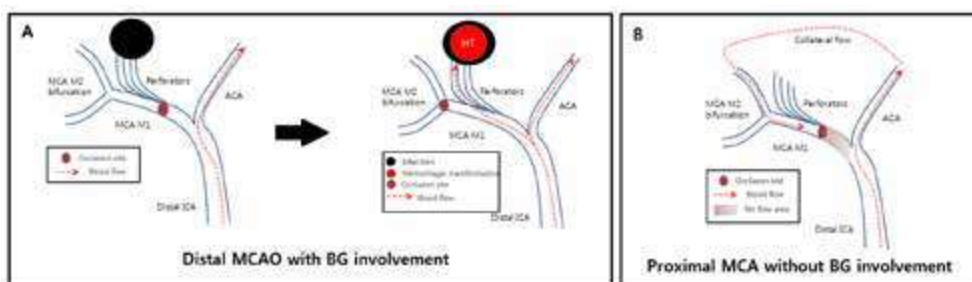
Patients with ischemic stroke due to MCAO were consecutively enrolled. The location of MCAO was determined by the ratio of the length of the ipsilesional MCA to that of the contralateral MCA and dichotomized to proximal and distal MCAO. Clinical and radiological characteristics were compared between patients with proximal and distal MCAO. Factors associated with the neurological change during admission were investigated.

### Results:

Among 181 included patients, MCAO location showed a bimodal peak (at the proximal [n = 99] and distal MCA [n = 82]). Proximal MCAO was more frequently associated with hyperlipidemia and large artery atherosclerosis, whereas distal MCAO was more frequently associated with hypertension, atrial fibrillation, and cardioembolic stroke. Cardioembolic stroke (odds ratio [OR] = 4.339, 95% confidence interval [CI] = 1.915–9.835;  $p < 0.001$ ) was independently associated with distal MCAO. Basal ganglia involvement was similar between the two groups (48% vs. 39%;  $p = 0.21$ ), whereas hemorrhagic transformation was more frequent in distal MCAO (10% vs. 23%;  $p = 0.02$ ). Patients with distal MCAO showed better neurological improvement during admission. Presence of fluid-attenuated inversion recovery (FLAIR) vessel sign (OR = 0.172, 95% CI = 0.051–0.586;  $p = 0.005$ ) and distal MCAO (OR = 0.200, 95% CI = 0.059–0.683;  $p = 0.011$ ) was independently associated with improvement during admission.

### Conclusions:

Proximal MCAO is more frequently associated with atherosclerosis, whereas distal MCAO is more frequently associated with cardioembolism. FLAIR vessel sign and distal MCAO were independently associated with neurological improvement during admission.



## Impact of Bone Mineral Density on Cerebral Small Vessel Disease Burden

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<sup>1</sup>Neurology, Chung-Ang University, Seoul, Korea

### Purpose:

Cerebral small vessel disease (SVD) and bone mineral loss are both prevalent among old population. We investigated the relationship between bone mineral density (BMD) and cerebral SVD burden among patients with cerebrovascular disease.

### Methods:

This is a cross-sectional study from single tertiary university hospital consisted of 897 consecutive patients older than 50 years with cerebral infarction or transient ischemic attack who underwent both brain MR imaging and bone mineral densitometry (mean age:  $71 \pm 10$ , female: 48%). The burdens of cerebral SVD included white matter hyperintensity, silent lacune and cerebral microbleed. BMD was measured by dual energy X-ray densitometry at lumbar spine and hip joints, and the patients were categorized into three groups according to their T score (cut-off values: -1.0 and -2.5).

### Results:

The number of patients in three groups included 313 (T1: T score  $\geq -1.0$ ), 339 (T2: T score between -1.0 and -2.5) and 245 (T3: T score  $\leq -2.5$ ), respectively, and the presence and the severity of every cerebral SVD phenotype shows increasing tendency as BMD decreases. Multivariable logistic regression analysis adjusting age, sex, hypertension, diabetes mellitus, body mass index, hematocrit and high sensitive C-reactive protein showed that BMD decrease at hip joint is independently associated with severe white matter hyperintensity (T2: odds ratio (OR) = 2.6, confidence interval (CI) = 1.3 – 5.0; T3: OR=5.0, CI=2.3 – 10.9, on the reference of T1).

### Conclusions:

Reduced BMD was independently associated with cerebral SVD burden among the patients with cerebrovascular disease. Future studies are warranted to elucidate pathophysiological mechanism between the two conditions and to examine whether BMD loss is a modifiable risk factor of cerebral SVD.

## Inflammation-Related Long Noncoding RNA Signature in a Rat Intracerebral Hemorrhage Model

Jeong-min Kim<sup>1</sup>, Jangsup Moon<sup>2</sup>, Soon-tae Lee<sup>2</sup>, Kon Chu<sup>2</sup>, Jung-suk Yu<sup>2</sup>, Dong-kyu Park<sup>2</sup>, Keun-hwa Jung<sup>2</sup>, Jae-kyu Roh<sup>3</sup>

<sup>1</sup>Neurology, Chung-Ang University, Seoul, Korea

<sup>2</sup>Neurology, Seoul National University Hospital, Seoul, Korea

<sup>3</sup>Neurology, The Armed Forces Capital Hospital, Seongnam, Gyeonggi-do, Korea

### Purpose:

We investigated the expression pattern of long noncoding RNAs from two different animal models of intracerebral hemorrhage (ICH), and performed gene ontology analysis to understand gene expression pattern after ICH.

### Methods:

We harvested hemorrhagic brain on 1, 3 and 7 days after ICH induction by stereotactic collagenase injection. After total RNA extraction and quality control, long noncoding RNA (lncRNA) and messenger RNA (mRNA) microarray analysis was performed by Agilent array platform comparing with normal control. The expression patterns of RNAs from collagenase induced ICH model were validated from autologous blood injection ICH model, and the significantly altered lncRNAs from microarray data were validated by quantitative reverse transcriptase polymerase chain reaction. Gene ontology analysis and pathway analysis were performed with differentially expressed mRNAs after ICH.

### Results:

Among 13661 studied lncRNAs, 83, 289, 401 lncRNAs were significantly elevated, while 52, 489, 786 lncRNAs were downregulated after 24 hours, 3 days and 7 days after collagenase induced ICH, respectively. The most upregulated lncRNA after one day from both ICH models is NR\_027324, which remained elevated until 7 days after ICH. Gene ontology analysis revealed that mRNAs related to immune related biological processes such as immune response, immune system process and defense response, extracellular region as cellular component and chemokine receptor/protein binding as molecular function are upregulated after ICH.

### Conclusions:

This study illustrates expression pattern of lncRNAs following ICH and found that NR\_027324 is consistently upregulated as an acute reactant from different ICH models, which is related with inflammatory response.

## Recurrent Stroke in a Patient with Hypertension and Brachydactyly Syndrome

Kyusik Kang<sup>1</sup>, Wong-woo Lee<sup>1</sup>, Jung-ju Lee<sup>1</sup>, Jong-moo Park<sup>1</sup>,  
Ohyun Kwon<sup>1</sup>, Byung Kun Kim<sup>1</sup>

<sup>1</sup>Neurology, Nowon Eulji Medical Center, Seoul, Korea

### Purpose:

Hypertension and brachydactyly syndrome is characterized by short stature, short metacarpals, and elevated blood pressure, and death from stroke before age 50 years when untreated. The gene responsible for the disease was mapped to chromosome 12p. The disease has not been reported in Korea. We are reporting a case of recurrent ischemic stroke associated with hypertension and brachydactyly syndrome.

### Methods:

Our patient underwent brain magnetic resonance imaging (MRI), magnetic resonance angiography (MRA), blood tests, echocardiography, and cerebrospinal fluid analysis.

### Results:

A 35-year-old woman came to Neurology clinic because of headache. Her blood pressure was 220/140 mm Hg. Brain MRI and MRA revealed no abnormality. She was placed on antihypertensive agents. She was admitted 7 years later for evaluation of headache, dizziness, and dysarthria. On examination, she was short (140 cm). She had brachydactyly of hands and feet. She was of normal intelligence and had a normal facial appearance. Upon neurological examination, she was alert and had mild dysarthria and mild left-sided hemiparesis. Diffusion-weighted imaging (DWI) obtained 60 minutes after onset revealed right pontine infarct. Immediately after the scan, she developed a right internuclear ophthalmoplegia, left limb ataxia, and left facial palsy. Therefore, she was treated with intravenous tissue plasminogen activator. Brain MRA revealed stenosis of the distal basilar and right posterior cerebral arteries and occlusion of the left posterior cerebral artery. A couple of hours after tissue plasminogen activator infusion, she became drowsy. A day later, her left hemiparesis deteriorated and her left arm and leg became numb. A repeat DWI showed additional infarct in the right thalamus. An electrocardiogram and an echocardiogram revealed no sources of cardiac embolism. Protein C and protein S activity, anticardiolipin and antiphospholipid antibody levels, and lactate: pyruvate ratio were normal. Results of tests for antinuclear antibodies and lupus anticoagulant were negative. Most of the symptoms resolved in a couple days. Two weeks after admission, she developed headache and dysphagia. A repeat DWI showed hyperintensity in the left parietotemporal cortex, thalamus, and internal capsule. A repeat brain MRA revealed progression of stenosis in the distal basilar and left middle cerebral arteries. Three months after onset, analysis of cerebrospinal fluid revealed no abnormality.

### Conclusions:

Rapidly progressing intracranial stenosis and early recurrent ischemic strokes in different vascular territories can be the manifestations of hypertension and brachydactyly syndrome.



## Embolitic Stroke from a Left Atrial-Esophageal Fistula After Radiofrequency Ablation for Atrial Fibrillation

Jusun Moon<sup>1</sup>, Joo Hye Sung<sup>1</sup>, Kyung-hee Cho<sup>1</sup>, Sungwook Yu<sup>1</sup>, Hayom Kim<sup>1</sup>

<sup>1</sup>Neurology, Korea University Anam Hospital, Seoul, Korea

### Purpose:

Left atrial to esophageal fistula (LAEF) is a rare but fatal complication of radiofrequency ablation (RFA) for atrial fibrillation. LAEF could give rise to embolic stroke, dysphagia, upper gastrointestinal (GI) bleeding and sepsis after recent history of RFA for atrial fibrillation.

### Methods:

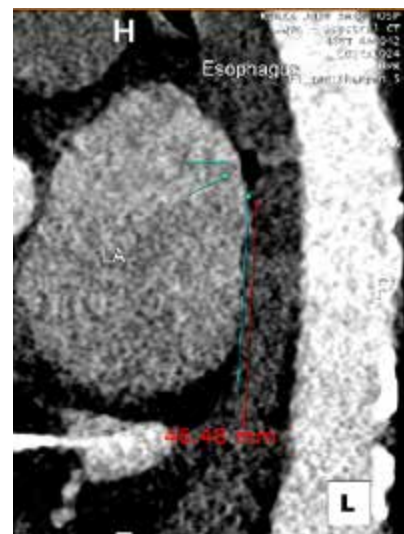
A 64-year-old male was brought to the emergency department (ED) because of an altered mental status with fever. He had undergone RFA for persistent atrial fibrillation one month earlier. Previously, he had ventricular tachycardia, hypertrophic cardiomyopathy, chronic kidney disease and liver transplantation for hepatocellular carcinoma. Diffusion weighted brain MRI revealed multiple acute infarcts in bilateral cerebrum and cerebellum. Next day, LAEF was found in chest CT via evaluation of fever. The patient was in septic condition with persistent fever and repeated seizures occurred. Patients were maintained on stupor conscious state and extensive vasogenic edema was detected in bilateral cerebrum on follow-up CT performed 10 days later. Antibiotics were administered and surgical treatment was considered. However, the caregivers refused surgical treatment.

### Results:

Sepsis has not improved and despite all efforts the patient has died.

### Conclusions:

Atrial-esophageal fistula is an extremely rare but one of the most fatal complications of left atrial ablation therapy performed for refractory atrial fibrillation.



## Transabdominal Functional Magnetic Stimulation for Constipation in Stroke or Traumatic Brain Injured Patients: Randomized Controlled Trial

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<sup>1</sup>PM & R, Presbyterian Medical Center (Jesus Hospital), Jeonju, Korea

### Purpose:

To investigate effects of the transabdominal functional magnetic stimulation (A-FMS) for constipation in stroke or traumatic brain injured patients.

### Methods:

Twenty-four stroke or traumatic brain injured patients (11 male, 13 female, median age 65 years, 22 stroke and 2 TBI) with constipation, who were admitted to the rehabilitation department, were enrolled and divided them into magnetic stimulation group (MS) and sham-treated control group (Sham) randomly and several parameters about constipation were evaluated such as total and segmental colon transit time (CTT), defecation frequency, and Bristol stool scale (BSS) before and after 2 weeks of A-FMS (5 times per week, total 10 times of A-FMS). Korean version of the modified Barthel index (K-MBI) was also evaluated.

### Results:

The change of segmental CTT in the left colon was significantly decreased ( $-8.2 \pm 3.85$  vs  $4.1 \pm 2.5$  hours,  $P < 0.05$  by paired sample T test) and frequency of defecation was significantly increased ( $1.5 \pm 0.15$  vs  $0.67 \pm 0.26$ ,  $P < 0.05$  by paired sample T test) in the MS compared to in the Sham. Stool hardness, evaluated by BSS, became softer in the MS than in the Sham significantly (from 2.3 to 3.5 in the MSG, and from 2.6 to 3.1 in the Sham,  $P < 0.05$  by Chi-squared test). The change of K-MBI had no difference between two groups.

### Conclusions:

The present study suggests that A-FMS has an additional effect for managing constipation in stroke or traumatic brain injured patients by improving segmental bowel movement and increasing frequency of defecation.



## Effect of Reducing Assistance During Robot-assisted Gait Training on Step Length Asymmetry

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### Purpose:

An assist-as-needed robot-assisted gait training protocol was recently developed. It allows active movement during training, but its exact criteria remain unknown. Asymmetric step length is a common abnormal gait pattern in hemiplegic stroke patients. We compared the effects of assist-as-needed robot-assisted gait training on the unaffected and affected limbs of hemiplegic stroke patients.

### Methods:

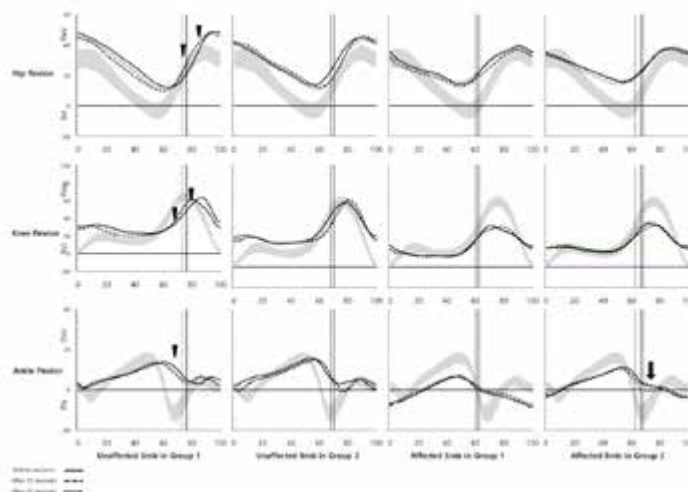
Twenty-four chronic stroke patients with asymmetric step lengths were randomly assigned to one of two groups. Twelve completed the study protocol. Group 1 underwent 20 sessions of assist-as-needed robot-assisted gait training for the unaffected limb and fully-assisted robot-assisted training for the affected limb. Group 2 underwent 20 sessions of robot-assisted gait training using the opposite protocol. Clinical measurements were obtained and three-dimensional gait analyses were performed at baseline and after 10 and 20 training sessions.

### Results:

Clinical measurements improved in both groups after 20 training sessions. The unaffected limb's step length asymmetry ratio and hip maximal extension moment significantly improved in group 1. The affected limb's maximal dorsiflexion angle for the ankle in the swing phase significantly improved in group 2.

### Conclusions:

Application of the assist-as-needed training mode for the unaffected limb helped improve step length asymmetry in chronic stroke patients.



## Association of Non-LDL Serum Lipid Indices with Recurrent Stroke Risk While on Lipid Modifier Treatment

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### Purpose:

Statin therapy primarily through its low-density lipoprotein cholesterol (LDL-C)-lowering effects is an established secondary stroke prevention strategy. However, the differential impact of key non-LDL-C serum lipid levels on recurrent stroke risk while on lipid modifier treatment remains unclear.

### Methods:

We analyzed the dataset of a multicenter trial involving 3640 recent (<4 months) noncardioembolic stroke patients followed for 2 years was analyzed. Participants were categorized into four groups of presumed improving lipid profile: Level 0, no lipid-lowering therapy (LT) prescribed; Level I, LT use with low high-density lipoprotein cholesterol (HDL-C) (<40 mg/dL for men; <50 mg/dL for women); Level II, LT use with high HDL-C ( $\geq$ 40 mg/dL for men;  $\geq$ 50 mg/dL for women); and Level III, Level II with low triglycerides (<150 mg/dL). Independent associations of LT category with stroke (primary outcome), as well as major vascular events (MVEs; stroke/coronary heart disease/vascular death) and all-cause death were assessed.

### Results:

LTs were mostly statins (>95%). Unadjusted recurrent stroke rate declined with LT category level (9.2% for level 0, 8.4% for level I, 7.5% for level II, and 5.7 for level III). Compared with level 0: the adjusted hazard ratio of stroke for level I was 0.78 (95% confidence interval, 0.59–1.03), level II 0.80 (0.54–1.18), and level III 0.63 (0.43–0.91). Multivariable analyses of MVEs and all-cause death followed a similar pattern of declining risk with higher LT category level.

### Conclusions:

Compared to non-use of lipid lowering therapy, there may be a hierarchy of residual vascular risk after stroke by non-LDL serum lipid type and target while on lipid modifier treatment. In particular, stroke patients with low HDL-C levels on conventional lipid modifiers may benefit from additional therapeutic strategies to improve their outcomes.

## Association Between Gamma-glutamyl Transferase and Cardioembolic Stroke

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### Purpose:

Recent studies have consistently reported that gamma-glutamyl transferase (GGT) is correlated with higher risk of stroke independent of stroke risk factors. However, it remains to be further elucidated why GGT is associated with stroke. To clarify the question, we focused on atrial fibrillation (AF), which has also been noted to have a close relationship with GGT.

### Methods:

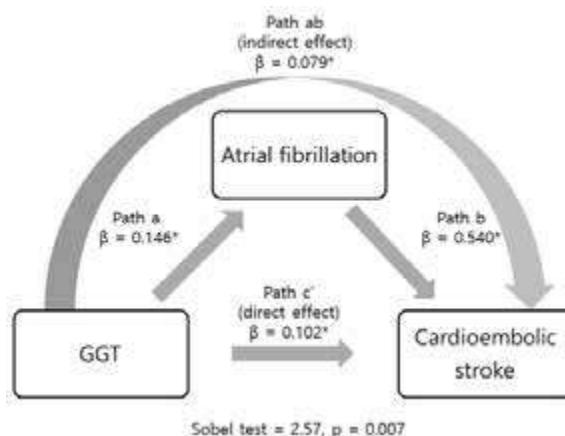
Acute ischemic stroke patients who were admitted to Seoul National University Hospital were analyzed using the binary logistic regression to assess the relationship between GGT, AF and cardioembolic stroke. To investigate whether AF mediates the relationship between GGT and cardioembolic stroke, mediation analysis was conducted.

### Results:

AF was found in 132 (15.0%) of 880 eligible patients, and 270 (30.7%) were categorized as cardioembolic. Those with greater GGT were associated with AF, and cardioembolic stroke in the present study. The relationship between GGT and cardioembolic stroke was 43.6% mediated by AF.

### Conclusions:

GGT had a greater association with cardioembolic stroke than other stroke subtypes, possibly through AF to a considerable extent. Relationship between GGT and stroke might be explained through the results of the present study, and it may be used as basic data to use GGT as biomarker to determine subtype among acute ischemic stroke patients.



## Abdominal Fatness and Cerebral White Matter Hyperintensity

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### Purpose:

Although Obesity has shown close relationships with metabolic and vascular diseases, the effect of adipose tissue on the development of white matter hyperintensity (WMH) is still unclear. In this study, we evaluated the relationship between abdominal fat distribution and WMH volume in a neurologically healthy population.

### Methods:

We assessed a consecutive series of subjects who were examined during voluntary health check-ups between January 2006 and December 2013. We directly measured both visceral adipose tissue (VAT) and subcutaneous adipose tissue (SAT) using abdominal computed tomography. The WMH volumes were also recorded quantitatively.

### Results:

A total of 2,504 subjects were included in this study (median WMH volume: 1.10 [0.20-2.60] mL, median VAT and SAT volume: 109.83 [75.11-151.25] and 151.22 [115.34-198.32] cm<sup>2</sup>, respectively). In multivariate analysis, the relationship between SAT and WMH volume remained significant ( $B = -0.170$ , standard error [SE] = 0.065,  $P = 0.006$ ) after adjusting for confounding factors. The protective effects of SAT on the WMH volume were more prominent in female participants ( $B = -0.295$ , SE = 0.138,  $P = 0.033$ ) and in severely obese participants ( $B = -0.358$ , SE = 0.167,  $P = 0.033$ ). In the comparison of WMH volume and risk factors according to the SAT and total adipose tissue (TAT) tertiles, SAT showed a negative correlation with diabetes, and glucose and triglyceride levels, while a positive correlation was found between SAT and the level of high-density lipoprotein cholesterol.

### Conclusions:

We demonstrated a favorable effect of SAT on WMH prevalence and severity. Given the same favorable association of SAT with various risk factors for the development of WMH, a protective role of SAT is strongly expected.

**Relationship between body fat distribution and square root-WMII volumes according to sexual differences**

	Total (n = 2,504)		Male (n = 1,378)		Female (n = 1,126)	
	B (SE)	P	B (SE)	P	B (SE)	P
<b>Model 1<sup>†</sup></b>						
BMI	-0.002 (0.007)	0.768	-0.005 (0.010)	0.628	-0.004 (0.011)	0.690
WC	0.002 (0.003)	0.437	0.003 (0.004)	0.465	-0.001 (0.004)	0.739
VAT <sup>*</sup>	-0.016 (0.042)	0.713	-0.024 (0.054)	0.661	-0.052 (0.075)	0.487
SAT <sup>*</sup>	-0.099 (0.048)	0.039	-0.055 (0.061)	0.363	-0.153 (0.091)	0.093
VAT/SAT ratio	0.084 (0.055)	0.128	0.059 (0.070)	0.400	0.134 (0.159)	0.402
<b>Model 2 (BMI)<sup>‡</sup></b>						
VAT <sup>*</sup>	-0.013 (0.055)	0.816	-0.011 (0.074)	0.880	-0.052 (0.092)	0.570
SAT <sup>*</sup>	-0.146 (0.061)	0.017	-0.070 (0.087)	0.421	-0.253 (0.128)	0.049
VAT/SAT ratio	0.085 (0.055)	0.122	0.060 (0.070)	0.390	0.132 (0.160)	0.409
<b>Model 3 (BMI+WC)<sup>§</sup></b>						
VAT <sup>*</sup>	-0.082 (0.062)	0.188	-0.111 (0.083)	0.180	-0.062 (0.100)	0.535
SAT <sup>*</sup>	-0.170 (0.062)	0.006	-0.215 (0.099)	0.029	-0.295 (0.138)	0.033
VAT/SAT ratio	0.065 (0.057)	0.252	0.054 (0.070)	0.436	0.133 (0.160)	0.409

SE = standard error, BMI = body mass index, WC = waist circumference, VAT = visceral adipose tissue, SAT = subcutaneous adipose tissue

<sup>\*</sup>These variables were introduced as log scale

<sup>†</sup>Adjusted for age, menopause (only in the analysis with female participants), hypertension, diabetes, current smoking and alcohol use, LDL cholesterol and hs-CRP levels.

<sup>‡</sup>Added body mass index with Model 1

<sup>§</sup>Added waist circumference with Model 2.

<sup>||</sup>VAT, SAT, and VAT/SAT ratio were respectively introduced in each model

## Cystatin C and the Risk of Cardioembolic Stroke in Patients without Chronic Kidney Disease

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### Purpose:

Atrial fibrillation (AF) is well-established risk factor for cardioembolic stroke. Epidemiological evidence indicates that there is increased risk of AF with chronic kidney disease (CKD). Atrial fibrillation, as an expression of myocardial dysfunction, and conditions with reduced renal function of endogenous and exogenous substances often coexist. Cystatin C (Cys-C) is now considered as a specific marker for detection of renal impairment. However, there are no data about the potential association of Cys-C with AF and cardioembolic stroke in the subjects without evident CKD. We investigated whether serum Cys-C level is associated with development of cardioembolic stroke in patients with AF.

### Methods:

Consecutive data were collected retrospectively at the Seoul National University Hospital (SNUH). Patients with ischemic stroke with subtypes of large artery atherosclerosis, small vessel occlusion and cardioembolism who admitted at the SNUH between November 2014 and November 2017 were screened. We excluded the patient who have a history of secondary hypertension, CKD (estimated glomerular filtration rate < 60 mL/min/1.73 m<sup>2</sup>), valvular heart disease, congenital heart disease, dilated or hypertrophy cardiomyopathy and thyroid disease. Atrial fibrillation of the cardioembolism group was confirmed by ECG or 24-hr Holter monitoring.

### Results:

Among the total 627 patients, 61.8% were male, with a mean age of 67.9 years. Compared to the other stroke mechanisms, a stepwise logistic regression analysis showed that cardioembolic stroke due to AF was independently associated with size of left atrium (OR, 1.196, 95% CI: 1.160–1.266), initial stroke severity (NIH Stroke Scale) (OR, 1.126, 95% CI: 1.083–1.189), and Cys-C (OR, 2.472, 95% CI: 1.255–15.129), but not with eGFR (OR 0.993, 95% CI: 0.977–1.009).

### Conclusions:

Cys-C is a superior, independent predictor for cardioembolic stroke due to AF in patients without evident CKD.

## Clinical Characteristics of Acute Cerebral Infarction in Patients with Familial Hypercholesterolemia

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### Purpose:

The patients with familial hypercholesterolemia (FH) suffer from early onset atherosclerotic vascular disease due to high level of cholesterol and subsequent vascular inflammation, especially in the form of coronary artery disease. We tried to investigate the prevalence of FH and its clinical characteristics among Korean stroke patients.

### Methods:

Between January, 2014 and May 2017, acute cerebral infarction or transient ischemic attack (TIA) patients who admitted Chung-Ang University Hospital were reviewed from stroke registry and the diagnosis of FH was made based on Dutch Lipid Clinic Network Diagnostic Criteria for FH. Their initial lipid profile, stroke subtypes and cerebral atherosclerosis pattern were reviewed.

### Results:

Among 1401 acute cerebral infarction or TIA patients, one probable and five possible FH were diagnosed (mean age =  $42 \pm 8$  years, one female patient). All the patients denied of previous coronary artery disease history and initial lipid panel revealed high total cholesterol ( $357 \pm 68$  mg/dL) and low density lipoprotein cholesterol levels ( $225 \pm 48$  mg/dL). Stroke mechanisms are heterogeneous, including one atherosclerotic, one small vessel occlusion, one vertebral artery dissection, one coagulopathy, one transient ischemia attack and one embolic stroke with unknown source. Three patients are combined with considerable degree of intracranial atherosclerosis, but the other three does not have any degree of atherosclerotic cerebral artery stenosis.

### Conclusions:

This study illustrates diverse stroke mechanism among the patients with FH. Further research is required to disclose exact incidence of FH among stroke population and its impact on the prognosis.

## Comparison of CHADS2, CHA2DS2-VASc, ATRIA, and Essen Stroke Risk Score to Predict Vascular Outcome in Stroke with Atrial Fibrillation

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Jin-man Jung<sup>4</sup>, Kyung-mi Oh<sup>5</sup>, Chi Kyung Kim<sup>5</sup>, Sungwook Yu<sup>6</sup>, Kwang Yeol Park<sup>7</sup>, Jeong-  
min Kim<sup>7</sup>, Jong-ho Park<sup>8</sup>, Jay Chol Choi<sup>9</sup>, Man-seok Park<sup>10</sup>, Joon-tae Kim<sup>10</sup>,  
Yang-ha Hwang<sup>11</sup>, Jong-won Chung<sup>1</sup>, Oh Young Bang<sup>1</sup>, Geong-moon Kim<sup>1</sup>, Woo-keun Seo<sup>1</sup>

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<sup>8</sup> Neurology, Seonam University Myongji Hospital, Seoul, Korea

<sup>9</sup> Neurology, Jeju National University, Jeju, Korea

<sup>10</sup> Neurology, Chonnam National University Hospital, Gwangju, Korea

<sup>11</sup> Neurology, Kyungpook National University School of Medicine and Hospital, Daegu, Korea

### Purpose:

Atrial fibrillation (AF) is one of major cause of ischemic stroke and stroke prevention is important in the clinical management of AF. Various clinical risk scoring systems such as CHADS2, CHA2DS2-VASc, ATRIA, and Essen stroke risk score have been developed and validated for the risk stratification in stroke patient with AF. The purpose of this study was to evaluate whether the 4 risk scoring systems to predict vascular outcomes in stroke patient with AF in Korean population.

### Methods:

K-ATTENTION (Korean ATrial fibrillaTion EvaluationN regisTry in Ischemic strOke patieNts) is real world, multicenter, cohort study, merging of prospective stroke registry from 11 tertiary centers reflecting real world data. Dataset included clinical, laboratory, neuroimaging, vascular outcome and details of medication before and after index stroke. To investigate the predictability of these scoring system, patients were stratified according to the oral anticoagulation (OAC) treatment history, 4 risk scoring systems. Using Cox regression model, the predictive value of 4 risk scoring systems to predict vascular outcome was investigated.

### Results:

A total of 3,112 subjects after exclusion of 101 subjects without data of vascular events from 3,213 of stroke with AF patients. Stroke with AF patients were included mean age 73.54±0.17, female 1511(48.6%). 2519 patients are prescribed OAC for stroke second prevention and 593 patients are not prescribed OAC. Patients without OAC treatment were older, had higher initial NIHSS score and higher mRS on 90 days than patients with OAC treatment. The crude rates of recurrent ischemic stroke, any stroke, death, and MACE were 6.0%, 7.3%, 13.0% and 19.1%,



respectively in patients with OAC treatment and 2.5%, 3.7%, 43.2% and 45.7%, respectively in patients without OAC treatment. The relative risk of vascular outcomes were sequentially elevated by increasing risk score of 4 risk scoring systems in patients with OAC treatment. However, in patients without OAC treatment, the incremental risk scores of 4 risk scoring systems failed to show an increase hazard ratios. In subgroup analysis about the interaction between 4 risk scoring systems, OAC treatment history for recurrent ischemic stroke, CHADS2 score and Essen stroke risk score shows statistical significant.( $p=0.003$  and  $0.022$ )

**Conclusions:**

The performance of CHADS2 score, CHA2DS2-VASc score, ATRIA score, and Essen stroke risk score in secondary prevention population were comparable to primary prevention population. However, the predictive value was limited to the patients with OAC treatment.

## Body Mass Index and Stroke Severity in Patients with Non-valvular Atrial Fibrillation

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### Purpose:

Obesity is known as the negative risk factor on survival after acute stroke (the obesity-stroke paradox). But, the study on the association between the obesity and stroke severity after acute ischemic stroke is sparse, especially the patients with non-valvular atrial fibrillation (NVAF). The objective of this study was to investigate the association between obesity and stroke severity in patient with non-valvular atrial fibrillation.

### Methods:

In this multi-center, retrospective observational study, total 1876 acute ischemic stroke patients with NVAF were included. Patients were categorized into underweight (body mass index [BMI]<18.5, n=121), normal (18.5≤BMI<25, n=1220), overweight (25≤BMI<30, n=481) and obese (30≤BMI, n=56). CHASDS2-VASc score was also collected. National Institutes of Health Stroke Scale (NIHSS) score at admission and discharge, modified Rankin Scale (mRS) score at 3 months were evaluated. For analysis, mRS was dichotomized to favorable outcome (mRS 0 to 2) or unfavorable outcome (mRS 3 to 6).

### Results:

In baseline characteristic analysis, initial and discharge NIHSS scores and 3 month mRS score were differed among 4 groups of patients. In subgroup analysis, overweight patients had low NIHSS score at admission ( $6.80 \pm 6.99$  vs  $8.00 \pm 7.55$ ,  $p<0.001$ ) and discharge ( $5.11 \pm 8.01$  vs  $8.27 \pm 8.54$ ,  $p=0.002$ ) compared with normal weight patients. Also, overweight patients had more favorable outcome (60.0% vs 54.4%,  $p=0.039$ ) compared with normal weight patients.

### Conclusions:

We found the association of BMI and stroke severity in the acute ischemic stroke patients with NVAF. Overweight patients had mild initial ischemic symptom and more favorable outcome compared with normal weight patients. Our results documented obesity paradox in the patients with NVAF. Further investigations are needed.

## The Association Between Stroke Incidence and Hypertriglyceridemic Waist Phenotype: The KoGES (Ansan-Ansung) Cohort Study

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### Purpose:

Stroke is a major disease in the aging society. The hypertriglyceridemic waist (HTGW) phenotype was suggested to be a screening tool for the people with an increased risk of cardiovascular diseases and type II Diabetes. The objective of our study was to investigate association between HTGW phenotype and incident stroke in Korea.

### Methods:

A total of 7,638 participants (mean age 51.7, 47.6% men, 52.4% women) without stroke at baseline in KoGES prospective cohort study were analyzed. During the average follow-up of 9.79 years, 225 cases of stroke were newly diagnosed. Subjects who had enlarged waist circumference (WC)-high tryglyceride(TG) were significantly associated with increased risk of stroke incidence. Subjects were divided into four groups by WC and TG level; 1) normal WC-normal TG (NWNT), 2) normal WC-high TG (NWHT), 3) enlarged WC-normal TG (EWNT), and 4) enlarged WC-high TG (EWHT). Enlarged WC was defined as  $WC \geq 90$  cm for men and  $\geq 85$  cm for women; high serum TG was defined as  $TG \geq 150$  mg/dL in men and women.

### Results:

We analyzed the association between the HTGW phenotype and incidence of stroke in Cox proportional hazard model. The hazard ratio (HR) and 95% confidence interval (95% CI) were 1.98(1.26, 3.10) after adjustment for confounding factors. In stratified analysis, women had high risk of stroke incidence in a EWHT group; the HR and CI were 2.37(1.24, 4.53).

### Conclusions:

Our study suggests that the HTGW phenotype is associated with stroke incidence. Associations are different according to sex in Middle-aged Korean. In conclusion, there would be needed making a strategy to prevent risk of stroke incidence with considering characteristics.

## Feasibility of Transcranial Doppler for Screening High-risk Patent Foramen Ovale from Cryptogenic Stroke Patients

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### Background:

Identifying high embolic risk patent foramen ovale (PFO) from the innocent bystanders has become important in the evaluation of patients with cryptogenic stroke (CS) since the recent clinical trials showed the benefits of the closure of PFO on the prevention of recurrent stroke.

Contrast-enhanced transesophageal echocardiography (TEE) is a gold standard to diagnose and evaluate the risk of PFO, but the tolerability and cooperation of handicapped stroke patients limit clinical applications. In this study, we aimed to evaluate the predictability of transcranial Doppler (TCD), a test deemed more feasible to stroke patients than TEE, in diagnosing high-risk PFO on TEE.

### Method:

We retrospectively reviewed the data of 485 patients with CS who underwent TEE and TCD to evaluate PFO. To classify the shunts, we applied a 5-level visual classification for TCD either at rest or during Valsalva maneuver (VM): no occurrence of micro-embolic signals; grade I, 1-10 signals; grade II, 11-30 signals; grade III, 31-100 signals; grade IV, 101-300; grade V, >300 or curtain pattern. High-risk PFO on TEE is defined as PFO with atrial septal aneurysm, hypermobility (phasic septal excursion into either atrium  $\geq 10$  mm), or PFO size (maximum separation of the septum primum from the secundum)  $\geq 2$  mm. Receiver operating characteristic (ROC) curve was used to determine the threshold value of TCD shunt grade for high-risk PFO which was demonstrated by TEE.

### Result:

Concordant results between TCD and TEE appeared at 344 patients (71.0%); present of shunt in 235 patients (48.5%), and no-shunts in 109 patients (22.5%). Patients with high risk PFO on TEE were detected in 133 (55.9%) among the 238 patients that were PFO positive on TEE. The proportion of high-risk PFO dramatically increased in accordance to the increase in TCD grade with VM. The best cut-off point of TCD grade with VM for detecting high risk shunt was grade 3 with an area under the curve (AUC) of 0.79, sensitivity of 73.1%, and specificity of 75.6%. TCD with VM missed only 2 patients as having PFO among the 133 patients with high-risk PFO on TEE.

### Conclusion:

This study showed that the findings of TCD on the diagnosis and evaluation of the risk of PFO were well correlated with those of TEE. Negative of shunt on TCD can exclude the possibility of high risk PFO; grade III or more on TCD suggests the presence of high risk PFO in patients with CS.