


ORIGINAL RESEARCH

# Mechanical Thrombectomy Up to 24 Hours in Large Vessel Occlusions and Infarct Velocity Assessment

Manabu Inoue , MD, PhD; Takeshi Yoshimoto , MD; Kanta Tanaka , MD, PhD; Junpei Koge, MD; Masayuki Shiozawa , MD; Tatsuya Nishii , MD, PhD; Yasutoshi Ohta , MD, PhD; Tetsuya Fukuda, MD, PhD; Tetsu Satow , MD, PhD; Hiroharu Kataoka, MD, PhD; Hiroshi Yamagami , MD, PhD; Masafumi Ihara , MD, PhD; Masatoshi Koga , MD, PhD; Michael Mlynash , MD, MS; Gregory W. Albers , MD; Kazunori Toyoda , MD, PhD

**BACKGROUND:** We retrospectively compared early- (<6 hours) versus late- (6–24 hours) presenting patients using perfusion-weighted imaging selection and evaluated clinical/radiographic outcomes.

**METHODS AND RESULTS:** Large vessel occlusion patients treated with mechanical thrombectomy from August 2017 to July 2020 within 24 hours of onset were retrieved from a single-center database. Perfusion-weighted imaging was analyzed by automated software and final infarct volume was measured semi-automatically within 14 days. The primary end point was good outcome (modified Rankin Scale 0–2 at 90 days). Secondary end points were excellent outcome (modified Rankin Scale 0–1 at 90 days), symptomatic intracranial hemorrhage, and death. Clinical characteristics/radiological values including hypoperfusion volume and infarct growth velocity (baseline volume/onset-to-image time) were compared between the groups. Of 1294 patients, 118 patients were included. The median age was 74 years, baseline National Institutes of Health Stroke Scale score was 14, and core volume was 13 mL. The late-presenting group had more female patients (67% versus 31%, respectively;  $P=0.001$ ). No statistically significant differences were seen in good outcome (42% versus 53%, respectively;  $P=0.30$ ), excellent outcome (26% versus 32%, respectively;  $P=0.51$ ), symptomatic intracranial hemorrhage (6.5% versus 4.6%, respectively;  $P=0.74$ ), and death (3.2% versus 5.7%, respectively;  $P=0.58$ ) between the groups. The late-presenting group had more atherothrombotic cerebral infarction (19% versus 6%, respectively;  $P=0.03$ ), smaller hypoperfusion volume (median: 77 versus 133 mL, respectively;  $P=0.04$ ), and slower infarct growth velocity (median: 0.6 versus 5.1 mL/h, respectively;  $P=0.03$ ).

**CONCLUSIONS:** Patients with early- and late-time windows treated with mechanical thrombectomy by automated perfusion-weighted imaging selection have similar outcomes, comparable with those in randomized trials, but different in infarct growth velocities.

**REGISTRATION:** URL: <https://www.clinicaltrials.gov>; Unique identifier: NCT02251665.

**Key Words:** acute stroke ■ infarct size ■ perfusion imaging ■ thrombectomy

The patient selection strategy for late-presenting large vessel occlusions (LVO) was established by 2 randomized controlled trials<sup>1,2</sup> using different mismatch approaches and was designated as class 1A evidence in the recent 2018 American

Heart Association (AHA)/American Stroke Association Guidelines for the Early Management of Patients With Acute Ischemic Stroke.<sup>3</sup> Although advanced imaging such as computed tomography/magnetic resonance perfusion imaging using automated software is not

Correspondence to: Manabu Inoue, MD, PhD, FAHA, FESO, FWSO, Department of Cerebrovascular Medicine/Division of Stroke Care Unit, National Cerebral and Cardiovascular Center, 6-1 Kishibe-Shimmachi, Suita, Osaka 564-8565, Japan. E-mail: [gakinoue@ncvc.go.jp](mailto:gakinoue@ncvc.go.jp)

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## CLINICAL PERSPECTIVE

### What Is New?

- We demonstrated the efficacy of mechanical thrombectomy in patients with large vessel occlusion with perfusion scans between 2 time windows (<6 and 6–24 hours) in the real-world clinical practice.
- There were no differences in clinical outcomes between these 2 time windows.
- We also found that the infarct velocity differed between the 2 time windows, with slower infarct growth at 6- to 24-hour time window population.

### What Are the Clinical Implications?

- Patients with late-presenting large vessel occlusion (from 6 to 24 hours) may still have clinical benefit from mechanical thrombectomy selected by perfusion scans.
- Previous trials have only reported perfusion mismatch selection up to 16 hours, although our data suggest benefits up to 24 hours; although similar findings were reported in the pooled analysis of the Analysis of Pooled Data from Randomized Studies of Thrombectomy More Than 6 Hours After Last Known Well database, our findings are from the real-world clinical practice.
- Infarct velocity was 0.6 mL/h in patients at 6- to 24-hour onset and 5.1 mL/h growth in <6-hour onset; this difference in infarct growth indicates the importance of efficient reperfusion therapy.

### Nonstandard Abbreviations and Acronyms

<b>CTP</b>	computed tomography perfusion
<b>LAA</b>	large artery atherosclerosis
<b>LVO</b>	large vessel occlusion
<b>mRS</b>	modified Rankin Scale
<b>MT</b>	mechanical thrombectomy
<b>Tmax</b>	time-to-maximum

widely established worldwide, the patient selection for late-presenting cases in these trials has changed the landscape for mechanical thrombectomy (MT).

Perfusion imaging can be performed efficiently, adding only a few minutes to the imaging workflow when using analysis software.<sup>4</sup> However, in some centers, perfusion imaging is not performed because of the perception that it is time-consuming. This leads to exclusion of patients who may benefit from MT. Presently, perfusion imaging analysis is not fully accessible in many centers. For example, perfusion imaging

in acute stroke beyond 6 hours was performed in only 12% of acute stroke care hospitals in Japan, and even when performed, most perfusion imaging analysis is done using an “eyeballing” semiquantitative method. Furthermore, most previous studies have limited numbers of late-presenting patients up to 16 hours, a shortage of real-world data, and used follow-up fluid-attenuated inversion-recovery images to assess the final infarct size within 5 days after onset which may be too early for an accurate estimate.

The AHA guidelines<sup>3</sup> indicate the clinical benefit of MT when performed <6 hours from stroke onset, while the DEFUSE 3<sup>2</sup> (Endovascular Therapy Following Imaging Evaluation for Ischemic Stroke 3) and DAWN<sup>1</sup> (Diffusion Weighted Imaging [DWI] or Computerized Tomography Perfusion [CTP] Assessment With Clinical Mismatch in the Triage of Wake Up and Late Presenting Strokes Undergoing Neurointervention) trials have shown the benefit of MT between 6 to 16 and 6 to 24 hours, respectively. Although perfusion mismatch selection is not a requirement in the AHA guidelines, recent stroke trials have shown the importance of comparing the 2 time-windows (<6 and 6–24 hours) using perfusion imaging to characterize its clinical benefit.

Herein, we retrospectively assessed the clinical outcomes and infarct velocity of LVO treatment from our single-center National Cerebral and Cardiovascular Center (NCVC) Stroke Registry database and estimated the difference between the early- (<6 hours) and late- (6–24 hours) presenting time windows using perfusion imaging for radiological outcomes.

## METHODS

The data that support the findings of this study are available from the corresponding author upon reasonable request.

### Patient Eligibility

Data on consecutive patients with a diagnosis of anterior circulation LVO acute ischemic stroke within 24 hours of onset treated by MT between August 2017 and April 2020 were collected from the NCVC Stroke Registry database. The NCVC Stroke Registry database<sup>5,6</sup> was developed in November 2011 for all stroke patients admitted to our stroke center. This Registry is one of the largest databases in Japan, with the addition of 800 to 900 stroke patients annually (180–200 acute perfusion scans annually).

All patient characteristics, radiological characteristics, acute treatment, time logistics, and modified Rankin Scale (mRS) at follow-up (90 days) were collected and early- (<6 hours) versus late- (6–24 hours) presenting patients were compared and assessed. To exclude the potential sources of selection bias,

the inclusion criterion for reperfusion therapy was determined in accordance with the patients' premorbid condition (an LVO with a pre-stroke baseline mRS  $\leq 3$  was required), the Japanese Guidelines for Intravenous Thrombolysis 3rd edition<sup>7</sup> and the Japanese Guidelines for Neuroendovascular MT 4th edition<sup>8</sup> to exclude the potential sources for selection bias. LVO was diagnosed by baseline magnetic resonance angiography to confirm an internal carotid artery or a middle cerebral artery M1 proximal (a horizontal segment of the middle cerebral artery of  $< 5$  mm from the terminal bifurcation of the internal carotid artery occlusion). MT was performed by neuro-interventionalists certified by the Japanese Society for Neuroendovascular Therapy. Exclusion criteria were renal failure or contrast agent allergy for perfusion scans, as well as inadequate perfusion scans.

Patients with contraindications to magnetic resonance imaging (MRI) such as claustrophobia, or with pacemakers and metallic contraindications were scanned by computed tomography perfusion (CTP). Perfusion analysis was performed using automated software (RAPID; iSchemaView, Menlo Park, CA). The stroke subtype was also collected which was determined according to the trial of Org 10172 in Acute Stroke Treatment (TOAST) criteria.<sup>9</sup> The stroke onset-to-qualifying imaging time, imaging-to-reperfusion time, and stroke onset-to-reperfusion time were collected as time logistics and the patient population was dichotomized into 2 time windows (early,  $< 6$  hours versus late, 6–24 hours).

This study was approved by the Institutional Review Board of NCV (M23-073-4) and the NCV Stroke Registry was registered to ClinicalTrials.gov (NCT02251665). Written informed consent was obtained from the patients for interventional treatment.

### Imaging Protocol and Analysis

MRI was performed on a 3.0 T system (MAGNETOM Spectra; Siemens Healthcare, Erlangen, Germany). The MRI protocol included an axial isotropic diffusion-weighted echo-planar spin-echo sequence and bolus-tracking perfusion-weighted imaging. Diffusion-weighted imaging was performed with an echo-planar sequence (field of view=230 mm, slice thickness=4 mm, number of slices=30, slice gap=5 mm, acquisition matrix=140×192). Perfusion-weighted imaging was performed with gradient echo-planar imaging (field of view=230 mm, repetition time=2000 ms, echo time=40 ms, acquisition matrix=96×96, total repetitions=50, gadolinium dose=15 mL, injection speed=4–5 mL/s). CTP was performed on a 320-slice computed tomography scanner (Aquilion ONE; Canon Medical System, Ohtawara, Japan) including a non-contrast computed tomography scan (120 kV, 250 mA, 4-mm axial slices)

and volume CTP (z-axis=160 mm, delay after start of contrast medium injection=4 seconds, total imaging duration=56 seconds, 80 kV, 120 mA, slice thickness=5 mm, collimation=320×0.5 mm).

All diffusion-weighted imaging and MRI/CTP images were retrospectively post-processed on an automated image postprocessing system (RAPID; iSchemaView, Menlo Park, CA). The ischemic core lesion was calculated by an apparent diffusion coefficient  $< 620 \times 10^{-6}$  mm<sup>2</sup>/s on b0/b1000 images in MRI or a relative reduction of cerebral blood flow  $< 30\%$  in CTP. The hypoperfused tissue, which represents the tissue penumbra, was estimated at previously validated thresholds of a time-to-maximum (Tmax)  $> 6$  seconds.<sup>10</sup> The mismatch ratio and the hypoperfusion index ratio, defined by the ratios of the volumes Tmax  $> 10$  seconds/Tmax  $> 6$  seconds, were also collected.

Final infarct volume within 14 days was mainly measured by fluid-attenuated inversion-recovery images (88%) using MIPAV software (<https://mipav.cit.nih.gov/>). The initial growth rates for all patients were determined using a similar approach to that previously reported (baseline core volume/time between symptom onset and baseline imaging).<sup>11</sup> Infarct growth rate was also calculated as infarct growth/time from onset.

### Outcomes

The primary outcome was a good outcome defined by an mRS 0–2 at 90 days after onset. The secondary outcomes were excellent outcome (mRS 0–1) at 90 days, symptomatic intracranial hemorrhage (sICH), or death; sICH was defined as a hemorrhage causing  $\geq 4$  points deterioration in the National Institutes of Health Stroke Scale within 48 hours from onset.<sup>12</sup>

### Statistical Analysis

For description of the general characteristics of the study population and the comparison of the 2 time-window groups, percentages are reported for categorical variables and median with interval from the Q1 (first quartile) and Q3 (third quartile) for continuous variables. The Chi-square test (Fisher exact test if not appropriate) and the Mann–Whitney *U* test were used to compare categorical and continuous variables, respectively. Significance was set at  $P < 0.05$  for all tests. Multivariable logistic regression analysis was performed to estimate the associations with outcomes adjusted for imbalances between the early and late treatment groups. We also investigated the presence of multicollinearity in these variables. Covariates were selected from the values that had significant differences from the univariate analysis. Odds ratios (OR) with 95% CI were also calculated. All statistical analyses were performed with statistical software (SPSS statistics v27; IBM, Chicago, IL).

## RESULTS

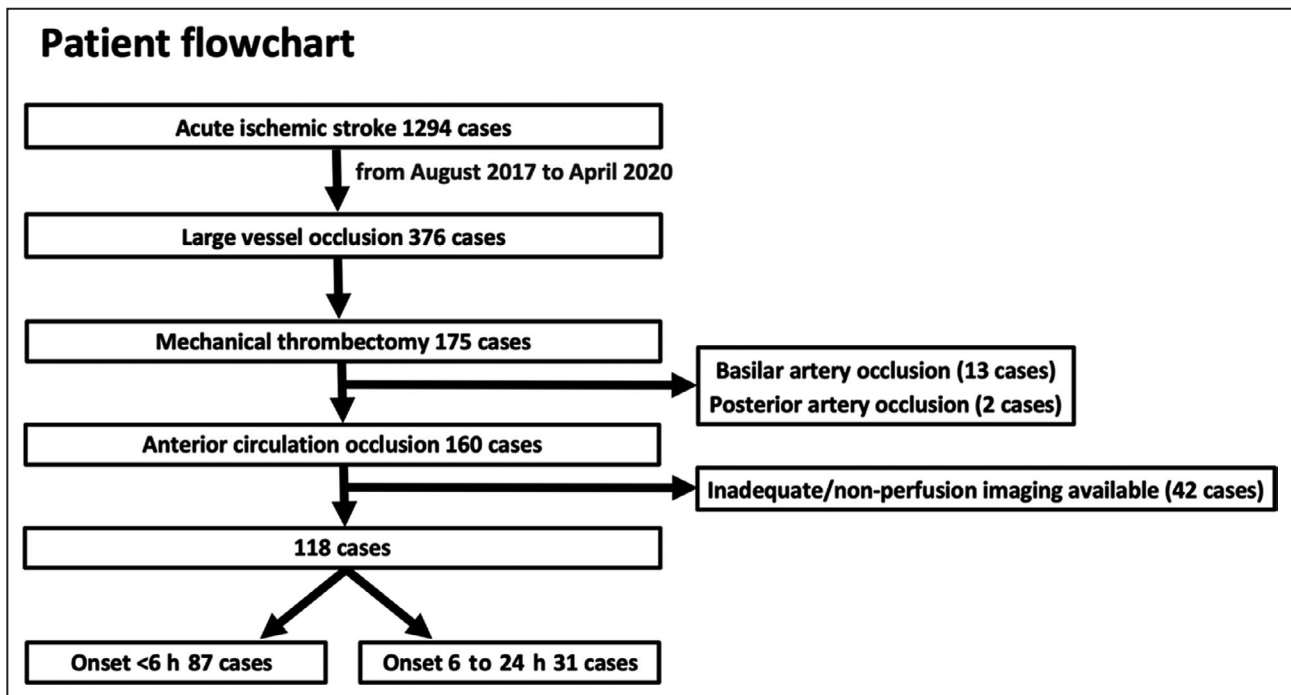
During the study period, 3847 patients were hospitalized, of whom 1294 patients with acute ischemic stroke were identified from the database. LVO was seen in 376 patients and MT was performed in 175 patients. Of these, posterior circulation occlusion was seen in 15 patients and 42 patients were removed because of inadequate/non-perfusion scans. A total of 118 patients met the inclusion criteria (Figure 1). Thirty-one patients were categorized as late-presenting time-window patients and 87 patients as early-presenting time-window patients. Baseline characteristics are shown in Table 1.

Baseline magnetic resonance perfusion was performed in 59 patients and CTP in 59 patients. There was a significant difference in the median Tmax >6 seconds volumes between the late time-window group (77 mL) and the early time-window group (133 mL) ( $P=0.04$ ). There were no significant differences in the median final volume (7 mL versus 17 mL, respectively;  $P=0.31$ ) or in the infarct growth rate measured within 14 days of onset (0.1% versus 0%, respectively;  $P=0.75$ ) between the 2 groups, while infarct growth velocity was significantly slower in the late time-window group (0.6 mL/h versus 5.1 mL/h, respectively;  $P=0.003$ ) (Figure 2).

No statistically significant differences were seen in the primary outcome (42% with good outcome in the

late-presenting time-window group versus 53% in the early time-window group;  $P=0.30$ ) or excellent outcomes (26% in the late-presenting time-window group versus 32% in the early time-window group;  $P=0.51$ ) between the 2 groups (Figure 3). Furthermore, there were no statistically significant differences in the rates of sICH (6.5% in the late-presenting group versus 4.6% in the early-presenting group;  $P=0.74$ ) or death (3.2% in the late-presenting group versus 5.7% in the early-presenting group;  $P=0.58$ ) were seen between the 2 groups.

In univariate analysis, there were no statistically significant differences in primary or secondary outcomes between the late and early treatment groups. Furthermore, logistic regression analysis showed no statistically significant difference in the association of each outcome between the 2 groups after adjustment (good functional outcome: adjusted OR, 0.65; 95% CI, 0.26–1.64;  $P=0.37$ ; excellent outcome: adjusted OR, 0.90; 95% CI, 0.32–2.54;  $P=0.84$ ). The statistical variance inflation factors in these variables were female sex (1.040), large-artery atherosclerosis (1.014), Tmax >6 seconds (1.071), and intravenous thrombolysis (1.040). Although intravenous thrombolysis showed a significant difference in the univariate analysis, it was not chosen as a covariate because it can be a very subtle variable. Intravenous thrombolysis can also be time dependent, since late (6–24 hours) window



**Figure 1.** Patient flowchart.

Patients are stratified from the database with inclusion criteria shown in the figure. The collection date was started from August 2017, when we first started using automated perfusion analysis software. Patients with posterior circulation ( $n=15$ ) or inadequate or non-available perfusion imaging ( $n=42$ ) were not included in this study.

**Table 1. Patient Demographics and Radiological Characteristics\***

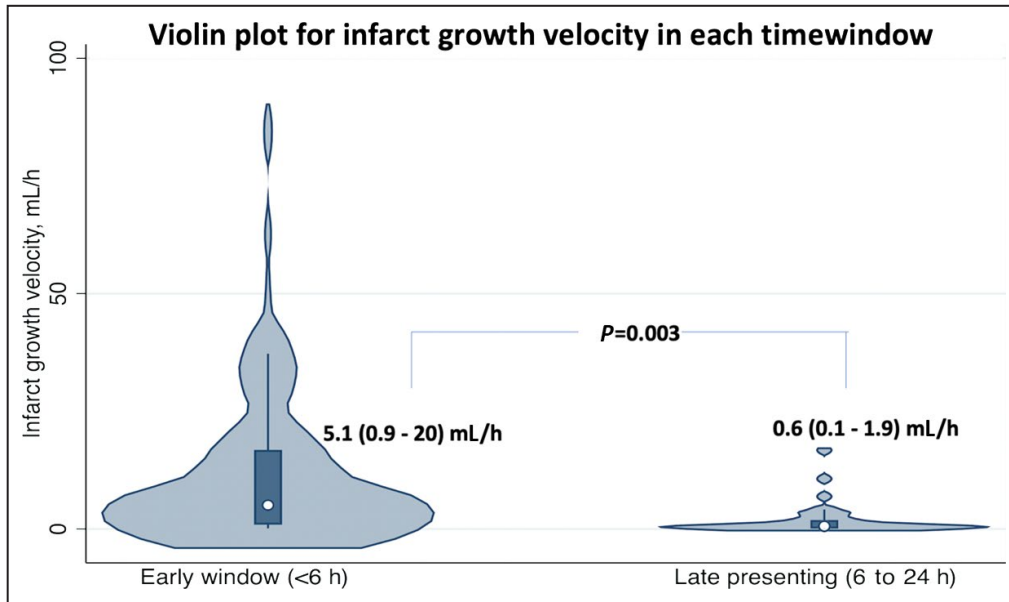
	Total (118 cases)	Late window LVO (31 cases)	Early window LVO (87 cases)	P value
<b>Demographics</b>				
Women, n (%)	47 (40)	20 (67)	27 (31)	0.001
Age, median (y) (Q1–Q3)	74 (70–83)	77 (70–82)	77 (69–83)	0.83
Prestroke mRS <sup>†</sup> score, median (Q1–Q3)	0 (0–2)	0 (0–2)	0 (0–2)	0.80
<b>Past medical history</b>				
Hypertension, n (%)	79 (67)	22 (71)	57 (66)	0.58
Diabetes, n (%)	28 (24)	6 (19)	22 (25)	0.51
Dyslipidemia, n (%)	53 (45)	16 (52)	37 (43)	0.38
Ischemic heart disease, n (%)	16 (14)	3 (10)	13 (15)	0.45
Previous stroke, n (%)	21 (18)	7 (23)	14 (16)	0.42
Current smoker, n (%)	32 (27)	5 (16)	27 (31)	0.10
Atrial fibrillation, n (%)	77 (65)	18 (58)	59 (68)	0.33
<b>Clinical features</b>				
Baseline NIHSS score <sup>‡</sup> , median (Q1–Q3)	14 (9–23)	13 (7–21)	13 (10–23)	0.31
<b>Etiology</b>				
Cardioembolic, n (%)	88 (75)	22 (71)	66 (76)	0.59
Large-artery atherosclerosis, n (%)	16 (14)	9 (29)	7 (8)	0.03
<b>Vessel occlusion</b>				
ICA, n (%)	43 (36)	12 (39)	31 (36)	0.76
MCA, n (%)	55 (47)	16 (52)	39 (45)	0.52
<b>Time logistics</b>				
Time from qualifying imaging to reperfusion, median min (Q1–Q3)	97 (72–166)	107 (80–206)	89 (71–144)	0.81
<b>Radiological characteristic</b>				
Magnetic resonance perfusion case, n (%)	59 (50)	19 (61)	40 (49)	0.24
Core volume, median mL (Q1–Q3)	13 (0–48)	12 (0–36)	13 (0–50)	0.26
ASPECTS, median (Q1–Q3)	10 (8–10) (n=54)	9 (8–10) (n=14)	10 (8–10) (n=40)	0.91
DWI-ASPECTS, median (Q1–Q3)	8 (7–10) (n=69)	8 (7–9) (n=19)	8 (7–10) (n=50)	0.46
Tmax >6 s volume, median mL (Q1–Q3)	118 (59–175)	77 (50–132)	133 (60–184)	0.04
Mismatch ratio, median (Q1–Q3)	4.0 (2.0–9.6)	3.9 (2.6–8.2)	3.9 (2.0–11.8)	0.87
Hypoperfusion index, median (Q1–Q3)	0.4 (0.1–0.6)	0.3 (0.2–0.5)	0.4 (0.2–0.6)	0.36
Final infarct volume within 14 d, median mL (Q1–Q3)	15 (3–41)	7 (3–30)	17 (3–48)	0.31
Infarct growth rate, median % (Q1–Q3), (Baseline-Follow Up)/Baseline	0 (–2.4–0.8)	0.1 (–3–0.8)	0 (–2.4–0.8)	0.75
Infarct growth velocity, median mL/h (Q1–Q3), (baseline volume/onset to image)	3.1 (0.5–15.3)	0.6 (0.1–1.9)	5.1 (0.9–20)	0.003
<b>Treatment</b>				
Intravenous thrombolysis, n (%)	46 (39)	3 (10)	43 (49)	<0.01
TICI 2b or more, n (%)	104 (88)	25 (81)	79 (91)	0.14
<b>Clinical outcomes</b>				
Good outcome (mRS 0–2), n (%)	59 (50)	13 (42)	46 (53)	0.30
Excellent outcome (mRS 0–1), n (%)	36 (31)	8 (26)	28 (32)	0.51
Symptomatic ICH, n (%)	6 (5.1)	2 (6.5)	4 (4.6)	0.74
Death, n (%)	6 (5.1)	1 (3.2)	5 (5.7)	0.58

ASPECTS indicates Alberta Stroke Program Early Computed Tomographic Score; BP, blood pressure; DWI, diffusion-weighted imaging; ICA, internal carotid artery; ICH, intracranial hemorrhage; IQR, interquartile range; LVO, large vessel occlusion; MCA, middle cerebral artery; mRS, modified Rankin Scale; NIHSS, National Institutes of Health Stroke Scale; Q1, quartile 1; Q3, quartile 3; and Tmax, time-to-maximum.

\*Values are presented as median (Q1–Q3) with an interval from the Q1 (first quartile) and Q3 (third quartile). Frequencies are presented as number (%).

<sup>†</sup>Scores on the mRS range from 0 to 6, with higher scores indicating higher disability.

<sup>‡</sup>Scores on the NIHSS range from 0 to 42, with higher scores indicating a higher deficit.



**Figure 2.** Violin plot for infarct growth velocity in each time window.

Infarct growth velocity (mL/h) was defined as the baseline volume/onset-to-image time. The median (interquartile range) infarct velocity was 5.1 (0.9–20) mL/h for the early time-window patients (<6 hours) and 0.6 (0.1–1.9) mL/h for the late time-window patients (6–24 hours) ( $P=0.003$ ).

patients hardly receive tissue plasminogen activator (tPA) after 4.5 hours but has clinical benefit to receive tPA for achieving favorable clinical outcomes (Table 2). Thus, we used sex, large-artery atherosclerosis, and  $T_{max} >6$  seconds as covariates.

## DISCUSSION

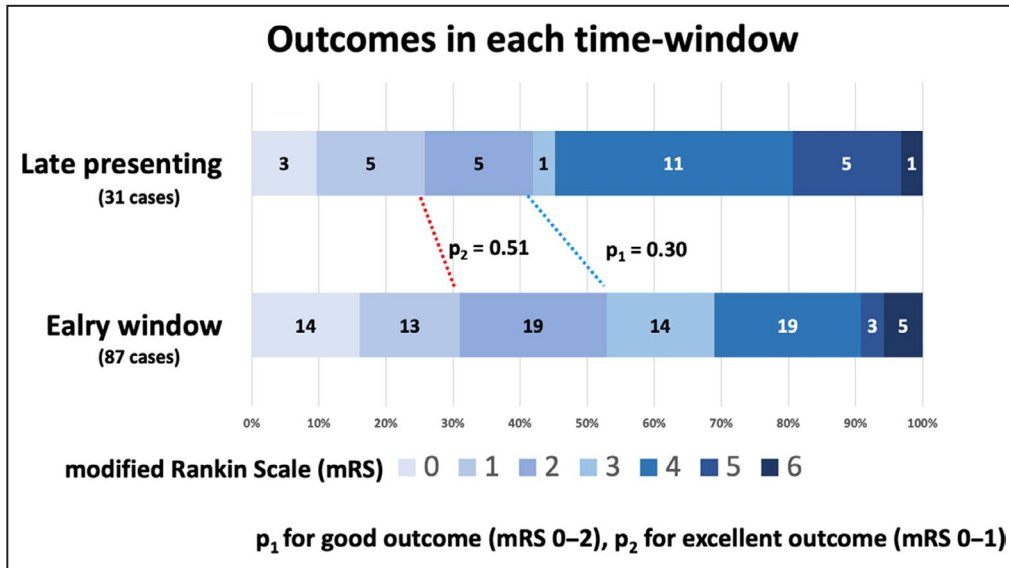
The main finding of our retrospective study was that both early and late time-window patients selected for thrombectomy confirmed by automated perfusion imaging had similar outcomes comparable with those from randomized trials in a real-world data set setting. Furthermore, by assessing the infarct growth rate and infarct velocity from follow-up imaging data (mainly fluid-attenuated inversion-recovery images) within 14 days, we found differences in infarct velocity (but not in infarct growth rate) between the early-presenting and late-presenting groups which was not observed in other major trials.

In the present study, there was a significant sex difference in the late-presenting group compared with the early group (67% versus 31% women, respectively;  $P=0.001$ ). Recent studies suggest that women have worse outcomes following LVO<sup>13</sup> because of the lower utilization of EVT. The worse outcomes in older women may be caused by delayed hospital arrival because of no housemates or no eyewitnesses at stroke occurrence.<sup>14</sup>

We also found that the late-presenting group had significantly more patients with large artery atherosclerosis (LAA) than patients with cardioembolic stroke

(29% versus 8%, respectively;  $P=0.03$ ). Patients with LAA often have less severe symptoms than patients with cardioembolic stroke and tend to have better collaterals, although we found no statistically significant difference in the median core volume between these groups (7 mL versus 13 mL, respectively;  $P=0.48$ ). These data suggest that collaterals are better in the late-presenting group with the same core volume, that patients with LAA may have better collaterals, and that a substantial percentage of patients with LVO have prolonged growth of the ischemic core into the longer time windows. Collaterals and core growth can be estimated by the hypoperfusion index, which is calculated by  $T_{max} >10$  seconds/ $T_{max} >6$  seconds.<sup>15,16</sup> The LAA group showed a trend toward a lower hypoperfusion index compared with the cardioembolic group (0.2 in LAA, interquartile range [IQR], 0.1–0.5 versus 0.4 in cardioembolic, IQR, 0.2–0.6;  $P=0.09$ ), which was consistent with a previous report.<sup>17</sup>

Although the median target mismatch ratio did not differ between the 2 groups (3.9 for both the early and late groups;  $P=0.87$ ), the late-presenting group had a slower infarct growth velocity. Core growth rates are highly variable in any time window,<sup>11,18</sup> which may slow core growth while the penumbras are maintained until the collaterals finally fail; this accounts for the individual variation in the specific brain tissue time frame. The final infarct volume after successful reperfusion would reflect to these infarct growth rates because the final infarct assessed near onset may include a component of cytotoxic edema. In this population, a successful reperfusion would minimize



**Figure 3. Outcomes in each time-window.** There were no differences in the primary outcome rates (modified Rankin Scale [mRS] 0–2 at 90 days) and excellent outcome rates (mRS 0–1 at 90 days) between the early time-window (<6 hours) and the late-presenting time-window (6–24 hours) patients. Primary outcomes were achieved in 53% of early time-window and 42% of late time-window patients ( $P=0.30$ ). The secondary outcome of mRS 0 to 1 at 90 days was achieved in 32% of early time-window and 26% of the late time-window patients ( $P=0.51$ ). Interestingly, the difference between the 2 groups was smaller (11% in mRS 0–2 vs 6% in mRS 0–1, respectively) for excellent outcome rates (mRS 0–1 at 90 days). mRS indicates modified Rankin Scale.

the influence of the infarct growth, resulting in better clinical outcomes. A unique aspect of the present study was that most final infarcts were measured by fluid-attenuated inversion-recovery images within 14 days, which avoids the limitations of early edema and Wallerian degeneration and atrophy. This measurement provides an accurate estimate of infarct evolution between onset and follow-up, with many studies using a 5-day follow-up for final infarct assessment.<sup>19</sup>

In the present study, we chose a 24-hour time window similar to the DAWN trial, while the DEFUSE 3 trial used a perfusion-weighted imaging core mismatch selection similar to ours, with a 16-hour time window. By comparing these 2 trials, ≈40% of the DEFUSE 3 patients did not meet the DAWN criteria.<sup>20</sup> Importantly, although these 2 trials are often considered similar, with no difference in the primary outcome between the DAWN eligible and ineligible patients in DEFUSE 3 (both groups showed a significant benefit), our findings support that perfusion-weighted imaging core

mismatch selection can extend the time window up to 24 hours. A recent published pooled analysis demonstrated that MT was associated with similar benefits between patients in the clinical mismatch and target perfusion mismatch subgroups during the 6- to 24-hour treatment window.<sup>21</sup>

### Strengths and Limitations

This study has several limitations. First, the database was collected from patients who received perfusion imaging and had an LVO and MT at a single center, while the treatment was not randomized, and the sample size was relatively small. Since this was not a randomized controlled trial, treatment bias may have occurred, although we set a strict inclusion criteria. Furthermore, this study represents an incremental, rather than a conceptual, advance over previously published trials. A strength of this study was the provision of real-world data that support the value of perfusion mismatch assessment in patients with LVO who received MT up to 24 hours; perfusion

**Table 2. Association Between Outcomes and the Late Versus Early Time-Window Groups**

	Crude OR (95% CI)	P value	Adjusted OR (95% CI)	P value
Good outcome (mRS 0–2) at 90 d	0.64 (0.28–1.47)	0.30	0.65 (0.26–1.64)	0.37
Excellent outcome (mRS 0–1) at 90 d	0.73 (0.29–1.84)	0.51	0.90 (0.32–2.54)	0.84

Adjusted for sex, large-artery atherosclerosis, time-to-maximum >6 seconds. Modified Rankin Scale is a 7-point disability scale with possible scores ranging from 0 to 6 (0 as no residual symptoms and 6 as diseased). mRS indicates modified Rankin Scale; and OR, odds ratios.

imaging selection in late time windows is currently only performed up to 16 hours. Additionally, final infarct volumes are usually measured at 5 days in clinical trials, while we assessed infarct volume at  $\approx$  14 days, which represents the optimal time to measure the infarction without the effects of edema.

## CONCLUSIONS

Our retrospective findings from a real-world data set setting showed that both early and late time-window patients selected for thrombectomy with automated perfusion imaging had outcomes comparable with those from randomized trials, despite extending the window from 16 to 24 hours. Infarct velocity was significantly different between the 2 groups.

## ARTICLE INFORMATION

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### Affiliations

Department of Cerebrovascular Medicine (M.I., J.K., M.S., M.K., K.T.), Division of Stroke Care Unit (M.I., K.T., H.Y.), Department of Neurology (T.Y., M.I.), Department of Radiology (T.N., Y.O., T.F.), and Department of Neurosurgery (T.S., H.K.), National Cerebral and Cardiovascular Center, Suita, Japan; Department of Stroke Neurology, National Hospital Organization Osaka National Hospital, Osaka, Japan (H.Y.); and Stanford Stroke Center, Stanford University, Stanford, CA (M.M., G.W.A.).

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### Disclosures

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